# TEST REPORT

FCC SAR Test for TVJLPENN5E2
Certification

**APPLICANT**
LG Electronics Inc.

**REPORT NO.**
HCT-SR-2503-FC004-R4

**DATE OF ISSUE**
April 10, 2025

**Tested by**
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**Technical Manager**
Yun Jeang Heo

Accredited by KOLAS, Republic of KOREA

HCT CO., LTD.
BongJai Huh / CEO



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# TEST REPORT

FCC SAR Test for certification

REPORT NO.
**HCT-SR-2503-FC004-R4**

DATE OF ISSUE
**Apr. 10, 2025**

FCC ID
**BEJTVJLPENN5E2**

| | |
|---|---|
| Applicant | **LG Electronics Inc.**<br>128, Yeoui-daero, Yeongdeungpo-gu, Seoul, Republic of Korea |
| Product Name<br>Model Name | Telematics<br>TVJLPENN5E2 |
| Date of Test | Mar. 13, 2025 |
| Location of Test | ■ Permanent Testing Lab ☐ On Site Testing Lab<br>(Address: 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383 KOREA) |
| FCC Rule Part(s) | CFR § 2.1093 |
| Test Results | PASS (SAR Limit : 1.6 W/kg)<br>Refer to the clause 3.2 Attestation of test result |

## REVISION HISTORY

The revision history for this test report is shown in table.

| Revision No. | Date of Issue | Description |
|---|---|---|
| 0 | Mar. 25, 2025 | Initial Release |
| 1 | Mar. 27, 2025 | Revised page. 7, 9, 13, 14, 30, 31, 32, 33 |
| 2 | Mar. 28, 2025 | Revised page. 7, 9, Sec. 14.1.1 |
| 3 | Apr. 01, 2025 | Revised Sec 3, 4, 7, 14, 16, 17 |
| 4 | Apr. 10, 2025 | Revised Product Name |

## Notice

| Content |
|---|
| The results shown in this test report only apply to the sample(s), as received, provided by the applicant, unless otherwise stated.<br>The test results have only been applied with the test methods required by the standard(s).<br>The laboratory is not accredited for the test results marked *.<br>Information provided by the applicant is marked **.<br>Test results provided by external providers are marked ***.<br><br>When confirmation of authenticity of this test report is required, please contact www.hct.co.kr<br><br>The test results in this test report are not associated with the ((KS Q) ISO/IEC 17025) accreditation by KOLAS (Korea Laboratory Accreditation Scheme) / A2LA (American Association for Laboratory Accreditation) that are under the ILAC (International Laboratory Accreditation Cooperation) Mutual Recognition Agreement (MRA). |

# CONTENTS

# 1. Test Regulations

The tests documented in this report were performed in accordance with FCC CFR § 2.1093, IEEE 1528-2013, ANSI C63.26-2015 the following FCC Published RF exposure KDB procedures:

- FCC KDB Publication 941225 D05 SAR for LTE Devices v02r05
- FCC KDB Publication 941225 D05A LTE Rel.10 KDB Inquiry sheet v01r02
- FCC KDB Publication 248227 D01 802.11 Wi-Fi SAR v02r02
- FCC KDB Publication 447498 D01 General RF Exposure Guidance v06
- FCC KDB Publication 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- FCC KDB Publication 865664 D02 SAR Reporting v01r02
- FCC KDB Publication 690783 D01 SAR Listings on Grants v01r03
- FCC KDB Publication 971168 D01 Power Meas License Digital Systems v03r01

In Addition to the above, the following information was used.

- April 2015 TCB Workshop Notes (Simultaneous transmission summation clarified)

# 2. Test Location

## 2.1 Test Laboratory

| | |
|---|---|
| Company Name | HCT Co., Ltd. |
| Address | 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si,Gyeonggi-do, 17383 KOREA |
| Telephone | 031-645-6300 |
| Fax. | 031-645-6401 |

## 2.2 Test Facilities

Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

| | |
|---|---|
| Korea | National Radio Research Agency (Designation No. KR0032) |
| | KOLAS (Testing No. KT197) |

# 3. Information of the EUT

## 3.1 General Information of the EUT

| | |
|---|---|
| **Model Name** | TVJLPENN5E2 |
| **Equipment Type** | Telematics |
| **FCC ID** | BEJTVJLPENN5E2 |
| **Application Type** | Certification |
| **Applicant** | LG Electronics Inc. |

## 3.2 Attestation of test result of device under test

| The Highest Reported SAR | | | |
|---|---|---|---|
| Band | Tx. Frequency | Equipment Class | Reported SAR (W/kg) 1 g Body |
| C-V2X | 5 900 ㎒~5 920 ㎒ | CVO | 0.000 |
| 2.4 ㎓ WLAN | 2 412 ㎒~ 2 462 ㎒ | DTS | 0.134 |
| U-NII-1 | 5 180 ㎒~ 5 240 ㎒ | NII | 0.069 |
| U-NII-3 | 5 745 ㎒~ 5 825 ㎒ | NII | 0.073 |
| Simultaneous SAR per KDB 690783 D01v01r03 | | | **0.307** |
| TER(Total Exposure Ratio) | | | **0.217** |
| Date(s) of Tests: | Mar. 13, 2025 | | |

# 4. Device Under Test Description

## 4.1 DUT specification

| Device Wireless specification overview | | |
|---|---|---|
| **Band & Mode** | **Operating Mode** | **Tx Frequency** |
| GSM850 | Data | 824.2 MHz ~ 848.8 MHz |
| GSM1900 | Data | 1 850.2 MHz ~ 1 909.8 MHz |
| UMTS Band 2 | Data | 1 852.4 MHz ~ 1 907.6 MHz |
| UMTS Band 4 | Data | 1 712.4 MHz ~ 1 752.6 MHz |
| UMTS Band 5 | Data | 826.4 MHz ~ 846.6 MHz |
| LTE FDD Band 2 (PCS) | Data | 1 850.7 MHz ~ 1 909.3 MHz |
| LTE FDD Band 4 (AWS) | Data | 1 710.7 MHz ~ 1 754.3 MHz |
| LTE FDD Band 5 (Cell) | Data | 824.7 MHz ~ 848.3 MHz |
| LTE FDD Band 7 | Data | 2 502.5 MHz ~ 2 567.5 MHz |
| LTE FDD Band 12 | Data | 699.7 MHz ~ 715.3 MHz |
| LTE FDD Band 13 | Data | 779.5 MHz ~ 784.5 MHz |
| LTE FDD Band 14 | Data | 790.5 MHz ~ 795.5 MHz |
| LTE FDD Band 17 | Data | 706.5 MHz ~ 713.5 MHz |
| LTE FDD Band 25 | Data | 1 850.7 MHz ~ 1 914.3 MHz |
| LTE FDD Band 26 | Data | 814.7 MHz ~ 848.3 MHz |
| LTE TDD Band 38 | Data | 2 572.5 MHz ~ 2 617.5 MHz |
| LTE TDD Band 41 | Data | 2 498.5 MHz ~ 2 687.5 MHz |
| LTE TDD Band 42 | Data | 3 402.5 MHz ~ 3 547.5 MHz |
| LTE FDD Band 66 (AWS) | Data | 1 710.7 MHz ~ 1 779.3 MHz |
| C-V2X | Data | 5 900 MHz ~ 5920 MHz |
| NR FDD Band n2 (PCS) | Data | 1 852.5 MHz ~ 1 907.5 MHz |
| NR FDD Band n5 | Data | 826.5 MHz ~ 846.5 MHz |
| NR FDD Band n7 | Data | 2 502.5 MHz ~ 2 567.5 MHz |
| NR FDD Band n12 | Data | 701.5 MHz ~ 713.5 MHz |
| NR FDD Band n13 | Data | 779.5 MHz ~ 784.5 MHz |
| NR FDD Band n14 | Data | 790.5 MHz ~795.5 MHz |
| NR FDD Band n25 (PCS) | Data | 1 852.5 MHz ~ 1 912.5 MHz |
| NR FDD Band n26 | Data | 816.5 MHz ~ 846.5 MHz |
| NR TDD Band n38 | Data | 2 575 MHz ~ 2 615 MHz |
| NR TDD Band n41 | Data | 2 501.01 MHz ~ 2 685 MHz |
| NR FDD Band n66 | Data | 1 712.5 MHz ~ 1 777.5 MHz |
| NR FDD Band n71 | Data | 665.5 MHz ~ 695.5 MHz |
| NR TDD Band n77 | Data | 3 710.01 MHz ~ 3 969.99 MHz |
| NR TDD Band n77 DoD | Data | 3 460.02 MHz ~ 3 540 MHz |
| NR TDD Band n78 | Data | 3 710.01 MHz ~ 3 789.99 MHz |
| NR TDD Band n78 DoD | Data | 3 460.02 MHz ~ 3 540 MHz |
| 2.4 GHz WLAN | Data | 2 412 MHz~ 2 462 MHz |
| U-NII-1 | Data | 5 180 MHz~ 5 240 MHz |
| U-NII-3 | Data | 5 745 MHz~ 5 825 MHz |

| Device Description | | |
|---|---|---|
| | **Mode** | **Serial Number** |
| Device Serial Numbers | C-V2X | 410VIXV000308 |
| | | 501VIXV900167 |
| | The manufacturer has confirmed that the devices tested have the same physical, mechanical and thermal characteristics are within operational tolerances expected for production units. | |

Note : WWAN, CV2X (Ant1)SAR testing results were referred to SAR Test Report, Report No.HCT-SR-2503-FC002-R2 and also perform simultaneous transmission analysis.

## 4.2 Nominal and 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 D01v06.

### 4.2.1 4G Nominal Output Power

**A. C-V2X Modes**

| Mode / Band | | Max. Modulated Average (dBm) |
|---|---|---|
| C-V2X | SISO Maximum | 23.3 |
| | SISO Nominal | 21.3 |
| | MIMO Maximum | 23.3 |
| | MIMO Nominal | 21.3 |

**Tolerance: -2.0 dB ~ +2.0 dB**

### 4.2.2 WLAN Nominal Output Power

**A. WLAN Modes**

| Mode / Band | | Max. Modulated Average (dBm) |
|---|---|---|
| 2.4G WLAN | Maximum | 13.5 |
| | Nominal | 11.5 |
| 5G WLAN | Maximum | 9.0 |
| | Nominal | 7.0 |

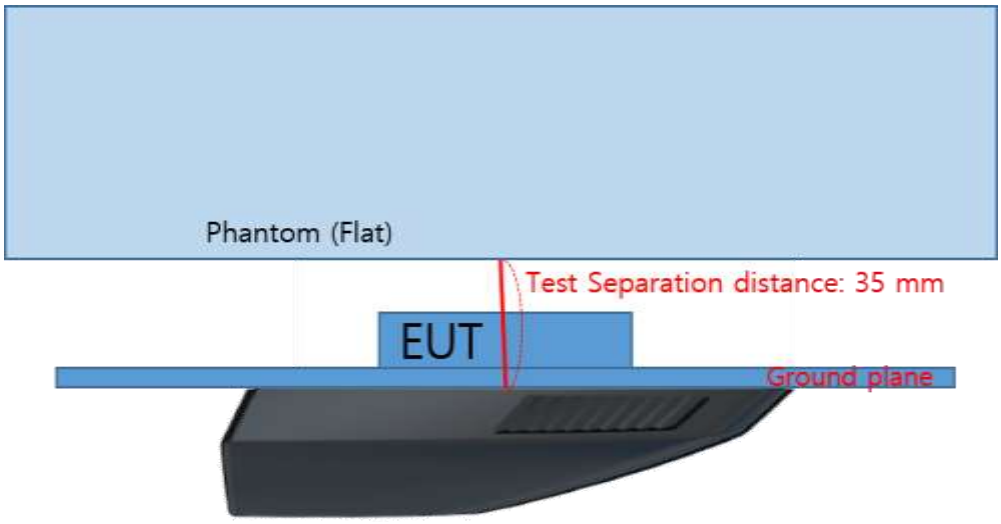
**Tolerance: -2.0 dB ~ +2.0 dB**

## 4.3 C-V2X Information

| Item. | | Description |
|---|---|---|
| Frequency Range | C-V2X | 5 900 ㎒ ~ 5 920 ㎒ |
| Channel Bandwidths | C-V2X | 10 ㎒,20 ㎒ |

| Ch. No.& Freq.(㎒) | | Low / Low-Mid | Mid | Mid-High / High |
|---|---|---|---|---|
| C-V2X | 10 ㎒ | 5 900(54990) | 5 910(55090) | 5 920(55190) |
| | 20 ㎒ | | 5 910(55090) | |
| UE Category | | Rel. 15, DL: Category 19, UL: Category 16 | | |
| Modulations Supported in UL | | QPSK, 16QAM, 64QAM | | |

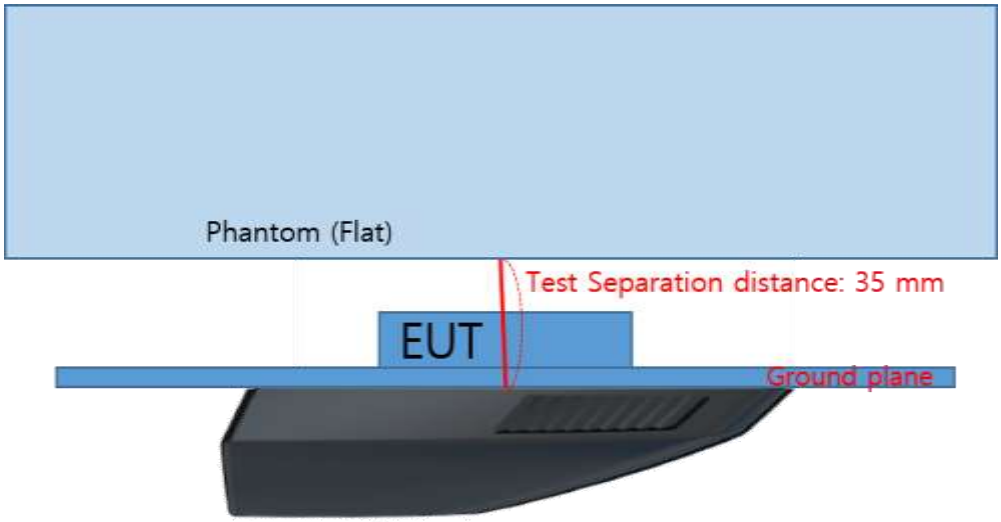
## 4.4 DUT Antenna Locations



# 5. SAR Test Considerations

## 5.1 Test requirements Per KDB Publication 447498 D01v06 and 616217 D04v01r02.

The required minimum test separation distance for incorporating transmitters and antennas is determined with user.




### Test Configurations

| Test Configurations | Antenna-to-edge/surface | SAR Required | Note |
|---|---|---|---|
| Rear | 35.0 mm | Yes | The test separation distance is normally determined by the closest distance between the antenna and the user. |

## 6. SAR Summation Scenario


Simultaneous transmission paths

This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB 447498 D01v06.

| Simultaneous Transmission Scenarios | |
|---|---|
| Applicable Combination | Exposure Condition |
| GSM + 2.4 GHz Wi-Fi | Yes |
| UMTS + 2.4 GHz Wi-Fi | Yes |
| LTE + 2.4 GHz Wi-Fi | Yes |
| NR + 2.4 GHz Wi-Fi | Yes |
| LTE + NR + 2.4 GHz Wi-Fi | Yes |
| GSM + 5 GHz Wi-Fi | Yes |
| UMTS + 5 GHz Wi-Fi | Yes |
| LTE + 5 GHz Wi-Fi | Yes |
| NR + 5 GHz Wi-Fi | Yes |
| LTE + NR + 5 GHz Wi-Fi | Yes |
| GSM + 5 GHz Wi-Fi + C-V2X | Yes |
| UMTS + 5 GHz Wi-Fi + C-V2X | Yes |
| LTE + 5 GHz Wi-Fi + C-V2X | Yes |
| NR + 5 GHz Wi-Fi + C-V2X | Yes |
| LTE + NR+5 GHz Wi-Fi + C-V2X | Yes |
| GSM + 2.4 GHz Wi-Fi + C-V2X | Yes |
| UMTS + 2.4 GHz Wi-Fi + C-V2X | Yes |
| LTE + 2.4 GHz Wi-Fi + C-V2X | Yes |
| NR + 2.4 GHz Wi-Fi + C-V2X | Yes |
| LTE + NR + 2.4 GHz Wi-Fi + C-V2X | Yes |
| 2.4 GHz Wi-Fi + C-V2X | Yes |
| 5 GHz Wi-Fi + C-V2X | Yes |

1. The highest reported SAR for each exposure condition is used for SAR summation purpose.

## 7. SAR Test Exclusion Applied

### SAR Test Exclusion Calculation for antennas <50mm

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

$$\frac{Max\ Power\ of\ Channel(mW)}{Test\ \ Separation\ Distance\ (mm)} * \sqrt{Frequency(GHz)} \leq\ 3.0 \text{ for } 1-\text{g SAR}$$

| Mode | Frequency | Maximum Allowed Power | Separation Distance | ≤ 3.0 for 1g SAR | SAR Test |
|---|---|---|---|---|---|
| | [MHz] | [mW] | [mm] | | |
| C-V2X | 5 920 | 199 | 35 | 13.82 | YES |
| 2.4G WLAN | 2 462 | 22 | 35 | 1.00 | No |
| 5G WLAN | 5 240 | 8 | 35 | 0.52 | No |
| 5G WLAN | 5 825 | 8 | 35 | 0.55 | No |

Based on the maximum conducted power of Bluetooth and antenna to use separation distance, 2.4G WLAN SAR was not required [(25/35)*√2.462] = 1.13 < 3.0 and 5G WLAN SAR [(8/35)*√5.240] = 0.52 < 3.0, [(8/35)*√5.825] = 0.55 < 3.0

This device contains transmitters that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v06 IV.C.1iii, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤ 1.6W/kg. When standalone SAR is not required to be measured per FCC KDB 447498 D01v06 4.3.22, the following equation must be used to estimate the standalone 1-g SAR and 10g SAR for simultaneous transmission assessment involving that transmitter.

$$Estimated\ SAR = \frac{\sqrt{f(GHZ)}}{7.5} * \frac{(Max\ Power\ of\ channel\ mW)}{Min\ Seperation\ Distance}.$$

Estimated 1-g SAR

| Mode | Frequency | Maximum Allowed Power | Separation Distance | Estimated 1g SAR |
|---|---|---|---|---|
| | [MHz] | [mW] | [mm] | [W/kg] |
| 2.4G WLAN | 2 462 | 22 | 35 | 0.134 |

| Mode | Frequency | Maximum Allowed Power | Separation Distance | Estimated 1g SAR |
|---|---|---|---|---|
| | [MHz] | [mW] | [mm] | [W/kg] |
| 5G WLAN | 5 240 | 8 | 35 | 0.069 |
| 5G WLAN | 5 825 | 8 | 35 | 0.073 |

# 8. Introduction

The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency radiation in ET Docket 93-62 on Aug. 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices.

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York 10017. The measurement procedure described in IEEE/ANSI C95.3-1992 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave is used for guidance in measuring SAR due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in Biological Effects and Exposure Criteria for Radio Frequency Electromagnetic Fields," NCRP Report No. 86 NCRP, 1986, Bethesda, MD 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.

**SAR Definition**

Specific Absorption Rate (SAR) is defined as the time derivative of the incremental electromagnetic energy (d*W*) absorbed by (dissipated in) an incremental mass (d*m*) contained in a volume element (d*V*) of a given density (*r*). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body.

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

Figure 1. SAR Mathematical Equation

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

Where:
= conductivity of the tissue-simulant material (S/m)
= mass density of the tissue-simulant material (kg/m³)
= Total RMS electric field strength (V/m)

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

# 9. Description of test equipment

## 9.1 SAR MEASUREMENT SETUP

These measurements are performed using the DASY4 automated dosimetric assessment system. It is made by Schmid& Partner Engineering AG (SPEAG) in Zurich, Switzerland. It consists of high precision robotics system (Staubli), robot controller, Pentium III computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Figure.2).

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The PC with Windows XP or Windows 7 or Window 10 or Window 11 is working with SAR Measurement system DASY4 & DASY5 & DASY6 &DASY8 A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

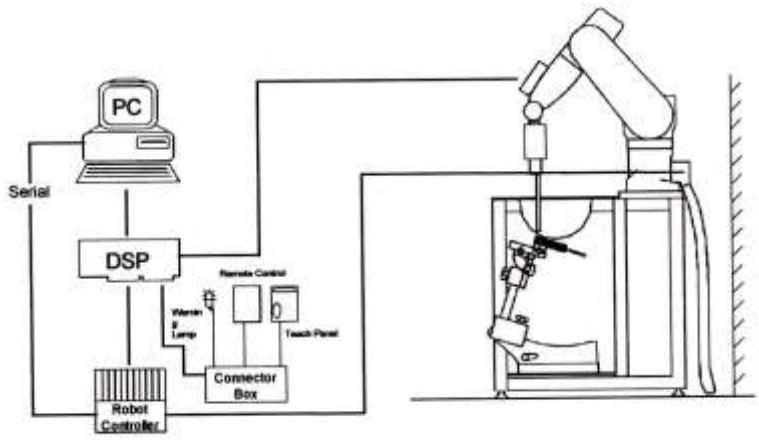



Figure 2. HCT SAR Lab. Test Measurement Set-up

The DAE consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in.

## 10. SAR Measurement Procedure

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

1. The SAR distribution at the exposed side of the head or body was measured at a distance no more than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the DUT's head and body area and the horizontal grid resolution was depending on the FCC KDB 865664 D01v01r04 table 4-1 & IEEE 1528-2013.

2. Based on step, the area of the maximum absorption was determined by sophisticated interpolations routines implemented in DASY software. When an Area Scan has measured all reachable point. DASY system computes the field maximal found in the scanned are, within a range of the maximum. SAR at this fixed point was measured and used as a reference value.

3. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB 865664 D01v01r04 table 4-1 and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (reference from the DASY manual.)

   a. The data at the surface were extrapolated, since the center of the dipoles is no more than 2.7 ㎜ away from the tip of the probe (it is different from the probe type) and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

   b. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed using the 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y, and z directions. The volume was integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.

   **c**. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan. If the value changed by more than 5 %, the SAR evaluation and drift measurements were repeated.

Area scan and zoom scan resolution setting follow KDB 865664 D01v01r04 quoted below.

<table>
<tr><td colspan="3"></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5±1 mm</td><td>·δ·ln(2)±0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30°±1°</td><td>20°±1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan Spatial resolution: $\Delta x_{Area}, \Delta y_{Area}$</td><td>≤ 2 GHz: ≤15 mm<br>2-3 GHz: ≤12 mm</td><td>3-4 GHz: ≤12 mm<br>4-6 GHz: ≤10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan Spatial resolution: $\Delta x_{zoom}, \Delta y_{zoom}$</td><td>≤ 2 GHz: ≤8mm<br>2-3 GHz: ≤5mm*</td><td>3-4 GHz: ≤5 mm*<br>4-6 GHz: ≤4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan Spatial resolution normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{zoom}(n)$</td><td>≤ 5 mm</td><td>3-4 GHz: ≤4 mm<br>4-5 GHz: ≤3 mm<br>5-6 GHz: ≤2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{zoom}(1)$: between1st two Points closest to phantom surface</td><td>≤ 4 mm</td><td>3-4 GHz: ≤3 mm<br>4-5 GHz: ≤2.5 mm<br>5-6 GHz: ≤2 mm</td></tr>
<tr><td>$\Delta z_{zoom}(n>1)$: between subsequent Points</td><td colspan="2">≤1.5·$\Delta z_{zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3-4 GHz: ≥28 mm<br>4-5 GHz: ≥25 mm<br>5-6 GHz: ≥22 mm</td></tr>
<tr><td colspan="5">Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.<br>* When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

## 11. RF EXPOSURE LIMITS

| HUMAN EXPOSURE | UNCONTROLLED ENVIRONMENT General Population | CONTROLLED ENVIRONMENT Occupational |
|---|---|---|
| | W/kg | W/kg |
| The SAR averaged over the whole body mass. | 0.08 | 0.4 |
| The peak spatially-averaged SAR for the head, neck and trunk, averaged over any 1 g of tissue* | 1.6 | 8 |
| The peak spatially-averaged SAR in the limbs, averaged over any 10 g of tissue* | 4 | 20 |

NOTES:

* The Spatial Peak value of the SAR averaged over any 1 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

** The Spatial Average value of the SAR averaged over the whole-body.

*** The Spatial Peak value of the SAR averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

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

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

# 12. SAR Test Considerations

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

## 12.1 Licensed Transmitter(s)

LTE SAR for the higher modulations and lower Bandwidths were not tested since the maximum average output power of all required channels and configurations was not more than 0.5 dB higher than the highest Bandwidth; and the reported LTE SAR for the highest Bandwidth was less than 1.45 W/kg for all configurations according to FCC KDB 941225 D05v02r05.

This Device supports 64QAM on the uplink and 64QAM on the downlink for LTE Operations. Conducted powers for 64QAM uplink configurations were measured per section 5.1 of FCC KDB 941225 D05v02r05. SAR was not required for 64QAM since the highest maximum output power for 64QAM is ≤ 0.5dB higher than the same configuration in QPSK and the reported SAR for QPSK configuration is ≤1.45 W/Kg, per section 5.2.4 for FCC KDB941225 D05v02r05.

# 13. 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 D01v06.

## Licensed Bands

| Test Description | Test Procedure Used |
|---|---|
| Conducted Output Power | - KDB 971168 D01 v03r01 – Section 5.2.4<br>- ANSI C63.26-2015 – Section 5.2.1 & 5.2.4.2 |

## Test Overview

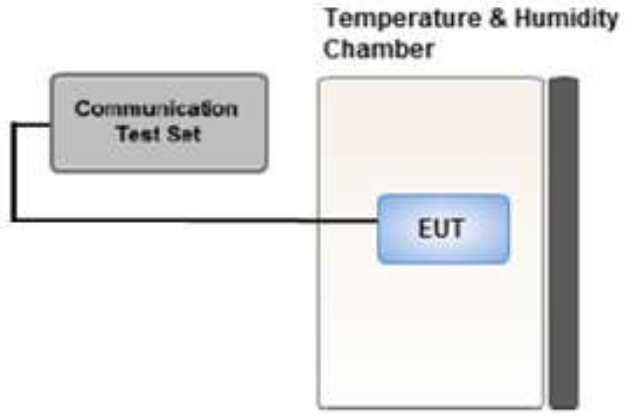
According to ANSI C63.26-2015 Section 5.2.1 when measuring the maximum RF output power from such devices, control over the EUT must be provided either through special test software (provided by manufacturer specifically for compliance testing, but not accessible by an end user) or through use of a base station emulator, communications test set, call box, or similar instrumentation that is capable of establishing a communications link with the EUT to enable control over variable parameters (e.g., output power, OBW, etc.).

In some cases, these instruments also include basic digital spectrum analyzer and/or power meter capabilities that can be utilized to measure the RF output power if the specified detectors and requirements can be realized and the measurement functions have been calibrated.

## Test Procedure

1. The RF port of the EUT was connected to the Communication Tester via an RF cable.
2. Conducted average power was measured using a calibrated Radio Communication Tester.

## Test setup



# 14.Maximum Output Power

## 14.1 C-V2X Maximum Conducted Output Power

### 14.1.1 C-V2X B47 Maximum Conducted Output Power

### C-V2X 10 MHz Bandwidth Conducted Power (Ant.1)

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power [dBm] | | | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|---|---|---|---|---|---|---|---|---|
| | | | | 54990Ch. 5 900 MHz | 55090 Ch. 5 910 MHz | 55190 Ch. 5 920 MHz | | |
| 10 MHz | QPSK | 1 | 2 | 23.04 | 22.94 | 22.53 | 0 | 0 |
| | | 1 | 25 | 23.05 | 22.82 | 22.45 | 0 | 0 |
| | | 1 | 48 | 22.89 | 22.63 | 22.33 | 0 | 0 |
| | | 25 | 2 | 22.19 | 21.95 | 21.64 | 0 | 0 |
| | | 25 | 12 | 22.14 | 21.91 | 21.61 | 0 | 0 |
| | | 25 | 23 | 22.08 | 21.88 | 21.54 | 0 | 0 |
| | | 48 | 2 | 22.16 | 21.92 | 21.56 | 0-1 | 1 |
| | 16QAM | 1 | 2 | 22.04 | 21.80 | 21.45 | 0-1 | 1 |
| | | 1 | 25 | 21.85 | 21.60 | 21.24 | 0-1 | 1 |
| | | 1 | 48 | 21.82 | 21.51 | 21.26 | 0-1 | 1 |
| | | 25 | 2 | 21.23 | 20.97 | 20.68 | 0-1 | 1 |
| | | 25 | 12 | 21.20 | 20.93 | 20.68 | 0-1 | 1 |
| | | 25 | 23 | 21.12 | 20.86 | 20.57 | 0-1 | 1 |
| | | 48 | 2 | 21.19 | 20.94 | 20.54 | 0-2 | 2 |
| | 64QAM | 1 | 2 | 21.18 | 20.92 | 20.60 | 0-2 | 2 |
| | | 1 | 25 | 21.02 | 20.70 | 20.39 | 0-2 | 2 |
| | | 1 | 48 | 20.98 | 20.64 | 19.70 | 0-2 | 2 |
| | | 25 | 2 | 20.29 | 19.97 | 20.01 | 0-2 | 2 |
| | | 25 | 12 | 20.28 | 19.99 | 19.71 | 0-2 | 2 |
| | | 25 | 23 | 20.12 | 19.87 | 19.61 | 0-2 | 2 |
| | | 48 | 2 | 20.23 | 19.90 | 19.62 | 0-3 | 3 |

## C-V2X 20 MHz Bandwidth Conducted Power (Ant.1)

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power [dBm] | | | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|---|---|---|---|---|---|---|---|---|
| | | | | | 55090 Ch. 5 910 MHz | | | |
| 20 MHz | QPSK | 1 | 2 | | 23.05 | | 0 | 0 |
| | | 1 | 50 | | 22.73 | | 0 | 0 |
| | | 1 | 96 | | 22.46 | | 0 | 0 |
| | | 48 | 2 | | 22.16 | | 0-1 | 1 |
| | | 48 | 24 | | 22.02 | | 0-1 | 1 |
| | | 48 | 47 | | 21.84 | | 0-1 | 1 |
| | | 96 | 2 | | 22.01 | | 0-1 | 1 |
| | 16QAM | 1 | 2 | | 21.98 | | 0-1 | 1 |
| | | 1 | 50 | | 21.70 | | 0-1 | 1 |
| | | 1 | 96 | | 21.36 | | 0-1 | 1 |
| | | 48 | 2 | | 21.16 | | 0-2 | 2 |
| | | 48 | 24 | | 20.39 | | 0-2 | 2 |
| | | 48 | 47 | | 20.82 | | 0-2 | 2 |
| | | 96 | 2 | | 20.97 | | 0-2 | 2 |
| | 64QAM | 1 | 2 | | 21.13 | | 0-2 | 2 |
| | | 1 | 50 | | 20.85 | | 0-2 | 2 |
| | | 1 | 96 | | 20.53 | | 0-2 | 2 |
| | | 48 | 2 | | 20.12 | | 0-3 | 3 |
| | | 48 | 24 | | 20.00 | | 0-3 | 3 |
| | | 48 | 47 | | 19.77 | | 0-3 | 3 |
| | | 96 | 2 | | 20.03 | | 0-3 | 3 |

## C-V2X 10 ㎒ Bandwidth Conducted Power (Ant.2)

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power [dBm] | | | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|---|---|---|---|---|---|---|---|---|
| | | | | 54990Ch. 5 900 ㎒ | 55090 Ch. 5 910 ㎒ | 55190 Ch. 5 920 ㎒ | | |
| 10 ㎒ | QPSK | 1 | 2 | 22.86 | 23.10 | 23.00 | 0 | 0 |
| | | 1 | 25 | 23.01 | 23.19 | 23.13 | 0 | 0 |
| | | 1 | 48 | 22.98 | 23.21 | 23.27 | 0 | 0 |
| | | 25 | 2 | 21.96 | 22.17 | 22.29 | 0 | 0 |
| | | 25 | 12 | 22.10 | 22.11 | 22.27 | 0 | 0 |
| | | 25 | 23 | 22.02 | 22.19 | 22.27 | 0 | 0 |
| | | 48 | 2 | 22.10 | 22.26 | 22.13 | 0-1 | 1 |
| | 16QAM | 1 | 2 | 21.72 | 21.88 | 21.73 | 0-1 | 1 |
| | | 1 | 25 | 21.87 | 21.85 | 21.82 | 0-1 | 1 |
| | | 1 | 48 | 22.01 | 22.18 | 21.87 | 0-1 | 1 |
| | | 25 | 2 | 21.03 | 21.26 | 21.21 | 0-1 | 1 |
| | | 25 | 12 | 21.12 | 21.17 | 21.24 | 0-1 | 1 |
| | | 25 | 23 | 21.17 | 21.26 | 21.27 | 0-1 | 1 |
| | | 48 | 2 | 21.00 | 21.27 | 21.13 | 0-2 | 2 |
| | 64QAM | 1 | 2 | 20.76 | 20.88 | 21.24 | 0-2 | 2 |
| | | 1 | 25 | 20.74 | 20.93 | 21.28 | 0-2 | 2 |
| | | 1 | 48 | 20.89 | 21.15 | 21.26 | 0-2 | 2 |
| | | 25 | 2 | 19.92 | 20.20 | 20.24 | 0-2 | 2 |
| | | 25 | 12 | 20.00 | 20.23 | 20.29 | 0-2 | 2 |
| | | 25 | 23 | 20.10 | 20.09 | 20.26 | 0-2 | 2 |
| | | 48 | 2 | 20.11 | 20.26 | 20.27 | 0-3 | 3 |

## C-V2X 20 MHz Bandwidth Conducted Power (Ant.2)

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power [dBm] | | | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|---|---|---|---|---|---|---|---|---|
| | | | | | 55090 Ch. 5 910 MHz | | | |
| 20 MHz | QPSK | 1 | 2 | | 23.01 | | 0 | 0 |
| | | 1 | 50 | | 22.99 | | 0 | 0 |
| | | 1 | 96 | | 23.28 | | 0 | 0 |
| | | 48 | 2 | | 22.22 | | 0-1 | 1 |
| | | 48 | 24 | | 22.27 | | 0-1 | 1 |
| | | 48 | 47 | | 22.27 | | 0-1 | 1 |
| | | 96 | 2 | | 22.22 | | 0-1 | 1 |
| | 16QAM | 1 | 2 | | 21.98 | | 0-1 | 1 |
| | | 1 | 50 | | 22.05 | | 0-1 | 1 |
| | | 1 | 96 | | 22.03 | | 0-1 | 1 |
| | | 48 | 2 | | 21.29 | | 0-2 | 2 |
| | | 48 | 24 | | 21.18 | | 0-2 | 2 |
| | | 48 | 47 | | 21.21 | | 0-2 | 2 |
| | | 96 | 2 | | 21.25 | | 0-2 | 2 |
| | 64QAM | 1 | 2 | | 20.90 | | 0-2 | 2 |
| | | 1 | 50 | | 20.96 | | 0-2 | 2 |
| | | 1 | 96 | | 21.04 | | 0-2 | 2 |
| | | 48 | 2 | | 20.11 | | 0-3 | 3 |
| | | 48 | 24 | | 20.19 | | 0-3 | 3 |
| | | 48 | 47 | | 20.23 | | 0-3 | 3 |
| | | 96 | 2 | | 20.19 | | 0-3 | 3 |

## C-V2X 10 ㎒ Bandwidth Conducted Power (MIMO Ant.1)

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power [dBm] | | | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|---|---|---|---|---|---|---|---|---|
| | | | | 54990Ch. 5 900 ㎒ | 55090 Ch. 5 910 ㎒ | 55190 Ch. 5 920 ㎒ | | |
| 10 ㎒ | QPSK | 1 | 2 | 19.41 | 19.31 | 18.83 | 0 | 0 |
| | | 1 | 25 | 19.55 | 19.13 | 18.60 | 0 | 0 |
| | | 1 | 48 | 19.19 | 19.04 | 18.50 | 0 | 0 |
| | | 25 | 2 | 18.59 | 18.26 | 17.91 | 0 | 0 |
| | | 25 | 12 | 18.45 | 18.30 | 17.91 | 0 | 0 |
| | | 25 | 23 | 18.45 | 18.35 | 17.80 | 0 | 0 |
| | | 48 | 2 | 18.58 | 18.32 | 17.71 | 0-1 | 1 |
| | 16QAM | 1 | 2 | 18.50 | 18.26 | 17.57 | 0-1 | 1 |
| | | 1 | 25 | 18.28 | 18.01 | 17.52 | 0-1 | 1 |
| | | 1 | 48 | 18.12 | 17.64 | 17.45 | 0-1 | 1 |
| | | 25 | 2 | 17.70 | 17.37 | 16.92 | 0-1 | 1 |
| | | 25 | 12 | 17.53 | 17.31 | 16.86 | 0-1 | 1 |
| | | 25 | 23 | 17.57 | 17.18 | 16.87 | 0-1 | 1 |
| | | 48 | 2 | 17.68 | 17.43 | 16.68 | 0-2 | 2 |
| | 64QAM | 1 | 2 | 17.53 | 17.33 | 16.80 | 0-2 | 2 |
| | | 1 | 25 | 17.50 | 17.16 | 16.64 | 0-2 | 2 |
| | | 1 | 48 | 17.40 | 17.01 | 15.68 | 0-2 | 2 |
| | | 25 | 2 | 16.63 | 16.32 | 16.28 | 0-2 | 2 |
| | | 25 | 12 | 16.74 | 16.39 | 15.93 | 0-2 | 2 |
| | | 25 | 23 | 16.50 | 16.37 | 15.82 | 0-2 | 2 |
| | | 48 | 2 | 16.72 | 16.35 | 15.79 | 0-3 | 3 |

### C-V2X 20 ㎒ Bandwidth Conducted Power (MIMO_Ant.1)

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power [dBm] | | | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|---|---|---|---|---|---|---|---|---|
| | | | | | 55090 Ch. 5 910 ㎒ | | | |
| 20 ㎒ | QPSK | 1 | 2 | | 19.54 | | 0 | 0 |
| | | 1 | 50 | | 19.10 | | 0 | 0 |
| | | 1 | 96 | | 18.86 | | 0 | 0 |
| | | 48 | 2 | | 18.58 | | 0-1 | 1 |
| | | 48 | 24 | | 18.39 | | 0-1 | 1 |
| | | 48 | 47 | | 18.34 | | 0-1 | 1 |
| | | 96 | 2 | | 18.51 | | 0-1 | 1 |
| | 16QAM | 1 | 2 | | 18.45 | | 0-1 | 1 |
| | | 1 | 50 | | 18.07 | | 0-1 | 1 |
| | | 1 | 96 | | 17.55 | | 0-1 | 1 |
| | | 48 | 2 | | 17.57 | | 0-2 | 2 |
| | | 48 | 24 | | 16.61 | | 0-2 | 2 |
| | | 48 | 47 | | 17.32 | | 0-2 | 2 |
| | | 96 | 2 | | 17.47 | | 0-2 | 2 |
| | 64QAM | 1 | 2 | | 17.54 | | 0-2 | 2 |
| | | 1 | 50 | | 17.30 | | 0-2 | 2 |
| | | 1 | 96 | | 17.00 | | 0-2 | 2 |
| | | 48 | 2 | | 16.57 | | 0-3 | 3 |
| | | 48 | 24 | | 16.31 | | 0-3 | 3 |
| | | 48 | 47 | | 16.19 | | 0-3 | 3 |
| | | 96 | 2 | | 16.53 | | 0-3 | 3 |

## C-V2X 10 ㎒ Bandwidth Conducted Power (MIMO Ant.2)

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power [dBm] | | | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|---|---|---|---|---|---|---|---|---|
| | | | | 54990Ch. 5 900 ㎒ | 55090 Ch. 5 910 ㎒ | 55190 Ch. 5 920 ㎒ | | |
| 10 ㎒ | QPSK | 1 | 2 | 19.78 | 20.04 | 19.88 | 0 | 0 |
| | | 1 | 25 | 20.10 | 20.17 | 20.03 | 0 | 0 |
| | | 1 | 48 | 19.88 | 20.11 | 19.87 | 0 | 0 |
| | | 25 | 2 | 18.96 | 19.14 | 19.03 | 0 | 0 |
| | | 25 | 12 | 19.10 | 19.19 | 19.06 | 0 | 0 |
| | | 25 | 23 | 19.10 | 19.21 | 19.07 | 0 | 0 |
| | | 48 | 2 | 19.16 | 19.29 | 19.02 | 0-1 | 1 |
| | 16QAM | 1 | 2 | 18.82 | 18.98 | 18.59 | 0-1 | 1 |
| | | 1 | 25 | 18.85 | 18.88 | 18.61 | 0-1 | 1 |
| | | 1 | 48 | 19.02 | 19.11 | 18.69 | 0-1 | 1 |
| | | 25 | 2 | 18.10 | 18.35 | 18.08 | 0-1 | 1 |
| | | 25 | 12 | 18.22 | 18.22 | 18.05 | 0-1 | 1 |
| | | 25 | 23 | 18.25 | 18.27 | 17.97 | 0-1 | 1 |
| | | 48 | 2 | 18.08 | 18.23 | 17.93 | 0-2 | 2 |
| | 64QAM | 1 | 2 | 17.70 | 17.93 | 17.98 | 0-2 | 2 |
| | | 1 | 25 | 17.71 | 17.84 | 17.97 | 0-2 | 2 |
| | | 1 | 48 | 17.87 | 18.03 | 17.50 | 0-2 | 2 |
| | | 25 | 2 | 16.87 | 17.19 | 17.01 | 0-2 | 2 |
| | | 25 | 12 | 17.05 | 17.31 | 17.00 | 0-2 | 2 |
| | | 25 | 23 | 17.02 | 17.18 | 17.13 | 0-2 | 2 |
| | | 48 | 2 | 17.07 | 17.32 | 17.17 | 0-3 | 3 |

### C-V2X 20 ㎒ Bandwidth Conducted Power (MIMO_Ant.2)

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power [dBm] | | | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|---|---|---|---|---|---|---|---|---|
| | | | | | 55090 Ch. 5 910 ㎒ | | | |
| 20 ㎒ | QPSK | 1 | 2 | | 20.02 | | 0 | 0 |
| | | 1 | 50 | | 19.95 | | 0 | 0 |
| | | 1 | 96 | | 19.95 | | 0 | 0 |
| | | 48 | 2 | | 19.29 | | 0-1 | 1 |
| | | 48 | 24 | | 19.22 | | 0-1 | 1 |
| | | 48 | 47 | | 19.18 | | 0-1 | 1 |
| | | 96 | 2 | | 19.20 | | 0-1 | 1 |
| | 16QAM | 1 | 2 | | 19.04 | | 0-1 | 1 |
| | | 1 | 50 | | 19.08 | | 0-1 | 1 |
| | | 1 | 96 | | 18.98 | | 0-1 | 1 |
| | | 48 | 2 | | 18.28 | | 0-2 | 2 |
| | | 48 | 24 | | 18.01 | | 0-2 | 2 |
| | | 48 | 47 | | 18.12 | | 0-2 | 2 |
| | | 96 | 2 | | 18.21 | | 0-2 | 2 |
| | 64QAM | 1 | 2 | | 17.96 | | 0-2 | 2 |
| | | 1 | 50 | | 17.99 | | 0-2 | 2 |
| | | 1 | 96 | | 17.97 | | 0-2 | 2 |
| | | 48 | 2 | | 17.07 | | 0-3 | 3 |
| | | 48 | 24 | | 17.27 | | 0-3 | 3 |
| | | 48 | 47 | | 17.18 | | 0-3 | 3 |
| | | 96 | 2 | | 17.21 | | 0-3 | 3 |

## C-V2X 10 ㎒ Bandwidth Conducted Power (MIMO Ant.1 + Ant.2 Sum Results)

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power [dBm] | | | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|---|---|---|---|---|---|---|---|---|
| | | | | 54990Ch. 5 900 ㎒ | 55090 Ch. 5 910 ㎒ | 55190 Ch. 5 920 ㎒ | | |
| 10 ㎒ | QPSK | 1 | 2 | 22.61 | 22.70 | 22.40 | 0 | 0 |
| | | 1 | 25 | 22.84 | 22.69 | 22.38 | 0 | 0 |
| | | 1 | 48 | 22.56 | 22.62 | 22.25 | 0 | 0 |
| | | 25 | 2 | 21.79 | 21.73 | 21.52 | 0 | 0 |
| | | 25 | 12 | 21.80 | 21.78 | 21.53 | 0 | 0 |
| | | 25 | 23 | 21.80 | 21.81 | 21.49 | 0 | 0 |
| | | 48 | 2 | 21.89 | 21.84 | 21.42 | 0-1 | 1 |
| | 16QAM | 1 | 2 | 21.67 | 21.65 | 21.12 | 0-1 | 1 |
| | | 1 | 25 | 21.58 | 21.48 | 21.11 | 0-1 | 1 |
| | | 1 | 48 | 21.60 | 21.45 | 21.12 | 0-1 | 1 |
| | | 25 | 2 | 20.91 | 20.90 | 20.55 | 0-1 | 1 |
| | | 25 | 12 | 20.90 | 20.80 | 20.51 | 0-1 | 1 |
| | | 25 | 23 | 20.93 | 20.77 | 20.47 | 0-1 | 1 |
| | | 48 | 2 | 20.89 | 20.86 | 20.36 | 0-2 | 2 |
| | 64QAM | 1 | 2 | 20.63 | 20.65 | 20.44 | 0-2 | 2 |
| | | 1 | 25 | 20.62 | 20.52 | 20.37 | 0-2 | 2 |
| | | 1 | 48 | 20.65 | 20.56 | 19.69 | 0-2 | 2 |
| | | 25 | 2 | 19.76 | 19.79 | 19.67 | 0-2 | 2 |
| | | 25 | 12 | 19.91 | 19.88 | 19.51 | 0-2 | 2 |
| | | 25 | 23 | 19.78 | 19.80 | 19.53 | 0-2 | 2 |
| | | 48 | 2 | 19.91 | 19.87 | 19.54 | 0-3 | 3 |

## C-V2X 20 MHz Bandwidth Conducted Power (MIMO Ant.1 + Ant.2 Sum Results)

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power [dBm] | | | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|---|---|---|---|---|---|---|---|---|
| | | | | | 55090 Ch. 5 910 MHz | | | |
| 20 MHz | QPSK | 1 | 2 | | 22.80 | | 0 | 0 |
| | | 1 | 50 | | 22.56 | | 0 | 0 |
| | | 1 | 96 | | 22.45 | | 0 | 0 |
| | | 48 | 2 | | 21.96 | | 0-1 | 1 |
| | | 48 | 24 | | 21.84 | | 0-1 | 1 |
| | | 48 | 47 | | 21.79 | | 0-1 | 1 |
| | | 96 | 2 | | 21.88 | | 0-1 | 1 |
| | 16QAM | 1 | 2 | | 21.77 | | 0-1 | 1 |
| | | 1 | 50 | | 21.61 | | 0-1 | 1 |
| | | 1 | 96 | | 21.33 | | 0-1 | 1 |
| | | 48 | 2 | | 20.95 | | 0-2 | 2 |
| | | 48 | 24 | | 20.38 | | 0-2 | 2 |
| | | 48 | 47 | | 20.75 | | 0-2 | 2 |
| | | 96 | 2 | | 20.87 | | 0-2 | 2 |
| | 64QAM | 1 | 2 | | 20.77 | | 0-2 | 2 |
| | | 1 | 50 | | 20.67 | | 0-2 | 2 |
| | | 1 | 96 | | 20.52 | | 0-2 | 2 |
| | | 48 | 2 | | 19.84 | | 0-3 | 3 |
| | | 48 | 24 | | 19.83 | | 0-3 | 3 |
| | | 48 | 47 | | 19.72 | | 0-3 | 3 |
| | | 96 | 2 | | 19.89 | | 0-3 | 3 |

# 15. System Verification

## 15.1 Tissue Verification

The head simulating material is calibrated by HCT using the DAKS 3.5 to determine the conductivity and permittivity.

| Table for Head Tissue Verification | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date of Tests | Tissue Temp. (°C) | Tissue Type | Freq. (㎒) | Measured Conductivity σ (S/m) | Measured Dielectric Constant, ε | Target Conductivity σ (S/m) | Target Dielectric Constant, ε | % dev σ | % dev ε |
| 03/13/2025 | 22.0 | 6 500H | 5 910 | 5.42 | 34.9 | 5.393 | 34.962 | 0.50 | -0.18 |
| | | | 5 935 | 5.45 | 34.8 | 5.409 | 35.148 | 0.76 | -0.99 |
| | | | 6 000 | 5.57 | 34.7 | 5.475 | 35.070 | 1.74 | -1.06 |
| | | | 6 425 | 6.23 | 34.2 | 5.982 | 34.550 | 4.15 | -1.01 |
| | | | 6 500 | 6.24 | 34.2 | 6.072 | 34.460 | 2.77 | -0.75 |
| | | | 6 525 | 6.22 | 34.2 | 6.101 | 34.430 | 1.95 | -0.67 |
| | | | 6 875 | 6.70 | 33.4 | 6.497 | 34.029 | 3.12 | -1.85 |
| | | | 7 000 | 6.86 | 33.1 | 6.650 | 33.880 | 3.16 | -2.30 |
| | | | 7 115 | 7.01 | 33.2 | 6.786 | 33.742 | 3.30 | -1.61 |

## 15.2 System Verification

Input Power: 50 ㎽

| Freq. | Date | Probe | Dipole | Liquid | Amb. Temp. | Liquid Temp. | 1 W Target $SAR_{1g}$ (SPEAG) | 50mW Measured $SAR_{1g}$ | 1 W Normalized $SAR_{1g}$ | Deviation | Limit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| [㎒] | | (S/N) | (S/N) | | [°C] | [°C] | [W/kg] | [W/kg] | [W/kg] | [%] | [%] |
| 6 500 | 03/13/2025 | 7370 | 1012 | Head | 22.1 | 22.0 | 297 | 14.80 | 296 | -0.34 | ± 10 |

SAR measurement was prior to assessment; the system is verified to the ± 10 % of the specifications at each frequency Band by using the system verification kit. (Graphic Plots Attached)
- Cabling the system, using the verification kit equipment.
- For all frequency band except 6 ㎓, Generate about 50 ㎽ Input level from the signal generator to the Dipole Antenna.
- Dipole antenna was placed below the flat phantom.
- The measured one-gram SAR at the surface of the phantom above the dipole feed-point should be within 10 % of the target reference value.

Note;
SAR Verification was performed according to the FCC KDB 865664 D01v01r04.

## 16. SAR Test Data Summary

| C-V2X SAR | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | | Mode | Ant. | Band width | Tune-Up Limit | Meas. Power | Power Drift | Test Position | MPR | RB Size | RB offset | Duty Cycle | Ant. State | Distance | Meas. SAR | Scaling Factor | Scaled SAR | Plot No. |
| MHz | Ch. | | | (MHz) | (dBm) | (dBm) | (dB) | | (dB) | | | | | (mm) | (W/kg) | | (W/kg) | |
| 5 910 | 55090 | QPSK | CV2X_1 | 20 | 23.3 | 23.05 | 0.01 | Rear | 0 | 1 | 2 | 1:1.07 | FREE | 35 | **0.000** | 1.059 | 0.000 | **B1** |
| 5 910 | 55090 | QPSK | CV2X_1 | 20 | 22.3 | 22.16 | 0.00 | Rear | 1 | 48 | 2 | 1:1.07 | FREE | 35 | 0.000 | 1.033 | 0.000 | - |
| ANSI/ IEEE C95.1 - 2005– Safety Limit<br>Spatial Peak<br>Uncontrolled Exposure/ General Population | | | | | | | | | Body<br>1.6 W/kg<br>Averaged over 1 gram | | | | | | | | | |

## 16.1 SAR Test Notes

**General Notes:**

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2013, FCC KDB Procedure.
2. Batteries are fully charged at the beginning of the SAR measurements. A standard battery was used for all SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB 447498 D01v06.
6. Per FCC KDB 648474 D04v01r03, SAR was evaluated without a headset connected to the device. Since the standalone reported SAR was 1.2 W/kg, no additional SAR evaluation using a headset cable were required.
7. Per FCC KDB 865664 D01v01r04, variability SAR measurement were performed when the measured SAR results for a frequency Band were greater than or equal to 0.8 W/kg for 1g SAR and >2 for 10g SAR Please see Section 15 for variability analysis.
8. This device utilizes power reduction for some wireless mode and technologies, as outlined in sec. 4 The maximum output power allowed for each transmitter and exposure condition was evaluated for SAR compliance based on expected use conditions and simultaneous scenarios.
9. During SAR testing for the Hotspot conditions per KDB 941225 D06v02r01, the actual portable hotspot operation (with actual simultaneous transmission of a transmitter with WiFi) was not activated.

**CV2X Notes:**

1. Due to Limitations of the CV2X SAR measurement equipment, SAR testing for CV2X Band was performed separately using test mode(FTM) software.

## 17. Simultaneous SAR Analysis

This device contains transmitters that may operate simultaneously (ENDC(4G+5G) operations). Therefore, simultaneous transmission analysis is required. Per KDB Publication 447498 D01v06 Sec.4.3.2 and IEEE 1528-2013 Sec.6.3.4.1.2, simultaneous transmission SAR test exclusion may be applied when the sum of 1g SAR and 10g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤1.6W/kg for 1g SAR and ≤4 W/kg for 10g SAR. The different test positions in an exposure condition may be considered collectively to determine SAR exclusion according to the sum of 1g or 10g SAR.

| Simultaneous Transmission Scenario | | | | | | |
|---|---|---|---|---|---|---|
| Band | | Position | NR SAR (W/kg) | LTE SAR (W/kg) | 2.4G WLAN (W/kg) | Σ 1-g SAR (W/kg) |
| | | | 1 | 2 | 3 | 1+2+3 |
| NR Band 25(2) | LTE Band 26(5) | Rear | 0.069 | 0.041 | 0.134 | 0.244 |
| | LTE Band 12 | | | 0.060 | | 0.263 |
| | LTE Band 13 | | | 0.053 | | 0.256 |
| | LTE Band 14 | | | 0.057 | | 0.260 |
| NR Band 26(5) | LTE Band 25(2) | Rear | 0.077 | 0.039 | 0.134 | 0.250 |
| | LTE Band 7 | | | 0.00 | | 0.211 |
| | LTE Band 66 | | | 0.042 | | 0.253 |
| NR Band 7 | LTE Band 26(5) | Rear | 0.035 | 0.041 | 0.134 | 0.210 |
| | LTE Band 12 | | | 0.060 | | 0.229 |
| NR Band 12 | LTE Band 25(2) | Rear | 0.119 | 0.039 | 0.134 | 0.292 |
| | LTE Band 66 | | | 0.042 | | 0.295 |
| NR Band 13 | LTE Band 66 | Rear | 0.08 | 0.042 | 0.134 | 0.256 |
| NR Band 66 | LTE Band 26(5) | Rear | 0.043 | 0.041 | 0.134 | 0.218 |
| | LTE Band 12 | | | 0.060 | | 0.237 |
| | LTE Band 13 | | | 0.053 | | 0.230 |
| | LTE Band 14 | | | 0.057 | | 0.234 |
| NR Band 71 | LTE Band 25(2) | Rear | 0.131 | 0.039 | 0.134 | 0.304 |
| | LTE Band 7 | | | 0.000 | | 0.265 |
| | LTE Band 66 | | | 0.042 | | 0.307 |
| NR Band 77(78) | LTE Band 25(2) | Rear | 0.045 | 0.039 | 0.134 | 0.218 |
| | LTE Band 26(5) | | | 0.041 | | 0.220 |
| | LTE Band 12 | | | 0.06 | | 0.239 |
| | LTE Band 7 | | | 0.000 | | 0.179 |
| | LTE Band 41(38) | | | 0.000 | | 0.179 |
| | LTE Band 66 | | | 0.042 | | 0.221 |

| Simultaneous Transmission Scenario | | | | | | |
|---|---|---|---|---|---|---|
| Band | | Position | NR SAR (W/kg) | LTE SAR (W/kg) | 5G WLAN (W/kg) | Σ 1-g SAR (W/kg) |
| | | | 1 | 2 | 3 | 1+2+3 |
| NR Band 25(2) | LTE Band 26(5) | Rear | 0.069 | 0.041 | 0.073 | 0.183 |
| | LTE Band 12 | | | 0.060 | | 0.202 |
| | LTE Band 13 | | | 0.053 | | 0.195 |
| | LTE Band 14 | | | 0.057 | | 0.199 |
| NR Band 26(5) | LTE Band 25(2) | Rear | 0.077 | 0.039 | 0.073 | 0.189 |
| | LTE Band 7 | | | 0.00 | | 0.150 |
| | LTE Band 66 | | | 0.042 | | 0.192 |
| NR Band 7 | LTE Band 26(5) | Rear | 0.035 | 0.041 | 0.073 | 0.149 |
| | LTE Band 12 | | | 0.060 | | 0.168 |
| NR Band 12 | LTE Band 25(2) | Rear | 0.119 | 0.039 | 0.073 | 0.231 |
| | LTE Band 66 | | | 0.042 | | 0.234 |
| NR Band 13 | LTE Band 66 | Rear | 0.08 | 0.042 | 0.073 | 0.195 |
| NR Band 66 | LTE Band 26(5) | Rear | 0.043 | 0.041 | 0.073 | 0.157 |
| | LTE Band 12 | | | 0.060 | | 0.176 |
| | LTE Band 13 | | | 0.053 | | 0.169 |
| | LTE Band 14 | | | 0.057 | | 0.173 |
| NR Band 71 | LTE Band 25(2) | Rear | 0.131 | 0.039 | 0.073 | 0.243 |
| | LTE Band 7 | | | 0.000 | | 0.204 |
| | LTE Band 66 | | | 0.042 | | 0.246 |
| NR Band 77(78) | LTE Band 25(2) | Rear | 0.045 | 0.039 | 0.073 | 0.157 |
| | LTE Band 26(5) | | | 0.041 | | 0.159 |
| | LTE Band 12 | | | 0.06 | | 0.178 |
| | LTE Band 7 | | | 0.000 | | 0.118 |
| | LTE Band 41(38) | | | 0.000 | | 0.118 |
| | LTE Band 66 | | | 0.042 | | 0.160 |

| Simultaneous Transmission Scenario | | | | |
|---|---|---|---|---|
| Band | Position | Main (W/kg) | 2.4G WLAN (W/kg) | Σ 1-g SAR (W/kg) |
| | | 1 | 2 | 1+2 |
| C-V2X | Rear | 0.000 | 0.134 | 0.134 |
| GSM850 | | 0.040 | | 0.174 |
| GSM1900 | | 0.034 | | 0.168 |
| UMTS B5 | | 0.000 | | 0.134 |
| UMTS B4 | | 0.042 | | 0.176 |
| UMTS B2 | | 0.042 | | 0.176 |
| NR FDD Band n14 | | 0.093 | | 0.227 |
| NR FDD Band n25 | | 0.069 | | 0.203 |
| NR FDD Band n26 | | 0.077 | | 0.211 |
| NR TDD Band n41 | | 0.031 | | 0.165 |

| Simultaneous Transmission Scenario | | | | |
|---|---|---|---|---|
| Band | Position | Main (W/kg) | 5G WLAN (W/kg) | Σ 1-g SAR (W/kg) |
| | | 1 | 2 | 1+2 |
| C-V2X | Rear | 0.000 | 0.073 | 0.073 |
| GSM850 | | 0.040 | | 0.113 |
| GSM1900 | | 0.034 | | 0.107 |
| UMTS B5 | | 0.000 | | 0.073 |
| UMTS B4 | | 0.042 | | 0.115 |
| UMTS B2 | | 0.042 | | 0.115 |
| NR FDD Band n14 | | 0.093 | | 0.166 |
| NR FDD Band n25 | | 0.069 | | 0.142 |
| NR FDD Band n26 | | 0.077 | | 0.15 |
| NR TDD Band n41 | | 0.031 | | 0.104 |

Note : WWAN SAR testing results were referred to SAR Test Report, Report No.HCT-SR-2503-FC002-R2 and also perform simultaneous transmission analysis.

This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB 447498 D01v06

Max WWAN Ant(0.173 W/Kg) + 5 GHz WI-FI Ant (0.092 W/Kg) = 0.265 W/Kg < 1.6 W/Kg
Max WWAN Ant(0.173 W/Kg) + 2.4 GHz WI-FI Ant (0.191 W/Kg) = 0.364 W/Kg < 1.6 W/Kg

The simultaneous transmission RF Exposure should be addressed as mixed mobile and portable according to the procedure in KDB 447498 D01v06 section 7.2:

Antennas that qualify for standalone SAR test exclusion must apply the estimated standalone SAR to determine simultaneous transmission test exclusion. a) The [Σ of (the highest measured or estimated SAR for each standalone antenna configuration, adjusted for maximum tune-up tolerance) / 1.6 W/kg] + [Σ of MPE ratios] is ≤ 1.0.

**Transmitters used in mobile device exposure conditions for simultaneous transmission operations**

| No. | Capable Transmit Configuration | Body |
|---|---|---|
| 1 | WWAN Ant + 2.4 GHz WI-FI Ant + C-V2X External Ant | Yes |
| 2 | WWAN Ant+ 5 GHz WI-FI Ant + C-V2X External Ant | Yes |

External Ant C-V2X MPE Result is 0.02274 mW/cm$^2$

1. [0.11 (Max WWAN Ant]] +[0.084 (2.4GHz WI-FI Ant Estimated SAR Result]] + [0.023(External Ant C-V2X MPE Result)] is 0.217 ≤ 1.0.
2. [0.11 (Max WWAN Ant)] +[0.046 (5GHz WI-FI Ant Estimated SAR Result)] + [0.023(External Ant C-V2X MPE Result)] is 0.179 ≤ 1.0.

## 18. Measurement Uncertainty

The measured SAR was <1.5 W/Kg for 1g SAR and <3.75 W/Kg, for 10g SAR for all frequency Bands. Therefore, per KDB Publication 865664 D01v01r04, the extended measurement uncertainty analysis per IEEE1528-2013 was not required.

## 19. SAR Test Equipment

| Manufacturer | Type / Model | S/N | Calib. Date | Calib.Interval | Calib.Due |
|---|---|---|---|---|---|
| SPEAG | ELI Phantom | - | N/A | N/A | N/A |
| HP | SAR System Control PC | - | N/A | N/A | N/A |
| Staubli | CS8Cspeag-TX90 | F17/ 59RAA1/ C/ 01 | N/A | N/A | N/A |
| N/A | TX90 XLspeag | F17/ 59RAA1/ A/ 01 | N/A | N/A | N/A |
| N/A | Teach Pendant (Joystick) | D21142606B | N/A | N/A | N/A |
| TESTO | 175-H1/Thermometer | 40331922309 | 12/25/2024 | Annual | 12/25/2025 |
| SPEAG | DAE4 | 1720 | 04/19/2024 | Annual | 04/19/2025 |
| SPEAG | E-Field Probe EX3DV4 | 7370 | 08/22/2024 | Annual | 08/22/2025 |
| SPEAG | Dipole D6.5GHz V2 | 1012 | 09/17/2024 | Annual | 09/17/2025 |
| Agilent | Power Meter E4419B | MY41291386 | 09/11/2024 | Annual | 09/11/2025 |
| Agilent | Power Sensor 8481A | SG1091286 | 09/12/2024 | Annual | 09/12/2025 |
| Agilent | 11636B/Power Divider | 58698 | 01/13/2025 | Annual | 01/13/2026 |
| SPEAG | DAKS 3.5 | 1031 | 04/22/2024 | Annual | 04/22/2025 |
| SPEAG | Vector Reflectometer | 0050813 | 04/15/2024 | Annual | 04/15/2025 |
| SPEAG | MXA Signal Analyzer | US51350329 | 04/23/2024 | Annual | 04/23/2025 |
| H.P | Network Analyzer /8753ES | 8753E | 08/20/2024 | Annual | 08/20/2025 |
| Agilent | Attenuator (3dB) 8693B | MY39260298 | 08/20/2024 | Annual | 08/20/2025 |
| HP | Attenuator (20dB) 8493C | 09271 | 08/20/2024 | Annual | 08/20/2025 |
| Agilent | Directional Bridge 86205A | 3140A04581 | 04/22/2024 | Annual | 04/22/2025 |
| KEYSIGHT | EXG Vector Signal Generator | MY50350097 | 03/05/2024 | Annual | 03/05/2025 |
| HP | Dual Directional Coupler | 16072 | 09/11/2024 | Annual | 09/11/2025 |

* The E-field probe was calibrated by SPEAG, by the waveguide technique procedure. Dipole Verification measurement is performed by HCT Lab. before each test. The brain/body simulating material is calibrated by HCT using the DAKS 3.5 to determine the conductivity and permittivity (dielectric constant) of the brain/body-equivalent material.

## 20. Conclusion

The SAR and RF Exposure measurement indicates that the EUT complies with the RF radiation exposure limits of the ANSI/ IEEE C95.1 - 2005.

These measurements were taken to simulate the RF effects exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

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

## 21. References

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# Appendix A. DUT Ant. Information & SETUP PHOTO

**Please refer to test DUT Ant. Information &setup photo file no. as follows:**

| Report No. |
| --- |
| HCT-SR-2503-FC004-P |