*Audix Technology Corp.*
*No. 491, Zhongfu Rd., Linkou Dist.,*
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# FCC 2.1093
# Power Density Evaluation Report

# for

# LG Electronics Inc.

# 222, LG-ro, Jinwi-myeon Pyeongtaek-Si, Gyeonggi-Do, 17709 Republic of Korea

| | | |
|---|---|---|
| **Product Name** | : | **Notebook Computer** |
| **Model Name** | : | **(1)16Z90R (2)16ZB90R (3)16ZD90R (4)16ZG90R** |
| **Brand** | : | **LG** |
| **FCC ID** | : | **BEJNT-16Z90R** |

| | | |
|---|---|---|
| **Prepared by:** | : | **AUDIX Technology Corporation, EMC Department** |

Testing Laboratory
1724

TESTING
NVLAP LAB CODE 200077-0

The test report is based on a single evaluation of one sample of the above-mentioned products. It does not imply an assessment of the whole production and does not permit the use of the test lab logo. The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.



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# TEST REPORT

| | | |
|---|---|---|
| Applicant | : | LG Electronics Inc. |
| Manufacturer | : | LG Electronics Inc. |
| Factory | : | LG Electronics Nanjing New Technology Co., Ltd. |
| EUT Description | | |
| (1) Product | : | Notebook Computer |
| (2) Model | : | (1)16Z90R (2)16ZB90R (3)16ZD90R (4)16ZG90R |
| (3) Brand | : | LG |
| (4) Power Supply | : | DC 20V, 3.25A |

Rules of Compliance and Applicable Standards:

Title 47FCC CFR, Part 2 §2.1093

***Audix Technology Corp.*** tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.
***Audix Technology Corp.*** does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens and samples.

Date of Report: 2022. 12. 12

Reviewed by: Annie Yu (Annie Yu/Administrator)

Approved by: Johnny Hsueh (Johnny Hsueh/Section Manager)



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# 1. REVISION RECORD OF TEST REPORT

| Edition No | Issued Date | Revision Summary | Report Number |
|---|---|---|---|
| 0 | 2022. 12. 12 | Original Report | EM-SR220089 |



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# 2. SUMMARY OF TEST RESULTS

- **For SAR Value**

**Test SKU: SKU #1 (with INPAQ Antenna)**

| Mode | Highest Reported Body SAR 1g | Limit | Result |
|---|---|---|---|
| WLAN 6E | 0.140W/kg | 1.6W/kg | PASS |

**Test SKU: SKU #1 (with LUXSHARE-ICT Antenna)**

| Mode | Highest Reported Body SAR 1g | Limit | Result |
|---|---|---|---|
| WLAN 6E | 0.099W/kg | 1.6W/kg | PASS |

- **For Power Density value**

**Test SKU: SKU #1 (with INPAQ Antenna)**

| Mode | Highest c-psPDtot averaging over 4cm$^2$ | Limit | Result |
|---|---|---|---|
| WLAN 6E | 1.491 W/m$^2$ | 10 W/m$^2$ | PASS |

**Test SKU: SKU #1 (with LUXSHARE-ICT Antenna)**

| Mode | Highest c-psPDtot averaging over 4cm$^2$ | Limit | Result |
|---|---|---|---|
| WLAN 6E | 2.578 W/m$^2$ | 10 W/m$^2$ | PASS |

**Test SKU: SKU #2 (with LUXSHARE-ICT Antenna)**

| Mode | Highest c-psPDtot averaging over 4cm$^2$ | Limit | Result |
|---|---|---|---|
| WLAN 6E | 3.410 W/m$^2$ | 10 W/m$^2$ | PASS |


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# 3. GENERAL INFORMATION

## 3.1. Description of Application

| | |
|---|---|
| Applicant | LG Electronics Inc.<br>222, LG-ro, Jinwi-myeon Pyeongtaek-Si, Gyeonggi-Do,<br>17709 Republic of Korea |
| Manufacturer | LG Electronics Inc.<br>222, LG-ro, Jinwi-myeon Pyeongtaek-Si, Gyeonggi-Do,<br>17709 Republic of Korea |
| Factory | LG Electronics Nanjing New Technology Co., Ltd.<br>No.346,Yaoxin Road, Economic & Technical Development Zone, Nanjing, China. |
| Product | Notebook Computer |
| Model | (1)16Z90R (2)16ZB90R (3)16ZD90R (4)16ZG90R<br>The difference between all models is different in the sales customers and color difference. |
| Brand | LG |


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## 3.2. Description of EUT

<table>
<tr><td>Test Model</td><td>16Z90R</td></tr>
<tr><td>Serial Number</td><td>N/A</td></tr>
<tr><td>Power Rating</td><td>DC 20V, 3.25A</td></tr>
<tr><td>Software Version</td><td>XY (X, Y can be 0 to 9 for different SW version not influence RF parameter)</td></tr>
<tr><td>RF Features</td><td>WLAN:802.11 a/b/g/n/ac/ax<br>Bluetooth: BT and BLE (BT 5.1)</td></tr>
<tr><td>Transmit Type</td><td>
<table>
<tr><th colspan="2">2.4 GHz</th></tr>
<tr><td>802.11b</td><td>1T1R</td></tr>
<tr><td>802.11g</td><td>1T1R</td></tr>
<tr><td>802.11n-HT20</td><td>2T2R</td></tr>
<tr><td>802.11n-HT40</td><td>2T2R</td></tr>
<tr><td>802.11ax-HE20</td><td>2T2R</td></tr>
<tr><td>802.11ax-HE40</td><td>2T2R</td></tr>
<tr><td>BT/BLE</td><td>1T1R</td></tr>
</table>
<table>
<tr><th colspan="2">U-NII Bands</th></tr>
<tr><td>802.11a</td><td>1T1R</td></tr>
<tr><td>802.11n-HT20/802.11ac-VHT20/802.11ax-HE20</td><td>2T2R</td></tr>
<tr><td>802.11n-HT40/802.11ac-VHT40/802.11ax-HE40</td><td>2T2R</td></tr>
<tr><td>802.11ac-VHT80/802.11ax-HE80</td><td>2T2R</td></tr>
<tr><td>802.11ac-VHT160/802.11ax-HE160</td><td>2T2R</td></tr>
</table>
The MIMO is uncorrelated and supported SDM(Spatial Division Multiplexing) mode only. This radio device doesn't support beamforming and Cyclic Delay Diversity (CDD).
</td></tr>
<tr><td>Test Sample</td><td>
<table>
<tr><th>Sample No.</th><th>Test Item</th><th>Firmware</th></tr>
<tr><td>01</td><td>SAR</td><td>N/A</td></tr>
<tr><td>03</td><td>SAR</td><td>N/A</td></tr>
</table>
</td></tr>
<tr><td>Sample Status</td><td>Trial sample</td></tr>
<tr><td>Date of Receipt</td><td>2022. 10. 13</td></tr>
<tr><td>Date of Test</td><td>2022. 10. 20 ~ 12. 08</td></tr>
<tr><td>Interface Ports of EUT</td><td>• One HDMI Port<br>• Two USB Type C Ports<br>• One Earphone Port<br>• One Micro SD Card Slot<br>• Two USB 3.0 Ports</td></tr>
<tr><td>Accessories Supplied</td><td>• AC Adapter<br>• USB C Cable<br>• LAN Gender</td></tr>
</table>



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## 3.3. Reference Test Guidance

TCB Workshop – April 2021: RF exposure Policies and Procedures
SPEAG DASY6 System Handbook (June 2020)
SPEAG DASY6 Application Note (Interim Procedures for Devices Operating at 6-10GHz)
47 CFR FCC Part 2(§2.1093)
IEC TR 63170:2018
IEC/IEEE 62209-1528:2020
FCC KDB 865664 D01 v01r02
FCC KDB 248227 D01 v02r02
FCC KDB 447498 D04 Interim General RF Exposure Guidance v01
FCC KDB 865664 D01 v01r04
FCC KDB 616217 D04 v01r02


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## 3.4. Antenna Information

| No. | Antenna Part Number | Manufacture | Antenna Type | Frequency (MHz) | Max Gain(dBi) | |
|---|---|---|---|---|---|---|
| | | | | | Main | AUX |
| 1. | WA-P-LELE-04-009 | INPAQ | Mono-Pole | 2400 | 2.2 | 1.9 |
| | | | | 2450 | 2.3 | 2.4 |
| | | | | 2500 | 3.1 | 2.3 |
| | | | | 5150 | 4.2 | 3.6 |
| | | | | 5400 | 4.2 | 3.7 |
| | | | | 5850 | 4.0 | 3.5 |
| | | | | 5925 | 4.3 | 3.5 |
| | | | | 6525 | 4.2 | 3.5 |
| | | | | 7125 | 4.1 | 2.3 |

According to KDB 662911 D01 d) ii), transmit signals are completely uncorrelated, then
Directional gain = $10 \log[(10^{G1/10} + 10^{G2/10} + \ldots + 10^{GN/10})/N_{ANT}]$ dBi

Note 1. 2.4G: Directional gain =

2400MHz: Directional gain = $10 \log[(10^{2.2/10} + 10^{1.9/10})/2] = 2.05$dBi

2450MHz: Directional gain = $10 \log[(10^{2.3/10} + 10^{2.4/10})/2] = 2.35$dBi

Note 2. 5G: Directional gain =

5150MHz: = $10 \log[(10^{4.2/10} + 10^{3.6/10})/2] = 3.91$dBi

5250MHz: = $10 \log[(10^{4.2/10} + 10^{3.6/10})/2] = 3.91$dBi

5350MHz: = $10 \log[(10^{4.2/10} + 10^{3.7/10})/2] = 3.96$dBi

5725MHz: = $10 \log[(10^{4.0/10} + 10^{3.5/10})/2] = 3.76$dBi

5825MHz: = $10 \log[(10^{4.0/10} + 10^{3.5/10})/2] = 3.76$dBi

Note 3. UNII Band (WLAN 6G):

5925MHz: Directional gain = $10 \log[(10^{4.3/10} + 10^{3.5/10})/2] = 3.92$dBi

6525MHz: Directional gain = $10 \log[(10^{4.2/10} + 10^{3.5/10})/2] = 3.86$dBi

7125MHz: Directional gain = $10 \log[(10^{4.1/10} + 10^{2.3/10})/2] = 3.29$dBi

We chose the antenna gain corresponding to the frequency listed on the table which is closer to center frequency of WLAN.



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| No. | Antenna Part Number | Manufacture | Antenna Type | Frequency (MHz) | Max Gain(dBi) | |
|---|---|---|---|---|---|---|
| | | | | | Main | AUX |
| 2. | L1LRF008-CS-H | LUXSHARE-ICT | Mono-Pole | 2400 | 6.3 | 0.9 |
| | | | | 2450 | 5.7 | 1.6 |
| | | | | 2500 | 2.7 | 3.5 |
| | | | | 5150 | -1.5 | 2.3 |
| | | | | 5400 | 3.4 | 4.5 |
| | | | | 5850 | 3.3 | 5.8 |
| | | | | 5925 | 2.9 | 4.7 |
| | | | | 6525 | 3.4 | 1.3 |
| | | | | 7125 | -4.9 | -1.6 |

According to KDB 662911 D01 d) ii), transmit signals are completely uncorrelated, then
Directional gain = $10 \log[(10^{G1/10} + 10^{G2/10} + \ldots + 10^{GN/10})/N_{ANT}]$ dBi

Note 1. 2.4G: Directional gain =

2400MHz: Directional gain = $10 \log[(10^{6.3/10} + 10^{0.9/10})/2]$= 4.42dBi

2450MHz: Directional gain = $10 \log[(10^{5.7/10} + 10^{1.6/10})/2]$= 4.11dBi

Note 2. 5G: Directional gain =

5150MHz: = $10 \log[(10^{-1.5/10} + 10^{2.3/10})/2]$= 0.80dBi

5250MHz: = $10 \log[(10^{-1.5/10} + 10^{2.3/10})/2]$= 0.80dBi

5350MHz: = $10 \log[(10^{3.4/10} + 10^{4.5/10})/2]$= 3.99dBi

5725MHz: = $10 \log[(10^{3.3/10} + 10^{5.8/10})/2]$= 4.70dBi

5825MHz: = $10 \log[(10^{3.3/10} + 10^{5.8/10})/2]$= 4.70dBi

Note 3. UNII Band (WLAN 6G):

5925MHz: Directional gain = $10 \log[(10^{2.9/10} + 10^{4.7/10})/2]$= 3.92dBi

6525MHz: Directional gain = $10 \log[(10^{3.4/10} + 10^{1.3/10})/2]$= 2.48dBi

7125MHz: Directional gain = $10 \log[(10^{-4.9/10} + 10^{-1.6/10})/2]$= -2.99dBi

We chose the antenna gain corresponding to the frequency listed on the table which is closer to center frequency of WLAN.



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## 3.5. EUT Specifications Assessed in Current Report

| Mode | U-NII Band | Fundamental Range (MHz) | Channel Number |
|---|---|---|---|
| 802.11ax-HE20 | 5 | 5955-6415 | 24 |
| | 6 | 6435-6515 | 5 |
| | 7 | 6535-6855 | 17 |
| | 8 | 6875-7115 | 13 |
| 802.11ax-HE40 | 5 | 5965-6405 | 12 |
| | 6 | 6445-6485 | 2 |
| | 7 | 6525-6845 | 9 |
| | 8 | 6885-7085 | 6 |
| 802.11ax-HE80 | 5 | 5985-6385 | 6 |
| | 6 | 6465-6545 | 2 |
| | 7 | 6625-6785 | 3 |
| | 8 | 6865-7025 | 3 |
| 802.11ax-HE160 | 5 | 6025-6345 | 3 |
| | 6 | 6505 | 1 |
| | 7 | 6665 | 1 |
| | 8 | 6825-6985 | 2 |

| Mode | Modulation | Data Rate (Mbps) |
|---|---|---|
| 802.11ax-HE20 | OFDMA (BPSK/ QPSK/ 16QAM/ 64QAM/ 256QAM/1024QAM) | Up to 287 |
| 802.11ax-HE40 | | Up to 574 |
| 802.11ax-HE80 | | Up to 1201 |
| 802.11ax-HE160 | | Up to 2402 |


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## 3.6. Description of Key Components

### 3.6.1. For the All Component Lists

| Item | Supplier | Model / Type | Character |
|---|---|---|---|
| System | Microsoft | Win 10 | --- |
| | | Win 10 Pro | |
| | | Win11 Home | |
| Main Board | LG | ROYAL MAIN B/D | GM<br>Manufacturer:<br>#1 Hannstar Board Tech (Jiang Yin) Corp.,Ltd.<br>#2 Elec&Eltek Company (MCO) Limited. |
| | LG | ROYAL NVIDIA MAIN B/D | PM<br>Manufacturer:<br>#1 Hannstar Board Tech (Jiang Yin) Corp.,Ltd.<br>#2 Elec&Eltek Company (MCO) Limited. |
| WLAN SUB Board | LG | 16Z90R SUB B/D | Manufacturer:<br>#1 HannstarBoardTech(Jiang Yin)Corp.,Ltd.<br>#2 JiangSuHuaShen Electronic co.,ltd (HXF)<br>#3 Elec&Eltek Company (MCO) Limited. |
| CPU<br>(Socket: BGA1744) | Intel | i7-1360P | 2.2GHz |
| | Intel | i5-1340P | 1.9GHz |
| 16” LCD Panel | LG Display | LP160WQ1 | Resolution: 2560 x 1600, 60Hz WQXGA IPS |
| | LG Display | LP160WQ2 | Resolution: 2560 x 1600, 144Hz WQXGA IPS |
| Storage (SSD) | SK hynix | --- | 256GB |
| | | --- | 512GB |
| | | --- | 1TB |
| | | --- | 2TB |
| | Samsung | --- | 256GB |
| | | --- | 256GB |
| | | --- | 512GB |
| | | --- | 1TB |
| | | --- | 2TB |
| Memory (RAM) | Samsung | --- | 16GB LPDDR5x(On Board) |
| | | --- | 8GB LPDDR5x(On Board) |
| | | --- | 32GB LPDDR5x(On Board) |
| | SK Hynix | --- | 16GB LPDDR5x(On Board) |
| | | --- | 8GB LPDDR5x(On Board) |
| | | --- | 32GB LPDDR5x(On Board) |
| Battery Pack | LG | LBY122CM | 90Wh with PM M/B,<br>DC 7.76V,90Wh |
| | LG | LBV7227E | 80Wh with GM M/B<br>DC 7.74V,80Wh |
| WLAN Combo Card | Intel | AX211D2W | WLAN and BT, 2x2 PCle M.2 1216 SD adapter card<br>FCC ID: PD9AX211D2<br>IC: 1000M-AX211D2 |
| WLAN Combo Antenna | LG (INPAQ) | WA-P-LELE-04-009 | PCB, Mono-pole Type<br>Main: Black, Aux: Gray |
| | LG (Luxshare) | L1LRF008-CS-H | PCB, Mono-pole Type<br>Main: Black, Aux: Gray |



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| Item | Supplier | Model / Type | Character |
|---|---|---|---|
| Keyboard | TIC | KT0120B8 | --- |
| | LITE-ON | SN8B01 | --- |
| Touch Pad | LITE-ON | SP8001(SG-A0630-00A) | --- |
| | ELAN | SD081A-36H0 | --- |
| Web Camera | Chicony | CKFLF26 | --- |
| | Luxvisions | 1BF225N3 | --- |
| LAN Gender (Type C to LAN) | SUZHOU MEC ELECTRONICS | 80-5946-111 | (White) 10/100 Megabit Ethernet |
| | | 80-5946-101 | (Black) 10/100 Megabit Ethernet |
| | ARIN TECH CO. LTD | GD-08MF-36-WH-LP10 | (White) 10/100 Megabit Ethernet |
| | | GD-08MF-36-BK-LP11 | (Black) 10/100 Megabit Ethernet |
| | HUIZHOU DEHONG TECHNOLOGY CO.,LTD. | 370-50713 | (White) 10/100 Megabit Ethernet |
| | | 370-50714 | (Black) 10/100 Megabit Ethernet |
| | Type C to LAN: Shielded, Undetached, 0.12m | | |
| AC Adapter | LG (PI ELECTRONICS) | LP65WFC20P-NJ W | I/P: AC 100-240V, 1.6A, 50-60Hz<br>O/P:DC 5V,3A(15W) or DC 9V, 3A(27W)or DC 15V,3A (45W) or DC 20V,3.25A (65W)<br>(US Type, Wall-mount) |
| | LG (PI ELECTRONICS) | LP65WFC20P-NJ B | I/P: AC 100-240V, 1.6A, 50-60Hz<br>O/P:DC 5V,3A(15W) or DC 9V, 3A(27W)or DC 15V,3A (45W) or DC 20V,3.25A (65W)<br>(US Type, Wall-mount) |
| | Type C Cable, Shielded, Undetached, 2.0m | | |

Remark: For more detailed features description, please refer to the manufacturer's specifications or the user manual.



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3.6.2. The EUT collocates with following worst components, which are used to establish a basic configuration of system during test:

| **SKU (Mode)** | | | **1** | **2** |
|---|---|---|---|---|
| Main Board | | LG, ROYAL NVIDIA MAIN B/D (PM) | V | |
| | | LG, ROYAL MAIN B/D (GM) | | V |
| SUB Board | | LG, 16Z90R SUB B/D | V | V |
| CPU | | Intel, i7-1360P | V | |
| | | Intel, i5-1340P | | V |
| 16” LCD Panel | | LG Display, LP160WQ2 | V | |
| | | LG Display, LP160WQ1 | | V |
| Storage (SSD) | | Samsung, 256GB | V | |
| | | Samsung, 2TB | V | |
| | | SK hynix, 256GB | | V |
| | | SK hynix, 2TB | | V |
| Memory (RAM) | | Samsung, 32GB | V | |
| | | SK hynix, 32GB | | V |
| Battery Pack | | LG, 90Wh | V | |
| | | LG, 80Wh | | V |
| Keyboard | | LITE-ON, SN8B01 | V | V |
| Touch Pad | | LITE-ON, SP8001(SG-A0630-00A) | V | V |
| Web Camera | | Chicony, CKFLF26 | V | V |
| WLAN Combo Card | | Intel, AX211D2W | V | V |
| Type C #1 | Link to LAN Gender | SUZHOU MEC ELECTRONICS, 80-5946-101 | V | V |
| Type C #2 | AC Adapter | LG (PI ELECTRONICS), LP65WFC20P-NJ B | V | V |

| | | | | |
|---|---|---|---|---|
| Evaluation method | INPAQ | LUXSHARE-ICT | INPAQ | LUXSHARE-ICT |
| | SKU #1 | SKU #1 | SKU #2 | SKU #2 |
| 6G Band | Full test | Full test | Worst case depend on INPAQ max SAR test result | Worst case depend on LUXSHARE-ICT max SAR test result |



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## 3.7. Description of Test Facility

| | |
|---|---|
| Name of Test Firm | Audix Technology Corporation / EMC Department<br>No. 491, Zhongfu Rd., Linkou Dist., New Taipei City 244, Taiwan, China<br>Tel: +886-2-26092133<br>Fax: +886-2-26099303<br>Website : www.audixtech.com<br>Contact e-mail: attemc_report@audixtech.com |
| Accreditations | The laboratory is accredited by following organizations under ISO/IEC 17025:2017<br>(1) NVLAP(USA)<br>NVLAP Lab Code 200077-0<br>(2) TAF(Taiwan)<br>No. 1724 |
| Test Facilities | FCC OET Designation Number under APEC MRA by NCC is : TW1724<br>ISED CAB Identifier Number under APEC TEL MRA by NCC is TW1724<br>(1) SAR Room |



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## 3.8. Measurement Uncertainty

**cDASY6 Module mmWave Uncertainty Budget**
**Evaluation Distances to the Antennas $> \lambda/2\pi$**
In Compliance with IEC/IEEE 63195

| Error Description | | Unc. Value (±dB) | Probab. Distri. | Div. | $(c_i)$ | Std. Unc. (±dB) | $(v_i)$ $v_{eff}$ |
|---|---|---|---|---|---|---|---|
| **Uncertainty terms dependent on the measurement system** | | | | | | | |
| CAL | Calibration | 0.49 | N | 1 | 1 | 0.49 | ∞ |
| COR | Probe correction | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| FRS | Frequency response (BW $\leq$ 1 GHz) | 0.20 | R | $\sqrt{3}$ | 1 | 0.12 | ∞ |
| SCC | Sensor cross coupling | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| ISO | Isotropy | 0.50 | R | $\sqrt{3}$ | 1 | 0.29 | ∞ |
| LIN | Linearity | 0.20 | R | $\sqrt{3}$ | 1 | 0.12 | ∞ |
| PSC | Probe scattering | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| PPO | Probe positioning offset | 0.30 | R | $\sqrt{3}$ | 1 | 0.17 | ∞ |
| PPR | Probe positioning repeatability | 0.04 | R | $\sqrt{3}$ | 1 | 0.02 | ∞ |
| SMO | Sensor mechanical offset | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| PSR | Probe spatial resolution | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| FLD | Field impedance dependance | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| APD | Amplitude and phase drift | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| APN | Amplitude and phase noise | 0.04 | R | $\sqrt{3}$ | 1 | 0.02 | ∞ |
| TR | Measurement area truncation | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| DAQ | Data acquisition | 0.03 | N | 1 | 1 | 0.03 | ∞ |
| SMP | Sampling | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| REC | Field reconstruction | 0.60 | R | $\sqrt{3}$ | 1 | 0.35 | ∞ |
| TRA | Forward transformation | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| SCA | Power density scaling | - | R | $\sqrt{3}$ | 1 | - | ∞ |
| SAV | Spatial averaging | 0.10 | R | $\sqrt{3}$ | 1 | 0.06 | ∞ |
| SDL | System detection limit | 0.04 | R | $\sqrt{3}$ | 1 | 0.02 | ∞ |
| **Uncertainty terms dependent on the DUT and environmental factors** | | | | | | | |
| PC | Probe coupling with DUT | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| MOD | Modulation response | 0.40 | R | $\sqrt{3}$ | 1 | 0.23 | ∞ |
| IT | Integration time | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| RT | Response time | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| DH | Device holder influence | 0.10 | R | $\sqrt{3}$ | 1 | 0.06 | ∞ |
| DA | DUT alignment | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| AC | RF ambient conditions | 0.04 | R | $\sqrt{3}$ | 1 | 0.02 | ∞ |
| AR | Ambient reflections | 0.04 | R | $\sqrt{3}$ | 1 | 0.02 | ∞ |
| MSI | Immunity / secondary reception | 0 | R | $\sqrt{3}$ | 1 | 0 | ∞ |
| DRI | Drift of the DUT | - | R | $\sqrt{3}$ | 1 | - | ∞ |
| Combined Standard Uncertainty | | | | | | 0.76 | ∞ |
| **Expanded Standard Uncertainty (95%)** | | | | | | **1.52** | |



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# 4. MEASUREMENT EQUIPMENTLIST

| Item | Type | Manufacturer | Model No. | Serial No. | Cal. Date | Cal. Interval |
|---|---|---|---|---|---|---|
| 1. | System Verification Device | SPEAG | 5G Verification Source 10 GHz | 1048 | 2022. 06. 16 | 1 Year |
| 2. | System Verification Device | SPEAG | 5G Verification Source 10 GHz | 2014 | 2021. 11. 01 | 1 Year |
| 3. | E-Field Probe | SPEAG | EUmmWV4 | 9544 | 2022. 04. 27 | 3 Years |
| 4. | E-Field Probe | SPEAG | EX3DV4 | 3855 | 2022. 09. 27 | 1 Year |
| 5. | Data Acquisition Electronic | SPEAG | DAE4 | 1337 | 2022. 03. 29 | 1 Year |
| 6. | Stäubli Robot TX90 XL | Stäubli | TX90 | F12/5K9SA1/ A101 | N.C.R. | N.C.R. |
| 7. | mmWave Phantom | SPEAG | QD 015 025CA | 1059 | N.C.R. | N.C.R. |
| 8. | D6.5GHzV2 system Validation Dipole | SPEAG | D6.5GHzV2 | 1051 | 2021. 11. 01 | 3 Years |
| 9. | ENA Network Analyzer | Agilent | E5071C-285 | MY46215502 | 2022. 05. 24 | 3 Years |
| 10. | SAR Software | SPEAG | Dasy6 SAR | V16.0.0.016 | N.C.R. | N.C.R. |
| 11. | SAR Software | SPEAG | C-6 module mmWave | V 2.02.34 | N.C.R. | N.C.R. |


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# 5. SAR MEASUREMENT SYSTEM

## 5.1. Definition of Specific Absorption Rate (SAR)

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.

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

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

SAR is expressed in units of Watts per kilogram (W/kg)
SAR measurement can be related to the electrical field in the tissue by

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

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

## 5.2. SPEAG DASY System

DASY system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY5 software defined. The DASY software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.


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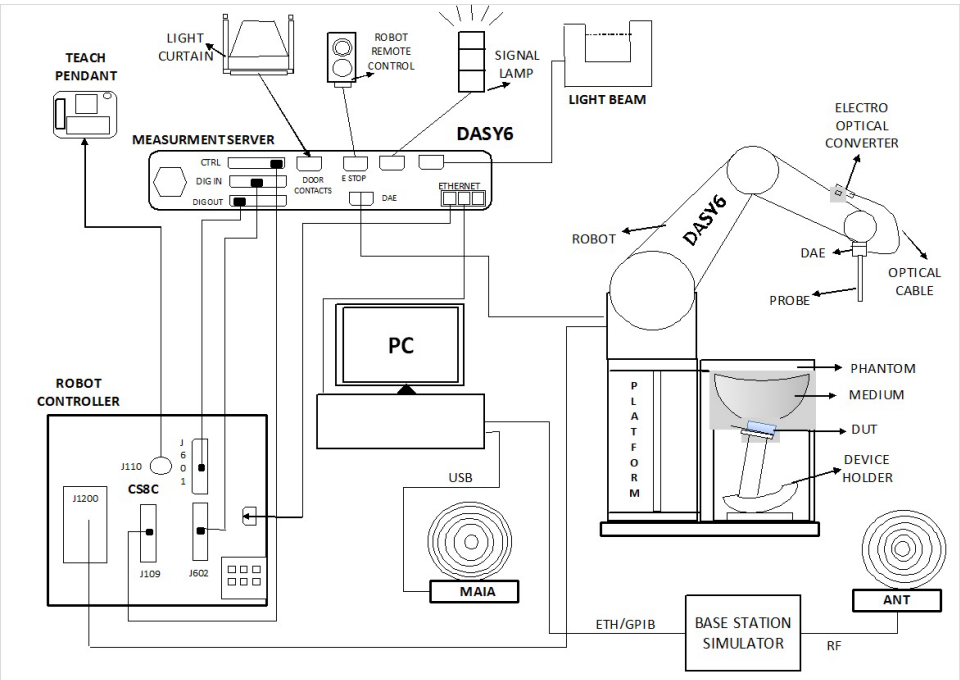


**Fig-3.1 DASY6 System Setup**

5.2.1. Robot

The DASY6 system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version CS8c from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

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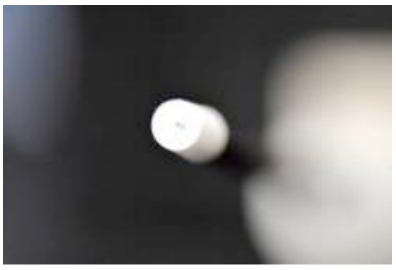
### 5.2.2. Probes

| | | |
|---|---|---|
| Model | EUmmWV4, |  |
| Frequency | 750 MHz to 110 GHz | |
| Dynamic Range | < 20 V/m - 10000 V/m with PRE-10<br>< 50 V/m - 3000 V/m minimum | |
| Linearity | < ±0.2 dB | |
| Hemispherical Isotropy | < 0.5 dB | |
| Position Precision | < 0.2 mm | |
| Dimensions | Overall length: 337 mm (tip: 20 mm)<br>Tip diameter: encapsulation 8 mm (internal sensor < 1mm)<br>Distance from probe tip to dipole centers: < 2 mm<br>Sensor displacement to probe's calibration point: < 0.3 mm | |

### 5.2.3. Data Acquisition Electronics (DAE)

| | | |
|---|---|---|
| Model | DAE4 | |
| Construction | Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY4/5 embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop. | |
| Measurement Range | -100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV) | |
| Input Offset Voltage | < 5µV (with auto zero) | |
| Input Bias Current | < 50 fA | |
| Dimensions | 60 x 60 x 68 mm | |



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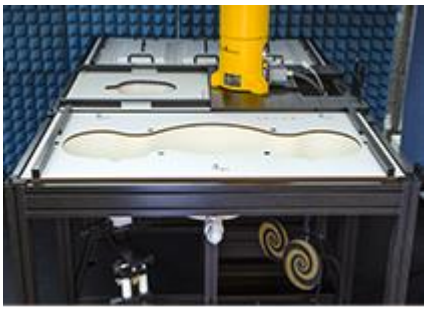
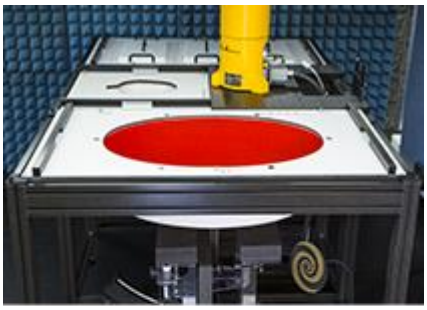
### 5.2.4. Phantom

| | | |
|---|---|---|
| Model | Twin SAM |  |
| Construction | The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot. | |
| Material | Vinylester, glass fiber reinforced (VE-GF) | |
| Shell Thickness | 2 ± 0.2 mm (6 ± 0.2 mm at ear point) | |
| Dimensions | Length: 1000 mm<br>Width: 500 mm<br>Height: adjustable feet | |
| Filling Volume | approx. 25 liters | |

| | | |
|---|---|---|
| Model | ELI |  |
| Construction | Phantom for compliance testing of handheld and body-mounted 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. | |
| Material | Vinylester, glass fiber reinforced (VE-GF) | |
| Shell Thickness | 2.0 ± 0.2 mm (bottom plate) | |
| Dimensions | Major axis: 600 mm<br>Minor axis: 400 mm | |
| Filling Volume | approx. 30 liters | |



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### 5.2.5. Device Holder

| | | |
|---|---|---|
| Model | Mounting Device | |
| Construction | In combination with the Twin SAM Phantom or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). | |
| Material | POM | |

| | | |
|---|---|---|
| Model | Laptop Extensions Kit | |
| Construction | Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. | |
| Material | POM, Acrylic glass, Foam | |

### 5.2.6. Reference Dipole

| | | |
|---|---|---|
| Model | System Validation Dipoles | |
| Construction | Symmetrical dipole with l/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions. | |
| Frequency | 750 MHz to 6500 MHz | |
| Return Loss | > 20 dB | |
| Power Capability | > 100 W (f < 1GHz), > 40 W (f > 1GHz) | |



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### 5.2.7. Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-5.1.

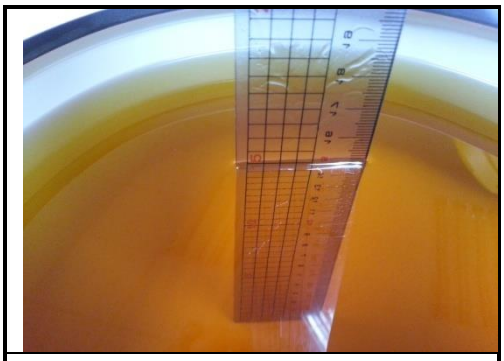

Photo of Liquid Height

The dielectric properties of the head tissue simulating liquids are defined in IEEE 1528 and FCC OET 65 Supplement C Appendix C. For the body tissue simulating liquids, the dielectric properties are defined in FCC OET 65 Supplement C Appendix C. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using an Agilent E5071C-285 Dielectric Probe Kit and an Agilent Network Analyzer.



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**Table-5.1 Targets of Tissue Simulating Liquid**

| Target Frequency [MHz] | Target Permittivity (εr) | Range of ± 5% | Target Conductivity σ[s/m] | Range of ± 5% |
|---|---|---|---|---|
| 750 | 41.9 | 39.805 ~ 43.995 | 0.89 | 0.846 ~ 0.935 |
| 835 | 41.5 | 39.425 ~ 43.575 | 0.90 | 0.855 ~ 0.945 |
| 900 | 41.5 | 39.425 ~ 43.575 | 0.97 | 0.922 ~ 1.019 |
| 1450 | 40.5 | 38.475 ~ 42.525 | 1.20 | 1.140 ~ 1.260 |
| 1640 | 40.3 | 38.285 ~ 42.315 | 1.29 | 1.226 ~ 1.355 |
| 1750 | 40.1 | 38.095 ~ 42.105 | 1.37 | 1.302 ~ 1.439 |
| 1800 | 40.0 | 38.000 ~ 42.000 | 1.40 | 1.330 ~ 1.470 |
| 1900 | 40.0 | 38.000 ~ 42.000 | 1.40 | 1.330 ~ 1.470 |
| 2000 | 40.0 | 38.000 ~ 42.000 | 1.40 | 1.330 ~ 1.470 |
| 2300 | 39.5 | 37.525 ~ 41.475 | 1.67 | 1.587 ~ 1.754 |
| 2450 | 39.2 | 37.240 ~ 41.160 | 1.80 | 1.710 ~ 1.890 |
| 2600 | 39.0 | 37.050 ~ 40.950 | 1.96 | 1.862 ~ 2.058 |
| 3500 | 37.9 | 36.005 ~ 39.795 | 2.91 | 2.765 ~ 3.056 |
| 5200 | 36.0 | 34.2.00 ~ 37.800 | 4.66 | 4.427 ~ 4.893 |
| 5300 | 35.9 | 34.105 ~ 37.695 | 4.76 | 4.522 ~ 4.998 |
| 5500 | 35.6 | 33.820 ~ 37.380 | 4.96 | 4.712 ~ 5.208 |
| 5600 | 35.5 | 33.725 ~ 37.275 | 5.07 | 4.817 ~ 5.324 |
| 5800 | 35.3 | 33.535 ~ 37.065 | 5.27 | 5.007 ~ 5.534 |
| 6000 | 35.1 | 33.345~ 36.855 | 5.48 | 5.206 ~ 5.754 |
| 6500 | 34.5 | 32.775 ~ 36.225 | 6.07 | 5.767 ~ 6.374 |
| 7000 | 33.9 | 32.205 ~ 35.595 | 6.65 | 6.318 ~ 6.983 |


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## Table-5.2-1 Recipes of Tissue Simulating Liquid, 30MHz to 900MHz

| **Frequency (MHz)** | **30** | **50** | | **144** | | **450** | | **835** | **900** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recipe source number** | 3 | 3 | 2 | 2 | 3 | 2 | 4 | 2 | 2 | 4 |
| **Ingredients (% by weight)** | | | | | | | | | | |
| De-ionized water | 48,30 | 48,30 | 53,53 | 55,12 | 48,30 | 48,53 | 56 | 50,36 | 50,31 | 56 |
| Tween 20 | | | 44,70 | 43,31 | | 49,51 | | 48,39 | 48,34 | |
| Oxidized mineral oil | | | | | | | 44 | | | 44 |
| Diethylenglycol monohexylether | | | | | | | | | | |
| Triton X-100 | | | | | | | | | | |
| Diacetin | 50,00 | 50,00 | | | 50,00 | | | | | |
| DGBE | | | | | | | | | | |
| NaCl | 1,60 | 1,60 | 1,77 | 1,57 | 1,60 | 1,96 | | 1,25 | 1,35 | |
| Additives and salt | 0,10 | 0,10 | | | 0,10 | | | | | |
| **Measured temperature dependence** | | | | | | | | | | |
| **Temp. (°C)** | | | 21 | 21 | | 21 | 20 | 21 | 21 | 20 |
| $\varepsilon_{\text{liquid temp. unc.}}$ (%) | 0,8 | 0,1 | | | 0,1 | 0,1 | | 0,04 | 0,04 | |
| $\sigma_{\text{liquid temp. unc.}}$ (%) | 2,8 | 2,8 | | | 2,6 | 4,2 | | 1,6 | 1,6 | |

## Table-5.2-2 Recipes of Tissue Simulating Liquid, 1800MHz to 10000MHz

| **Frequency (MHz)** | **1 800** | | **2 450** | **4 000** | **5 000** | **5 200** | **5 800** | **6 000** | **8 000** | **10 000** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Recipe source number** | 2 | 4 | 4 | 4 | 4 | 1 | 1 | 4 | 5 | 5 |
| **Ingredients (% by weight)** | | | | | | | | | | |
| De-ionized water | 54,23 | 56 | 56 | 56 | 56 | 65,53 | 65,53 | 56 | 67,8 | 66,0 |
| Tween | 45,27 | | | | | | | | 31,1 | 33,0 |
| Oxidized mineral oil | | 44 | 44 | 44 | 44 | | | 44 | | |
| Diethylenglycol monohexylether | | | | | | 17,24 | 17,24 | | | |
| Triton X-100 | | | | | | 17,24 | 17,24 | | | |
| Diacetin | | | | | | | | | | |
| DGBE | | | | | | | | | | |
| NaCl | 0,50 | | | | | | | | | |
| Additives and salt | | | | | | | | | | |
| **Measured temperature dependence** | | | | | | | | | | |
| **Temp. (°C)** | 21 | 20 | 20 | 20 | 20 | 22 | 22 | 20 | 20 | 20 |
| $\varepsilon_{\text{liquid temp. unc.}}$ (%) | 0,4 | | | | | 1,7 | 1,8 | | | |
| $\sigma_{\text{liquid temp. unc.}}$ (%) | 2,3 | | | | | 2,7 | 2,6 | | | |

NOTE 1 Multiple columns under a single frequency indicate optional recipes.

NOTE 2 Recipe source numbers: 1 verified by different labs, 2 Reference [59], 3 developed by IT'IS Foundation, 4 developed by IT'IS Foundation, 5 Reference [60].

NOTE 3 The values of $\varepsilon_{\text{liquid temp. unc.}}$ and $\sigma_{\text{liquid temp. unc.}}$ are liquid temperature uncertainties described in O.9.6, based on measurements of the applicable liquid recipes given above. These are not part of the original publications but have been subsequently developed by the project team.

NOTE 4 The recipes at 8 000 MHz and 10 000 MHz are sufficiently broadband that they cover the frequency range of 6 000 MHz to 10 000 MHz within a tolerance of ±10 % for permittivity and conductivity.



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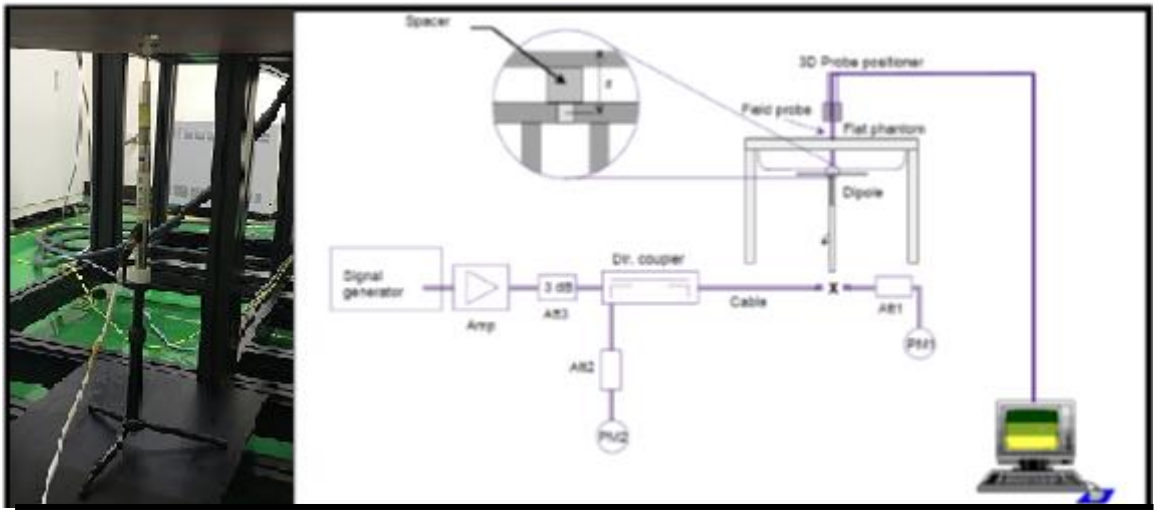
## 5.3. SAR System Verification

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.




The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The power meter PM1 measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power (250 mW is used for 700 MHz to 3 GHz, 100 mW is used for 3.5 GHz to 6.5 GHz) at the dipole connector and the power meter PM2 is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2.

After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.



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### 5.3.1. SAR System Verification Result

Dipole Kit: D6.5GHzV2

Test Date: 2022. 10. 20 Liquid Temp. [℃]: 20.0

| Frequency [MHz] | 1g SAR | | | | | 10g SAR | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6500MHz | Zoom Scan to 100mW | Normalize to 1W | Target Value Reference result ± 10% window | | | Zoom Scan to 100mW | Normalize to 1W | Target Value Reference result ± 10% window | | |
| | 27.8 | 278 | 288 | | | 5.65 | 56.5 | 53.6 | | |
| | | | 259.20 | to | 316.80 | | | 48.24 | to | 58.96 |

Dipole Kit: D6.5GHzV2

Test Date: 2022. 10. 27 Liquid Temp. [℃]: 20.0

| Frequency [MHz] | 1g SAR | | | | | 10g SAR | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6500MHz | Zoom Scan to 100mW | Normalize to 1W | Target Value Reference result ± 10% window | | | Zoom Scan to 100mW | Normalize to 1W | Target Value Reference result ± 10% window | | |
| | 28.4 | 284 | 288 | | | 5.57 | 55.7 | 53.6 | | |
| | | | 259.20 | to | 316.80 | | | 48.24 | to | 58.96 |

Dipole Kit: D6.5GHzV2

Test Date: 2022. 12. 07 Liquid Temp. [℃]: 21.0

| Frequency [MHz] | 1g SAR | | | | | 10g SAR | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6500MHz | Zoom Scan to 100mW | Normalize to 1W | Target Value Reference result ± 10% window | | | Zoom Scan to 100mW | Normalize to 1W | Target Value Reference result ± 10% window | | |
| | 28.9 | 289 | 288 | | | 5.70 | 57.0 | 53.6 | | |
| | | | 259.20 | to | 316.80 | | | 48.24 | to | 58.96 |



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### 5.3.2. SAR System Check Data

.

**Measurement Report for D6.5GHz, , , UID 0 -, Channel 0 (6500.0MHz)**

**Device under Test Properties**

| Model, Manufacturer | Dimensions [mm] | IMEI | DUT Type |
|---|---|---|---|
| D6.5GHz, | 50.0 x 10.0 x 8.0 | | Other |

**Exposure Conditions**

| Phantom Section, TSL | Position, Test Distance [mm] | Band | Group, UID | Frequency [MHz], Channel Number | Conversion Factor | TSL Conductivity [S/m] | TSL Permittivity |
|---|---|---|---|---|---|---|---|
| Flat, HSL | , | | , 0-- | 6500.0, 0 | 5.55 | 6.08 | 34.0 |

**Hardware Setup**

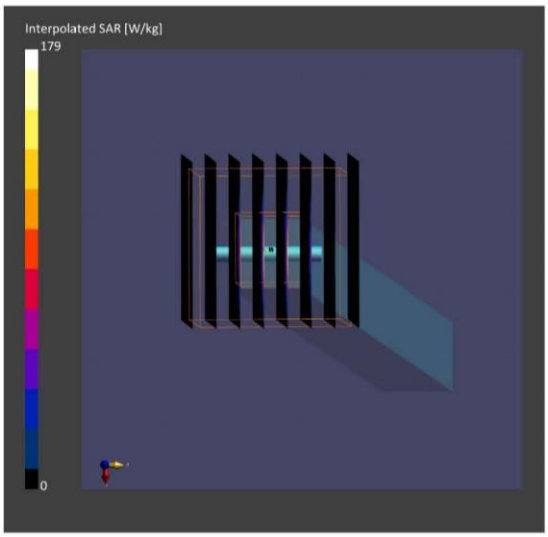
| Phantom | TSL, Measured Date | Probe, Calibration Date | DAE, Calibration Date |
|---|---|---|---|
| ELI V5.0 (20deg probe tilt) - 1170 | HBBL-600-10000 | EX3DV4 - SN3855, 2022-09-27 | DAE4 Sn1337, 2022-03-29 |

**Scan Setup**

| | Area Scan | Zoom Scan |
|---|---|---|
| Grid Extents [mm] | 51.0 x 85.0 | 22.0 x 22.0 x 22.0 |
| Grid Steps [mm] | 8.5 x 8.5 | 3.4 x 3.4 x 1.4 |
| Sensor Surface [mm] | 3.0 | 1.4 |
| Graded Grid | Yes | Yes |
| Grading Ratio | 1.5 | 1.4 |
| MAIA | N/A | N/A |
| Surface Detection | VMS + 6p | VMS + 6p |
| Scan Method | Measured | Measured |

**Measurement Results**

| | Area Scan | Zoom Scan |
|---|---|---|
| Date | 2022-10-20 | 2022-10-20 |
| psSAR1g [W/kg] | 24.1 | 27.8 |
| psSAR10g [W/kg] | 5.47 | 5.65 |
| psAPD (1.0cm2, sq) [W/m2] | | 279 |
| psAPD (4.0cm2, sq) [W/m2] | | 133 |
| Power Drift [dB] | -0.06 | 0.05 |
| Power Scaling | Disabled | Disabled |
| Scaling Factor [dB] | | |
| TSL Correction | No correction | No correction |
| M2/M1 [%] | | 52.2 |
| Dist 3dB Peak [mm] | | 4.1 |



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.

**Measurement Report for D6.5GHz, , , UID 0 -, Channel 0 (6500.0MHz)**

**Device under Test Properties**

| Model, Manufacturer | Dimensions [mm] | IMEI | DUT Type |
|---|---|---|---|
| D6.5GHz, | 50.0 x 10.0 x 8.0 | | Phone |

**Exposure Conditions**

| Phantom Section, TSL | Position, Test Distance [mm] | Band | Group, UID | Frequency [MHz], Channel Number | Conversion Factor | TSL Conductivity [S/m] | TSL Permittivity |
|---|---|---|---|---|---|---|---|
| Flat, HSL | , | | , 0-- | 6500.0, 0 | 5.55 | 6.08 | 34.0 |

**Hardware Setup**

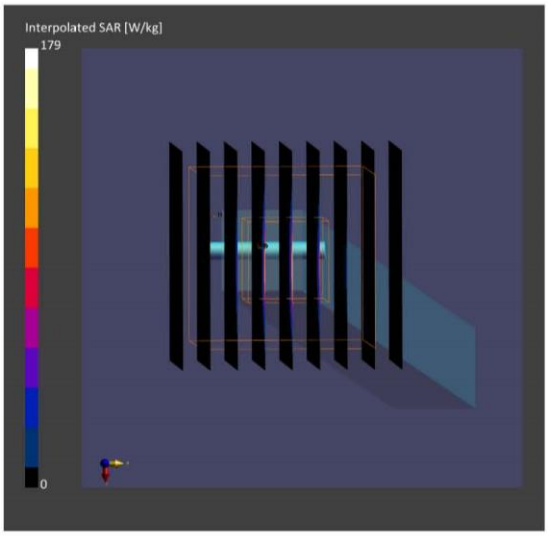
| Phantom | TSL, Measured Date | Probe, Calibration Date | DAE, Calibration Date |
|---|---|---|---|
| ELI V5.0 (20deg probe tilt) - 1170 | HBBL-600-10000 | EX3DV4 - SN3855, 2022-09-27 | DAE4 Sn1337, 2022-03-29 |

**Scan Setup**

| | Area Scan | Zoom Scan |
|---|---|---|
| Grid Extents [mm] | 51.0 x 85.0 | 22.0 x 22.0 x 22.0 |
| Grid Steps [mm] | 8.5 x 8.5 | 3.4 x 3.4 x 1.4 |
| Sensor Surface [mm] | 3.0 | 1.4 |
| Graded Grid | Yes | Yes |
| Grading Ratio | 1.5 | 1.4 |
| MAIA | N/A | N/A |
| Surface Detection | VMS + 6p | VMS + 6p |
| Scan Method | Measured | Measured |

**Measurement Results**

| | Area Scan | Zoom Scan |
|---|---|---|
| Date | 2022-10-27 | 2022-10-27 |
| psSAR1g [W/kg] | 24.6 | 28.4 |
| psSAR10g [W/kg] | 5.35 | 5.57 |
| psAPD (1.0cm2, sq) [W/m2] | | 284 |
| psAPD (4.0cm2, sq) [W/m2] | | 136 |
| Power Drift [dB] | -0.02 | 0.09 |
| Power Scaling | Disabled | Disabled |
| Scaling Factor [dB] | | |
| TSL Correction | No correction | No correction |
| M2/M1 [%] | | 53.9 |
| Dist 3dB Peak [mm] | | 4.4 |



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.

**Measurement Report for D6.5GHz, , , UID 0 -, Channel 0 (6500.0MHz)**

**Device under Test Properties**

| Model, Manufacturer | Dimensions [mm] | IMEI | DUT Type |
|---|---|---|---|
| D6.5GHz, | 50.0 x 10.0 x 8.0 | | Other |

**Exposure Conditions**

| Phantom Section, TSL | Position, Test Distance [mm] | Band | Group, UID | Frequency [MHz], Channel Number | Conversion Factor | TSL Conductivity [S/m] | TSL Permittivity |
|---|---|---|---|---|---|---|---|
| Flat, HSL | 5.00 | | , 0-- | 6500.0, 0 | 5.55 | 6.08 | 34.0 |

**Hardware Setup**

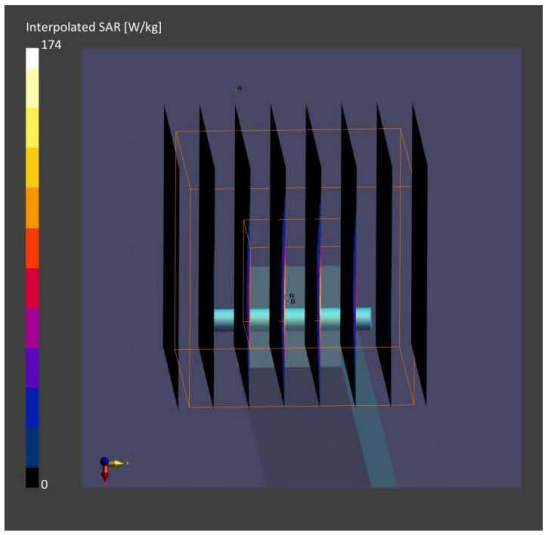
| Phantom | TSL, Measured Date | Probe, Calibration Date | DAE, Calibration Date |
|---|---|---|---|
| ELI V5.0 (20deg probe tilt) - 1170 | HBBL-600-10000 | EX3DV4 - SN3855, 2022-09-27 | DAE4 Sn1337, 2022-03-29 |

**Scan Setup**

| | Area Scan | Zoom Scan |
|---|---|---|
| Grid Extents [mm] | 51.0 x 85.0 | 22.0 x 22.0 x 22.0 |
| Grid Steps [mm] | 8.5 x 8.5 | 3.4 x 3.4 x 1.4 |
| Sensor Surface [mm] | 3.0 | 1.4 |
| Graded Grid | Yes | Yes |
| Grading Ratio | 1.5 | 1.4 |
| MAIA | N/A | N/A |
| Surface Detection | VMS + 6p | VMS + 6p |
| Scan Method | Measured | Measured |

**Measurement Results**

| | Area Scan | Zoom Scan |
|---|---|---|
| Date | 2022-12-07 | 2021-12-07 |
| psSAR1g [W/kg] | 26.2 | 28.9 |
| psSAR10g [W/kg] | 5.48 | 5.70 |
| psAPD (1.0cm2, sq) [W/m2] | | 289 |
| psAPD (4.0cm2, sq) [W/m2] | | 133 |
| Power Drift [dB] | -0.08 | 0.03 |
| Power Scaling | Disabled | Disabled |
| Scaling Factor [dB] | | |
| TSL Correction | No correction | No correction |
| M2/M1 [%] | | 52.7 |
| Dist 3dB Peak [mm] | | 4.3 |



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## 5.4. SAR Measurement Procedure

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

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

The SAR measurement procedures for each of test conditions are as follows:

(a) Make EUT to transmit maximum output power
(b) Measure conducted output power through RF cable
(c) Place the EUT in the specific position of phantom
(d) Perform SAR testing steps on the DASY system
(e) Record the SAR value

### 5.4.1. Area & Zoom Scan Procedure

According to IEC/IEEE 62209-1528, the resolution for Area and Zoom scan is specified in the table below.

| Items | ≤ 2 GHz | 2-3 GHz | 3-4 GHz | 4-5 GHz | 5-6 GHz |
|---|---|---|---|---|---|
| Area Scan (Δx, Δy) | ≤ 15mm | ≤ 12mm | ≤ 12mm | ≤ 10mm | ≤ 10mm |
| Zoom Scan (Δx, Δy) | ≤ 8mm | ≤ 5mm | ≤ 5mm | ≤ 4mm | ≤ 4mm |
| Zoom Scan (Δz) | ≤ 5mm | ≤ 5mm | ≤ 4mm | ≤ 3mm | ≤ 2mm |
| Zoom Scan Volume | ≥30mm | ≥30mm | ≥28mm | ≥25mm | ≥22mm |

Note:
When zoom scan is required and report SAR is <= 1.4 W/kg, the zoom scan resolution of Δx / Δy (2-3GHz: ≤ 8 mm, 3-4GHz: ≤ 7 mm, 4-6GHz: ≤ 5 mm) may be applied.

According to IEC/IEEE 62209-1528, if the zoom scan measured as specified in the preceding paragraphs complies with both of the following items, or if the peak spatial-average SAR is below 0.1 W/kg, no additional measurements are needed:

(1) The smallest horizontal distance from the local SAR peaks to all points 3 dB below the SAR peak shall be larger than the horizontal gird steps in both x and y directions (Δx, Δy). This shall be checked for the measured zoom scan plane conformal to the phantom at the distance $z_{M1}$.
(2) The ratio of the SAR at the second measured point (M2) to the SAR at the closest measured point (M1) at the x, y location of the measured mazimum SAR value shall be at least 30%.


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5.4.2. Volume Scan Procedure

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

5.4.3. Power Drift Monitoring

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

5.4.4. Spatial Peak SAR Evaluation

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

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

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

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


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### 5.4.5. SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.



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# 6. POWER DENSITY MEASUREMENT SYSTEM

## 6.1. Definition of Power Density

- The power density for an electromagnetic field represents the rate of energy transfer per unit area. The local power density at a given spatial point is deduced from electromagnetic fields by the following formula:
  S energy per unit time and unit area crossing the infinitesimal surface d*A* characterized by the normal unit vector ˆn

$$S = \frac{1}{T}\int (\mathbf{E}\times\mathbf{H})\cdot\hat{\mathbf{n}}\,dT$$

  where E and H are the electric and magnetic fields as function of time, respectively, and T is the period of the waveform.

- The spatial-average power density distribution on the evaluation surface is determined per the IEC TR 63170. The spatial area, A is specified by the applicable exposure limit or regulatory requirements. The circular shape was used.

$$S_{av} = \frac{1}{2A}\Re\left(\int \mathbf{E}\times\mathbf{H}^{*}\cdot\hat{\mathbf{n}}\,dA\right)$$



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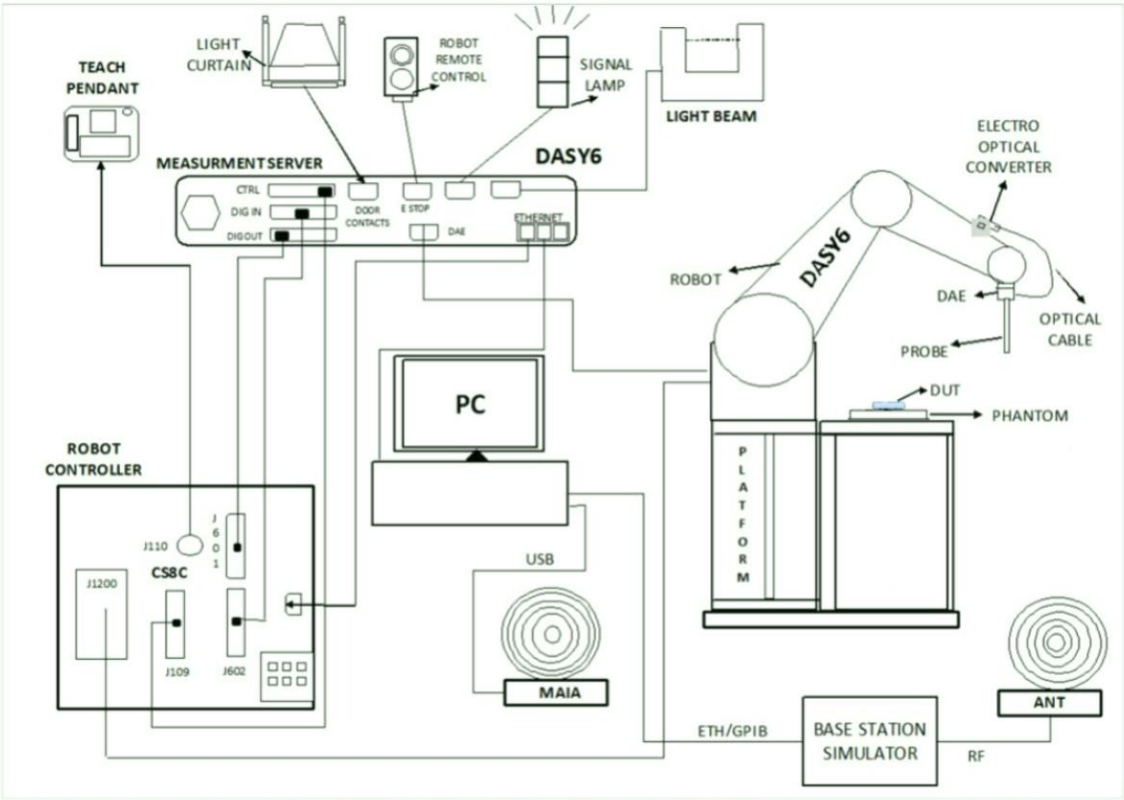
## 6.2. Measurement Setup

DASY system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY6 software defined. The DASY software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.



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### 6.2.1. Robot

The DASY6 system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version CS8c from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

### 6.2.2. EUmmWv2 mm-Wave Probe

The EUmmWV2 probe is based on the pseudo-vector probe design, which not only measures the field magnitude but also derives its polarization ellipse. This probe concept also has the advantage that the sensor angle errors or distortions of the field by the substrate can be largely nullified by calibration. This is particularly important as, at these very high frequencies, field distortions by the substrate are dependent on the wavelength. The design entails two small 0.8 mm dipole sensors mechanically protected by high-density foam, printed on both sides of a 0.9 mm wide and 0.12 mm thick glass substrate. The body of the probe is specifically constructed to minimize distortion by the scattered fields.

The probe consists of two sensors with different angles arranged in the same plane in the probe axis. Three or more measurements of the two sensors are taken for different probe rotational angles to derive the amplitude and polarization information. These probes are the most flexible and accurate probes currently available for measuring field amplitude.



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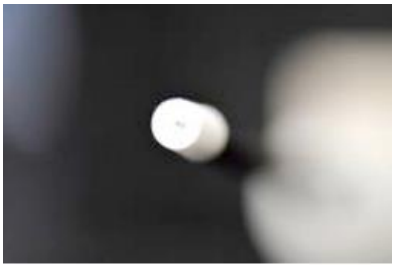
The probe design allows measurements at distances as small as 2 mm from the sensors to the surface of the device under test (DUT). The typical sensor to probe tip distance is 1.5 mm. The exact distance is calibrated.

| | | |
|---|---|---|
| Model | EUmmWV4 |  |
| Frequency | 750 MHz to 110 GHz | |
| Dynamic Range | < 20 V/m - 10000 V/m with PRE-10<br>< 50 V/m - 3000 V/m minimum | |
| Linearity | < ±0.2 dB | |
| Hemispherical Isotropy | < 0.5 dB | |
| Position Precision | < 0.2 mm | |
| Dimensions | Overall length: 337 mm (tip: 20 mm)<br>Tip diameter: encapsulation 8 mm (internal sensor < 1mm)<br>Distance from probe tip to dipole centers: < 2 mm<br>Sensor displacement to probe's calibration point: < 0.3 mm | |

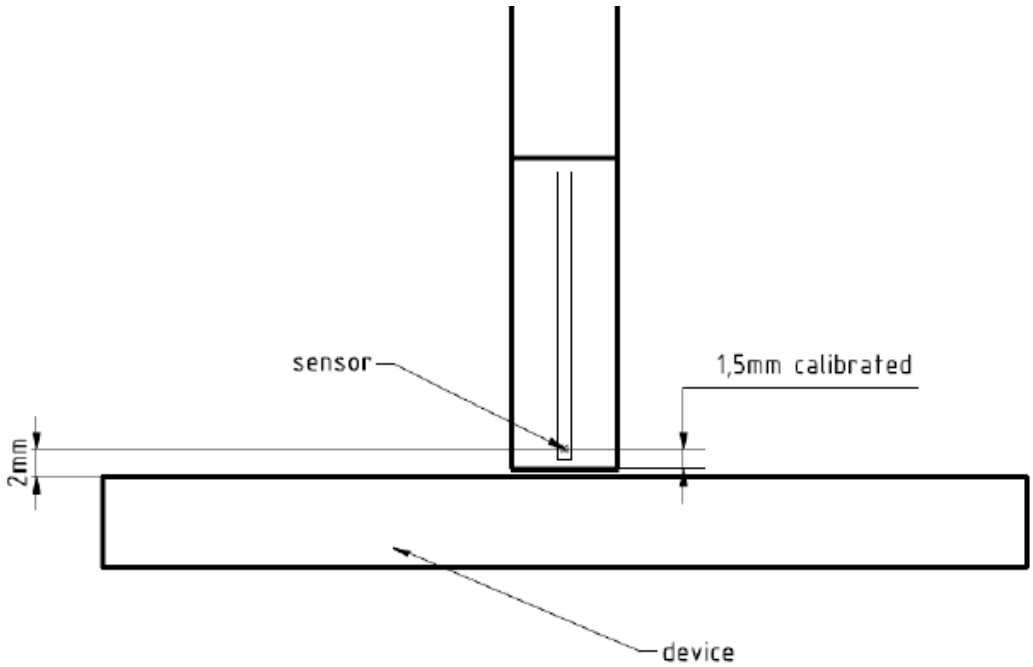



Illustration of Distance-Sensor to EUT Surface



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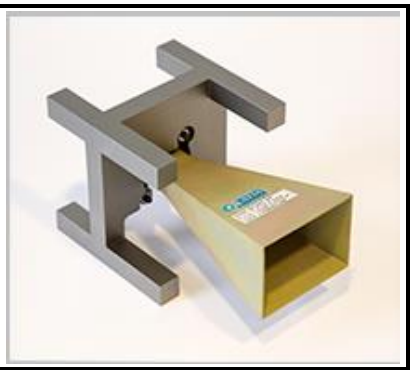
### 6.2.3. System Verification Sources

| | | |
|---|---|---|
| Item | 5G Verification Source 10 GHz |  |
| Frequency | 10GHz at 10mm from the antenna | |
| E-field polarization | linear | |
| Input power | max.20W | |
| Connector | SMA | |
| Operation | requires a stable source with known forward power to perform system performance check or validation | |

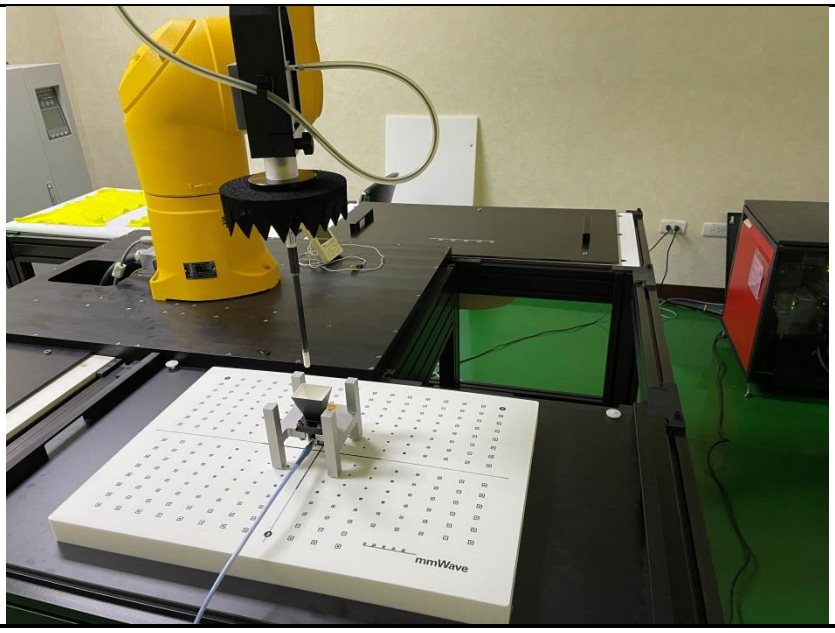
## 6.3. Power Density System Verification

The system was verified to be within ±0.66 dB of the power density targets on the calibration certificate according to the test system specification in the user's manual and calibration facility recommendation. The ±0.66 dB deviation threshold represents the expanded uncertainty for system performance checks using SPEAG's mmWave verification sources. The same spatial resolution and measurement region used in the source calibration was applied during the system check.

System check using 10 GHz source to support 6-7GHz incident-PD results done with EUmmWV probe, the test procedure was following by the SPEAG AppNote Procedures for Device Operating at 6 – 10GHz.

| Frequency (GHz) | Grid Step | Grid Extent X/Y (mm) | Measurement Points |
|---|---|---|---|
| 10 | 0.25 (λ/4) | 120/120 | 16x16 |

System Verification Setup Photo



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### 6.3.1. System Verification Result

| System Verification Antenna: 5G Verfication Source 10GHz (S/N: 2014)<br>Test Date: 2022. 10. 29 | | | | | |
|---|---|---|---|---|---|
| Square Averaging | | | | | |
| Frequency | Avg. Area | Target Avg Power Density ($W/m^2$) | Measured Avg Power Density (W/m2) | Difference (dB) | Uncertainty (dB) |
| 10GHz | $4cm^2$ | 149.00 | 132.00 | -0.53 | ±0.66 |
| Remark: 1. Distance Horn Aperture to measured plane is 10.0m<br>Remark: 2. Difference = log(Measured Avg Power Density/Target Avg Power Density)*10<br>Remark: 3. Measured Avg Power Density = [(psPDn+)+(psPDtot+)+(psPDmod+)]/3 | | | | | |

| System Verification Antenna: 5G Verfication Source 10GHz (S/N: 1048)<br>Test Date: 2022. 12. 08 | | | | | |
|---|---|---|---|---|---|
| Square Averaging | | | | | |
| Frequency | Avg. Area | Target Avg Power Density ($W/m^2$) | Measured Avg Power Density (W/m2) | Difference (dB) | Uncertainty (dB) |
| 10GHz | $4cm^2$ | 47.80 | 45.60 | -0.20 | ±0.66 |
| Remark: 1. Distance Horn Aperture to measured plane is 10.0m<br>Remark: 2. Difference = log(Measured Avg Power Density/Target Avg Power Density)*10<br>Remark: 3. Measured Avg Power Density = [(psPDn+)+(psPDtot+)+(psPDmod+)]/3 | | | | | |

Note:
1. The difference between the normalized measured local power density and the numerically validated target value is within the reported expanded uncertainty of the measurement system
2. The difference between the measured local power density and the measured reference value is within ±10 % for system repeatability.



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**Measurement Report for Device, FRONT, Validation band, UID 0 -, Channel 10000 (10000.0MHz)**

**Device under Test Properties**

| Model, Manufacturer | Dimensions [mm] | IMEI | DUT Type |
|---|---|---|---|
| , Device | 100.0 x 100.0 x 100.0 | | Phone |

**Exposure Conditions**

| Phantom Section | Position, Test Distance [mm] | Band | Group, UID | Frequency [MHz], Channel Number | Conversion Factor |
|---|---|---|---|---|---|
| 5G Air | FRONT, 10.00 | Validation band | CW, 0-- | 10000.0, 10000 | 1.0 |

**Hardware Setup**

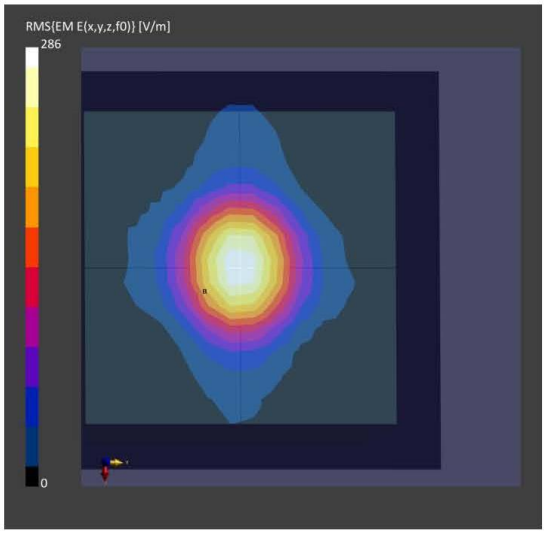
| Phantom | Medium | Probe, Calibration Date | DAE, Calibration Date |
|---|---|---|---|
| mmWave- 1059 | Air--- | EUmmWV4 - SN9544_F1-55GHz, 2022-04-27 | DAE4 Sn1337, 2022-03-29 |

**Scan Setup**

| | 5G Scan |
|---|---|
| Grid Extents [mm] | 120.0 x 120.0 |
| Grid Steps [lambda] | 0.25 x 0.25 |
| Sensor Surface [mm] | 10.0 |
| MAIA | N/A |

**Measurement Results**

| | 5G Scan |
|---|---|
| Date | 2022-10-29 |
| Avg. Area [$cm^2$] | 4.00 |
| psPDn+ [$W/m^2$] | 129 |
| psPDtot+ [$W/m^2$] | 132 |
| psPDmod+ [$W/m^2$] | 138 |
| $E_{max}$ [V/m] | 286 |
| Power Drift [dB] | 0.01 |



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**Measurement Report for Device, FRONT, Validation band, UID 0 -, Channel 10000 (10000.0MHz)**

**Device under Test Properties**

| Model, Manufacturer | Dimensions [mm] | IMEI | DUT Type |
|---|---|---|---|
| , Device | 100.0 x 100.0 x 172.0 | | - |

**Exposure Conditions**

| Phantom Section | Position, Test Distance [mm] | Band | Group, UID | Frequency [MHz], Channel Number | Conversion Factor |
|---|---|---|---|---|---|
| 5G Air | FRONT, 10.00 | Validation band | CW, 0– | 10000.0, 10000 | 1.0 |

**Hardware Setup**

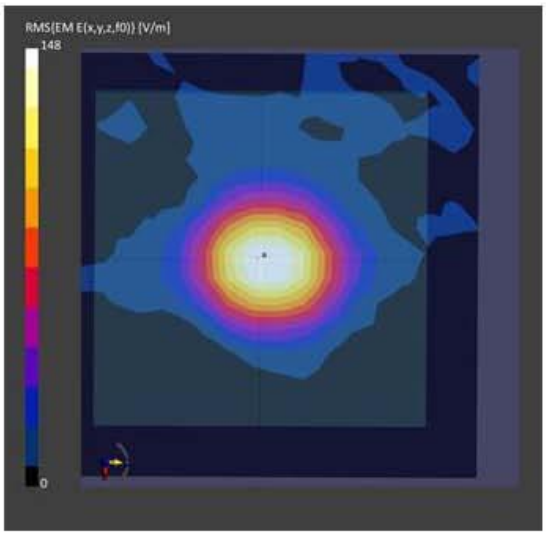
| Phantom | Medium | Probe, Calibration Date | DAE, Calibration Date |
|---|---|---|---|
| mmWave- 1059 | Air–- | EUmmWV4 - SN9544_F1-55GHz, 2021-04-01 | DAE4 Sn679, 2020-05-06 |

**Scan Setup**

| | 5G Scan |
|---|---|
| Grid Extents [mm] | 120.0 x 120.0 |
| Grid Steps [lambda] | 0.25 x 0.25 |
| Sensor Surface [mm] | 10.0 |
| MAIA | N/A |

**Measurement Results**

| | 5G Scan |
|---|---|
| Date | 2022-12-08 |
| Avg. Area [cm²] | 4.00 |
| psPDn+ [W/m²] | 45.5 |
| psPDtot+ [W/m²] | 45.6 |
| psPDmod+ [W/m²] | 46.3 |
| $E_{max}$ [V/m] | 148 |
| Power Drift [dB] | -0.09 |



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## 6.4. Power Density Measurement Procedure

Please refer to standard IEC TR 63170 section 6.4.2.

### 6.4.1. Total field and power density reconstruction

Computation of the power density in general requires knowledge of the electric (E-) and magnetic (H-) field amplitudes and phases in the plane of incidence. Reconstruction of these quantities from pseudo-vector E-field measurements is feasible, as they are constrained by Maxwell's equations. A reconstruction approach based on the Gerchberg–Saxton algorithm has been developed, which benefits from the availability of the E-field polarization ellipse information obtained with the probe. This reconstruction algorithm, together with the ability of the probe to measure extremely close to the source without perturbing the field, permits reconstruction of the E- and H-fields, as well as of the power density, on measurement planes located as near as $\lambda/5$ away.

### 6.4.2. Power density averaging

The average of the reconstructed power density has been evaluated over a circular area in each measurement plane. The area of the circle is defined by the user; for this study the area was defined as 1 $cm^2$ and 4 $cm^2$. Note that the average is only evaluated for grid points where the averaging circle is completely filled with values; for points at the edge where the averaging circle is only partly filled with values, the averaged power density is set to zero.


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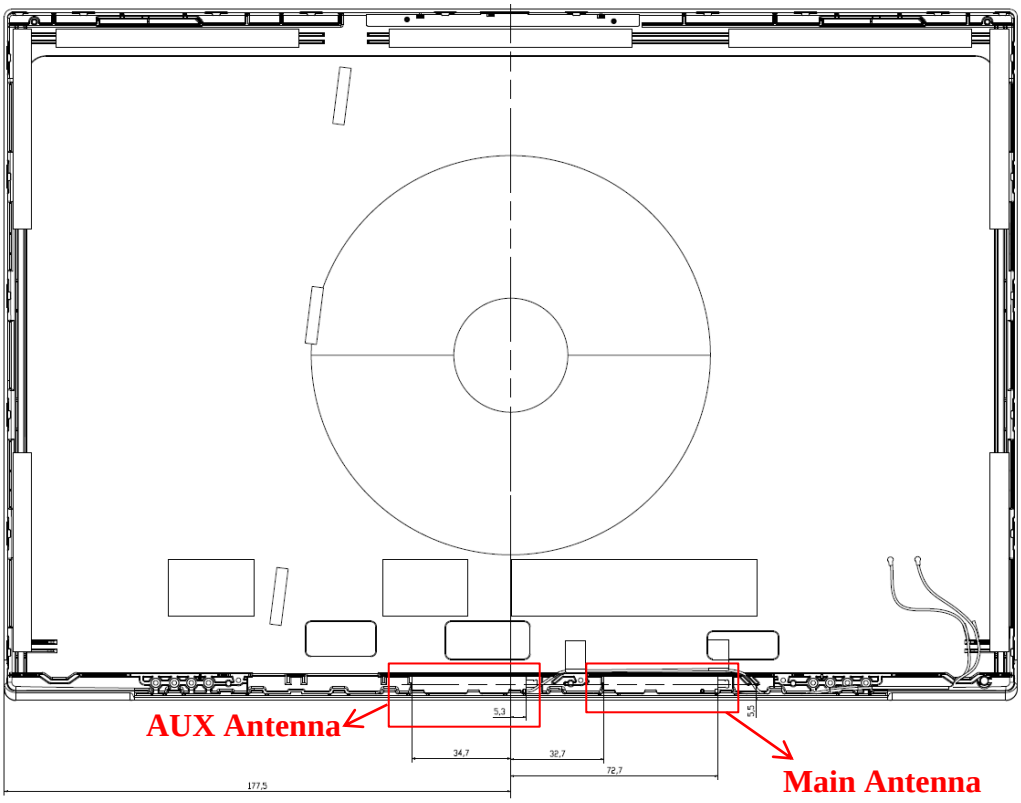
# 7. SAR MEASUREMENT EVALUATION

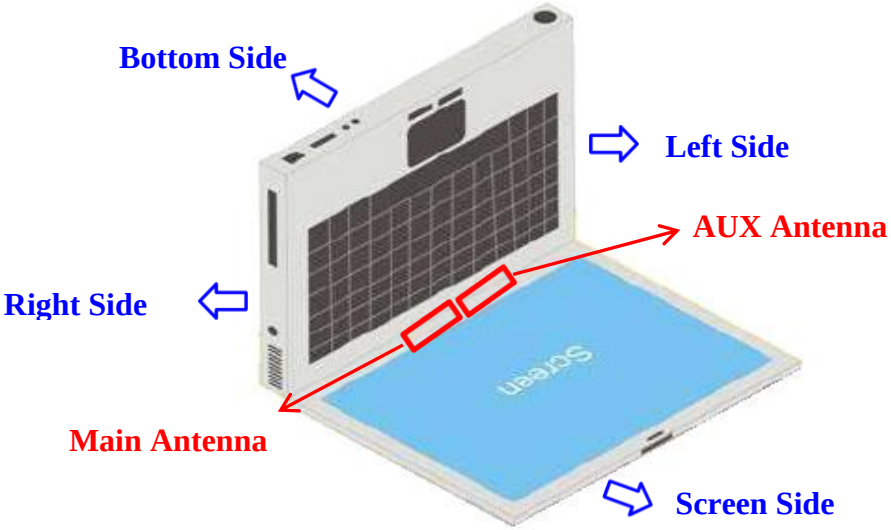
## 7.1. EUT Configuration and Setting

Test program "DRTU" is used for enabling EUT BT or WLAN function under continues transmitting and choosing data rate/ channel and supported stable power rating.

## 7.2. EUT Testing Position

**Antenna Location**



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**Antenna Distance to Edge**

| Antenna Distance to Edge (mm) | | | | |
|---|---|---|---|---|
| Antenna | Bottom Side | Left Side | Right Side | Screen Side |
| WLAN 6G | < 5 | 142.8 | 104.8 | < 5 |

The SAR testing required mode is listed as below.

| Antenna | Bottom Side | Left Side | Right Side | Screen Side |
|---|---|---|---|---|
| WLAN 6G | √ | | | √ |

## 7.3. Tissue Calibration Result

The dielectric parameters of the liquids were verified prior to the SAR evaluation using Aligent Dielectric Probe Kit and Aligent E5071C Vector Network Analyzer.

| Tissue Simulate Measurement | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frequency [MHz] | Description | Dielectric Parameters | | | | | | Tissue Temp. [℃] |
| | | $\varepsilon_r$ | | | σ[s/m] | | | |
| 6500MHz | Reference result ± 5% window | 34.50 | | | 6.07 | | | N/A |
| | | 32.775 | to | 36.225 | 5.767 | to | 6.374 | |
| | 2022. 10. 20 | 34.0 | | | 6.08 | | | 20 |
| | 2022. 10. 27 | 34.0 | | | 6.08 | | | 20 |
| | 2022. 12. 07 | 34.0 | | | 6.08 | | | 21 |



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# 8. SAR EXPOSURE LIMITS

## 8.1. RF Exposure Limits for Frequencies Blow 6GHz

- Uncontrolled Environment

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

- Controlled Environment

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

| Type Exposure | Uncontrolled Environment Limit | Controlled Environment Limit |
|---|---|---|
| Spatial Peak SAR<br>(1g cube tissue for brain or body) | 1.60 W/kg | 8.00 W/kg |
| Spatial Average SAR (whole body) | 0.08 W/kg | 0.40 W/kg |
| Spatial Peak SAR<br>(10g for hands, feet, ankles and wrist) | 4.00 W/kg | 20.00 W/kg |


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## 8.2. RF Exposure Limits for Frequencies Above 6GHz

Per FCC §1.1310 (d)(3), the MPE limits are applied for frequencies above 6GHz. Power Density is expressed in units of $W/m^2$ or $mW/cm^2$.

Peak Spatially Averaged Power Density was evaluated over a circular area 4 $cm^2$ per interim FCC Guidance for near-field power density evaluations per April 2019 TCB Workshop notes.

| Type Exposure | Uncontrolled Environment Limit | Controlled Environment Limit |
|---|---|---|
| Power Density | 1.0$mW/cm^2$ | 5.0$mW/cm^2$ |

Note: 1.0$mW/cm^2$ is 10$W/m^2$.



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# 9. CONDUCTED POWER MEASUREMENT

The measuring conducted power and maximum Tune-up power are shown as below:

- OFDM Modulation

| Mode | U-NII Band | Centre Frequency (MHz) | Output Power (dBm) | | | | | | SAR Test |
|---|---|---|---|---|---|---|---|---|---|
| | | | AUX | | | Main | | | |
| | | | Average Power | Tune-Up Limit | Scale Factor | Average Power | Tune-Up Limit | Scale Factor | |
| 802.11ax-HE20 | 5 | 5955 | 1.55 | 2.3 | --- | 1.31 | 2.0 | --- | No |
| | | 6175 | 1.42 | 2.0 | --- | 1.23 | 2.0 | --- | No |
| | | 6415 | 1.26 | 2.0 | --- | 1.27 | 2.0 | --- | No |
| | 6 | 6435 | 1.28 | 2.0 | --- | 1.35 | 2.0 | --- | No |
| | | 6475 | 1.60 | 2.3 | --- | 1.37 | 2.0 | --- | No |
| | | 6515 | 1.50 | 2.3 | --- | 1.25 | 2.0 | --- | No |
| | 7 | 6535 | 0.77 | 1.3 | --- | 0.49 | 1.0 | --- | No |
| | | 6695 | 0.79 | 1.3 | --- | 0.08 | 1.0 | --- | No |
| | | 6855 | 0.88 | 1.5 | --- | 0.15 | 1.0 | --- | No |
| | 8 | 6875 | 1.03 | 2.0 | --- | 0.29 | 1.0 | --- | No |
| | | 6995 | 0.81 | 1.5 | --- | 0.10 | 1.0 | --- | No |
| | | 7115 | -3.45 | -3.0 | --- | -2.95 | -1.5 | --- | No |
| 802.11ax-HE40 | 5 | 5965 | 5.20 | 6.0 | --- | 5.13 | 6.0 | --- | No |
| | | 6165 | 5.06 | 6.0 | --- | 5.05 | 6.0 | --- | No |
| | | 6405 | 4.89 | 5.5 | --- | 5.01 | 6.0 | --- | No |
| | 6 | 6445 | 4.83 | 5.5 | --- | 5.16 | 6.0 | --- | No |
| | | 6485 | 5.08 | 6.0 | --- | 5.10 | 6.0 | --- | No |
| | 7 | 6525 | 5.14 | 6.0 | --- | 5.09 | 6.0 | --- | No |
| | | 6685 | 4.36 | 5.0 | --- | 4.13 | 5.0 | --- | No |
| | | 6845 | 4.39 | 5.0 | --- | 4.02 | 5.0 | --- | No |
| | 8 | 6885 | 4.51 | 5.3 | --- | 4.21 | 5.0 | --- | No |
| | | 7005 | 4.36 | 5.0 | --- | 4.01 | 5.0 | --- | No |
| | | 7085 | 4.62 | 5.3 | --- | 4.35 | 5.0 | --- | No |
| 802.11ax-HE80 | 5 | 5985 | 7.03 | 8.0 | --- | 6.42 | 7.0 | --- | No |
| | | 6145 | 6.94 | 7.5 | --- | 6.25 | 7.0 | --- | No |
| | | 6385 | 7.19 | 8.0 | --- | 6.71 | 7.3 | --- | No |
| | 6 | 6465 | 6.99 | 7.5 | --- | 6.38 | 7.0 | --- | No |
| | | 6545 | 7.00 | 8.0 | --- | 6.27 | 7.0 | --- | No |
| | 7 | 6625 | 6.38 | 7.0 | --- | 5.40 | 6.0 | --- | No |
| | | 6705 | 6.08 | 7.0 | --- | 5.30 | 6.0 | --- | No |
| | | 6785 | 5.96 | 6.5 | --- | 5.22 | 6.0 | --- | No |
| | 8 | 6865 | 5.92 | 6.5 | --- | 5.34 | 6.0 | --- | No |
| | | 6945 | 6.10 | 7.0 | --- | 5.58 | 6.3 | --- | No |
| | | 7025 | 6.37 | 7.0 | --- | 5.72 | 6.3 | --- | No |



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| Mode | U-NII Band | Centre Frequency (MHz) | Output Power (dBm) | | | | | | SAR Test |
|---|---|---|---|---|---|---|---|---|---|
| | | | AUX | | | Main | | | |
| | | | Average Power | Tune-Up Limit | Scale Factor | Average Power | Tune-Up Limit | Scale Factor | |
| 802.11ax-HE160 | 5 | 6025 | 9.79 | 10.3 | 1.125 | 9.76 | 10.3 | 1.132 | Yes |
| | | 6185 | 9.90 | 10.5 | --- | 9.60 | 10.3 | --- | No |
| | | 6345 | 10.02 | 11.0 | 1.253 | 9.82 | 10.5 | 1.169 | Yes |
| | 6 | 6505 | 9.90 | 10.5 | 1.148 | 9.36 | 10.0 | 1.159 | Yes |
| | 7 | 6665 | 9.21 | 10.0 | 1.199 | 8.45 | 9.0 | 1.135 | Yes |
| | | 6825 | 8.95 | 9.5 | --- | 8.54 | 9.3 | --- | No |
| | 8 | 6985 | 9.21 | 10.0 | 1.199 | 8.90 | 9.5 | 1.148 | Yes |

Note: Per PCB workshop April 2021 U-NII 6-7GHz Interim procedure, Start with 5 minimum of test channels across full 5925-7125MHz band and adapt conducted power and SAR test reduction procedures of KDB 248227 v02r02.



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# 10. TEST RESULT

## 10.1. SAR Test Result

| | | | |
|---|---|---|---|
| Test Date | 2022. 10. 20 | Temp./Hum. | 22℃/72% |
| Test Voltage | AC 120V, 60Hz (with AC Adapter) | Tested by | Sean Wang |
| Test SKU | SKU #1 (with INPAQ Antenna) | | |

Liquid Temperature : 20.0℃ Depth of Liquid:＞15cm

**Test Mode: WIFI 6E**

| Remark | Test Position: Body | Antenna Position | Separation Distance (mm) | Freque-ncy | Conducted Power (dBm) | Maximum Tune-up (dBm) | SAR 1g (W/kg) | Scale Factor | Repor-ted SAR | Limit (W/kg) | psAPD[Note 2] ($W/m^2$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | 1 $cm^2$ | 4 $cm^2$ |
| 802.11ax-HE160 | | | | | | | | | | | | |
| Antenna:ANT 1-AUX | | | | | | | | | | | | |
| | Screen | Fixed | 5 | 6025 | 9.79 | 10.30 | 0.080 | 1.125 | 0.090 | 1.60 | 0.797 | 0.606 |
| | Screen | Fixed | 5 | 6345 | 10.02 | 11.00 | 0.083 | 1.253 | 0.104 | 1.60 | 0.829 | 0.604 |
| | Screen | Fixed | 5 | 6505 | 9.90 | 10.50 | 0.050 | 1.148 | 0.057 | 1.60 | 0.497 | 0.383 |
| | Screen | Fixed | 5 | 6665 | 9.21 | 10.00 | 0.030 | 1.199 | 0.036 | 1.60 | 0.298 | 0.233 |
| | Screen | Fixed | 5 | 6985 | 9.21 | 10.00 | 0.063 | 1.199 | 0.076 | 1.60 | 0.631 | 0.340 |
| | Bottom | Fixed | 0 | 6985 | 9.21 | 10.00 | 0.019 | 1.199 | 0.023 | 1.60 | 0.187 | 0.137 |
| Antenna: ANT 2-Main | | | | | | | | | | | | |
| | Screen | Fixed | 5 | 6025 | 9.76 | 10.30 | 0.096 | 1.132 | 0.109 | 1.60 | 0.962 | 0.736 |
| | Screen | Fixed | 5 | 6345 | 9.82 | 10.50 | 0.120 | 1.169 | **0.140** | 1.60 | 1.200 | 0.939 |
| | Screen | Fixed | 5 | 6505 | 9.36 | 10.00 | 0.025 | 1.159 | 0.029 | 1.60 | 0.253 | 0.209 |
| | Screen | Fixed | 5 | 6665 | 8.45 | 9.00 | 0.086 | 1.135 | 0.098 | 1.60 | 0.865 | 0.635 |
| Note 1 | Screen | Fixed | 5 | 6985 | 8.90 | 9.50 | **0.121** | 1.148 | 0.139 | 1.60 | 1.210 | 0.765 |
| Note 1 | Bottom | Fixed | 0 | 6985 | 8.90 | 9.50 | 0.025 | 1.148 | 0.029 | 1.60 | 0.248 | 0.161 |

Note: 1. We only presented the worst plots for each test configuration.
2. For reference purposes only, not specifically for compliance,



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| Test Date | 2022. 12. 07 | Temp./Hum. | 21℃/56% |
|---|---|---|---|
| Test Voltage | AC 120V, 60Hz (with AC Adapter) | Tested by | Sean Wang |
| Test SKU | SKU #1 (with LUXSHARE-ICT Antenna) | | |

Liquid Temperature : 21.0℃ Depth of Liquid:＞15cm

**Test Mode: WIFI 6E**

| Remark | Test Position: Body | Antenna Position | Separation Distance (mm) | Freque-ncy | Conducted Power (dBm) | Maximum Tune-up (dBm) | SAR 1g (W/kg) | Scale Factor | Repor-ted SAR | Limit (W/kg) | psAPD[Note 2] ($W/m^2$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | 1 $cm^2$ | 4 $cm^2$ |
| 802.11ax-HE160 | | | | | | | | | | | | |
| Antenna:ANT 1-AUX | | | | | | | | | | | | |
| | Screen | Fixed | 5 | 6025 | 9.79 | 10.30 | 0.043 | 1.125 | 0.048 | 1.60 | 0.426 | 0.208 |
| | Screen | Fixed | 5 | 6345 | 10.02 | 11.00 | 0.026 | 1.253 | 0.033 | 1.60 | 0.261 | 0.162 |
| | Screen | Fixed | 5 | 6505 | 9.90 | 10.50 | 0.086 | 1.148 | 0.099 | 1.60 | 0.862 | 0.674 |
| | Screen | Fixed | 5 | 6665 | 9.21 | 10.00 | 0.056 | 1.199 | 0.067 | 1.60 | 0.564 | 0.283 |
| | Screen | Fixed | 5 | 6985 | 9.21 | 10.00 | 0.053 | 1.199 | 0.064 | 1.60 | 0.527 | 0.247 |
| | Bottom | Fixed | 0 | 6665 | 9.21 | 10.00 | 0.013 | 1.199 | 0.016 | 1.60 | 0.131 | 0.102 |
| Antenna: ANT 2-Main | | | | | | | | | | | | |
| | Screen | Fixed | 5 | 6025 | 9.76 | 10.30 | 0.056 | 1.132 | 0.063 | 1.60 | 0.561 | 0.343 |
| | Screen | Fixed | 5 | 6345 | 9.82 | 10.50 | 0.077 | 1.169 | 0.090 | 1.60 | 0.775 | 0.436 |
| | Screen | Fixed | 5 | 6505 | 9.36 | 10.00 | 0.077 | 1.159 | 0.089 | 1.60 | 0.773 | 0.535 |
| Note 1 | Screen | Fixed | 5 | 6665 | 8.45 | 9.00 | **0.087** | 1.135 | **0.099** | 1.60 | 0.871 | 0.494 |
| | Screen | Fixed | 5 | 6985 | 8.90 | 9.50 | 0.047 | 1.148 | 0.054 | 1.60 | 0.472 | 0.272 |
| Note 1 | Bottom | Fixed | 0 | 6665 | 8.45 | 9.00 | 0.071 | 1.135 | 0.081 | 1.60 | 0.708 | 0.378 |

Note: 1. We only presented the worst plots for each test configuration.
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## Worst Case For SAR Test Result

| | | | |
|---|---|---|---|
| Test Date | 2022. 10. 20 | Temp./Hum. | 22℃/72% |
| Test Voltage | AC 120V, 60Hz (with AC Adapter) | Tested by | Sean Wang |
| Test SKU | SKU #2 (with INPAQ Antenna) | | |

| Liquid Temperature : 20.0℃ | | | | | | | | | | | | Depth of Liquid:＞15cm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Test Mode: WIFI 6E** | | | | | | | | | | | | |
| Remark | Test Position: Body | Antenna Position | Separation Distance (mm) | Freque-ncy | Conducted Power (dBm) | Maximum Tune-up (dBm) | SAR 1g (W/kg) | Scale Factor | Repor-ted SAR | Limit (W/kg) | psAPD[Note 2] ($W/m^2$) | |
| | | | | | | | | | | | 1 $cm^2$ | 4 $cm^2$ |
| 802.11ax-HE160 | | | | | | | | | | | | |
| Antenna:ANT 1-AUX | | | | | | | | | | | | |
| | Screen | Fixed | 5 | 6985 | 9.21 | 10.00 | 0.053 | 1.199 | 0.064 | 1.60 | 0.531 | 0.322 |
| Antenna: ANT 2-Main | | | | | | | | | | | | |
| | Screen | Fixed | 5 | 6985 | 8.90 | 9.50 | 0.111 | 1.148 | 0.127 | 1.60 | 1.110 | 0.748 |

| | | | |
|---|---|---|---|
| Test Date | 2022. 10. 27 | Temp./Hum. | 22℃/50% |
| Test Voltage | AC 120V, 60Hz (with AC Adapter) | Tested by | Sean Wang |
| Test SKU | SKU #2 (with LUXSHARE-ICT Antenna) | | |

| Liquid Temperature : 20.0℃ | | | | | | | | | | | | Depth of Liquid:＞15cm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Test Mode: WIFI 6E** | | | | | | | | | | | | |
| Remark | Test Position: Body | Antenna Position | Separation Distance (mm) | Freque-ncy | Conducted Power (dBm) | Maximum Tune-up (dBm) | SAR 1g (W/kg) | Scale Factor | Repor-ted SAR | Limit (W/kg) | psAPD[Note 2] ($W/m^2$) | |
| | | | | | | | | | | | 1 $cm^2$ | 4 $cm^2$ |
| 802.11ax-HE160 | | | | | | | | | | | | |
| Antenna:ANT 1-AUX | | | | | | | | | | | | |
| | Screen | Fixed | 5 | 6665 | 9.21 | 10.00 | 0.049 | 1.199 | 0.059 | 1.60 | 0.494 | 0.325 |
| Antenna: ANT 2-Main | | | | | | | | | | | | |
| | Screen | Fixed | 5 | 6665 | 8.45 | 9.00 | 0.082 | 1.135 | 0.093 | 1.60 | 0.824 | 0.525 |



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## 10.2. Power Density Test Result

| Test Date | 2022. 10. 29 | Temp./Hum. | 22℃/55% |
|---|---|---|---|
| Test Voltage | AC 120V, 60Hz (with AC Adapter) | Tested by | Sean Wang |
| Test SKU | SKU #1 (with INPAQ Antenna) | | |

**Test Mode: WIFI 6E**

| Test Position: Body | Antenna Position | Separation Distance (mm) | Frequency | Uncertainty Cor.Factor Note1 | Scale Factor | psPDtot ($W/m^2$) $4cm^2$ | C-psPDtot+ Note2 ($W/m^2$) $4cm^2$ | Limit ($W/m^2$) $4cm^2$ |
|---|---|---|---|---|---|---|---|---|
| 802.11ax-HE160 | | | | | | | | |
| Antenna:ANT 1-AUX | | | | | | | | |
| Screen | Fixed | 2 | 6025 | 1.12 | 1.125 | 0.307 | 0.387 | 10.00 |
| Screen | Fixed | 2 | 6345 | 1.12 | 1.253 | 0.372 | 0.522 | 10.00 |
| Screen | Fixed | 2 | 6505 | 1.12 | 1.148 | 1.140 | 1.466 | 10.00 |
| Screen | Fixed | 2 | 6665 | 1.12 | 1.199 | 0.575 | 0.772 | 10.00 |
| Screen | Fixed | 2 | 6985 | 1.12 | 1.199 | 1.040 | 1.397 | 10.00 |
| Antenna:ANT 2-Main | | | | | | | | |
| Screen | Fixed | 2 | 6025 | 1.12 | 1.132 | 1.100 | 1.395 | 10.00 |
| Screen | Fixed | 2 | 6345 | 1.12 | 1.169 | 0.656 | 0.859 | 10.00 |
| Screen | Fixed | 2 | 6505 | 1.12 | 1.159 | 1.050 | 1.363 | 10.00 |
| Screen | Fixed | 2 | 6665 | 1.12 | 1.135 | 1.130 | 1.436 | 10.00 |
| Screen | Fixed | 2 | 6985 | 1.12 | 1.148 | 1.160 | **1.491** | 10.00 |

Note 1: The correction factor uncertainty in dB corresponds to the difference between the actual uncertainty and the 30% target value, as per the TCB Workshop April. 2021.
Per IEC 62479:2010, actual uncertainty is 1.52 dB(42%) so the correction factor is 0.7 + 0.42 = 1.12.

Note 2: c-psPDtot = Compensated PStot.

**Total Exposure Ratio**

| WLAN 6E ANT AUX C-psPDtot avg | WLAN 6E ANT Main C-psPDtot avg | BT ANT AUX Note $SAR_{1g}$ | TER | Limit |
|---|---|---|---|---|
| 1.466 / 10 = 0.147 | 1.491 / 10 = 0.149 | 0.066 / 1.6 = 0.041 | 0.337 | ≤1 |

Note: The BT Highest Body $SAR_{1g}$ is 0.016 W/kg, please refer to report number EM-SR220088



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| | | | |
|---|---|---|---|
| Test Date | 2022. 12. 08 | Temp./Hum. | 23℃/55% |
| Test Voltage | AC 120V, 60Hz (with AC Adapter) | Tested by | Sean Wang |
| Test SKU | SKU #1 (with LUXSHARE-ICT Antenna) | | |

**Test Mode: WIFI 6E**

| Test Position: Body | Antenna Position | Separation Distance (mm) | Frequency | Uncertainty Cor.Factor Note1 | Scale Factor | psPDtot ($W/m^2$) $4cm^2$ | C-psPDtot+ Note2 ($W/m^2$) $4cm^2$ | Limit ($W/m^2$) $4cm^2$ |
|---|---|---|---|---|---|---|---|---|
| 802.11ax-HE160 | | | | | | | | |
| Antenna:ANT 1-AUX | | | | | | | | |
| Screen | Fixed | 2 | 6025 | 1.12 | 1.125 | 1.060 | 1.336 | 10.00 |
| Screen | Fixed | 2 | 6345 | 1.12 | 1.253 | 1.780 | 2.498 | 10.00 |
| Screen | Fixed | 2 | 6505 | 1.12 | 1.148 | 1.690 | 2.173 | 10.00 |
| Screen | Fixed | 2 | 6665 | 1.12 | 1.199 | 1.920 | **2.578** | 10.00 |
| Screen | Fixed | 2 | 6985 | 1.12 | 1.199 | 1.580 | 2.122 | 10.00 |
| Antenna:ANT 2-Main | | | | | | | | |
| Screen | Fixed | 2 | 6025 | 1.12 | 1.132 | 0.691 | 0.876 | 10.00 |
| Screen | Fixed | 2 | 6345 | 1.12 | 1.169 | 0.745 | 0.975 | 10.00 |
| Screen | Fixed | 2 | 6505 | 1.12 | 1.159 | 1.040 | 1.350 | 10.00 |
| Screen | Fixed | 2 | 6665 | 1.12 | 1.135 | 0.817 | 1.039 | 10.00 |
| Screen | Fixed | 2 | 6985 | 1.12 | 1.148 | 0.858 | 1.103 | 10.00 |

Note 1: The correction factor uncertainty in dB corresponds to the difference between the actual uncertainty and the 30% target value, as per the TCB Workshop April. 2021.
Per IEC 62479:2010, actual uncertainty is 1.52 dB(42%) so the correction factor is 0.7 + 0.42 = 1.12.

Note 2: c-psPDtot = Compensated PStot.

## Total Exposure Ratio

| WLAN 6E ANT AUX C-psPDtot avg | WLAN 6E ANT Main C-psPDtot avg | BT ANT AUX Note $SAR_{1g}$ | TER | Limit |
|---|---|---|---|---|
| 2.578 / 10 = 0.258 | 1.350 / 10 = 0.135 | 0.033 / 1.6 = 0.021 | 0.413 | ≤1 |

Note: The BT Highest Body $SAR_{1g}$ is 0.016 W/kg, please refer to report number EM-SR220088



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**Worst Case For Power Density Test Result**

| | | | |
|---|---|---|---|
| Test Date | 2022. 10. 29 | Temp./Hum. | 22℃/55% |
| Test Voltage | AC 120V, 60Hz (with AC Adapter) | Tested by | Sean Wang |
| Test SKU | SKU #2 (with INPAQ Antenna) | | |

| **Test Mode: WIFI 6E** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test Position: Body | Antenna Position | Separation Distance (mm) | Frequency | Uncertainty Cor.Factor Note1 | Scale Factor | psPDtot ($W/m^2$) $4cm^2$ | C-psPDtot+ Note2 ($W/m^2$) $4cm^2$ | Limit ($W/m^2$) $4cm^2$ |
| 802.11ax-HE160 | | | | | | | | |
| Antenna:ANT 1-AUX | | | | | | | | |
| Screen | Fixed | 2 | 6985 | 1.12 | 1.199 | 0.978 | 1.313 | 10.00 |
| Antenna:ANT 2-Main | | | | | | | | |
| Screen | Fixed | 2 | 6985 | 1.12 | 1.148 | 1.050 | 1.350 | 10.00 |

Note 1: The correction factor uncertainty in dB corresponds to the difference between the actual uncertainty and the 30% target value, as per the TCB Workshop April. 2021.

Per IEC 62479:2010, actual uncertainty is 1.52 dB(42%) so the correction factor is 0.7 + 0.42 = 1.12.

Note 2: c-psPDtot = Compensated PStot.



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| Test Date | 2022. 12. 08 | Temp./Hum. | 23℃/55% |
|---|---|---|---|
| Test Voltage | AC 120V, 60Hz (with AC Adapter) | Tested by | Sean Wang |
| Test SKU | SKU #2 (with LUXSHARE-ICT Antenna) | | |

**Test Mode: WIFI 6E**

| Test Position: Body | Antenna Position | Separation Distance (mm) | Frequency | Uncertainty Cor.Factor Note1 | Scale Factor | psPDtot ($W/m^2$) $4cm^2$ | C-psPDtot+ Note2 ($W/m^2$) $4cm^2$ | Limit ($W/m^2$) $4cm^2$ |
|---|---|---|---|---|---|---|---|---|
| 802.11ax-HE160 | | | | | | | | |
| Antenna:ANT 1-AUX | | | | | | | | |
| Screen | Fixed | 2 | 6025 | 1.12 | 1.125 | 1.150 | 1.449 | 10.00 |
| Screen | Fixed | 2 | 6345 | 1.12 | 1.253 | 2.430 | **3.410** | 10.00 |
| Screen | Fixed | 2 | 6505 | 1.12 | 1.148 | 2.060 | 2.649 | 10.00 |
| *Screen | Fixed | 2 | 6665 | 1.12 | 1.199 | 2.200 | 2.954 | 10.00 |
| Screen | Fixed | 2 | 6985 | 1.12 | 1.199 | 1.970 | 2.645 | 10.00 |
| Antenna:ANT 2-Main | | | | | | | | |
| Screen | Fixed | 2 | 6025 | 1.12 | 1.132 | 0.661 | 0.838 | 10.00 |
| Screen | Fixed | 2 | 6345 | 1.12 | 1.169 | 0.534 | 0.699 | 10.00 |
| Screen | Fixed | 2 | 6505 | 1.12 | 1.159 | 1.210 | 1.571 | 10.00 |
| Screen | Fixed | 2 | 6665 | 1.12 | 1.135 | 1.260 | 1.602 | 10.00 |
| Screen | Fixed | 2 | 6985 | 1.12 | 1.148 | 0.479 | 0.616 | 10.00 |

Note 1: The correction factor uncertainty in dB corresponds to the difference between the actual uncertainty and the 30% target value, as per the TCB Workshop April. 2021.
Per IEC 62479:2010, actual uncertainty is 1.52 dB(42%) so the correction factor is 0.7 + 0.42 = 1.12.

Note 2: c-psPDtot = Compensated PStot.

Note 3: "*" means the test result was worse than SKU #1 (with LUXSHARE-ICT Antenna), and this SKU #2 (with LUXSHARE-ICT Antenna) was exhibited full test.

**Total Exposure Ratio**

| WLAN 6E ANT AUX C-psPDtot avg | WLAN 6E ANT Main C-psPDtot avg | BT ANT AUX Note $SAR_{1g}$ | TER | Limit |
|---|---|---|---|---|
| 3.410 / 10 = 0.341 | 1.602 / 10 = 0.160 | 0.043 / 1.6 = 0.027 | 0.528 | ≤1 |

Note: The BT Highest Body $SAR_{1g}$ is 0.016 W/kg, please refer to report number EM-SR220088



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# APPENDIX A

## GRAPH RESULT

(Model: 16Z90R)



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# APPENDIX B

## TEST PHOTOGRAPHS

(Model: 16Z90R)



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# APPENDIX C

## Test Equipment Calibration Data



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