

# TEST REPORT

**Applicant:** Tiinlab Corporation  
**Address:** No. 3333, Liuxian Avenue, Tower A, 35th Floor,  
Tanglang City, Nanshan District, Shenzhen, China  
**Equipment Type:** Wireless Earphones  
**Model Name:** EO009  
**Brand Name:** omthing  
**FCC ID:** 2ASDIEO009  
**Test Standard:** FCC 47 CFR Part 2.1093  
(refer section 3.1)  
**Maximum SAR:** Head (1 g): 0.01 W/kg  
**Test Date:** Jun. 20, 2022  
**Date of Issue:** Jul. 06, 2022

**ISSUED BY:**

Shenzhen BALUN Technology Co., Ltd.

**Tested by:** Zhang Jiwei**Checked by:** Liyao Zong**Approved by:** Wei Yanquan  
(Chief Engineer)*Zhang Jiwei**Liyao Zong**Wei Yanquan*

### Revision History

| Version        | Issue Date           | Revisions Content    |
|----------------|----------------------|----------------------|
| <u>Rev. 01</u> | <u>Jul. 06, 2022</u> | <u>Initial Issue</u> |

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# 1 GENERAL INFORMATION

## 1.1 Identification of the Testing Laboratory

|              |                                                                                                                          |
|--------------|--------------------------------------------------------------------------------------------------------------------------|
| Company Name | Shenzhen BALUN Technology Co., Ltd.                                                                                      |
| Address      | Block B, 1/F, Baisha Science and Technology Park, Shahe West Road, Nanshan District, ShenZhen, GuangDong Province, China |
| Phone Number | +86 755 6685 0100                                                                                                        |

## 1.2 Identification of the Responsible Testing Location

|                           |                                                                                                                                                                                                         |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Location             | Shenzhen BALUN Technology Co., Ltd.                                                                                                                                                                     |
| Address                   | Block B, 1/F, Baisha Science and Technology Park, Shahe West Road, Nanshan District, ShenZhen, GuangDong Province, China                                                                                |
| Accreditation Certificate | The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.                                                                        |
| Description               | All measurement facilities used to collect the measurement data are located at Block B, 1/F, Baisha Science and Technology Park, Shahe West Road, Nanshan District, ShenZhen, GuangDong Province, China |

## 2 PRODUCT INFORMATION

### 2.1 Applicant Information

|           |                                                                                                 |
|-----------|-------------------------------------------------------------------------------------------------|
| Applicant | Tiinlab Corporation                                                                             |
| Address   | No. 3333, Liuxian Avenue, Tower A, 35th Floor, Tanglang City, Nanshan District, Shenzhen, China |

### 2.2 Manufacturer Information

|              |                                                                                                 |
|--------------|-------------------------------------------------------------------------------------------------|
| Manufacturer | Tiinlab Corporation                                                                             |
| Address      | No. 3333, Liuxian Avenue, Tower A, 35th Floor, Tanglang City, Nanshan District, Shenzhen, China |

### 2.3 Factory Information

|         |     |
|---------|-----|
| Factory | N/A |
| Address | N/A |

### 2.4 General Description for Equipment under Test (EUT)

|                                           |                    |
|-------------------------------------------|--------------------|
| EUT Name                                  | Wireless Earphones |
| Model Name Under Test                     | EO009              |
| Series Model Name                         | N/A                |
| Description of Model name differentiation | N/A                |
| Hardware Version                          | V1.2               |
| Software Version                          | V1.5               |
| Dimensions (Approx.)                      | N/A                |
| Weight (Approx.)                          | N/A                |

### 2.5 Ancillary Equipment

|                       |                 |                                                   |
|-----------------------|-----------------|---------------------------------------------------|
| Ancillary Equipment 1 | Battery         |                                                   |
|                       | Brand Name      | N/A                                               |
|                       | Model No.       | HHX501010-37mAh                                   |
|                       | Serial No.      | N/A                                               |
|                       | Capacitance     | 37 mAh                                            |
|                       | Rated Voltage   | 3.8 V                                             |
|                       | Limited Voltage | 4.2 V                                             |
|                       | Manufacturer    | ShenZhen Hui Hua Xin Battery Technology Co., Ltd. |

## 2.6 Technical Information

|                                   |                        |
|-----------------------------------|------------------------|
| Network and Wireless connectivity | Bluetooth (BR+EDR+BLE) |
|-----------------------------------|------------------------|

The requirement for the following technical information of the EUT was tested in this report:

|                   |                                                     |                                              |
|-------------------|-----------------------------------------------------|----------------------------------------------|
| Operating Mode    | Bluetooth                                           |                                              |
| Frequency Range   | Bluetooth                                           | 2402 ~ 2480 MHz                              |
| Antenna Type      | FPC Antenna                                         |                                              |
| Hotspot Function  | Not Support                                         |                                              |
| Exposure Category | General Population/Uncontrolled exposure            |                                              |
| EUT Stage         | Portable Device                                     |                                              |
| Product           | Type                                                |                                              |
|                   | <input checked="" type="checkbox"/> Production unit | <input type="checkbox"/> Identical prototype |

### 3 SUMMARY OF TEST RESULT

#### 3.1 Test Standards

| No. | Identity                  | Document Title                                                                                                                                                              |
|-----|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | 47 CFR Part 2.1093        | Radiofrequency radiation exposure evaluation: portable devices                                                                                                              |
| 2   | ANSI C95.1-1992           | IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz                                                  |
| 3   | IEEE Std. 1528-2013       | Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques |
| 4   | FCC KDB 447498 D04        | RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices                                                                                 |
| 5   | FCC KDB 865664 D01 v01r04 | SAR Measurement 100 MHz to 6 GHz                                                                                                                                            |
| 6   | FCC KDB 865664 D02 v01r02 | RF Exposure Reporting                                                                                                                                                       |

### 3.2 Device Category and SAR Limit

This device belongs to portable device category because its radiating structure is allowed to be used within 20 centimeters of the body of the user.

Limit for General Population/Uncontrolled exposure should be applied for this device, it is 1.6 W/kg as averaged over any 1 gram of tissue.

Table of Exposure Limits:

| Body Position                                                                       | SAR Value (W/Kg)                             |                                      |
|-------------------------------------------------------------------------------------|----------------------------------------------|--------------------------------------|
|                                                                                     | General Population/<br>Uncontrolled Exposure | Occupational/<br>Controlled Exposure |
| Whole-Body SAR<br>(averaged over the entire body)                                   | 0.08                                         | 0.4                                  |
| Partial-Body SAR<br>(averaged over any 1 gram of tissue)                            | 1.60                                         | 8.0                                  |
| SAR for hands, wrists, feet and<br>ankles<br>(averaged over any 10 grams of tissue) | 4.0                                          | 20.0                                 |

**NOTE:**

**General Population/Uncontrolled Exposure:** Locations where there is the exposure of individuals who have no knowledge or control of their exposure. 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.

**Occupational/Controlled Exposure:** Locations where there is exposure that may be incurred by persons who are aware of the potential for exposure. 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.

### 3.3 Test Result Summary

#### 3.3.1 Highest SAR (1 g Value)

| Frequency Band | Maximum Report SAR<br>(W/kg) 1 g |
|----------------|----------------------------------|
|                | Head                             |
| Bluetooth      | 0.01                             |
| Limits (W/kg)  | 1.60                             |
| Test Verdict   | Pass                             |

### 3.4 Test Uncertainty

According to KDB 865664 D01, When the highest measured 1 g SAR within a frequency band is  $< 1.5$  W/kg, the extensive SAR measurement uncertainty analysis is not required in SAR reports submitted for equipment approval.

The maximum 1 g SAR for the EUT in this report is 0.011 W/kg, which is lower than 1.5 W/kg, so the extensive SAR measurement uncertainty analysis is not required in this report.

## 4 MEASUREMENT SYSTEM

### 4.1 Specific Absorption Rate (SAR) Definition

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 ( $\rho$ ). The equation description is as below:

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

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

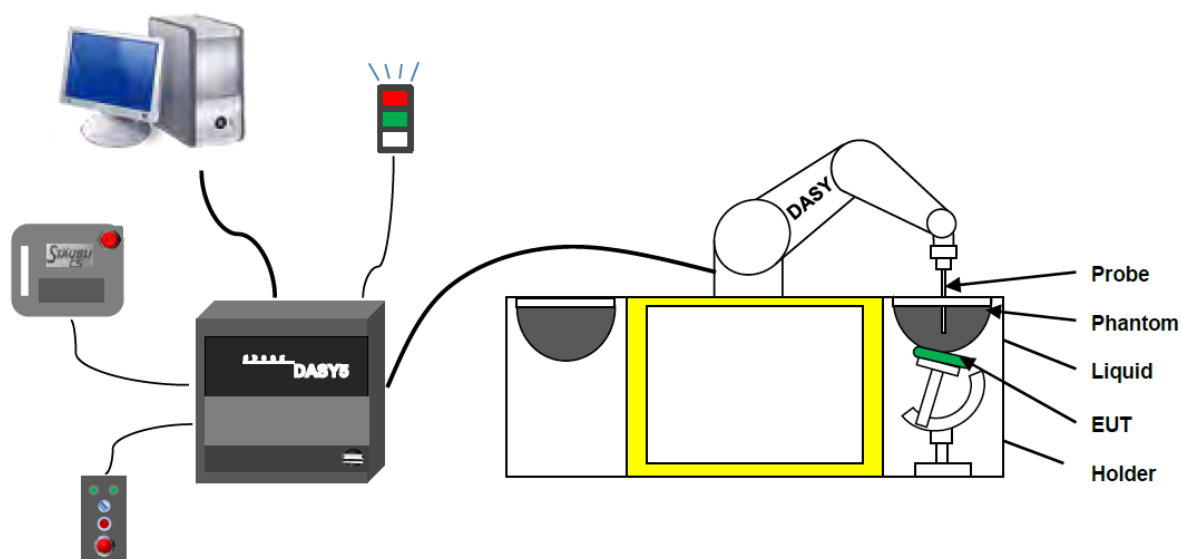
$$\text{SAR} = \frac{\sigma E^2}{\rho}$$

Where:  $\sigma$  is the conductivity of the tissue,

$\rho$  is the mass density of the tissue and E is the RMS electrical field strength.

## 4.2 DASY SAR System

### 4.2.1 DASY SAR System Diagram



The DASY5 system for performing compliance tests consists of the following items:

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
3. A data acquisition electronic (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
4. A unit to operate the optical surface detector which is connected to the EOC.
5. The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.
6. The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation.
7. DASY5 software and SEMCAD data evaluation software.
8. Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling the testing of left-hand and right-hand usage.
10. The device holder for handheld mobile phones.
11. Tissue simulating liquid mixed according to the given recipes.
12. System validation dipoles allowing to validate the proper functioning of the system.

#### 4.2.2 Robot

The Dasy SAR system uses the high precision robots. Symmetrical design with triangular core Built-in optical fiber for surface detection system For the 6-axis controller system, Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents). The robot series have many features that are important for our application:



- High precision  
(repeatability  $\pm 0.02$  mm)
- High reliability  
(industrial design)
- Low maintenance costs  
(virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements  
(brush less synchron motors; no stepper motors)
- Low ELF interference  
(motor control \_elds shielded via the closed metallic construction shields)

### 4.2.3 E-Field Probe

The probe is specially designed and calibrated for use in liquids with high permittivities for the measurements the Specific Dosimetric E-Field Probe EX3DV4-SN:7663 with following specifications is used.

|               |                                                                                                                                                                                                                 |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Construction  | Symmetrical design with triangular core Built-in optical fiber for surface detection systemBuilt-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycolether) |
| Calibration   | ISO/IEC 17025 calibration service available                                                                                                                                                                     |
| Frequency     | 10 MHz to 6 GHz; Linearity: $\pm 0.2$ dB (30 MHz to 6 GHz)                                                                                                                                                      |
| Directivity   | $\pm 0.2$ dB in HSL (rotation around probe axis) ; $\pm 0.4$ dB in HSL (rotation normal to probe axis)                                                                                                          |
| Dynamic range | 5 $\mu$ W/g to > 100 mW/g; Linearity: $\pm 0.2$ dB                                                                                                                                                              |
| Dimensions    | Overall length: 337 mm (Tip: 9 mm) Tip diameter: 2.5 mm (Body: 10 mm) Distance from probe tip to dipole centers: 1.0 mm                                                                                         |
| Application   | General dosimetry up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms (EX3DV4)                                                                                          |



### E-Field Probe Calibration Process

Probe calibration is realized, in compliance with CENELEC EN 62209-1/-2 and IEEE 1528 std, with CALISAR, Antennessa proprietary calibration system. The calibration is performed with the EN 62209-1/2 annexe technique using reference guide at the five frequencies.

#### 4.2.4 Data Acquisition Electronics

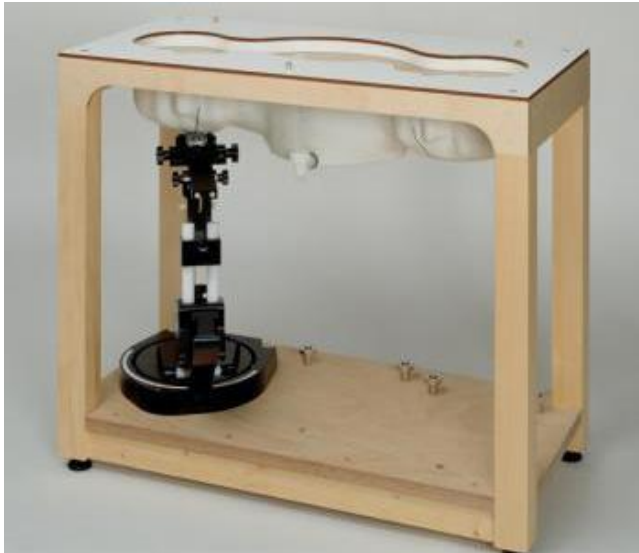
The data acquisition electronics (DAE) consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through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



- Input Impedance: 200M $\Omega$ m
- The Inputs: Symmetrical and Floating
- Common Mode Rejection: Above 80dB

#### 4.2.5 Phantoms

For the measurements the Specific Anthropomorphic Mannequin (SAM) defined by the IEEE SCC-34/SC2 group is used. The phantom is a polyurethane shell integrated in a wooden table. The thickness of the phantom amounts to 2mm +/- 0.2mm. It enables the dosimetric evaluation of left and right phone usage and includes an additional flat phantom part for the simplified performance check. The phantom set-up includes a cover, which prevents the evaporation of the liquid.



- Left hand
- Right hand
- Flat phantom

**Photo of Phantom SN1857**



| Serial Number | Material                           | Length | Height |
|---------------|------------------------------------|--------|--------|
| SN 1857 SAM   | Vinylester, glass fiber reinforced | 1000   | 500    |

#### 4.2.6 Device Holder

The DASY5 device holder has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of  $65^\circ$ . The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. This device holder is used for standard mobile phones or PDA's only. If necessary an additional support of polystyrene material is used. Larger DUT's (e.g. notebooks) cannot be tested using this device holder. Instead a support of bigger polystyrene cubes and thin polystyrene plates is used to position the DUT in all relevant positions to find and measure spots with maximum SAR values. Therefore those devices are normally only tested at the flat part of the SAM.

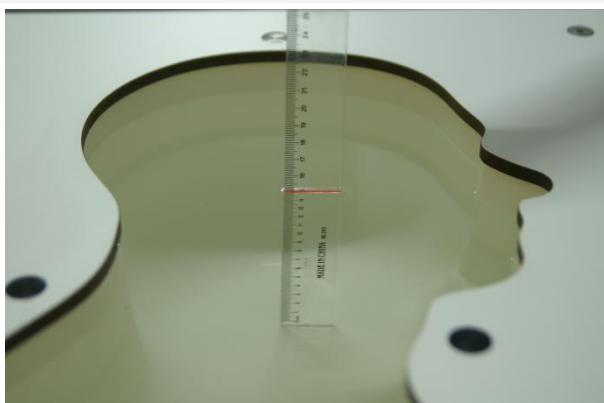


The positioning system allows obtaining cheek and tilting position with a very good accuracy. Incompliance with CENELEC, the tilt angle uncertainty is lower than  $1^\circ$ .

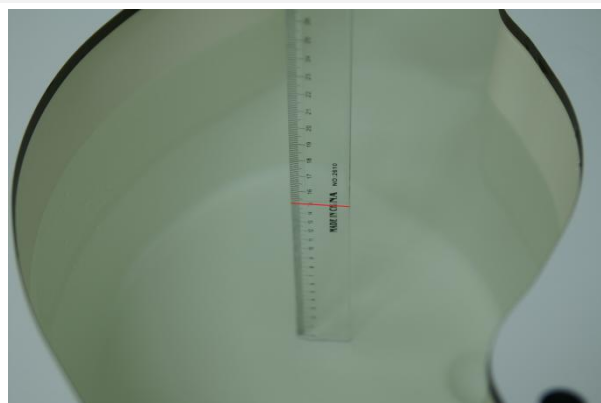
### 4.2.7 Simulating Liquid

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%.

**Head Liquid Depth**



**Body Liquid Depth**



The following table gives the recipes for tissue simulating liquid and the theoretical Conductivity/Permittivity.

| Head (Reference IEEE1528)           |              |                       |                  |             |                     |             |                                |                            |
|-------------------------------------|--------------|-----------------------|------------------|-------------|---------------------|-------------|--------------------------------|----------------------------|
| Frequency<br>(MHz)                  | Water<br>(%) | Sugar<br>(%)          | Cellulose<br>(%) | Salt<br>(%) | Preventol<br>(%)    | DGBE<br>(%) | Conductivity<br>$\sigma$ (S/m) | Permittivity<br>$\epsilon$ |
| 750                                 | 41.1         | 57.0                  | 0.2              | 1.4         | 0.2                 | 0           | 0.89                           | 41.9                       |
| 835                                 | 40.3         | 57.9                  | 0.2              | 1.4         | 0.2                 | 0           | 0.90                           | 41.5                       |
| 900                                 | 40.3         | 57.9                  | 0.2              | 1.4         | 0.2                 | 0           | 0.97                           | 41.5                       |
| 1800, 1900, 2000                    | 55.2         | 0                     | 0                | 0.3         | 0                   | 44.5        | 1.4                            | 40.0                       |
| 2450                                | 55.0         | 0                     | 0                | 0.1         | 0                   | 44.9        | 1.80                           | 39.2                       |
| 2600                                | 54.9         | 0                     | 0                | 0.1         | 0                   | 45.0        | 1.96                           | 39.0                       |
| Frequency<br>(MHz)                  | Water<br>(%) | Hexyl Carbitol<br>(%) |                  |             | Triton X-100<br>(%) |             | Conductivity<br>$\sigma$ (S/m) | Permittivity<br>$\epsilon$ |
| 5200                                | 62.52        | 17.24                 |                  |             | 17.24               |             | 4.66                           | 36.0                       |
| 5800                                | 62.52        | 17.24                 |                  |             | 17.24               |             | 5.27                           | 35.3                       |
| Body (From instrument manufacturer) |              |                       |                  |             |                     |             |                                |                            |
| Frequency<br>(MHz)                  | Water<br>(%) | Sugar<br>(%)          | Cellulose<br>(%) | Salt<br>(%) | Preventol<br>(%)    | DGBE<br>(%) | Conductivity<br>$\sigma$ (S/m) | Permittivity<br>$\epsilon$ |
| 750                                 | 51.7         | 47.2                  | 0                | 0.9         | 0.1                 | 0           | 0.96                           | 55.5                       |
| 835                                 | 50.8         | 48.2                  | 0                | 0.9         | 0.1                 | 0           | 0.97                           | 55.2                       |
| 900                                 | 50.8         | 48.2                  | 0                | 0.9         | 0.1                 | 0           | 1.05                           | 55.0                       |
| 1800, 1900, 2000                    | 70.2         | 0                     | 0                | 0.4         | 0                   | 29.4        | 1.52                           | 53.3                       |
| 2450                                | 68.6         | 0                     | 0                | 0.1         | 0                   | 31.3        | 1.95                           | 52.7                       |
| 2600                                | 68.2         | 0                     | 0                | 0.1         | 0                   | 31.7        | 2.16                           | 52.5                       |
| Frequency(MHz)                      | Water        | DGBE                  |                  |             | Salt                |             | Conductivity                   | Permittivity               |

|      |       | (%)   | (%) | $\sigma$ (S/m) | $\varepsilon$ |
|------|-------|-------|-----|----------------|---------------|
| 5200 | 78.60 | 21.40 | /   | 5.54           | 47.86         |
| 5800 | 78.50 | 21.40 | 0.1 | 6.0            | 48.20         |

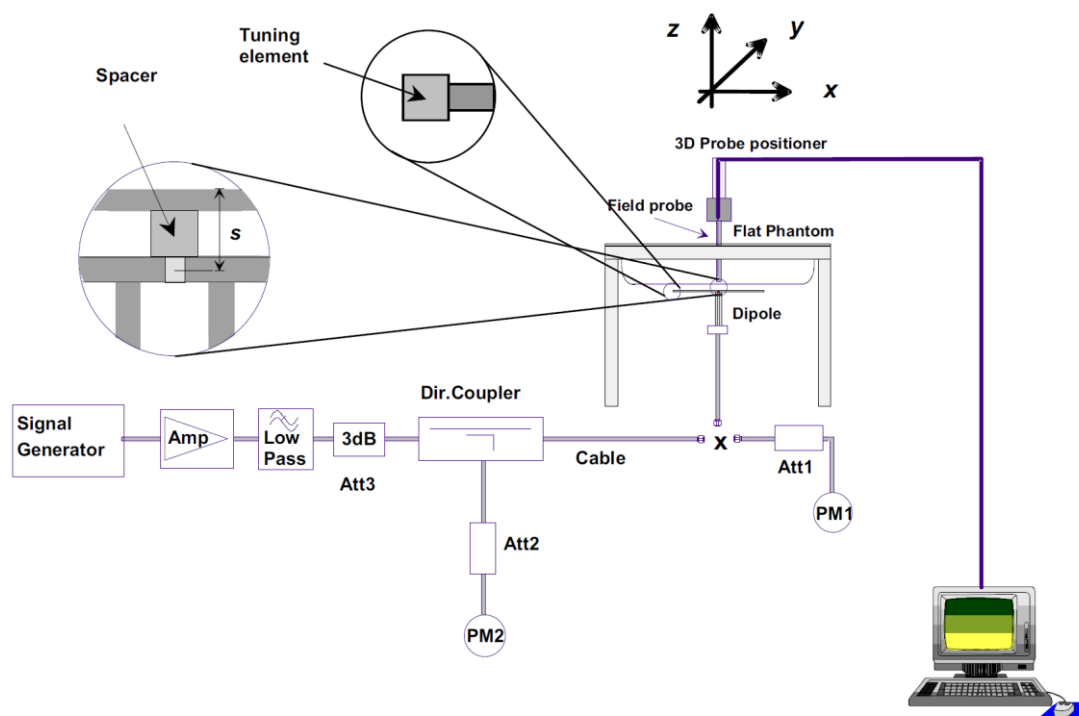
## 5 SYSTEM VERIFICATION

### 5.1 Purpose of System Check

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

### 5.2 System Check Setup

In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



## 6 TEST POSITION CONFIGURATIONS

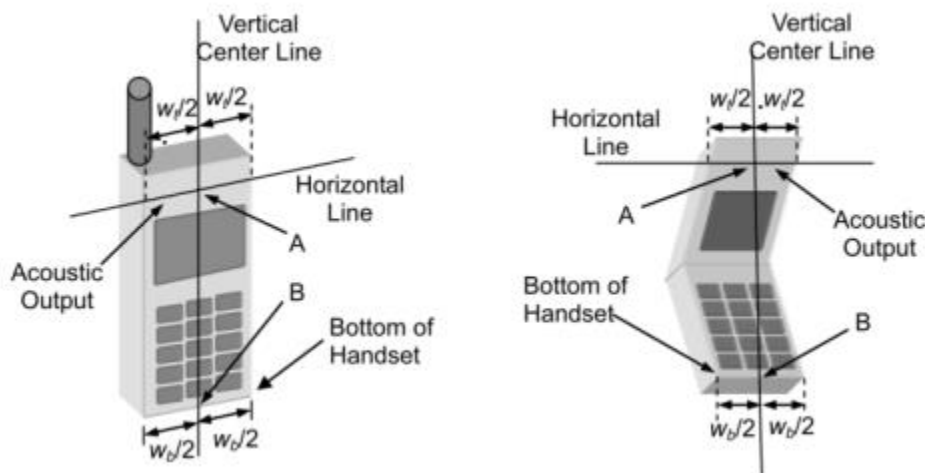
According to KDB 648474 D04 Handset, handsets are tested for SAR compliance in head, body-worn accessory and other use configurations described in the following subsections.

### 6.1 Head Exposure Conditions

Head exposure is limited to next to the ear voice mode operations. Head SAR compliance is tested according to the test positions defined in IEEE Std 1528-2013 using the SAM phantom illustrated as below.

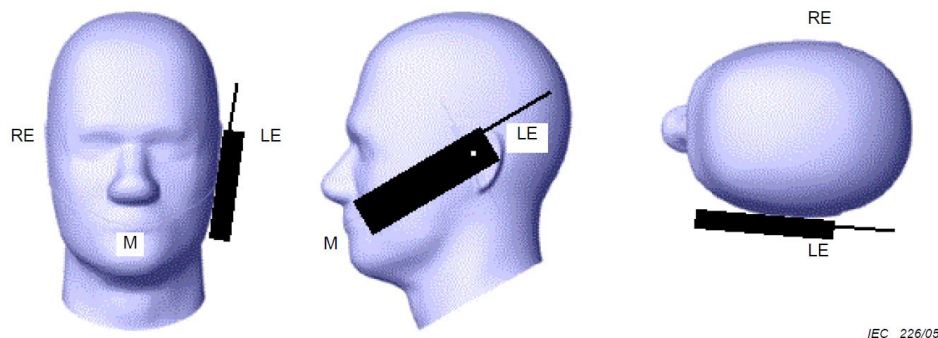
#### 6.1.1 Two Imaginary Lines on the Handset

- The vertical center line passes through two points on the front side of the handset - the midpoint of the width  $w_t$  of the handset at the level of the acoustic output, and the midpoint of the width  $w_b$  of the bottom of the handset.
- The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output. The horizontal line is also tangential to the face of the handset at point A.
- The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output; however, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical center line is not necessarily parallel to the front face of the handset, especially for clamshell handsets, handsets with flip covers, and other irregularly shaped handsets.



#### 6.1.2 Cheek Position

- To position the device with the vertical center line of the body of the device and the horizontal line crossing the center piece in a plane parallel to the sagittal plane of the phantom. While maintaining the device in this plane, align the vertical center line with the reference plane containing the three ear and mouth reference point (M: Mouth, RE: Right Ear, and LE: Left Ear) and align the center of the ear piece with the line RE-LE.
- To move the device towards the phantom with the ear piece aligned with the line LE-RE until the phone touched the ear. While maintaining the device in the reference plane and maintaining the phone contact with the ear, move the bottom of the phone until any point on the front side is in contact with the cheek of the phantom or until contact with the ear is lost.



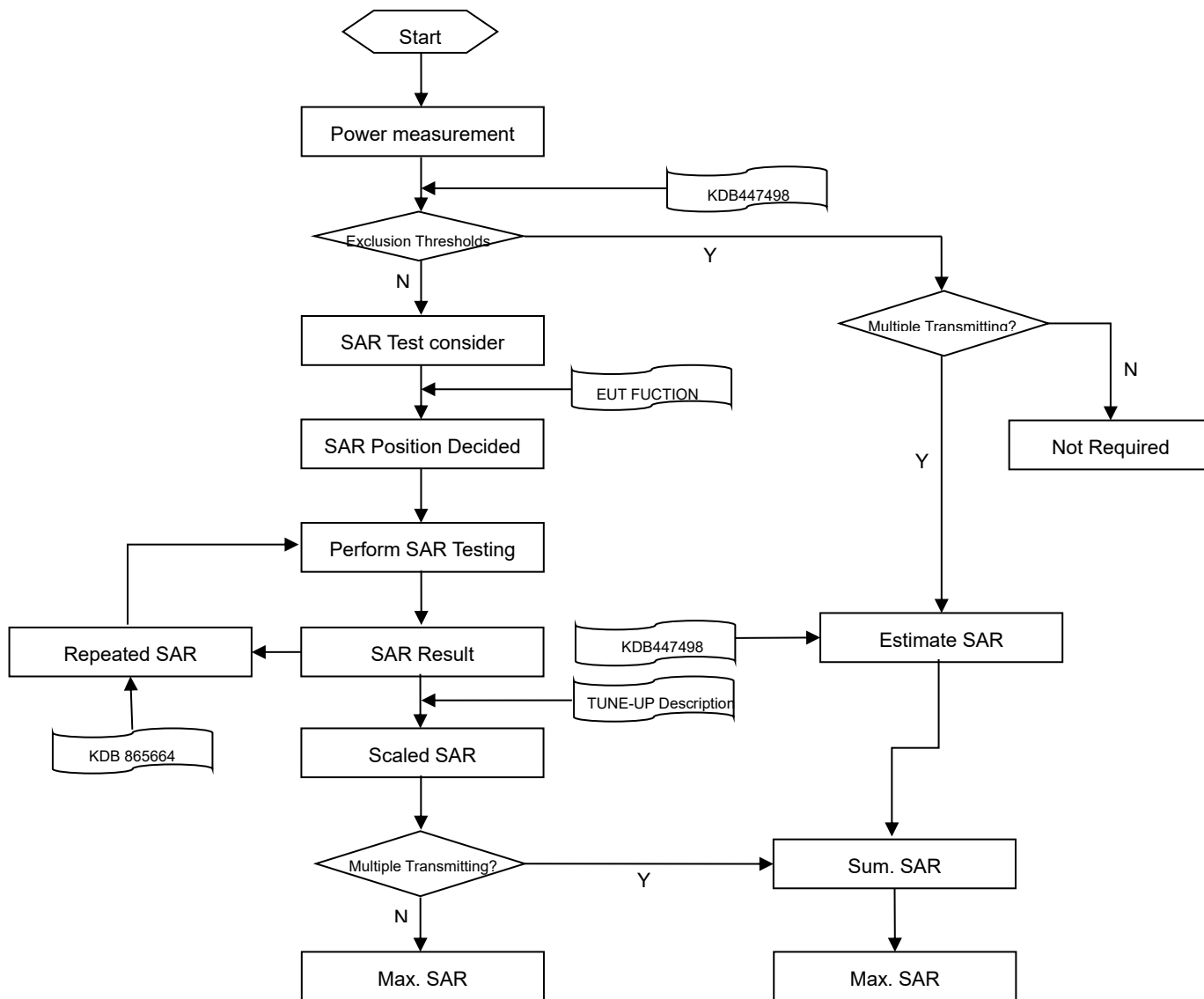
### 6.1.3 Tilted Position

- (a) To position the device in the “cheek” position described above.
- (b) While maintaining the device the reference plane described above and pivoting against the ear, moves it outward away from the mouth by an angle of 15 degrees or until contact with the ear is lost.



## 7 MEASUREMENT PROCEDURE

### 7.1 Measurement Process Diagram



## 7.2 SAR Scan General Requirement

Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1 g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2013.

|                                                                                                        |                           |                                                                | ≤3GHz                                                                                                                                                                                                                                                             | >3GHz                                  |
|--------------------------------------------------------------------------------------------------------|---------------------------|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface |                           |                                                                | 5±1 mm                                                                                                                                                                                                                                                            | ½·δ·ln(2)±0.5 mm                       |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location              |                           |                                                                | 30°±1°                                                                                                                                                                                                                                                            | 20°±1°                                 |
| Maximum area scan spatial resolution: Δx Area , Δy Area                                                |                           |                                                                | ≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm                                                                                                                                                                                                                            | 3–4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm |
|                                                                                                        |                           |                                                                | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device. |                                        |
| Maximum zoom scan spatial resolution: Δx Zoom , Δy Zoom                                                |                           |                                                                | ≤ 2 GHz: ≤ 8 mm<br>2 –3 GHz: ≤ 5 mm*                                                                                                                                                                                                                              | 3–4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm* |
| Maximum zoom scan spatial resolution, normal to phantom surface                                        | uniform grid: Δz Zoom (n) |                                                                | ≤ 5 mm                                                                                                                                                                                                                                                            | 3–4 GHz: ≤ 4 mm                        |
|                                                                                                        |                           |                                                                |                                                                                                                                                                                                                                                                   | 4–5 GHz: ≤ 3 mm                        |
|                                                                                                        |                           |                                                                |                                                                                                                                                                                                                                                                   | 5–6 GHz: ≤ 2 mm                        |
|                                                                                                        | graded grid               | Δz Zoom (1): between 1st two points closest to phantom surface | ≤ 4 mm                                                                                                                                                                                                                                                            | 3–4 GHz: ≤ 3 mm                        |
|                                                                                                        |                           |                                                                |                                                                                                                                                                                                                                                                   | 4–5 GHz: ≤ 2.5 mm                      |
|                                                                                                        |                           | Δz Zoom (n>1): between subsequent points                       | ≤ 1.5·Δz Zoom (n-1)                                                                                                                                                                                                                                               |                                        |
| Minimum zoom scan volume                                                                               | x, y, z                   |                                                                | ≥30 mm                                                                                                                                                                                                                                                            | 3–4 GHz: ≥ 28 mm                       |
|                                                                                                        |                           |                                                                |                                                                                                                                                                                                                                                                   | 4–5 GHz: ≥ 25 mm                       |
|                                                                                                        |                           |                                                                |                                                                                                                                                                                                                                                                   | 5–6 GHz: ≥ 22 mm                       |

### Note:

1.  $\delta$  is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
2. \* When zoom scan is required and the reported SAR from the area scan based 1 g SAR estimation procedures of KDB 447498 is  $\leq 1.4$  W/kg,  $\leq 8$  mm,  $\leq 7$  mm and  $\leq 5$  mm zoom scan resolution may be applied, respectively, for 2 GHz to 3GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

## 7.3 Measurement Procedure

The following steps are used for each test position

- a. Establish a call with the maximum output power with a base station simulator. The connection between the mobile and the base station simulator is established via air interface
- b. Measurement of the local E-field value at a fixed location. This value serves as a reference value for calculating a possible power drift.
- c. Measurement of the SAR distribution with a grid of 8 to 16mm \* 8 to 16 mm and a constant distance to the inner surface of the phantom. Since the sensors cannot directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With these values the area of the maximum SAR is calculated by an interpolation scheme.
- d. Around this point, a cube of 30 \* 30 \* 30 mm or 32 \* 32 \* 32 mm is assessed by measuring 5 or 8 \* 5 or 8\*4 or 5 mm. With these data, the peak spatial-average SAR value can be calculated.

## 7.4 Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. Area scan and zoom scan resolution setting follows KDB 865664 D01v01r04 quoted below.

When the 1 g SAR of the highest peak is within 2 dB of the SAR limit, additional zoom scans are required for other peaks within 2 dB of the highest peak that have not been included in any zoom scan to ensure there is no increase in SAR.

## 8 CONDUCTED RF OUTPUT POWER

### 8.1 Bluetooth

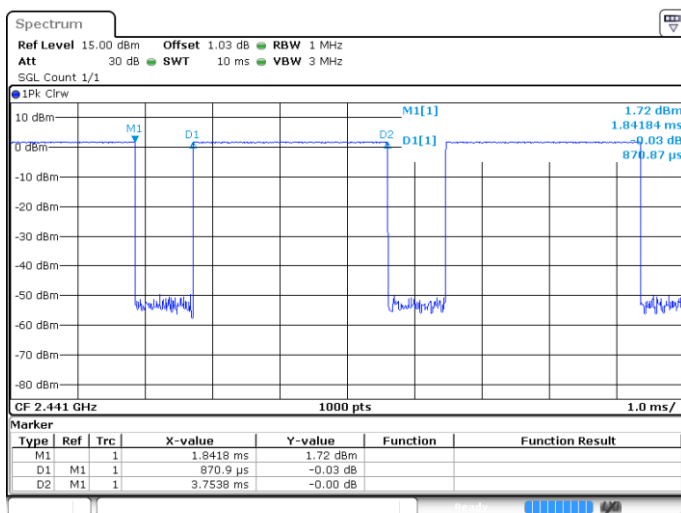
| Mode                | GFSK |      |             | $\pi/4$ -DQPSK |      |      |
|---------------------|------|------|-------------|----------------|------|------|
| Channel             | 0    | 0    | 39          | 78             | 39   | 78   |
| Frequency (MHz)     | 2402 | 2402 | 2441        | 2480           | 2441 | 2480 |
| Peak Power (dBm)    | 0.97 | 1.81 | <b>2.22</b> | 1.83           | 2.40 | 2.66 |
| Tune-Up Limit (dBm) | 2.00 | 3.00 | 3.00        | 2.00           | 3.00 | 3.00 |
| SAR Test Require    | Yes  | Yes  | Yes         | No             | No   | No   |
| Mode                | BLE  |      |             | /              |      |      |
| Channel             | 0    | 19   | 39          | /              | /    | /    |
| Frequency (MHz)     | 2402 | 2440 | 2480        | /              | /    | /    |
| Peak Power (dBm)    | 0.57 | 0.92 | 2.50        | /              | /    | /    |
| Tune-Up Limit (dBm) | 2.00 | 2.00 | 3.00        | /              | /    | /    |
| SAR Test Require    | No   | No   | No          | /              | /    | /    |

Note: Since Bluetooth BR mode is the maximum output power mode, SAR measurements were performed with test software using DH5 modulation, and SAR measurement is not required for the EDR and LE. When the secondary mode is  $\leq \frac{1}{4}$  dB higher than the primary mode.

Note: The Bluetooth duty cycle is 76.8 % as following figure, according to 2016 Oct. TCB workshop for Bluetooth SAR scaling need further consideration and the maximum duty cycle is 100%, therefore the actual duty cycle will be scaled up to 100% for Bluetooth reported SAR calculation.

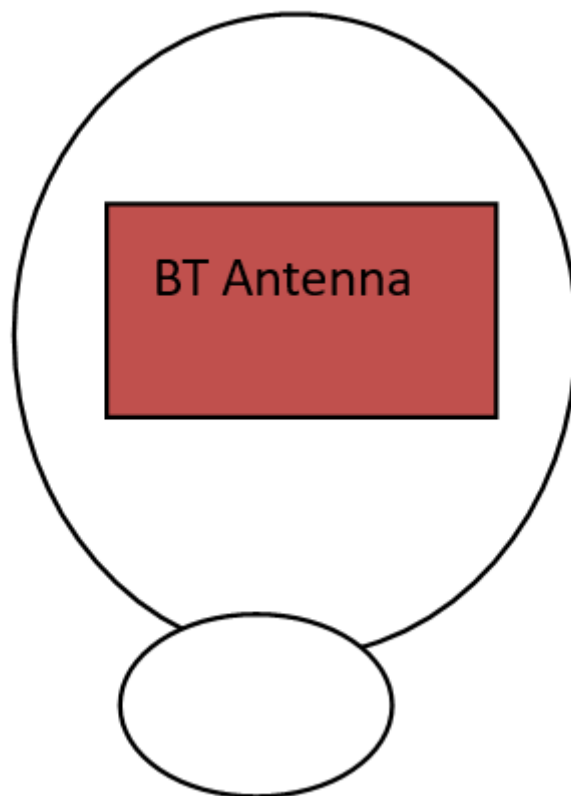
#### Duty Cycle

##### Bluetooth-GFSK



Date: 10 MAY 2022 15:24:32

## 9 TEST EXCLUSION CONSIDERATION



## 9.1 SAR Test Exclusion Consideration Table

According with FCC KDB 447498 D04, Appendix B, The SAR-based exemption formula applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold Pth (mW).

This method shall only be used at separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive). The following table shows the power threshold from 5mm to 50mm.

| Power Thresholds (mW) |                                       |                                 |                                 |                                 |                                 |
|-----------------------|---------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Frequency (MHz)       | At separation distance of $\leq 5$ mm | At separation distance of 10 mm | At separation distance of 15 mm | At separation distance of 20 mm | At separation distance of 25 mm |
| 300                   | 39 mW                                 | 65 mW                           | 88 mW                           | 110 mW                          | 129 mW                          |
| 450                   | 22 mW                                 | 44 mW                           | 67 mW                           | 89 mW                           | 112 mW                          |
| 835                   | 9 mW                                  | 25 mW                           | 44 mW                           | 66 mW                           | 90 mW                           |
| 1900                  | 3 mW                                  | 12 mW                           | 26 mW                           | 44 mW                           | 66 mW                           |
| 2450                  | 3 mW                                  | 10 mW                           | 22 mW                           | 38 mW                           | 59 mW                           |
| 3600                  | 2 mW                                  | 8 mW                            | 18 mW                           | 32 mW                           | 49 mW                           |
| 5800                  | 1 mW                                  | 6 mW                            | 14 mW                           | 25 mW                           | 40 mW                           |
| Frequency (MHz)       | At separation distance of 30 mm       | At separation distance of 35 mm | At separation distance of 40 mm | At separation distance of 45 mm | At separation distance of 50 mm |
| 300                   | 148 mW                                | 166 mW                          | 184 mW                          | 201 mW                          | 217 mW                          |
| 450                   | 135 mW                                | 158 mW                          | 180 mW                          | 203 mW                          | 226 mW                          |
| 835                   | 116 mW                                | 145 mW                          | 175 mW                          | 207 mW                          | 240 mW                          |
| 1900                  | 92 mW                                 | 122 mW                          | 157 mW                          | 195 mW                          | 236 mW                          |
| 2450                  | 83 mW                                 | 111 mW                          | 143 mW                          | 179 mW                          | 219 mW                          |
| 3600                  | 71 mW                                 | 96 mW                           | 125 mW                          | 158 mW                          | 195 mW                          |
| 5800                  | 58 mW                                 | 80 mW                           | 106 mW                          | 136 mW                          | 169 mW                          |

### 9.1.1 SAR Test Consideration

| Test Position Configurations | Mode                     | Bluetooth |
|------------------------------|--------------------------|-----------|
| Calculated Frequency(MHz)    |                          | 2480      |
| Headset                      | Distance to User (mm)    | 0.00      |
|                              | Max. Peak Power (dBm)    | 3.00      |
|                              | Max. Peak Power (mW)     | 2.00      |
|                              | Exclusion Threshold (mW) | 0.00      |
|                              | SAR Test Required        | Yes       |

Note:

- Maximum power is the source-based time-average power and represents the maximum RF output power including tune-up tolerance among production units
- Per KDB 447498 D04, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
- Per KDB 447498 D04, standalone SAR test exclusion threshold is applied; If the distance of the antenna to the user is < 5mm, 5mm is used to determine SAR exclusion threshold
- Per KDB 447498 D04, for separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive), the threshold Pth (mW) is given by Following:

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

where

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

- f(GHz) is the RF channel transmit frequency in GHz
- d is the separation distance (cm), The result is rounded to one decimal place for comparison
- $ERP_{20cm}$  are determined by:

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

- Per KDB 248227 D01, choose the highest output power channel to test SAR and determine further SAR exclusion.8. For each frequency band, testing at higher data rates and higher order modulations is not required when the maximum average output power for each of these configurations is less than 1/4dB higher than those measured at the lowest data rate

## 10 TEST RESULT

### 10.1 Bluetooth

| Mode                                                                           | Position    | Dist.<br>(mm) | Ch. | Freq.<br>(MHz) | Power<br>Drift<br>(dB) | 1g<br>Meas.<br>SAR<br>(W/Kg) | Meas.<br>Power<br>(dBm) | Max.<br>tune-up<br>Power<br>(dBm) | Scaling<br>Factor | Duty<br>Cycle<br>(%) | Duty<br>Cycle<br>Factor | 1 g<br>Scaled<br>SAR<br>(W/Kg) | Meas.<br>No. |
|--------------------------------------------------------------------------------|-------------|---------------|-----|----------------|------------------------|------------------------------|-------------------------|-----------------------------------|-------------------|----------------------|-------------------------|--------------------------------|--------------|
| <b>Headset</b>                                                                 |             |               |     |                |                        |                              |                         |                                   |                   |                      |                         |                                |              |
| DH5                                                                            | Front Side  | 0             | 78  | 2480           | 0.01                   | 0.007                        | 2.22                    | 3.00                              | 1.197             | 76.80                | 1.302                   | <b>0.011</b>                   | 1#           |
|                                                                                |             | 0             | 0   | 2402           | 0.05                   | 0.002                        | 0.97                    | 2.00                              | 1.268             | 76.80                | 1.302                   | 0.002                          | /            |
|                                                                                |             | 0             | 39  | 2441           | 0.09                   | 0.006                        | 1.81                    | 3.00                              | 1.315             | 76.80                | 1.302                   | 0.010                          | /            |
|                                                                                | Back Side   | 0             | 78  | 2480           | 0.01                   | 0.006                        | 2.22                    | 3.00                              | 1.197             | 76.80                | 1.302                   | 0.009                          | /            |
|                                                                                | Left Edge   | 0             | 78  | 2480           | -0.06                  | 0.005                        | 2.22                    | 3.00                              | 1.197             | 76.80                | 1.302                   | 0.008                          | /            |
|                                                                                | Right Side  | 0             | 78  | 2480           | 0.01                   | 0.007                        | 2.22                    | 3.00                              | 1.197             | 76.80                | 1.302                   | 0.011                          | /            |
|                                                                                | Top Side    | 0             | 78  | 2480           | 0.08                   | 0.006                        | 2.22                    | 3.00                              | 1.197             | 76.80                | 1.302                   | 0.010                          | /            |
|                                                                                | Bottom Side | 0             | 78  | 2480           | 0.05                   | 0.006                        | 2.22                    | 3.00                              | 1.197             | 76.80                | 1.302                   | 0.009                          | /            |
| Note: Refer to ANNEX C for the detailed test data for each test configuration. |             |               |     |                |                        |                              |                         |                                   |                   |                      |                         |                                |              |

## 11 SAR Measurement Variability

According to KDB 865664 D01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are  $\leq 1.45$  W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is  $\leq 1.10$ , the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR repeated measurement procedure:

1. When the highest measured SAR is  $< 0.80$  W/kg, repeated measurement is not required.
2. When the highest measured SAR is  $\geq 0.80$  W/kg, repeat that measurement once.
3. If the ratio of largest to smallest SAR for the original and first repeated measurements is  $> 1.20$ , or when the original or repeated measurement is  $\geq 1.45$  W/kg, perform a second repeated measurement.
4. If the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ , and the original, first or second repeated measurement is  $\geq 1.5$  W/kg, perform a third repeated measurement.

Note: For 1g SAR, the highest measured 1g SAR is  $0.007 < 0.80$  W/kg, repeated measurement is not required.

## 12 SIMULTANEOUS TRANSMISSION

Note: The product has only one antenna for Bluetooth, so simultaneous transmission evaluation is not required in this report.

## 13 TEST EQUIPMENTS LIST

| Description                  | Manufacturer | Model     | Serial No./Version | Cal. Date  | Cal. Due   |
|------------------------------|--------------|-----------|--------------------|------------|------------|
| PC                           | Dell         | N/A       | N/A                | N/A        | N/A        |
| Test Software                | Speag        | DASY5     | 52.8.8.1222        | N/A        | N/A        |
| 2450MHz Validation Dipole    | Speag        | D2450V2   | SN: 952            | 2021/05/19 | 2024/05/18 |
| E-Field Probe                | Speag        | EX3DV4    | SN: 7663           | 2021/07/23 | 2022/07/22 |
| Data Acquisition Electronics | Speag        | DAE4      | SN: 1454           | 2021/11/05 | 2022/11/04 |
| Signal Generator             | R&S          | SMB100A   | 177746             | 2021/08/24 | 2022/08/23 |
| Power Meter                  | R&S          | NRVD-B2   | 7250BJ-0112/2011   | 2021/09/08 | 2022/09/07 |
| Power Sensor                 | R&S          | NRV-Z4    | 100381             | 2021/09/08 | 2022/09/07 |
| Power Sensor                 | R&S          | NRV-Z2    | 100211             | 2021/09/08 | 2022/09/07 |
| Network Analyzer             | Agilent      | E5071C    | MY46103472         | 2021/12/29 | 2022/12/28 |
| Thermometer                  | Elitech      | RC-4HC    | EF720B004820       | 2021/12/01 | 2022/11/30 |
| Power Amplifier              | SATIMO       | 6552B     | 22374              | N/A        | N/A        |
| Dielectric Probe Kit         | SATIMO       | SCLMP     | SN 25/13 OCPG56    | N/A        | N/A        |
| Phantom1                     | Speag        | SAM       | SN: 1857           | N/A        | N/A        |
| Phantom2                     | Speag        | ELI4      | SN: 1012           | N/A        | N/A        |
| Attenuator                   | COM-MW       | ZA-S1-31  | 1305003187         | N/A        | N/A        |
| Directional coupler          | AA-MCS       | AAMCS-UDC | 000272             | N/A        | N/A        |

Note: For dipole antennas, BALUN has adopted 3 years as calibration intervals, and on annual basis, every measurement dipole has been evaluated and is in compliance with the following criteria:

1. There is no physical damage on the dipole;
2. System validation with specific dipole is within 10% of calibrated value;
3. Return-loss in within 20% of calibrated measurement.
4. Impedance (real or imaginary parts) in within 5 Ohms of calibrated measurement.

## ANNEX A SIMULATING LIQUID VERIFICATION RESULT

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an SCLMP Dielectric Probe Kit.

| Date       | Liquid Type | Fre. (MHz) | Temp. (°C) | Meas. Conductivity ( $\sigma$ ) (S/m) | Meas. Permittivity ( $\epsilon$ ) | Target Conductivity ( $\sigma$ ) (S/m) | Target Permittivity ( $\epsilon$ ) | Conductivity Tolerance (%) | Permittivity Tolerance (%) |
|------------|-------------|------------|------------|---------------------------------------|-----------------------------------|----------------------------------------|------------------------------------|----------------------------|----------------------------|
| 2022.06.20 | Head        | 2450       | 21.7       | 1.80                                  | 39.68                             | 1.80                                   | 39.20                              | 0.22                       | 1.21                       |

Note: The tolerance limit of Conductivity and Permittivity is  $\pm 5\%$ .

## ANNEX B SYSTEM CHECK RESULT

Comparing to the original SAR value provided by SPEAG, the validation data should be within its specification of 10 % (for 1 g).

| Date                                                        | Liquid Type | Freq. (MHz) | Power (mW) | Measured SAR (W/kg) | Normalized SAR (W/kg) | Dipole SAR (W/kg) | Tolerance (%) |
|-------------------------------------------------------------|-------------|-------------|------------|---------------------|-----------------------|-------------------|---------------|
| 2022.06.20                                                  | Head        | 2450        | 100        | 5.410               | 54.10                 | 53.00             | 2.08          |
| Note: The tolerance limit of System validation $\pm 10\%$ . |             |             |            |                     |                       |                   |               |

## System Performance Check Data (2450MHz)

Date: 2022.06.20

Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.804$  S/m;  $\epsilon_r = 39.675$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Left Section

Ambient Temperature: 22.5 Liquid Temperature: 21.7

DASY5 Configuration:

- Probe: EX3DV4 - SN7663; ConvF(8.19, 8.19, 8.19); Calibrated: 2021/7/23
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 2021/11/05
- Phantom: SAM (20deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CC; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**CW2450 100mw/Area Scan (101x101x1):** Interpolated grid:  $dx=1.000$  mm,  $dy=1.000$  mm

Maximum value of SAR (interpolated) = 5.38 W/kg

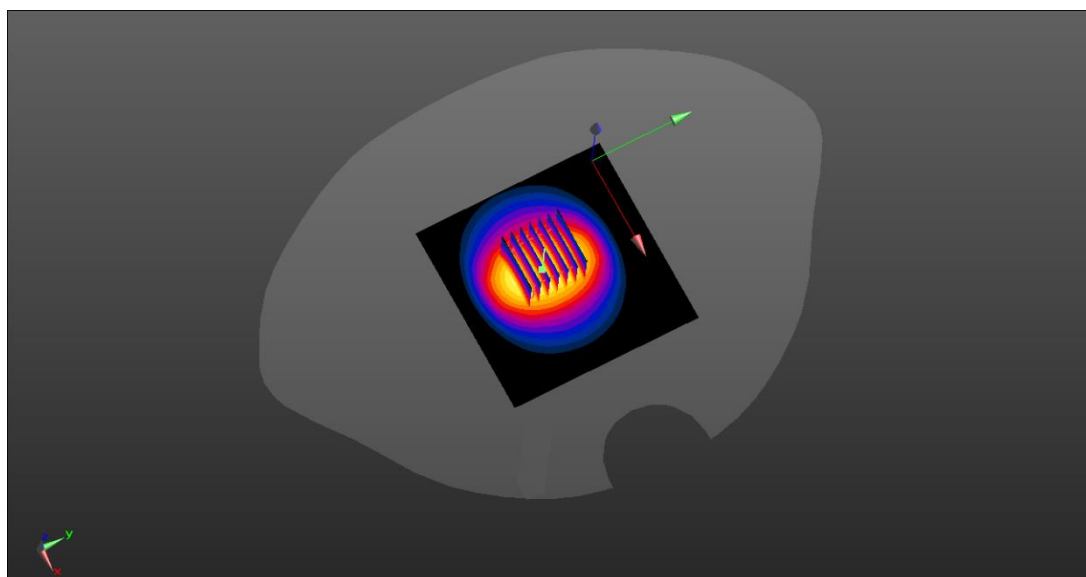
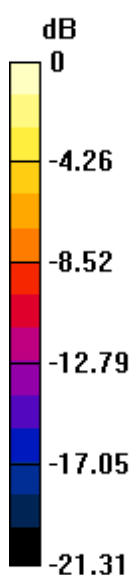
**CW2450 100mw/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 57.69 V/m; Power Drift = -0.16 dB

Peak SAR (extrapolated) = 11.5 W/kg

**SAR(1 g) = 5.41 W/kg; SAR(10 g) = 2.48 W/kg**

Maximum value of SAR (measured) = 5.26 W/kg



0 dB = 5.26 W/kg

## ANNEX C TEST DATA

### Meas.1 Body Plane with Front Side 0mm on 78 Channel on Bluetooth

Date: 2022.06.20

Communication System Band: Bluetooth; Frequency: 2480 MHz; Duty Cycle: 1:1.302

Medium parameters used (interpolated):  $f = 2480$  MHz;  $\sigma = 1.839$  S/m;  $\epsilon_r = 39.437$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Ambient Temperature: 22.5 Liquid Temperature: 21.7

DASY5 Configuration:

- Probe: EX3DV4 - SN7663; ConvF(8.19, 8.19, 8.19); Calibrated: 2021/7/23
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 2021/11/05
- Phantom: SAM (20deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CC; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch78/Area Scan (81x81x1):** Interpolated grid:  $dx=1.200$  mm,  $dy=1.200$  mm

Maximum value of SAR (interpolated) = 0.00779 W/kg

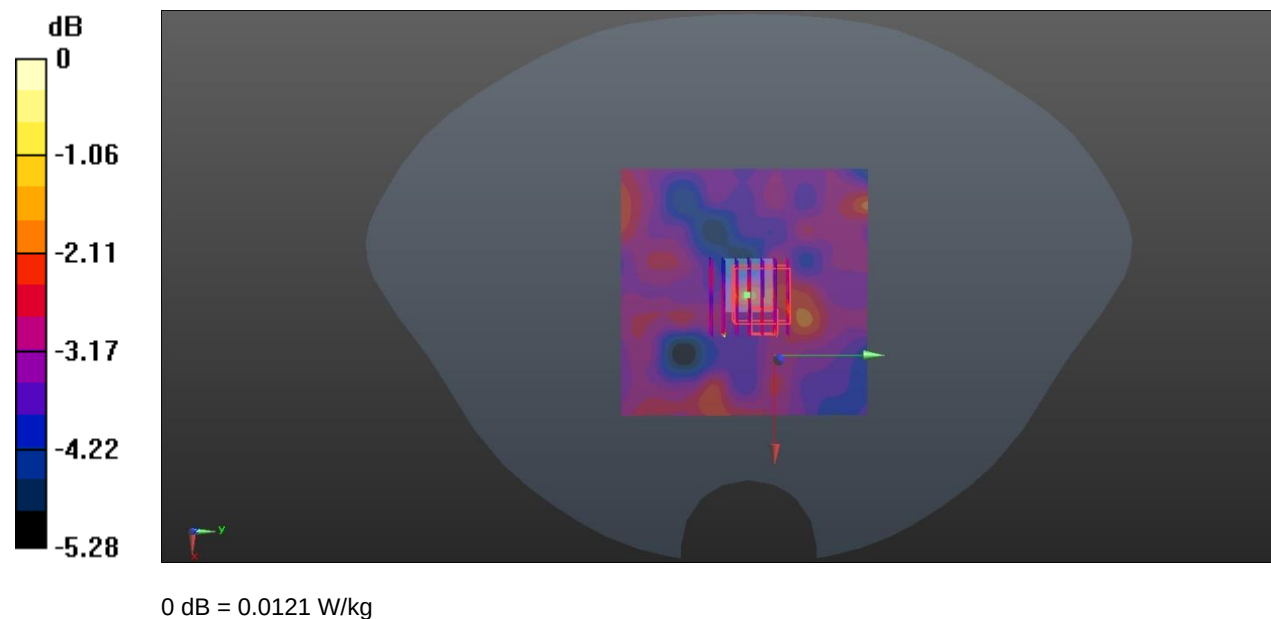
**Ch78/Zoom Scan (7x7x7)/Cube 0:** Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 1.288 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 0.0120 W/kg

**SAR(1 g) = 0.007 W/kg; SAR(10 g) = 0.006 W/kg**

Maximum value of SAR (measured) = 0.0121 W/kg



## **ANNEX D EUT EXTERNAL PHOTOS**

Please refer the document “BL-SZ2241151-AW.pdf”.

## **ANNEX E SAR TEST SETUP PHOTOS**

Please refer the document “BL-SZ2241151-AS.pdf”.

## **ANNEX F CALIBRATION REPORT**

Please refer the document “CALIBRATION REPORT.pdf”.

## Statement

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