# TEST REPORT

| | | |
|---|---|---|
| **APPLICANT** | : | Tiinlab Corporation |
| **PRODUCT NAME** | : | Wireless Earphones |
| **MODEL NAME** | : | EC305 |
| **BRAND NAME** | : | 1MORE |
| **FCC ID** | : | 2ASDI-EC305 |
| **STANDARD(S)** | : | FCC 47 CFR Part 2(2.1093)<br>IEEE 1528-2013 |
| **RECEIPT DATE** | : | 2023-06-07 |
| **TEST DATE** | : | 2023-07-03 |
| **ISSUE DATE** | : | 2023-08-14 |

Edited by: Xie Yiyun (Rapporteur)

Approved by: Shen Junsheng (Supervisor)

**NOTE:** This document is issued by Shenzhen Morlab Communications Technology Co., Ltd., the test report shall not be reproduced except in full without prior written permission of the company. The test results apply only to the particular sample(s) tested and to the specific tests carried out which is available on request for validation and information confirmed at our website.

MORLAB
Shenzhen Morlab Communications Technology Co., Ltd.
FL.1-3, Building A, FeiYang Science Park, No.8 LongChang Road,
Block67, BaoAn District, ShenZhen , GuangDong Province, P. R. China
Tel: 86-755-36698555 Fax: 86-755-36698525
Http://www.morlab.cn E-mail: service@morlab.cn

# DIRECTORY


1 SAR Results Summary ..... 4
2 Technical Information ..... 5
2.1 Applicant and Manufacturer Information ..... 5
2.2 Equipment under Test (EUT) Description ..... 5
2.3 Accessories Information ..... 5
2.4 Environment of Test Site ..... 6
3 Specific Absorption Rate (SAR) ..... 7
3.1 Introduction ..... 7
3.2 SAR Definition ..... 7
4 RF Exposure Limits ..... 8
4.1 Uncontrolled Environment ..... 8
4.2 Controlled Environment ..... 8
5 Applied Reference Documents ..... 9
6 SAR Measurement System ..... 10
6.1 E-Field Probe ..... 11
6.2 Data Acquisition Electronics (DAE) ..... 11
6.3 Robot ..... 12
6.4 Measurement Server ..... 12
6.5 Light Beam Unit ..... 12
6.6 Phantom ..... 13
6.7 Device Holder ..... 13
6.8 Data Storage and Evaluation ..... 14
6.9 Test Equipment List ..... 16
7 Tissue Simulating Liquids ..... 17
8 SAR System Verification ..... 19
9 EUT Testing Position ..... 21
9.1 SAR Evaluations near the Mouth/Jaw Regions of the SAM ..... 21
9.2 Body Worn Accessory Configurations ..... 21
9.3 DUTs with Alternative form Factor ..... 22

10 Measurement Procedures ..... 23
10.1 Spatial Peak SAR Evaluation ..... 24
10.2 Power Reference Measurement ..... 24
10.3 Area Scan Procedures ..... 24
10.4 Zoom Scan Procedures ..... 25
10.5 SAR Averaged Methods ..... 25
10.6 Power Drift Monitoring ..... 25
11 Conducted RF Output Power ..... 26
12 Exposure Positions Consideration ..... 27
13 Block Diagram of the Tests to be Performed ..... 28
13.1 Head ..... 28
14 SAR Test Results Summary ..... 29
14.1 Test Guidance: ..... 29
14.2 Standalone Head SAR ..... 30
15 Simultaneous Transmission Considerations ..... 31
16 Measurement Uncertainty ..... 32
17 Measurement Conclusion ..... 33
Annex A General Information ..... 34
Annex B Test Setup Photos
Annex C Plots of System Performance Check
Annex D Plots of Maximum SAR Test Results
Annex E DASY Calibration Certificate

| Change History | | |
|---|---|---|
| Version | Date | Reason for Change |
| 1.0 | 2023-08-14 | First edition |
| | | |

# 1 SAR Results Summary

The maximum results of Specific Absorption Rate (SAR) found during test as bellows:
<Highest Reported standalone SAR Summary>

| Frequency Band | | Highest SAR Summary (1g SAR (W/kg)) |
|---|---|---|
| | | Head |
| | | (Separation 0mm) |
| 2.4GHz Band | Bluetooth | 0.339 |

| | | |
|---|---|---|
| Highest Simultaneous Transmission $SAR_{1g}$ (W/Kg): | 0.511 W/kg | Limit(W/kg): 1.6 W/kg |

**Note:**

1. This device is in compliance with Specific Absorption Rate (SAR) for general population or uncontrolled exposure limits (1.6W/kg as averaged over any 1 gram of tissue; specified in FCC 47 CFR part 1 (1.1310) and IEEE C95.1-1991), and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013 and FCC KDB publications.
2. When the test result is a critical value, we will use the measurement uncertainty give the judgment result based on the 95% confidence intervals.

# 2 Technical Information

**Note:** Provide by applicant.

## 2.1 Applicant and Manufacturer Information

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

## 2.2 Equipment under Test (EUT) Description

| | |
|---|---|
| **Product Name:** | Wireless Earphones |
| **EUT No.:** | 1# |
| **Hardware Version:** | V2.0 |
| **Software Version:** | V1.2 |
| **Frequency Bands:** | Bluetooth: 2402 MHz ~ 2480 MHz |
| **Modulation Mode:** | BR+EDR: GFSK(1Mbps), π/4-DQPSK(2Mbps), 8-DPSK(3Mbps)<br>Bluetooth LE: GFSK(1Mbps, 2Mbps) |
| **Antenna Type:** | FPC Antenna |
| **SIM Cards Description:** | N/A |

## 2.3 Accessories Information

| | | |
|---|---|---|
| **Battery Type 1: (Earphone)** | Manufacturer: | Shenzhen Hynetech Company Limited |
| | Brand Name: | N/A |
| | Model: | CP1054AA |
| | Capacity: | 45 mAh |
| | Rated Voltage: | 3.7 V |
| **Battery Type 2: (Charging box)** | Manufacturer: | Huizhou Everpower Technology Co., Ltd. |
| | Brand Name: | N/A |
| | Model: | HT591736S-D01 |
| | Capacity: | 410 mAh |
| | Rated Voltage: | 3.6 V |

**Note:** For a more detailed description, please refer to specification or user's manual supplied by the applicant and/or manufacturer.

## 2.4 Environment of Test Site

| | |
|---|---|
| **Temperature:** | 20 ... 25 ° C |
| **Humidity:** | 30 ... 75 % |
| **Atmospheric Pressure:** | 980 ... 1020 hPa |

| | |
|---|---|
| **Test Frequency:** | Bluetooth |
| **Operation Mode:** | Call established |

During SAR test, EUT is in Traffic Mode (Channel Allocated) at Normal Voltage Condition. A communication link is set up with a System Simulator (SS) by air link, and a call is established.

The EUT shall use its internal transmitter. The antenna(s), battery and accessories shall be those specified by the Factory. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output. If a wireless link is used, the antenna connected to the output of the base station simulator shall be placed at least 50 cm away from the handset.

The signal transmitted by the simulator to the antenna feeding point shall be lower than the output power level of the handset by at least 35 dB.

# 3 Specific Absorption Rate (SAR)

## 3.1 Introduction

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

## 3.2 SAR Definition

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

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

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

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

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

Where: C is the specific heat capacity, $\delta T$ is the temperature rise and $\delta t$ is the exposure duration, or related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and |E| is the RMS electrical field strength. However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

# 4 RF Exposure Limits

## 4.1 Uncontrolled Environment

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

## 4.2 Controlled Environment

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

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

| Type Exposure | Uncontrolled Environment Limit |
|---|---|
| Spatial Peak SAR (1g cube tissue for head and trunk) | 1.60W/kg |
| Spatial Peak SAR (10g cube tissue for limbs) | 4.00W/kg |
| Spatial Peak SAR (1g cube tissue for whole body) | 0.08 W/kg |

**Note:**

1. Occupational/Uncontrolled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure(i.e. as a result of employment or occupation).
2. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

# 5 Applied Reference Documents

Leading reference documents for testing:

| Identity | Document Title | Method Determination Remark |
|---|---|---|
| FCC 47 CFR Part 2(2.1093) | Radio Frequency Radiation Exposure Evaluation: Portable Devices | No deviation |
| IEEE 1528-2013 | IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques | No deviation |
| KDB 447498 D04v01 | General RF Exposure Guidance | No deviation |
| KDB 865664 D01v01r04 | SAR Measurement 100 MHz to 6 GHz | No deviation |
| KDB 865664 D02v01r02 | RF Exposure Reporting | No deviation |
| KDB 941225 D06v02r01 | SAR Evaluation Procedures For Portable Devices With Wireless Router Capabilities | No deviation |
| **Note 1:** Additions to, deviation, or exclusions from the method shall be judged in the "method determination" column of add, deviate or exclude from the specific method shall be explained in the "Remark" of the above table. | | |

# 6 SAR Measurement System

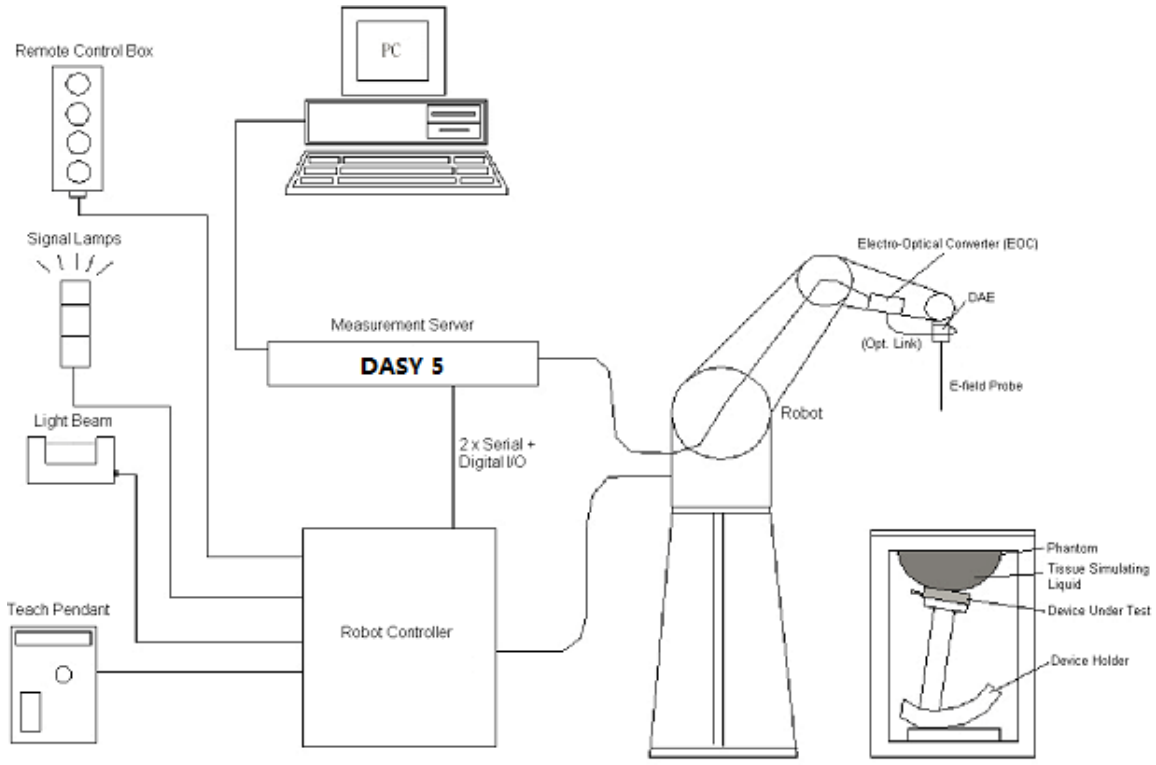



**Fig.6.1 SPEAG DASY System Configurations**

The DASY system for performance compliance tests is illustrated above graphically. This system consists of the following items:

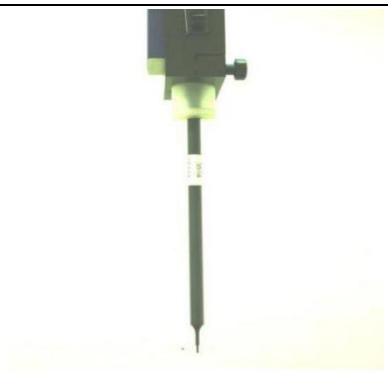
- A standard high precision 6-axis robot with controller, a teach pendant and software.
- A data acquisition electronic (DAE) attached to the robot arm extension.
- A dosimetric probe equipped with an optical surface detector system.
- The electro-optical converter (EOC) performs the conversion between optical and electrical signals.
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning.
- A computer operating Windows XP.
- DASY software.
- Remove control with teach pendant and additional circuitry for robot safety such as warming lamps, etc.
- The SAM twin phantom.
- A device holder.
- Tissue simulating liquid.
- Dipole for evaluating the proper functioning of the system.

## 6.1 E-Field Probe

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

➢ **E-Field Probe Specification**

**<EX3DV4 Probe>**

| | | |
|---|---|---|
| **Construction** | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |  |
| **Frequency** | 10 MHz to 6 GHz; Linearity: ± 0.2 dB | |
| **Directivity** | ± 0.3 dB in HSL (rotation around probe axis)<br>± 0.5 dB in tissue material (rotation normal to probe axis) | |
| **Dynamic Range** | 10 μW/g to 100 mW/g; Linearity: ± 0.2 dB | |
| **Dimensions** | Overall length: 330 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm | **Fig 6.3 Photo of EX3DV4** |

➢ **E-Field Probe Calibration**

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than ±10%. The spherical isotropy shall be evaluated and within ±0.25 dB. The sensitivity parameters (Norm X, Norm Y and Norm Z), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested. The calibration data can be referred to Annex E of this report.

## 6.2 Data Acquisition Electronics (DAE)

The Data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

**Fig. 6.4 Photo of DAE**

## 6.3 Robot

The SPEAG DASY system uses the high precision robots (DASY5: TX60XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubliis used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability 0.02 mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; nobelt drives)
- Jerk-free straight movements
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)

**Fig. 6.5 Photo of Robot**

## 6.4 Measurement Server

The measurement server is based on a PC/104 CPU board with CPU (DASY 5: 400MHz, Intel Celeron), chip-disk (DASY5: 128 MB), RAM (DASY5: 128 MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.

**Fig. 6.6 Photo of Server for DASY5**

## 6.5 Light Beam Unit

The light beam switch allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, such that the robot coordinates are valid for the probe tip.

The repeatability of this process is better than0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.

**Fig. 6.7 Photo of Light Beam**

## 6.6 Phantom

**<SAM Twin Phantom>**

| | | |
|---|---|---|
| **Shell Thickness** | 2 ± 0.2 mm (sagging: <1%)<br>Center ear point: 6 ± 0.2 mm | <br>**Fig. 6.8 Photo of SAM Phantom** |
| **Filling Volume Dimensions** | Approx. 25 liters<br>Length: 1000 mm; Width: 500 mm;<br>Height: adjustable feet | |
| **Measurement Areas** | Left Head, Right Head, Flat phantom | |

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

## 6.7 Device Holder

**<Device Holder for SAM Twin Phantom>**

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5 mm distance, a positioning uncertainty of ±0.5 mm would produce a SAR uncertainty of ± 20 %. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (ERP).

Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-low POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

**<Laptop Extension Kit>**

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

Fig 6.9 Device Holder

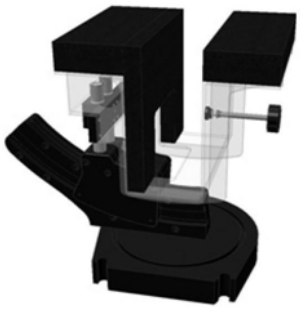


Fig 6.10 Laptop Extension Kit

## 6.8 Data Storage and Evaluation

➢ **Data Storage**

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files. The post-processing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verifications of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type (e.g., [V/m], [mW/g]). Some of these units are not available in certain situations or give meaningless results, e.g., a SAR-output in a non-lose media, will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

➢ **Data Evaluation**

The DASY post-processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

| | | |
|---|---|---|
| **Probe Parameters:** | - Sensitivity | $Norm_i$, $a_{i0}$, $a_{i1}$, $a_{i2}$ |
| | - Conversion | $ConvF_i$ |
| | - Diode compression point | $dcp_i$ |
| **Device Parameters:** | - Frequency | f |
| | - Crest | cf |
| **Media Parameters:** | - Conductivity | σ |
| | - Density | ρ |

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multi-meter option, the parameters of the

actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power.

The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

WithVi = compensated signal of channel i, (i = x, y, z)

Ui= input signal of channel i, (i = x, y, z)

cf = crest factor of exciting field (DASY parameter)

dcpi= diode compression point (DASY parameter)

From the compensated input signals, the primary field data for each channel can be evaluated:

E- Field Probes: $E_i = \sqrt{\frac{v_i}{Norm_i \cdot ConvF}}$

H-Field Probes: $H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}$

WithVi = compensated signal of channel i, (i = x, y, z)

Normi= senor sensitivity of channel i, (i = x, y, z), μV/ (V/m) 2

ConvF = sensitivity enhancement in solution

aij = sensor sensitivity factors for H-field probes

f = carrier frequency (GHz)

Ei = electric field strength of channel i in V/m

Hi = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$\mathrm{SAR} = \mathrm{E}_{\mathrm{tot}}^2 \times \frac{\sigma}{\rho \times 1000}$$

With SAR = local specific absorption rate in mW/g

Etot= total field strength in V/m

σ = conductivity in (mho/m) or (Siemens/m)

ρ= equipment tissue density in g/cm3

Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.

## 6.9 Test Equipment List

| Manufacturer | Name of Equipment | Type/Model | Serial No./ SW Version | Calibration | |
|---|---|---|---|---|---|
| | | | | Last Cal. | Due Date |
| SPEAG | 2450MHz System Validation Kit | D2450V2 | 805 | 2021.12.17 | 2024.12.16 |
| SPEAG | DOSIMETRIC ASSESSMENT SYSTEM | DASY52 | 52.10.4.1527 | NCR | NCR |
| SPEAG | Dosimetric E-Field Probe | EX3DV4 | 7608 | 2023.03.15 | 2024.03.14 |
| SPEAG | Data Acquisition Electronics | DAE4 | 1643 | 2023.02.22 | 2024.02.21 |
| SPEAG | Twin-SAM | QD000P41Ax | 2020 | NCR | NCR |
| SPEAG | Phone Positioner | N/A | N/A | NCR | NCR |
| Agilent | Network Analyzer | E5071B | MY42404762 | 2023.02.09 | 2024.02.08 |
| Speag | Dielectric Assessment KIT | DAK-3.5 | 1279 | 2022.09.17 | 2023.09.16 |
| mini-circuits | Amplifier | ZHL-42W+ | 608501717 | NCR | NCR |
| Agilent | Signal Generator | N5182B | MY53050509 | 2022.11.30 | 2023.11.29 |
| R&S | Power Senor | NRP8S | 103215 | 2023.02.09 | 2024.02.08 |
| Agilent | Power Meter | E4416A | MY45102093 | 2022.10.11 | 2023.10.10 |
| R&S | Power Sensor | NRP8S | 103240 | 2023.02.09 | 2024.02.08 |
| Anritsu | Power Meter | E4418B | GB43318055 | 2022.08.30 | 2023.08.29 |
| Agilent | Dual Directional Coupler | 778D | 50422 | NA | NA |
| MCL | Attenuation | 351-218-010 | N/A | NA | NA |
| R&S | Spectrum Analyzer | N9030A | MY54170556 | 2022.10.10 | 2023.10.09 |
| KTJ | Thermo meter | TA298 | N/A | 2022.12.08 | 2023.12.07 |
| SPEAG | Tissue Simulating Liquids | HBBL600-10000V6 | | 24H | |

**Note:**

1. The calibration certificate of DASY can be referred to Annex E of this report.
2. The Insertion Loss calibration of Dual Directional Coupler and Attenuator were characterized via the network analyzer and compensated during system check.
3. The dielectric probe kit was calibrated via the network analyzer, with the specified procedure (calibrated in pure water) and calibration kit (standard) short circuit, before the dielectric measurement. The specific procedure and calibration kit are provided by Speag.
4. In system check we need to monitor the level on the power meter, and adjust the power amplifier level to have precise power level to the dipole; the measured SAR will be normalized to 1W input power according to the ratio of1W to the input power to the dipole. For system check, the calibration of the power amplifier is deemed not critically required for correct measurement; the power meter is critical and we do have calibration for it.
5. Attenuator insertion loss is calibrated by the network Analyzer, which the calibration is valid, before system check.

6. N.C.R means No Calibration Requirement.

# 7 Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. 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, which is shown in Fig. 7.1, for body SAR testing, the liquid height from the center of the flat phantom to liquid top surface is larger than 15 cm, which is shown in Fig. 7.2.

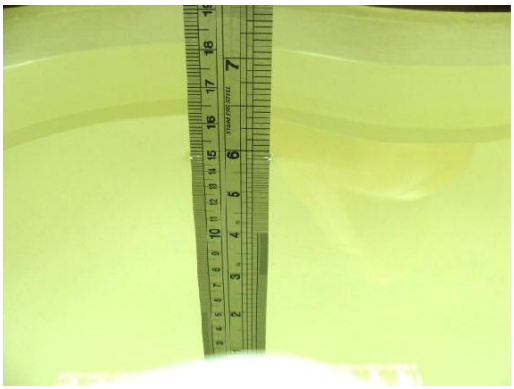


**Fig 7.1 Photo of Liquid Height for Head SAR**

**Fig 7.2 Photo of Liquid Height for Body SAR**

The following table gives there cipes for tissue simulating liquids

| Frequency (MHz) | Water (%) | Sugar (%) | Cellulose (%) | Salt (%) | Preventol (%) | DGBE (%) | Conductivity (σ) | Permittivity (εr) |
|---|---|---|---|---|---|---|---|---|
| Head | | | | | | | | |
| 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 |
| 1800,1900,2000 | 55.2 | 0 | 0 | 0.3 | 0 | 44.5 | 1.40 | 40.0 |
| 2450 | 55.0 | 0 | 0 | 0 | 0 | 45.0 | 1.80 | 39.2 |
| 2600 | 54.8 | 0 | 0 | 0.1 | 0 | 45.1 | 1.96 | 39.0 |

Simulating Liquid for 5GHz, Manufactured by SPEAG

| Ingredients | (% by weight) |
|---|---|
| Water | 64~78% |
| Mineral oil | 11~18% |
| Emulsifiers | 9~15% |
| Additives and Salt | 2~3% |

The relative permittivity and conductivity of the tissue material should be within±5% of the values given in the table below recommended by the FCC OET 65supplement C and RSS 102 Issue 5.

| Target Frequency | Head | | Body | |
|---|---|---|---|---|
| (MHz) | ε r | σ (S/m) | ε r | σ (S/m) |
| 150 | 52.3 | 0.76 | 61.9 | 0.80 |
| 300 | 45.3 | 0.87 | 58.2 | 0.92 |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 |
| 900 | 41.5 | 0.97 | 55.0 | 1.05 |
| 915 | 41.5 | 0.98 | 55.0 | 1.06 |
| 1450 | 40.5 | 1.20 | 54.0 | 1.30 |
| 1610 | 40.3 | 1.29 | 53.8 | 1.40 |
| 1800-2000 | 40.0 | 1.40 | 53.3 | 1.52 |
| 2450 | 39.2 | 1.80 | 52.7 | 1.95 |
| 3000 | 38.5 | 2.40 | 52.0 | 2.73 |
| 5800 | 35.3 | 5.27 | 48.2 | 6.00 |

( ε r = relative permittivity, σ = conductivity and ρ = 1000 kg/m$^3$)

The dielectric parameters of liquids were verified prior to the SAR evaluation using a Speag Dielectric Probe Kit and an Agilent Network Analyzer.

The following table shows the measuring results for simulating liquid.

| **Fre. (MHz)** | **Tissue Type** | **Liquid Temp. (℃)** | **Conductivity (σ)** | **Conductivity Target (σ)** | **Delta (σ) (%)** | **Limit (%)** | **Date** |
|---|---|---|---|---|---|---|---|
| 2450 | HSL | 22.1 | 1.817 | 1.80 | 0.94 | ±5 | 2023.07.03 |
| | | | | | | | |
| **Fre. (MHz)** | **Tissue Type** | **Liquid Temp. (℃)** | **Permittivity (εr)** | **Permittivity Target (εr)** | **Delta (εr) (%)** | **Limit (%)** | **Date** |
| 2450 | HSL | 22.1 | 38.800 | 39.20 | -1.02 | ±5 | 2023.07.03 |

# 8 SAR System Verification

Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder.

- **Purpose of System Performance 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.

- **System 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:

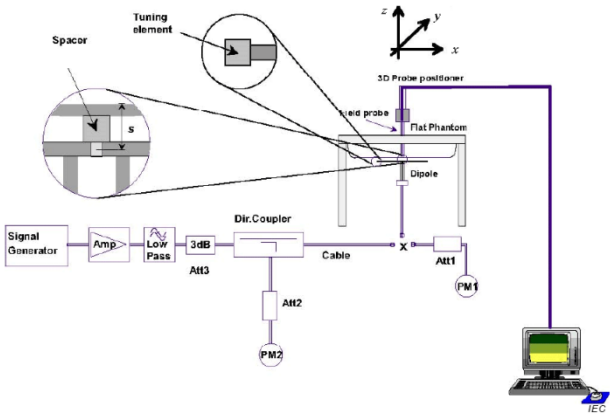



**Fig.7.1 System Verification Setup Diagram**

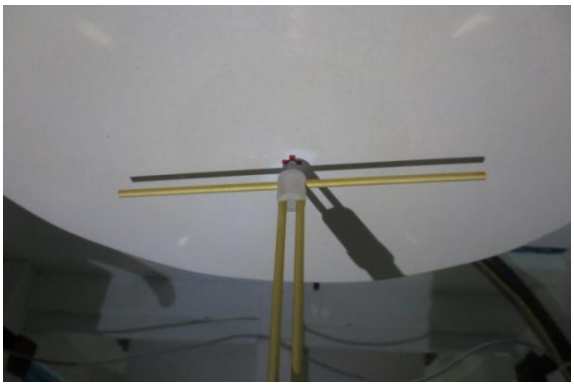


**Fig.7.2 Photo of Dipole setup**

➢ **System Verification Results**

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

| Dipole S/N | Probe S/N | DAE S/N |
|---|---|---|
| D2450V2-805 | 7608 | 1643 |

**<1g SAR>**

| Date | Freq. (MHz) | Tissue Type | Input Power (mW) | Measured 1g SAR (W/kg) | Targeted 1g SAR (W/kg) | Normalized 1g SAR (W/kg) | Deviation (%) |
|---|---|---|---|---|---|---|---|
| 2023.07.03 | 2450 | HSL | 250 | 13.60 | 52.30 | 54.4 | 4.02 |

**<10g SAR>**

| Date | Freq. (MHz) | Tissue Type | Input Power (mW) | Measured 10g SAR (W/kg) | Targeted 10g SAR (W/kg) | Normalized 10g SAR (W/kg) | Deviation (%) |
|---|---|---|---|---|---|---|---|
| 2023.07.03 | 2450 | HSL | 250 | 6.31 | 23.90 | 25.24 | 5.61 |

**Note:** System checks the specific test data please see Annex C

# 9 EUT Testing Position

This EUT was tested in six different positions. They are Front/Back/Left/Right/Top/Bottom Side of the EUT with phantom 0 mm gap, as illustrated below, please refer to Annex B for the test setup photos.

## 9.1 SAR Evaluations near the Mouth/Jaw Regions of the SAM

Antennas located near the bottom of a phone may require SAR measurements around the mouth and jaw regions of the SAM head phantom. This typically applies to clam-shell style phones that are generally longer in the unfolded normal use positions or to certain older style long rectangular phones.

Under these circumstances, the following procedures apply, adopted from the FCC guidance on SAR handsets document FCC KDB Publication 648474 D04v01r03. The SAR required in these regions of SAM should be measured using a flat phantom. The phone should be positioned with a separation distance of 4 mm between the ear reference point (ERP) and the outer surface of the flat phantom shell. While maintaining this distance at the ERP location, the low (bottom) edge of the phone should be lowered from the phantom to establish the same separation distance between the peak SAR locations identified by the truncated partial SAR distribution measured with the SAM phantom. The distance from the peak SAR location to the phone is determined by the straight line passing perpendicularly through the phantom surface. When it is not feasible to maintain 4 mm separation at the ERP while also establishing the required separation at the peak SAR location, the top edge of the phone will be allowed to touch the phantom with a separation < 4 mm at the ERP. The phone should not be tilted to the left or right while placed in this inclined position to the flat phantom.

## 9.2 Body Worn Accessory Configurations

- To position the device parallel to the phantom surface with either keypad up or down.
- To adjust the device parallel to the flat phantom.
- To adjust the distance between the device surface and the flat phantom to 10 mm or holster surface and the flat phantom to 0 mm.

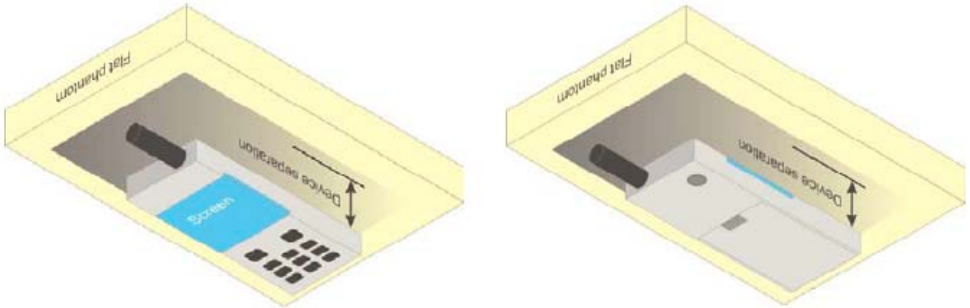



**Fig.9.1 Illustration for Body Worn Position**

## 9.3 DUTs with Alternative form Factor

➢ **Head mounted device(Headset)**

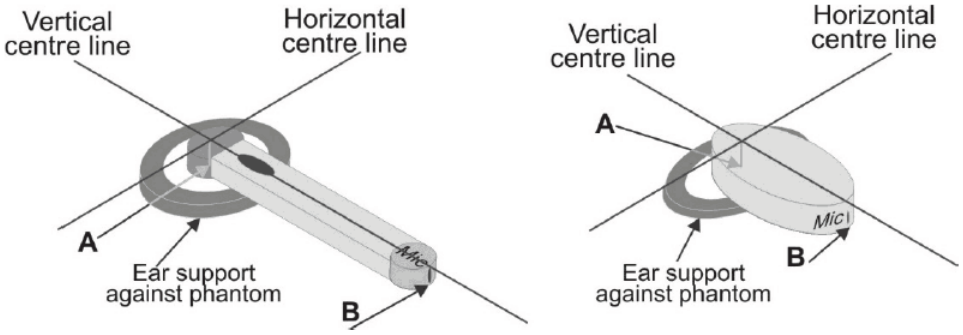
device operated next to the side of the head consisting of an acoustic output or earphone and a microphone and containing a radio transmitter and receiver held in position on or around the ear by mechanical support, e.g. around the head. A head mounted device (headset) is designed to be used at the ear but does not protrude into the pinna or the auditory canal. For all practical purposes of this Standard, it is considered as a handset as it contains the same basic components and performs the same basic functions

Note 1 to entry: Where the device under test is a head mounted device (headset), the user shall read the term handset to mean head mounted device throughout this Standard.

Note 2 to entry: A head mounted device that is intended to be used in a way not considered for testing by SAM phantom explained in this Standard is outside the scope of this Standard. (e.g. ear bud).

For the purpose of this Standard the DUT is considered to be a conventional bar type (rectangular, cuboid) form factor. However the basic principles defined and specified here may be applied to other form factors for other devices covered by the scope of this Standard.

One such device is a wireless headset (e.g. connected by Bluetooth), which can be evaluated in the same manner as any other DUT in this Standard by applying a similar geometry and coordinate mapping from this device to the DUT definition provided in Figure 4.



# 10 Measurement Procedures

The measurement procedures are as bellows:

**<Conducted power measurement>**

- For WWAN power measurement, use base station simulator to configure EUT WWAN transition in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.
- Read the WWAN RF power level from the base station simulator.
- For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band.
- Connect EUT RF port through RF cable to the power meter or spectrum analyzer, and measure WLAN/BT output power.

**<SAR measurement>**

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

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

- Power reference measurement
- Area scan
- Zoom scan
- Power drift measurement

## 10.1 Spatial Peak SAR Evaluation

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

The base for the evaluation is a “cube” measurement. The measured volume must include the 1g and 10 g 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 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

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

## 10.2 Power Reference Measurement

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

## 10.3 Area Scan Procedures

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a10mm$^2$ step integral, with 1mm interpolation used to locate the peak SAR area used for zoom scan assessments. When an Area Scan has measured all reachable points, it computes the field maxima found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing.

## 10.4 Zoom Scan Procedures

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. A density of 1000 kg/m$^3$ is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1g cube is 10mm, with the side length of the 10 g cube 21,5mm.The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications utilize a physical step of 5x5x7 (8mmx8mmx5mm)providing a volume of 32mm in the X & Y axis, and 30mm in the Z axis.

## 10.5 SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Sheppard'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 1g and 10g cubes, the extrapolation distance should not be larger than 5 mm.

## 10.6 Power Drift Monitoring

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

# 11 Conducted RF Output Power

➢ Bluetooth Conducted Power (Left ear & Right ear)

| Mode | Channel | Frequency (MHz) | Average power (dBm) | |
|---|---|---|---|---|
| | | | DH5 1Mbps | |
| | | | Measured | Tune-up Limit (dBm) |
| BR / EDR | CH 00 | 2402 | 6.91 | 8.00 |
| | CH 39 | 2441 | 5.45 | 6.50 |
| | CH 78 | 2480 | 4.79 | 5.50 |

| Mode | Channel | Frequency (MHz) | Average power (dBm) | |
|---|---|---|---|---|
| | | | 2DH5 2Mbps | |
| | | | Measured | Tune-up Limit (dBm) |
| BR / EDR | CH 00 | 2402 | 6.45 | 7.00 |
| | CH 39 | 2441 | 5.36 | 6.00 |
| | CH 78 | 2480 | 4.76 | 5.50 |

| Mode | Channel | Frequency (MHz) | Average power (dBm) | |
|---|---|---|---|---|
| | | | 3DH5 3Mbps | |
| | | | Measured | Tune-up Limit (dBm) |
| BR / EDR | CH 00 | 2402 | 6.57 | 7.50 |
| | CH 39 | 2441 | 5.35 | 6.00 |
| | CH 78 | 2480 | 4.72 | 5.50 |

| Mode | Channel | Frequency (MHz) | Average power (dBm) | |
|---|---|---|---|---|
| | | | GFSK 1Mbps | |
| | | | Measured | Tune-up Limit (dBm) |
| LE | CH 00 | 2402 | 5.75 | 6.50 |
| | CH 19 | 2440 | 4.38 | 5.00 |
| | CH 39 | 2480 | 4.05 | 5.00 |

| Mode | Channel | Frequency (MHz) | Average power (dBm) | |
|---|---|---|---|---|
| | | | GFSK 2Mbps | |
| | | | Measured | Tune-up Limit (dBm) |
| LE | CH 00 | 2402 | 2.9 | 3.50 |
| | CH 19 | 2440 | 1.81 | 2.50 |
| | CH 39 | 2480 | 1.22 | 2.00 |

# 12 Exposure Positions Consideration

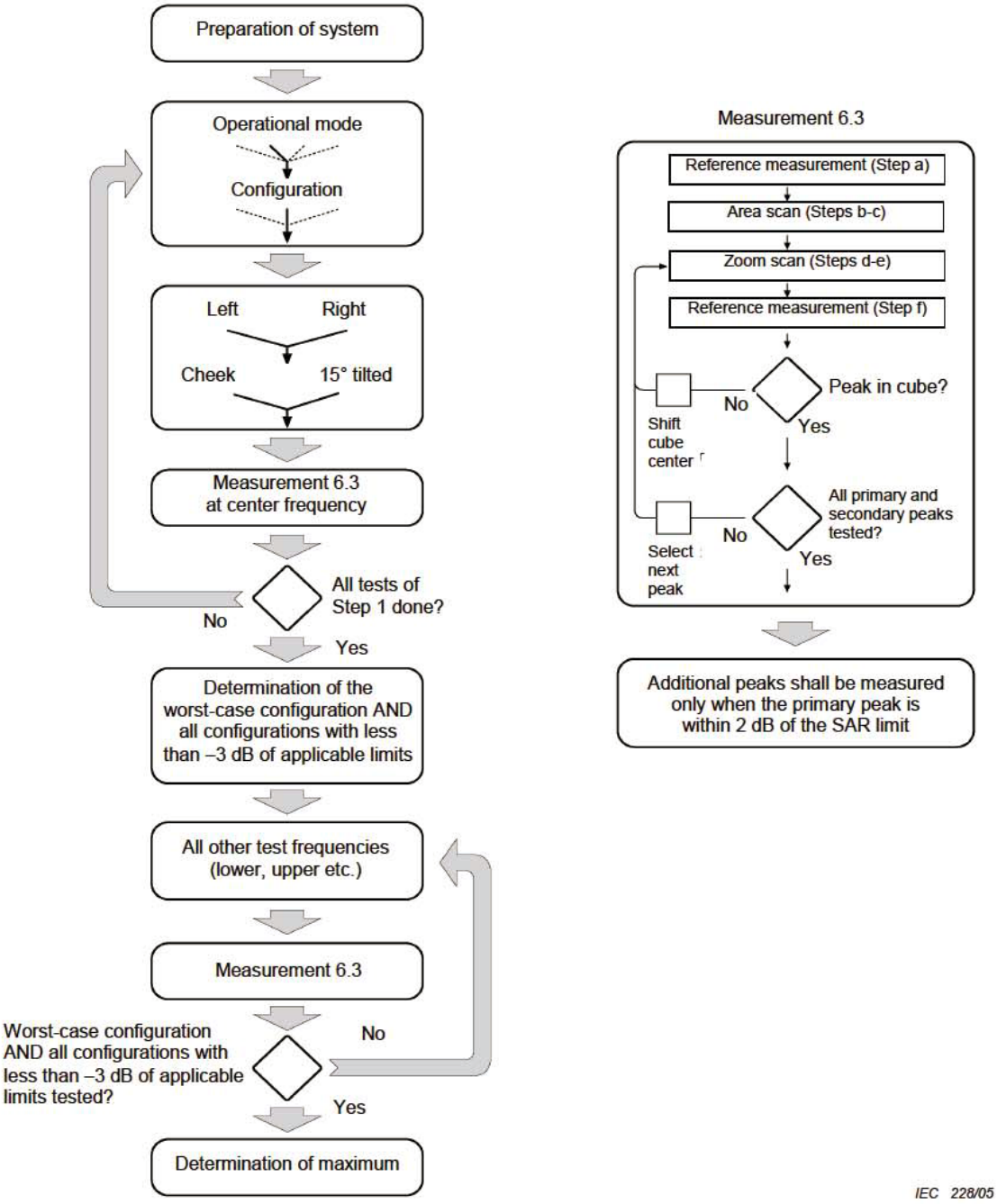
- EUT Antenna Locations

| |
|---|
| The location of antenna was recorded in annex B |
| Bluetooth Antenna:<br>Bluetooth |

**Note:** The distance between the device and each surface is less than 5mm. Therefore, all surfaces need to be tested.

# 13 Block Diagram of the Tests to be Performed

## 13.1 Head



# 14 SAR Test Results Summary

## 14.1 Test Guidance:

1. The reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
   a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
   b. For Bluetooth: Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor
2. The SAR testing shall be performed at the middle frequency channels of each operating mode as the primary test channel. If the SAR measured at the middle channel for each test configuration is at least 3.0dB lower than the SAR limit, testing at the high and low channels is optional. And the High and Low frequency channels must be tested at a worst exposure position, and if the primary test channel reported SAR is ≥0.8 W/kg at the test exposure position, the High and Low frequency channels are also must be required.
3. This device was tested under the flat phantom for the head SAR.

## 14.2 Standalone Head SAR

- Bluetooth Left ear SAR

| Plot No. | Band/Mode | Test Position | CH. | Ave. Power (dBm) | Tune-Up Limit (dBm) | Tune-Up Scaling Factor | Meas. $SAR_{1g}$ (W/kg) | Reported $SAR_{1g}$ (W/kg) |
|---|---|---|---|---|---|---|---|---|
| | Bluetooth/DH5 | Front Side | 0 | 6.91 | 8.00 | 1.285 | 0.086 | 0.119 |
| | Bluetooth/DH5 | Back Side | 0 | 6.91 | 8.00 | 1.285 | 0.196 | 0.270 |
| | Bluetooth/DH5 | Left Side | 0 | 6.91 | 8.00 | 1.285 | 0.118 | 0.163 |
| 1# | Bluetooth/DH5 | Right Side | 0 | 6.91 | 8.00 | 1.285 | 0.246 | 0.339 |
| | Bluetooth/DH5 | Top Side | 0 | 6.91 | 8.00 | 1.285 | 0.054 | 0.074 |
| | Bluetooth/DH5 | Bottom Side | 0 | 6.91 | 8.00 | 1.285 | 0.019 | 0.026 |

- Bluetooth Right ear SAR

| Plot No. | Band/Mode | Test Position | CH. | Ave. Power (dBm) | Tune-Up Limit (dBm) | Tune-Up Scaling Factor | Meas. $SAR_{1g}$ (W/kg) | Reported $SAR_{1g}$ (W/kg) |
|---|---|---|---|---|---|---|---|---|
| | Bluetooth/DH5 | Front Side | 0 | 6.91 | 8.00 | 1.285 | 0.066 | 0.091 |
| | Bluetooth/DH5 | Back Side | 0 | 6.91 | 8.00 | 1.285 | 0.175 | 0.241 |
| 2# | Bluetooth/DH5 | Left Side | 0 | 6.91 | 8.00 | 1.285 | 0.183 | 0.252 |
| | Bluetooth/DH5 | Right Side | 0 | 6.91 | 8.00 | 1.285 | 0.104 | 0.143 |
| | Bluetooth/DH5 | Top Side | 0 | 6.91 | 8.00 | 1.285 | 0.039 | 0.054 |
| | Bluetooth/DH5 | Bottom Side | 0 | 6.91 | 8.00 | 1.285 | 0.015 | 0.021 |

**Note:**

1. Per KDB 447498 D04v01, for each exposure position, if the highest output channel Reported SAR ≤0.8W/kg, other channels SAR testing is not necessary.
2. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required when the measured SAR is ≥ 0.8W/kg.
3. The Bluetooth reported 1g SAR (W/kg) should be scaled with the duty cycle scaling factor 1.073.

# 15 Simultaneous Transmission Considerations

➢ **Simultaneous Transmission Capabilities**

| No. | Simultaneous Transmission Consideration | Head |
|---|---|---|
| 1 | Bluetooth Left ear + Bluetooth Right ear | Yes |

**Note:** According to FCC KDB Publication 447498 D04v01, transmitters are considered to be transmitting simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds. Possible transmission paths for the EUT are shown in below Figure and are color-coded to indicate communication modes which share the same path. Modes which share the same transmission path cannot transmit simultaneously with one another.

➢ **Simultaneous Transmission Analysis**

| Exposure Position | 1 | 2 | 1+2 Summed 1g SAR (W/kg) |
|---|---|---|---|
| | Bluetooth(Left) | Bluetooth(Right) | |
| | 1g SAR (W/kg) | 1g SAR (W/kg) | |
| Front Side | 0.119 | 0.091 | 0.210 |
| Back Side | 0.270 | 0.241 | 0.511 |
| Left Side | 0.163 | 0.252 | 0.415 |
| Right Side | 0.339 | 0.143 | 0.482 |
| Top Side | 0.074 | 0.054 | 0.128 |
| Bottom Side | 0.026 | 0.021 | 0.047 |

# 16 Measurement Uncertainty

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

# 17 Measurement Conclusion

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of FCC, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested. Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.

# Annex A General Information

## 1. Identification of the Responsible Testing Laboratory

| | |
|---|---|
| Laboratory Name: | Shenzhen Morlab Communications Technology Co., Ltd. |
| Laboratory Address: | FL.1-3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China |
| Telephone: | +86 755 36698555 |
| Facsimile: | +86 755 36698525 |

## 2. Identification of the Responsible Testing Location

| | |
|---|---|
| Name: | Shenzhen Morlab Communications Technology Co., Ltd. |
| Address: | FL.1-3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China |

## 3. Facilities and Accreditations

The FCC designation number is CN1192, the test firm registration number is 226174.

**Note:**

The main report is end here and the other Annex (B,C,D,E) will be submitted separately.

****** END OF MAIN REPORT ******