# FCC SAR Test Report

| | | |
|---|---|---|
| Product | : | two way radio |
| Trade mark | : | Blackfin |
| Model/Type reference | : | WT-1004 |
| Report Number | : | 181217009SAR-1 |
| Date of Issue | : | Jan. 08, 2019 |
| FCC ID | : | 2AMXI-WT-1004 |
| Test Standards | : | FCC 47 CFR Part 2 §2.1093<br>ANSI/IEEE C95.1-1992<br>IEEE Std 1528-2013 |
| Test result | : | PASS |

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## Version

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| V1.0 | Jan. 08, 2019 | Original |

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# 1 General Information

## 1.1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for the EUT are as follows:

| Equipment Class | Mode | Highest Reported Face $SAR_{1g}$ (2.5 cm Gap) (W/kg) | Highest Reported Body-worn $SAR_{1g}$ (1.0 cm Gap) (W/kg) |
|---|---|---|---|
| PCF | PTT | 0.33 | 1.12 |

## 1.2 EUT Description

### 1.2.1 General Description

| | |
|---|---|
| **Product Name** | two way radio |
| **Trade mark** | Blackfin |
| **Model No.(EUT)** | WT-1004 |
| **FCC ID** | 2AMXI-WT-1004 |
| **HW Version** | N/A |
| **SW Version** | N/A |
| **Tx Frequency Bands (Unit: MHz)** | 462.5625 MHz to 462.7125 MHz<br>467.5625 MHz to 467.7125 MHz<br>462.5500 MHz to 462.7250 MHz |
| **Antenna Type** | Integral Antenna |
| **EUT Stage** | Identical Prototype |

### 1.2.2 List of Accessory

| | | |
|---|---|---|
| **Battery** | **Brand Name** | FB |
| | **Model Name** | FB-43AAAJ600mAh 1.2V |
| | **Power Rating** | 1.2Vdc, 600mAh |
| | **Type** | NI-MH |

## 1.3 Maximum Conducted Power

The maximum conducted average power (Unit: dBm) including tune-up tolerance is shown as below.

| Mode | Average Power (dBm) |
|---|---|
| PTT | 27.0 |

## 1.4 Other Information

| | |
|---|---|
| Sample Received Date: | Dec. 17, 2018 |
| Sample tested Date: | Jan. 03, 2019 |

## 1.5 Testing Location

Shenzhen UnionTrust Quality and Technology Co., Ltd.
Address: Address: 16/F, Block A, Building 6, Baoneng Science and Technology Park, Qingxiang Road No.1, Longhua New District, Shenzhen, China
Telephone: +86-755-28230888 Fax: +86-755-28230886
Mail: info@uttlab.com Website: Http://www.uttlab.com

## 1.6 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

**CNAS-Lab Code: L9069**

The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC/EN 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

**IC-Registration No.: 21600-1**

The 3m Semi-anechoic chamber of Shenzhen UnionTrust Quality and Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 21600-1.

**A2LA-Lab Certificate No.: 4312.01**

Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

**FCC Accredited Lab.**
**Designation Number: CN1194**
**Test Firm Registration Number: 259480**

## 1.7 Guidance Standard

The tests documented in this report were performed in accordance with FCC 47 CFR Part 2 §2.1093, IEEE Std 1528-2013, ANSI/IEEE C95.1-1992, the following FCC Published RF exposure KDB procedures:

KDB 865664 D01 v01r04

KDB 865664 D02 v01r02

KDB 447498 D01 v06

The equipment have been tested by **Shenzhen UnionTrust Quality and Technology Co., Ltd.**, and found compliance with the requirement of the above standards.

# 2 Specific Absorption Rate (SAR)

## 2.1 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, by appropriate techniques, to produce specific absorption rates (SARs) as averaged over the whole-body, any 1 g or any 10 g of tissue (defined as a tissue volume in the shape of a cube). All SAR values are to be averaged over any six-minute period. When portable device was used within 20 cm of the user's body, SAR evaluation of the device will be required. The SAR limit in chapter 2.3.

## 2.2 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:

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

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

SAR measurement can be related to the electrical field in the tissue by

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

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

## 2.3 SAR Limits

(A) Limits for Occupational/Controlled Exposure (W/kg)

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|---|---|---|
| 0.4 | 8.0 | 20.0 |

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

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|---|---|---|
| 0.08 | 1.6 | 4.0 |

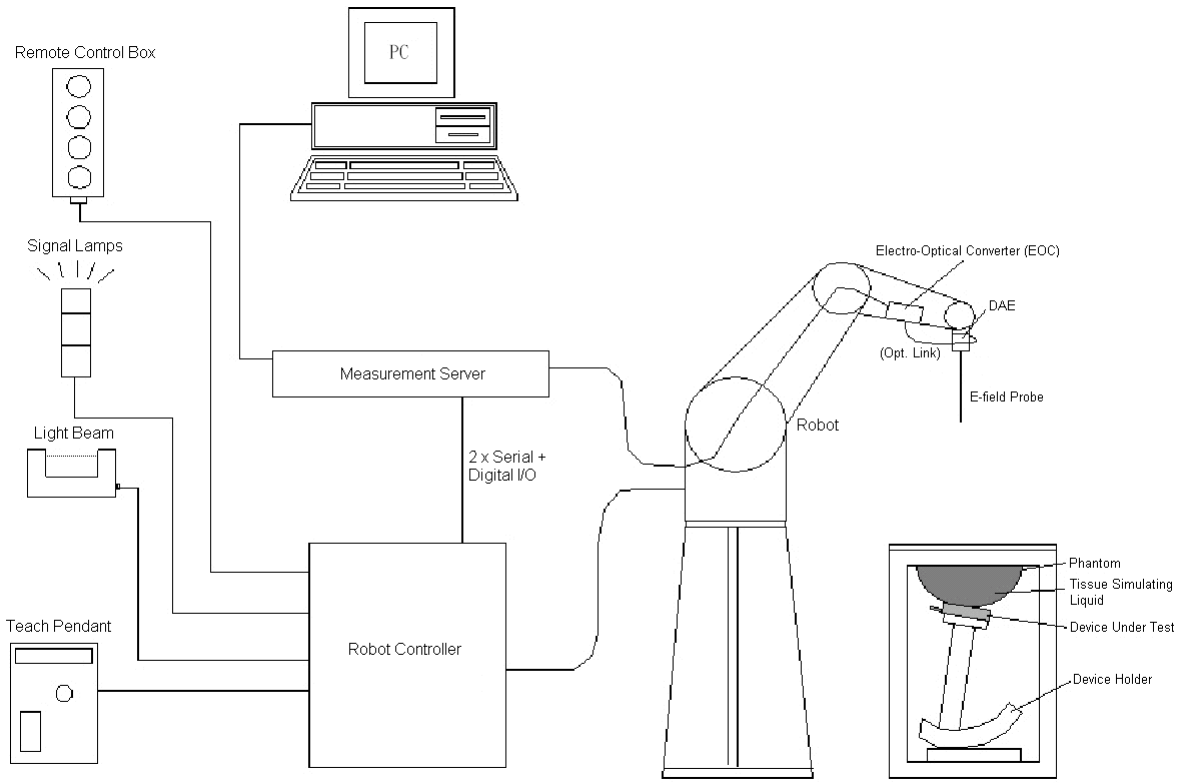
**Note:**

1. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1 gram 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.
2. At frequencies above 6.0 GHz, SAR limits are not applicable and MPE limits for power density should be applied at 5 cm or more from the transmitting device.
3. The SAR limit is specified in FCC 47 CFR Part 2 §2.1093, ANSI/IEEE C95.1-1992.

# 3 SAR Measurement System

## 3.1 SPEAG DASY System

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




DASY Measurement System

### 3.1.1 Robot

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

- High precision (repeatability ±0.02 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

### 3.1.2 Probe

The SAR measurement is conducted with the dosimetric probe. 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.

| | | |
|---|---|---|
| **Model** | EX3DV4 | |
| **Construction** | Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). | |
| **Frequency** | 10 MHz to 6 GHz<br>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<br>Linearity: ± 0.2 dB (noise: typically < 1 µW/g) | |
| **Dimensions** | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm | |

| | | |
|---|---|---|
| **Model** | ES3DV3 | |
| **Construction** | Symmetrical design with triangular core. Interleaved sensors. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE). | |
| **Frequency** | 10 MHz to 4 GHz<br>Linearity: ± 0.2 dB | |
| **Directivity** | ± 0.2 dB in HSL (rotation around probe axis)<br>± 0.3 dB in tissue material (rotation normal to probe axis) | |
| **Dynamic Range** | 5 µW/g to 100 mW/g<br>Linearity: ± 0.2 dB | |
| **Dimensions** | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 3.9 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.0 mm | |

### 3.1.3 Data Acquisition Electronics (DAE)

| | | |
|---|---|---|
| **Model** | DAE3, DAE4 | |
| **Construction** | Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop. | |
| **Measurement Range** | -100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV) | |
| **Input Offset Voltage** | < 5µV (with auto zero) | |
| **Input Bias Current** | < 50 fA | |
| **Dimensions** | 60 x 60 x 68 mm | |

### 3.1.4 Phantom

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

| | | |
|---|---|---|
| **Model** | ELI | |
| **Construction** | Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles. | |
| **Material** | Vinylester, glass fiber reinforced (VE-GF) | |
| **Shell Thickness** | 2.0 ± 0.2 mm (bottom plate) | |
| **Dimensions** | Major axis: 600 mm<br>Minor axis: 400 mm | |
| **Filling Volume** | approx. 30 liters | |

### 3.1.5 Device Holder

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

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

## 3.2 SAR Scan Procedure

### 3.2.1 SAR Reference Measurement (drift)

Prior to the SAR test, local SAR shall be measured at a stationary reference point where the SAR exceeds the lower detection limit of the measurement system.

### 3.2.2 Area Scan

Measurement procedures for evaluating the SAR of wireless device start with a coarse measurement grid to determine the approximate location of the local peak SAR values. This is known as the area-scan procedure. All antennas and radiating structures that may contribute to the measured SAR or influence the SAR distribution must be included in the area scan. The area scan measurement resolution must enable the extrapolation algorithms of the SAR system to correctly identify the peak SAR location(s) for subsequent zoom scan measurements to correctly determine the 1-g SAR. Area scans are performed at a constant distance from the phantom surface, determined by the measurement frequencies. When a measured peak is closer than ½ the zoom scan volume dimension (x, y) from the edge of the area scan region, unless the entire peak and gram-averaging volume are both captured within the zoom scan volume, the area scan must be repeated by shifting and expanding the area scan region to ensure all peaks are away from the area scan boundary. The area scan resolutions specified in the table below must be applied to the SAR measurements.

| | ≤ 3 GHz | > 3 GHz |
|---|---|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | 5 mm ± 1 mm | ½·δ·ln(2) mm ± 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: $\Delta x_{Area}$, $\Delta y_{Area}$ | ≤ 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. | |

### 3.2.3 Zoom Scan

To evaluate the peak spatial-average SAR values with respect to 1 g or 10 g cubes, fine resolution volume scans, called zoom scans, are performed at the peak SAR locations identified during the area scan. If the cube volume within the zoom scan chosen to calculate the peak spatial-average SAR touches any boundary of the zoom-scan volume, the zoom scan shall be repeated with the center of the zoom-scan volume shifted to the new maximum SAR location. For any secondary peaks found in the area scan that are within 2 dB of the maximum peak and are not within this zoom scan, the zoom scan shall be performed for such peaks, unless the peak spatial-average SAR at the location of the maximum peak is more than 2 dB below the applicable SAR limit (i.e., 1 W/kg for a 1.6 W/kg 1 g limit, or 1.26 W/kg for a 2 W/kg 10 g limit). The zoom scan resolutions specified in the table below must be applied to the SAR measurements.

| | | | ≤ 3 GHz | > 3 GHz |
|---|---|---|---|---|
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$, $\Delta y_{Zoom}$ | | | ≤ 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: $\Delta Z_{Zoom}$(n) | | ≤ 5 mm | 3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm |
| | graded grid | $\Delta Z_{Zoom}$(1): between $1^{ST}$ two points closest to phantom surface | ≤ 4 mm | 3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm |
| | | $\Delta Z_{Zoom}$(n>1): between subsequent points | ≤ 1.5·$\Delta Z_{Zoom}$(n-1) mm | |
| Minimum zoom scan volume | x, y, z | | ≥ 30 mm | 3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>5 – 6 GHz: ≥ 22 mm |
| Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.<br>* When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB Publication 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. | | | | |

### 3.2.4 SAR Drift Measurement

The local SAR (or conducted power) shall be measured at exactly the same location as in 3.2.1 section. The absolute value of the measurement drift (the difference between the SAR measured in 3.2.1 and 3.2.4 section) shall be recorded. The SAR drift shall be kept within ± 5%.

## 3.3 Test Equipment

| Equipment | Manufacturer | Model | SN | Cal. Date | Cal. Interval |
|---|---|---|---|---|---|
| COMOSAR 450 MHz REFERENCE DIPOLE | MVG | SID450 | SN 46/11 DIP 0G450-184 | Mar. 10, 2017 | 3 Year |
| Dosimetric E-Field Probe | SPEAG | EX3DV4 | 3953 | Jun. 26, 2018 | 1 Year |
| Data Acquisition Electronics | SPEAG | DAE4 | 1398 | Feb. 08, 2018 | 1 Year |
| ENA Series Network Analyzer | Agilent | 8753ES | MY40000519 | Apr. 14, 2018 | 1 Year |
| Dielectric Assessment Kit | SPEAG | DAK-3.5 | 1056 | N/A | N/A |
| USB/GPIB Interface | Agilent | 82357B | N10149 | N/A | N/A |
| EXG-B RF Analog Signal Generator | KEYSIGHT | N5171B | MY53051777 | Nov. 24, 2018 | 1 Year |
| USB Wideband Power Sensor | KEYSIGHT | U2021XA | MY55430035 | Nov. 24, 2018 | 1 Year |
| USB Wideband Power Sensor | KEYSIGHT | U2021XA | MY55430023 | Nov. 24, 2018 | 1 Year |
| Thermometer | Shanghai Gao Zhi Precision Instrument Co., Ltd. | HB6801 | 120100323 | Nov. 24, 2018 | 1 Year |
| Coupler | REBES | TC-05180-10 S | 161221001 | Nov. 24, 2018 | 1 Year |
| Amplifier | Mini-Circuit | ZHL42 | QA1252001 | N/A | N/A |
| DC Source | Agilent | 66319B | MY43000795 | N/A | N/A |

## 3.4 Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

## 3.5 Tissue Dielectric Parameter Measurement & System Verification

### 3.5.1 Tissue Simulating Liquids

The temperature of the tissue-equivalent medium used during measurement must also be within 18 °C to 25 °C and within ± 2 °C of the temperature when the tissue parameters are characterized. The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 - 4 days of use; or earlier if the dielectric parameters can become out of tolerance.

The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm with ≤ ± 0.5 cm variation for SAR measurements ≤ 3 GHz and ≥ 10.0 cm with ≤ ± 0.5 cm variation for measurements > 3 GHz. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in Table-3.1.

Photo of Liquid Height

Table-3.1 Tissue Dielectric Parameters for Head and Body

| Target Frequency | Head | | Body | |
|---|---|---|---|---|
| (MHz) | εr | σ (S/m) | εr | σ (S/m) |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 |
| *750* | *41.9* | *0.89* | *55.5* | *0.96* |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 |
| 900 | 41.5 | 0.97 | 55.0 | 1.05 |
| *1450* | *40.5* | *1.20* | *54.0* | *1.30* |
| *1640* | *40.3* | *1.29* | *53.8* | *1.40* |
| *1750* | *40.1* | *1.37* | *53.4* | *1.49* |
| 1800 | 40.0 | 1.40 | 53.3 | 1.52 |
| 1900 | 40.0 | 1.40 | 53.3 | 1.52 |
| 2000 | 40.0 | 1.40 | 53.3 | 1.52 |
| *2300* | *39.5* | *1.67* | *52.9* | *1.81* |
| 2450 | 39.2 | 1.80 | 52.7 | 1.95 |
| *2600* | *39.0* | *1.96* | *52.5* | *2.16* |
| *3500* | *37.9* | *2.91* | *51.3* | *3.31* |
| *5200* | *36.0* | *4.66* | *49.0* | *5.30* |
| *5300* | *35.9* | *4.76* | *48.9* | *5.42* |
| *5500* | *35.6* | *4.96* | *48.6* | *5.65* |
| *5600* | *35.5* | *5.07* | *48.5* | *5.77* |
| 5800 | 35.3 | 5.27 | 48.2 | 6.00 |
| (εr = relative permittivity, σ = conductivity and ρ = 1000 kg/m3) | | | | |

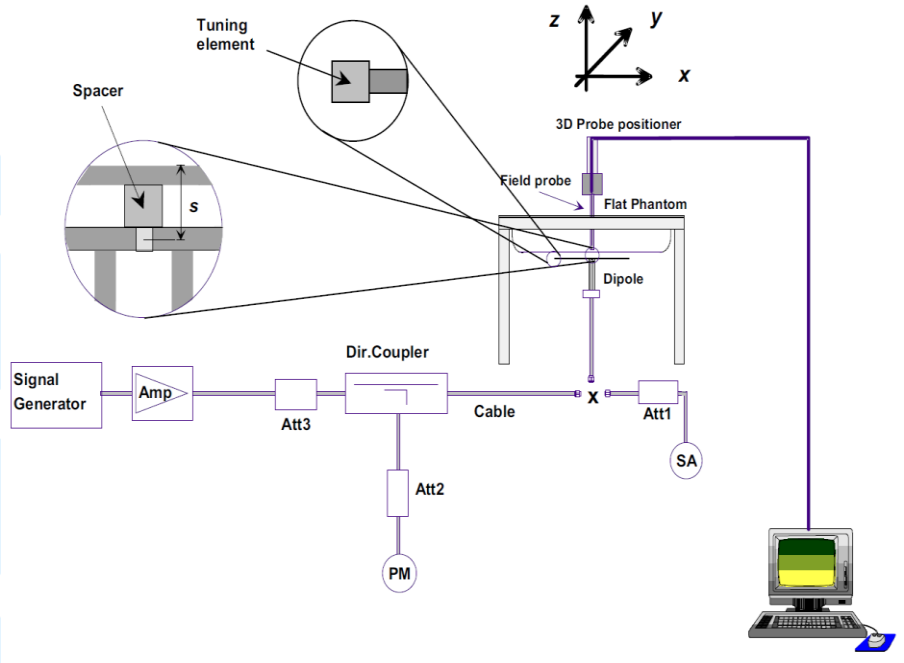
The following table gives the recipes for tissue simulating liquids.

Table-3.2 Recipes of Tissue Simulating Liquid

| Tissue Type | Bactericide | DGBE | HEC | NaCl | Sucrose | Triton X-100 | Water | Diethylene Glycol Mono-hexylether |
|---|---|---|---|---|---|---|---|---|
| H450 | 0.19 | - | 0.98 | 3.95 | 56.32 | - | 38.56 | - |
| H750 | 0.2 | - | 0.2 | 1.4 | 57.0 | - | 41.1 | - |
| H835 | 0.1 | - | 1.0 | 1.4 | 57.0 | - | 40.5 | - |
| H900 | 0.1 | - | 1.0 | 1.5 | 56.5 | - | 40.9 | - |
| H1450 | - | 45.5 | - | 0.7 | - | - | 53.8 | - |
| H1640 | - | 45.8 | - | 0.5 | - | - | 53.7 | - |
| H1750 | - | 44.5 | - | 0.3 | - | - | 55.2 | - |
| H1800 | - | 44.9 | - | 0.2 | - | - | 54.9 | - |
| H1900 | - | 44.9 | - | 0.2 | - | - | 54.9 | - |
| H2000 | - | 50 | - | – | - | - | 50 | - |
| H2300 | - | 44.9 | - | 0.1 | - | - | 55.0 | - |
| H2450 | - | 45.0 | - | 0.1 | - | - | 54.9 | - |
| H2600 | - | 45.1 | - | 0.1 | - | - | 54.8 | - |
| H3500 | - | 8.0 | - | 0.2 | - | 20.0 | 71.8 | - |
| H5G | - | - | - | - | - | 17.2 | 65.52 | 17.3 |
| B450 | 0.05 | - | 0.52 | 1.49 | 46.78 | - | 51.16 | - |
| B750 | 0.2 | - | 0.2 | 0.8 | 48.8 | - | 50.0 | - |
| B835 | 0.2 | - | 0.2 | 0.9 | 48.5 | - | 50.2 | - |
| B900 | 0.2 | - | 0.2 | 0.9 | 48.2 | - | 50.5 | - |
| B1450 | - | 34.0 | - | 0.3 | - | - | 65.7 | - |
| B1640 | - | 32.5 | - | 0.3 | - | - | 67.2 | - |
| B1750 | - | 29.4 | - | 0.4 | - | - | 70.2 | - |
| B1800 | - | 29.5 | - | 0.4 | - | - | 70.1 | - |
| B1900 | - | 29.5 | - | 0.3 | - | - | 70.2 | - |
| B2000 | - | 30.0 | - | 0.2 | - | - | 69.8 | - |
| B2300 | - | 31.0 | - | 0.1 | - | - | 68.9 | - |
| B2450 | - | 31.4 | - | 0.1 | - | - | 68.5 | - |
| B2600 | - | 31.8 | - | 0.1 | - | - | 68.1 | - |
| B3500 | - | 28.8 | - | 0.1 | - | - | 71.1 | - |
| B5G | - | - | - | - | - | 10.7 | 78.6 | 10.7 |

### 3.5.2 System Check Description

The system check procedure provides a simple, fast, and reliable test method that can be performed daily or before every SAR measurement. The objective here is to ascertain that the measurement system has acceptable accuracy and repeatability. This test requires a flat phantom and a radiating source. The system verification setup is shown as below.




System Verification Setup

### 3.5.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

| Test Date | Tissue Type | Frequency (MHz) | Liquid Temp. (℃) | Measured Conductivity (σ) | Measured Permittivity ($\varepsilon_r$) | Target Conductivity (σ) | Target Permittivity ($\varepsilon_r$) | Conductivity Deviation (%) | Permittivity Deviation (%) |
|---|---|---|---|---|---|---|---|---|---|
| Jan. 03, 2019 | Head | 450 | 22.0 | 0.850 | 43.600 | 0.87 | 43.50 | -2.30 | 0.23 |
| Jan. 03, 2019 | Body | 450 | 22.0 | 0.960 | 55.630 | 0.94 | 56.70 | 2.13 | -1.89 |

**Note:**

The dielectric properties of the tissue simulating liquid must be measured within 24 hours before the SAR testing and within ± 5% of the target values. The variation of the liquid temperature must be within ± 2 °C during the test.

### 3.5.4 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01. The validation status in tabulated summary is as below.

| Test Date | Probe S/N | Calibration Point | | Measured Conductivity (σ) | Measured Permittivity ($\varepsilon_r$) | Validation for CW | | | Validation for Modulation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Sensitivity Range | Probe Linearity | Probe Isotropy | Modulation Type | Duty Factor | PAR |
| Jul. 29, 2018 | 3953 | Head | 450 | 0.87 | 43.5 | Pass | Pass | Pass | FM | Pass | Pass |
| Jul. 29, 2018 | 3953 | Body | 450 | 0.97 | 56.1 | Pass | Pass | Pass | FM | Pass | Pass |

### 3.5.5 System Verification

The measuring result for system verification is tabulated as below.

| Test Date | Tissue Type | Frequency (MHz) | 1W Target SAR-1g (W/kg) | Measured SAR-1g (W/kg) | Normalized to 1W SAR-1g (W/kg) | Deviation (%) | Dipole S/N | Probe S/N | DAE S/N |
|---|---|---|---|---|---|---|---|---|---|
| Jan. 03, 2019 | Head | 450 | 4.74 | 0.296 | 4.69 | -1.03 | SN 46/11 DIP 0G450-184 | 3953 | 1398 |
| Jan. 03, 2019 | Body | 450 | 4.78 | 0.305 | 4.83 | 1.13 | SN 46/11 DIP 0G450-184 | 3953 | 1398 |

**Note:**

Comparing to the reference SAR value, the validation data should be within its specification of 10%. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

# 4 SAR Measurement Evaluation

## 4.1 EUT Configuration and Setting

The device was configured to transmit continuously at the required channel and modulation, using the highest transmission duty factor for SAR measurement.

## 4.2 EUT Testing Position

### 4.2.1 Body-worn Accessory Exposure Conditions

| RF Exposure Conditions | Test Position | Separation Distance | SAR test exclusion |
|---|---|---|---|
| Body-worn | Rear Face | 0 ~ 2.5 cm | N/A |

Note:

1. Body-worn accessories that do not contain metallic or conductive components may be tested according to worst-case exposure configurations, typically according to the smallest test separation distance required for the group of body-worn accessories with similar operating and exposure characteristics. All body-worn accessories containing metallic components are tested in conjunction with the host device.
2. Body-worn accessory SAR compliance is based on a single minimum test separation distance for all wireless and operating modes applicable to each body-worn accessory used by the host, and according to the relevant voice and/or data mode transmissions and operations. If a body-worn accessory supports voice only operations in its normal and expected use conditions, testing of data mode for body-worn compliance is not required.
3. A conservative minimum test separation distance for supporting off-the-shelf body-worn accessories that may be acquired by users of consumer handsets should be used to test for body-worn accessory SAR compliance. This distance is determined by the handset manufacturer according to the typical body-worn accessories users may acquire at the time of equipment certification, but not more than 2.5 cm, to enable users to purchase aftermarket body-worn accessories with the required minimum separation.
4. Devices that are designed to operate on the body of users using lanyards and straps or without requiring additional body-worn accessories must be tested for SAR compliance using a conservative minimum test separation distance ≤ 5 mm to support compliance.
5. When device supports VoIP, SAR evaluation for body-worn accessory Exposure Conditions using the most appropriate wireless data mode configurations is required.
6. Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories.
7. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for the body-worn accessory with a headset attached to the handset.
8. When a body-worn accessory is not supplied with the PTT radio, a test separation distance ≤ 10 mm, applicable to the device form factor, must be applied to determine body-worn accessory SAR test exclusion.

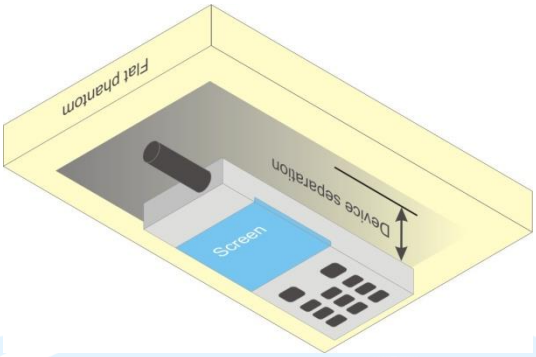



Fig-4.1 Body Worn Position

### 4.2.2 Face Exposure Conditions

| RF Exposure Conditions | Test Position | Separation Distance | SAR test exclusion |
|---|---|---|---|
| Face | Front Face | 0 ~ 2.5 cm | N/A |

1. A test separation distance of 25 mm must be applied for in-front-of the face SAR test exclusion and SAR measurements.

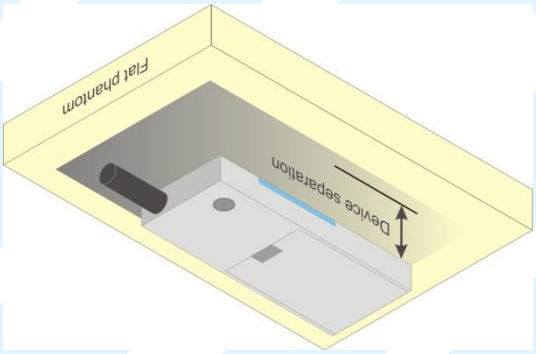



Fig-4.2 Face Position

## 4.3 Measured Conducted Power Result

| Mode | | Channel | Frequency (MHz) | Average Power (dBm) |
|---|---|---|---|---|
| PTT | FRS | 1 | 462.5625 | 26.44 |
| | | 2 | 462.5875 | 26.41 |
| | | 3 | 462.6125 | 26.42 |
| | | 4 | 462.6375 | 26.44 |
| | | 5 | 462.6625 | 26.44 |
| | | 6 | 462.6875 | 26.43 |
| | | 7 | 462.7125 | 26.44 |
| | FRS | 8 | 467.5625 | 26.55 |
| | | 9 | 467.5875 | 26.56 |
| | | 10 | 467.6125 | 26.57 |
| | | 11 | 467.6375 | 26.57 |
| | | 12 | 467.6625 | 26.56 |
| | | 13 | 467.6875 | 26.56 |
| | | 14 | 467.7125 | 26.56 |
| | FRS | 15 | 462.5500 | 26.44 |
| | | 16 | 462.5750 | 26.44 |
| | | 17 | 462.6000 | 26.41 |
| | | 18 | 462.6250 | 26.42 |
| | | 19 | 462.6500 | 26.42 |
| | | 20 | 462.6750 | 26.42 |
| | | 21 | 462.7000 | 26.42 |
| | | 22 | 462.7250 | 26.42 |

## 4.4 SAR Test Exclusion Evaluations

### 4.4.1 Standalone SAR Test Exclusion Considerations

According to KDB 447498 D01, the SAR test exclusion condition is based on source-based time-averaged maximum conducted output power, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The 1-g and 10-g *SAR test exclusion thresholds* are determined by the following:

a) For 100 MHz to 6 GHz and *test separation distances* ≤ 50 mm:

$$\frac{Max.Tune\ up\ Power_{(mW)}}{Min.Test\ Separation\ Distance_{(mm)}} \times \sqrt{f_{(GHz)}} \leq 3.0 \text{ for SAR-1g, } \leq 7.5 \text{ for SAR-10g}$$

When the minimum *test separation distance* is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

b) For 100 MHz to 1500 MHz and *test separation distances* > 50 mm:

{[Threshold for 50 mm in step a)] + [(test separation distance – 50 mm) · ($f_{(MHz)}$/150)]} mW

c) For > 1500 MHz and ≤ 6 GHz and *test separation distances* > 50 mm:

{[Threshold for 50 mm in step a)] + [(test separation distance – 50 mm) ·10]} mW

When the calculated result in step a) is <= 3.0 for SAR-1g exposure condition, or <= 7.5 for SAR-10g exposure condition, the SAR testing exclusion is applied.

When the device output power is less than the calculated result (power threshold, mW) shown in in step b) and c), the SAR testing exclusion is applied.

### 4.4.2 Estimated SAR Calculation

According to KDB 447498 D01, when an antenna qualifies for the standalone SAR test exclusion and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria:

a) For *test separation distances* ≤ 50 mm:

$$Estimated\ SAR = \frac{Max.Tune\ up\ Power_{(mW)}}{Min.Test\ Separation\ Distance_{(mm)}} \times \frac{\sqrt{f(\mathrm{GHz})}}{x}$$

Where $x$ = 7.5 for 1-g SAR and $x$ = 18.75 for 10-g SAR.

b) For *test separation distances* > 50 mm, 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR.

## 4.5 SAR Testing Results

### 4.5.1 SAR Test Reduction Considerations

**KDB 447498 D01 General RF Exposure Guidance**

Testing of other required channels within the operating mode of a frequency band is not required when the *reported* SAR for the mid-band or highest output power channel is:

a) ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
b) ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
c) ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

A duty factor of 50% was applied to determine compliance for radios with maximum operating duty factors ≤ 50%.

### 4.5.2 SAR Results for Body-worn Exposure Condition (Separation Distance is 1.0 cm)

| Plot No. | Band | Mode | Test Position | Ch. | Battery | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaling Factor | Scaled SAR-1g (W/kg) | Scaled SAR-1g (W/kg) 75% Duty Cycle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PTT | FRS | Rear Face | 4 | 1 | 27.0 | 26.44 | -0.07 | 1.25 | 1.14 | 1.42 | 1.07 |
| | PTT | FRS | Rear Face | 11 | 1 | 27.0 | 26.57 | -0.10 | 0.957 | 1.10 | 1.06 | 0.79 |
| | PTT | FRS | Rear Face | 19 | 1 | 27.0 | 26.42 | -0.03 | 1.15 | 1.14 | 1.31 | 0.99 |
| 2 | PTT | FRS | Rear Face | 4 | 2 | 27.0 | 26.44 | -0.04 | **1.31** | 1.14 | 1.49 | **1.12** |
| | PTT | FRS | Rear Face | 4 | 2 | 27.0 | 26.44 | -0.01 | 1.28 | 1.14 | 1.46 | 1.09 |

Note: Battery 2 is alkaline battery purchased by users

### 4.5.3 SAR Results for Face Exposure Condition (Separation Distance is 2.5 cm)

| Plot No. | Band | Mode | Test Position | Ch. | Battery | Max. Tune-up Power (dBm) | Measured Conducted Power (dBm) | Power Drift (dB) | Measured SAR-1g (W/kg) | Scaling Factor | Scaled SAR-1g (W/kg) | Scaled SAR-1g (W/kg) 75% Duty Cycle |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PTT | FRS | Front Face | 4 | 1 | 27.0 | 26.44 | -0.04 | 0.357 | 1.14 | 0.41 | 0.30 |
| | PTT | FRS | Front Face | 11 | 1 | 27.0 | 26.57 | -0.06 | 0.362 | 1.10 | 0.40 | 0.30 |
| | PTT | FRS | Front Face | 19 | 1 | 27.0 | 26.42 | -0.05 | 0.323 | 1.14 | 0.37 | 0.28 |
| 1 | PTT | FRS | Front Face | 11 | 2 | 27.0 | 26.57 | -0.03 | **0.397** | 1.10 | 0.44 | **0.33** |

Note: Battery 2 is alkaline battery purchased by users

### 4.5.4 Repeated Measurement

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 ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 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 >= 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 >= 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 >= 1.5 W/kg, perform a third repeated measurement.

| Band | Mode | Test Position | Ch. | Original Measured SAR-1g (W/kg) | 1st Repeated SAR-1g (W/kg) | L/S Ratio | 2nd Repeated SAR-1g (W/kg) | L/S Ratio | 3rd Repeated SAR-1g (W/kg) | L/S Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| PTT | FRS | Rear Face | 4 | 1.31 | 1.28 | 1.02 | N/A | N/A | N/A | N/A |

*** End of Report ***

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# Appendix A. SAR Plots of System Verification

The plots for system verification with largest deviation for each SAR system combination are shown as follows.

# Appendix B. SAR Plots of SAR Measurement

The SAR plots for highest measured SAR in each exposure configuration, wireless mode and frequency band combination, and measured SAR > 1.5 W/kg are shown as follows.

# Appendix C. Calibration Certificate for Probe and Dipole

The calibration certificates are shown as follows.

# Appendix D. Photographs of EUT and Setup