



# TEST REPORT

REPORT NUMBER: I23W00027-SAR-Rev2

ON

Type of Equipment: Infrared Thermal Camera

Type of Designation: Fotric P9/Fotric P8/Fotric P7/Fotric P6/Fotric P5/Fotric P4

Brand Name: FOTRIC

Manufacturer: FOTRIC INC.

FCC ID: 2AZTCJAGUAR

ACCORDING TO


IEEE C95.1-2019

IEEE Std 1528-2013

Chongqing Academy of Information and Communication Technology

*Month date, year*

Jul. 28th, 2023

*Signature***Xiang Luoyong***Director***Note:**

The test results in this test report relate only to the devices specified in this report. This report shall not be reproduced except in full without the written approval of Chongqing Academy of Information and Communications Technology.

**Chongqing Academy of Information and Communication Technology**

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**Revision Version**

<b>Report Number</b>	<b>Revision</b>	<b>Date</b>	<b>Memo</b>
I23W00027-SAR	00	2023-6-25	Initial creation of test report
I23W00027-SAR-Rev1	01	2023-7-20	First change of test report
I23W00027-SAR-Rev2	02	2023-7-28	Second change of test report
Note: This version has changed the section 2, 13.1, 14.3, 15.1.			

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## 1. Test Laboratory

### 1.1 Testing Location

Company Name:	Chongqing Academy of Information and Communications Technology
Address:	No. 8, Yuma Road, Chayuan New City, Nan'an District, Chongqing, P. R. China
Postal Code:	401336
Telephone:	0086-23-88069965/021-68866880
Fax:	0086-23-88608777

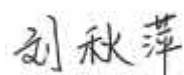
### 1.2 Testing Environment

Normal Temperature:	18°C-25°C
Relative Humidity:	30%-70%
Ambient noise & Reflection:	< 0.012 W/kg

### 1.3 Project Data

Testing Start Date:	2023-6-11
Testing End Date:	2023-6-12

### 1.4 Signature



2023-7-28

**Liu Qiuping**  
(Prepared this test report)

Date



2023-7-28

**Yu Chun**  
(Reviewed this test report)

Date



2023-7-28

**Xiang Luoyong**  
Director of the laboratory  
(Approved this test report)

Date

**Chongqing Academy of Information and Communication Technology**

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Tel: 0086-23-88069965 FAX: 0086-23-88608777

## 2. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **Infrared Thermal Camera Fotric P9/Fotric P8/Fotric P7/Fotric P6/Fotric P5/Fotric P4** are as follow:

**Table 2.1: Highest Reported SAR (1g, W/kg)**

Technology Band	Body(0mm)
Wi-Fi 2.4G	0.13
Wi-Fi 5G U-NII-2A	0.57
Wi-Fi 5G U-NII-2C	0.64
Wi-Fi 5G U-NII-3	0.11

**Remark:** The SAR values found for the tracker are below the maximum recommended levels of 1.6 W/kg as averaged over any 1g tissue according to the IEEE C95.1-2019.

For body operation, this device has been tested and meets FCC RF exposure guidelines when used with any accessory that contains no metal and which provides a minimum separation distance of 0 mm between this device and the body of the user. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.

The measurement together with the test system set-up is described in Chapter 7 of this test report.

A detailed description of the equipment under test can be found in Chapter 4 of this test report.

The maximum SAR value is obtained at the case of **Table 2.1**, and the values are:

**Body: 0.64 W/kg (1g).**

### 3. Client Information

#### 3.1 Applicant Information

Company Name:	FOTRIC INC.
Address /Post:	No. 14, Lane 2500, Xiupu Road, Pudong District, Shanghai, PRC
Telephone:	--
Fax:	--
Email:	--
Contact Person:	--

#### 3.2 Manufacturer Information

Company Name:	FOTRIC INC.
Address /Post:	No. 14, Lane 2500, Xiupu Road, Pudong District, Shanghai, PRC
Telephone:	--
Fax:	--
Email:	--
Contact Person:	--

## 4. Equipment Under Test (EUT) and Ancillary Equipment (AE)

### 4.1 About EUT

<b>Description:</b>	Infrared Thermal Camera
<b>Model name:</b>	Fotric P9/Fotric P8/Fotric P7/Fotric P6/Fotric P5/Fotric P4
<b>Operating mode(s):</b>	Wi-Fi 2.4G, Wi-Fi 5G U-NII-1/2A/2C/3, BT, BLE
<b>Tested Tx Frequency:</b>	2412-2462 MHz (Wi-Fi 2.4G)
	5180-5240 MHz (Wi-Fi 5G U-NII-1)
	5260-5320 MHz (Wi-Fi 5G U-NII-2A)
	5500-5720 MHz (Wi-Fi 5G U-NII-2C)
	5745-5825 MHz (Wi-Fi 5G U-NII-3)
	2402-2480 MHz (BT)
<b>Device type:</b>	Portable device
<b>Antenna type:</b>	Internal antenna



**4.2 Internal Identification of EUT used during the test**

EUT ID*	SN or IMEI	HW Version	SW Version	Date of receipt
S1	--	0.6.2.4	V3.0.0	2023-6-9

\*EUT ID: is used to identify the test sample in the lab internally.

**4.3 Internal Identification of AE used during the test**

AE ID*	Description	Model	SN	Manufacturer
--	--	--	--	--

\*AE ID: is used to identify the test sample in the lab internally.

## 5. Reference Documents

### 5.1 Applicable Limit Regulations

**IEEE C95.1: 2019:** IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz.

It specifies the maximum exposure limit of **1.6 W/kg** as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

### 5.2 Applicable Measurement Standards

**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.

**KDB447498 D01: General RF Exposure Guidance v06:** Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

**KDB248227 D01: 802.11 Wi-Fi SAR v02r02:** SAR GUIDANCE FOR IEEE 802.11 (Wi-Fi) TRANSMITTERS.

**KDB865664 D01 SAR measurement 100 MHz to 6 GHz v01r04:** SAR Measurement Requirements for 100 MHz to 6 GHz.

**KDB865664 D02 RF Exposure Reporting v01r02:** RF Exposure Compliance Reporting and Documentation Considerations.

## 6. Specific Absorption Rate (SAR)

### 6.1 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/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.

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

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

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

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

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

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

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

Where:  $\sigma$  is the conductivity of the tissue,  $\rho$  is the mass density of tissue and  $E$  is the RMS electrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

## 7.1 Measurement Set-up

- A standard high precision 6-axis robot (Stäubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (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.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and theDASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## 7.2 DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY5 software reads the reflection during a software approach and looks for the maximum using 2<sup>nd</sup> order curve fitting. The approach is stopped at reaching the maximum.

### Probe Specifications:

**Model:** EX3DV4  
**Frequency:** 650MHz — 6GHz  
**Calibration:** In head and body simulating tissue at  
Frequencies from 650 up to 4900MHz  
**Linearity:**  $\pm 0.2$  dB

**Dynamic Range:** 10mW/kg-100W/kg

**Probe Length:** 330 mm

**Probe Tip Length:** 20mm

**Body Diameter:** 12 mm

**Tip Diameter:** 2.5mm

**Tip-Center :** 1 mm

**Application:** SAR Dosimetry Test Compliance tests of  
trackers Dosimetry in strong gradient  
fields



Picture 7-2 Near-field Probe



Picture 7-3 E-field Probe

### 7.3 E-field Probe Calibration

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm<sup>2</sup>) using an RF Signal generator, TEM cell, and RF Power Meter.

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equate to 1 mW/cm<sup>2</sup>.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C \frac{\Delta T}{\Delta t}$$

Where:

$\Delta t$  = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

$\Delta T$  = Temperature increase due to RF exposure.

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

Where:

$\sigma$  = Simulated tissue conductivity,

$\rho$  = Tissue density (kg/m<sup>3</sup>).

## 7.4 Other Test Equipment

### 7.4.1 Data Acquisition Electronics(DAE)

The data acquisition electronics 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. The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



**Picture7.4.1-1: DAE**

#### **7.4.2 Robot**

The SPEAG DASY system uses the high precision robots (DASY5: TX90) type 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 0.02mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements (brushless synchron motors; no stepper motors)
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)



**Picture7.4.2-1: DASY 5**



### 7.4.3 Measurement Server

The Measurement server is based on a PC/104 CPU board with CPU (DASY5: 400 MHz, Intel Celeron), chipdisk (DASY5: 128MB), RAM (DASY5: 128MB). 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 real-time data evaluation of field measurements and surface detection, controls robot movements and handles safety operation. The PC operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with an expansion port which is reserved for future applications. Please note that this expansion port does not have a standardized pinout, and therefore only devices provided by SPEAG can be connected. Devices from any other supplier could seriously damage the measurement server.



Picture 7.4.3-1: Server for DASY 5

### 7.4.4 Device Holder for 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 5mm distance, a positioning uncertainty of  $\pm 0.5\text{mm}$  would produce a SAR uncertainty of  $\pm 20\%$ . 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.

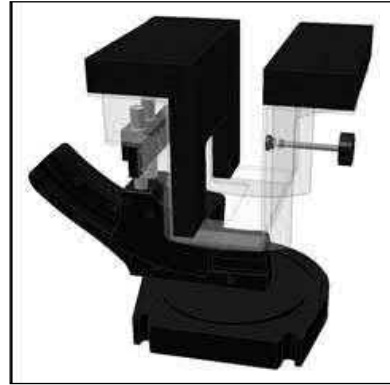
The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference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

Thus the device needs no repositioning when changing the angles. The DASY device holder is constructed of low-loss POM material having the following dielectric parameters:

relative permittivity=3 and loss tangent=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 positioner. The extension is fully compatible with the Twin-SAM and ELI phantoms.

**Picture 7.4.4-1: Device Holder****Picture 7.4.4-2: Laptop Extension Kit**

#### 7.4.5 Phantom

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a table. The shape of the shell is based on data from an anatomical study designed to

Represent the 90<sup>th</sup> percentile of the population. The phantom enables the dissymmetric evaluation of SAR for both left and right handed handset usage, as well as body-worn usage using the flat phantom region. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. The shell phantom has a 2mm shell thickness (except the ear region where shell thickness increases to 6 mm).

Shell Thickness:  $2 \pm 0.2$  mm

Filling Volume: Approx. 25 liters

Dimensions: 810 x 1000 x 500 mm (H x L x W)

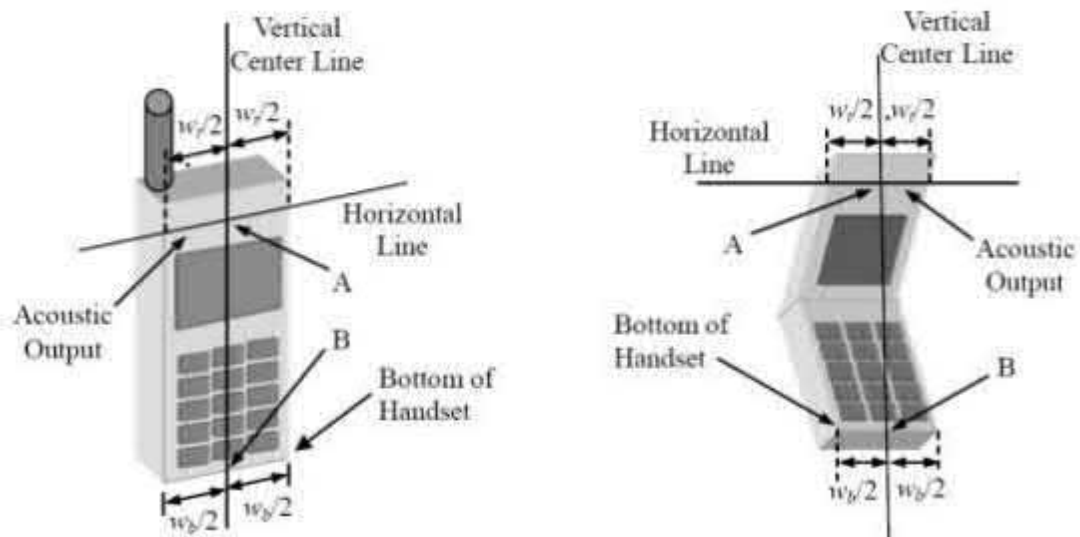
Available: Special

**Picture 7.4.5-1: SAM Twin Phantom**

## 8. Position of the wireless device in relation to the phantom

### 8.1 General considerations

This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.



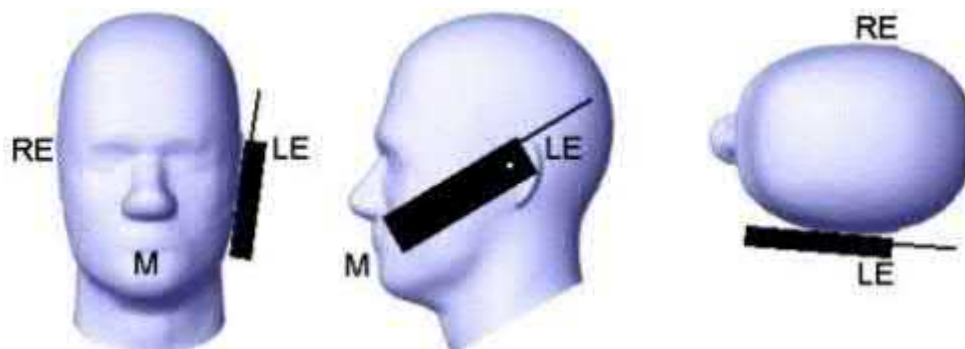
$w_t$  Width of the handset at the level of the acoustic

$w_b$  Width of the bottom of the handset

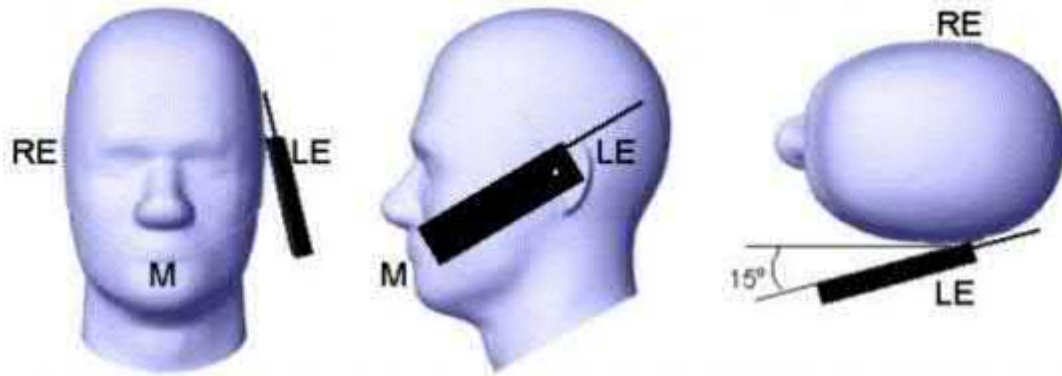
A Midpoint of the width  $w_t$  of the handset at the level of the acoustic output

B Midpoint of the width  $w_b$  of the bottom of the handset

Picture 12-a Typical “fixed” case handset    Picture 12-b Typical “clam-shell” case handset



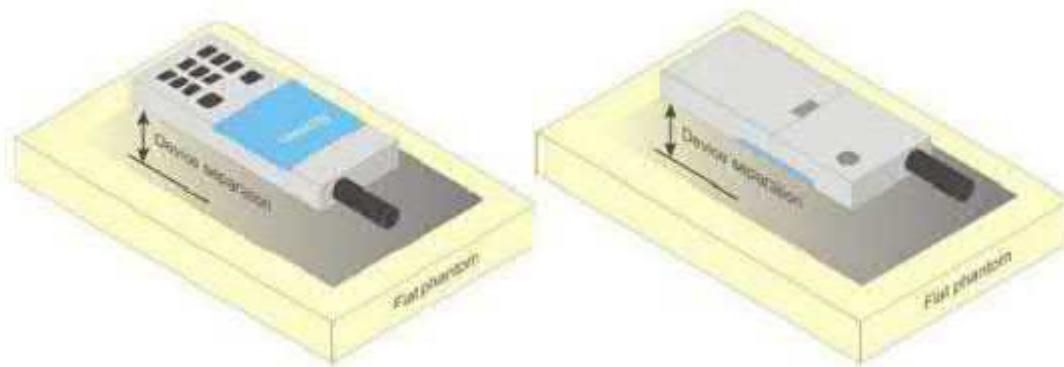
Picture 8.1-1 Cheek position of the wireless device on the left side of SAM



Picture 8.1-2 Tilt position of the wireless device on the left side of SAM

## 8.2 Body-worn device

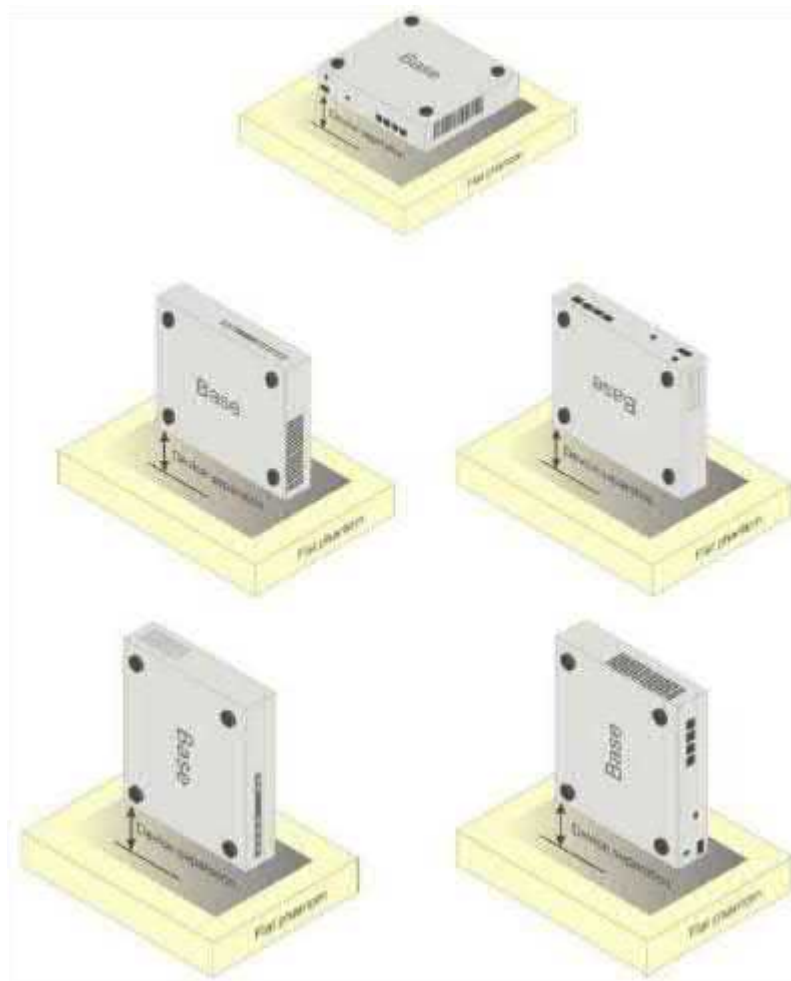
A typical example of a body-worn device is a tracker, wireless enabled PDA or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.



Picture 8.2-1 Test positions for body-worn devices

### 8.3 Desktop device

A typical example of a desktop device is a wireless enabled desktop computer placed on a table or desk when used. The DUT shall be positioned at the distance and in the orientation to the phantom that corresponds to the intended use as specified by the manufacturer in the user instructions. For devices that employ an external antenna with variable positions, tests shall be performed for all antenna positions specified. Picture16 show positions for desktop device SAR tests. If the intended use is not specified, the device shall be tested directly against the flat phantom.



Picture 8.3-1 Test positions for desktop devices

#### 8.4 DUT Setup Photo



Picture 8.4-1: Specific Absorption Rate Test Layout

## 9. Tissue Simulating Liquids

### 9.1 Equivalent Tissues

The liquid used for the frequency range of 750-6000 MHz consisted of water, sugar, salt and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table 9.1-1 and 9.1-2 shows the detail solution. The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

**Table 9.1-1 Composition of the Head Tissue Equivalent Matter**

Frequency (MHz)	2450	5200	5800
<b>Ingredients (% by weight)</b>			
<b>Water</b>	58.79	65.52	65.52
<b>Sugar</b>	/	/	/
<b>Salt</b>	0.06	/	/
<b>Preventol</b>	/	/	/
<b>Cellulose</b>	/	/	/
<b>TritonX-100</b>	/	17.24	17.24
<b>Diethylenglycol monohexylether</b>	/	17.24	17.24
<b>DGBE</b>	41.15	/	/
<b>Dielectric Parameters Target Value</b>	f=2450 MHz $\epsilon=39.2$ $\sigma=1.80$	f=5200 MHz $\epsilon=36.8$ $\sigma=4.60$	f=5800 MHz $\epsilon=35.2$ $\sigma=5.29$

Table 9.1-2 Targets for tissue simulating liquid

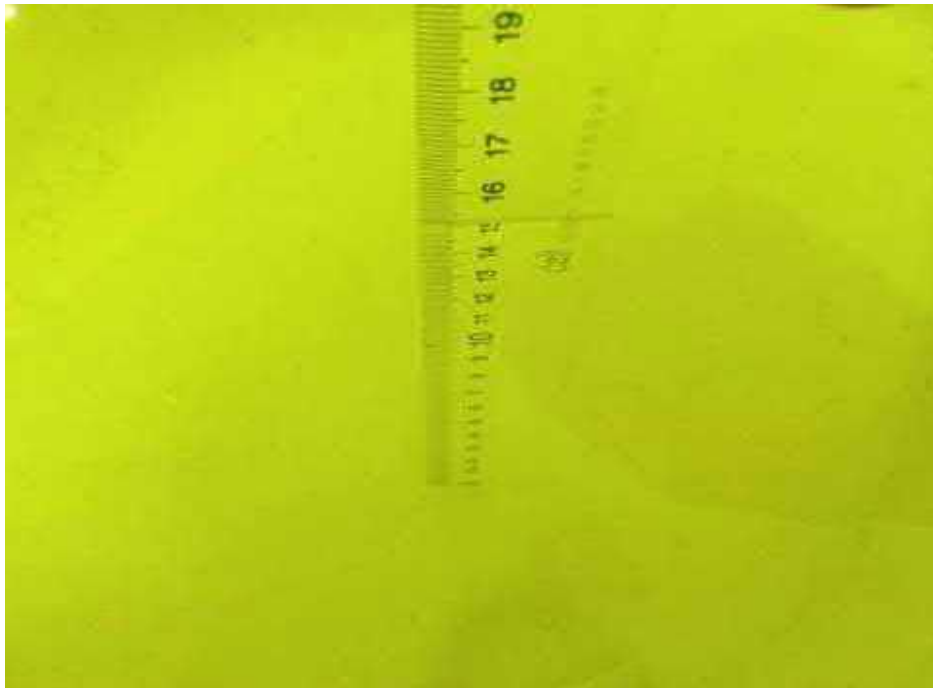
Frequency (MHz)	Liquid Type	Conductivity ( $\sigma$ )	$\pm 5\%$ Range	Permittivity ( $\epsilon$ )	$\pm 5\%$ Range
2450	Head	1.80	1.710~1.890	39.2	37.240~41.160
5000	Head	4.45	4.228~4.672	36.2	34.390~38.010
5200	Head	4.66	4.427~4.893	36.0	34.200~37.800
5400	Head	4.86	4.617~5.103	35.8	34.010~37.590
5600	Head	5.07	4.817~5.323	35.5	33.725~37.275
5800	Head	5.27	5.007~5.533	35.3	33.535~37.065
6000	Head	5.48	5.206~5.754	35.1	33.345~36.855



## 9.2 Dielectric Performance

**Table 9.2-1: Dielectric Performance of Head Tissue Simulating Liquid**

Frequency (MHz)	Head(Standard)		Temperature	Date	Test Result		Deviation	
	Permittivity $\epsilon$	Conductivity $\sigma$			Permittivity $\epsilon$	Conductivity $\sigma$	Permittivity $\epsilon$	Conductivity $\sigma$
2450	39.20	1.80	20.5℃	2023-6-11	37.665	1.823	-3.92%	1.28%
5300	35.90	4.76	20.3℃	2023-6-12	34.905	4.758	-2.77%	-0.04%
5600	35.50	5.07	20.3℃	2023-6-12	34.322	5.069	-3.32%	-0.02%
5800	35.30	5.27	20.3℃	2023-6-12	33.918	5.284	-3.92%	0.27%



**Picture 9.2-1: Liquid depth in the Flat Phantom**

## 10. System Validation

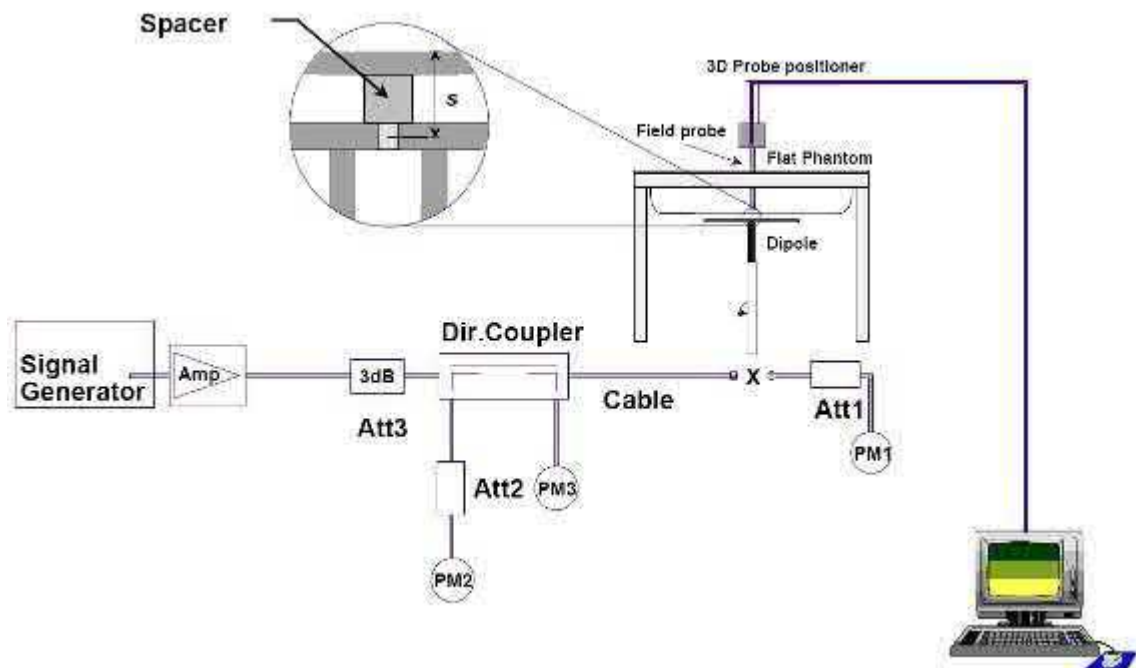
### 10.1 System Validation

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.

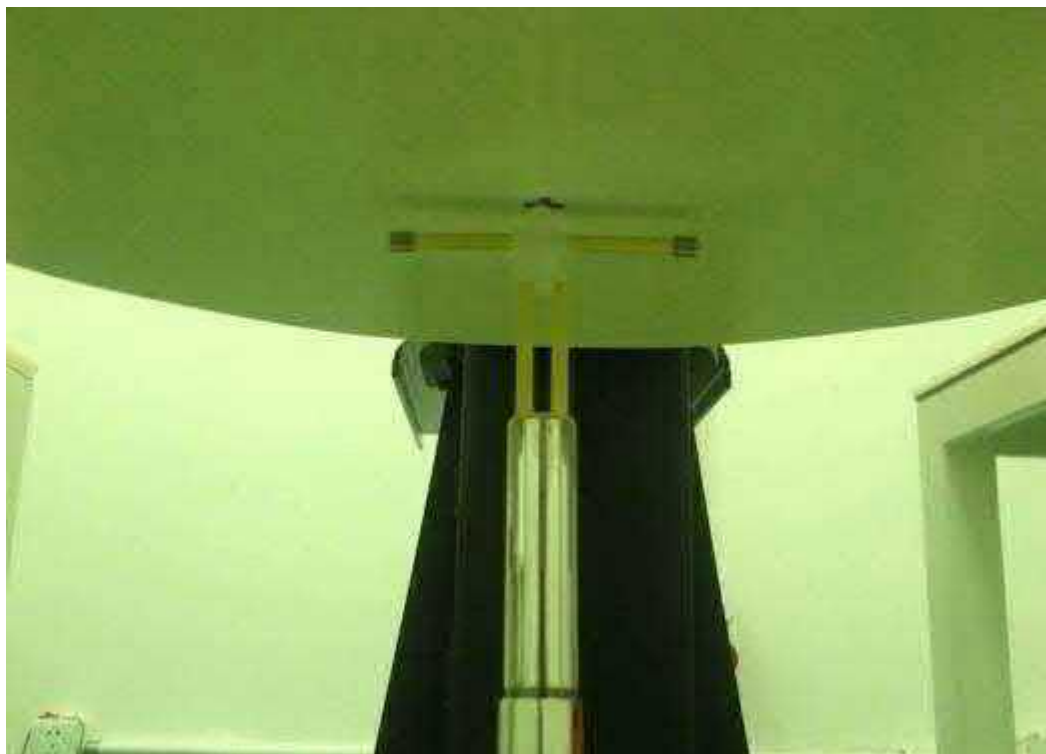
### 10.2 System Setup

In the simplified setup for system evaluation, the DUT 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:

**Picture 10.2-1 System Setup for System Evaluation**



The output power on dipole port must be calibrated to 24 dBm (250mW) before dipole is connected. The results are normalized to 1 W input power.



Picture 10.2-1: Photo of Dipole Setup

Table 10.2-1: System Validation of Head

Frequency (MHz)	Average Target Value (w/kg)		Temperature	Date	Test Result (w/kg)		Deviation (%)	
	10g	1g			10g	1g	10g	1g
2450	24.70	53.80	21.5℃	2023-6-11	24.96	54.00	1.05%	0.37%
5300	22.60	78.70	21.4℃	2023-6-12	23.10	81.70	2.21%	3.81%
5600	22.80	80.00	21.4℃	2023-6-12	23.40	82.50	2.63%	3.13%
5800	21.50	76.70	21.4℃	2023-6-12	22.30	78.70	3.72%	2.61%

NOTE: The system verifies that the measured input power level is equivalent to 250mW for 0.6GHz to 3GHz and above 3GHz is equivalent to 100mW, and the measured results are compared with the target value by converting to 1W.

## 11. Measurement Procedures

### 11.1 Tests to be performed

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in Picture 19

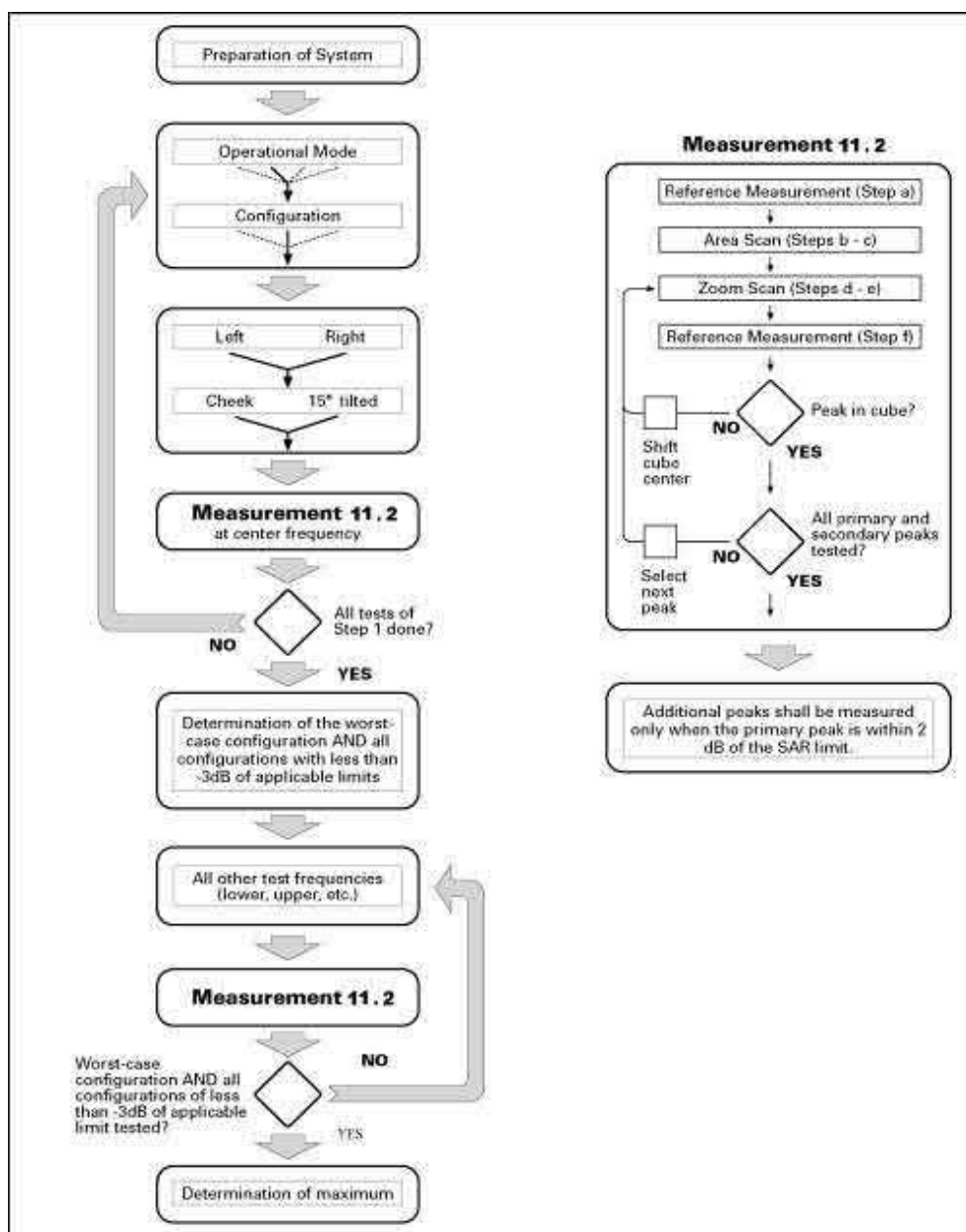
**Step 1:** The tests described in 11.2 shall be performed at the channel that is closest to the centre of the transmit frequency band ( $f_c$ ) for:

- a) all device positions (cheek and tilt, for both left and right sides of the SAM phantom, as described in Chapter 8),
- b) all configurations for each device position in a), e.g., antenna extended and retracted, and
- c) all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.

If more than three frequencies need to be tested according to 11.1 (i.e.,  $N_c > 3$ ), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

**Step 2:** For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in 11.2 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

**Step 3:** Examine all data to determine the highest value of the peak spatial-average SAR found in Steps 1 to 2.



Picture 11.1-1: Block diagram of the tests to be performed

## 11.2 Measurement procedure

The following procedure shall be performed for each of the test conditions (see Picture 19) described in 11.1:

a) Measure the local SAR at a test point within 8 mm or less in the normal direction from the inner surface of the phantom.

b) Measure the two-dimensional SAR distribution within the phantom (area scan procedure). The boundary of the measurement area shall not be closer than 20 mm from the phantom side walls. The distance between the measurement points should enable the detection of the location of local maximum with an accuracy of better than half the linear dimension of the tissue cube after interpolation. A maximum grid spacing of 20 mm for frequencies below 3 GHz and  $(60/f \text{ [GHz]})$  mm for frequencies of 3 GHz and greater is recommended. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and  $\delta \ln(2)/2$  mm for frequencies of 3 GHz and greater, where  $\delta$  is the plane wave skin depth and  $\ln(x)$  is the natural logarithm. The maximum variation of the sensor-phantom surface shall be  $\pm 1$  mm for frequencies below 3 GHz and  $\pm 0.5$  mm for frequencies of 3 GHz and greater. At all measurement points the angle of the probe with respect to the line normal to the surface should be less than  $5^\circ$ . If this cannot be achieved for a measurement distance to the phantom inner surface shorter than the probe diameter, additional uncertainty evaluation is needed.

c) From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that are not within the zoom-scan volume; additional peaks shall be measured only when the primary peak is within 2 dB of the SAR limit. This is consistent with the 2 dB threshold already stated;

d) Measure the three-dimensional SAR distribution at the local maxima locations identified in step

e) The horizontal grid step shall be  $(24 / f \text{ [GHz]})$  mm or less but not more than 8 mm. The minimum zoom size of 30 mm by 30 mm and 30 mm for frequencies below 3 GHz. For higher frequencies, the minimum zoom size of 22 mm by 22 mm and 22 mm. The grid step in the vertical direction shall be  $(8 \cdot f \text{ [GHz]})$  mm or less but not more than 5 mm, if uniform spacing is used. If variable spacing is used in the vertical direction, the maximum spacing between the two closest measured points to the phantom shell shall be  $(12 / f \text{ [GHz]})$  mm or less but not more than 4 mm, and the spacing between further points shall increase by an incremental factor not exceeding 1.5. When variable spacing is used, extrapolation routines shall be tested with the same spacing as used in measurements. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and  $\delta \ln(2)/2$  mm for frequencies of 3 GHz and greater, where  $\delta$  is the plane wave skin depth and  $\ln(x)$  is the natural logarithm. Separate grids shall be centered on each of the local SAR maxima found in step c). Uncertainties due to field distortion between the media boundary and the dielectric enclosure of the probe should also be minimized, which is achieved if the distance between the phantom surface and physical tip of the probe is larger than probe tip diameter. Other methods may utilize correction procedures for these boundary effects that enable high precision measurements closer than half the probe diameter. For all

measurement points, the angle of the probe with respect to the flat phantom surface shall be less than 5°. If this cannot be achieved an additional uncertainty evaluation is needed.

f) Use post processing( e.g. interpolation and extrapolation ) procedures to determine the local SAR values at the spatial resolution needed for mass averaging.

### **11.3 SAR Measurement for Wi-Fi & Bluetooth**

Normal network operating configurations are not suitable for measuring the SAR of 802.11 transmitters in general. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure that the results are consistent and reliable.

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in a test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

Per KDB 248227 D01v02r02, for 2.4GHz 802.11g/n SAR testing is not required when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is  $\leq 1.2$  W/kg.

Per KDB 248227 D01v02r02, U-NII-1 SAR testing is not required when the U-NII-2A band highest reported SAR for a test configuration is  $\leq 1.2$  W/kg, SAR is not required for U-NII-1 band.

For all positions / configurations, when the reported SAR is  $> 0.8$  W/kg, SAR is measured for these test positions / configurations on the subsequent next highest measured output power channel(s) until the reported SAR is  $\leq 1.2$  W/kg or all required channels are tested.

### **11.4 Power Drift**

To control the output power stability during the SAR test, DASY5 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Section 15 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

## 12. Area Scan Based 1-g SAR

### 12.1 Requirement of KDB

According to the KDB447498D01v06, when the implementation is based the specific polynomial fit algorithm as presented at the 29th Bioelectromagnetics Society meeting (2007) and the estimated 1-g SAR is  $\leq 1.2 \text{ W/kg}$ , a zoom scan measurement is not required provided it is also not needed for any other purpose; for example, if the peak SAR location required for simultaneous transmission SAR test exclusion can be determined accurately by the SAR system or manually to discriminate between isotropic peak and scattered noisy SAR distributions from area scans.

There must not be any warning or alert messages due to various measurement concerns identified by the SAR system; for example, noise in measurements, peaks too close to scan boundary, peaks are too sharp, spatial resolution and uncertainty issues etc. The SAR system verification must also demonstrate that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR (See Annex A). When all the SAR results for each exposure condition in a frequency band and wireless mode are based on estimated 1-g SAR, the 1-g SAR for the highest SAR configuration must be determined by a zoom scan.

### 12.2 Fast SAR Algorithms

The approach is based on the area scan measurement applying a frequency dependent attenuation parameter. This attenuation parameter was empirically determined by analyzing a large number of phones. The MOTOROLA FAST SAR was developed and validated by the MOTOROLA Research Group in Ft. Lauderdale.

In the initial study, an approximation algorithm based on Linear fit was developed. The accuracy of the algorithm has been demonstrated across a broad frequency range (136-2450 MHz) and for both 1-g and 10-g averaged SAR using a sample of 264 SAR measurements from 55 wireless handsets. For the sample size studied, the root-mean-squared errors of the algorithm are 1.2% and 5.8% for 1-g and 10-g averaged SAR, respectively. The paper describing the algorithm in detail is expected to be published in August 2004 within the Special Issue of Transactions on MTT.

In the second step, the same research group optimized the fitting algorithm to an Polynomial fit where by the frequency validity was extended to cover the range 30-6000 MHz. Details of this study can be found in the BEMS 2007 Proceedings. Both algorithms are implemented in DASY software.



### 13. Conducted Output Power

#### 13.1 Conducted Output Power

Table 13.1-1 The conducted power for Wi-Fi 2.4G

Wi-Fi 2.4G			Maximum Conducted Power (dBm)	
Mode	BW	Channel/Frequency(MHz)	Tune up(dBm)	Conducted Power(dBm)
802.11b	20M	1/2412	17.50	16.71
		6/2437	17.50	16.46
		11/2462	17.50	16.46
802.11g	20M	1/2412	13.50	12.53
		6/2437	13.50	12.28
		11/2462	13.50	12.43
802.11n	20M	1/2412	12.50	11.63
		6/2437	12.50	11.47
		11/2462	12.50	11.65
	40M	3/2422	13.50	12.10
		6/2437	13.50	12.67
		9/2452	13.50	12.10

Table 13.1-2 The conducted power for Wi-Fi 5G

Wi-Fi 5G			Maximum Conducted Power (dBm)			
Mode	BW	Channel/Frequency(MHz)	Tune up(dBm)	Conducted Power(dBm)	Duty Factor(dB)	Total power(dBm)
802.11a	20M	36/5180	5.50	3.34	0.58	3.92
		40/5200	5.00	2.73	0.59	3.32
		48/5240	5.00	2.40	0.59	2.99
		52/5260	5.50	3.13	0.59	3.72
		56/5280	6.00	3.60	0.59	4.19
		64/5320	6.00	3.93	0.59	4.52
		100/5500	5.00	2.58	0.59	3.17
		120/5600	4.50	2.22	0.59	2.81
		140/5700	3.00	0.47	0.59	1.06
		144/5720	2.50	0.01	0.59	0.60
		149/5745	1.00	-1.08	0.58	-0.50
		157/5785	1.00	-1.85	0.58	-1.27

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802.11a	20M	165/5825	0.50	-1.82	0.58	-1.24
802.11n	20M	36/5180	4.50	3.24	0.62	3.86
		40/5200	4.00	2.32	0.63	2.95
		48/5240	3.00	1.89	0.63	2.52
		52/5260	4.00	3.06	0.62	3.68
		56/5280	4.50	3.44	0.62	4.06
		64/5320	5.00	3.87	0.62	4.49
		100/5500	3.50	2.38	0.62	3.00
		120/5600	3.00	2.03	0.63	2.66
		140/5700	1.50	0.56	0.62	1.18
		144/5720	0.50	-0.42	0.63	0.21
		149/5745	0.00	-0.97	0.63	-0.34
		157/5785	-1.00	-2.36	0.62	-1.74
		165/5825	-1.00	-2.33	0.62	-1.71
802.11n	40M	38/5190	5.00	3.53	1.17	4.70
		46/5230	5.00	3.34	1.16	4.50
		54/5270	5.00	3.60	1.17	4.77
		62/5310	5.50	4.29	1.17	5.46
		102/5510	4.50	2.92	1.17	4.09
		118/5590	4.00	2.60	1.17	3.77
		134/5670	2.50	0.92	1.16	2.08
		142/5710	2.00	0.28	1.46	1.74
		151/5755	1.00	-0.62	1.17	0.55
		159/5795	1.00	-0.80	1.17	0.37
802.11ac	20M	36/5180	4.00	3.18	0.62	3.80
		40/5200	3.50	2.60	0.62	3.22
		48/5240	3.50	2.58	0.62	3.20
		52/5260	4.00	3.24	0.62	3.86
		56/5280	4.50	3.67	0.62	4.29
		64/5320	5.00	3.80	0.62	4.42
		100/5500	3.00	2.13	0.63	2.76
		120/5600	3.00	1.83	0.63	2.46

802.11ac	20M	140/5700	1.00	0.07	0.63	0.70
		144/5720	0.50	-0.49	0.62	0.13
		149/5745	0.00	-1.01	0.63	-0.38
		157/5785	-1.00	-2.08	0.62	-1.46
		165/5825	0.00	-1.77	0.62	-1.15
802.11ac	40M	38/5190	5.00	3.46	1.46	4.92
		46/5230	4.00	2.48	1.45	3.93
		54/5270	5.50	3.61	1.46	5.07
		62/5310	5.50	4.03	1.46	5.49
		102/5510	4.50	2.77	1.46	4.23
		118/5590	4.50	2.79	1.46	4.25
		134/5670	2.50	0.69	1.46	2.15
		142/5710	2.00	0.44	1.46	1.90
		151/5755	1.00	-0.86	1.45	0.59
		159/5795	1.00	-1.24	1.46	0.22
802.11ac	80M	42/5210	4.50	1.97	2.52	4.49
		58/5290	6.00	3.00	2.52	5.52
		106/5530	4.50	1.84	2.53	4.37
		122/5610	4.00	0.67	2.52	3.19
		138/5690	2.00	-0.57	2.53	1.96
		155/5775	1.00	-1.88	2.52	0.64

Table 13.1-3 The conducted power for BT

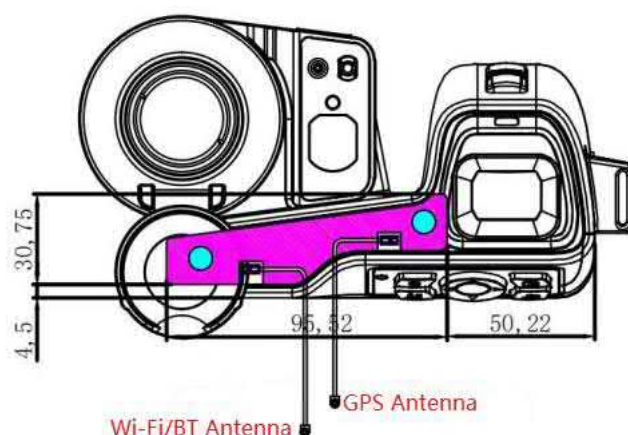
Bluetooth	Maximum Conducted Power (dBm)					
Channel/Frequency(MHz)	0/2402		39/2441		78/2480	
Mode	Tune up(dBm)	Conducted Power(dBm)	Tune up(dBm)	Conducted Power(dBm)	Tune up(dBm)	Conducted Power(dBm)
GFSK	4.00	3.05	5.50	4.34	4.00	3.05
DQPSK	4.00	3.59	5.50	4.65	4.00	3.08
8DPSK	4.00	3.41	5.50	4.43	4.00	3.15
Mode	Channel/Frequency(MHz)		Tune up(dBm)		Conducted Power(dBm)	
BLE(1M)	0/2402		0.00		-0.88	
	19/2440		0.00		-0.38	
	39/2480		0.00		-1.21	

## 14. Simultaneous TX SAR Considerations

### 14.1 Introduction

The following procedures adopted from “FCC SAR Considerations for Cell Phones with Multiple Transmitters” are applicable to handsets with built-in unlicensed transmitters such as 802.11 a/b/g and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

### 14.2 Transmit Antenna Position



Picture 14.2-1 Antenna Position

### 14.3 BT Exposure Evaluation

According to KDB 447498D01, the 1g and 10g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances < 50 mm are determined by:

$$\left[ \frac{\text{measured maximum average output power (mW)}}{\text{Minimum separation distance (mm)}} \right] \cdot \sqrt{f \text{ (GHz)}} < 3.0 \text{ for 1g SAR and } < 7.5 \text{ for 10g extremity SAR where}$$

- $f$ (GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is < 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Table 14.3-1 BT Exposure Evaluation

Channel	Frequency(GHz)	Max.Tune up(dBm)	Max.Tune up(mw)	Distance(mm)	Result	exclusion thresholds for 1-g SAR
CH 78	2.480	5.50	3.55	5.00	1.10	3.00

Result: Base on the calculation value, No SAR measurement is required.

#### 14.4 Simultaneous Transmission for EUT

The device does not support Simultaneous Transmission.

## 15.SAR Test Result

### 15.1 SAR Result

**Table 15.1-1: SAR Values for Wi-Fi 2.4G**

Test Position	Cover Type	Mode	BW(MHz)	Duty Cycle(%)	Channel	Frequency (MHz)	Measured power (dBm)	Tune-up (dBm)	Power Drift (dB)	Limit of 1gSAR 1.6 W/kg (mW/g)				Figure No.
										Measured SAR1g	Duty Cycle Scaling Factor	Tune-up Scaling Factor	Report SAR1g	
Body SAR (0mm)														
Front Side	Standard	802.11b	20	100.00	1	2412	16.71	17.50	0.00	0.000	1.00	1.20	0.00	/
Back Side	Standard	802.11b	20	100.00	1	2412	16.71	17.50	0.00	0.000	1.00	1.20	0.00	/
Left Side	Standard	802.11b	20	100.00	1	2412	16.71	17.50	0.00	0.000	1.00	1.20	0.00	/
Right Side	Standard	802.11b	20	100.00	1	2412	16.71	17.50	0.00	0.000	1.00	1.20	0.00	/
Top Side	Standard	802.11b	20	100.00	1	2412	16.71	17.50	0.10	0.078	1.00	1.20	0.09	/
Back Side-Open	Standard	802.11b	20	100.00	1	2412	16.71	17.50	0.00	0.000	1.00	1.20	0.00	/
Left Side-Open	Standard	802.11b	20	100.00	1	2412	16.71	17.50	0.00	0.000	1.00	1.20	0.00	/
Top Side-Open	Standard	802.11b	20	100.00	1	2412	16.71	17.50	0.06	0.110	1.00	1.20	0.13	A.1

**Table 15.1-2: SAR Values for Wi-Fi 5G U-NII-2A**

Test Position	Cover Type	Mode	BW(MHz)	Duty Cycle(%)	Channel	Frequency (MHz)	Measured power (dBm)	Tune-up (dBm)	Power Drift (dB)	Limit of 1gSAR 1.6 W/kg (mW/g)				Figure No.
										Measured SAR1g	Duty Cycle Scaling Factor	Tune-up Scaling Factor	Report SAR1g	
Body SAR (0mm)														
Front Side	Standard	802.11a	20	87.30	64	5320	4.52	6.00	0.00	0.000	1.15	1.41	0.00	/
Back Side	Standard	802.11a	20	87.30	64	5320	4.52	6.00	0.00	0.000	1.15	1.41	0.00	/
Left Side	Standard	802.11a	20	87.30	64	5320	4.52	6.00	0.00	0.000	1.15	1.41	0.00	/
Right Side	Standard	802.11a	20	87.30	64	5320	4.52	6.00	0.00	0.000	1.15	1.41	0.00	/
Top Side	Standard	802.11a	20	87.30	64	5320	4.52	6.00	0.02	0.344	1.15	1.41	0.55	/
Back Side-Open	Standard	802.11a	20	87.30	64	5320	4.52	6.00	0.00	0.000	1.15	1.41	0.00	/
Left Side-Open	Standard	802.11a	20	87.30	64	5320	4.52	6.00	0.00	0.000	1.15	1.41	0.00	/
Top Side-Open	Standard	802.11a	20	87.30	64	5320	4.52	6.00	0.03	0.355	1.15	1.41	0.57	A.2

**Table 15.1-3: SAR Values for Wi-Fi 5G U-NII-2C**

Test Position	Cover Type	Mode	BW(MHz)	Duty Cycle(%)	Channel	Frequency (MHz)	Measured power (dBm)	Tune-up (dBm)	Power Drift (dB)	Limit of 1gSAR 1.6 W/kg (mW/g)				Figure No.
										Measured SAR1g	Duty Cycle Scaling Factor	Tune-up Scaling Factor	Report SAR1g	
Body SAR (0mm)														
Front Side	Standard	802.11a	20	87.30	100	5500	3.17	5.00	0.00	0.000	1.15	1.52	0.00	/
Back Side	Standard	802.11a	20	87.30	100	5500	3.17	5.00	0.00	0.000	1.15	1.52	0.00	/
Left Side	Standard	802.11a	20	87.30	100	5500	3.17	5.00	0.00	0.000	1.15	1.52	0.00	/
Right Side	Standard	802.11a	20	87.30	100	5500	3.17	5.00	0.00	0.000	1.15	1.52	0.00	/
Top Side	Standard	802.11a	20	87.30	100	5500	3.17	5.00	0.10	0.260	1.15	1.52	0.45	/
Back Side-Open	Standard	802.11a	20	87.30	100	5500	3.17	5.00	0.00	0.000	1.15	1.52	0.00	/
Left Side-Open	Standard	802.11a	20	87.30	100	5500	3.17	5.00	0.00	0.000	1.15	1.52	0.00	/
Top Side-Open	Standard	802.11a	20	87.30	100	5500	3.17	5.00	0.10	0.369	1.15	1.52	0.64	A.3

Table 15.1-4: SAR Values for Wi-Fi 5G U-NII-3

Test Position	Cover Type	Mode	BW(MHz)	Duty Cycle(%)	Channel	Frequency (MHz)	Measured power (dBm)	Tune-up (dBm)	Power Drift (dB)	Limit of 1gSAR 1.6 W/kg (mW/g)				Figure No.
										Measured SAR1g	Duty Cycle Scaling Factor	Tune-up Scaling Factor	Report SAR1g	
Body SAR (0mm)														
Front Side	Standard	802.11a	20	87.50	157	5785	-1.27	1.00	0.00	0.000	1.14	1.69	0.00	/
Back Side	Standard	802.11a	20	87.50	157	5785	-1.27	1.00	0.00	0.000	1.14	1.69	0.00	/
Left Side	Standard	802.11a	20	87.50	157	5785	-1.27	1.00	0.00	0.000	1.14	1.69	0.00	/
Right Side	Standard	802.11a	20	87.50	157	5785	-1.27	1.00	0.00	0.000	1.14	1.69	0.00	/
Top Side	Standard	802.11a	20	87.50	157	5785	-1.27	1.00	0.10	0.056	1.14	1.69	0.11	/
Back Side-Open	Standard	802.11a	20	87.50	157	5785	-1.27	1.00	0.00	0.000	1.14	1.69	0.00	/
Left Side-Open	Standard	802.11a	20	87.50	157	5785	-1.27	1.00	0.00	0.000	1.14	1.69	0.00	/
Top Side-Open	Standard	802.11a	20	87.50	157	5785	-1.27	1.00	0.01	0.059	1.14	1.69	0.11	A.4

## 15.2. SAR Measurement Variability

SAR measurement variability must be 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.

The following procedures are applied to determine if repeated measurements are required.

- 1) Repeated measurement is not required when the original highest measured SAR is  $< 0.80$  W/kg; steps 2) through 4) do not apply.
- 2) When the original highest measured SAR is  $\geq 0.80$  W/kg, repeat that measurement once.
- 3) Perform a second repeated measurement only 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 ( $\sim 10\%$  from the 1-g SAR limit).
- 4) Perform a third repeated measurement only if the original, first or second repeated measurement is  $\geq 1.5$  W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .



## 16. Measurement Uncertainty

**Measurement Uncertainty for Normal SAR Tests (below 3GHz)**

Error Description	Uncert. Value	Prob. Dist.	Div.	(Ci)	(Ci)	Std. Unc.[%]	Std. Unc.[%]	(Ui) ueff
				1g	10g	(1g)	(10g)	
Measurement System								
Probe Calibration	12.1	N	2	1	1	6.05	6.05	∞
Axial Isotropy	4.7	R	√3	0.7	0.7	1.90	1.90	∞
Hemispherical Isotropy	9.6	R	√3	0.7	0.7	3.88	3.88	∞
Boundary effects	1.0	R	√3	1	1	0.58	0.58	∞
Linearity	4.7	R	√3	1	1	2.71	2.71	∞
System Detection Limits	1.0	R	√3	1	1	0.58	0.58	∞
Readout Electronics	0.3	N	1	1	1	0.30	0.30	∞
Response Time	0.8	R	√3	1	1	0.50	0.50	∞
Integration Time	2.6	R	√3	1	1	1.50	1.50	∞
RF ambient conditions-noise	0	R	√3	1	1	0.00	0.00	∞
RF ambient conditions-reflection	0	R	√3	1	1	0.00	0.00	∞
Probe Positioned mech.restrictions	0.2	R	√3	1	1	0.12	0.12	∞
Probe Positioning with respect to phantom shell	2.9	R	√3	1	1	1.67	1.67	∞
Post-processing	4.0	R	√3	1	1	2.31	2.31	∞
Test Sample Related								
Device Holder	2.54	N	1	1	1	2.54	2.54	3
Test sample Positioning	0.5	N	1	1	1	0.50	0.50	63
Power Drift	5.0	R	√3	1	1	2.89	2.89	∞
Phantom and Setup								
Phantom Uncertainty	7.5	R	√3	1	1	4.33	4.33	∞
Liquid Conductivity (target)	5.0	R	√3	0.64	0.43	1.85	1.24	∞
Liquid Conductivity (meas..)	2.5	N	1	0.64	0.43	1.60	1.08	∞
Liquid Permittivity (target)	5.00	R	√3	0.6	0.49	1.73	1.41	∞
Liquid Permittivity (meas..)	0.4	N	1	0.6	0.49	0.24	0.20	∞
Combined Std. Uncertainty	$U_c = \sqrt{\sum_{i=1}^{23} C_i^2 U_i^2}$	RSS				10.09	9.96	
Expanded STD Uncertainty	$U_c = 2U_c'$					20.18	19.93	

## Measurement Uncertainty for Fast SAR Tests (below 3GHz)

Error Description	Uncert. Value	Prob. Dist.	Div.	(Ci)	(Ci)	Std. Unc.[%]	Std. Unc.[%]	(Ui) ueff
				1g	10g	(1g)	(10g)	
Measurement System								
Probe Calibration	12.1	N	2	1	1	6.05	6.05	∞
Axial Isotropy	4.7	R	√3	0.7	0.7	1.90	1.90	∞
Hemispherical Isotropy	9.6	R	√3	0.7	0.7	3.88	3.88	∞
Boundary effects	1.0	R	√3	1	1	0.58	0.58	∞
Linearity	4.7	R	√3	1	1	2.71	2.71	∞
System Detection Limits	1.0	R	√3	1	1	0.58	0.58	∞
Readout Electronics	0.3	N	1	1	1	0.30	0.30	∞
Response Time	0.8	R	√3	1	1	0.50	0.50	∞
Integration Time	2.6	R	√3	1	1	1.50	1.50	∞
RF ambient conditions-noise	0	R	√3	1	1	0.00	0.00	∞
RF ambient conditions-reflection	0	R	√3	1	1	0.00	0.00	∞
Probe Positioned mech.retrictions	0.2	R	√3	1	1	0.12	0.12	∞
Probe Positioning with respect to phantom shell	2.9	R	√3	1	1	1.67	1.67	∞
Post-processing	4.0	R	√3	1	1	2.31	2.31	∞
Fast SAR-Z-Approximation	7.0	R	√3	1	1	4.0	4.0	∞
Test Sample Related								
Device Holder	2.54	N	1	1	1	2.54	2.54	3
Test dample Positioning	0.5	N	1	1	1	0.50	0.50	63
Power Drift	5.0	R	√3	1	1	2.89	2.89	∞
Phantom and Setup								
Phantom Uncertainty	7.5	R	√3	1	1	4.33	4.33	∞
Liquid Conductivity (target)	5.0	R	√3	0.64	0.43	1.85	1.24	∞
Liquid Conductivity (meas..)	2.5	N	1	0.64	0.43	1.60	1.08	∞
Liquid Permittivity (target)	5.00	R	√3	0.6	0.49	1.73	1.41	∞
Liquid Permittivity (meas..)	0.4	N	1	0.6	0.49	0.24	0.20	∞
Combined Std. Uncertainty	$U_c^{' } = \sqrt{\sum_{i=1}^N Ci^2Ui^2}$	RSS				10.85	10.73	
Expanded STD Uncertainty	$U_c = 2U_c^{' }$					21.70	21.46	

## Measurement Uncertainty for Normal SAR Tests (3GHz-6GHz)

Error Description	Uncert. Value	Prob. Dist.	Div.	(Ci)	(Ci)	Std. Unc.[%]	Std. Unc.[%]	(Ui) ueff
				1g	10g	(1g)	(10g)	
Measurement System								
Probe Calibration	13.3	N	2	1	1	6.65	6.65	∞
Axial Isotropy	4.7	R	√3	0.7	0.7	1.90	1.90	∞
Hemispherical Isotropy	9.6	R	√3	0.7	0.7	3.88	3.88	∞
Boundary effects	2.0	R	√3	1	1	1.15	1.15	∞
Linearity	4.7	R	√3	1	1	2.71	2.71	∞
System Detection Limits	1.0	R	√3	1	1	0.58	0.58	∞
Readout Electronics	0.3	N	1	1	1	0.30	0.30	∞
Response Time	0.8	R	√3	1	1	0.50	0.50	∞
Integration Time	2.6	R	√3	1	1	1.50	1.50	∞
RF ambient conditions-noise	0	R	√3	1	1	0.00	0.00	∞
RF ambient conditions-reflection	0	R	√3	1	1	0.00	0.00	∞
Probe Positioned mech.restrictions	0.4	R	√3	1	1	0.23	0.23	∞
Probe Positioning with respect to phantom shell	6.7	R	√3	1	1	3.87	3.87	∞
Post-processing	4.0	R	√3	1	1	2.31	2.31	∞
Test Sample Related								
Device Holder	2.54	N	1	1	1	2.54	2.54	3
Test sample Positioning	0.5	N	1	1	1	0.50	0.50	63
Power Drift	5.0	R	√3	1	1	2.89	2.89	∞
Phantom and Setup								
Phantom Uncertainty	7.9	R	√3	1	1	4.56	4.56	∞
Liquid Conductivity (target)	5.0	R	√3	0.64	0.43	1.85	1.24	∞
Liquid Conductivity (meas..)	2.5	N	1	0.64	0.43	1.60	1.08	∞
Liquid Permittivity (target)	5.00	R	√3	0.6	0.49	1.73	1.41	∞
Liquid Permittivity (meas..)	0.4	N	1	0.6	0.49	0.24	0.20	∞
Combined Std. Uncertainty	$U_c' = \sqrt{\sum_{i=1}^{23} C_i^2 U_i^2}$	RSS				11.17	11.05	
Expanded STD Uncertainty	$U_c = 2U_c'$					22.34	22.11	

## Measurement Uncertainty for Fast SAR Tests (3GHz-6GHz)

Error Description	Uncert. Value	Prob. Dist.	Div.	(Ci)	(Ci)	Std. Unc.[%]	Std. Unc.[%]	(Ui) ueff
				1g	10g	(1g)	(10g)	
Measurement System								
Probe Calibration	13.3	N	2	1	1	6.65	6.65	∞
Axial Isotropy	4.7	R	√ 3	0.7	0.7	1.90	1.90	∞
Hemispherical Isotropy	9.6	R	√ 3	0.7	0.7	3.88	3.88	∞
Boundary effects	2.0	R	√ 3	1	1	1.15	1.15	∞
Linearity	4.7	R	√ 3	1	1	2.71	2.71	∞
System Detection Limits	1.0	R	√ 3	1	1	0.58	0.58	∞
Readout Electronics	0.3	N	1	1	1	0.30	0.30	∞
Response Time	0.8	R	√ 3	1	1	0.50	0.50	∞
Integration Time	2.6	R	√ 3	1	1	1.50	1.50	∞
RF ambient conditions-noise	0	R	√ 3	1	1	0.00	0.00	∞
RF ambient conditions-reflection	0	R	√ 3	1	1	0.00	0.00	∞
Probe Positioned mech.restrictions	0.4	R	√ 3	1	1	0.23	0.23	∞
Probe Positioning with respect to phantom shell	6.7	R	√ 3	1	1	3.87	3.87	∞
Post-processing	4.0	R	√ 3	1	1	2.31	2.31	∞
Fast SAR-Z-Approximation	14.0	R	√ 3	1	1	8.10	8.10	∞
Test Sample Related								
Device Holder	2.54	N	1	1	1	2.54	2.54	3
Test sample Positioning	0.5	N	1	1	1	0.50	0.50	63
Power Drift	5.0	R	√ 3	1	1	2.89	2.89	∞
Phantom and Setup								
Phantom Uncertainty	7.9	R	√ 3	1	1	4.56	4.56	∞
Liquid Conductivity (target)	5.0	R	√ 3	0.64	0.43	1.85	1.24	∞
Liquid Conductivity (meas..)	2.5	N	1	0.64	0.43	1.60	1.08	∞
Liquid Permittivity (target)	5.00	R	√ 3	0.6	0.49	1.73	1.41	∞
Liquid Permittivity (meas..)	0.4	N	1	0.6	0.49	0.24	0.20	∞
Combined Std. Uncertainty	$U_c' = \sqrt{\sum_{i=1}^3 Ci^2Ui^2}$	RSS				13.80	13.70	
Expanded STD Uncertainty	$U_c = 2U_c'$					27.60	27.40	

## 17. MAIN TEST INSTRUMENTS

**Table 17-1: List of Main Instruments**

No.	Name	Type	Serial Number	Software version	Hardware version	Calibration Date	Valid Period
01	Probe	EX3DV4	3844	--	--	2022-07-08	2023-07-07
02	DAE	DAE4	1244	--	--	2023-04-10	2024-04-09
03	Network analyzer	N5242A	MY51221755	A.09.33.09	--	2022-10-17	2023-10-16
04	Power meter	NRX	103851	02.50.21112602	--	2022-08-22	2023-08-21
05	Power sensor	NRP18S-10	101841	--	--	2022-08-22	2023-08-21
06	Power sensor	NRP18S-10	101842	--	--	2022-08-22	2023-08-21
07	Signal Generator	E8247C	MY43000157	--	C.03.07	2022-08-22	2023-08-21
08	Amplifier	NTWPA-07605	22039018	--	--	2022-08-22	2023-08-21
09	D2450V2	Dipole	886	--	--	2020-10-13	2023-10-12
10	D5GHz	Dipole	1172	--	--	2022-03-15	2025-03-14

\*\*\*END OF REPORT BODY\*\*\*

## ANNEX A. GRAPH RESULTS

### Wi-Fi 2.4G 11b Top Mode Low 0mm open

Date/Time: 2023/6/11

Electronics: DAE4 Sn1244

Medium parameters used:  $f = 2412$  MHz;  $\sigma = 1.796$  S/m;  $\epsilon_r = 37.732$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.5°C Liquid Temperature: 20.4°C

Communication System: Wlan 2450 2450MHz; Frequency: 2412 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3844ConvF(7.69, 7.69, 7.69) @ 2412 MHz

### Wi-Fi 2.4G 11b Top Mode Low 0mm open/Area Scan (6x10x1):

Measurement grid:  $dx=12$ mm,  $dy=12$ mm

Maximum value of SAR (measured) = 0.0911 W/kg

### Wi-Fi 2.4G 11b Top Mode Low 0mm open/Zoom Scan (7x7x7)/Cube 0:

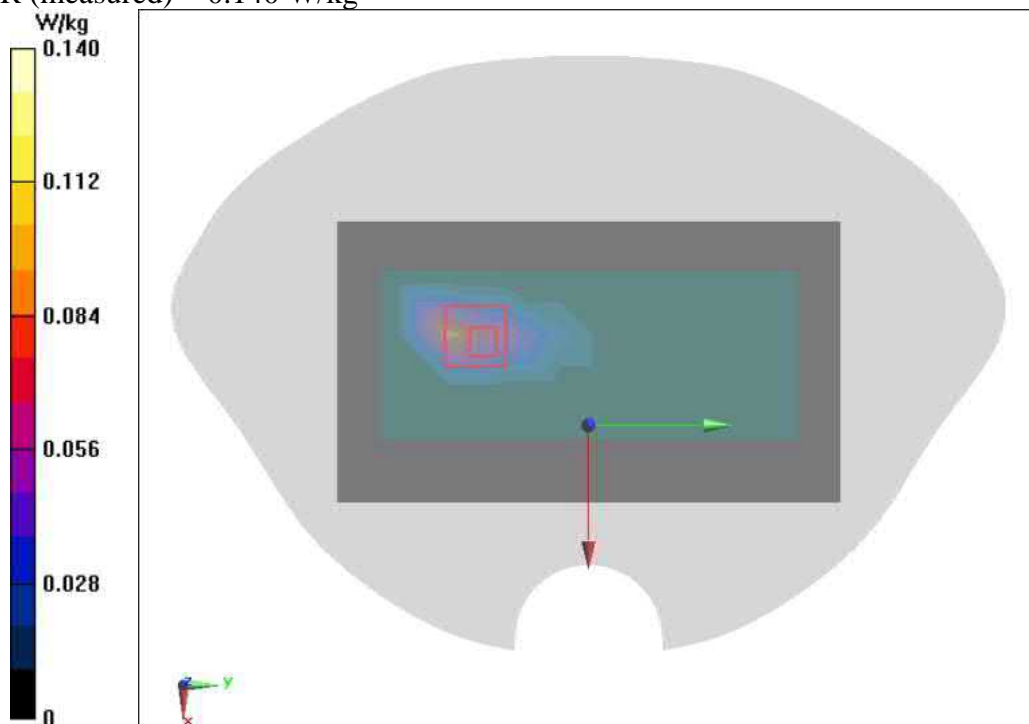
Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 0.7000 V/m; Power Drift = 0.06 dB

Peak SAR (extrapolated) = 0.392 W/kg

SAR(1 g) = 0.110 W/kg; SAR(10 g) = 0.031 W/kg

Maximum of SAR (measured) = 0.140 W/kg



A.1

**Wi-Fi 5G U-NII-2A 11a Top Mode High 0mm open**

Date/Time: 2023/6/12

Electronics: DAE4 Sn1244

Medium parameters used:  $f = 5320$  MHz;  $\sigma = 4.781$  S/m;  $\epsilon_r = 34.859$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.4°C Liquid Temperature: 20.3°C

Communication System: 5G-U-NII-2A 5GHz; Frequency: 5320 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3844ConvF(5.48, 5.48, 5.48) @ 5320 MHz

**Wi-Fi 5G U-NII-2A 11a Top Mode High 0mm open/Area Scan (6x10x1):**

Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 0.495 W/kg

**Wi-Fi 5G U-NII-2A 11a Top Mode High 0mm open/Zoom Scan (7x7x7)/Cube 0:**

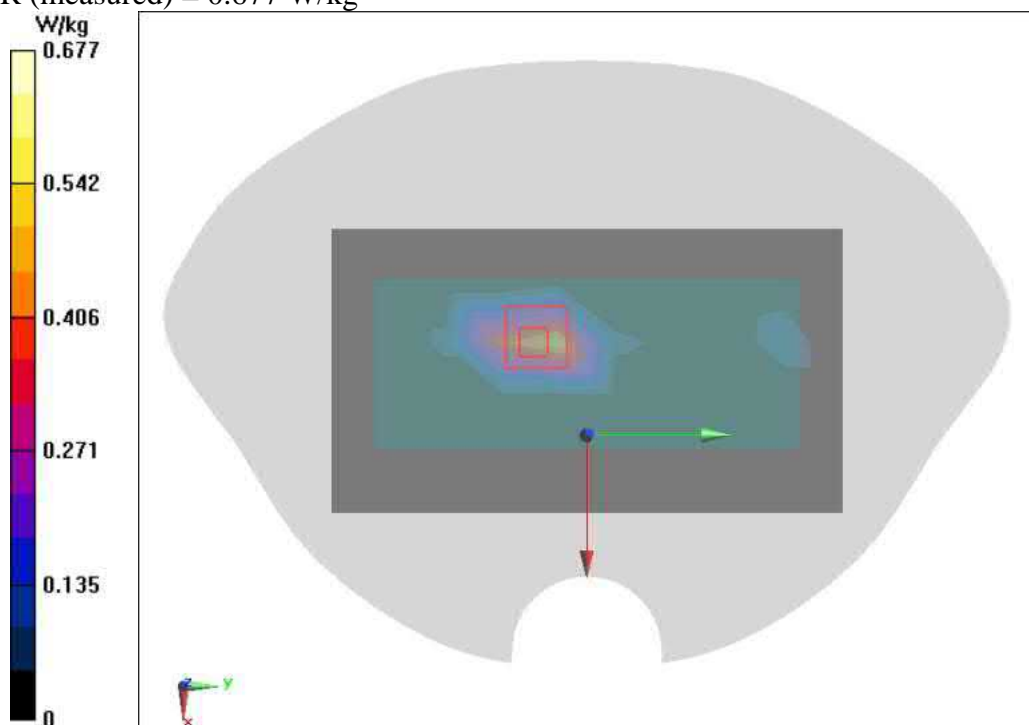
Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 3.675 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 2.36 W/kg

SAR(1 g) = 0.355 W/kg; SAR(10 g) = 0.088 W/kg

Maximum of SAR (measured) = 0.677 W/kg



A.2

**Wi-Fi 5G U-NII-2C 11a Top Mode Low 0mm open**

Date/Time: 2023/6/12

Electronics: DAE4 Sn1244

Medium parameters used:  $f = 5500$  MHz;  $\sigma = 4.965$  S/m;  $\epsilon_r = 34.524$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.4°C Liquid Temperature: 20.3°C

Communication System: 5G-U-NII-2C 5GHz; Frequency: 5500 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3844ConvF(4.96, 4.96, 4.96) @ 5500 MHz

**Wi-Fi 5G U-NII-2C 11a Top Mode Low 0mm open/Area Scan (6x10x1):**

Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 0.948 W/kg

**Wi-Fi 5G U-NII-2C 11a Top Mode Low 0mm open/Zoom Scan (7x7x7)/Cube 0:**

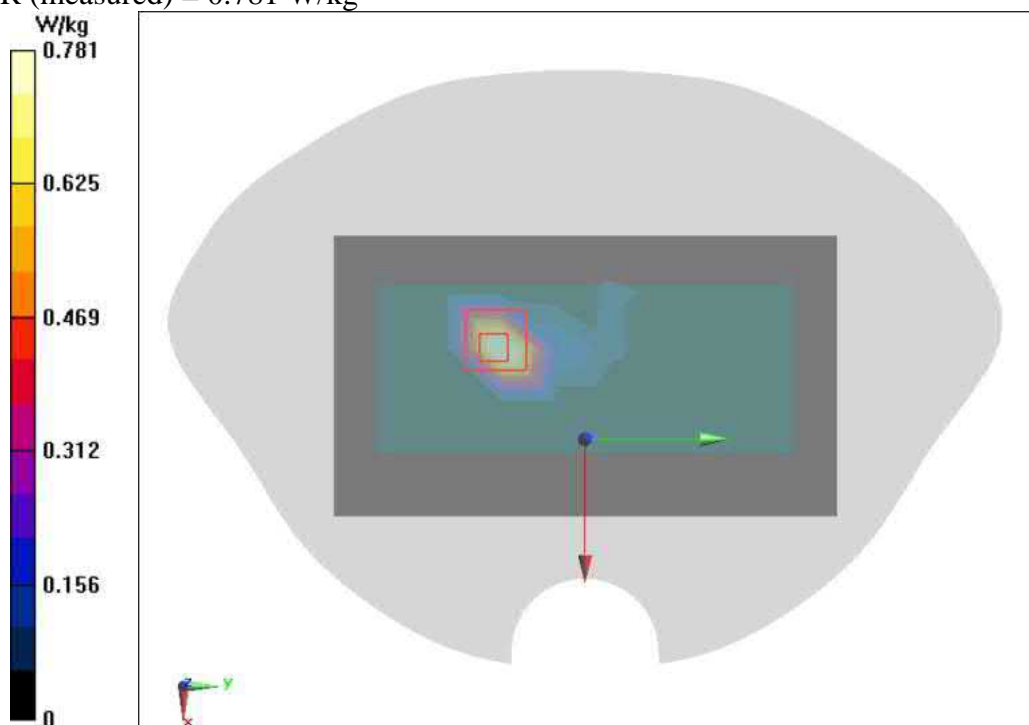
Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 0 V/m; Power Drift = 0.10 dB

Peak SAR (extrapolated) = 2.94 W/kg

SAR(1 g) = 0.369 W/kg; SAR(10 g) = 0.095 W/kg

Maximum of SAR (measured) = 0.781 W/kg

**A.3**



**Wi-Fi 5G U-NII-3 11a Top Mode Low 0mm open**

Date/Time: 2023/6/12

Electronics: DAE4 Sn1244

Medium parameters used:  $f = 5745$  MHz;  $\sigma = 5.237$  S/m;  $\epsilon_r = 34.052$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.4°C Liquid Temperature: 20.3°C

Communication System: 5G-U-NII-3 5GHz; Frequency: 5745 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3844ConvF(5.01, 5.01, 5.01) @ 5745 MHz

**Wi-Fi 5G U-NII-3 11a Top Mode Low 0mm open/Area Scan (8x13x1):**

Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 0.141 W/kg

**Wi-Fi 5G U-NII-3 11a Top Mode Low 0mm open/Zoom Scan (7x7x7)/Cube 0:**

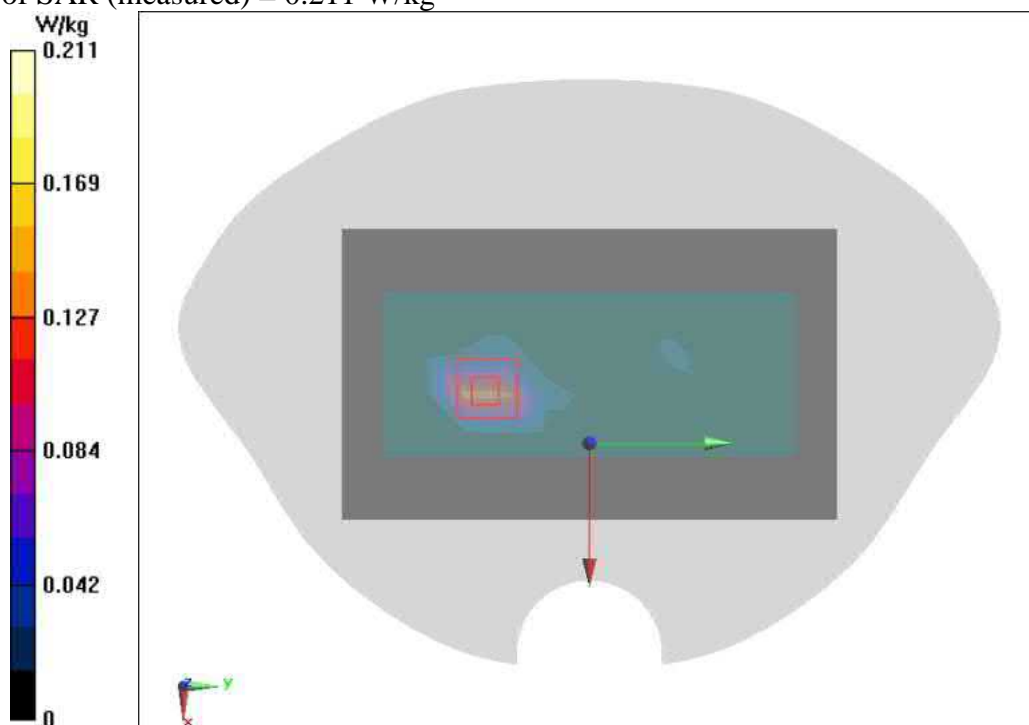
Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 0 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 0.387 W/kg

SAR(1 g) = 0.059 W/kg; SAR(10 g) = 0.016 W/kg

Maximum value of SAR (measured) = 0.211 W/kg



A.4

## ANNEX B. SYSTEM VALIDATION RESULTS

### Head 2450MHz

Date/Time: 2023/6/11

Electronics: DAE4 Sn1244

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.823$  S/m;  $\epsilon_r = 37.665$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.5°C Liquid Temperature: 20.5°C

Communication System: CW 2450MHz; Frequency: 2450 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3844ConvF(7.69, 7.69, 7.69) @ 2450 MHz

#### System Check Head 2450MHz/Area Scan (11x11x1):

Measurement grid:  $dx=12$ mm,  $dy=12$ mm

Maximum value of SAR (measured) = 14.2 W/kg

#### System Check Head 2450MHz/Zoom Scan (7x7x7)/Cube 0:

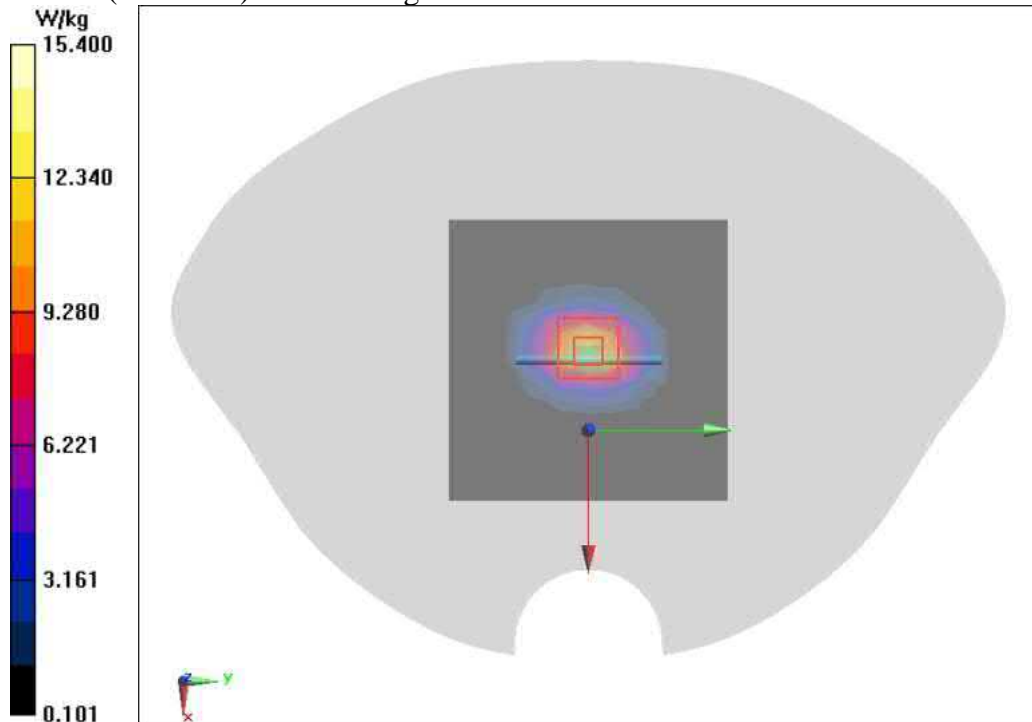
Measurement grid:  $dx=5$ mm,  $dy=5$ mm,  $dz=5$ mm

Reference Value = 89.10 V/m; Power Drift = 0.00 dB

Peak SAR (extrapolated) = 28.7 W/kg

SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.24 W/kg

Maximum value of SAR (measured) = 15.4 W/kg



B.1

**Head 5300MHz**

Date/Time: 2023/6/12

Electronics: DAE4 Sn1244

Medium parameters used:  $f = 5300$  MHz;  $\sigma = 4.758$  S/m;  $\epsilon_r = 34.905$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.4°C Liquid Temperature: 20.3°C

Communication System: CW 5GHz; Frequency: 5300 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3844ConvF(5.48, 5.48, 5.48) @ 5300 MHz

**System Check Head 5300MHz/Area Scan (10x10x1):**

Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 17.9 W/kg

**System Check Head 5300MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (7x7x7)/Cube 0:**

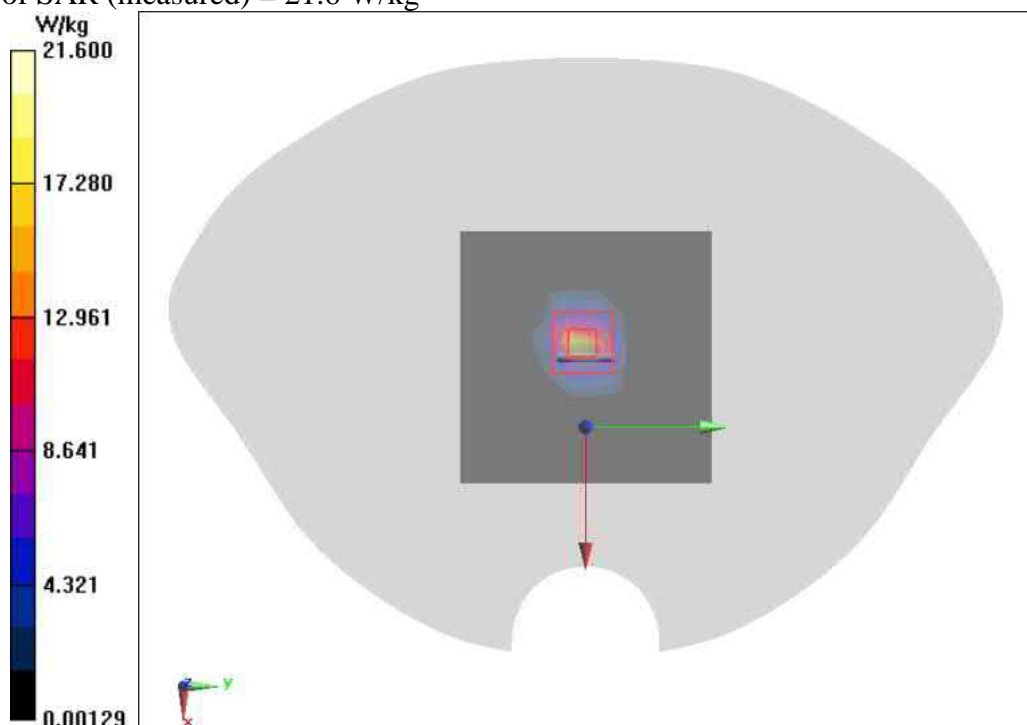
Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 62.34 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 35.1 W/kg

SAR(1 g) = 8.17 W/kg; SAR(10 g) = 2.31 W/kg

Maximum value of SAR (measured) = 21.6 W/kg

**B.2**

**Head 5600MHz**

Date/Time: 2023/6/12

Electronics: DAE4 Sn1244

Medium parameters used:  $f = 5600$  MHz;  $\sigma = 5.069$  S/m;  $\epsilon_r = 34.322$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.4°C Liquid Temperature: 20.3°C

Communication System: CW 5GHz; Frequency: 5600 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3844ConvF(4.96, 4.96, 4.96) @ 5600 MHz

**System Check Head 5600MHz/Area Scan (10x10x1):**

Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 16.4 W/kg

**System Check Head 5600MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (7x7x7)/Cube 0:**

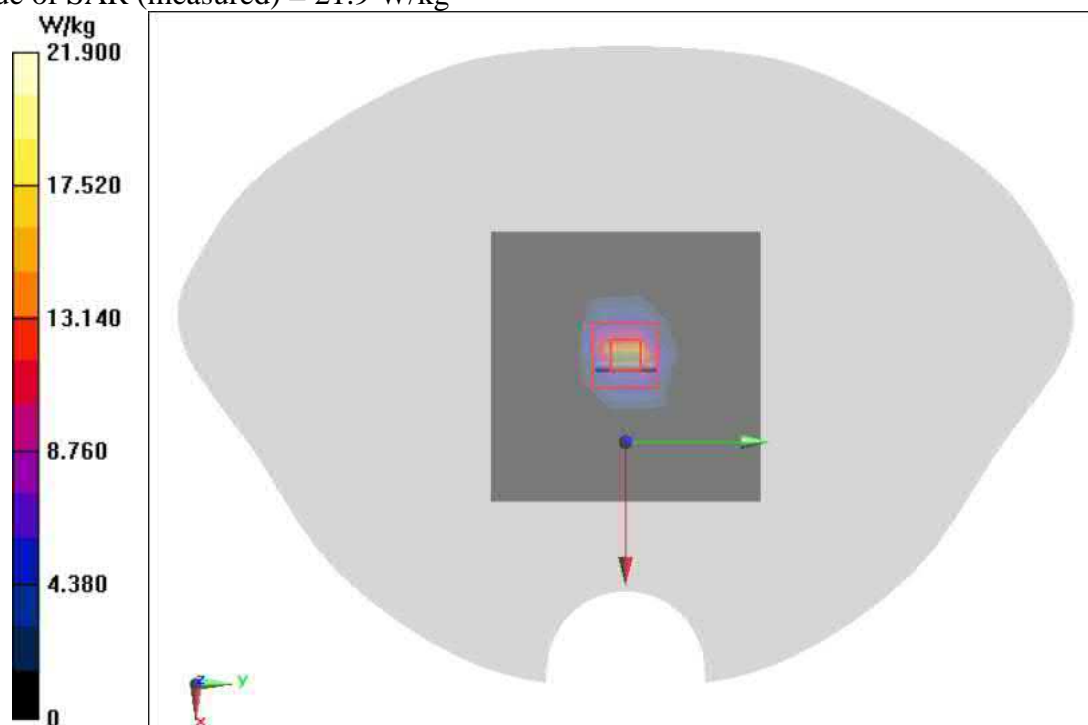
Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 64.41 V/m; Power Drift = 0.16 dB

Peak SAR (extrapolated) = 36.4 W/kg

SAR(1 g) = 8.25 W/kg; SAR(10 g) = 2.34 W/kg

Maximum value of SAR (measured) = 21.9 W/kg

**B.3**

**Head 5800MHz**

Date/Time: 2023/6/12

Electronics: DAE4 Sn1244

Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.284$  S/m;  $\epsilon_r = 33.918$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 21.4°C Liquid Temperature: 20.3°C

Communication System: CW 5GHz; Frequency: 5800 MHz; Duty Cycle: 1:1

Probe: EX3DV4 - SN3844ConvF(5.01, 5.01, 5.01) @ 5800 MHz

**System Check Head 5800MHz/Area Scan (10x10x1):**

Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 16.4 W/kg

**System Check Head 5800MHz/Zoom Scan (4x4x1.4mm, graded), dist=1.4mm (7x7x7)/Cube 0:**

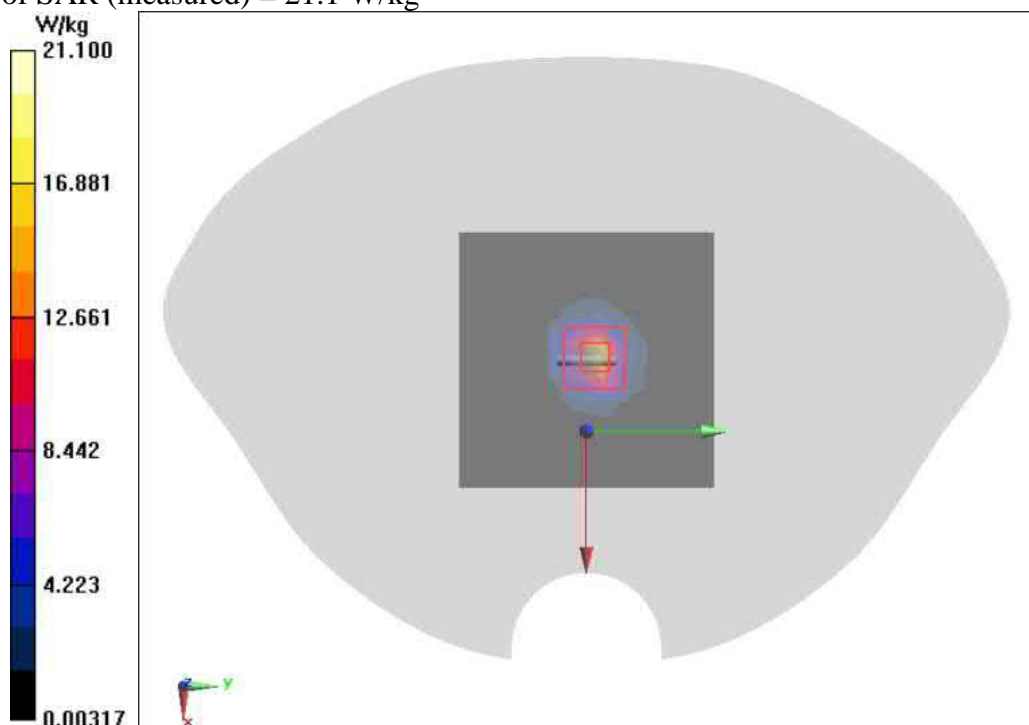
Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 64.17 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 35.3 W/kg

SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.23 W/kg

Maximum value of SAR (measured) = 21.1 W/kg

**B.4**

## ANNEX C. CALIBRATION REPORT



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 CNAS L0570

Client : 3in

Certificate No: J23Z60207

## CALIBRATION CERTIFICATE

Object DAE4 - SN: 1244

Calibration Procedure(s) FF-Z11-002-01  
 Calibration Procedure for the Data Acquisition Electronics (DAEx)

Calibration date: April 10, 2023

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.

Calibration Equipment used (M&amp;TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	14-Jun-22 (CTTL, No.J22X04180)	Jun-23

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: April 11, 2023

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Certificate No: J23Z60207

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**Glossary:**

DAE data acquisition electronics  
Connector angle information used in DASY system to align probe sensor X to the robot coordinate system.

**Methods Applied and Interpretation of Parameters:**

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.





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#### DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV, full range = -100...+300 mV

Low Range: 1LSB = 61nV, full range = -1.....+3mV


DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	403.859 ± 0.15% (k=2)	403.585 ± 0.15% (k=2)	404.504 ± 0.15% (k=2)
Low Range	3.95256 ± 0.7% (k=2)	3.97026 ± 0.7% (k=2)	3.97966 ± 0.7% (k=2)

#### Connector Angle


Connector Angle to be used in DASY system	23.5° ± 1 °
---	-------------






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Client **CATR(Chongqing)**
Certificate No: **Z22-60227**

### CALIBRATION CERTIFICATE

Object: **EX3DV4 - SN : 3844**

Calibration Procedure(s): **FF-Z11-004-02**  
**Calibration Procedures for Dosimetric E-field Probes**

Calibration date: **July 08, 2022**


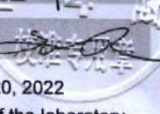
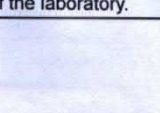
This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	14-Jun-22(CTTL, No.J22X04181)	Jun-23
Power sensor NRP-Z91	101547	14-Jun-22(CTTL, No.J22X04181)	Jun-23
Power sensor NRP-Z91	101548	14-Jun-22(CTTL, No.J22X04181)	Jun-23
Reference 10dBAttenuator	18N50W-10dB	20-Jan-21(CTTL, No.J21X00486)	Jan-23
Reference 20dBAttenuator	18N50W-20dB	20-Jan-21(CTTL, No.J21X00485)	Jan-23
Reference Probe EX3DV4	SN 7464	26-Jan-22(SPEAG, No.EX3-7464_Jan22)	Jan-23
DAE4	SN 1555	20-Aug-21(SPEAG, No.DAE4-1555_Aug21/2)	Aug-22

Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
SignalGenerator MG3700A	6201052605	14-Jun-22(CTTL, No.J22X04182)	Jun-23
Network Analyzer E5071C	MY46110673	14-Jan-22(CTTL, No.J22X00406)	Jan-23

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: July 20, 2022

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Certificate No: Z22-60227
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#### Glossary:

TSL	tissue simulating liquid
NORM <sub>x,y,z</sub>	sensitivity in free space
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A,B,C,D	modulation dependent linearization parameters
Polarization $\Phi$	$\Phi$ rotation around probe axis
Polarization $\theta$	$\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), $\theta=0$ is normal to probe axis

Connector Angle information used in DASY system to align probe sensor X to the robot coordinate system

#### Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\theta=0$  ( $f \leq 900\text{MHz}$  in TEM-cell;  $f > 1800\text{MHz}$ : waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the  $E^2$ -field uncertainty inside TSL (see below ConvF).
- NORM( $f$ )<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* frequency\_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; VR<sub>x,y,z</sub>; A,B,C** are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800\text{MHz}$ ) and inside waveguide using analytical field distributions based on power measurements for  $f > 800\text{MHz}$ . The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM<sub>x,y,z</sub> \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from  $\pm 50\text{MHz}$  to  $\pm 100\text{MHz}$ .
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).

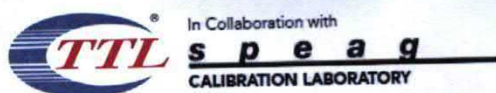
Certificate No: Z22-60227

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## DASY/EASY – Parameters of Probe: EX3DV4 – SN:3844

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc ( $k=2$ )
Norm( $\mu V/(V/m)^2$ ) <sup>A</sup>	0.49	0.41	0.19	±10.0%
DCP(mV) <sup>B</sup>	103.0	101.8	97.3	

### Modulation Calibration Parameters

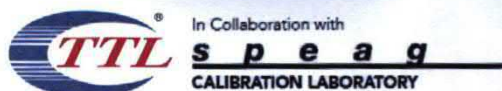
UID	Communication System Name		A dB	B dB· $\mu V$	C	D dB	VR mV	Unc <sup>E</sup> ( $k=2$ )
0	CW	X	0.0	0.0	1.0	0.00	162.7	±2.5%
		Y	0.0	0.0	1.0		144.4	
		Z	0.0	0.0	1.0		85.6	

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution Corresponds to a coverage probability of approximately 95%.

<sup>A</sup> The uncertainties of Norm X, Y, Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Page 4).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



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## DASY/EASY – Parameters of Probe: EX3DV4 – SN:3844

### Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz] <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	41.9	0.89	9.96	9.96	9.96	0.21	1.17	± 12.1%
900	41.5	0.97	9.55	9.55	9.55	0.29	1.00	± 12.1%
1750	40.1	1.37	8.50	8.50	8.50	0.24	1.03	± 12.1%
1900	40.0	1.40	8.10	8.10	8.10	0.24	1.01	± 12.1%
2100	39.8	1.49	8.18	8.18	8.18	0.23	1.18	± 12.1%
2300	39.5	1.67	7.95	7.95	7.95	0.65	0.67	± 12.1%
2450	39.2	1.80	7.69	7.69	7.69	0.65	0.68	± 12.1%
2600	39.0	1.96	7.49	7.49	7.49	0.65	0.67	± 12.1%
3300	38.2	2.71	7.24	7.24	7.24	0.46	0.96	± 13.3%
3500	37.9	2.91	7.00	7.00	7.00	0.48	0.97	± 13.3%
3700	37.7	3.12	6.78	6.78	6.78	0.43	1.03	± 13.3%
3900	37.5	3.32	6.74	6.74	6.74	0.40	1.25	± 13.3%
5250	35.9	4.71	5.48	5.48	5.48	0.55	1.17	± 13.3%
5600	35.5	5.07	4.96	4.96	4.96	0.60	1.16	± 13.3%
5750	35.4	5.22	5.01	5.01	5.01	0.55	1.22	± 13.3%

<sup>C</sup> Frequency validity above 300 MHz of  $\pm 100$  MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to  $\pm 50$  MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is  $\pm 10, 25, 40, 50$  and  $70$  MHz for ConvF assessments at  $30, 64, 128, 150$  and  $220$  MHz respectively. Above  $5$  GHz frequency validity can be extended to  $\pm 110$  MHz.

<sup>F</sup> At frequency below  $3$  GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to  $\pm 10\%$  if liquid compensation formula is applied to measured SAR values. At frequencies above  $3$  GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to  $\pm 5\%$ . The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than  $\pm 1\%$  for frequencies below  $3$  GHz and below  $\pm 2\%$  for the frequencies between  $3-6$  GHz at any distance larger than half the probe tip diameter from the boundary.

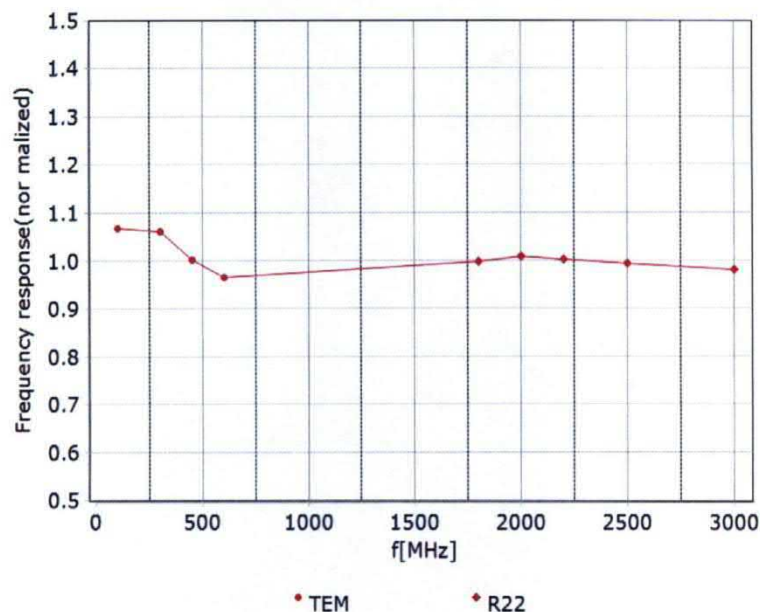


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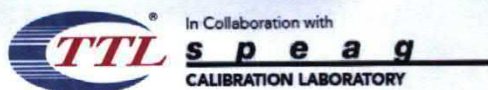


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### Frequency Response of E-Field (TEM-Cell: ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field:  $\pm 7.4\%$  ( $k=2$ )



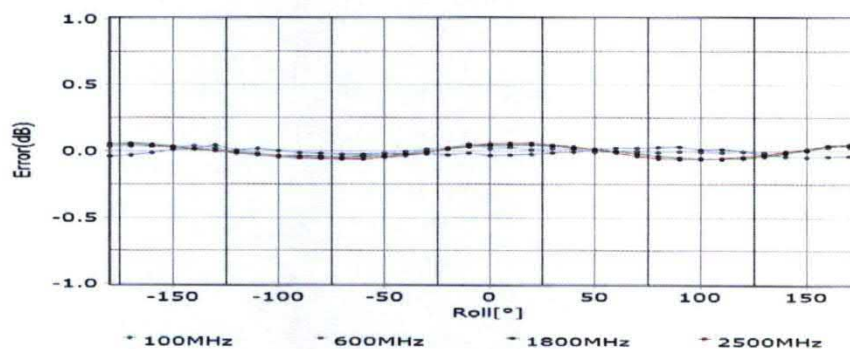
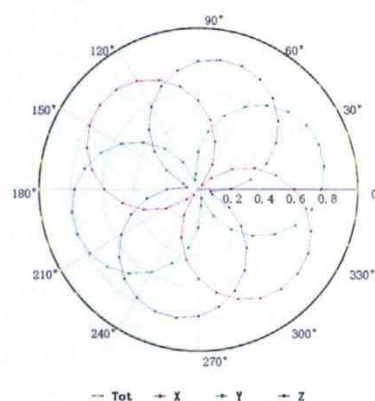
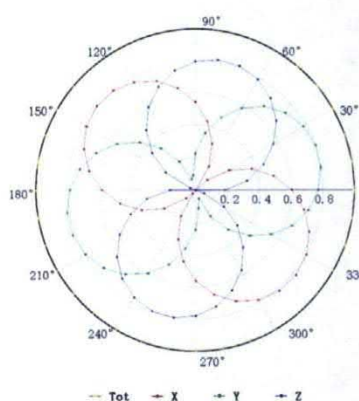
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## Receiving Pattern ( $\Phi$ ), $\theta=0^\circ$

**f=600 MHz, TEM**

**f=1800 MHz, R22**



Uncertainty of Axial Isotropy Assessment:  $\pm 1.2\%$  ( $k=2$ )

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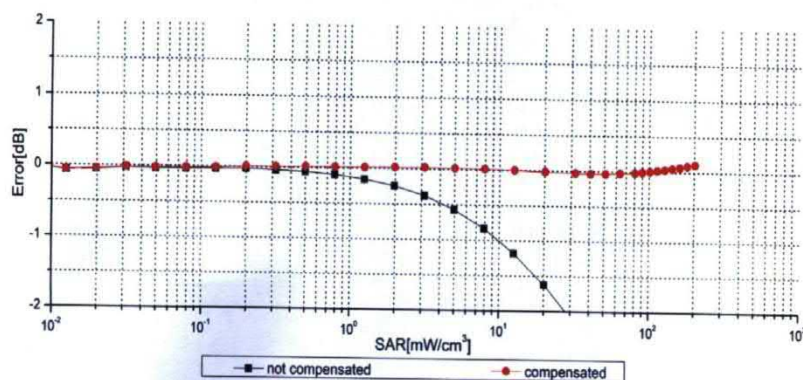
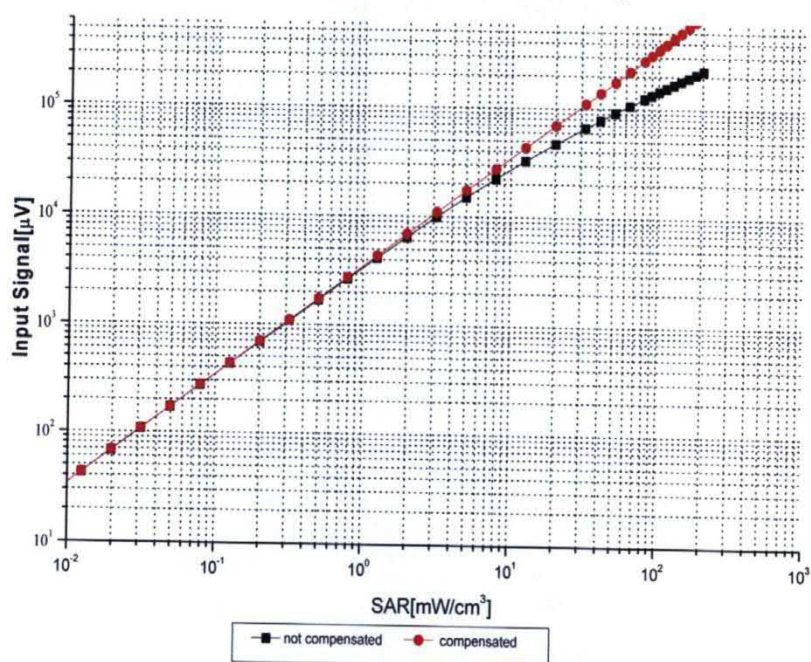




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### Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f = 900 \text{ MHz}$ )



Uncertainty of Linearity Assessment:  $\pm 0.9\%$  ( $k=2$ )

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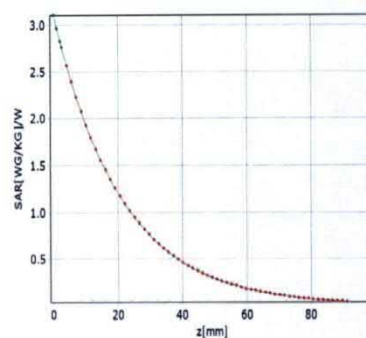
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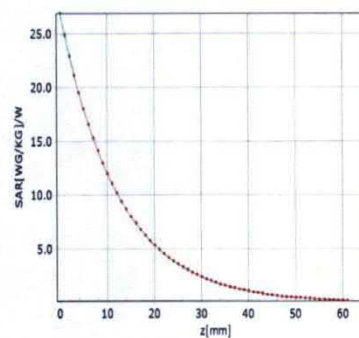
## Conversion Factor Assessment

$f=750\text{ MHz, WGLS R9(H\_convF)}$

$f=1750\text{ MHz, WGLS R22(H\_convF)}$

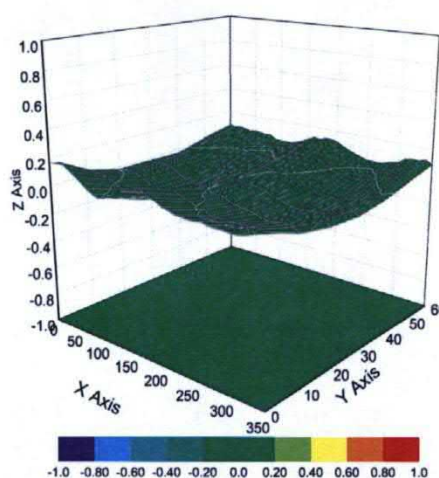


\* analytical \* measured



\* analytical \* measured

## Deviation from Isotropy in Liquid

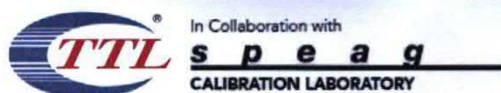


Uncertainty of Spherical Isotropy Assessment:  $\pm 3.2\%$  ( $k=2$ )

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## DASY/EASY – Parameters of Probe: EX3DV4 – SN:3844

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	25.7
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	9mm
Tip Diameter	2.5mm
Probe Tip to Sensor X Calibration Point	1mm
Probe Tip to Sensor Y Calibration Point	1mm
Probe Tip to Sensor Z Calibration Point	1mm
Recommended Measurement Distance from Surface	1.4mm



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Client **CATR(Chongqing)**

Certificate No: **Z20-60405**

## CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 886**

Calibration Procedure(s) **FF-Z11-003-01**  
**Calibration Procedures for dipole validation kits**

Calibration date: **October 13, 2020**

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)°C and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106276	12-May-20 (CTTL, No.J20X02965)	May-21
Power sensor NRP6A	101369	12-May-20 (CTTL, No.J20X02965)	May-21
ReferenceProbe EX3DV4	SN 3617	30-Jan-20(SPEAG,No.EX3-3617_Jan20)	Jan-21
DAE4	SN 771	10-Feb-20(CTTL-SPEAG,No.Z20-60017)	Feb-21
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	25-Feb-20 (CTTL, No.J20X00516)	Feb-21
NetworkAnalyzer E5071C	MY46110673	10-Feb-20 (CTTL, No.J20X00515)	Feb-21

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: October 22, 2020

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#### Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
N/A	not applicable or not measured

#### Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- IEC 62209-1, "Measurement procedure for assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices- Part 1: Device used next to the ear (Frequency range of 300MHz to 6GHz)", July 2016
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

#### Additional Documentation:

- DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution Corresponds to a coverage probability of approximately 95%.





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### Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

### Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	39.0 $\pm$ 6 %	1.81 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	----	----

### SAR result with Head TSL

SAR averaged over 1 $\text{cm}^3$ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	53.8 W/kg $\pm$ 18.8 % ( $k=2$ )
SAR averaged over 10 $\text{cm}^3$ (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	6.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.7 W/kg $\pm$ 18.7 % ( $k=2$ )

### Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	53.2 $\pm$ 6 %	1.96 mho/m $\pm$ 6 %
Body TSL temperature change during test	<1.0 °C	----	----

### SAR result with Body TSL

SAR averaged over 1 $\text{cm}^3$ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.9 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	51.7 W/kg $\pm$ 18.8 % ( $k=2$ )
SAR averaged over 10 $\text{cm}^3$ (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	5.97 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	23.9 W/kg $\pm$ 18.7 % ( $k=2$ )

Certificate No: Z20-60405

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## Appendix (Additional assessments outside the scope of CNAS L0570)

### Antenna Parameters with Head TSL

Impedance, transformed to feed point	52.2Ω+ 3.85 jΩ
Return Loss	- 27.2dB

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.5Ω+ 4.57 jΩ
Return Loss	- 26.8dB

### General Antenna Parameters and Design

Electrical Delay (one direction)	1.024 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.  
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

### Additional EUT Data

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# **DASY5 Validation Report for Head TSL**

Date: 10.13.2020

Test Laboratory: CTTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 886**

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.809$  S/m;  $\epsilon_r = 39.02$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.65, 7.65, 7.65) @ 2450 MHz; Calibrated: 2020-01-30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2020-02-10
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

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

Reference Value = 106.1 V/m; Power Drift = -0.07 dB

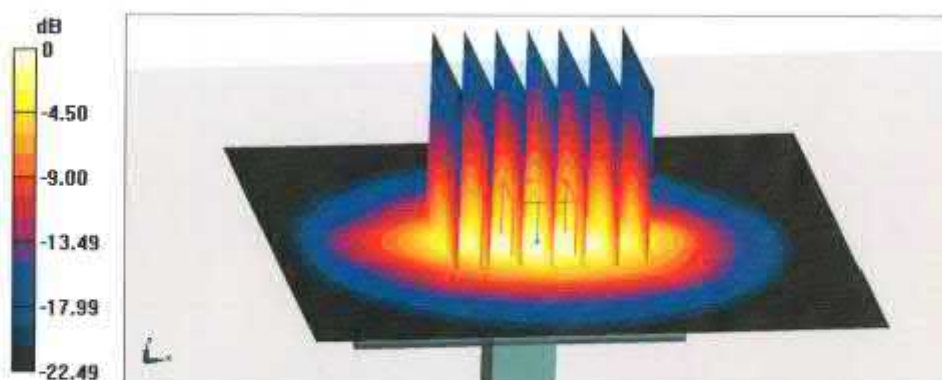
Peak SAR (extrapolated) = 28.3 W/kg

**SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.18 W/kg**

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 47.9%

Maximum value of SAR (measured) = 22.7 W/kg



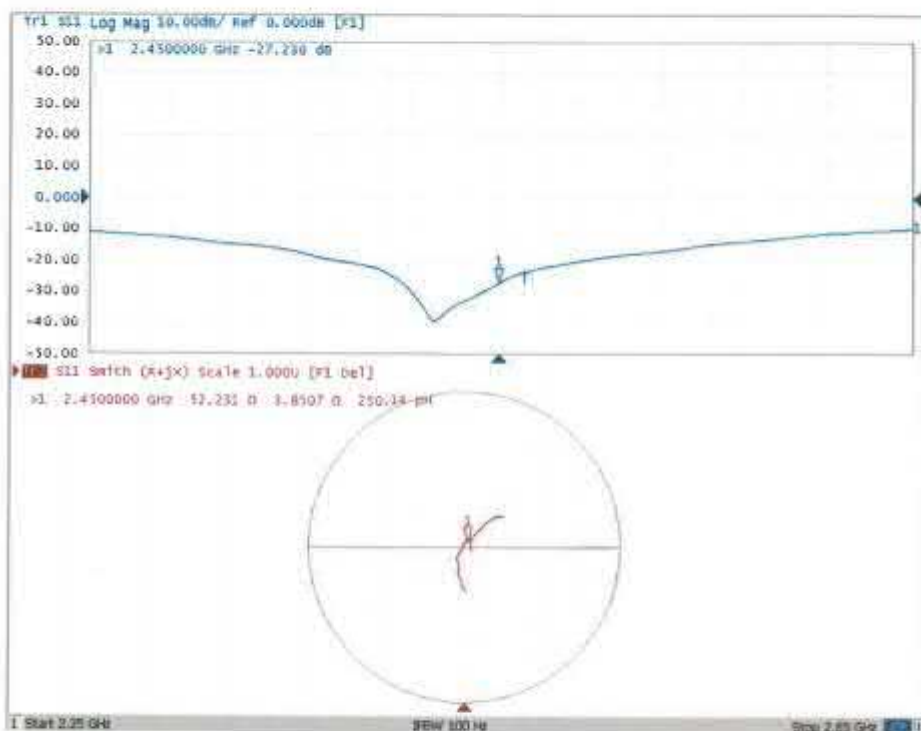
0 dB = 22.7 W/kg = 13.56 dBW/kg



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### Impedance Measurement Plot for Head TSL







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# **DASY5 Validation Report for Body TSL**

Date: 10.13.2020

Test Laboratory: CCTL, Beijing, China

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 886**

Communication System: UID 0, CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used:  $f = 2450$  MHz;  $\sigma = 1.955$  S/m;  $\epsilon_r = 53.24$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Center Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3617; ConvF(7.76, 7.76, 7.76) @ 2450 MHz; Calibrated: 2020-01-30
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2020-02-10
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial: 1062
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

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

Reference Value = 100.1 V/m; Power Drift = 0.02 dB

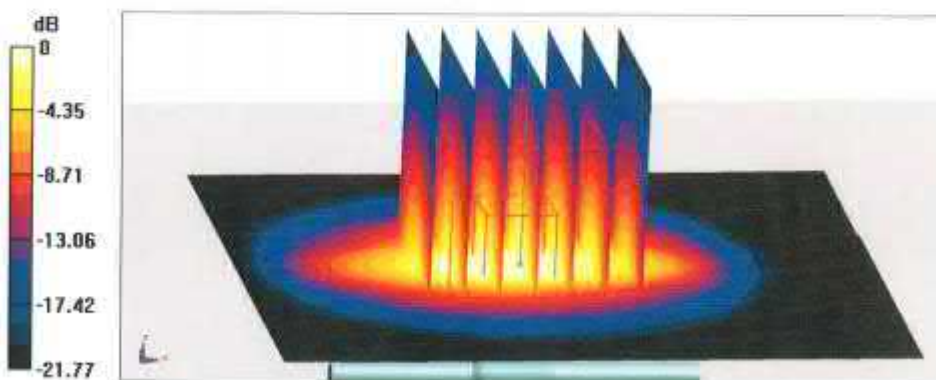
Peak SAR (extrapolated) = 26.5 W/kg

**SAR(1 g) = 12.9 W/kg; SAR(10 g) = 5.97 W/kg**

Smallest distance from peaks to all points 3 dB below = 8 mm

Ratio of SAR at M2 to SAR at M1 = 50%

Maximum value of SAR (measured) = 21.5 W/kg



0 dB = 21.5 W/kg = 13.32 dBW/kg

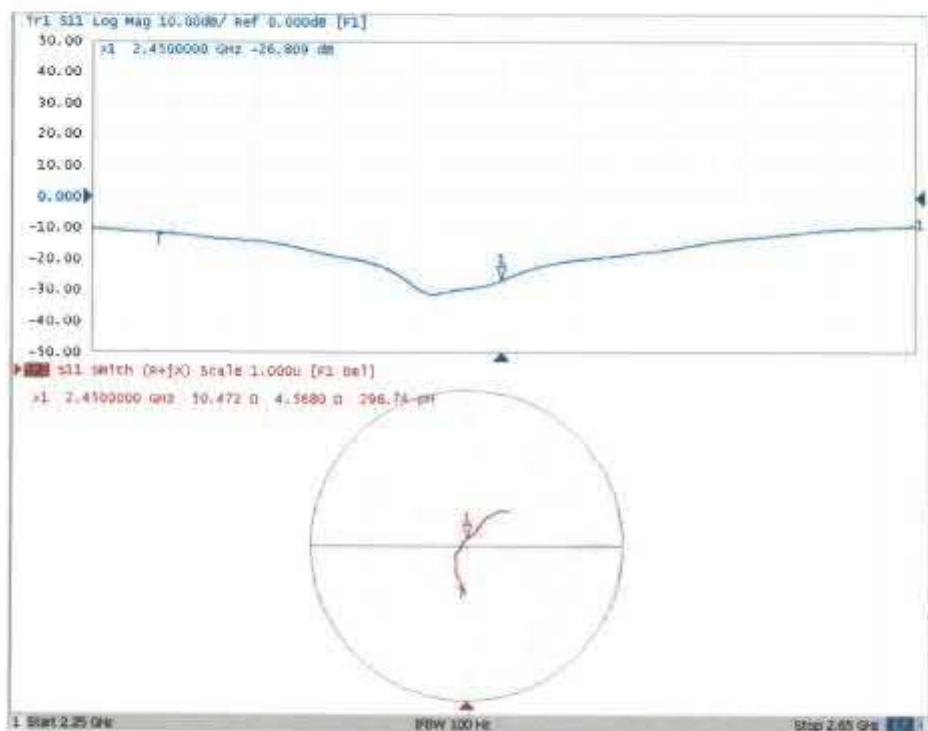




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### Impedance Measurement Plot for Body TSL





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Certificate No: Z22-60065

## CALIBRATION CERTIFICATE

Object D5GHzV2 - SN: 1172

Calibration Procedure(s) FF-Z11-003-01  
Calibration Procedures for dipole validation kits

Calibration date: March 15, 2022

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22±3)°C and humidity<70%.

Calibration Equipment used (M&amp;TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	24-Sep-21 (CTTL, No.J21X08326)	Sep-22
Power sensor NRP8S	104291	24-Sep-21 (CTTL, No.J21X08326)	Sep-22
Reference Probe EX3DV4	SN 7307	26-May-21(SPEAG,No.EX3-7307_May21)	May-22
DAE4	SN 1556	12-Jan-22(CTTL-SPEAG,No.Z22-60007)	Jan-23
Secondary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	13-Jan-22 (CTTL, No. J22X00409)	Jan-23
Network Analyzer E5071C	MY46110673	14-Jan-22 (CTTL, No. J22X00406)	Jan-23

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: March 19, 2022

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: Z22-60065

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#### Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM <sub>x,y,z</sub>
N/A	not applicable or not measured

#### Calibration is Performed According to the Following Standards:

- a) IEC/IEEE 62209-1528, "Measurement Procedure for The Assessment of Specific Absorption Rate of Human Exposure to Radio Frequency Fields from Hand-held and Body-mounted Wireless Communication Devices- Part 1528: Human Models, Instrumentation and Procedures (Frequency range of 4 MHz to 10 GHz)", October 2020
- b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

#### Additional Documentation:

- c) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution Corresponds to a coverage probability of approximately 95%.



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### Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY52	52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz $\pm$ 1 MHz 5300 MHz $\pm$ 1 MHz 5500 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5800 MHz $\pm$ 1 MHz	

### Head TSL parameters at 5200MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	35.9 $\pm$ 6 %	4.64 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	----	----

### SAR result with Head TSL at 5200MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	7.58 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	75.7 W/kg $\pm$ 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.18 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.8 W/kg $\pm$ 24.2 % (k=2)





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#### Head TSL parameters at 5300MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.7 ± 6 %	4.75 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	----	----

#### SAR result with Head TSL at 5300MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.88 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	78.7 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.6 W/kg ± 24.2 % (k=2)

#### Head TSL parameters at 5500MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.3 ± 6 %	4.96 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	----	----

#### SAR result with Head TSL at 5500MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	82.2 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.3 W/kg ± 24.2 % (k=2)



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#### Head TSL parameters at 5600MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.2 ± 6 %	5.07 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	----	----

#### SAR result with Head TSL at 5600MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.02 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.0 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.8 W/kg ± 24.2 % (k=2)

#### Head TSL parameters at 5800MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.9 ± 6 %	5.26 mho/m ± 6 %
Head TSL temperature change during test	<1.0 °C	----	----

#### SAR result with Head TSL at 5800MHz

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.69 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	76.7 W/kg ± 24.4 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	Condition	
SAR measured	100 mW input power	2.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	21.5 W/kg ± 24.2 % (k=2)



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#### Appendix (Additional assessments outside the scope of CNAS L0570)

##### Antenna Parameters with Head TSL at 5200MHz

Impedance, transformed to feed point	49.3Ω- 8.81jΩ
Return Loss	- 21.0dB

##### Antenna Parameters with Head TSL at 5300MHz

Impedance, transformed to feed point	49.7Ω- 6.44jΩ
Return Loss	- 23.8dB

##### Antenna Parameters with Head TSL at 5500MHz

Impedance, transformed to feed point	52.9Ω- 5.05jΩ
Return Loss	- 24.9dB

##### Antenna Parameters with Head TSL at 5600MHz

Impedance, transformed to feed point	56.2Ω- 3.42jΩ
Return Loss	- 23.5dB

##### Antenna Parameters with Head TSL at 5800MHz

Impedance, transformed to feed point	56.3Ω- 5.84jΩ
Return Loss	- 21.8dB



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#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.111 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feed-point can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard. No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feed-point may be damaged.

#### Additional EUT Data

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# **DASY5 Validation Report for Head TSL**

Date: 2022-03-15

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1172

Communication System: CW; Frequency: 5200 MHz, Frequency: 5300 MHz,  
Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz, Duty Cycle: 1:1  
Medium parameters used:  $f = 5200 \text{ MHz}$ ;  $\sigma = 4.64 \text{ S/m}$ ;  $\epsilon_r = 35.88$ ;  $\rho = 1000 \text{ kg/m}^3$   
Medium parameters used:  $f = 5300 \text{ MHz}$ ;  $\sigma = 4.745 \text{ S/m}$ ;  $\epsilon_r = 35.68$ ;  $\rho = 1000 \text{ kg/m}^3$   
Medium parameters used:  $f = 5500 \text{ MHz}$ ;  $\sigma = 4.955 \text{ S/m}$ ;  $\epsilon_r = 35.32$ ;  $\rho = 1000 \text{ kg/m}^3$   
Medium parameters used:  $f = 5600 \text{ MHz}$ ;  $\sigma = 5.067 \text{ S/m}$ ;  $\epsilon_r = 35.17$ ;  $\rho = 1000 \text{ kg/m}^3$   
Medium parameters used:  $f = 5800 \text{ MHz}$ ;  $\sigma = 5.264 \text{ S/m}$ ;  $\epsilon_r = 34.9$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: Right Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

## DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(5.77, 5.77, 5.77) @ 5200 MHz;  
ConvF(5.6, 5.6, 5.6) @ 5300 MHz; ConvF(5.25, 5.25, 5.25) @ 5500 MHz;  
ConvF(5.1, 5.1, 5.1) @ 5600 MHz; ConvF(5, 5, 5) @ 5800 MHz; Calibrated:  
2021-05-26
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1556; Calibrated: 2022-01-12
- Phantom: MFP\_V5.1C (20deg probe tilt); Type: QD 000 P51 Cx; Serial:  
1062
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

**Dipole Calibration /Pin=100mW, d=10mm, f=5200 MHz/Zoom Scan,**  
**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 62.58 V/m; Power Drift = -0.01 dB  
Peak SAR (extrapolated) = 29.1 W/kg  
**SAR(1 g) = 7.58 W/kg; SAR(10 g) = 2.18 W/kg**  
Smallest distance from peaks to all points 3 dB below = 7.2 mm  
Ratio of SAR at M2 to SAR at M1 = 66.7%  
Maximum value of SAR (measured) = 17.3 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5300 MHz/Zoom Scan,**  
**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
Reference Value = 63.71 V/m; Power Drift = 0.04 dB  
Peak SAR (extrapolated) = 31.3 W/kg  
**SAR(1 g) = 7.88 W/kg; SAR(10 g) = 2.26 W/kg**  
Smallest distance from peaks to all points 3 dB below = 7.2 mm  
Ratio of SAR at M2 to SAR at M1 = 65.7%  
Maximum value of SAR (measured) = 18.4 W/kg

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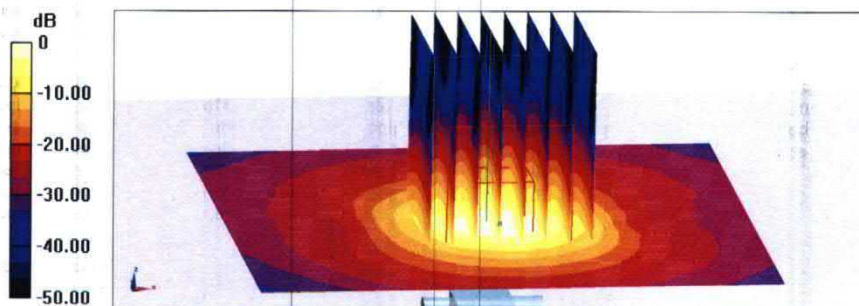
Add: No.52 HuaYuanBei Road, Haidian District, Beijing, 100191, China  
 Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504  
 E-mail: cttl@chinattl.com http://www.chinattl.cn



**Dipole Calibration /Pin=100mW, d=10mm, f=5500 MHz/Zoom Scan,**  
**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
 Reference Value = 64.62 V/m; Power Drift = 0.01 dB  
 Peak SAR (extrapolated) = 34.7 W/kg  
**SAR(1 g) = 8.23 W/kg; SAR(10 g) = 2.33 W/kg**  
 Smallest distance from peaks to all points 3 dB below = 7.2 mm  
 Ratio of SAR at M2 to SAR at M1 = 63.9%  
 Maximum value of SAR (measured) = 19.6 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5600 MHz/Zoom Scan,**  
**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
 Reference Value = 68.14 V/m; Power Drift = -0.05 dB  
 Peak SAR (extrapolated) = 33.8 W/kg  
**SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.29 W/kg**  
 Smallest distance from peaks to all points 3 dB below = 7.2 mm  
 Ratio of SAR at M2 to SAR at M1 = 63.4%  
 Maximum value of SAR (measured) = 19.4 W/kg

**Dipole Calibration /Pin=100mW, d=10mm, f=5800 MHz/Zoom Scan,**  
**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm  
 Reference Value = 61.10 V/m; Power Drift = 0.04 dB  
 Peak SAR (extrapolated) = 35.1 W/kg  
**SAR(1 g) = 7.69 W/kg; SAR(10 g) = 2.16 W/kg**  
 Smallest distance from peaks to all points 3 dB below = 7.2 mm  
 Ratio of SAR at M2 to SAR at M1 = 61.4%  
 Maximum value of SAR (measured) = 18.8 W/kg



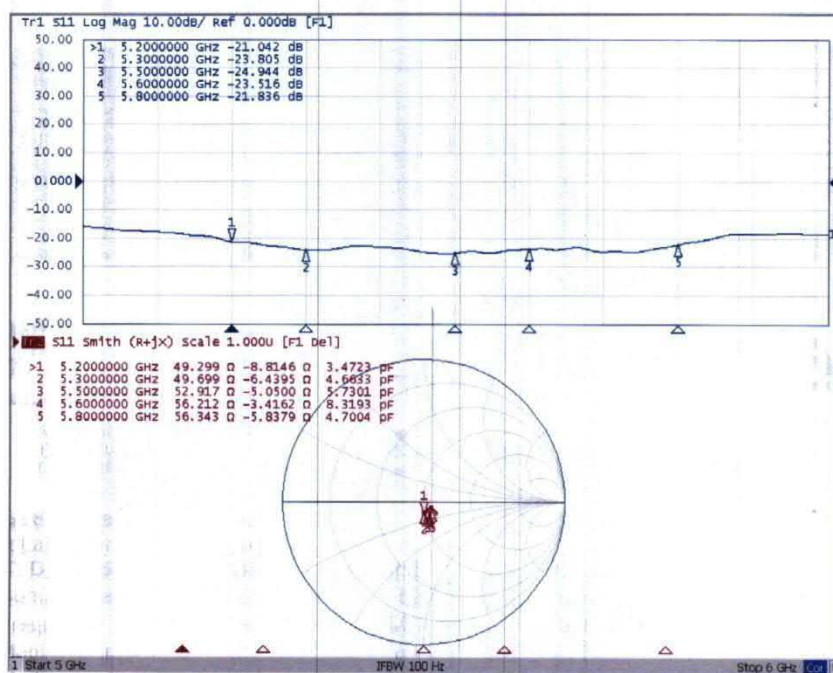
0 dB = 18.8 W/kg = 12.74 dBW/kg



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### Impedance Measurement Plot for Head TSL



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## ANNEX D. Accreditation Certificate

**Accredited Laboratory**

A2LA has accredited

**CHONGQING ACADEMY OF INFORMATION AND  
COMMUNICATIONS TECHNOLOGY**

Chongqing, People's Republic of China

for technical competence in the field of

**Electrical Testing**

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories. This laboratory also meets the requirements of any additional program requirements in the Electrical field.  
This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system  
(refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

Presented this 20<sup>th</sup> day of July 2022

Mr. Trace McInturff, Vice President, Accreditation Services  
For the Accreditation Council  
Certificate Number 4897-01  
Valid to May 31, 2024

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

**Chongqing Academy of Information and Communication Technology**

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Tel: 0086-23-88069965 FAX: 0086-23-88608777