TEST REPORT

APPLICANT	:	Jiangsu SEUIC Technology Co.,Ltd.
PRODUCT NAME	:	Industrial Handheld Terminal
MODEL NAME	:	AUTOID Q7
BRAND NAME	:	Seuic
FCC ID	:	2AC68-AUTOIDQ7
STANDARD(S)	:	47CFR 2.1093 IEEE 1528-2013
RECEIPT DATE	:	2019-05-23
TEST DATE	:	2019-06-18 to 2019-06-19
ISSUE DATE	:	2019-07-06

Edited by: _____
Liang Yumei (Rapporteur)

Approved by: _____
Peng Huarui (Supervisor)

DIRECTORY

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Change History		
Version	**Date**	**Description**
1.0	2019-07-06	Original

1 SAR Results Summary

The maximum results of Specific Absorption Rate (SAR) found during test as bellows:

<Highest Reported standalone SAR Summary>

Frequency Band		(1g SAR (W/kg)
		Body-worn
		Separation (0mm)
WLAN	2.4GHz WLAN	**0.415**
WLAN	5GHz WLAN	0.412
2.4GHz Band	Bluetooth	N/A

Max Scaled SAR1g (W/Kg):	Body-worn	0.415 W/kg	Limit(W/kg): 1.6 W/kg

Note:

1. The highest simultaneous transmission is scalar summation of Reported standalone SAR per FCC KDB 690783 D01 v01r03, and scalar SAR summation of all possible simultaneous transmission scenarios are < 1.6W/kg.

2. This device is compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-2005, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013.

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2 Technical Information

Note: Provide by applicant.

2.1 Applicant and Manufacturer Information

Applicant:	Jiangsu SEUIC Technology Co.,Ltd.
Applicant Address:	NO.15 Xinghuo Road, Nanjing New & High Technology Industry Development Zone, Nanjing 210061, China
Manufacturer:	Jiangsu SEUIC Technology Co.,Ltd.
Manufacturer Address:	NO.15 Xinghuo Road, Nanjing New & High Technology Industry Development Zone, Nanjing 210061, China

2.2 Equipment Under Test (EUT) Description

EUT Name:	Industrial Handheld Terminal
Hardware Version:	D310PA_V3_MB
Software Version:	D310P_20190412_V142
Frequency Bands:	WLAN 2.4GHz: 2412 MHz~2462 MHz WLAN 5.2GHz: 5180 MHz~5240 MHz WLAN 5.3GHz: 5260 MHz~5320 MHz WLAN 5.5GHz: 5500 MHz~5700 MHz WLAN 5.8GHz: 5745 MHz~5825 MHz Bluetooth: 2402 MHz ~2480 MHz
Modulation Mode:	802.11b: DSSS 802.11g/n-HT20/40: OFDM 802.11a/ac-VHT20/40/80: OFDM Bluetooth: GFSK, π/4-DQPSK, 8-DPSK BLE:GFSK
Operation Class	Class B
Antenna Type:	WLAN: PIFA Antenna Bluetooth: PIFA Antenna

Note:

1. There are two types of device per the user manual, one with handle bar and another without handle bar, the last one was used for SAR measurement.

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

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2.3 Environment of Test Site

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

Test frequency:	WLAN 2.4 GHz; WLAN 5 GHz;
Operation mode:	Call established
Power Level:	WLAN 2.4 GHz(Maximum output power) WLAN 5 GHz(Maximum output power)

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

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

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

3   Introduction

3.1   Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/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.

3.2   SAR Definition

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

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

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

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

Where: C is the specific heat capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

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

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4   RF Exposure Limits

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

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

Note:

1. This limit is according to recommendation1999/519/EC, Annex II (Basic Restrictions)
2. Occupational/Uncontrolled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure,(i.e. as a result of employment or occupation)

5   Applied Reference Documents

Leading reference documents for testing:

No.	Identity	Document Title	Method determination /Remark
1	47 CFR§2.1093	Radio Frequency Radiation Exposure Evaluation: Portable Devices	No deviation
2	IEEE 1528-2013	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques	No deviation
3	KDB 447498 D01v06	General RF Exposure Guidance	No deviation
4	KDB 248227 D01v02r02	SAR Measurement Procedures for 802.11 Transmitters	No deviation
5	KDB 865664 D01v01r04	SAR Measurement 100 MHz to 6 GHz	No deviation
6	KDB 865664 D02v01r02	RF Exposure Reporting	No deviation
7	KDB 648474 D04v01r03	Handset SAR	No deviation

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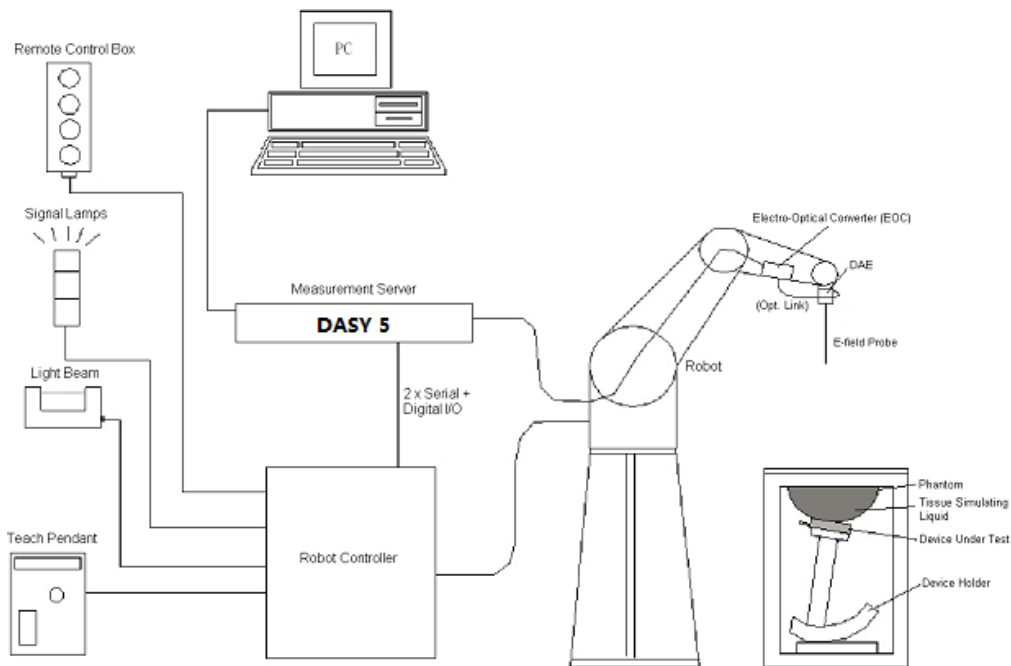Page 9 of 40

6 SAR Measurement System

Fig.6.1 SPEAG DASY System Configurations

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

➢ A standard high precision 6-axis robot with controller, a teach pendant and software

➢ A data acquisition electronic (DAE) attached to the robot arm extension

➢ A dosimetric probe equipped with an optical surface detector system

➢ The electro-optical converter (EOC) performs the conversion between optical and electrical signals

➢ A measurement server performs the time critical tasks such as signal filtering, control of the robot operationand fast movement interrupts.

➢ A probe alignment unit which improves the accuracy of the probe positioning

➢ A computer operating Windows XP

➢ DASY software

➢ Remove control with teach pendant and additional circuitry for robot safety such as warming lamps, etc.

➢ The SAM twin phantom

➢ A device holder

➢ Tissue simulating liquid

➢ Dipole for evaluating the proper functioning of the system

Component details are described in the following sub-sections.

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6.1 E-Field Probe

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

➢ **E-Field Probe Specification**

\<EX3DV4 Probe\>

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

➢ **E-Field Probe Calibration**

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

6.2 Data Acquisition Electronics (DAE)

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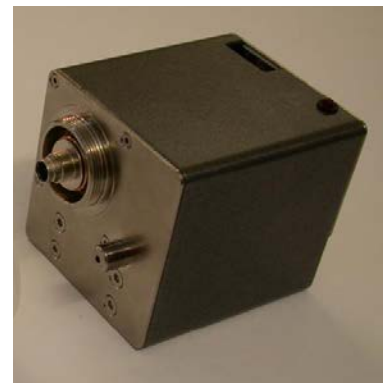

Fig. 6.2 Photo of DAE

6.3 Robot

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

- High precision (repeat ability 0.02 mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)

Fig. 6.3 Photo of Robot

6.4 Measurement Server

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

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

Fig. 6.4 Photo of Server for DASY5

6.5 Light Beam Unit

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

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

Fig. 6.5 Photo of Light Beam

6.6 Phantom

\<SAM Twin Phantom\>

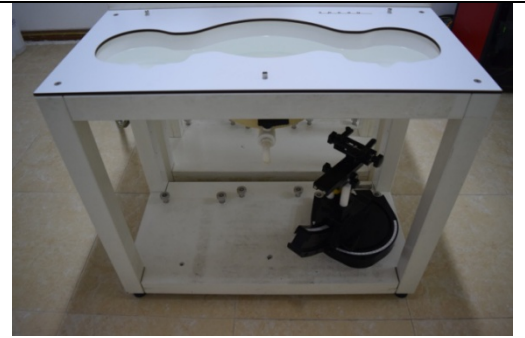|		
Shell Thickness	2 ± 0.2 mm (sagging: <1%) Center ear point: 6 ± 0.2 mm	
Filling Volume Dimensions	Approx. 25 liters Length: 1000 mm; Width: 500 mm; Height: adjustable feet	
Measurement Areas	Left Head, Right Head, Flat phantom	

Fig. 6.6Photo of SAM Phantom

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

6.7 Device Holder

\<Device Holder for SAM Twin Phantom\>

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

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

Thus the device needs no repositioning when changing the angles.

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

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Fig. 6.7Photo of Device Holder

<Laptop Extension Kit>

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

Fig 6.8 Laptop Extension Kit

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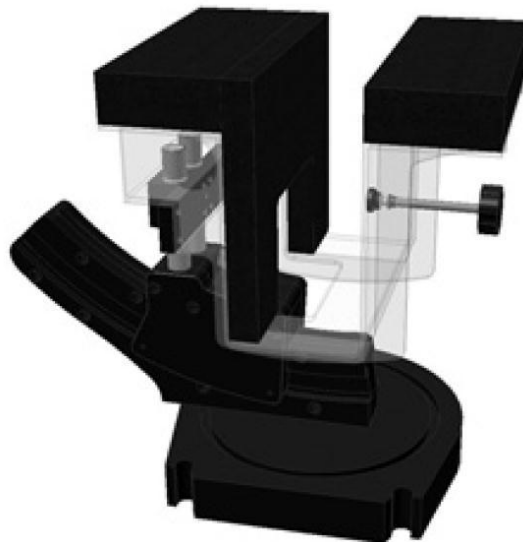
6.8 Data storage and Evaluation

➢ **Data Storage**

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

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

➢ **Data Evaluation**

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

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

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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

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The formula for each channel can be given as:

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

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

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

cf = crest factor of exciting field (DASY parameter)

dcp^i= diode compression point (DASY parameter)

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

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

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

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

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

ConvF = sensitivity enhancement in solution

a_{ij} = sensor sensitivity factors for H-field probes

f = carrier frequency (GHz)

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

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

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

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

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

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

With   SAR = local specific absorption rate in mW/g

E_{tot}= total field strength in V/m

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

ρ= equipment tissue density in g/cm^3

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

6.9 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	2450MHz System Validation Kit	D2450V2	805	2018.10.26	2019.10.25
SPEAG	5000MHz System Validation Kit	D5GHzV2	1176	2018.11.06	2019.11.05
SPEAG	Dosimetric E-Field Probe	EX3DV4	3823	2018.11.12	2019.11.11
SPEAG	Data Acquisition Electronics	DAE4	480	2019.04.11	2020.04.10
SPEAG	Dielectric Assessment KIT	DAK-3.5	1279	2018.11.03	2019.11.02
SPEAG	SAM Twin Phantom 1	QD 000 P40 CB	TP-1471	NCR	NCR
SPEAG	SAM Twin Phantom 2	QD 000 P40 CB	TP-1464	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
R&S	Network Emulator	CMW500	124534	2019.04.17	2020.04.16
Agilent	Network Analyzer	E5071B	MY42404762	2019.04.15	2020.04.14
mini-circuits	Amplifier	ZHL-42W+	608501717	NCR	NCR
mini-circuits	Amplifier	ZVE-8G+	754401735	NCR	NCR
Agilent	Signal Generator	N5182B	MY53050509	2019.04.17	2020.04.16
Agilent	Power Senor	N8482A	MY41090849	2018.11.23	2019.11.22
Agilent	Power Meter	E4416A	MY45102093	2018.11.23	2019.11.22
Anritsu	Power Sensor	MA2411B	N/A	2018.11.23	2019.11.22
Anritsu	Power Meter	NRVD	101066	2018.11.23	2019.11.22
MCL	Attenuation1	351-218-010	N/A	NA	NA
Agilent	Dual Directional Coupler	778D	50422	NA	NA
THERMOMETER	Thermo meter	DC-803	N/A	2018.11.22	2019.11.21
N/A	Tissue Simulating Liquids	2400-6000MHz	N/A	24H	

Note:

1. The calibration certificate of DASY can be referred to appendix E of this report.

2. The Insertion Loss calibration of Dual Directional Coupler and Attenuator were characterized via the network analyzer and compensated during system check.

3. The dielectric probe kit was calibrated via the network analyzer, with the specified procedure (calibrated in pure water) and calibration kit (standard) short circuit, before the dielectric measurement. The specific procedure and calibration kit are provided by Speag.

4. In system check we need to monitor the level on the power meter, and adjust the power amplifier level to have precise power level to the dipole; the measured SAR will be normalized to 1W input power according to the ratio of1W to the input power to the dipole. For system check, the calibration of the power amplifier is deemed not critically required for correct measurement; the power meter is critical

and we do have calibration for it

5. Attenuator insertion loss is calibrated by the network Analyzer, which the calibration is valid, before system check.
6. N.C.R means No Calibration Requirement.

6.10 Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 6.11, for body SAR testing, the liquid height from the center of the flat phantom to liquid top surface is larger than 15 cm, which is shown in Fig. 6.12.
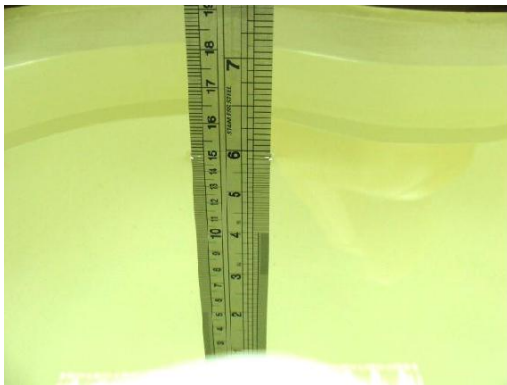
Fig 6.10 Photo of Liquid Height for Head SAR   **Fig 6.11 Photo of Liquid Height for Body SAR**

Thefollowingtablegivestherecipesfortissuesimulatingliquids

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (εr)
Head								
750	41.1	57.0	0.2	1.4	0.2	0	0.89	41.9
835	40.3	57.9	0.2	1.4	0.2	0	0.90	41.5
1800, 1900, 2000	55.2	0	0	0.3	0	44.5	1.40	40.0
2450	55.0	0	0	0	0	45.0	1.80	39.2
2600	54.8	0	0	0.1	0	45.1	1.96	39.0
Body								
750	51.7	47.2	0	0.9	0.1	0	0.96	55.5
835	50.8	48.2	0	0.9	0.1	0	0.97	55.2
1800, 1900, 2000	70.2	0	0	0.4	0	29.4	1.52	53.3
2450	68.6	0	0	0	0	31.4	1.96	52.7
2600	68.1	0	0	0.1	0	31.8	2.16	52.5

Simulating Liquid for 5GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	64~78%
Mineral oil	11~18%

Emulsifiers	9~15%
Additives and Salt	2~3%

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

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

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

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

The following table shows the measuring results for simulating liquid.

Frequency (MHz)	Tissue Type	Liquid Temp. (℃)	Conductivity (σ)	Conductivity Target (σ)	Delta (σ) (%)	Limit (%)	Date
2450	MSL	22.5	1.898	1.95	-2.67	±5	2019.06.19
5250	MSL	22.1	5.410	5.36	0.93	±5	2019.06.18
5600	MSL	22.1	5.789	5.77	0.33	±5	2019.06.18
5750	MSL	22.1	6.062	5.94	2.05	±5	2019.06.18

Frequency (MHz)	Tissue Type	Liquid Temp. (℃)	Permittivity (εr)	Permittivity Target (εr)	Delta (εr) (%)	Limit (%)	Date
2450	MSL	22.5	53.460	52.70	1.44	±5	2019.06.19
5250	MSL	22.1	48.366	48.95	-1.19	±5	2019.06.18
5600	MSL	22.1	47.929	48.50	-1.18	±5	2019.06.18
5750	MSL	22.1	47.473	48.28	-1.67	±5	2019.06.18

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7   SAR System Verification

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

➢ **Purpose of System Performance check**

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

➢ **System Setup**

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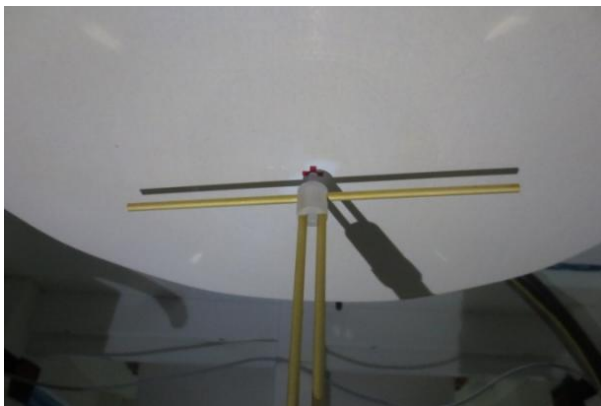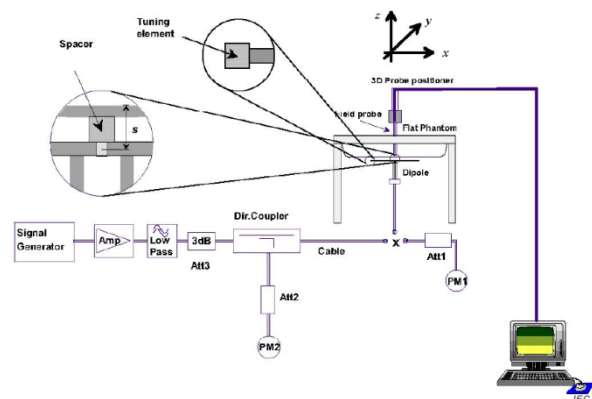

Fig.7.1 Photo of Dipole setup

Fig.7.2 System Verification Setup Diagram

➢ **System Verification Results**

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

Dipole S/N	Probe S/N	DAE S/N
D2450V2-805	3823	480
D5GHzV2-1176-5250	3823	480
D5GHzV2-1176-5600	3823	480
D5GHzV2-1176-5750	3823	480

<1g SAR>

Date	Freq. (MHz)	Tissue Type	Input Power (mW)	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Deviation (%)
2019.06.19	2450	MSL	250	12.30	50.50	49.2	-2.57
2019.06.18	5250	MSL	100	7.59	72.70	75.9	4.40
2019.06.18	5600	MSL	100	7.86	77.30	78.6	1.68
2019.06.18	5750	MSL	100	7.76	75.30	77.6	3.05

<10g SAR>

Date	Freq. (MHz)	Tissue Type	Input Power (mW)	Measured 10g SAR (W/kg)	Targeted 10g SAR (W/kg)	Normalized 10g SAR (W/kg)	Deviation (%)
2019.06.19	2450	MSL	250	5.73	23.50	22.92	-2.47
2019.06.18	5250	MSL	100	2.09	20.60	20.9	1.46
2019.06.18	5600	MSL	100	2.17	21.80	21.7	-0.46
2019.06.18	5750	MSL	100	2.12	21.10	21.2	0.47

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

8 EUT Testing Position

This EUT was tested in ten different positions. They are right cheek/right tilted/left cheek/left tilted for head, Front/Back/Right Side/Top Side/Bottom Side of the EUT with phantom 10 mm gap, as illustrated below, please refer to Appendix B for the test setup photos.

8.1 SAR Evaluations near the Mouth/Jaw Regions of the SAM Phantom

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

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

8.2 Body Worn Accessory Configurations

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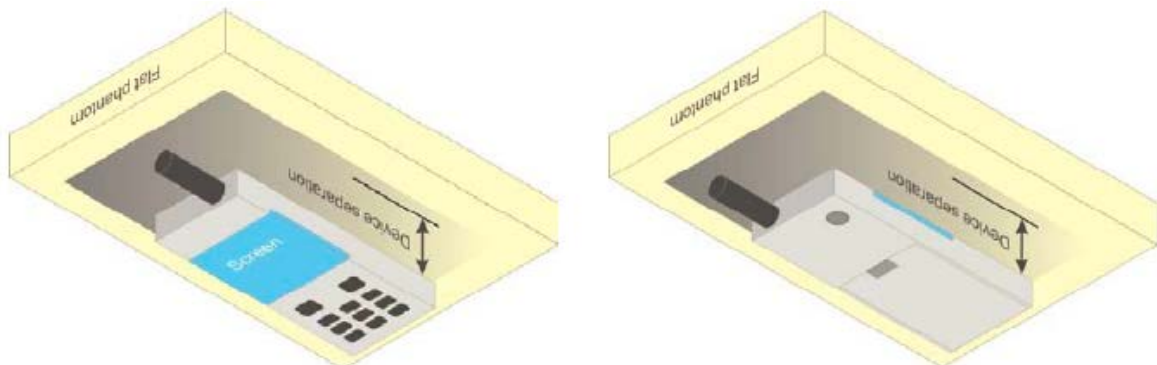

Fig.8.1 Illustration for Body Worn Position

9 Measurement Procedures

The measurement procedures are as bellows:

\<Conducted power measurement\>

➢ For WWAN power measurement, use base station simulator to configure EUT WWAN transition in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.

➢ Read the WWAN RF power level from the base station simulator.

➢ For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band.

➢ Connect EUT RF port through RF cable to the power meter or spectrum analyzer, and measure WLAN/BT output power.

\<Conducted power measurement\>

➢ Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.

➢ Place the EUT in positions as Appendix B demonstrates.

➢ Set scan area, grid size and other setting on the DASY software.

➢ Measure SAR results for the highest power channel on each testing position.

➢ Find out the largest SAR result on these testing positions of each band.

➢ Measure SAR results for other channels in worst SAR testing position if the Reported SAR or highest power channel is larger than 0.8 W/kg.

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

➢ Power reference measurement

➢ Area scan

➢ Zoom scan

➢ Power drift measurement

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9.1 Spatial Peak SAR Evaluation

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

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

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

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

9.2 Power Reference Measurement

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

9.3 Area Scan Procedures

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a10mm^2 step integral, with 1mm interpolation used to locate the peak SAR area used for zoom scan assessments.

When an Area Scan has measured all reachable points, it computes the field maxima found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE1528-2003, EN 50361 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan).

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9.4 Zoom Scan Procedures

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. A density of 1000 kg/m³ is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1g cube is 10mm, with the side length of the 10 g cube 21,5mm.The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications utilize a physical step of 5x5x7 (8mmx8mmx5mm) providing a volume of 32mm in the X & Y axis, and 30mm in the Z axis.

9.5 SAR Averaged Methods

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

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

9.6 Power Drift Monitoring

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

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10   Conducted RF Output Power

➤ **WLAN 2.4 GHz Band Conducted Power**

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN	802.11b 1Mbps	CH 1	2412	17.79	18.00	97.51
		CH 6	2437	17.58	18.00	
		CH 11	2462	17.21	17.50	
	802.11g 6Mbps	CH 1	2412	14.68	15.00	87.18
		CH 6	2437	14.36	14.50	
		CH 11	2462	13.97	14.50	
	802.11n-HT20 MCS0	CH 1	2412	12.75	13.00	86.44
		CH 6	2437	12.39	12.50	
		CH 11	2462	12.00	12.50	
	802.11n-HT40 MCS0	CH 3	2422	12.04	12.50	76.26
		CH 6	2437	11.83	12.00	
		CH 9	2452	11.61	12.00	

Note:

1. Per KDB 447498 D01v06, the 1-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:

    [(*max. power of channel, including tune-up tolerance, mW*) / (*min. test separation distance, mm*)] · [√f(GHz)] ≤ 3.0

    for 1-g 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

Channel	Frequency (GHz)	Max. Tune-up Power (dBm)	Max. Power (mW)	Test distance (mm)	Result	Exclusion thresholds for 1-g SAR
b/CH 01	2.412	18.00	63.10	5	19.60	3.0
g/CH 01	2.412	15.00	31.62	5	9.82	3.0

2. Base on the result of note1, RF exposure evaluation of 802.11 b and g mode is required.

3. Per KDB 248227 D01v02r02, choose the highest output power channel to test SAR and determine further SAR exclusion.

4. Per KDB 248227 D01v02r02, In the 2.4 GHz band, separate SAR procedures are applied to DSSS and OFDM configurations to simplify DSSS test requirements. SAR is not required for the following 2.4 GHz OFDM conditions:

    1) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.

    2) 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 ≤ 1.2 W/kg.

5. The output power of all data rate were pre-scan, just the worst case (the lowest data rate) of all mode were shown in report.

➢ **WLAN 5.2 GHz Band Conducted Power**

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.2GHz WLAN	802.11a 6Mbps	CH 36	5180	11.78	12.00	87.18
		CH 44	5220	11.61	12.00	
		CH 48	5240	12.10	12.50	
	802.11n-HT20 MCS0	CH 36	5180	11.63	12.00	86.44
		CH 44	5220	11.15	11.50	
		CH 48	5240	11.88	12.00	
	802.11n-HT40 MCS0	CH 38	5190	10.05	10.50	76.26
		CH 46	5230	9.79	10.00	
	802.11ac-VHT20 MCS0	CH 36	5180	9.64	10.00	82.98
		CH 44	5220	9.39	10.00	
		CH 48	5240	10.20	10.50	
	802.11ac-VHT40 MCS0	CH 38	5190	10.09	10.50	71.1
		CH 46	5230	9.86	10.00	
	802.11ac-VHT80 MCS0	CH 42	5210	8.69	9.00	55.36

Note:

1. Per KDB 447498 D01v06, the 1-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤50 mm are determined by:

   [(*max. power of channel, including tune-up tolerance, mW*)/ (*min. test separation distance, mm*)] · [√f(GHz)] ≤ 3.0 for1-g 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

Channel	Frequency (GHz)	Max. Tune-up Power (dBm)	Max. Power (mW)	Test distance (mm)	Result	Exclusion thresholds for 1-g SAR
a/CH 48	5. 240	12.50	17.78	5	8.14	3.0

2. Per KDB 248227 D01v02r02, choose the highest output power channel to test SAR and determine further SAR exclusion.

3. The output power of all data rate were pre-scan, just the worst case (the lowest data rate) of all mode were shown in report.

4. Per KDB 248227 D01V02r02 section 2.2, when the EUT in continuously transmitting mode, the actual duty cycle is 100%, so the duty cycle factor is 1.

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> **WLAN 5.3 GHz Band Conducted Power**

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.3GHz WLAN	802.11a 6Mbps	CH 52	5260	12.01	12.50	87.18
		CH 60	5300	11.81	12.00	
		CH 64	5320	11.90	12.00	
	802.11n-HT20 MCS0	CH 52	5260	11.77	12.00	86.44
		CH 60	5300	11.56	12.00	
		CH 64	5320	11.22	11.50	
	802.11n-HT40 MCS0	CH 54	5270	10.47	11.00	76.26
		CH 62	5310	10.21	10.50	
	802.11ac-VHT20 MCS0	CH 52	5260	10.08	10.50	82.98
		CH 60	5300	9.91	10.00	
		CH 64	5320	9.68	10.00	
	802.11ac-VHT40 MCS0	CH 54	5270	10.48	11.00	71.10
		CH 62	5310	10.21	10.50	
	802.11ac-VHT80 MCS0	CH 58	5290	9.05	9.50	55.36

Note:

1. Per KDB 447498 D01v06, the 1-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤50 mm are determined by:

   [(*max. power of channel, including tune-up tolerance, mW*)/ (*min. test separation distance, mm*)] · [$\sqrt{f(GHz)}$] ≤ 3.0 for 1-g 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

Channel	Frequency (GHz)	Max. Tune-up Power (dBm)	Max. Power (mW)	Test distance (mm)	Result	Exclusion thresholds for 1-g SAR
a/CH 52	5.260	12.50	17.78	5	8.16	3.0

2. Per KDB 248227 D01v02r02, choose the highest output power channel to test SAR and determine further SAR exclusion.

3. The output power of all data rate were pre-scan, just the worst case (the lowest data rate) of all mode were shown in report.

4. Per KDB 248227 D01V02r02 section 2.2, when the EUT in continuously transmitting mode, the actual duty cycle is 100%, so the duty cycle factor is 1.

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> **WLAN 5.5 GHz Band Conducted Power**

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.5GHz WLAN	802.11a 6Mbps	CH 100	5500	11.60	12.00	87.18
		CH 120	5600	11.92	12.00	
		CH 144	5720	11.58	12.00	
	802.11n-HT20 MCS0	CH 100	5500	11.02	11.50	86.44
		CH 120	5600	11.07	11.50	
		CH 144	5720	10.54	11.00	
	802.11n-HT40 MCS0	CH 102	5510	9.91	10.00	76.26
		CH 126	5630	9.88	10.00	
		CH 142	5710	8.87	9.00	
	802.11ac-VHT20 MCS0	CH 100	5500	9.15	9.50	82.98
		CH 120	5600	9.31	9.50	
		CH 144	5720	8.79	9.00	
	802.11ac-VHT40 MCS0	CH 102	5510	9.96	10.50	71.10
		CH 126	5630	9.89	10.50	
		CH 142	5710	8.99	9.50	
	802.11ac-VHT80 MCS0	CH 106	5530	8.39	9.00	55.36
		CH 138	5690	7.86	8.00	

Note:

1. Per KDB 447498 D01v06, the 1-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤50 mm are determined by:

   [(*max. power of channel, including tune-up tolerance, mW*)/ (*min. test separation distance, mm*)] · [$\sqrt{}$f(GHz)] ≤ 3.0 for1-g 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

Channel	Frequency (GHz)	Max. Tune-up Power (dBm)	Max. Power (mW)	Test distance (mm)	Result	Exclusion thresholds for 1-g SAR
a/CH 120	5.600	12.00	15.85	5	7.50	3.0

2. Per KDB 248227 D01v02r02, choose the highest output power channel to test SAR and determine further SAR exclusion.

3. The output power of all data rate were pre-scan, just the worst case (the lowest data rate) of all mode were shown in report.

4. Per KDB 248227 D01V02r02 section 2.2, when the EUT in continuously transmitting mode, the actual duty cycle is 100%, so the duty cycle factor is 1.

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> **WLAN 5.8 GHz Band Conducted Power**

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.8GHz WLAN	802.11a MCS0	CH 149	5745	11.41	11.50	87.18
		CH 157	5785	11.12	11.50	
		CH 165	5825	10.82	11.00	
	802.11n-HT20 MCS0	CH 149	5745	10.41	10.50	86.44
		CH 157	5785	10.30	10.50	
		CH 165	5825	9.94	10.00	
	802.11n-HT40 MCS0	CH 151	5755	9.70	10.00	76.26
		CH 159	5795	9.39	10.00	
	802.11ac-VHT20 MCS0	CH 149	5745	8.87	9.00	82.98
		CH 157	5785	8.65	9.00	
		CH 165	5825	8.40	9.00	
	802.11ac-VHT40 MCS0	CH 151	5755	9.68	10.00	71.10
		CH 159	5795	9.46	10.00	
	802.11ac-VHT80 MCS0	CH 155	5775	8.22	9.00	55.36

Note:

1. Per KDB 447498 D01v06, the 1-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤50 mm are determined by:

    [(*max. power of channel, including tune-up tolerance, mW*)/ (*min. test separation distance, mm*)] · [√f(GHz)] ≤ 3.0 for1-g 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

Channel	Frequency (GHz)	Max. Tune-up Power (dBm)	Max. Power (mW)	Test distance (mm)	Result	Exclusion thresholds for 1-g SAR
a/CH 149	5.745	11.50	14.13	5	6.77	3.0

2. Per KDB 248227 D01v02r02, choose the highest output power channel to test SAR and determine further SAR exclusion.

3. The output power of all data rate were pre-scan, just the worst case (the lowest data rate) of all mode were shown in report.

4. Per KDB 248227 D01V02r02 section 2.2, when the EUT in continuously transmitting mode, the actual duty cycle is 100%, so the duty cycle factor is 1.

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➢ **Bluetooth Conducted Power**

Mode	Channel	Frequency (MHz)	Average power (dBm)		
			1Mbps	2Mbps	3Mbps
BR / EDR	CH 00	2402	7.35	4.84	4.77
	CH 39	2441	7.46	4.47	4.84
	CH 78	2480	7.21	4.17	4.57
Tune-up Limit (dBm)			8.00	5.00	5.00

Mode	Channel	Frequency (MHz)	Average power (dBm)
			GFSK
LE	CH 00	2402	1.63
	CH 19	2440	1.57
	CH 39	2480	1.51
Tune-up Limit (dBm)			2.00

Note:

1. Per KDB 447498 D01v06, the 1-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:

   [(*max. power of channel, including tune-up tolerance, mW*) / (*min. test separation distance, mm*)] · [√f(GHz)] ≤ 3.0 for 1-g 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

Channel	Frequency (GHz)	Max. Tune-up Power (dBm)	Max. Power (mW)	Test distance (mm)	Result	Exclusion thresholds for 1-g SAR
a/CH 39	2.441	8.00	6.31	5	1.97	3.0

2. The max. tune-up power was provided by manufacturer, base on the result of note 1, RF exposure evaluation is not required.

3. The output power of all data rate were pre-scan, just the worst case of all mode were shown in report.

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

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11 Exposure Positions Consideration

11.1 EUT Antenna Location

Note: Please see Annex B

11.2 Test Positions Consideration

Distance of Antennas to EUT edge/surface Test distance: 10mm						
Antennas	Back	Front	Top Side	Bottom Side	Right Side	Left Side
WLAN/Bluetooth	<25mm	<25mm	<25mm	122mm	58mm	<25mm

Test Positions Test distance: 10mm						
Antennas	Back	Front	Top Side	Bottom Side	Right Side	Left Side
WLAN/Bluetooth	Yes	Yes	Yes	No	No	Yes

Note:

1. Body-worn mode SAR assessments are required.

2. Per KDB 447498 D01v06, for handsets the test separation distance is determined by the smallest distance between the outer surface of the device and the user, which is 0 mm for head SAR and 10 mm for body-worn and hotspot SAR.

11.3 Body
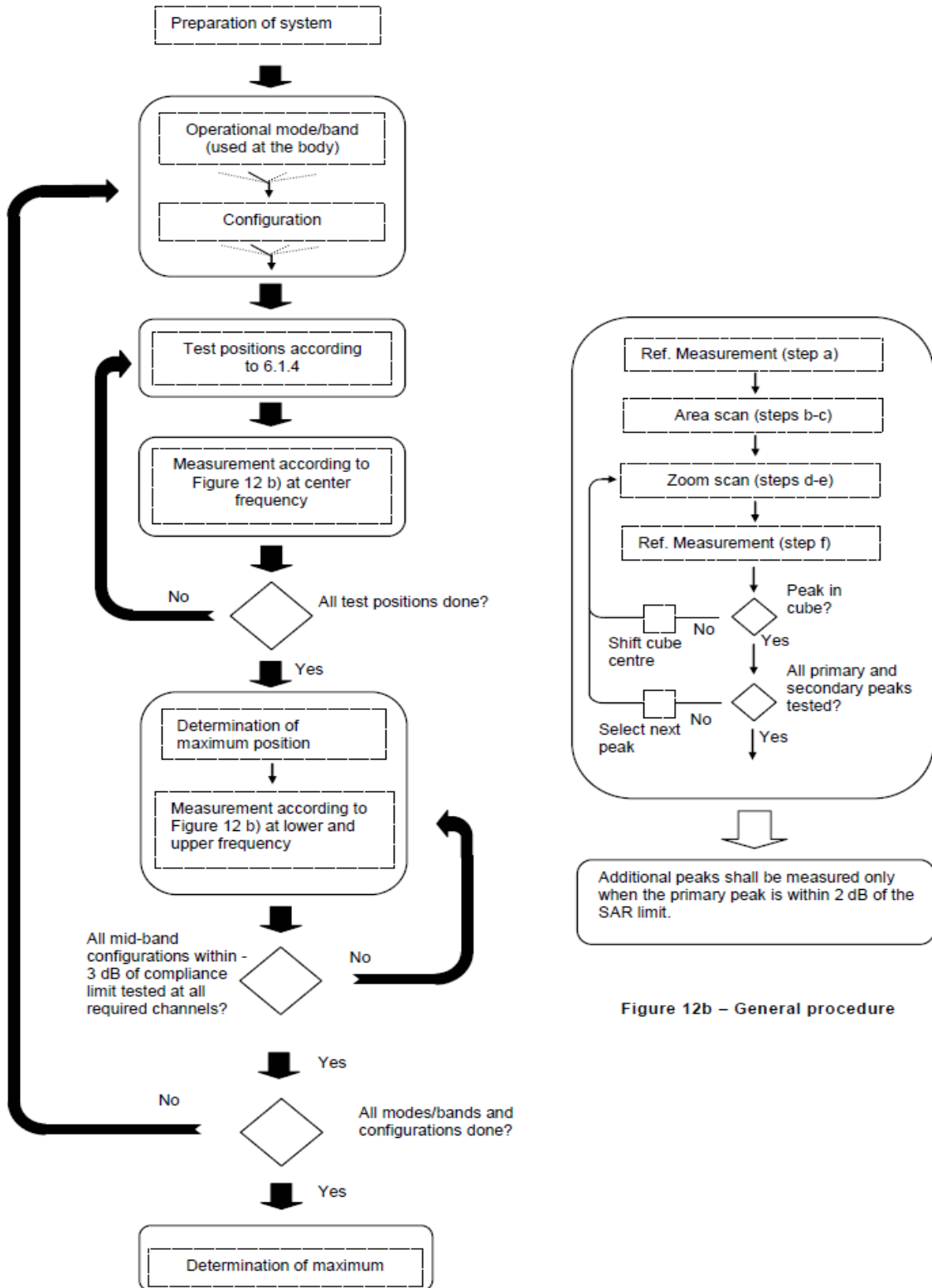
Figure 12b – General procedure

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12 Test Guidance

1. The reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.

   a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.

   b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)"

   c. For WWAN: Reported SAR(W/kg)= Measured SAR(W/kg)*Tune-up Scaling Factor

   d. For WLAN/Bluetooth: Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor

2. Per KDB 447498 D01v06, for each exposure position, if the highest output power channel Reported SAR ≤ 0.8W/kg, other channels SAR testing is not necessary.

3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required when the measured SAR is ≥ 0.8W/kg.

4. Per KDB 248227 D01v02r02, for 802.11b DSSS , when the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required in that exposure configuration.

5. Per KDB 648474 D04v01r03, when the reported SAR for a body-worn accessory measured without a headset connected to the handset is ≤ 1.2 W/kg, SAR testing with a headset connected to the handset is not required.

6. There are two types of device per the user manual, one with handle bar and another without handle bar, the last one was used for SAR measurement.

7. According to the TCB workshop publication handheld scanner SAR that inverting the barcode scanner so the pistol is facing upwards but outside the front of the flat phantom (near the spigot). The most concervative distance gap of 0mm will be used for SAR measurement, and the handle bar one is not required for both of them have the same antenna on the top side of the devce, and it will share the same result with the maintain EUT(without handle bar).

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13   SAR Test Results Summary

13.1 Standalone Body-worn SAR

➢   **WLAN 2.4GHz Body-worn SAR**

Plot No.	Band/Mode	Test Position	CH.	Ave. Power (dBm)	Tune-up Limit (dBm)	Tune-up Scaling Factor	Meas. SAR$_{1g}$ (W/kg)	Reported SAR$_{1g}$ (W/kg)
	2.4GHz/802.11b	Front Side	1	17.79	18.00	1.050	0.133	0.143
1#	2.4GHz/802.11b	Back Side	1	17.79	18.00	1.050	0.385	**0.415**
2#	5.2GHz/802.11a	Front Side	48	12.10	12.50	1.096	0.238	**0.299**
	5.2GHz/802.11a	Back Side	48	12.10	12.50	1.096	0.073	0.092
3#	5.3GHz/802.11a	Front Side	52	12.01	12.50	1.119	0.278	**0.357**
	5.3GHz/802.11a	Back Side	52	12.01	12.50	1.119	0.103	0.132
4#	5.5GHz/802.11a	Front Side	120	11.92	12.00	1.019	0.353	**0.412**
	5.5GHz/802.11a	Back Side	120	11.92	12.00	1.019	0.108	0.126
5#	5.8GHz/802.11a	Front Side	149	11.41	11.50	1.021	0.309	**0.362**
	5.8GHz/802.11a	Back Side	149	11.41	11.50	1.021	0.102	0.119

Note:

1.   Per KDB 447498 D01v06, for each exposure position, if the highest output channel Reported SAR ≤ 0.8W/kg, other channels SAR testing is not necessary.

2.   According to KDB 865664 D02v01r02, SAR plot is required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination.

3.   The WLAN 2.4GHz Reported 1g SAR (W/kg) has been calculated together with the duty cycle scaling factor 1.026.

4.   The WLAN 5GHz Reported 1g SAR (W/kg) has been calculated together with the duty cycle scaling factor 1.147.

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14 Multi-Band Simultaneous Transmission Considerations

Both the WLAN & Bluetooth share the same antenna of the device, therefore it will not transmit simultaneously.

15 Measurement Uncertainty

The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type A evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A Type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience, and knowledge of the behavior and properties of relevant materials and instruments, manufacture's specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution,rectangular or triangular distributions indicated in below Table.

Uncertainty Distributions	Normal	Rectangular	Triangular	U-Shape
Multi-plying Factor	1/k(b)	$1/\sqrt{3}$	$1/\sqrt{6}$	$1/\sqrt{2}$

Standard Uncertainty for Assumed Distribution

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual "root-sum-squares" (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is shown in the following tables.

a	b	c	d	e= f(d,k)	f	g	h= c*f/e	i= c*g/e	k

Uncertainty Component	Sec.	Tol (+- %)	Prob. Dist.	Div.	Ci (1g)	Ci (10g)	1g Ui (+-%)	10g Ui (+-%)	Vi
Measurement System									
Probe calibration	E.2.1	5.83	N	1	1	1	5.83	5.83	∞
Axial Isotropy	E.2.2	3.5	R	$\sqrt{3}$	1	1	2.02	2.02	∞
Hemispherical Isotropy	E.2.2	5.9	R	$\sqrt{3}$	1	1	3.41	3.41	∞
Boundary effect	E.2.3	1.0	R	$\sqrt{3}$	1	1	0.58	0.58	∞
Linearity	E.2.4	4.7	R	$\sqrt{3}$	1	1	2.71	2.71	∞
System detection limits	E.2.5	1.0	R	$\sqrt{3}$	1	1	0.58	0.58	∞
Readout Electronics	E.2.6	0.5	N	1	1	1	0.5	0.5	∞
Reponse Time	E.2.7	3.0	R	$\sqrt{3}$	1	1	3.0	3.0	∞
Integration Time	E.2.8	1.4	R	$\sqrt{3}$	1	1	0.81	0.81	∞
RF ambient Conditions	E.6.1	3.0	R	$\sqrt{3}$	1	1	1.73	1.73	∞
Probe positioner Mechanical Tolerance	E.6.2	1.4	R	$\sqrt{3}$	1	1	0.81	0.81	∞
Probe positioning with respect to Phantom Shell	E.6.3	1.4	R	$\sqrt{3}$	1	1	0.81	0.81	∞
Extrapolation, interpolation and integration Algoritms for Max. SAR Evaluation	E.5.2	2.3	R	$\sqrt{3}$	1	1	1.33	1.33	∞
Test sample Related									
Test sample positioning	E.4.2.1	2.6	N	1	1	1	2.6	2.6	N-1
Device Holder Uncertainty	E.4.1.1	3.0	N	1	1	1	5.11	5.11	∞
Output power Power drift - SAR drift measurement	6.6.2	5.0	R	$\sqrt{3}$	1	1	2.89	2.89	∞
Phantom and Tissue Parameters									
Phantom Uncertainty (Shape and thickness tolerances)	E.3.1	4.0	R	$\sqrt{3}$	1	1	2.31	2.31	∞
Liquid conductivity - deviation from target value	E.3.2	2.0	R	$\sqrt{3}$	0.64	0.43	1.69	1.13	∞
Liquid conductivity - measurement uncertainty	E.3.3	2.5	N	1	0.64	0.43	3.20	2.15	M
Liquid permittivity - deviation from target value	E.3.2	2.5	R	$\sqrt{3}$	0.6	0.49	1.28	1.04	∞
Liquid permittivity - measurement uncertainty	E.3.3	5.0	N	1	0.6	0.49	6.00	4.90	M
Liquid conductivity – temperature uncertainty	E.3.4		R	$\sqrt{3}$	0.78	0.41			∞
Liquid permittivity – temperature uncertainty	E.3.4		R	$\sqrt{3}$	0.23	0.26			∞
Combined Standard Uncertainty			RSS				11.55	12.07	
Expanded Uncertainty (95% Confidence interval)			K=2				±23.20	±24.17	

16 Measurement Conclusion

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

Annex A General Information

1. Identification of the Responsible Testing Laboratory

Laboratory Name:	Shenzhen Morlab Communications Technology Co., Ltd. Morlab Laboratory
Laboratory Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China
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2. Identification of the Responsible Testing Location

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

Annex B Test Setup Photos

Dimensions (L*W*H):162mm (L) × 78mm (W) × 9mm (H) Antenna map
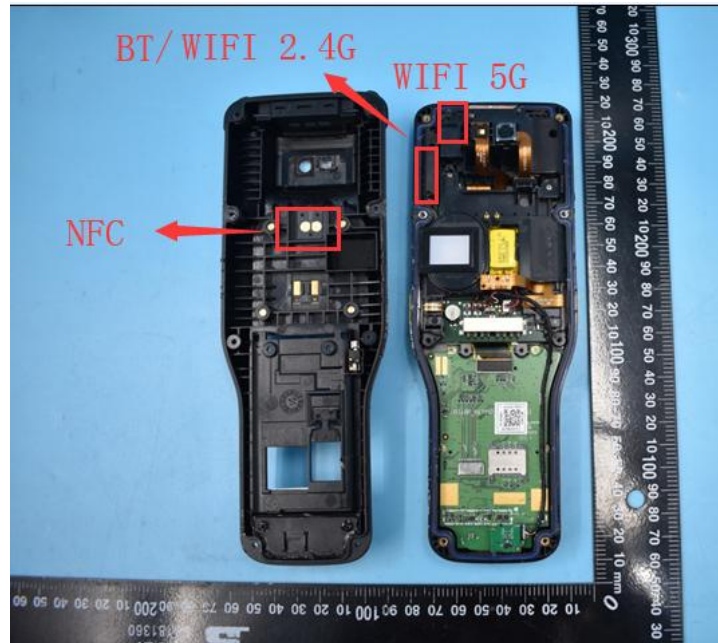
Body

Front Side

(Test distance: 0mm, Thickness of EUT: 40mm)

Back Side
(Test distance: 0mm, Thickness of EUT: 40mm)
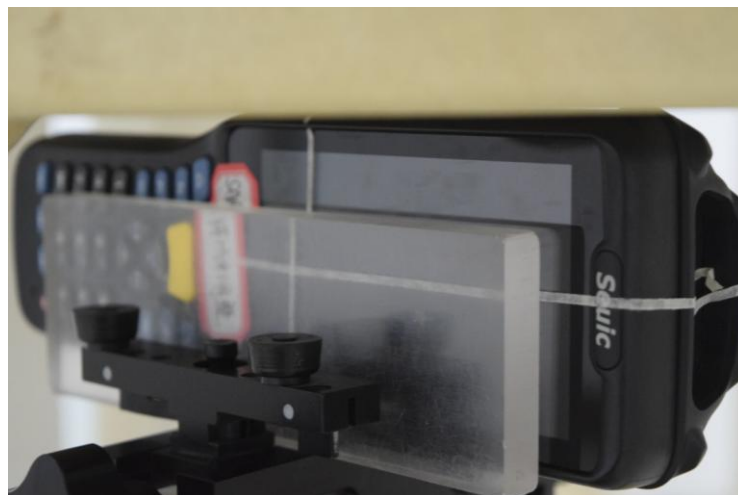
Left Side
(Test distance: 0mm, Thickness of EUT: 40mm)

Right Side
(Test distance: 0mm, Thickness of EUT: 40mm)
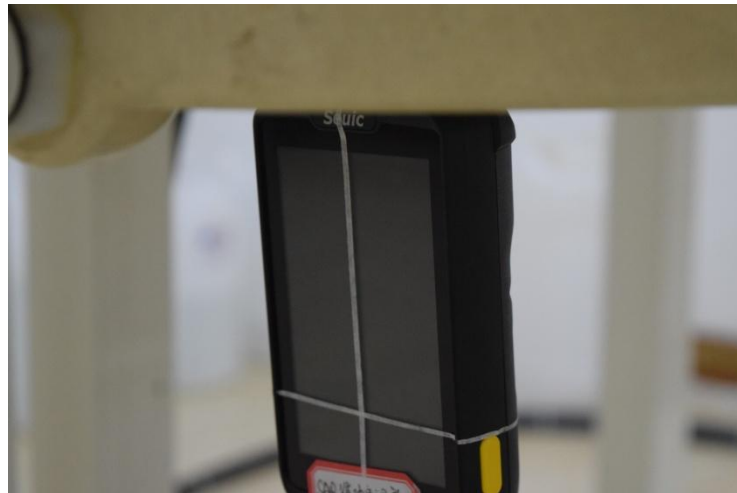
Top Side
(Test distance: 0mm, Thickness of EUT: 40mm)

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Annex C Plots of System Performance Check

System Check_2450MHz_Body_190619

Communication System: UID 0, CW (0); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: MSL_2450 Medium parameters used: f = 2450 MHz; σ = 1.898 S/m; $ε_r$ = 53.46; ρ = 1000 kg/m^3
Ambient Temperature：23.3 ℃；Liquid Temperature：22.5 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3823; ConvF(7.15, 7.15, 7.15); Calibrated: 2018.11.12;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn480; Calibrated: 2019.04.11
- Phantom: SAM 1; Type: QD000P40CC; Serial: TP:1471
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

CW 2450/Area Scan (101x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 14.3 W/kg

CW 2450/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 87.03 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 24.5 W/kg
SAR(1 g) = 12.3 W/kg; SAR(10 g) = 5.73 W/kg
Maximum value of SAR (measured) = 14.2 W/kg
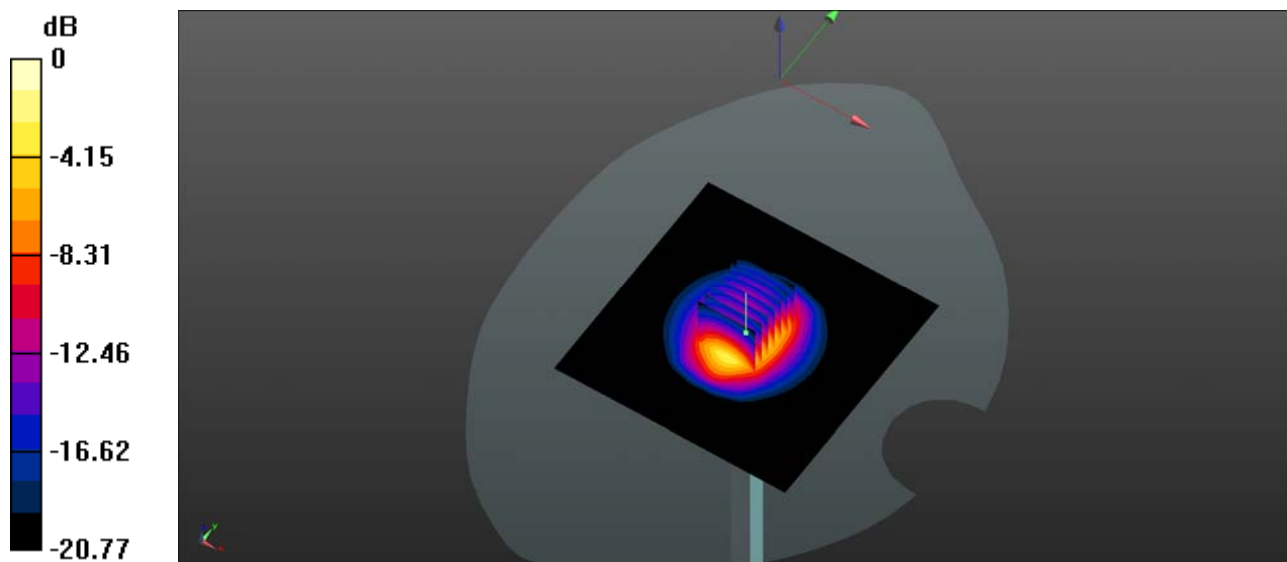
0 dB = 14.3 W/kg

System Check_5250MHz_Body_190618

Communication System: UID 0, CW (0); Frequency: 5250 MHz;Duty Cycle: 1:1
Medium: MSL_5250 Medium parameters used: f = 5250 MHz; σ = 5.41 S/m; ε_r = 48.366; ρ = 1000 kg/m^3
Ambient Temperature：23.2 ℃；Liquid Temperature：22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3823; ConvF(4.73, 4.73, 4.73); Calibrated: 2018.11.12;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn480; Calibrated: 2019.04.11
- Phantom: SAM 1; Type: QD000P40CC; Serial: TP:1471
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

CW 5250/Area Scan (201x201x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 11.0 W/kg

CW 5250/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 37.26 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 58.8 W/kg
SAR(1 g) = 7.59 W/kg; SAR(10 g) = 2.09 W/kg
Maximum value of SAR (measured) = 10.5 W/kg
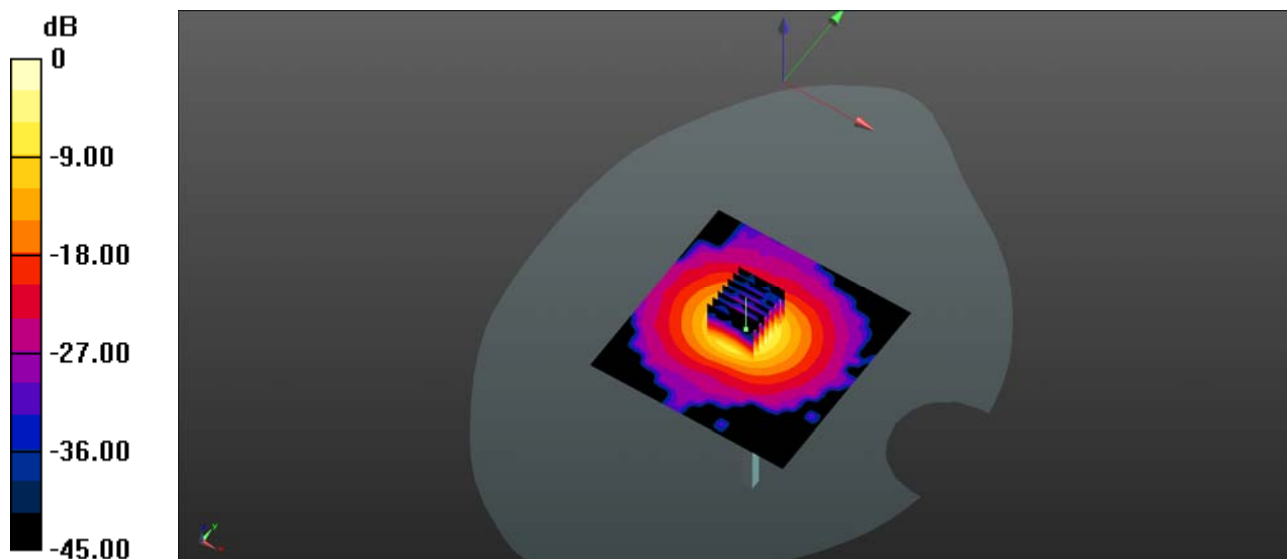
0 dB = 11.0 W/kg = 10.41 dBW/kg

System Check_5600MHz_Body_190618

Communication System: UID 0, CW (0); Frequency: 5600 MHz;Duty Cycle: 1:1
Medium: MSL_5600 Medium parameters used: f = 5600 MHz; σ = 5.789 S/m; ε_r = 47.929; ρ = 1000 kg/m^3
Ambient Temperature：23.2 ℃；Liquid Temperature：22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3823; ConvF(3.96, 3.96, 3.96); Calibrated: 2018.11.12;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn480; Calibrated: 2019.04.11
- Phantom: SAM 1; Type: QD000P40CC; Serial: TP:1471
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

CW 5600/Area Scan (201x201x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
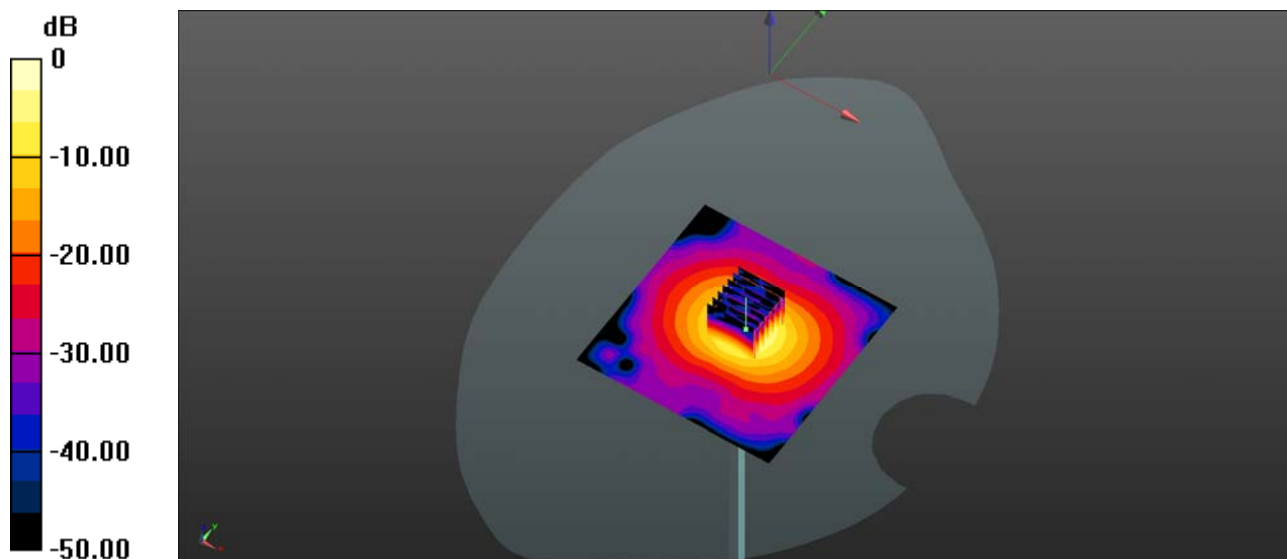Maximum value of SAR (interpolated) = 11.5 W/kg

CW 5600/Zoom Scan (7x7x13)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 35.84 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 47.8 W/kg
SAR(1 g) = 7.86 W/kg; SAR(10 g) = 2.17 W/kg
Maximum value of SAR (measured) = 11.4 W/kg
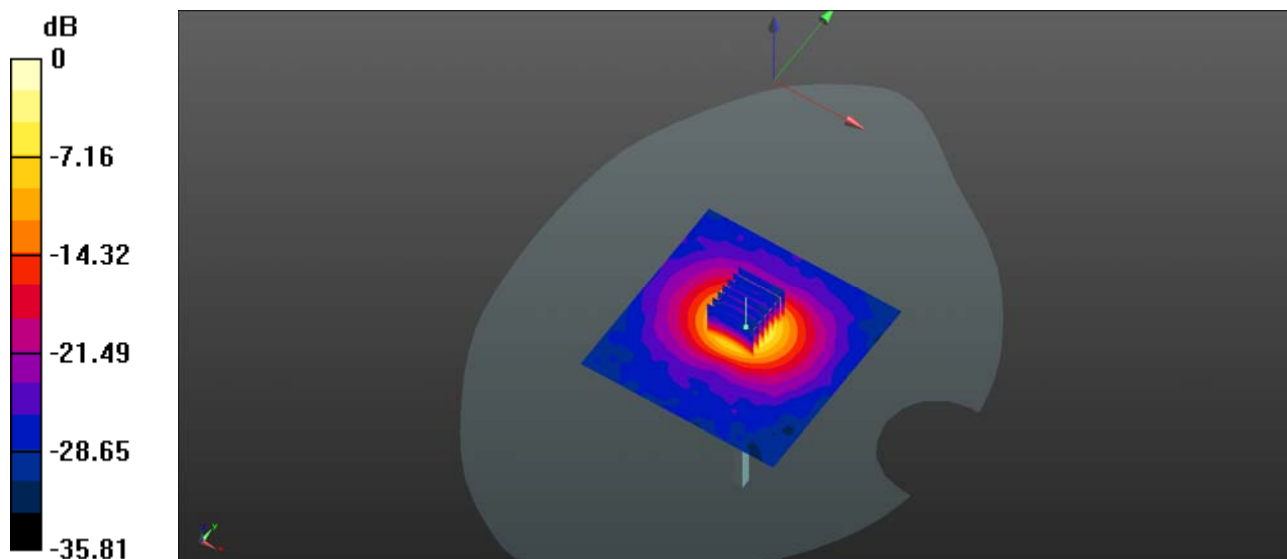
0 dB = 11.5 W/kg

System Check_5750MHz_Body_190618

Communication System: UID 0, CW (0); Frequency: 5750 MHz;Duty Cycle: 1:1
Medium: HSL_5750 Medium parameters used: f = 5750 MHz; σ = 6.062 S/m; ε_r = 47.473; ρ = 1000 kg/m^3
Ambient Temperature：23.2 ℃；Liquid Temperature：22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3823; ConvF(3.98, 3.98, 3.98); Calibrated: 2018.11.12;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn480; Calibrated: 2019.04.11
- Phantom: SAM 1; Type: QD000P40CC; Serial: TP:1471
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

CW 5750/Area Scan (101x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
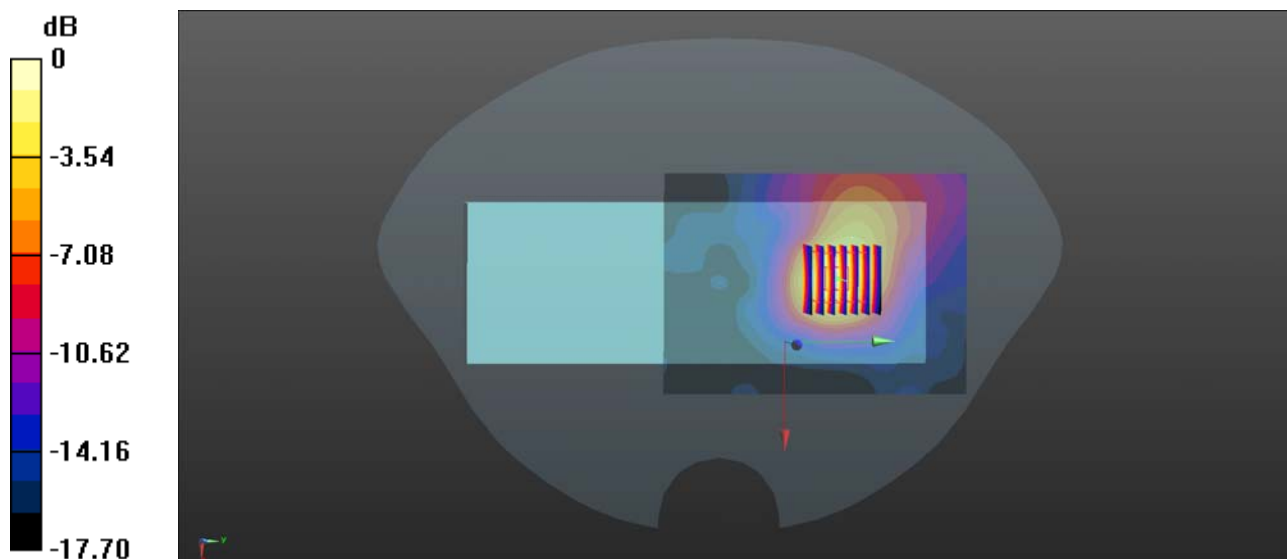Maximum value of SAR (interpolated) = 10.8 W/kg

CW 5750/Zoom Scan (7x7x13)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 37.15 V/m; Power Drift = 0.12 dB
Peak SAR (extrapolated) = 47.2 W/kg
SAR(1 g) = 7.76 W/kg; SAR(10 g) = 2.12 W/kg
Maximum value of SAR (measured) = 10.8 W/kg

0 dB = 10.8 W/kg

Annex D Plots of Maximum SAR Test Results

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WLAN 2.4GHz_802.11b 1Mbps_ Back Side_0mm_Ch1

Communication System: UID 0, WLAN 2.4GHz 802.11b (0); Frequency: 2412 MHz;Duty Cycle: 1:1
Medium: MSL_2450 Medium parameters used: f = 2412 MHz; σ = 1.818 S/m; ε_r = 53.137; ρ = 1000 kg/m^3
Ambient Temperature：23.3 ℃；Liquid Temperature：22.5 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3823; ConvF(7.15, 7.15, 7.15); Calibrated: 2018.11.12;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn480; Calibrated: 2019.04.11
- Phantom: SAM 1; Type: QD000P40CC; Serial: TP:1471
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch1/Area Scan (81x111x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.459 W/kg

Ch1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.054 V/m; Power Drift = 0.18 dB
Peak SAR (extrapolated) = 0.650 W/kg
SAR(1 g) = 0.385 W/kg; SAR(10 g) = 0.204 W/kg
Maximum value of SAR (measured) = 0.427 W/kg

0 dB = 0.459 W/kg

Test Laboratory: SAR Lab. of Shenzhen Morlab Communications Technology Co., Ltd.   Date: 2019.06.18
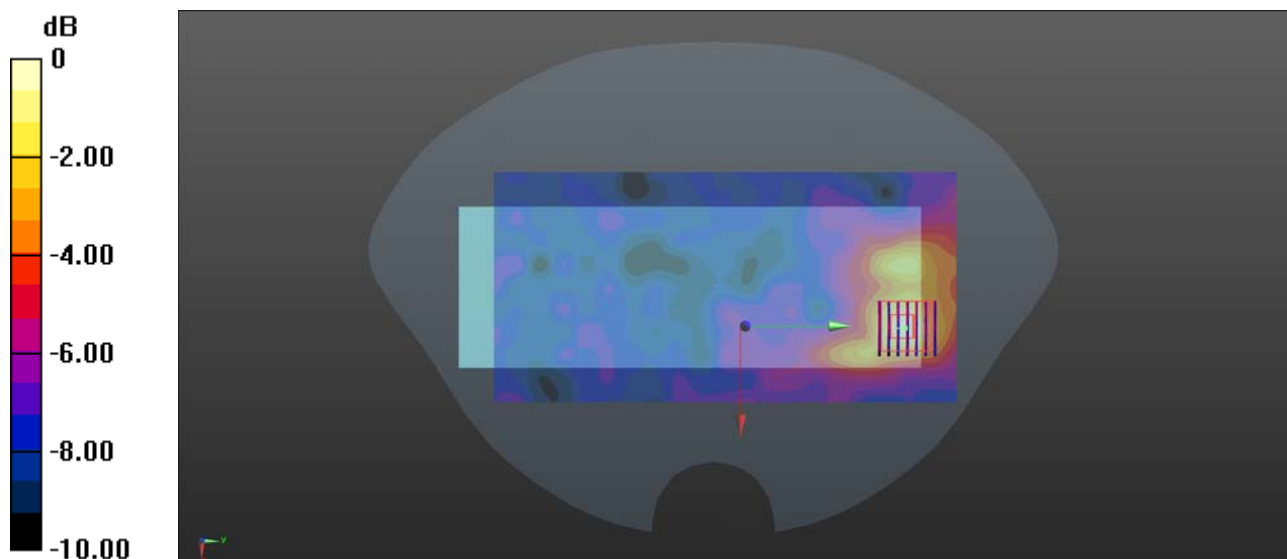
WLAN 5GHz Band 1_802.11a 6Mbps_Front Side_0mm_Ch48

Communication System: UID 0, WLAN 5GHz (0); Frequency: 5240 MHz;Duty Cycle: 1:1
Medium: MSL_5250 Medium parameters used: f = 5240 MHz; σ = 5.393 S/m; ε_r = 48.417; ρ = 1000 kg/m^3
Ambient Temperature：23.2 ℃；Liquid Temperature：22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3823; ConvF(4.73, 4.73, 4.73); Calibrated: 2018.11.12;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn480; Calibrated: 2019.04.11
- Phantom: SAM 1; Type: QD000P40CC; Serial: TP:1471
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch48/Area Scan (101x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.429 W/kg

Ch48/Zoom Scan (7x7x13)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.510 V/m; Power Drift = -0.17 dB
Peak SAR (extrapolated) = 1.22 W/kg
SAR(1 g) = 0.238 W/kg; SAR(10 g) = 0.081 W/kg
Maximum value of SAR (measured) = 0.462 W/kg

0 dB = 0.429 W/kg

WLAN 5GHz Band 2_802.11a 6Mbps_Front Side_0mm_Ch52

Communication System: UID 0, WLAN 5GHz (0); Frequency: 5260 MHz;Duty Cycle: 1:1
Medium: MSL_5250 Medium parameters used: f = 5260 MHz; σ = 5.43 S/m; ε$_r$ = 48.327; ρ = 1000 kg/m^3
Ambient Temperature：23.2 ℃；Liquid Temperature：22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3823; ConvF(4.73, 4.73, 4.73); Calibrated: 2018.11.12;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn480; Calibrated: 2019.04.11
- Phantom: SAM 1; Type: QD000P40CC; Serial: TP:1471
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch52/Area Scan (101x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.510 W/kg

Ch52/Zoom Scan (7x7x13)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.648 V/m; Power Drift = 0.12 dB
Peak SAR (extrapolated) = 1.27 W/kg
SAR(1 g) = 0.278 W/kg; SAR(10 g) = 0.120 W/kg
Maximum value of SAR (measured) = 0.522 W/kg
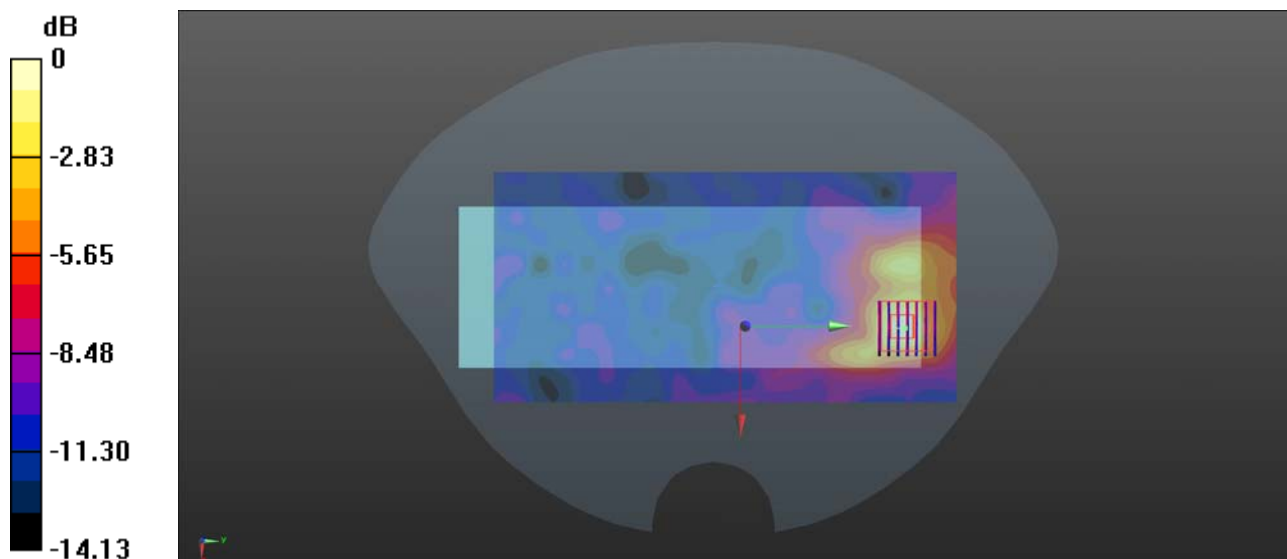
0 dB = 0.510 W/kg

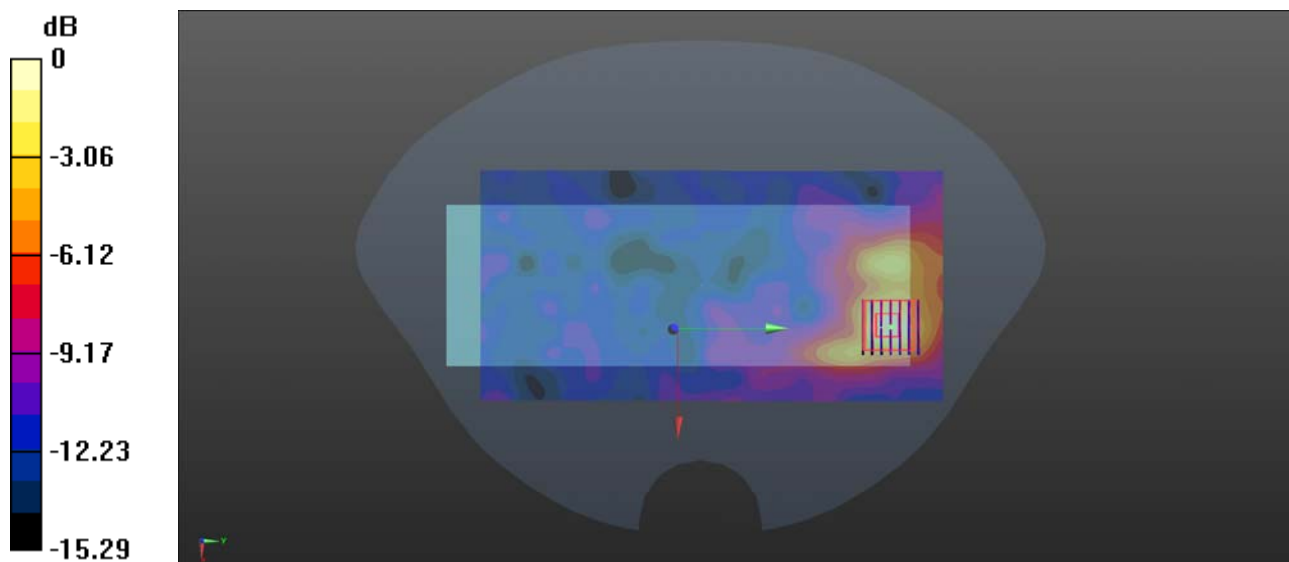## WLAN 5GHz Band 3_802.11a 6Mbps_Front Side_0mm_Ch120

Communication System: UID 0, WLAN 5GHz (0); Frequency: 5600 MHz;Duty Cycle: 1:1
Medium: MSL_5600 Medium parameters used: f = 5600 MHz; σ = 5.789 S/m; ε_r = 47.929; ρ = 1000 kg/m^3
Ambient Temperature：23.2 ℃；Liquid Temperature：22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3823; ConvF(3.97, 3.97, 3.97); Calibrated: 2017.09.30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn480; Calibrated: 2019.04.11
- Phantom: SAM 1; Type: QD000P40CC; Serial: TP:1471
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch120/Area Scan (101x201x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.634 W/kg

Ch120/Zoom Scan (7x7x13)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 3.200 V/m; Power Drift = -0.16 dB
Peak SAR (extrapolated) = 1.40 W/kg
SAR(1 g) = 0.353 W/kg; SAR(10 g) = 0.145 W/kg
Maximum value of SAR (measured) = 0.690 W/kg

0 dB = 0.634 W/kg
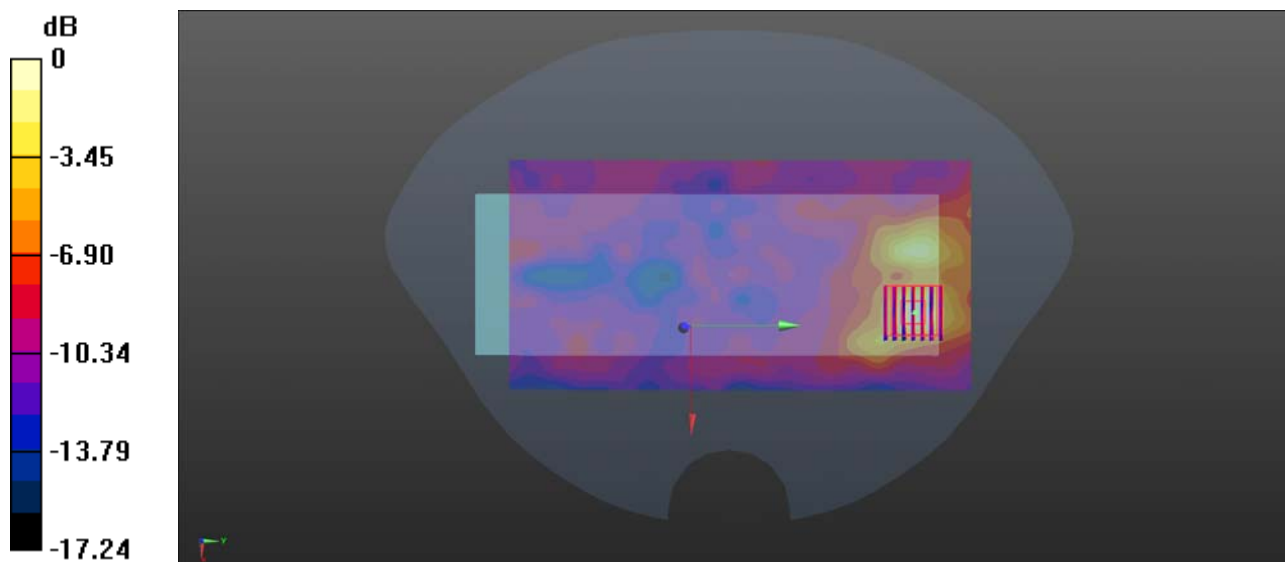
WLAN 5GHz Band 4_802.11a 6Mbps_ Front Side_0mm_Ch149

Communication System: UID 0, WLAN 5GHz (0); Frequency: 5745 MHz;Duty Cycle: 1:1
Medium: MSL_5750 Medium parameters used: f = 5745 MHz; σ = 6.052 S/m; ε_r = 47.488; ρ = 1000 kg/m^3
Ambient Temperature：23.2 ℃；Liquid Temperature：22.1 ℃

DASY5 Configuration:
- Probe: EX3DV4 - SN3823; ConvF(3.99, 3.99, 3.99); Calibrated: 2017.09.30;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn480; Calibrated: 2019.04.11
- Phantom: SAM 1; Type: QD000P40CC; Serial: TP:1471
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch149/Area Scan (101x201x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.551 W/kg

Ch149/Zoom Scan (7x7x13)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.286 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 1.72 W/kg
SAR(1 g) = 0.309 W/kg; SAR(10 g) = 0.124 W/kg
Maximum value of SAR (measured) = 0.596 W/kg

0 dB = 0.551 W/kg