

TEST REPORT

Report No.: BCTC2310106798-4E

Applicant: NINGBO AUDITORYWORKS CO., LTD.

Product Name: Nearhub Tail

Model/Type
reference: AW-NT10

Tested Date: 2024-03-06 to 2024-03-08

Issued Date: 2024-04-03

Shenzhen BCTC Testing Co., Ltd.



FCC ID: 2BAHR-NT10

Product Name: Nearhub Tail

Trademark: N/A

Model/Type Ref.: AW-NT10
AW-NT***** ("*" can be 0-9, A-Z, a-z or blank, indicate different enclosure color, performance, sales area or customer)

Applicant: NINGBO AUDITORYWORKS CO., LTD.

Address: 3-314 Lingqiao Road 229, Haishu District, Ningbo City, Zhejiang Province, China

Manufacturer: NINGBO AUDITORYWORKS CO., LTD.

Address: 3-314 Lingqiao Road 229, Haishu District, Ningbo City, Zhejiang Province, China

Prepared By: Shenzhen BCTC Testing Co., Ltd.

Address: 1-2/F., Building B, Pengzhou Industrial Park, No.158, Fuyuan 1st Road, Zhancheng, Fuhai Subdistrict, Bao'an District, Shenzhen, Guangdong, China

Sample Received Date: 2024-03-06

Sample tested Date: 2024-03-06 to 2024-03-08

Issue Date: 2024-04-03

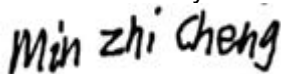
SAR Max. Values is: 0.978 W/kg (1g) for Body

Test Standards: IEEE Std C95.1, 2019/ IEEE Std 1528™-2013/FCC Part 2.1093

Test Results: PASS

Remark: This is SAR test report

Tested by:



Min Zhi Cheng/ Project Handler

Approved by:



Zero Zhou/ Reviewer

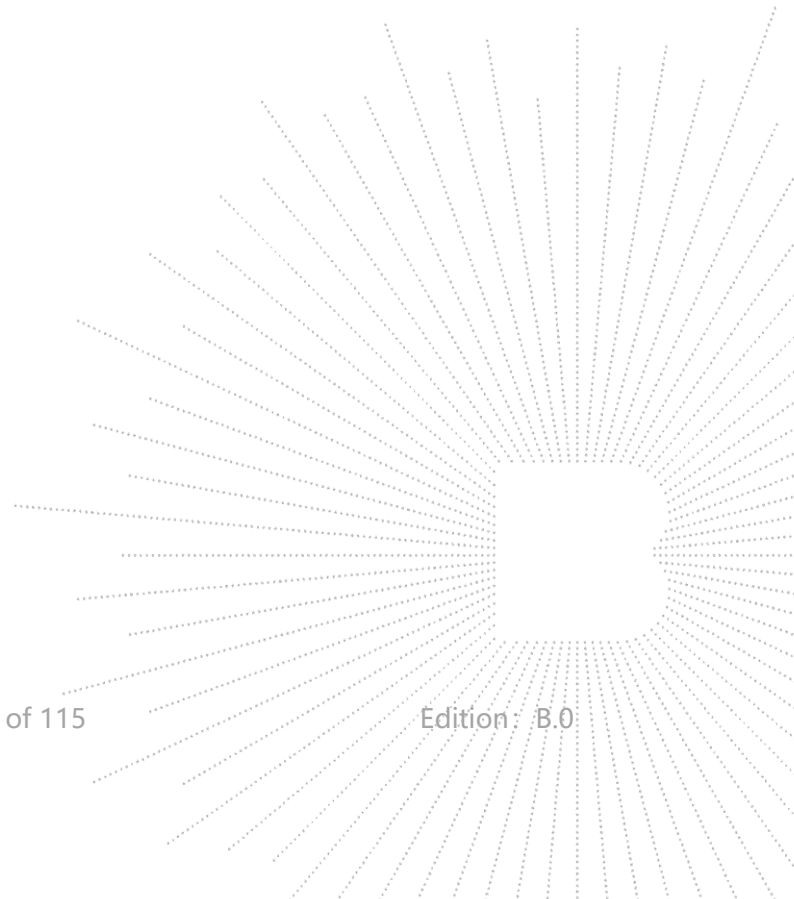
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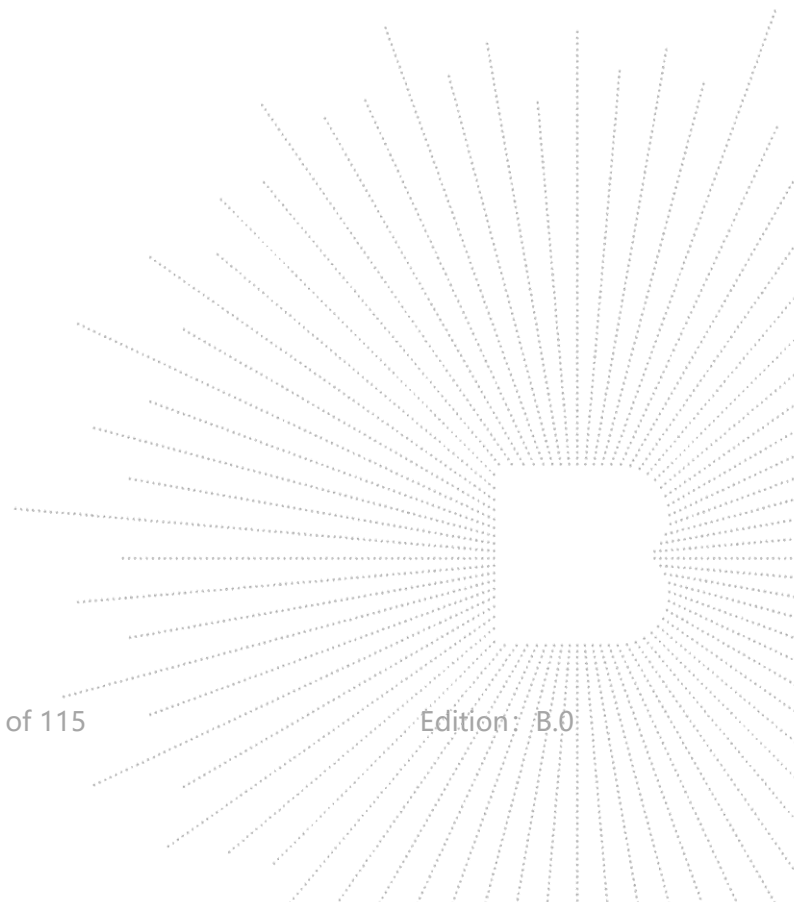
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(Note: N/A Means Not Applicable)



1. Version

Report No.	Issue Date	Description	Approved
BCTC2310106798-4E	2024-04-03	Original	Valid



2. Test Standards

IEEE Std 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.

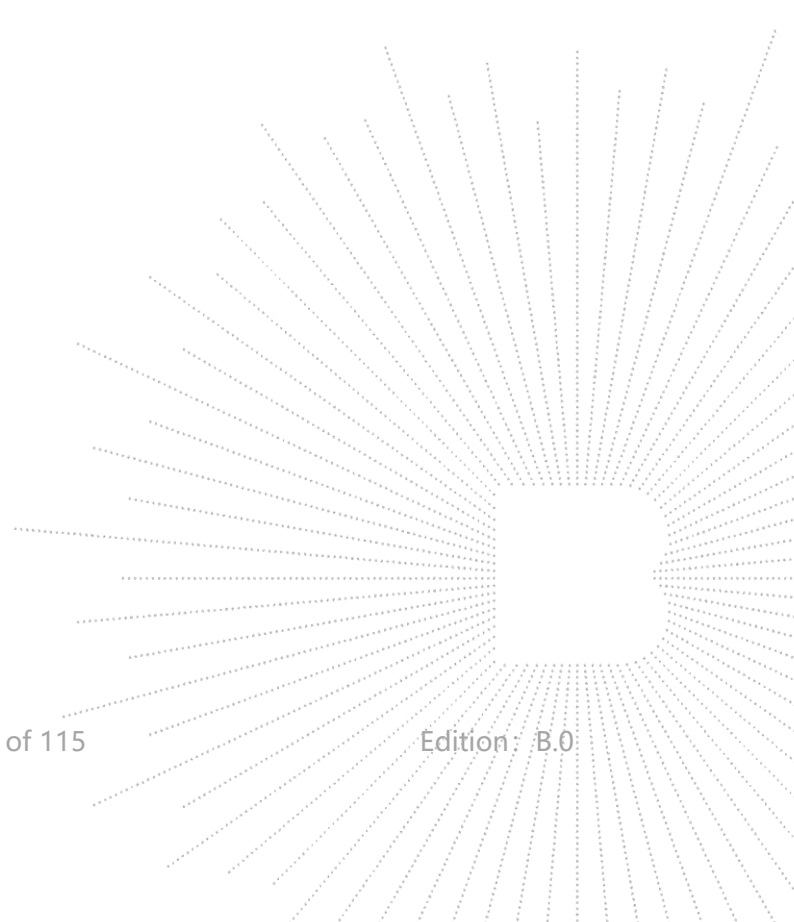
IEEE Std 1528™-2013: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

FCC Part 2.1093 Radiofrequency Radiation Exposure Evaluation: Portable Devices

KDB 447498 D01 General RF Exposure Guidance v06: Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies

KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04: SAR Measurement Requirements for 100 MHz to 6 GHz

KDB 865664 D02 RF Exposure Reporting v01r02: RF Exposure Compliance Reporting and Documentation Considerations

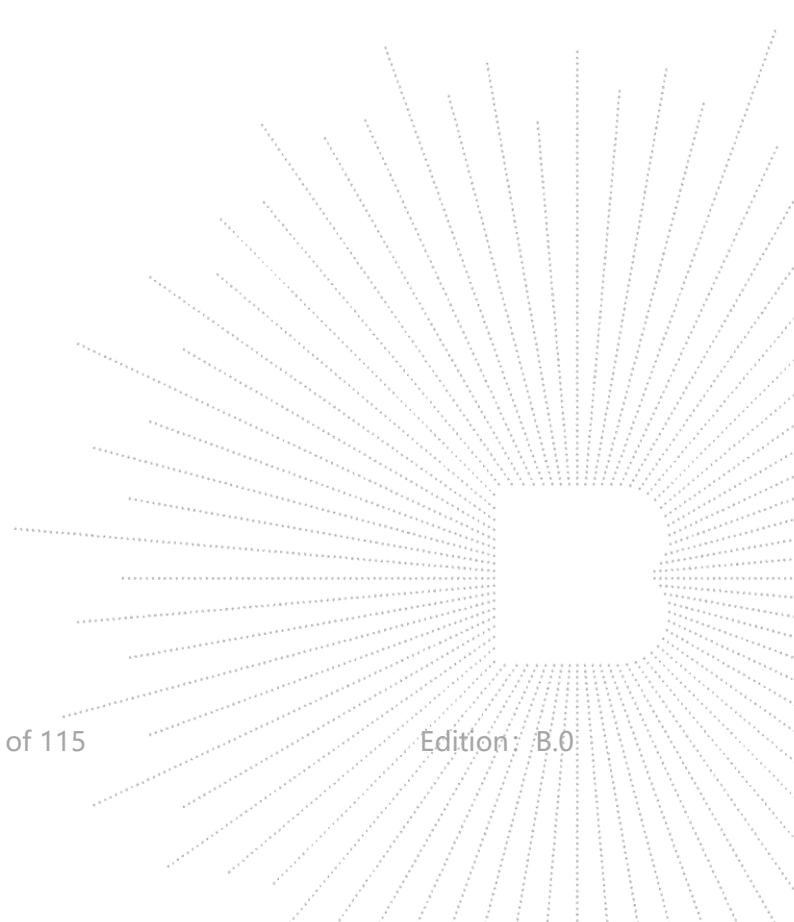


3. Test Summary

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

Frequency Band	Report SAR _{1g} (W/kg)	SAR _{1g} Limit (W/kg)
	Body (0mm Gap)	
WIFI 2.4G ANT A	0.543	1.6
WIFI 2.4G ANT B	0.273	1.6
WIFI 5G ANT A	0.978	1.6
WIFI 5G ANT B	0.964	1.6
Simultaneous Transmission	1.337	1.6

The device is in 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 C95.1-2019, and had been tested in accordance with the measurement methods and procedure specified in IEEE 1528-2013.

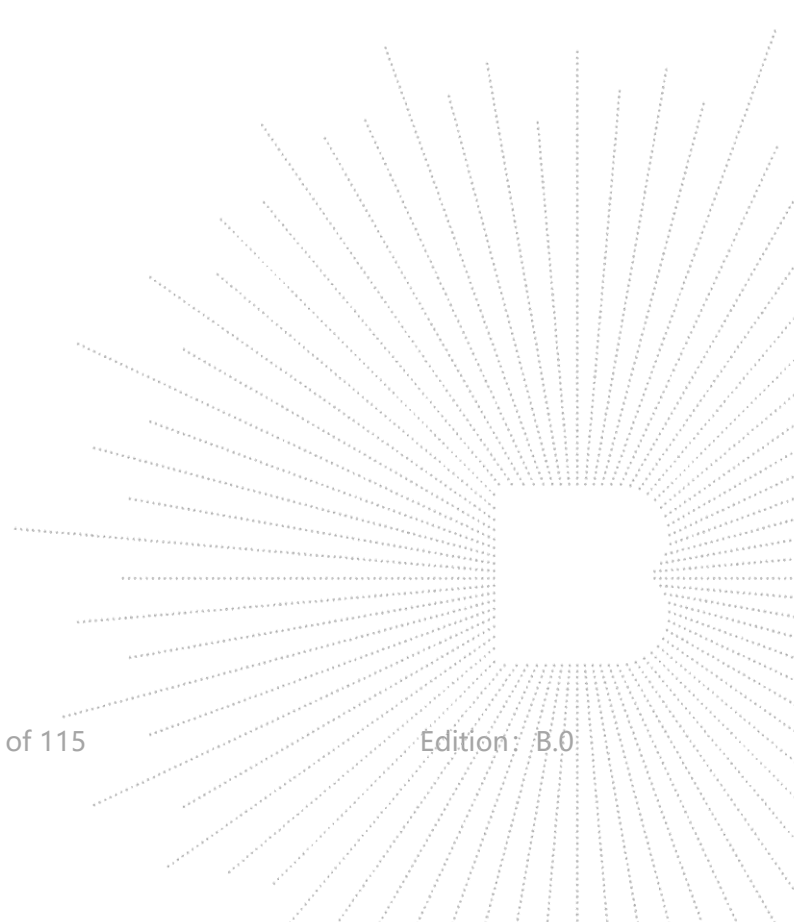


4. SAR Limits

EXPOSURE LIMITS	FCC Limit (1g Tissue)	
	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average(averaged over the whole body)	0.08	0.4
Spatial Peak(averaged over any 1 g of tissue)	1.6	8.0
Spatial Peak(hands/wrists/ feet/anklesaveraged over 10 g)	4.0	20.0

Population/Uncontrolled Environments are defined as locations where there is the exposure of individual who have no knowledge or control of their exposure.

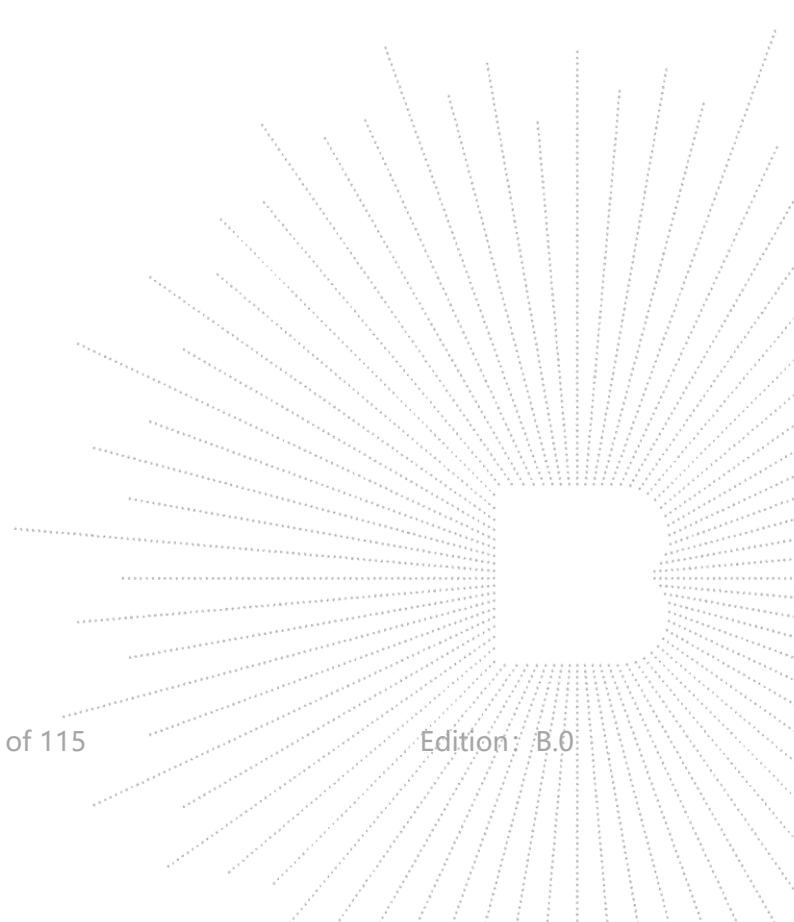
Occupational/Controlled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).



5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg and the measured 10-g SAR within a frequency band is < 3.75 W/kg. The expanded SAR measurement uncertainty must be $\leq 30\%$, for a confidence interval of $k=2$. If these conditions are met, extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

Therefore, the measurement uncertainty is not required.



6. Product Information and Test Setup

6.1 Product Information

Model/Type reference:	AW-NT10 AW-NT***** ("*" can be 0-9, A-Z, a-z or blank, indicate different enclosure color, performance, sales area or customer)
Model differences:	All models are the same circuit and RF modules, with differences in model name, housing color, performance, sales region, or customer. The test model is AW-NT10.
Hardware Version:	N/A
Software Version:	N/A
Ratings:	DC 5V
Remark:	The antenna gain of the product comes from the antenna report provided by the customer, and the test data is affected by the customer information.

WIFI 2.4G

Operation Frequency:	802.11b/g/n20MHz:2412~2462 MHz 802.11n40MHz:2422~2452 MHz 802.11b:11/5.5/2/1 Mbps
Bit Rate of Transmitter:	802.11g:54/48/36/24/18/12/9/6Mbps 802.11n Up to 150Mbps
Type of Modulation:	OFDM/DSSS
Number Of Channel:	802.11b/g/n20MHz:11 CH 802.11n40MHz: 7 CH
Antenna installation:	FPC antenna*2
Antenna Gain:	Antenna A & B: 1.82 dBi

WIFI 5G

IEEE 802.11 WLAN Mode Supported	802.11a/n (20MHz channel bandwidth) 802.11n (40MHz channel bandwidth) 802.11ac(80MHz channel bandwidth) 5180-5240MHz for 802.11a/n/ac(HT20); 5190-5230MHz for 802.11n/ac(HT40); 5210MHz for 802.11 ac80; 5260-5320MHz for 802.11a/n/ac(HT20); 5270-5310MHz for 802.11n/ac(HT40); 5290MHz for 802.11 ac80;
Operation Frequency:	5500-5700MHz for 802.11a/n/ac(HT20); 5410-5670MHz for 802.11n/ac(HT40); 5530-5610MHz for 802.11 ac80; 5745-5825 MHz for 802.11a/n/ac(HT20); 5755-5795 MHz for 802.11n/ac(HT40); 5775MHz for 802.11 ac80
Data Rate	802.11a: 6,9,12,18,24,36,48,54Mbps; 802.11n(HT20/HT40):MCS0-MCS15; 802.11ac(VHT20): NSS1, MCS0-MCS8 802.11ac(VHT40/VHT80):NSS1, MCS0-MCS9
Type of Modulation:	OFDM with BPSK/QPSK/16QAM/64QAM/256QAM for 802.11a/n/ac
Antenna installation:	FPC antenna*2
Antenna Gain:	5.1G: Antenna A & B: 3.21 dBi 5.3G: Antenna A & B: 3.21 dBi 5.6G: Antenna A & B: 3.39 dBi 5.8G: Antenna A & B: 3.39 dBi

6.2 Test Setup Configuration

See test photographs attached in EUT TEST SETUP PHOTOGRAPHS for the actual connections between Product and support equipment.

6.3 Support Equipment

Cable of Product

No.	Cable Type	Quantity	Provider	Length (m)	Shielded	Note
1	--	--	Applicant	---	Yes/No	--
2	--	--	BCTC	--	Yes/No	--

No.	Device Type	Brand	Model	Series No.	Note
1.	---	---	---	---	---
2.	--	--	--	--	--

Notes:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

6.4 Test Environment

1. Normal Test Conditions:

Humidity(%):	35-75
Atmospheric Pressure(kPa):	95-105
Temperature(°C):	18-25

2. Extreme Test Conditions:

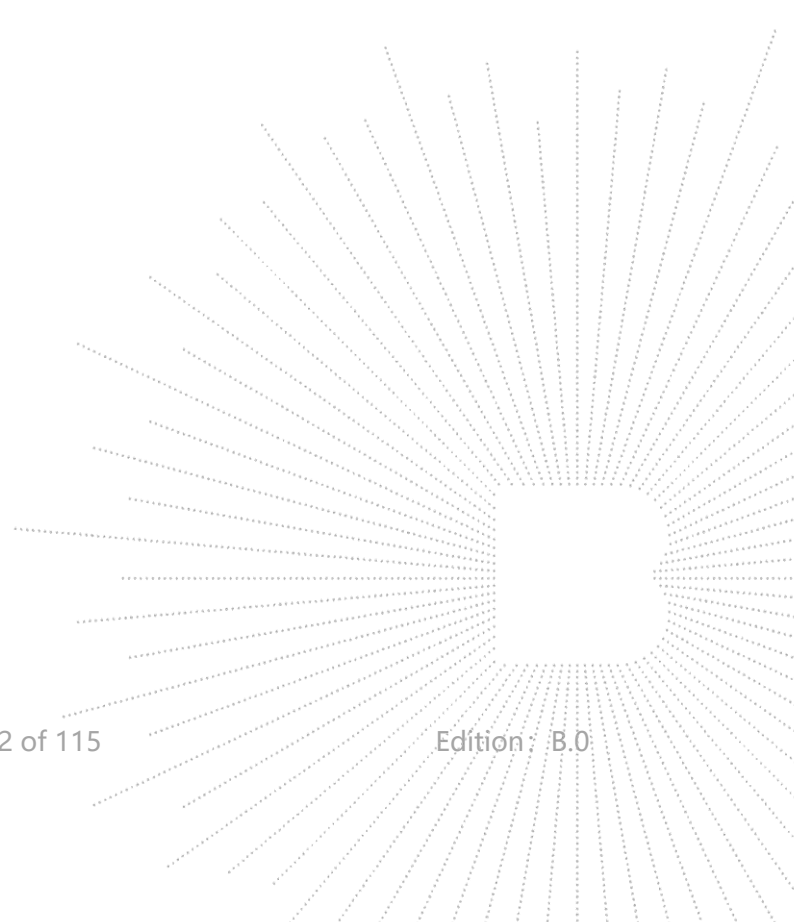
N/A

7. Test Facility and Test Instrument Used

7.1 Test Facility

All measurement facilities used to collect the measurement data are located at Shenzhen BCTC Testing Co., Ltd. Address: 1-2/F., Building B, Pengzhou Industrial Park, No.158, Fuyuan 1st Road, Zhancheng, Fuhai Subdistrict, Bao'an District, Shenzhen, Guangdong, China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-1 other equivalent standards.

FCC Test Firm Registration Number: 712850
A2LA certificate registration number is: CN1212
ISED Registered No.: 23583
ISED CAB identifier: CN0017



7.2 Test Instrument Used

Equipment	Manufacturer	Model#	Serial#	Last Cal.	Next Cal.
PC	DELL	\	\	N/A	N/A
SAR Measurement system	SATIMO	\	\	N/A	N/A
Signal Generator	Keysight	83711B	US37100131	Aug. 29, 2023	Aug. 28, 2024
Multimeter	Keithley	1160271	\	Nov. 10, 2023	Nov 09, 2024
S-parameter Network Analyzer	R&S	ZVB 8	101353	Dec. 07, 2023	Dec. 06, 2024
Wideband Radio Communication Tester	R&S	CMW500	\	Nov. 10, 2023	Nov 09, 2024
E SAR PROBE 6GHz	MVG	SSE2	2623-EPGO-420	July 18, 2023	July 17, 2024
DIPOLE 2450	SATIMO	SID 2450	SN 47/21 DIP 2G450-627	Nov. 25, 2021	Nov. 24, 2024
DIPOLE 5000	SATIMO	SID5000	SN 47/21 DIP 2G450-629	Nov. 25, 2021	Nov. 24, 2024
COMOSAR OPENCoaxial Probe	SATIMO	\	\	Nov. 18, 2023	Nov. 17, 2024
SAR Locator	SATIMO	\	\	Nov. 18, 2023	Nov. 17, 2024
Communication Antenna	SATIMO	\	\	Nov. 18, 2023	Nov. 17, 2024
FEATURE PHONEPOSITIONING DEVICE	SATIMO	\	\	N/A	N/A
DUMMY PROBE	SATIMO	\	\	N/A	N/A
SAM Phantom	MVG	\	SN 13/09 SAM68	N/A	N/A
Liquid measurement Kit	HP	85033D	3423A08186	N/A	N/A
Power meter	Agilent	E4419	\	May 15, 2023	May 14, 2024
Power meter	Agilent	E4419	\	May 15, 2023	May 14, 2024
Power sensor	Agilent	E9300A	\	May 15, 2023	May 14, 2024
Power sensor	Agilent	E9300A	\	May 15, 2023	May 14, 2024
Directional Coupler	Krytar 158020	131467	\	Nov. 10, 2023	Nov 09, 2024
Thermometer	BTE	\	\	Dec. 02, 2023	Dec. 01, 2024
Broad Band Tissue Simulation Liquid	Schmid	\	\	N/A	N/A

Note:

Per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three year extended calibration interval. Each measured dipole is expected to evaluate with following criteria at least on annual interval.

1. There is no physical damage on the dipole;
2. System check with specific dipole is within 10% of calibrated values;
3. The most recent return-loss results, measured at least annually, deviates by no more than 20% from the previous measurement;
4. The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.

Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

8. Specific Absorption Rate (SAR)

8.1 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.

8.2 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:

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

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

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

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

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

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

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.

9. SAR Measurement System

9.1 The Measurement System

Comosar is a system that is able to determine the SAR distribution inside a phantom of human being according to different standards. The Comosar system consists of the following items:

- Main computer to control all the system
- 6 axis robot
- Data acquisition system
- Miniature E-field probe
- Phone holder
- Head simulating tissue

The following figure shows the system.



The EUT under test operating at the maximum power level is placed in the phone holder, under the phantom, which is filled with head simulating liquid. The E-Field probe measures the electric field inside the phantom. The OpenSAR software computes the results to give a SAR value in a 1g or 10g mass.

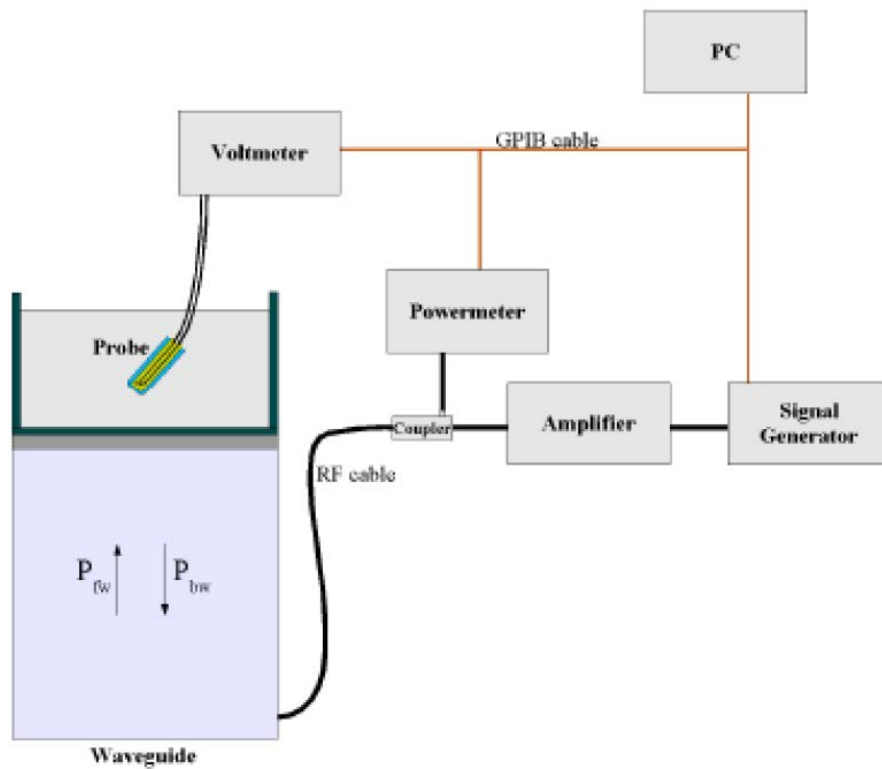
9.2 Probe

For the measurements the Specific Dosimetric E-Field Probe SN 46/21 EPGO362 with following specifications is used

- Dynamic range: 0.01-100 W/kg
- Tip Diameter : 5 mm
- Distance between probe tip and sensor center: 2.10mm
- Distance between sensor center and the inner phantom surface: 4 mm (repeatability better than +/- 1mm)
- Probe linearity: <0.25 dB
- Axial Isotropy: <0.25 dB
- Spherical Isotropy: <0.50 dB
- Calibration range: 835 to 2500MHz for head & body simulating liquid.

Angle between probe axis (evaluation axis) and surface normal line: less than 30°

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



$$SAR = \frac{4(p_{fw} - p_{pbw})}{ab\delta} \cos^2\left(\pi \frac{y}{a}\right) c^{(2\pi/\delta)}$$

Where :

Pfw = Forward Power

Pbw = Backward Power

a and b = Waveguide dimensions

l = Skin depth

Keithley configuration:

Rate = Medium; Filter = ON; RDGS = 10; Filter type = Moving Average; Range auto after each calibration, a SAR measurement is performed on a validation dipole and compared with a NPL calibrated probe, to verify it.

The calibration factors, CF(N), for the 3 sensors corresponding to dipole 1, dipole 2 and dipole 3 are:

$$CF(N) = SAR(N)/Vlin(N) \quad (N=1,2,3)$$

The linearised output voltage Vlin(N) is obtained from the displayed output voltage V(N) using

$$Vlin(N) = V(N) * (1 + V(N)/DCP(N)) \quad (N=1,2,3)$$

where DCP is the diode compression point in mV.

9.3 Probe Calibration Process

Dosimetric Assessment Procedure

Each E-Probe/Probe Amplifier combination has unique calibration parameters. SATIMO Probe 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/cm²) using an with CALISAR, Antenna proprietary calibration system.

Free Space Assessment Procedure

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 rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1mW/cm².

Temperature Assessment Procedure

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated head 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.

Where:

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

Δt = exposure time (30 seconds),

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

ΔT = temperature increase due to RF exposure.

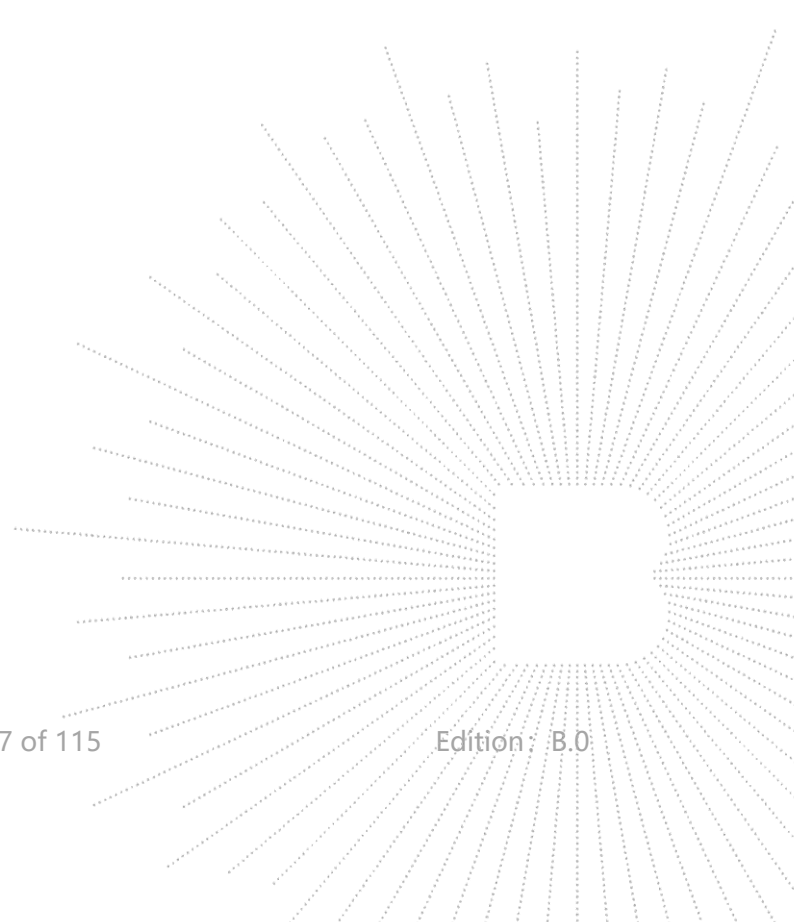
SAR is proportional to $\Delta T/\Delta t$, the initial rate of tissue heating, before thermal diffusion takes place. The electric field in the simulated tissue can be used to estimate SAR by equating the thermally derived SAR to that with the E- field component.

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

Where:

σ = simulated tissue conductivity,

ρ = Tissue density (1.25 g/cm³ for brain tissue)

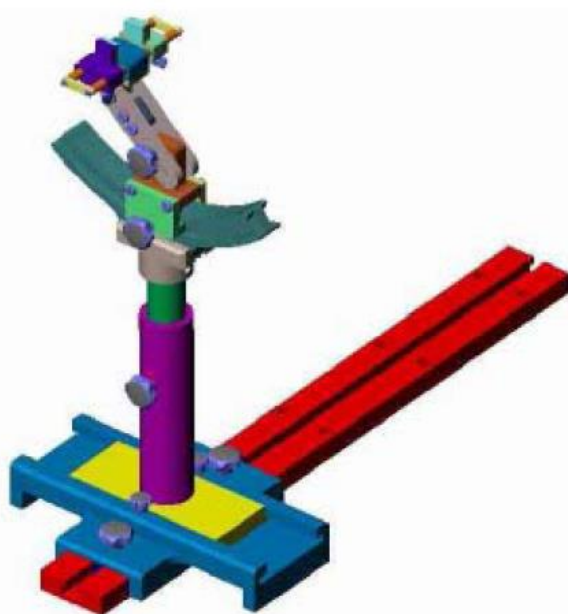


9.4 Phantom

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

9.5 Device Holder

The positioning system allows obtaining cheek and tilting position with a very good accuracy. In compliance with CENELEC, the tilt angle uncertainty is lower than 1°.



System Material	Permittivity	Loss Tangent
Delrin	3.7	0.005

10. Tissue Simulating Liquids

10.1 Composition of Tissue Simulating Liquid

For the measurement of the field distribution inside the SAM phantom with SMTIMO, 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. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. Please see the following photos for the liquid height.



Liquid Height for Body SAR

The Composition of Tissue Simulating Liquid

Frequency (MHz)	Water (%)	Salt (%)	1,2-Propane diol (%)	HEC (%)	Preventol (%)	DGBE (%)
Head/Body						
835	40.3	1.4	57.9	0.2	0.2	0
900	40.3	1.4	57.9	0.2	0.2	0
1800-2000	55.2	0.3	0	0	0	44.5
2450	55.0	0.1	0	0	0	44.9
2600	54.9	0.1	0	0	0	45.0

Frequency (MHz)	Water (%)	Hexyl Carbitol (%)	Triton X-100 (%)
Head/Body			
5000-6000	65.52	17.24	17.24

10.2 Limit

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters

computed from the 4-Cole-Cole equations described in Reference [12] and extrapolated according to the head parameters specified in P1528.

Target Frequency (MHz)	Head	
	Conductivity (σ)	Permittivity (ϵ_r)
150	0.76	52.3
300	0.87	45.3
450	0.87	43.5
750	0.89	41.9
835	0.90	41.5
900	0.97	41.5
915	0.98	41.5
1450	1.20	40.5
1610	1.29	40.3
1800-2000	1.40	40.0
2450	1.80	39.2
2600	1.96	39.0
3000	2.40	38.5
5200	4.66	36.0
5400	4.86	35.8
5600	5.07	35.5
5800	5.27	35.3

10.3 Tissue Calibration Result

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an R&S ZVB 8. Dielectric Probe Kit and an Agilent Network Analyzer.

Calibration Result for Dielectric Parameters of Tissue Simulating Liquid

Frequency (MHz)	Liquid	Target (σ)	Target (ϵ_r)	Measured (σ)	Measured (ϵ_r)	Delta (σ)%	Delta (ϵ_r)%	Limit (%)	Temp TSL (°C)	Date
2450	Head	1.80	39.20	1.765	38.310	-1.94	-2.27	±5	22.8	06/03/2024
5200	Head	4.66	36.00	4.550	35.915	-2.36	-0.24	±5	23.0	07/03/2024
5400	Head	4.86	35.80	4.875	37.071	0.31	3.55	±5	23.0	07/03/2024
5600	Head	5.07	35.50	5.148	34.944	1.54	-1.57	±5	23.0	07/03/2024
5800	Head	5.27	35.30	5.144	34.011	-2.39	-3.65	±5	23.0	07/03/2024

Remark:

1. The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within $\pm 2^\circ\text{C}$ of the temperature when the tissue parameters are characterized.
2. The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.

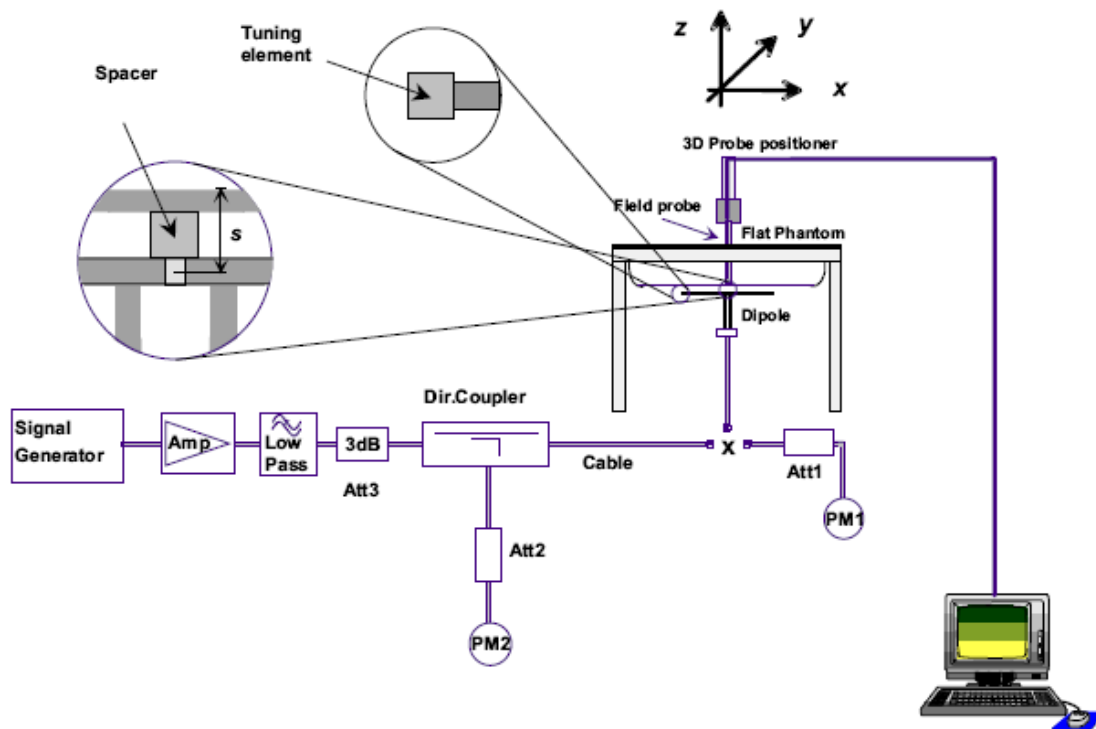
11. System Check

11.1 Purpose of System Performance Check

At the device test frequencies. System check verifies the measurement repeatability of a SAR system before compliance testing and is not a validation of all system specifications. The latter is not required for testing a device but is mandatory before the system is deployed. The system check detects possible short-term drift and unacceptable measurement errors or uncertainties in the system.

11.2 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 which comes from a signal generator at frequency 600MHz-6000MHz. 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 output power on dipole port must be calibrated to 20 dBm (100 mW) before dipole is connected.



System Verification Setup Block Diagram



Setup Photo of Dipole Antenna

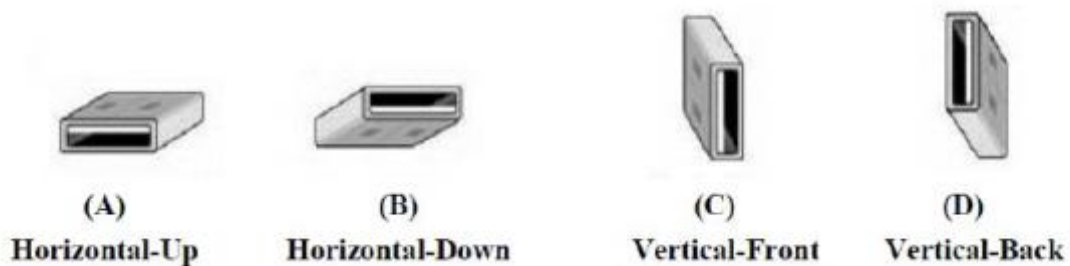
11.3 Validation Results

Comparing to the original SAR value provided by SATIMO, the validation data should be within its specification of 10 %. The following table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion.

Frequency (MHz)	Power	Measured SAR _{1g} (W/Kg)	Normalize to 1 Watt	Drift (%)	1W Target	Difference Percentage (%)	Limit (%)	Liquid Temp	Date
					SAR _{1g} (W/Kg)				
2450	250mW	13.955	55.821	-2.565	55.16	1.198	±10	22.8	06/03/2024
5200	250mW	19.154	76.617	-0.751	76.41	0.271	±10	23.0	07/03/2024
5400	250mW	20.589	82.354	2.040	80.52	2.278	±10	23.0	07/03/2024
5600	250mW	19.566	78.264	3.569	79.08	-1.032	±10	23.0	07/03/2024
5800	250mW	18.366	73.465	1.250	76.49	-3.955	±10	23.0	07/03/2024

12. EUT Testing Position

- Power is supplied to the EUT through the USB port.
- Adjust the distance between the EUT surface and the plane module to 0mm to test all directions of the EUT [see figure below:(A) Horizontal-Up, (B) Horizontal-Down, (C) Vertical-Front, (D) Vertical-Back]



13. SAR Measurement Procedures

13.1 Measurement Procedures

The measurement procedures are as follows:

- (a) Use base station simulator (if applicable) or engineering software to transmit RF power continuously (continuous Tx) in the highest power channel.
- (b) Keep EUT to radiate maximum output power or 100% factor (if applicable)
- (c) Measure output power through RF cable and power meter.
- (d) Place the EUT in the positions as Annex D demonstrates.
- (e) Set scan area, grid size and other setting on the SATIMO software.
- (f) Measure SAR results for the highest power channel on each testing position.
- (g) Find out the largest SAR result on these testing positions of each band
- (h) Measure SAR results for other channels in worst SAR testing position if the SAR of 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:

- (a) Power reference measurement
- (b) Area scan
- (c) Zoom scan
- (d) Power drift measurement

13.2 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 SATIMO 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 10g 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. The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

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

13.3 Area & Zoom Scan Procedures

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan measures 5x5x7 points with step size 8, 8 and 5 mm for 300 MHz to 3 GHz, and 8x8x8 points with step size 4, 4 and 2.5 mm for 3 GHz to 6 GHz. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g.

			≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 mm $\pm$ 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2)$ mm $\pm$ 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			30° $\pm$ 1°	20° $\pm$ 1°
Maximum area scan spatial resolution: Δx_{Area} , Δy_{Area}			≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: Δx_{Zoom} , Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$ mm	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.				
* When zoom scan is required and the <u>reported</u> SAR from the <u>area scan based 1-g SAR estimation</u> procedures of KDB Publication 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.				

13.4 Volume Scan Procedures

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing (step-size is 4, 4 and 2.5 mm). When all volume scan were completed, the software can combine and subsequently superpose these measurement data to calculating the multiband SAR.

13.5 SAR Averaged Methods

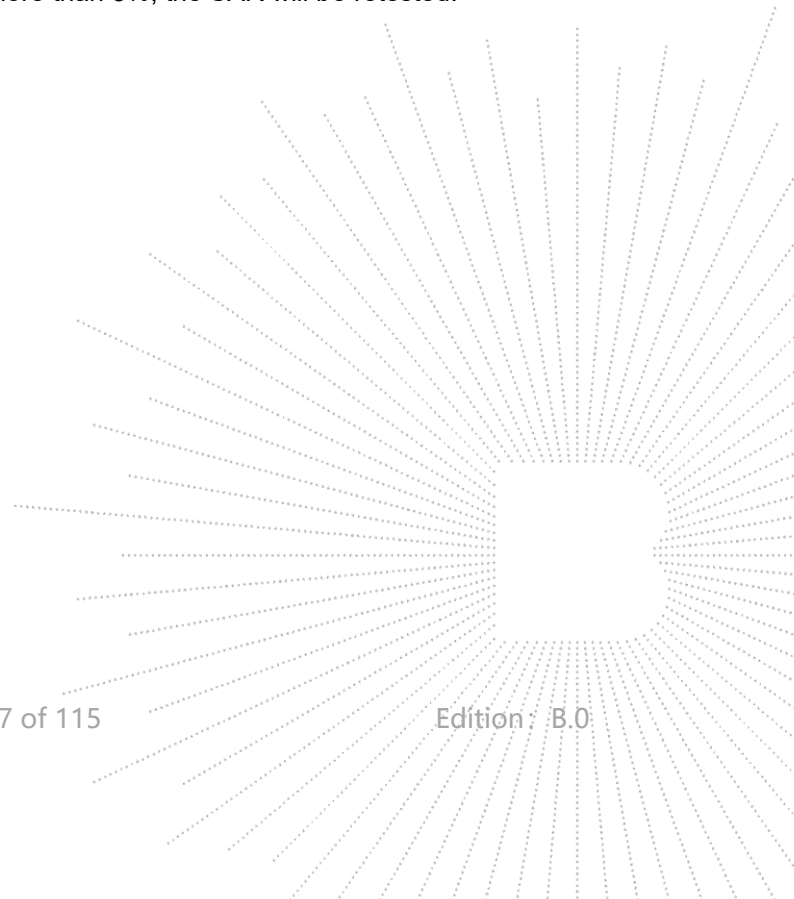
The local SAR inside the phantom is measured using small dipole sensing elements inside a probe body. The probe tip must not be in contact with the phantom surface in order to minimize measurements errors, but the highest local SAR will occur at the surface of the phantom.

An extrapolation is using to determinate this highest local SAR values. The extrapolation is based on a fourth-order least-square polynomial fit of measured data. The local SAR value is then extrapolated from the liquid surface with a 1mm step.

The measurements have to be performed over a limited time (due to the duration of the battery) so the step of measurement is high. It could vary between 5 and 8 mm. To obtain an accurate assessment of the maximum SAR averaged over 10g and 1 g requires a very fine resolution in the three dimensional scanned data array.

13.6 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In SATIMO 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 drift more than 5%, the SAR will be retested.



14. SAR Test Result

14.1 Conducted RF Output Power

WIFI 2.4G				
Mode	Frequency (MHz)	Conducted Power (dBm) ANT A	Conducted Power (dBm) ANT B	Total Conducted Power (dBm)
802.11b	2412	12.02	12.46	/
	2437	11.95	12.58	/
	2462	11.37	12.26	/
802.11g	2412	10.39	10.98	/
	2437	10.94	11.56	/
	2462	10.87	11.77	/
802.11n20	2412	10.17	11.10	13.67
	2437	10.21	11.54	13.94
	2462	10.41	11.68	14.10
802.11n40	2422	7.73	9.86	11.93
	2437	7.59	10.54	12.32
	2452	7.88	10.76	12.56

WIFI 5.1G				
Mode	Frequency (MHz)	Conducted Power (dBm) ANT A	Conducted Power (dBm) ANT B	Total Conducted Power (dBm)
802.11a	5180	10.45	10.95	/
	5200	10.54	10.48	/
	5240	9.96	11.05	/
802.11n20	5180	8.41	9.02	11.74
	5200	8.57	9.09	11.85
	5240	9.13	9.60	12.38
802.11n40	5190	7.49	8.31	10.93
	5230	7.52	8.44	11.01
802.11ac20	5180	8.60	9.20	11.92
	5200	8.12	8.96	11.57
	5240	8.97	9.77	12.40
802.11ac40	5190	7.18	8.09	10.67
	5230	7.83	8.35	11.11
802.11ac80	5210	6.83	7.31	10.09

WIFI 5.3G				
Mode	Frequency (MHz)	Conducted Power (dBm) ANT A	Conducted Power (dBm) ANT B	Total Conducted Power (dBm)
802.11a	5260	10.40	11.02	/
	5280	10.69	11.09	/
	5320	11.82	12.54	/
802.11n20	5260	9.84	9.73	12.80
	5280	9.79	9.98	12.90
	5320	11.18	11.47	14.34
802.11n40	5270	8.47	8.70	11.60
	5310	9.15	9.63	12.41
802.11ac20	5260	9.54	10.31	12.95
	5280	10.07	10.15	13.12
	5320	10.92	11.66	14.32
802.11ac40	5270	8.26	9.03	11.67
	5310	9.12	8.88	12.01
802.11ac80	5290	7.12	7.29	10.22

WIFI 5.6G				
Mode	Frequency (MHz)	Conducted Power (dBm) ANT A	Conducted Power (dBm) ANT B	Total Conducted Power (dBm)
802.11a	5500	11.32	11.75	/
	5580	11.51	11.57	/
	5700	10.43	10.37	/
802.11n20	5500	9.92	10.39	13.17
	5580	10.13	10.61	13.39
	5700	9.58	9.06	12.34
802.11n40	5510	8.24	8.90	11.59
	5550	7.70	9.13	11.48
	5670	8.04	8.06	11.06
802.11ac20	5500	9.89	10.24	13.08
	5580	9.79	10.74	13.30
	5700	10.76	8.89	12.94
802.11ac40	5510	8.26	9.01	11.66
	5550	8.22	8.89	11.58
	5670	9.94	8.07	12.12
802.11ac80	5530	6.77	7.75	10.30

WIFI 5.8G				
Mode	Frequency (MHz)	Conducted Power (dBm) ANT A	Conducted Power (dBm) ANT B	Total Conducted Power (dBm)
802.11a	5745	8.82	8.48	/
	5785	8.98	9.53	/
	5825	8.87	8.49	/
802.11n20	5745	7.30	6.95	10.14
	5785	7.50	7.45	12.23
	5825	8.06	6.96	10.56
802.11n40	5755	7.79	7.05	10.45
	5795	7.66	6.22	10.01
802.11ac20	5745	7.92	6.95	10.47
	5785	8.20	7.14	10.71
	5825	8.01	7.21	10.64
802.11ac40	5755	6.93	6.42	9.69
	5795	7.70	6.49	10.15
802.11ac80	5775	6.80	6.30	9.57

14.2 Measured and Reported (Scaled) SAR Results

The calculated SAR is obtained by the following formula:

1. Reported SAR for WWAN=Measured SAR * Tune-up Scaling factor
2. Reported SAR for WLAN and Bluetooth=Measured SAR * Tune-up Scaling factor * Duty Cycle Scaling factor
3. Duty Cycle Scaling factor=1/ Duty Cycle (%)

KDB 447498 D01 General RF Exposure Guidance:

Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

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

KDB 248227 D01 802.11 Wi-Fi SAR

SAR test reduction for 802.11 Wi-Fi transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements.

For 2.4 GHz 802.11b DSSS, either the initial test position procedure for multiple exposure test positions or the DSSS procedure for fixed exposure position is applied; these are mutually exclusive. For 2.4 GHz and 5 GHz OFDM configurations, the initial test configuration is applied to measure SAR using either the initial test position procedure for multiple exposure test position configurations or the initial test configuration procedures for fixed exposure test conditions.

DSSS and OFDM configurations are considered separately according to the required SAR procedures. SAR is measured in the initial test position using the 802.11 transmission mode configuration required by the DSSS procedure or initial test configuration and subsequent test configuration(s) according to the OFDM procedures.16 The initial test position procedure is described in the following:

- a) When the *reported* SAR of the initial test position is ≤ 0.4 W/kg, further SAR measurement is not required for the other (remaining) test positions in that exposure configuration and 802.11 transmission mode combinations within the frequency band or aggregated band. SAR is also not required for that exposure configuration in the subsequent test configuration(s).
- b) When the *reported* SAR of the initial test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position using subsequent highest extrapolated or estimated 1-g SAR conditions determined by area scans or next closest/smallest test separation distance and maximum RF coupling test positions based on manufacturer justification, on the highest maximum output power channel, until the *reported* SAR is ≤ 0.8 W/kg or all required test positions (left, right, touch, tilt or subsequent surfaces and edges) are tested.
- c) For all positions/configurations tested using the initial test position and subsequent test positions, 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 ≤ 1.2 W/kg or all required channels are tested.

Additional power measurements may be required for this step, which should be limited to those necessary for identifying the subsequent highest output power channels.

When the specified maximum output power is the same for both UNII 1 and UNII 2A, begin SAR measurements in UNII 2A with the channel with the highest measured output power. If the reported SAR for UNII 2A is ≤ 1.2 W/kg, SAR is not required for UNII 1; otherwise treat the remaining bands separately and test them independently for SAR.

When the specified maximum output power is different between UNII 1 and UNII 2A, begin SAR with the band that has the higher specified maximum output. If the highest reported SAR for the band with the highest specified power is ≤ 1.2 W/kg, testing for the band with the lower specified output power is not required; otherwise test the remaining bands independently for SAR

WIFI 2.4G ANT A										
RF Exposure Conditions	Mode	Test Position	CH.	Freq. (MHz)	Output Power (dBm)	Turn up (dBm)	Turn-up Scaling Factor	SAR1g (W/kg)		Plot No.
								Meas.	Scaled	
Body (0mm)	802.11b	Horizontal-Up	1	2412	12.02	12.5	1.117	0.486	0.543	1
		Horizontal-Down	1	2412	12.02	12.5	1.117	0.160	0.179	
		Vertical-Front	1	2412	12.02	12.5	1.117	0.071	0.079	
		Vertical-Back	1	2412	12.02	12.5	1.117	0.060	0.067	
		Horizontal-Up	6	2437	11.95	12.5	1.135	0.471	0.535	
		Horizontal-Up	11	2462	11.37	12.5	1.297	0.418	0.542	

WIFI 2.4G ANT B										
RF Exposure Conditions	Mode	Test Position	CH.	Freq. (MHz)	Output Power (dBm)	Turn up (dBm)	Turn-up Scaling Factor	SAR1g (W/kg)		Plot No.
								Meas.	Scaled	
Body (0mm)	802.11b	Horizontal-Up	6	2437	12.58	13.0	1.102	0.065	0.072	
		Horizontal-Down	6	2437	12.58	13.0	1.102	0.235	0.259	
		Vertical-Front	6	2437	12.58	13.0	1.102	0.064	0.070	
		Vertical-Back	6	2437	12.58	13.0	1.102	0.061	0.067	
		Horizontal-Down	1	2412	12.46	13.0	1.132	0.215	0.243	
		Horizontal-Down	11	2462	12.26	13.0	1.186	0.230	0.273	2

WIFI 5.1G ANT A										
RF Exposure Conditions	Mode	Test Position	CH.	Freq. (MHz)	Output Power (dBm)	Turn up (dBm)	Turn-up Scaling Factor	SAR1g (W/kg)		Plot No.
								Meas.	Scaled	
Body (0mm)	802.11a	Horizontal-Up	40	5200	10.54	11.0	1.112	0.471	0.524	
		Horizontal-Down	40	5200	10.54	11.0	1.112	0.297	0.330	
		Vertical-Front	40	5200	10.54	11.0	1.112	0.056	0.062	
		Vertical-Back	40	5200	10.54	11.0	1.112	0.079	0.088	
		Horizontal-Up	36	5180	10.45	11.0	1.135	0.488	0.554	
		Horizontal-Up	48	5240	9.96	11.0	1.271	0.437	0.555	3

WIFI 5.1G ANT B										
RF Exposure Conditions	Mode	Test Position	CH.	Freq. (MHz)	Output Power (dBm)	Turn up (dBm)	Turn-up Scaling Factor	SAR1g (W/kg)		Plot No.
								Meas.	Scaled	
Body (0mm)	802.11a	Horizontal-Up	48	5240	11.05	11.5	1.109	0.136	0.151	
		Horizontal-Down	48	5240	11.05	11.5	1.109	0.498	0.552	
		Vertical-Front	48	5240	11.05	11.5	1.109	0.033	0.037	
		Vertical-Back	48	5240	11.05	11.5	1.109	0.083	0.092	
		Horizontal-Down	36	5180	10.95	11.5	1.135	0.475	0.539	
		Horizontal-Down	40	5200	10.48	11.5	1.265	0.430	0.544	4

WIFI 5.3G ANT A										
RF Exposure Conditions	Mode	Test Position	CH.	Freq. (MHz)	Output Power (dBm)	Turn up (dBm)	Turn-up Scaling Factor	SAR1g (W/kg)		Plot No.
								Meas.	Scaled	
Body (0mm)	802.11a	Horizontal-Up	64	5320	11.82	12.5	1.169	0.670	0.784	
		Horizontal-Down	64	5320	11.82	12.5	1.169	0.319	0.373	
		Vertical-Front	64	5320	11.82	12.5	1.169	0.108	0.126	
		Vertical-Back	64	5320	11.82	12.5	1.169	0.110	0.129	
		Horizontal-Up	52	5260	10.40	12.5	1.622	0.603	0.978	5
		Horizontal-Up	56	5280	10.69	12.5	1.517	0.610	0.925	

WIFI 5.3G ANT B										
RF Exposure Conditions	Mode	Test Position	CH.	Freq. (MHz)	Output Power (dBm)	Turn up (dBm)	Turn-up Scaling Factor	SAR1g (W/kg)		Plot No.
								Meas.	Scaled	
Body (0mm)	802.11a	Horizontal-Up	64	5320	12.54	13.0	1.112	0.297	0.330	
		Horizontal-Down	64	5320	12.54	13.0	1.112	0.637	0.708	
		Vertical-Front	64	5320	12.54	13.0	1.112	0.115	0.128	
		Vertical-Back	64	5320	12.54	13.0	1.112	0.107	0.119	
		Horizontal-Down	52	5260	11.02	13.0	1.578	0.611	0.964	6
		Horizontal-Down	56	5280	11.09	13.0	1.552	0.606	0.941	

WIFI 5.6G ANT A										
RF Exposure Conditions	Mode	Test Position	CH.	Freq. (MHz)	Output Power (dBm)	Turn up (dBm)	Turn-up Scaling Factor	SAR1g (W/kg)		Plot No.
								Meas.	Scaled	
Body (0mm)	802.11a	Horizontal-Up	120	5580	11.51	12.0	1.119	0.590	0.660	
		Horizontal-Down	120	5580	11.51	12.0	1.119	0.306	0.343	
		Vertical-Front	120	5580	11.51	12.0	1.119	0.094	0.105	
		Vertical-Back	120	5580	11.51	12.0	1.119	0.136	0.152	
		Horizontal-Up	100	5500	11.32	12.0	1.169	0.533	0.623	
		Horizontal-Up	140	5700	10.43	12.0	1.435	0.502	0.721	7

WIFI 5.6G ANT B										
RF Exposure Conditions	Mode	Test Position	CH.	Freq. (MHz)	Output Power (dBm)	Turn up (dBm)	Turn-up Scaling Factor	SAR1g (W/kg)		Plot No.
								Meas.	Scaled	
Body (0mm)	802.11a	Horizontal-Up	100	5500	11.75	12.0	1.059	0.190	0.201	
		Horizontal-Down	100	5500	11.75	12.0	1.059	0.364	0.386	
		Vertical-Front	100	5500	11.75	12.0	1.059	0.084	0.089	
		Vertical-Back	100	5500	11.75	12.0	1.059	0.092	0.097	
		Horizontal-Down	120	5580	11.57	12.0	1.104	0.384	0.424	
		Horizontal-Down	140	5700	10.37	12.0	1.455	0.301	0.438	8

WIFI 5.8G ANT A										
RF Exposure Conditions	Mode	Test Position	CH.	Freq. (MHz)	Output Power (dBm)	Turn up (dBm)	Turn-up Scaling Factor	SAR1g (W/kg)		Plot No.
								Meas.	Scaled	
Body (0mm)	802.11a	Horizontal-Up	157	5785	8.98	9.5	1.127	0.498	0.561	9
		Horizontal-Down	157	5785	8.98	9.5	1.127	0.206	0.232	
		Vertical-Front	157	5785	8.98	9.5	1.127	0.076	0.086	
		Vertical-Back	157	5785	8.98	9.5	1.127	0.059	0.067	
		Horizontal-Up	149	5745	8.82	9.5	1.169	0.464	0.543	
		Horizontal-Up	165	5825	8.87	9.5	1.156	0.419	0.484	

WIFI 5.8G ANT B										
RF Exposure Conditions	Mode	Test Position	CH.	Freq. (MHz)	Output Power (dBm)	Turn up (dBm)	Turn-up Scaling Factor	SAR1g (W/kg)		Plot No.
								Meas.	Scaled	
Body (0mm)	802.11a	Horizontal-Up	157	5785	9.53	10.0	1.114	0.187	0.208	
		Horizontal-Down	157	5785	9.53	10.0	1.114	0.362	0.403	
		Vertical-Front	157	5785	9.53	10.0	1.114	0.055	0.061	
		Vertical-Back	157	5785	9.53	10.0	1.114	0.078	0.087	
		Horizontal-Down	149	5745	8.48	10.0	1.419	0.370	0.525	10
		Horizontal-Down	165	5825	8.49	10.0	1.416	0.309	0.437	

14.3 SAR Measurement Variability

According to KDB865664, Repeated measurements are required only when the measured SAR is ≥ 0.80 W/kg. If the measured SAR value of the initial repeated measurement is < 1.45 W/kg with $\leq 20\%$ variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. A second repeated measurement is required only if the measured result for the initial repeated measurement is within 10% of the SAR limit and vary by more than 20%, which are often related to device and measurement setup difficulties. The following procedures are applied to determine if repeated measurements are required. The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.¹⁹ The repeated measurement results must be clearly identified in the SAR report. All measured SAR, including the repeated results, must be considered to determine compliance and for reporting according to KDB 690783. Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.

- 1) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
- 2) 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 ≥ 1.45 W/kg ($\sim 10\%$ from the 1-g SAR limit).
- 3) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20 .
- 4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20 .

Test Mode	Frequency Band (MHz)	RF Exposure Configuration	Test Position	Repeated SAR (yes/no)	Highest Measured SAR1-g (W/Kg)	First Repeated	
						Measured SAR1-g (W/Kg)	Largest to Smallest SAR Ratio
/	/	Body	/	yes	/	/	/

14.4 Simultaneous Transmission Evaluation

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneous transmitting antenna.

Application Simultaneous Transmission information:

No.	Configurations	Body SAR
1	WIFI (ANT A) + WIFI (ANT B)	YES
2	WIFI 2.4G + WIFI 5G	NO

Remark:

- WIFI 2.4G and WIFI 5G cannot transmit simultaneously
- According to the KDB 447498 D01 v06, when standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:
 - (max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)]·[√f(GHz)/x] W/kg for test separation distances ≤ 50 mm; where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.
 - 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm

Estimated stand alone SAR						
Communication system	Frequency (MHz)	Maximum Power (dBm)	Maximum Power (mW)	Separation Distance (mm)	X	Estimated SAR1-g (W/kg)
/	/	/	/	5	3	/
/	/	/	/	10	7.5	/

- Per FCC KD B447498 D01, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the transmitting antenna in a specific a physical test configuration is ≤1.6 W/Kg. When the sum is greater than the SAR limit, SAR test exclusion is determined by the SAR to peak location separation ratio.

$$\text{Ratio} = \frac{(\text{SAR}_1 + \text{SAR}_2)^{1.5}}{(\text{peak location separation, mm})} < 0.04$$

- Simultaneous transmission of maximum SAR sum calculation.

RF Exposure Conditions	Test Position	ANT A	ANT B	Summed SAR (W/kg)	SAR1-g Limit (W/kg)
		Scaled SAR (W/kg)	Scaled SAR (W/kg)		
Body	Horizontal-Up	0.978	0.330	1.308	1.6
	Horizontal-Down	0.373	0.964	1.337	1.6
	Vertical-Front	0.126	0.128	0.254	1.6
	Vertical-Back	0.152	0.118	0.270	1.6

15. Test Plots

15.1 System Performance Check

System check at 2450 MHz

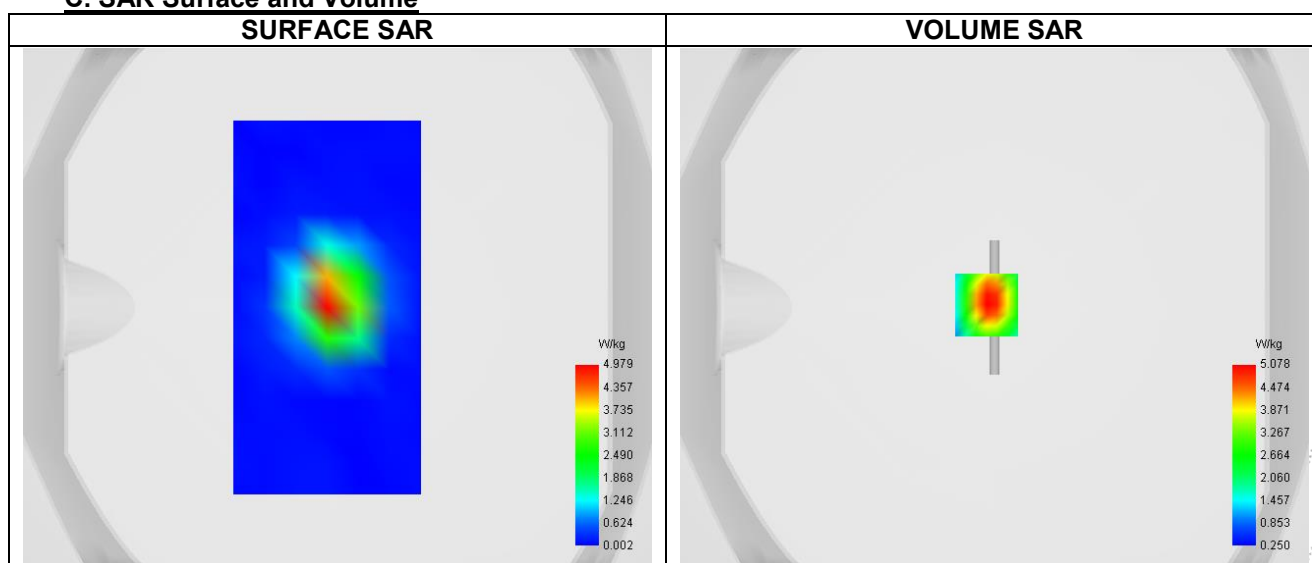
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	1.32
Area Scan	surf_sam_plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	CW2450
Channels	Middle
Signal	CW

B. Permittivity

Frequency (MHz)	2450.000
Relative permittivity (real part)	38.310
Relative permittivity (imaginary part)	14.330
Conductivity (S/m)	1.765

C. SAR Surface and Volume



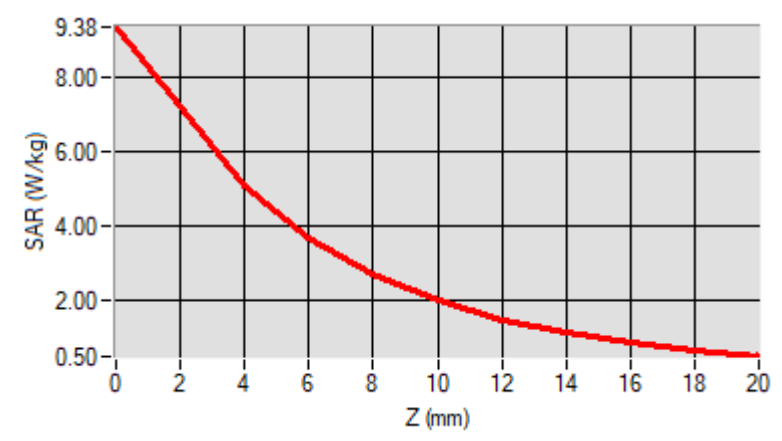
Maximum location: X=-3.00, Y=1.00 ; SAR Peak: 9.50 W/kg

D. SAR 1g & 10g

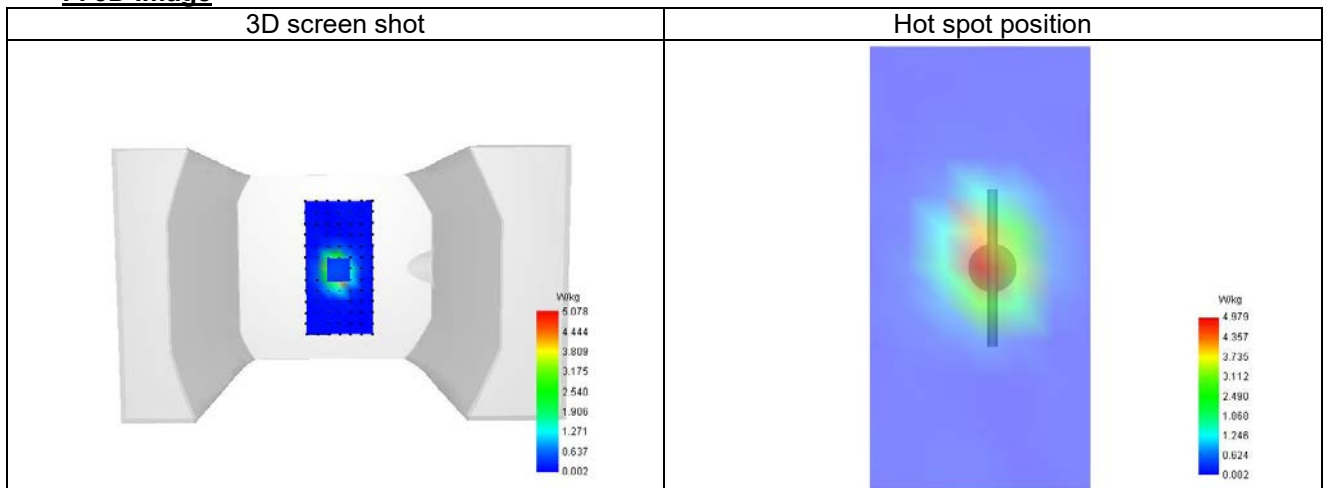
SAR 10g (W/Kg)	6.112
SAR 1g (W/Kg)	13.955
Variation (%)	-2.565
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00
SAR (W/Kg)	9.380	5.078	3.712	2.709	2.001	1.499	1.138	0.871	0.667



F. 3D Image



System check at 5200 MHz

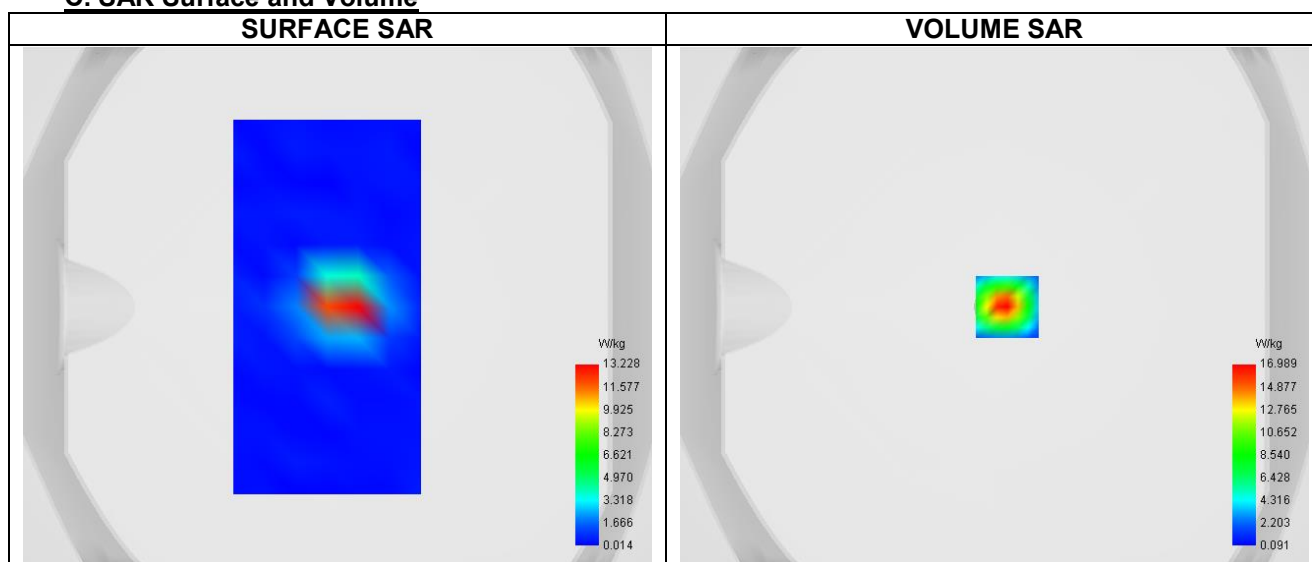
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	0.97
Area Scan	surf_sam_plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Dipole
Band	CW5200
Channels	Middle
Signal	CW

B. Permittivity

Frequency (MHz)	5200.000
Relative permittivity (real part)	35.915
Relative permittivity (imaginary part)	18.140
Conductivity (S/m)	4.550

C. SAR Surface and Volume



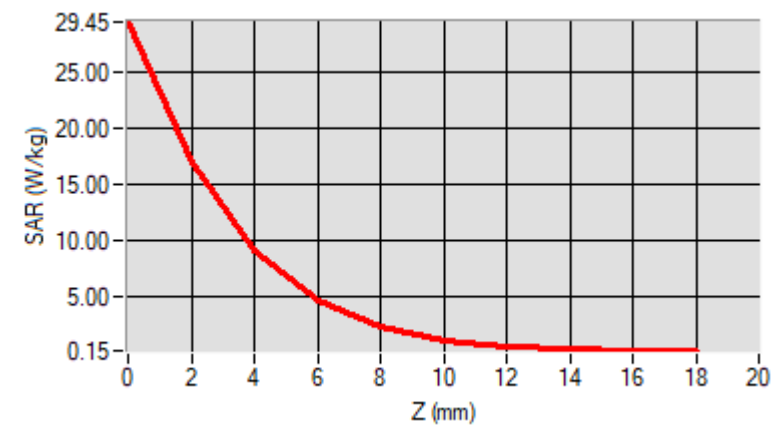
Maximum location: X=5.00, Y=0.00 ; SAR Peak: 30.79 W/kg

D. SAR 1g & 10g

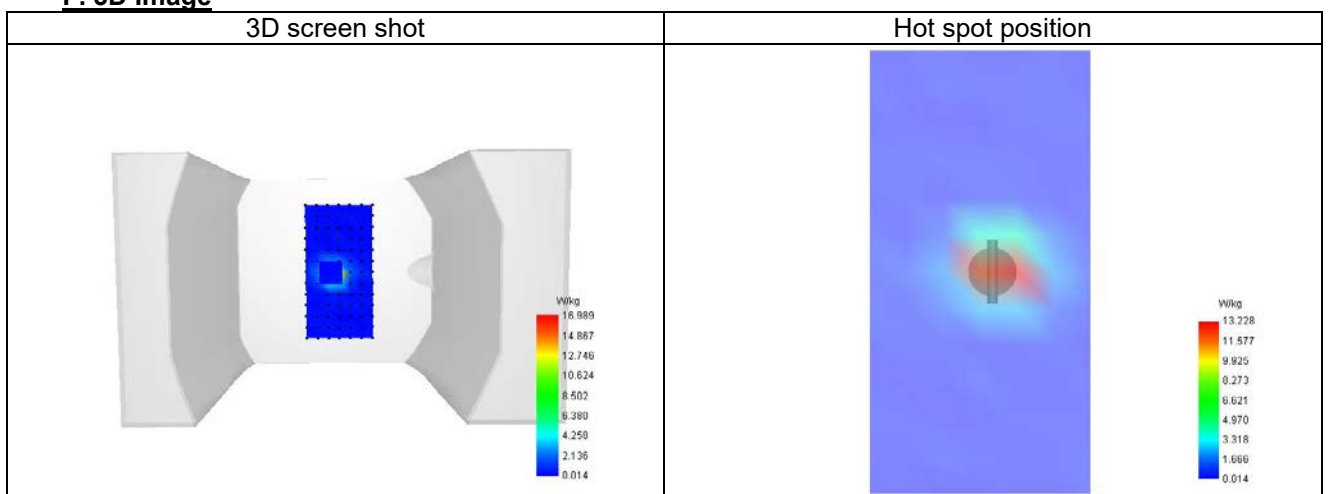
SAR 10g (W/Kg)	5.312
SAR 1g (W/Kg)	19.154
Variation (%)	-0.751
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00
SAR (W/Kg)	29.452	16.989	9.130	4.585	2.232	1.083	0.552	0.315	0.209



F. 3D Image



System check at 5400 MHz

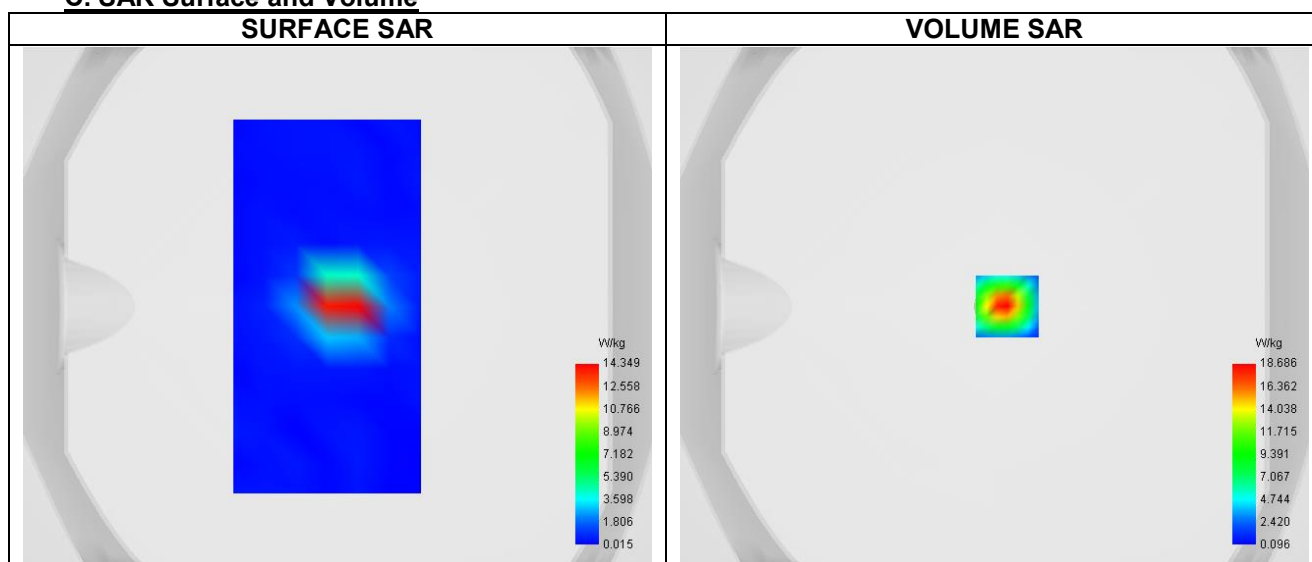
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	1.00
Area Scan	surf_sam_plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Dipole
Band	CW5400
Channels	Middle
Signal	CW

B. Permittivity

Frequency (MHz)	5400.000
Relative permittivity (real part)	37.071
Relative permittivity (imaginary part)	18.300
Conductivity (S/m)	4.875

C. SAR Surface and Volume



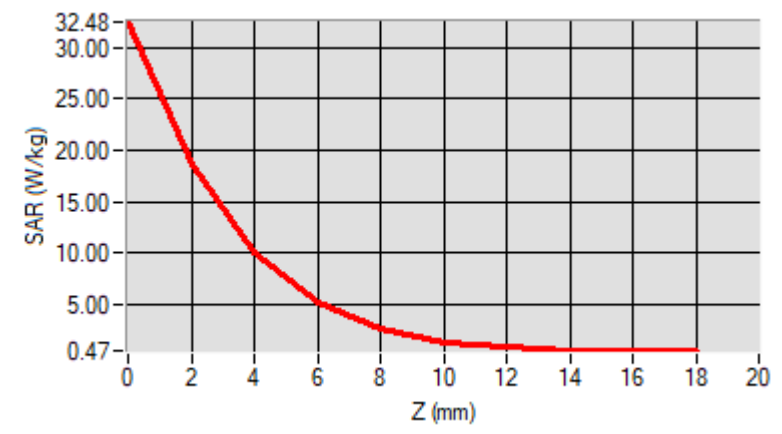
Maximum location: X=5.00, Y=0.00 ; SAR Peak: 34.04 W/kg

D. SAR 1g & 10g

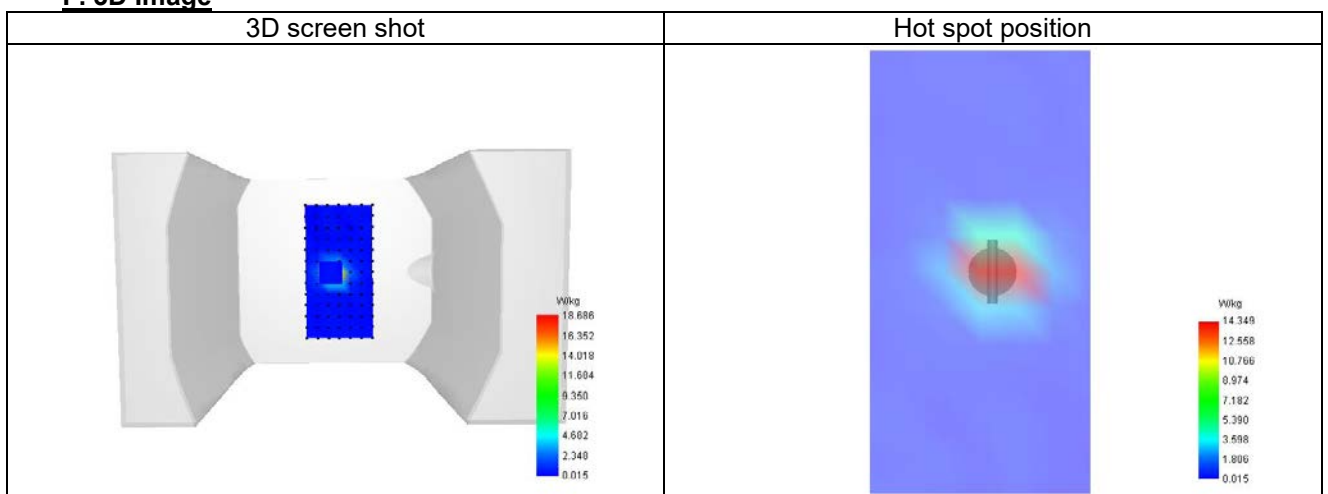
SAR 10g (W/Kg)	5.597
SAR 1g (W/Kg)	20.589
Variation (%)	2.040
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00
SAR (W/Kg)	32.476	18.686	10.034	5.088	2.563	1.347	0.796	0.566	0.487



F. 3D Image



System check at 5600 MHz

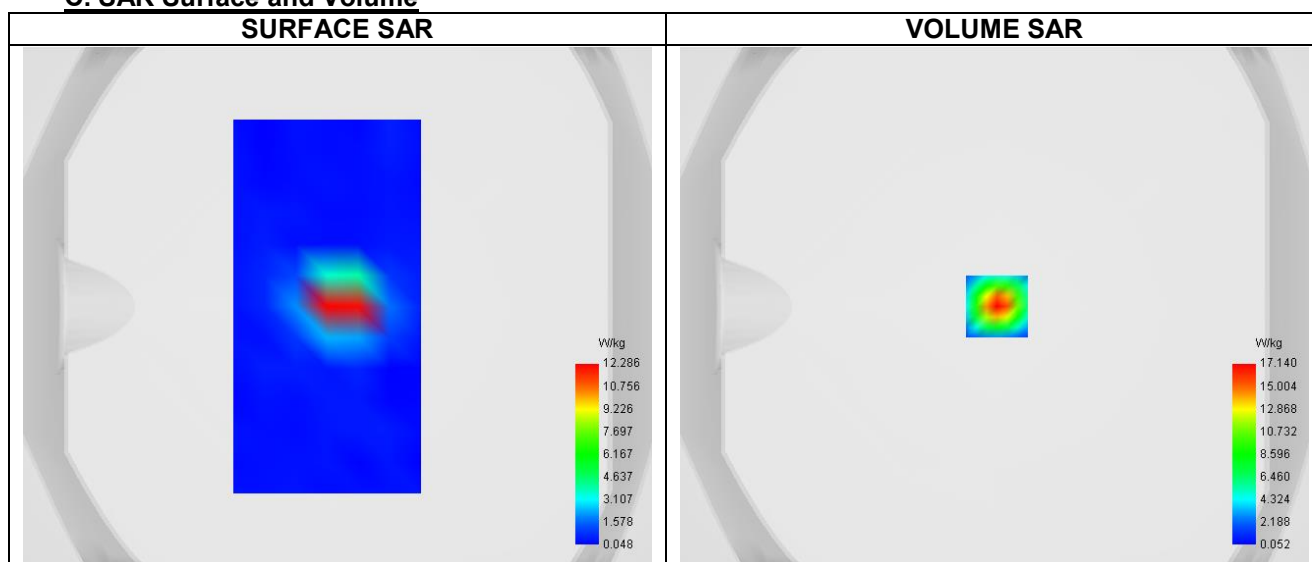
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	0.95
Area Scan	surf_sam_plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Dipole
Band	CW5600
Channels	Middle
Signal	CW

B. Permittivity

Frequency (MHz)	5600.000
Relative permittivity (real part)	34.944
Relative permittivity (imaginary part)	18.460
Conductivity (S/m)	5.148

C. SAR Surface and Volume



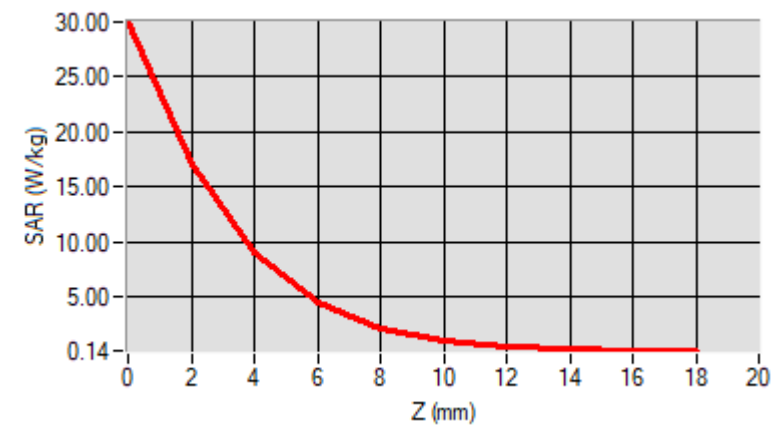
Maximum location: X=1.00, Y=0.00 ; SAR Peak: 31.08 W/kg

D. SAR 1g & 10g

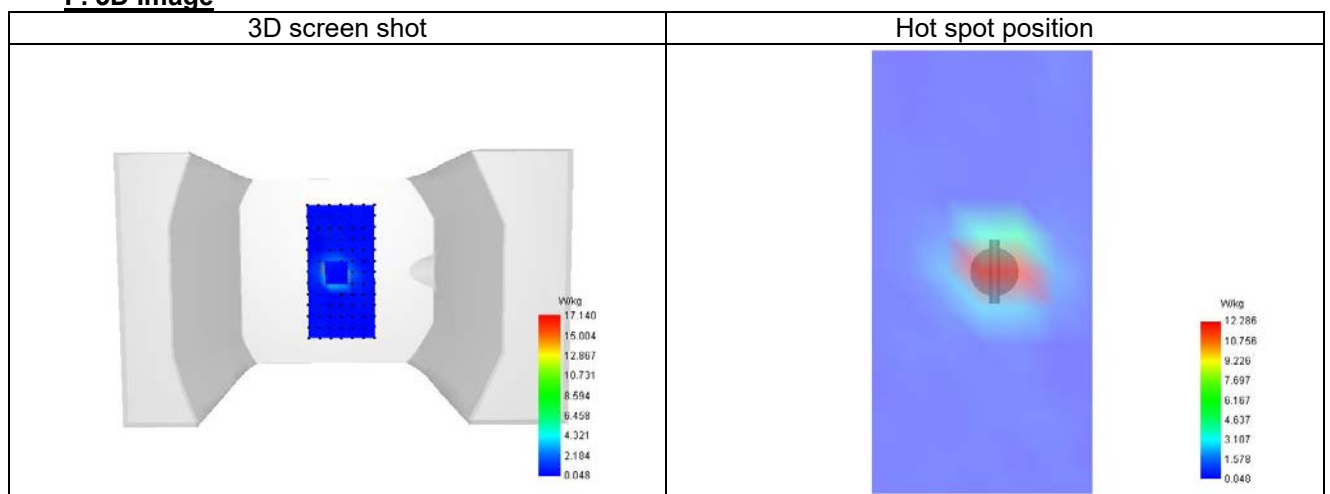
SAR 10g (W/Kg)	5.884
SAR 1g (W/Kg)	19.566
Variation (%)	3.569
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00
SAR (W/Kg)	30.005	17.140	9.077	4.467	2.119	0.999	0.495	0.280	0.189



F. 3D Image



System check at 5800 MHz

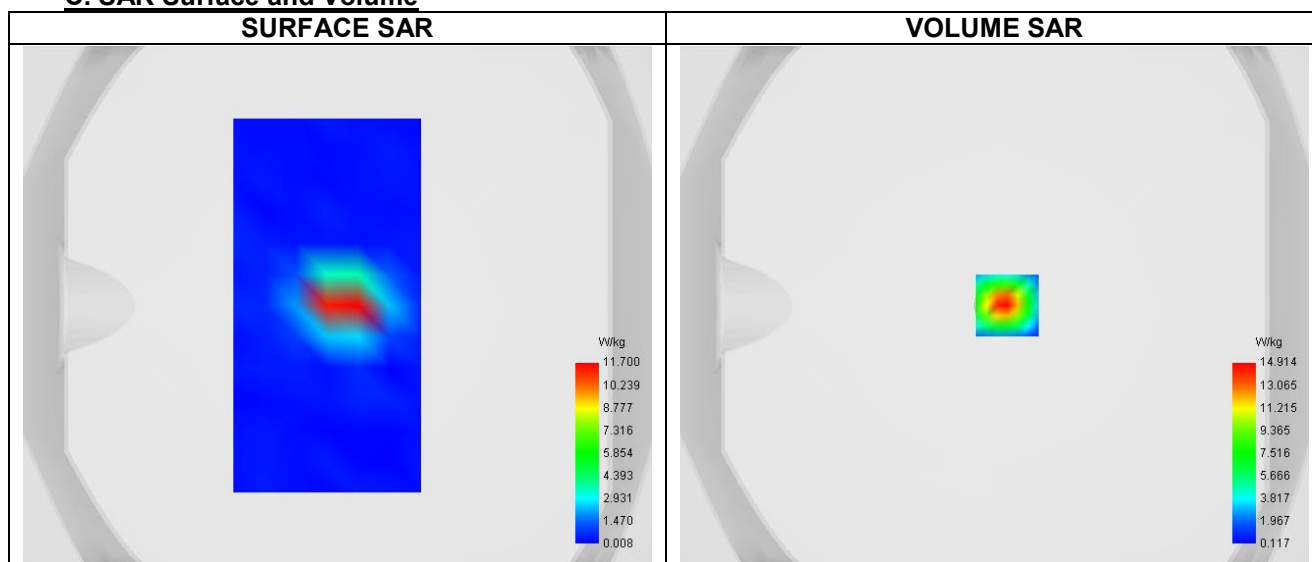
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	1.05
Area Scan	surf_sam_plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Dipole
Band	CW5800
Channels	Middle
Signal	CW

B. Permittivity

Frequency (MHz)	5800.000
Relative permittivity (real part)	34.011
Relative permittivity (imaginary part)	18.620
Conductivity (S/m)	5.144

C. SAR Surface and Volume



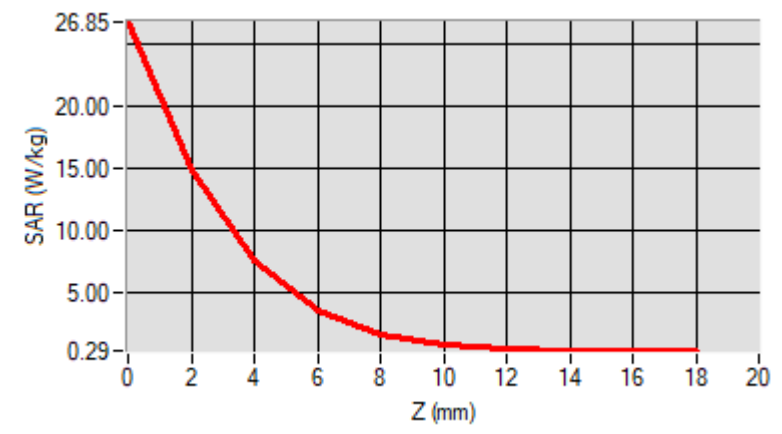
Maximum location: X=5.00, Y=0.00 ; SAR Peak: 28.22 W/kg

D. SAR 1g & 10g

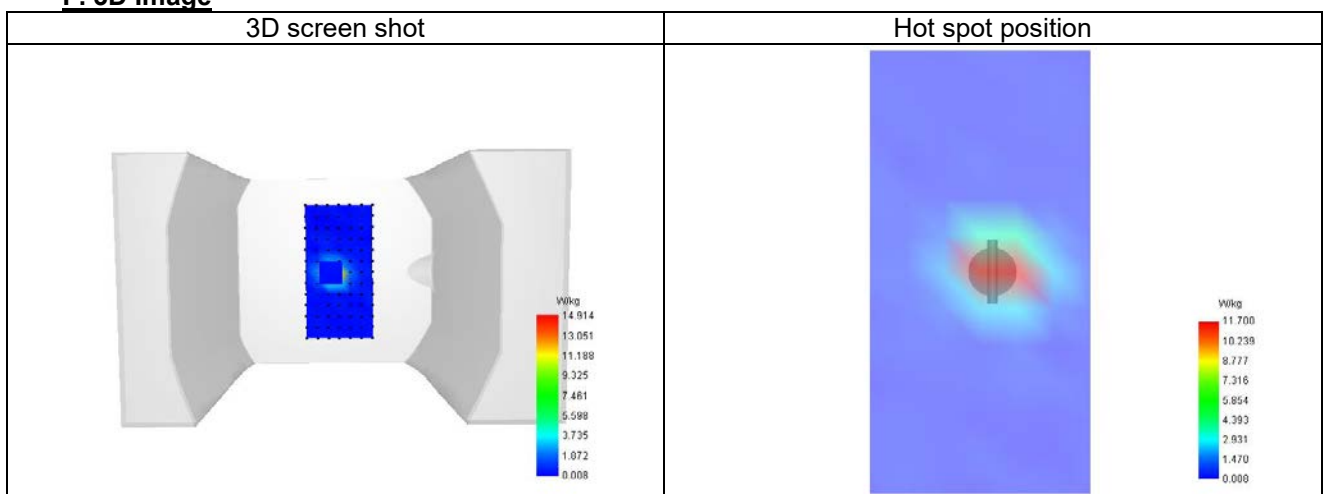
SAR 10g (W/Kg)	5.337
SAR 1g (W/Kg)	18.366
Variation (%)	1.250
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00
SAR (W/Kg)	26.852	14.914	7.581	3.559	1.627	0.770	0.423	0.303	0.288



F. 3D Image



15.2 SAR Test Graph Results

Plot 1

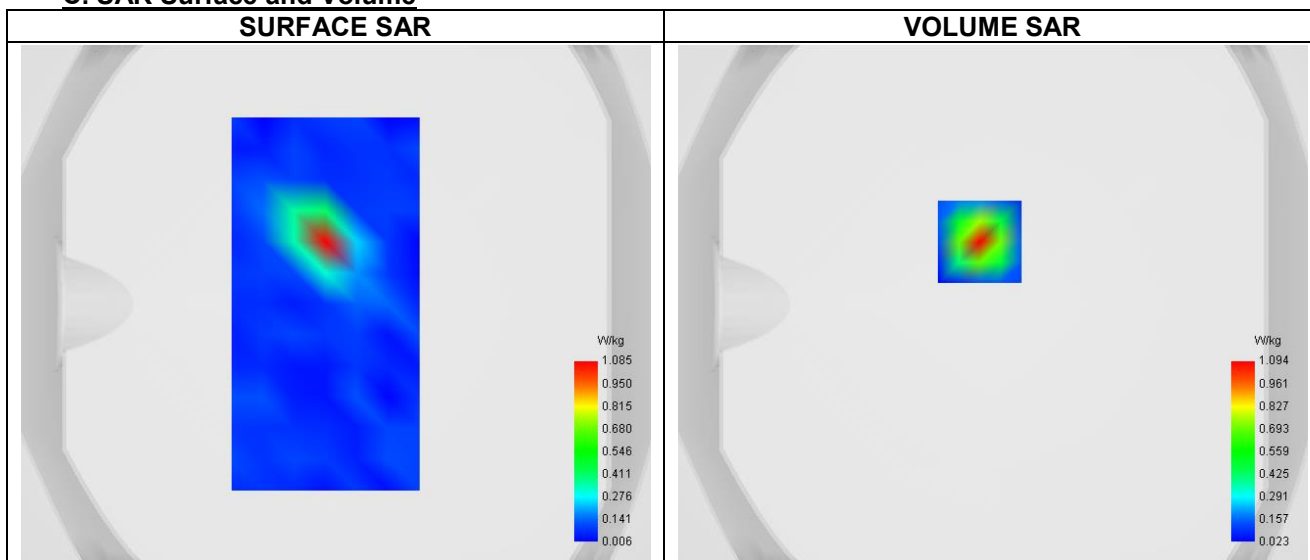
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	1.32
Area Scan	surf_sam_plan.txt
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	ISM
Channels	Lower (1)
Signal	IEEE 802.11 b

B. Permittivity

Frequency (MHz)	2412.000
Relative permittivity (real part)	38.310
Relative permittivity (imaginary part)	14.275
Conductivity (S/m)	1.765

C. SAR Surface and Volume



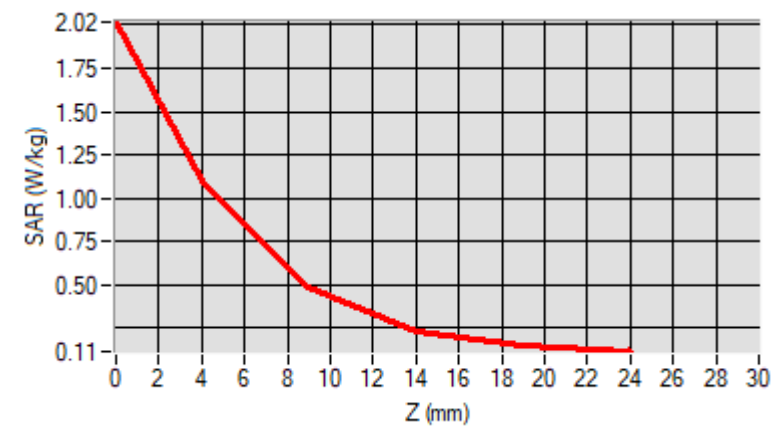
Maximum location: X=-5.00, Y=24.00 ; SAR Peak: 2.01 W/kg

D. SAR 1g & 10g

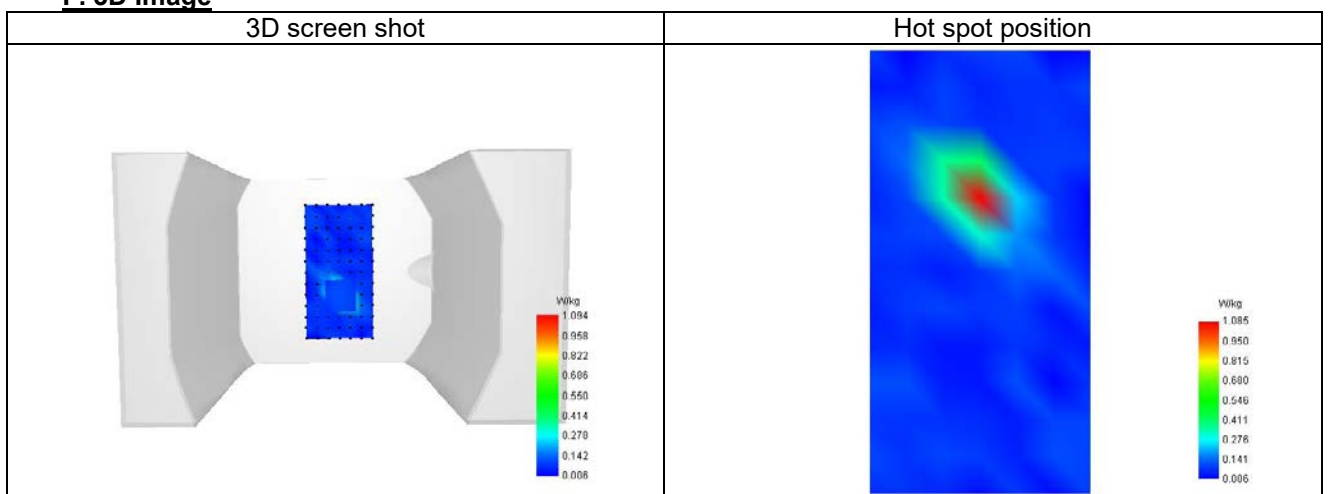
SAR 10g (W/Kg)	0.309
SAR 1g (W/Kg)	0.486
Variation (%)	2.870
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	2.016	1.094	0.484	0.231	0.145



F. 3D Image



Plot 2

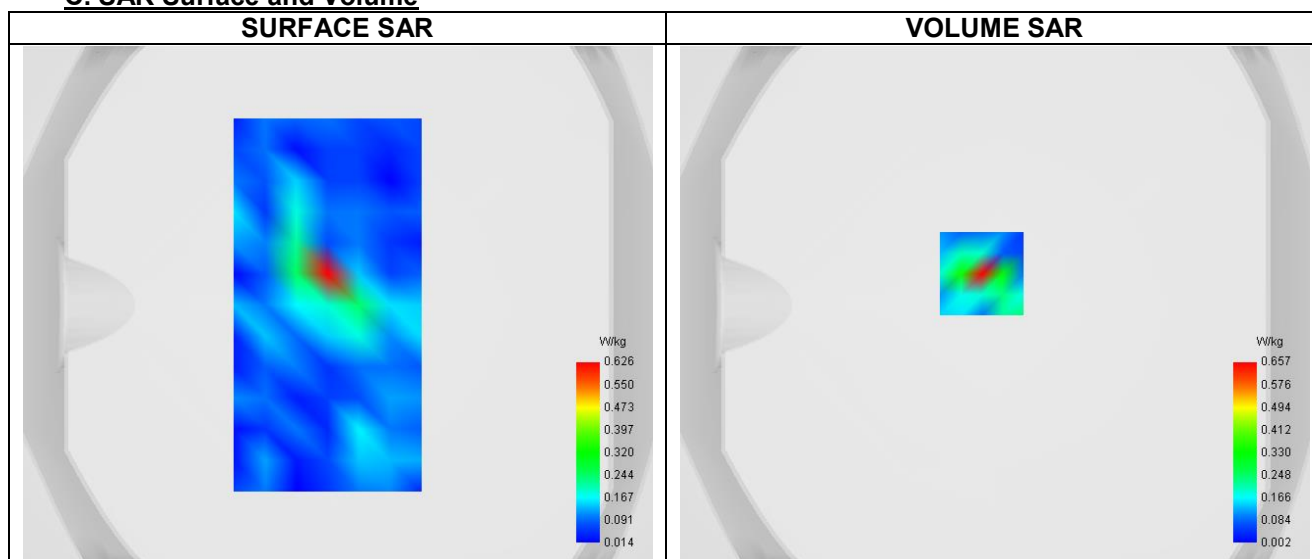
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	1.11
Area Scan	surf_sam_plan.txt
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	ISM
Channels	Higher (11)
Signal	IEEE 802.11 b

B. Permittivity

Frequency (MHz)	2462.000
Relative permittivity (real part)	38.310
Relative permittivity (imaginary part)	13.182
Conductivity (S/m)	1.765

C. SAR Surface and Volume



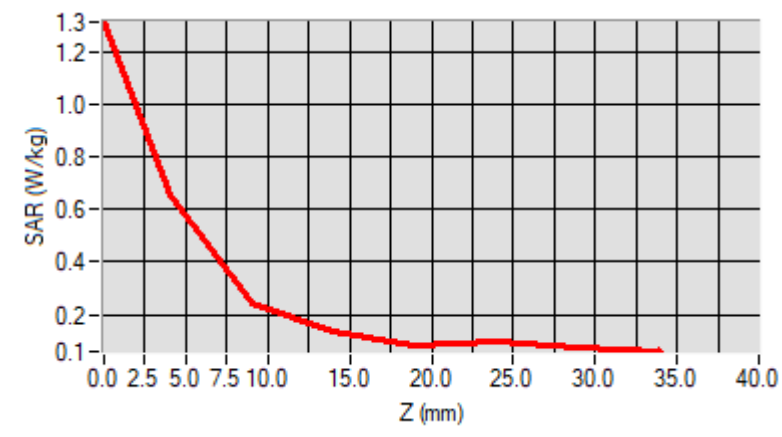
Maximum location: X=-5.00, Y=12.00 ; SAR Peak: 1.28 W/kg

D. SAR 1g & 10g

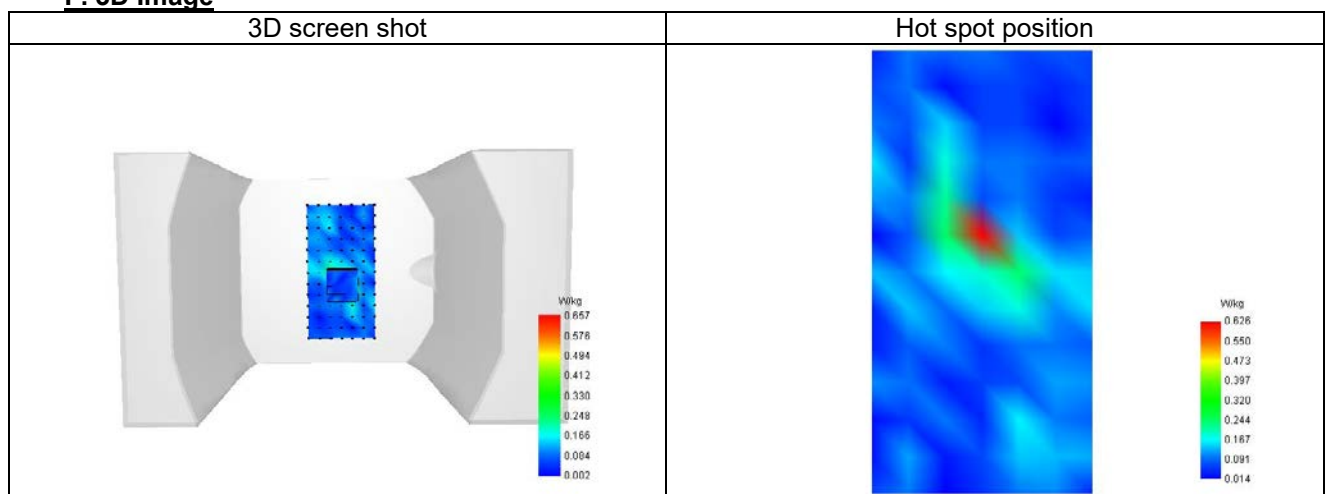
SAR 10g (W/Kg)	0.180
SAR 1g (W/Kg)	0.230
Variation (%)	2.760
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	1.312	0.657	0.243	0.136	0.079	0.097	0.072



F. 3D Image



Plot 3

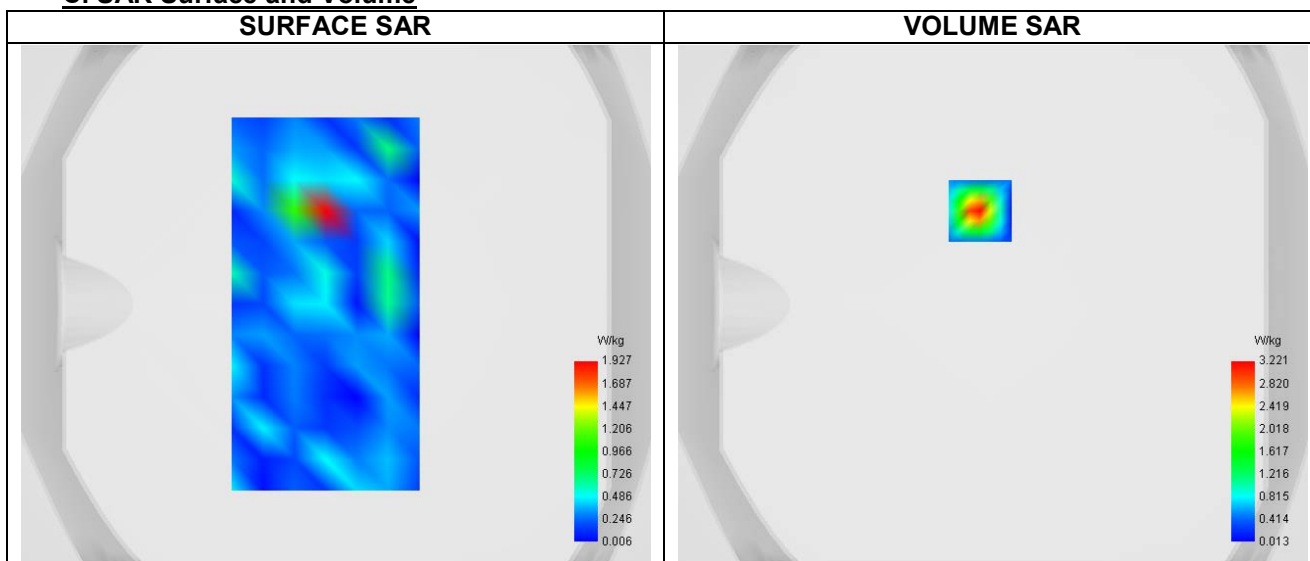
A. Experimental conditions.

Probe	SN 26/23 EPGO420
ConvF	0.97
Area Scan	surf_sam_plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	5200
Channels	Higher (2)
Signal	--

B. Permittivity

Frequency (MHz)	5240.000
Relative permittivity (real part)	35.915
Relative permittivity (imaginary part)	18.172
Conductivity (S/m)	4.550

C. SAR Surface and Volume

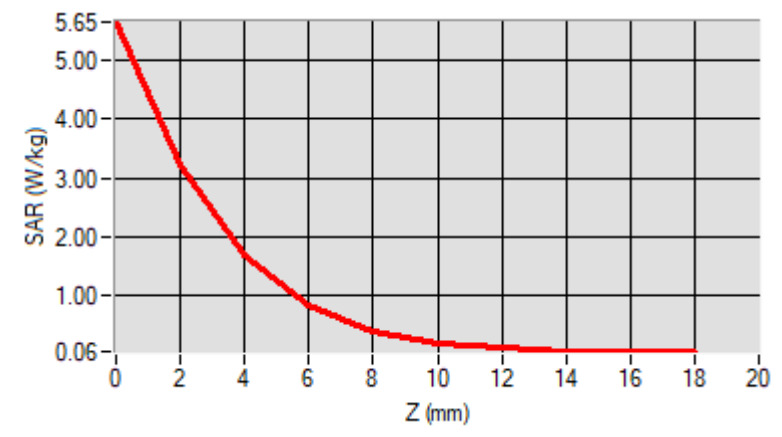


D. SAR 1g & 10g

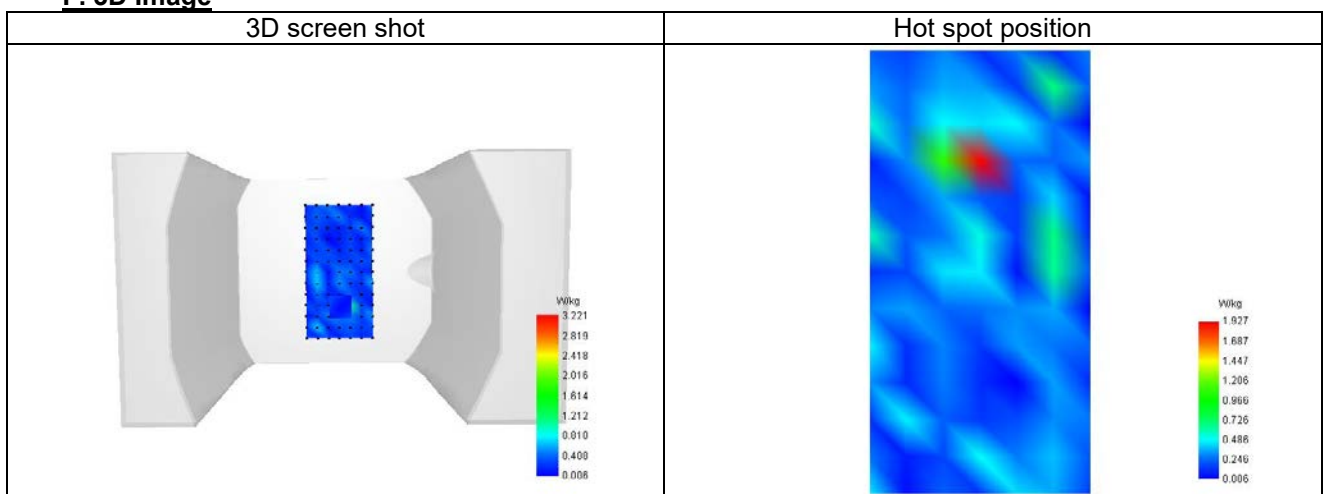
SAR 10g (W/Kg)	0.291
SAR 1g (W/Kg)	0.437
Variation (%)	2.005
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00
SAR (W/Kg)	5.652	3.221	1.704	0.843	0.410	0.205	0.114	0.077	0.064



F. 3D Image



Plot 4

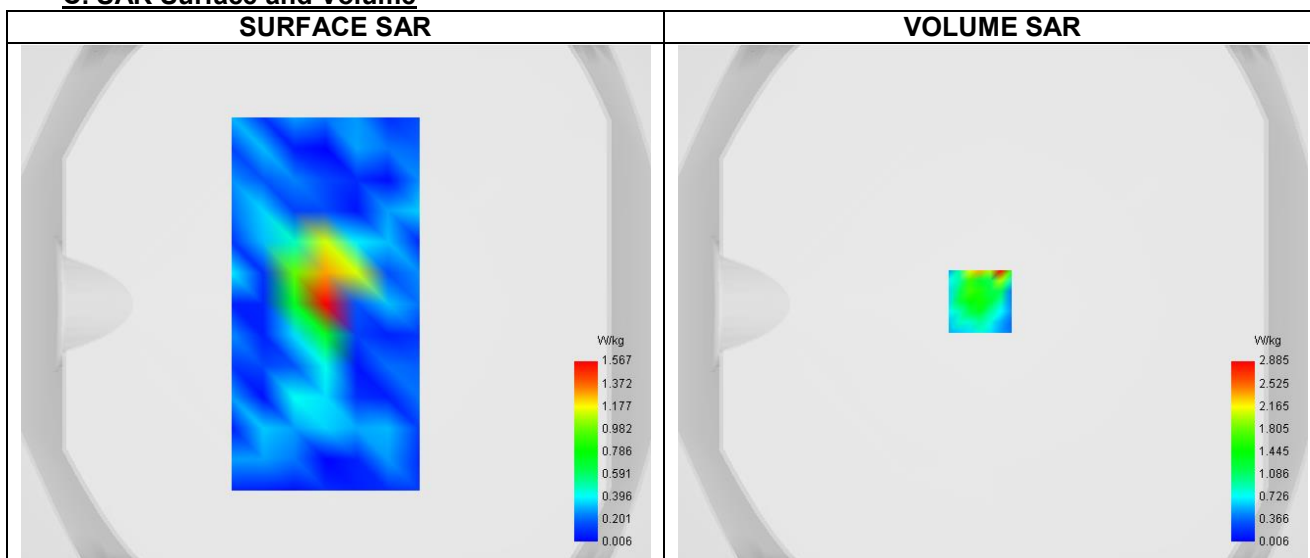
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	1.18
Area Scan	surf_sam_plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	5200
Channels	Middle (1)
Signal	--

B. Permittivity

Frequency (MHz)	5200.000
Relative permittivity (real part)	35.915
Relative permittivity (imaginary part)	16.144
Conductivity (S/m)	4.550

C. SAR Surface and Volume

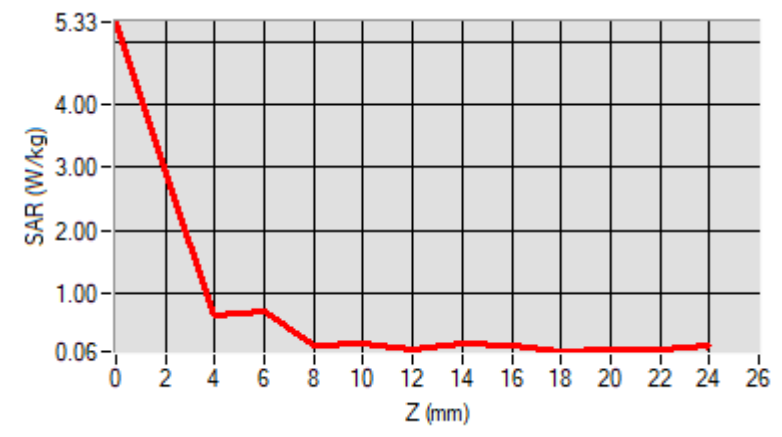


D. SAR 1g & 10g

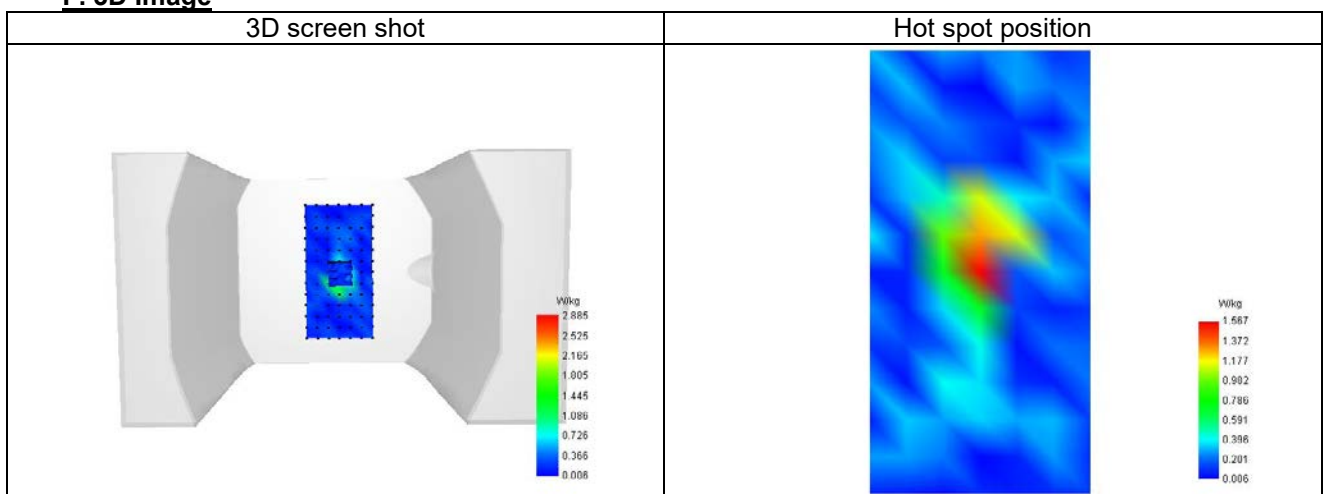
SAR 10g (W/Kg)	0.244
SAR 1g (W/Kg)	0.430
Variation (%)	0.430
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00
SAR (W/Kg)	5.326	2.885	0.625	0.687	0.157	0.193	0.085	0.173	0.149	0.057	0.104	0.091



F. 3D Image



Plot 5

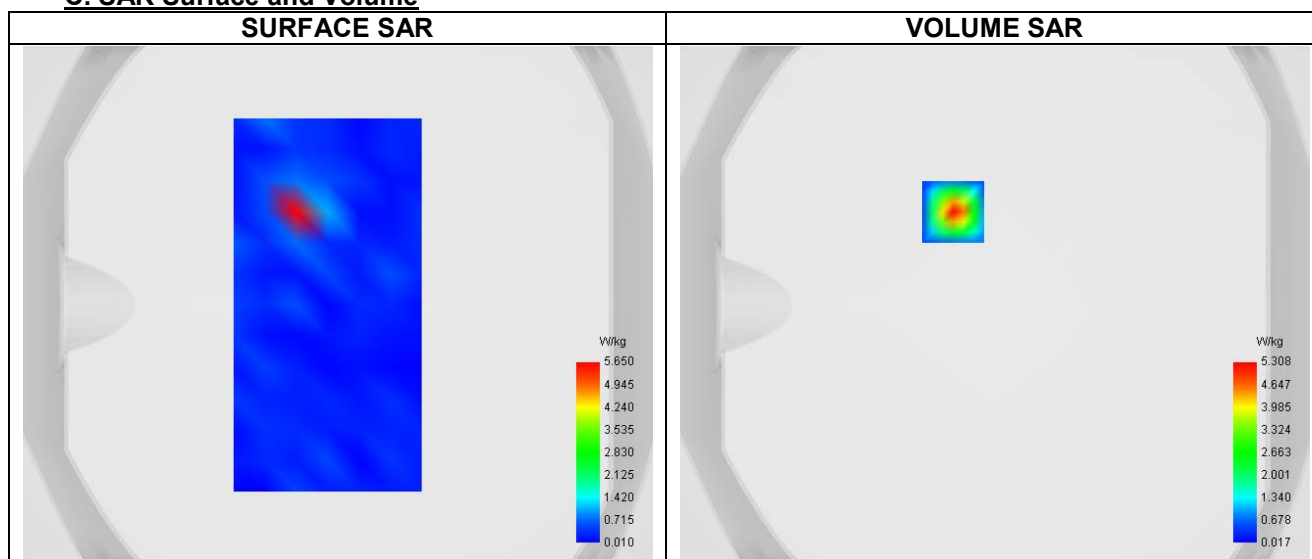
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	0.97
Area Scan	surf sam plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	5300
Channels	Lower (0)
Signal	--

B. Permittivity

Frequency (MHz)	5260.000
Relative permittivity (real part)	37.071
Relative permittivity (imaginary part)	18.204
Conductivity (S/m)	4.875

C. SAR Surface and Volume



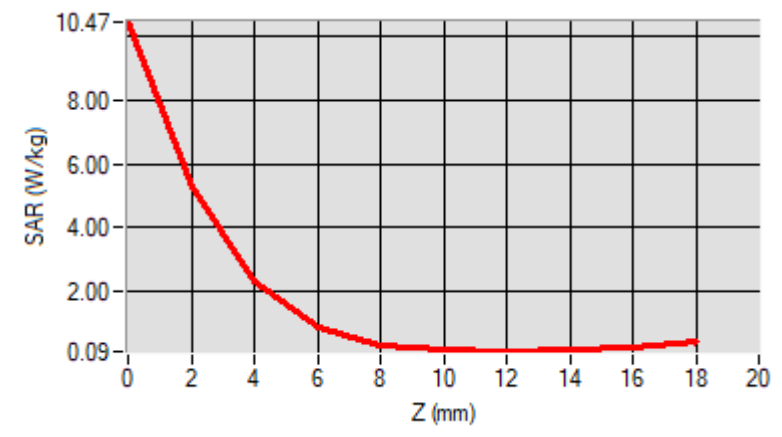
Maximum location: X=-16.00, Y=36.00 ; SAR Peak: 11.10 W/kg

D. SAR 1g & 10g

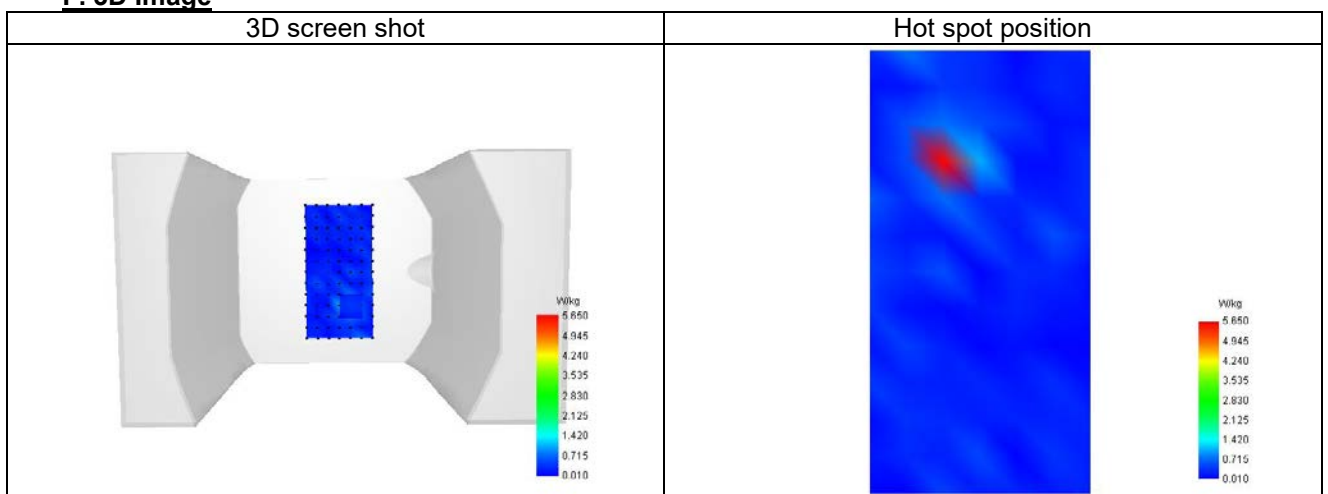
SAR 10g (W/Kg)	0.381
SAR 1g (W/Kg)	0.603
Variation (%)	2.970
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00
SAR (W/Kg)	10.468	5.308	2.309	0.874	0.315	0.132	0.094	0.126	0.224



F. 3D Image



Plot 6

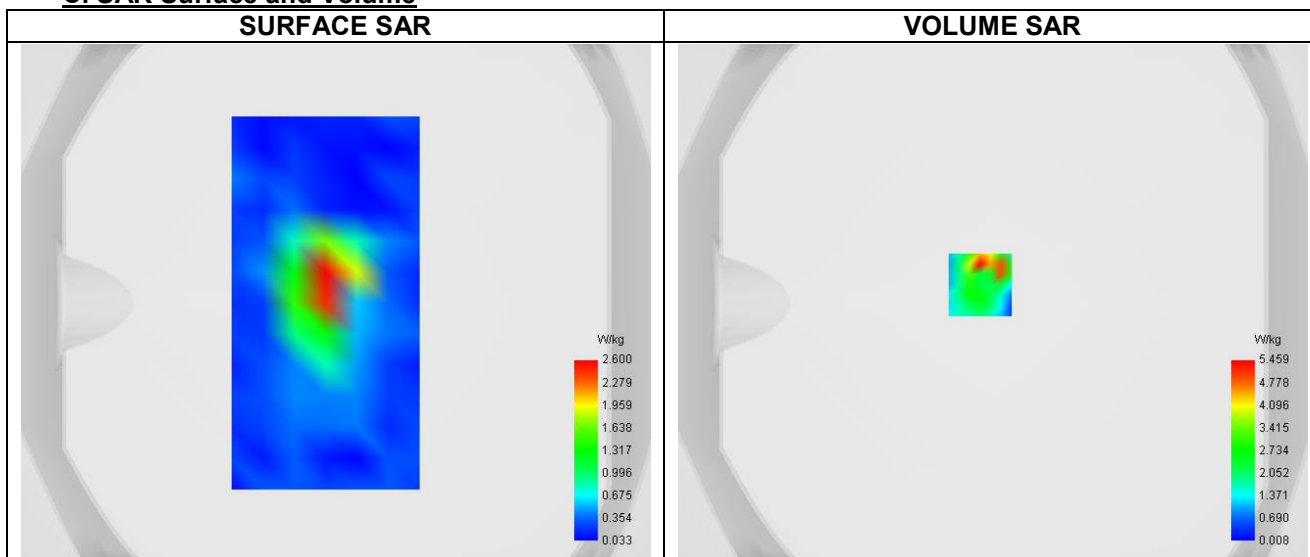
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	1.18
Area Scan	surf_sam_plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	5300
Channels	Lower (0)
Signal	--

B. Permittivity

Frequency (MHz)	5260.000
Relative permittivity (real part)	37.071
Relative permittivity (imaginary part)	16.158
Conductivity (S/m)	4.875

C. SAR Surface and Volume

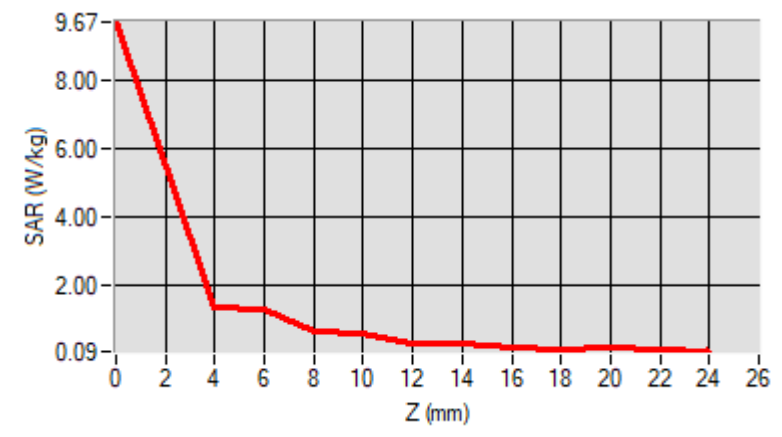


D. SAR 1g & 10g

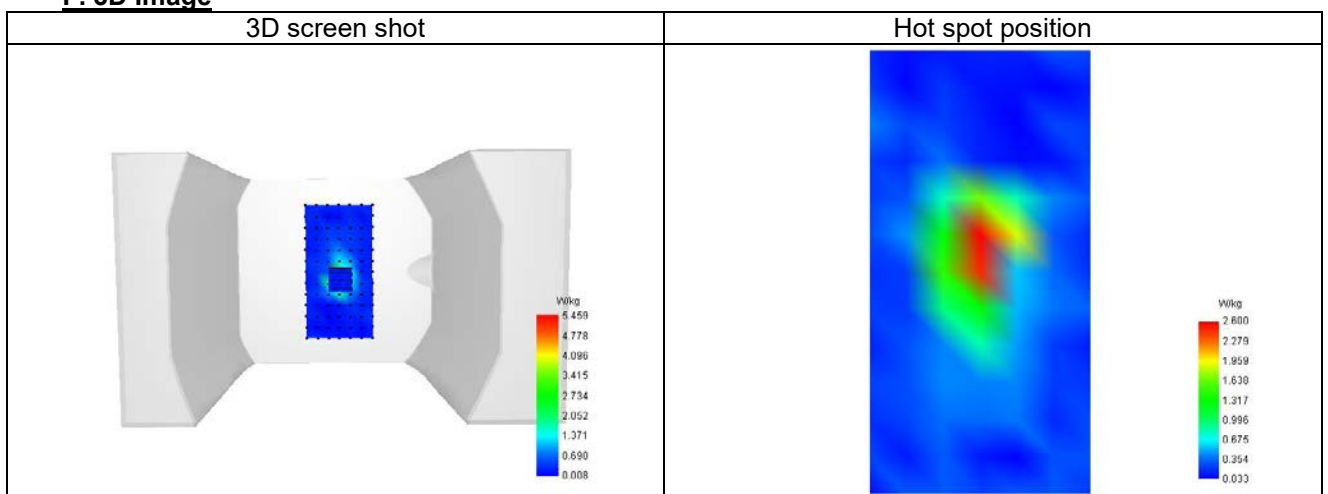
SAR 10g (W/Kg)	0.390
SAR 1g (W/Kg)	0.611
Variation (%)	-1.839
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00
SAR (W/Kg)	9.673	5.459	1.353	1.331	0.660	0.627	0.328	0.299	0.186	0.159	0.205	0.126



F. 3D Image



Plot 7

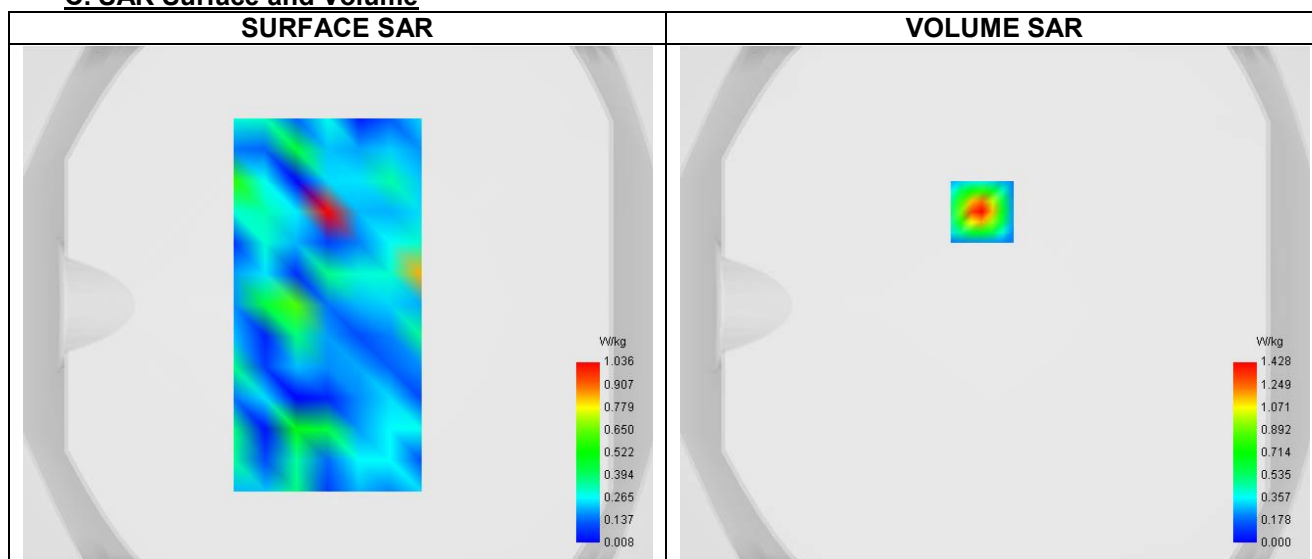
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	1.05
Area Scan	surf sam plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	5600
Channels	Higher (2)
Signal	--

B. Permittivity

Frequency (MHz)	5700.000
Relative permittivity (real part)	34.944
Relative permittivity (imaginary part)	18.608
Conductivity (S/m)	5.148

C. SAR Surface and Volume



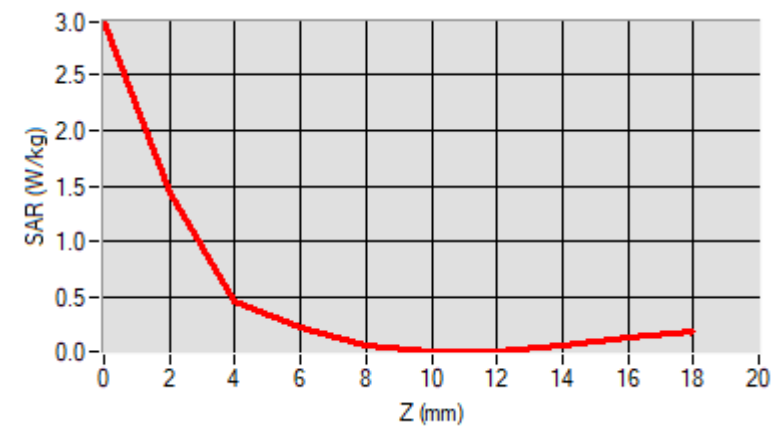
Maximum location: X=-5.00, Y=36.00 ; SAR Peak: 3.52 W/kg

D. SAR 1g & 10g

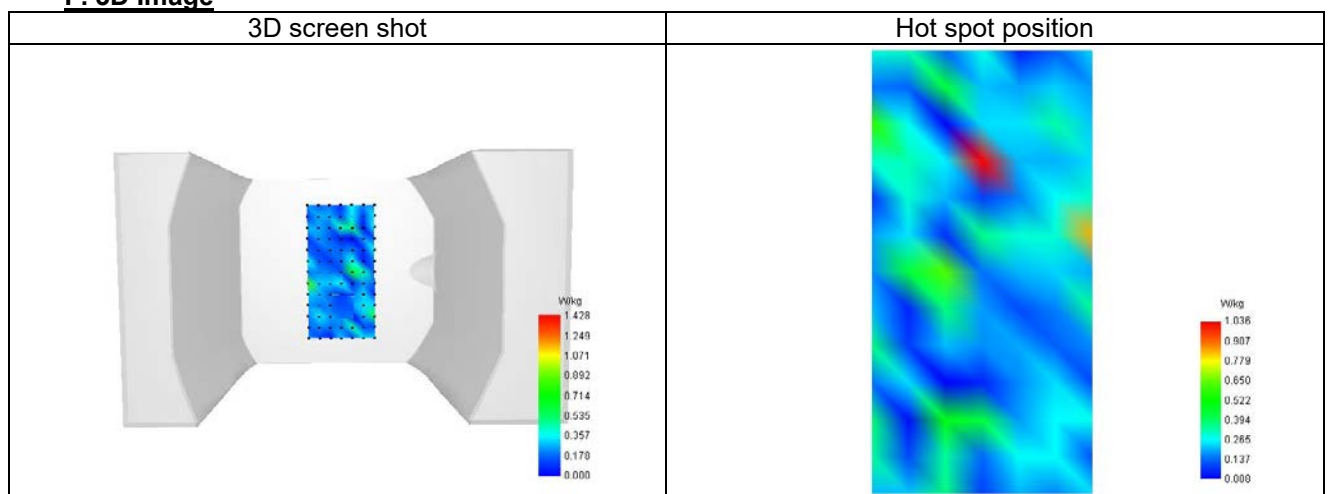
SAR 10g (W/Kg)	0.317
SAR 1g (W/Kg)	0.502
Variation (%)	-2.870
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00
SAR (W/Kg)	2.981	1.428	0.460	0.214	0.048	0.001	0.001	0.049	0.125



F. 3D Image



Plot 8

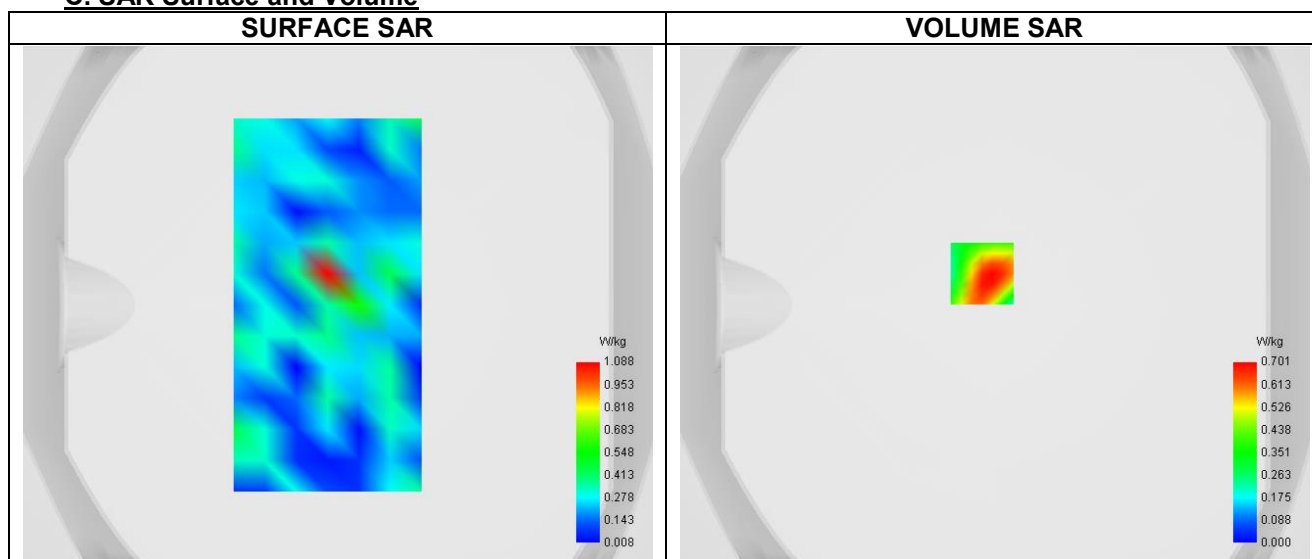
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	1.05
Area Scan	surf_sam_plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	5600
Channels	Higher (2)
Signal	--

B. Permittivity

Frequency (MHz)	5700.000
Relative permittivity (real part)	34.944
Relative permittivity (imaginary part)	18.655
Conductivity (S/m)	5.148

C. SAR Surface and Volume



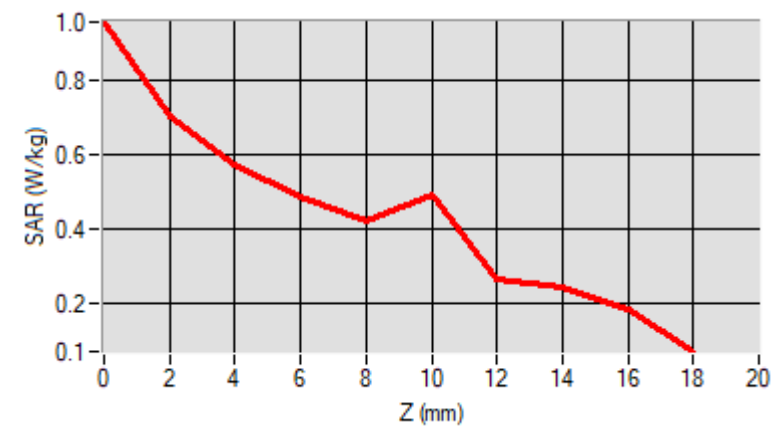
Maximum location: X=-5.00, Y=12.00 ; SAR Peak: 1.13 W/kg

D. SAR 1g & 10g

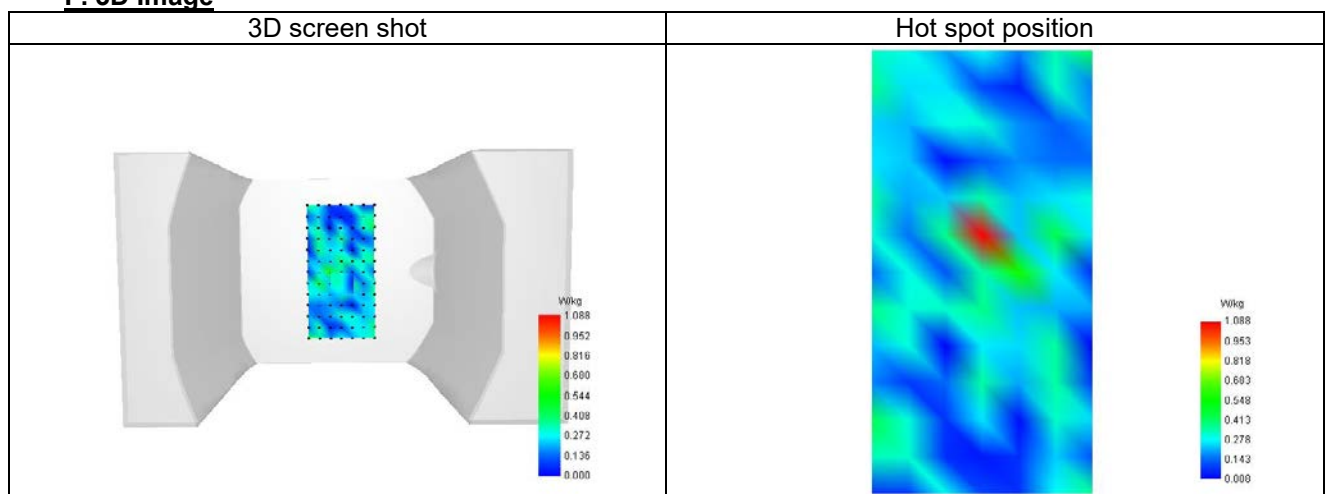
SAR 10g (W/Kg)	0.280
SAR 1g (W/Kg)	0.301
Variation (%)	-3.070
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00
SAR (W/Kg)	0.957	0.701	0.573	0.485	0.423	0.490	0.264	0.242	0.183



F. 3D Image



Plot 9

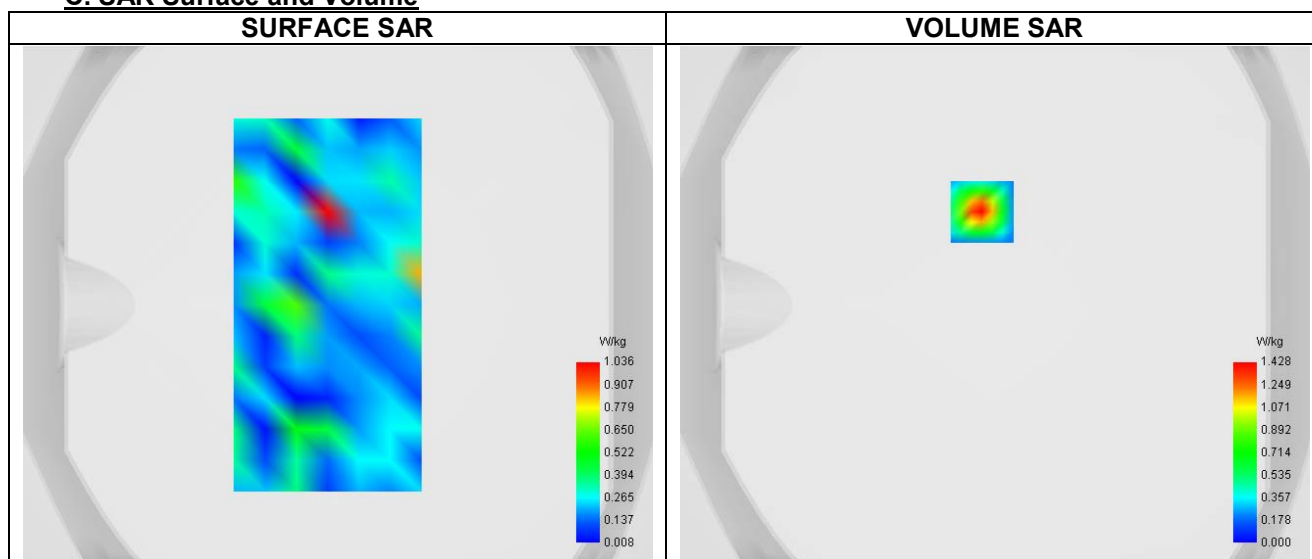
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	1.05
Area Scan	surf_sam_plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	5800
Channels	Middle (1)
Signal	--

B. Permittivity

Frequency (MHz)	5785.000
Relative permittivity (real part)	34.011
Relative permittivity (imaginary part)	18.608
Conductivity (S/m)	5.144

C. SAR Surface and Volume



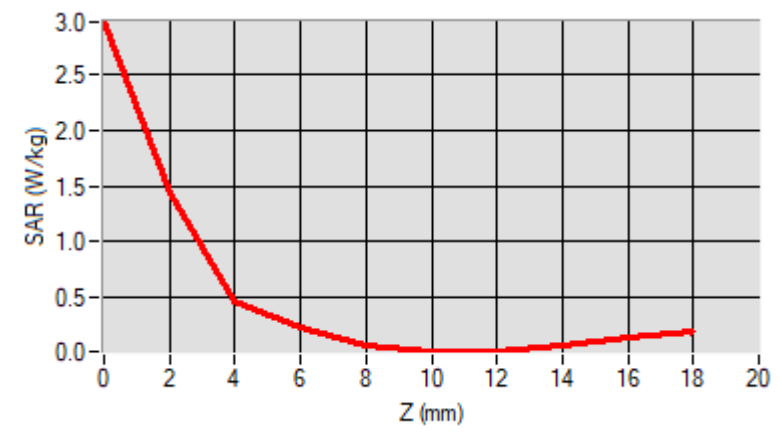
Maximum location: X=-5.00, Y=36.00 ; SAR Peak: 3.52 W/kg

D. SAR 1g & 10g

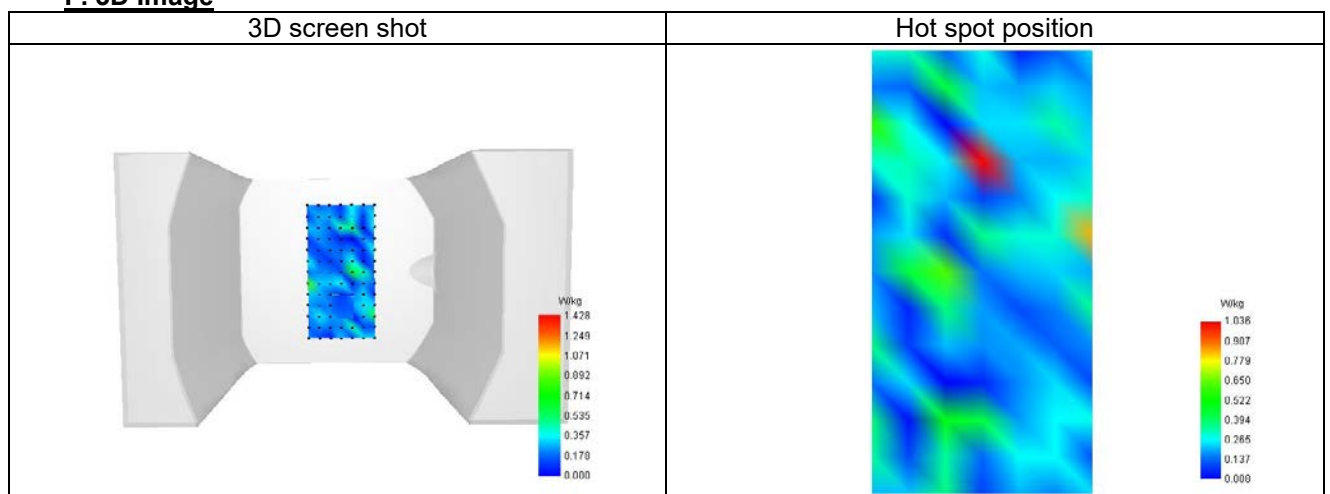
SAR 10g (W/Kg)	0.230
SAR 1g (W/Kg)	0.498
Variation (%)	3.620
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00
SAR (W/Kg)	2.981	1.428	0.460	0.214	0.048	0.001	0.001	0.049	0.125



F. 3D Image



Plot 10

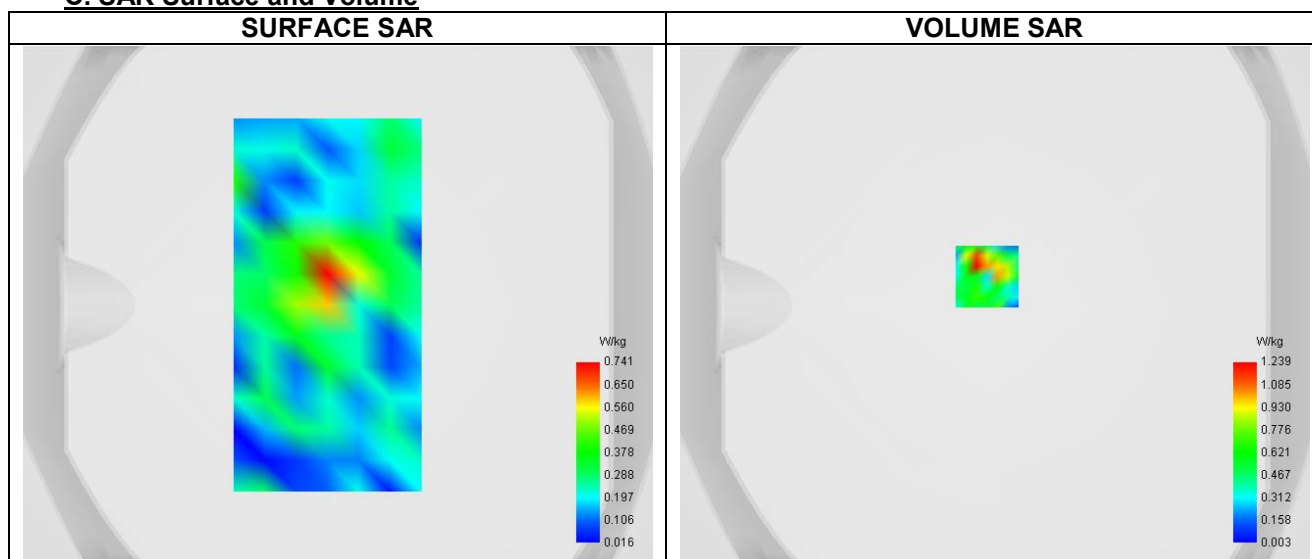
A. Experimental conditions.

Probe	SN 26/23 EPG0420
ConvF	1.15
Area Scan	surf sam plan.txt
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	5800
Channels	Lower (0)
Signal	--

B. Permittivity

Frequency (MHz)	5745.000
Relative permittivity (real part)	34.011
Relative permittivity (imaginary part)	16.344
Conductivity (S/m)	5.144

C. SAR Surface and Volume

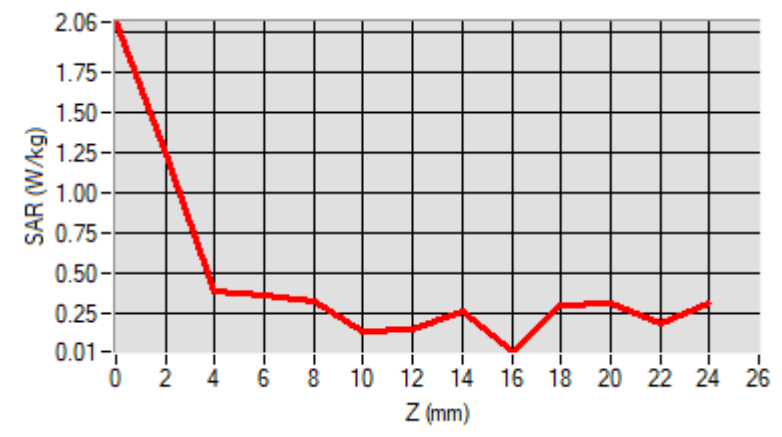


D. SAR 1g & 10g

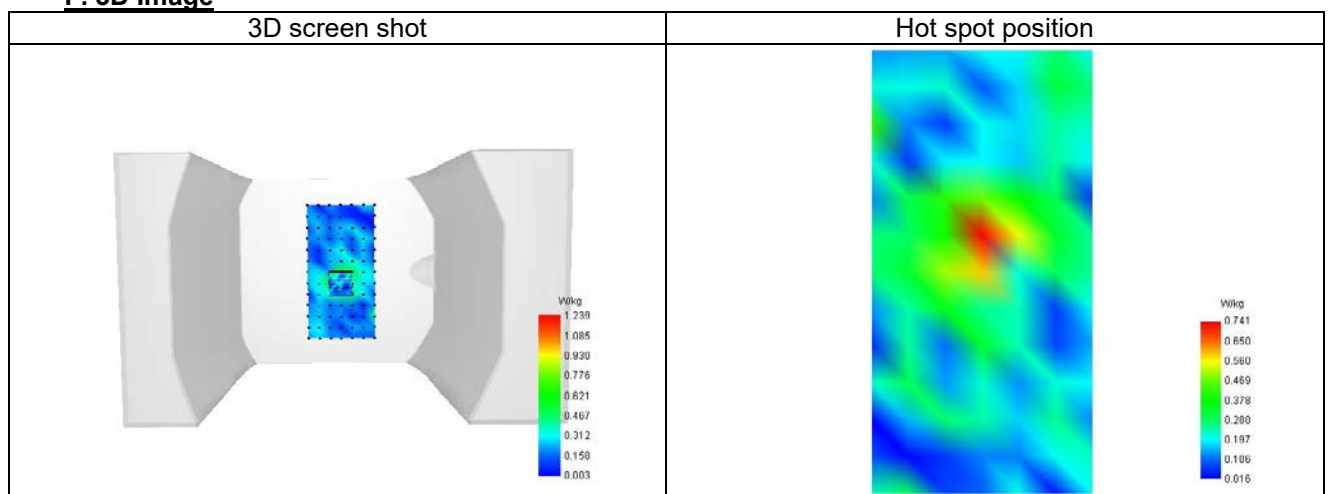
SAR 10g (W/Kg)	0.264
SAR 1g (W/Kg)	0.370
Variation (%)	-2.910
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00
SAR (W/Kg)	2.059	1.239	0.384	0.357	0.314	0.136	0.141	0.251	0.007	0.298	0.307	0.183

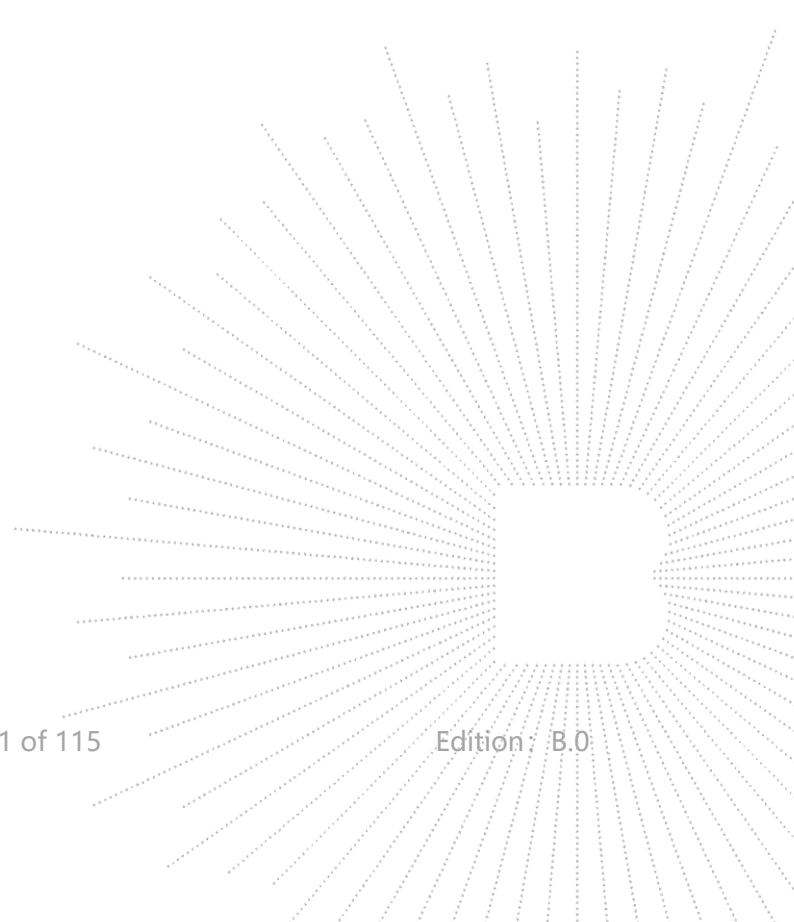


F. 3D Image



16 CALIBRATION CERTIFICATES

Probe-EPGO420 Calibration Certificate
SID2450Dipole Calibration Ceriticate
SID5000Dipole Calibration Ceriticate



**COMOSAR E-Field Probe Calibration Report**

Ref : ACR.199.1.23.BES.A

SHENZHEN BCTC TECHNOLOGY CO., LTD.

**1 ~2/ F, NO. B FACTORY BUILDING, PENGZHOU
INDUSTRIAL PARK, FUYUAN 1ST ROAD,
TANGWEI COMMUNITY, FUHAI STREET, BAO'AN
DISTRICT, SHENZHEN, GUANGDONG, CHINA
MVG COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: 2623-EPGO-420**

Calibrated at MVG**Z.I. de la pointe du diable**

**Technopôle Brest Iroise – 295 avenue Alexis de Rochon
29280 PLOUZANE - FRANCE**

Calibration date: 7/18/2023

Accreditations #2-6789
Scope available on www.cofrac.fr

The use of the Cofrac brand and the accreditation references is prohibited from any reproduction.

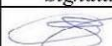
Summary:

This document presents the method and results from an accredited COMOSAR Dosimetric E-Field Probe calibration performed at MVG, using the CALIPROBE test bench, for use with a MVG COMOSAR system only. The test results covered by accreditation are traceable to the International System of Units (SI).

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.199.1.23.BES.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Cyrille ONNEE	Measurement Responsible	7/18/2023	
<i>Checked & approved by:</i>	Jérôme Luc	Technical Manager	7/18/2023	
<i>Authorized by:</i>	Yann Toutain	Laboratory Director	7/18/2023	

Yann
Toutain ID

Signature numérique
de Yann Toutain ID
Date : 2023.07.18
10:38:49 +02'00'

	<i>Customer Name</i>
<i>Distribution :</i>	Shenzhen BCTC Technology Co., Ltd.

<i>Issue</i>	<i>Name</i>	<i>Date</i>	<i>Modifications</i>
A	Cyrille ONNEE	7/18/2023	Initial release

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE2
Serial Number	2623-EPGO-420
Product Condition (new / used)	New
Frequency Range of Probe	0.15 GHz-7.5GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.228 MΩ Dipole 2: R2=0.238 MΩ Dipole 3: R3=0.230 MΩ

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

MVG's COMOSAR E field Probes are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards.



Figure 1 – MVG COMOSAR Dosimetric E field Probe

Probe Length	330 mm
Length of Individual Dipoles	24.5 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	2.55 mm
Distance between dipoles / probe extremity	12.7 mm

3 MEASUREMENT METHOD

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their effect. All calibrations / measurements performed meet the fore-mentioned standards.

3.1 SENSITIVITY

The sensitivity factors of the three dipoles were determined using a two step calibration method (air and tissue simulating liquid) using waveguides as outlined in the standards for frequency range 600-7500MHz and using the calorimeter cell method (transfer method) as outlined in the standards for frequency 150-450 MHz.



3.2 LINEARITY

The evaluation of the linearity was done in free space using the waveguide, performing a power sweep to cover the SAR range 0.01W/kg to 100W/kg.

3.3 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 to 360 degrees in 15-degree steps. The hemispherical isotropy is determined by inserting the probe in a thin plastic box filled with tissue-equivalent liquid, with the plastic box illuminated with the fields from a half wave dipole. The dipole is rotated about its axis (0°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

3.4 BOUNDARY EFFECT

The boundary effect is defined as the deviation between the SAR measured data and the expected exponential decay in the liquid when the probe is oriented normal to the interface. To evaluate this effect, the liquid filled flat phantom is exposed to fields from either a reference dipole or waveguide. With the probe normal to the phantom surface, the peak spatial average SAR is measured and compared to the analytical value at the surface.

The boundary effect uncertainty can be estimated according to the following uncertainty approximation formula based on linear and exponential extrapolations between the surface and d_{be} + d_{step} along lines that are approximately normal to the surface:

$$SAR_{uncertainty} [\%] = \Delta SAR_{be} \frac{(d_{be} + d_{step})^2}{2d_{step}} \frac{(e^{-d_{be}/\delta} - e^{-(d_{be} + d_{step})/\delta})}{\delta/2} \quad \text{for } (d_{be} + d_{step}) < 10 \text{ mm}$$

where

$SAR_{uncertainty}$	is the uncertainty in percent of the probe boundary effect
d_{be}	is the distance between the surface and the closest <i>zoom-scan</i> measurement point, in millimetre
Δ_{step}	is the separation distance between the first and second measurement points that are closest to the phantom surface, in millimetre, assuming the boundary effect at the second location is negligible
δ	is the minimum penetration depth in millimetres of the head tissue-equivalent liquids defined in this standard, i.e., $\delta \approx 14$ mm at 3 GHz;
ΔSAR_{be}	in percent of SAR is the deviation between the measured SAR value, at the distance d_{be} from the boundary, and the analytical SAR value.

The measured worst case boundary effect SARuncertainty[%] for scanning distances larger than 4mm is 1.0% Limit, 2%).



4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty associated with a SAR probe calibration using the waveguide or calorimetric cell technique depending on the frequency.

The estimated expanded uncertainty (k=2) in calibration for SAR (W/kg) is +/-11% for the frequency range 150-450MHz.

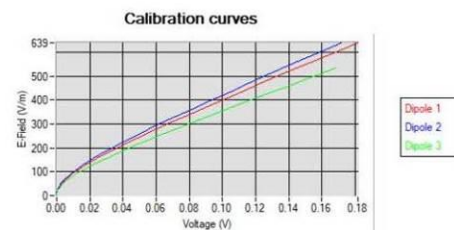
The estimated expanded uncertainty (k=2) in calibration for SAR (W/kg) is +/-14% for the frequency range 600-7500MHz.

5 CALIBRATION RESULTS

Ambient condition	
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

5.1 CALIBRATION IN AIR

The following curve represents the measurement in waveguide of the voltage picked up by the probe toward the E-field generated inside the waveguide.



From this curve, the sensitivity in air is calculated using the below formula.

$$E^2 = \sum_{i=1}^3 \frac{V_i (1 + V_i / DCP_i)}{Norm_i}$$

where

Vi=voltage readings on the 3 channels of the probe

DCPi=diode compression point given below for the 3 channels of the probe

Normi=dipole sensitivity given below for the 3 channels of the probe

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Normx dipole 1 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normy dipole 2 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normz dipole 3 ($\mu\text{V}/(\text{V}/\text{m})^2$)
1.21	1.09	1.56

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
106	109	103

5.2 CALIBRATION IN LIQUID

The calorimeter cell or the waveguide is used to determine the calibration in liquid using the formula below.

$$ConvF = \frac{E_{liquid}^2}{E_{air}^2}$$

The E-field in the liquid is determined from the SAR measurement according to the below formula.

$$E_{liquid}^2 = \frac{\rho SAR}{\sigma}$$

where

σ =the conductivity of the liquid

ρ =the volumetric density of the liquid

SAR=the SAR measured from the formula that depends on the setup used. The SAR formulas are given below

For the calorimeter cell (150-450 MHz), the formula is:

$$SAR = c \frac{dT}{dt}$$

where

c =the specific heat for the liquid

dT/dt =the temperature rises over the time

For the waveguide setup (600-75000 MHz), the formula is:

$$SAR = \frac{4P_W}{ab\delta} e^{-\frac{2z}{\delta}}$$

where

a =the larger cross-sectional of the waveguide

b =the smaller cross-sectional of the waveguide

δ =the skin depth for the liquid in the waveguide

P_W =the power delivered to the liquid

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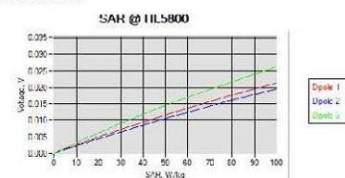
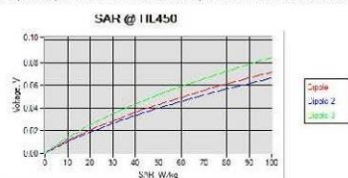

COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.199.1.23.BES.A

The below table summarize the ConvF for the calibrated liquid. The curves give examples for the measured SAR depending on the voltage in some liquid.

Liquid	Frequency (MHz*)	ConvF
HL450	450	0.86
BL450	450	0.78
HL750	750	0.80
BL750	750	0.87
HL850	835	0.81
BL850	835	0.80
HL900	900	0.76
BL900	900	0.87
HL1800	1800	0.96
BL1800	1800	1.01
HL1900	1900	1.04
BL1900	1900	1.11
HL2100	2100	1.00
BL2100	2100	1.16
HL2300	2300	1.11
BL2300	2300	1.23
HL2450	2450	1.11
BL2450	2450	1.32
HL2600	2600	1.03
BL2600	2600	1.19
HL5200	5200	1.18
BL5200	5200	0.97
HL5400	5400	1.17
BL5400	5400	1.00
HL5600	5600	1.20
BL5600	5600	0.95
HL5800	5800	1.15
BL5800	5800	1.05

(*) Frequency validity is +/-50MHz below 600MHz, +/-100MHz from 600MHz to 6GHz and +/-700MHz above 6GHz



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6 VERIFICATION RESULTS

The figures below represent the measured linearity and axial isotropy for this probe. The probe specification is ± 0.2 dB for linearity and ± 0.15 dB for axial isotropy.

