

FCC SAR TEST REPORT

Report No.: BCTC2301770787-5E

Applicant: Nex Computer LLC

Product Name: NexDock

Model/Type Ref.: NexDock Wireless

Tested Date: 2023-02-21 to 2023-02-22

Issued Date: 2023-04-27

Shenzhen BCTC Testing Co., Ltd.



FCC ID:2AIMUNDW2213

Product Name: NexDock
Trademark: N/A
Model/Type Ref.: NexDock Wireless
Applicant: Nex Computer LLC
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Sample Received Date: 2023-02-06
Sample tested Date: 2023-02-21 to 2023-02-22
Issue Date: 2023-02-23
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:



Hubery Cai/ Project Handler

Approved by:



Zero Zhou/Reviewer

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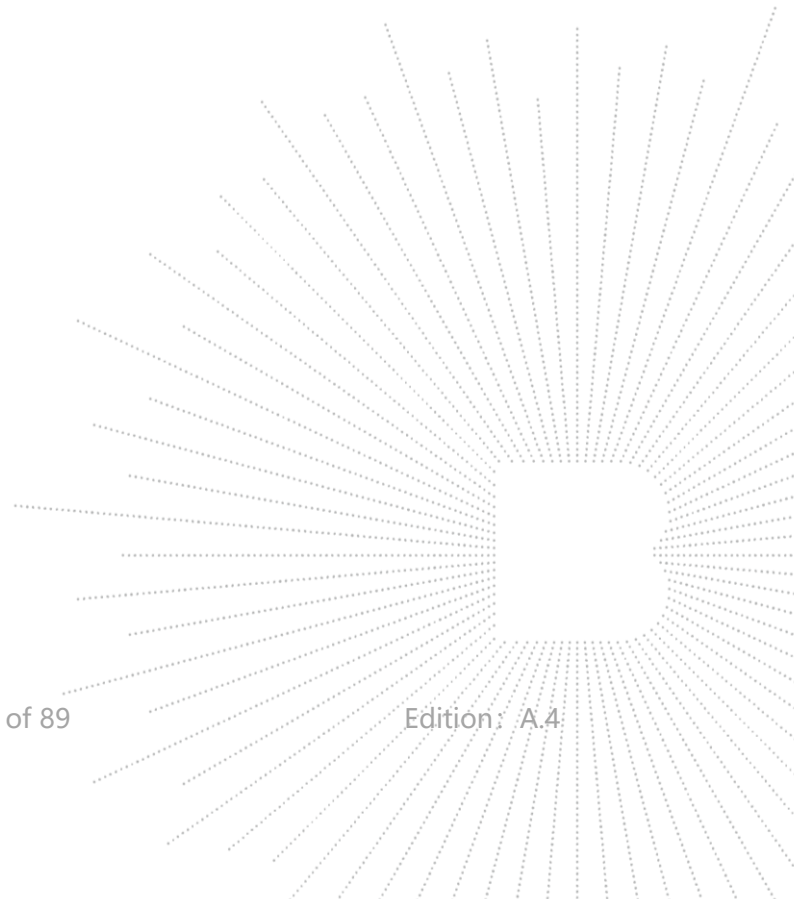
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(Note: N/A Means Not Applicable)

1. Version

Report No.	Issue Date	Description	Approved
BCTC2301770787-5E	2023-04-27	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

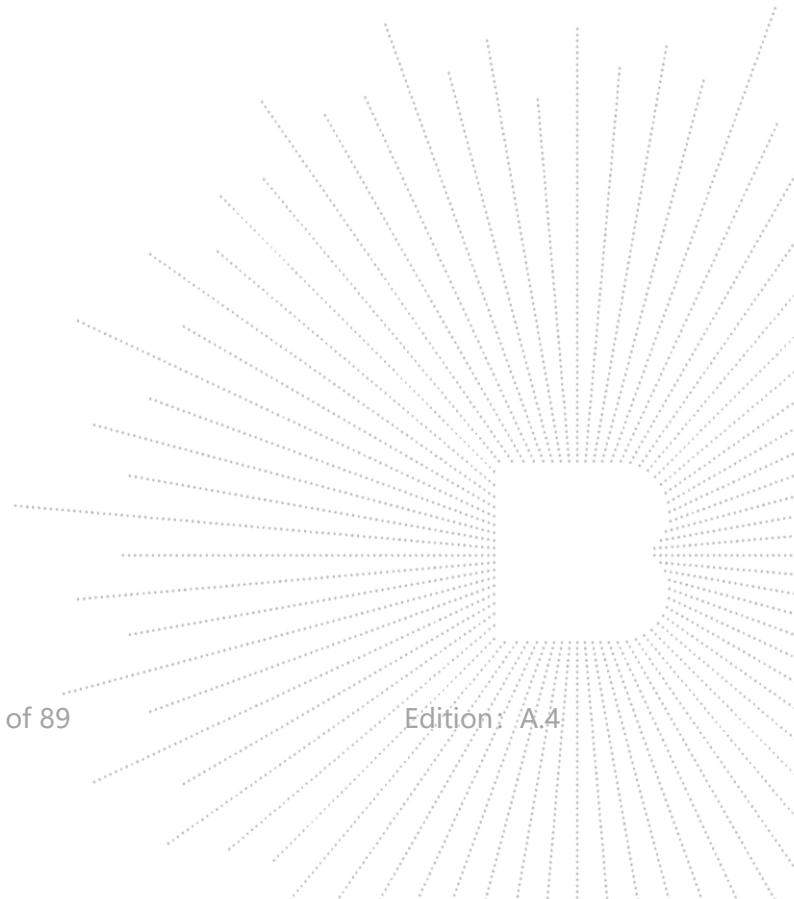
KDB447498 D01 General RF Exposure Guidance v06 : Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies

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

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

KDB 248227 D01 802.11 Wi-Fi SAR v02r02: SAR GUIDANCE FOR IEEE 802.11 (Wi-Fi) TRANSMITTERS

KDB 616217 D04 SAR for laptop and tablets v01r02: SAR EVALUATION CONSIDERATIONS FOR LAPTOP, NOTEBOOK, NETBOOK AND TABLET COMPUTERS



3. Test Summary

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

Frequency Band	Body (0mm Gap)	SAR _{1g} Limit (W/kg)
	Report SAR _{1g} (W/kg)	
WIFI 2.4G	0.150	1.6
WIFI 5G	0.289	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.

Highest Reported simultaneous SAR

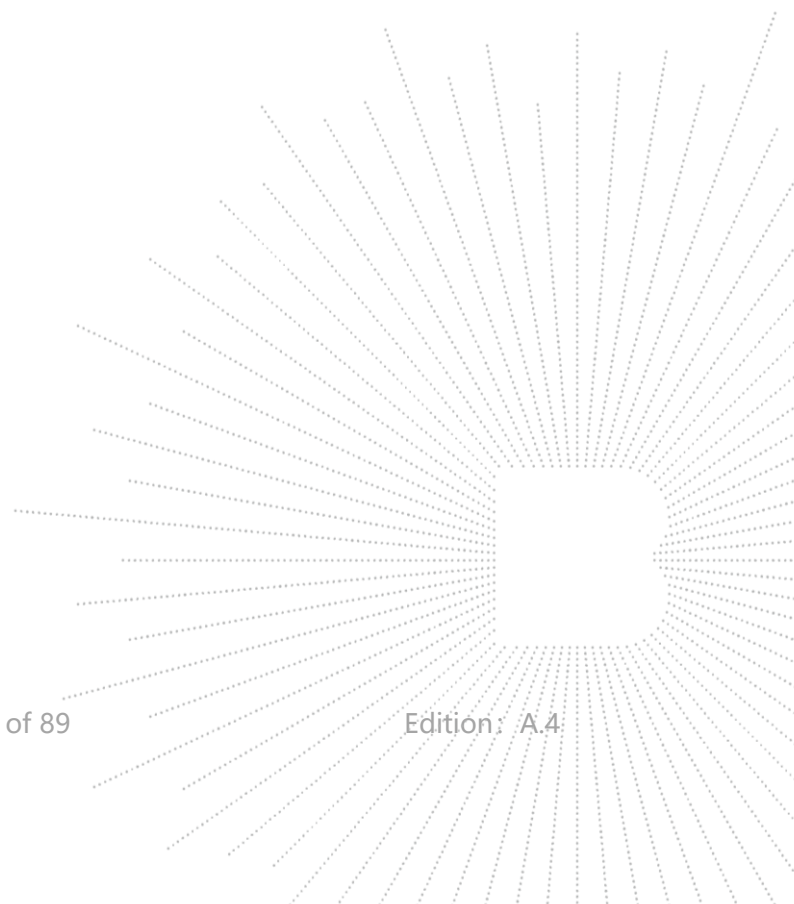
Exposure Position	Classment Class	Highest Reported Simultaneous Transmission SAR _{1-g} (W/kg)
Body	WIFI	0.441
	BT	

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

Not required as SAR measurement uncertainty analysis is required in SAR reports only when the highest measured SAR in a frequency band is ≥ 1.5 W/kg for 1-g SAR according to KDB865664D01.

Uncertainty Component	Tol (+-%)	Prob. Dist.	Div.	Ci (1g)	Ci (10g)	1g Ui (+-%)	10g Ui (+-%)	Veff
Measurement System								
Probe calibration	5.8	N	1	1	1	5.80	5.80	∞
Axial Isotropy	3.5	R	√3	$\sqrt{1 - c_p}$	$\sqrt{1 - c_p}$	1.43	1.43	∞
Hemispherical Isotropy	5.9	R	√3	$\sqrt{c_p}$	$\sqrt{c_p}$	2.41	2.41	∞
Boundary effect	1.0	R	√3	1	1	0.58	0.58	∞
Linearity	4.7	R	√3	1	1	2.71	2.71	∞
System detection limits	1.0	R	√3	1	1	0.58	0.58	∞
Readout Electronics	0.5	N	1	1	1	0.50	0.50	∞
Response Time	0.0	R	√3	1	1	0.00	0.00	∞
Integration Time	1.4	R	√3	1	1	0.81	0.81	∞
RF ambient Conditions - Noise	3.0	R	√3	1	1	1.73	1.73	∞
RF ambient Conditions - Reflections	3.0	R	√3	1	1	1.73	1.73	∞
Probe positioner Mechanical Tolerance	1.4	R	√3	1	1	0.81	0.81	∞
Probe positioning with respect to Phantom Shell	1.4	R	√3	1	1	0.81	0.81	∞
Max. SAR Evaluation	1.0	R	√3	1	1	0.6	0.6	∞
Test sample Related								
Device positioning	2.6	N	1	1	1	2.6	2.6	11
Device holder	3.0	N	1	1	1	3.0	3.0	7
Drift of output power	5.0	N	√3	1	1	2.89	2.89	∞
Phantom and Tissue Parameters								
Phantom uncertainty	4.00	R	√3	1	1	2.31	2.31	∞
Liquid conductivity (target)	2.50	N	1	0.78	0.71	1.95	1.78	5
Liquid conductivity (meas)	4.00	N	1	0.23	0.26	0.92	1.04	5
Liquid Permittivity (target)	2.50	N	1	0.78	0.71	1.95	1.78	∞
Liquid Permittivity (meas)	5.00	N	1	0.23	0.26	1.15	1.30	∞
Combined Standard		RSS	$U_c = \sqrt{\sum_{i=1}^n c_i^2 U_i^2}$			10.63 %	10.54%	
Expanded Uncertainty (95% Confidence interval)	U = k UC , k=2					21.26 %	21.08%	

6. Product Information And Test Setup

6.1 Product Information

Model/Type Ref.:	NexDock Wireless
Model differences:	N/A
Hardware Version:	N/A
Software Version:	N/A
Remark:	The antenna gain of the product is provided by the customer, and the test data is affected by the customer information.
Ratings:	DC 12V 2A Battery: DC 7.6V
Adapter 1 information:	MODEL:JP-P08 Input:AC100-240V 50/60Hz 0.5A Max PD Output: DC 5V 3A/DC 9V 2.22A/DC 12V 1.67A
Adapter 2 information:	MODEL:S-TR-151PU4 Input:AC100-240V 50/60Hz 0.5A Max PD Output: DC 5V 3A/DC 9V 2.22A/DC 12V 1.67A

WIFI 2.4G

Operation Frequency:	802.11b/g/n20MHz:2412~2462 MHz 802.11n40MHz:2422~2452 MHz
Bit Rate of Transmitter:	802.11b:11/5.5/2/1 Mbps 802.11g:54/48/36/24/18/12/9/6Mbps 802.11n Up to 75Mbps
Type of Modulation:	WIFI: OFDM/DSSS
Number Of Channel:	802.11b/g/n20MHz:11 CH 802.11n40MHz: 7 CH
Antenna installation:	FPCB antenna
Antenna Gain:	3.43 dBi

BT 1

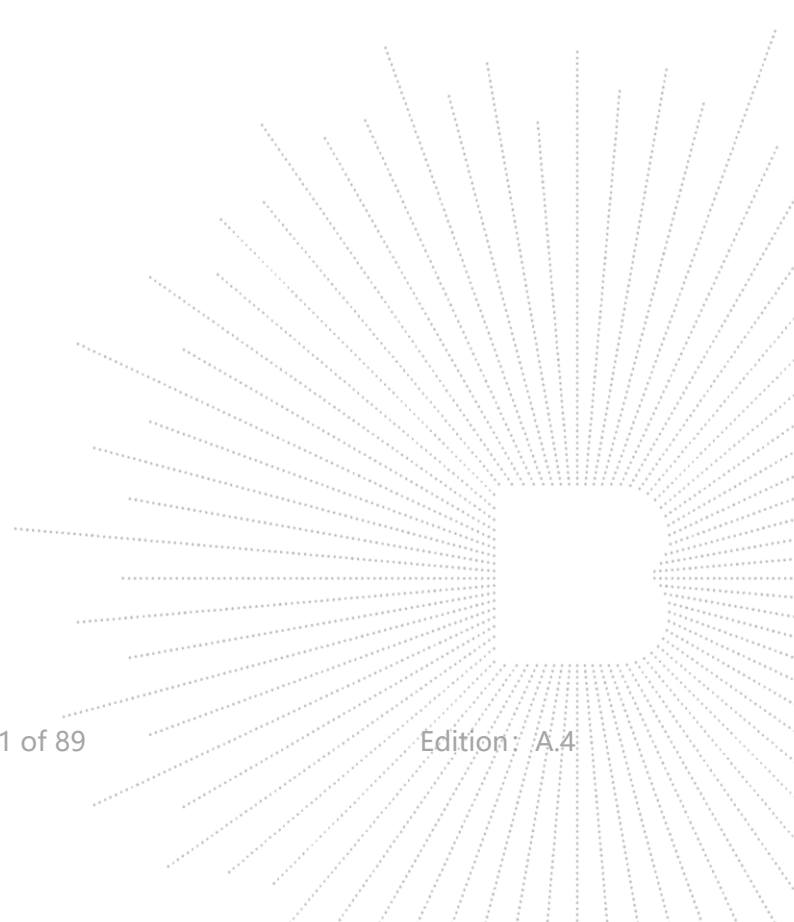
Operation Frequency:	Bluetooth: 2402-2480MHz
Type of Modulation:	Bluetooth: GFSK
Number Of Channel:	40CH
Antenna installation:	FPCB antenna
Antenna Gain:	3.46 dBi

BT 2

Operation Frequency:	Bluetooth: 2402-2480MHz
Type of Modulation:	Bluetooth: GFSK
Number Of Channel:	40CH
Antenna installation:	FPCB antenna
Antenna Gain:	2.16 dBi

WIFI 5G

Operation Frequency:	5180-5240MHz for 802.11a/n(HT20)/ac20; 5190-5230MHz for 802.11n(HT40)/ac40; 5210MHz for 802.11 ac80; 5745-5825 MHz for 802.11a/n(HT20)/ac20; 5755-5795 MHz for 802.11a/n(HT40)/ac40; 5775MHz for 802.11 ac80;
Bit Rate of Transmitter:	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-MCS
Type of Modulation:	OFDM with BPSK/QPSK/16QAM/64QAM/256QAM for 802.11a/n/ac;
Number Of Channel:	4 channels for 802.11a/n20 in the 5180-5240MHz band ; 2 channels for 802.11 n40 in the 5190-5230MHz band ; 1 channels for 802.11 ac80 in the 5210MHz band ; 5 channels for 802.11a/n20 in the 5745-5825MHz band ; 2 channels for 802.11 n40 in the 5755-5795MHz band ; 1 channels for 802.11 ac80 in the 5775MHz band ;
Antenna installation:	FPCB antenna
Antenna Gain:	5.1G:2.1 dBi 5.8G:2.27 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(%):	54
Atmospheric Pressure(kPa):	101
Temperature(°C):	21

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.

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	Agilent	83712A	\	May 24, 2022	May 23, 2023
Multimeter	Keithley	1160271	\	Nov. 10, 2022	Nov 09, 2023
S-parameter Network Analyzer	R&S	ZVB 8	101353	Dec. 07, 2022	Dec. 06, 2023
Wideband Radio Communication Tester	R&S	CMW500	\	Nov. 10, 2022	Nov 09, 2023
E SAR PROBE 6GHz	MVG	SSE2	SN EPGO373	June 29, 2022	June 28, 2023
DIPOLE 2450	SATIMO	SID 2450	SN 47/21 DIP 0G835-621	Nov. 20, 2021	Nov. 19, 2024
DIPOLE 5000	SATIMO	SID5000	SN 47/21 DIP 5G000-629	Nov. 20, 2021	Nov. 19, 2024
COMOSAR OPENCoaxial Probe	SATIMO	\	\	Nov. 18, 2022	Nov. 17, 2023
SAR Locator	SATIMO	\	\	Nov. 18, 2022	Nov. 17, 2023
Communication Antenna	SATIMO	\	\	Nov. 18, 2022	Nov. 17, 2023
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	Nov. 18, 2022	Nov. 17, 2023
Power meter	Agilent	E4419	\	May 24, 2022	May 23, 2023
Power meter	Agilent	E4419	\	May 24, 2022	May 23, 2023
Power sensor	Agilent	E9300A	\	May 24, 2022	May 23, 2023
Power sensor	Agilent	E9300A	\	May 24, 2022	May 23, 2023
Directional Coupler	Krytar 158020	131467	\	Nov. 10, 2022	Nov 09, 2023

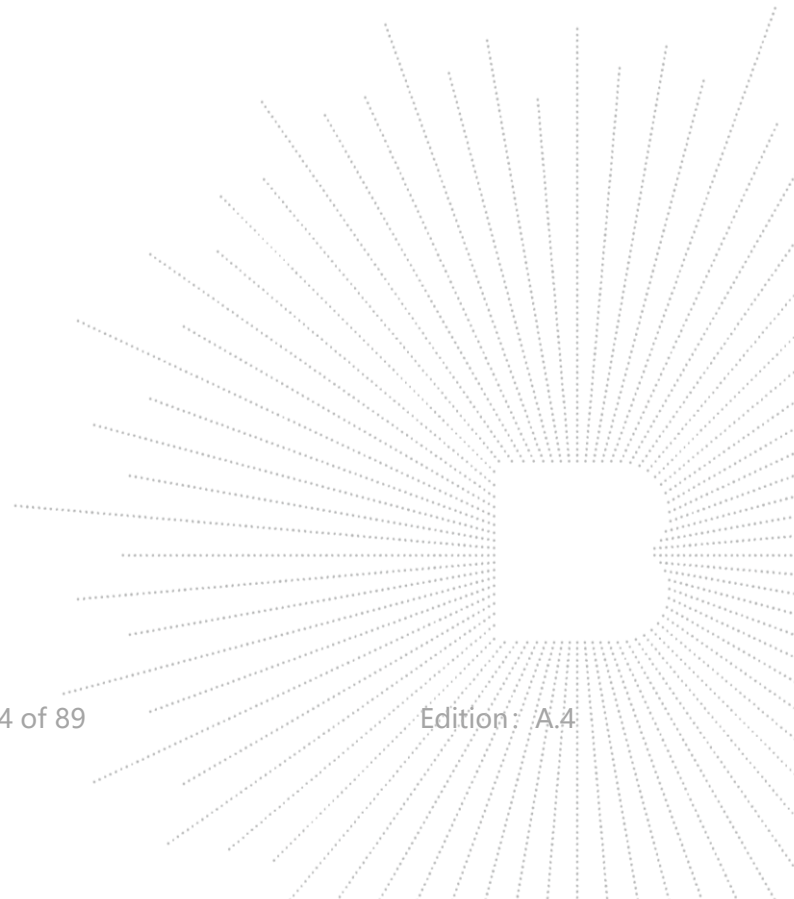
Note:

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.

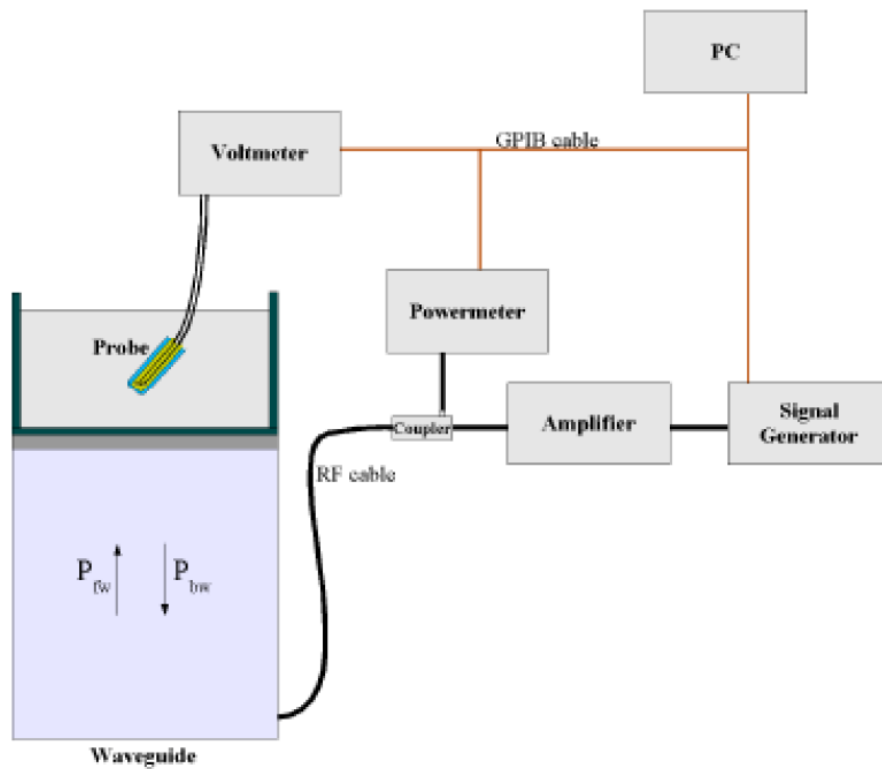
9.2 Probe

For the measurements the Specific Dosimetric E-Field Probe SN 46/21 EPG0362 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, Antenna proprietary calibration system. The calibration is performed with the EN 62209-1 annex technique using reference guide at the five frequencies.



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

Where :

P_{fw} = Forward Power

P_{bw} = Backward Power

a and b = Waveguide dimensions

δ = 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:

$$CF(N) = SAR(N)/V_{lin}(N) \quad (N=1,2,3)$$

The linearised output voltage $V_{lin}(N)$ is obtained from the displayed output voltage $V(N)$ using

$$V_{lin}(N) = V(N) * (1 + V(N)/DCP(N)) \quad (N=1,2,3)$$

where DCP is the diode compression point in mV.

9.3 Test Procedure

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.

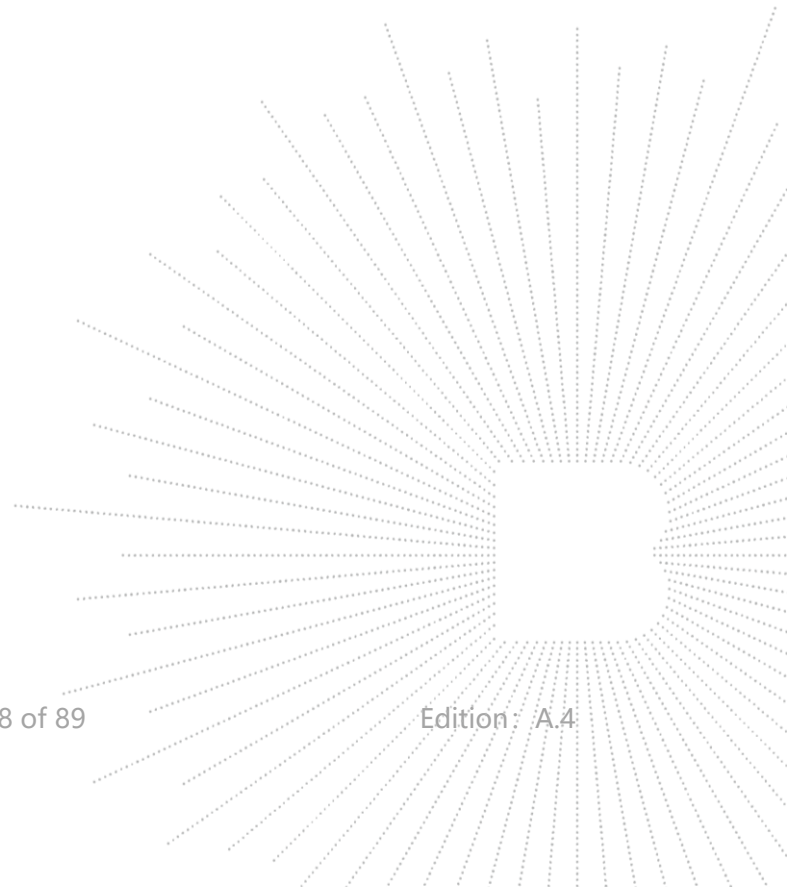
$$SAR = \frac{|E|^2 \cdot \sigma}{\rho}$$

Where:

σ = simulated tissue conductivity,

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

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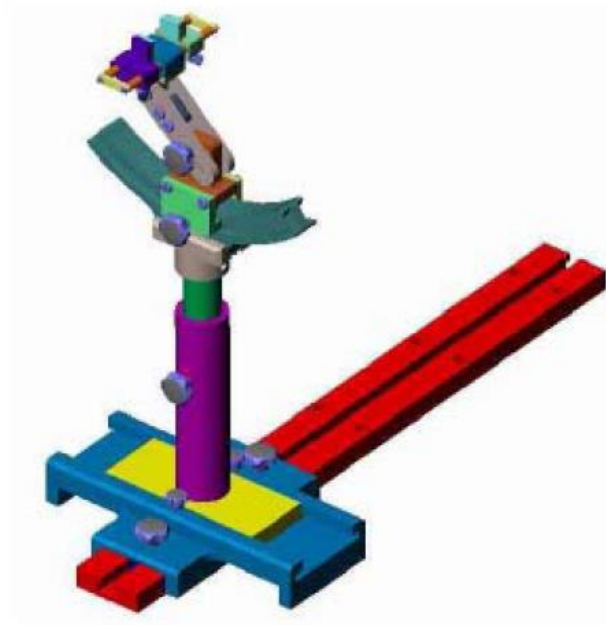


9.4 Phantom

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/Body	
	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 Permittivity (F/m)	Target Conductivity (S/m)	Measured Permittivity (F/m)	Measured Conductivity (S/m)	Deviation Percentage(%) (F/m)	Deviation Percentage(%) (S/m)	Date	Temp. Ambient TSL (°C)
2450	Head	39.20	1.80	39.725	1.819	1.34	1.06	02/21/2023	21.0
5200	Head	36.00	4.66	35.104	4.810	-2.49	3.22	02/22/2023	21.0
5800	Head	35.30	5.27	34.512	5.165	-2.23	-1.99	02/22/2023	21.0

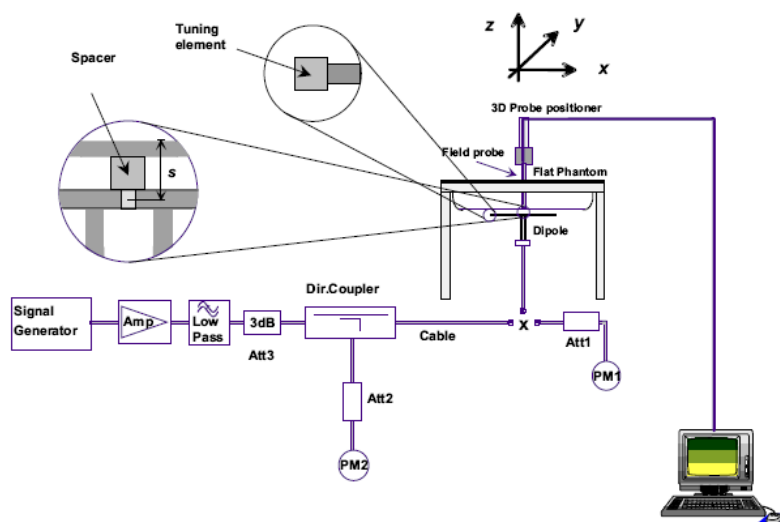
11. SAR Measurement Evaluation

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 850MHz,900 MHz,1800MHz,2000MHz, 2450MHz,2600MHz. 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 24 dBm (250 mW) before dipole is connected.



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.

Mixture Type	Frequency (MHz)	Power	SAR _{1g} (W/Kg)	SAR _{10g} (W/Kg)	Drift (%)	1W Target		Difference percentage		Liquid Temp	Date
						SAR _{1g} (W/Kg)	SAR _{10g} (W/Kg)	1g	10g		
Head	2450	100 mW	5.376	2.534	2.560	55.16	24.15	-2.54%	4.93%	21.0	02/21/2023
		Normalize to 1 Watt	53.76	25.34							
Head	5200	100 mW	8.015	2.265	2.130	76.41	21.86	4.89%	3.61%	21.0	02/22/2023
		Normalize to 1 Watt	80.15	22.65							

Head	5800	100 mW	7.356	2.131	-3.430	76.49	22.03	-3.83%	-3.27%	21.0	02/22/2023
		Normalize to 1 Watt	73.56	21.31							

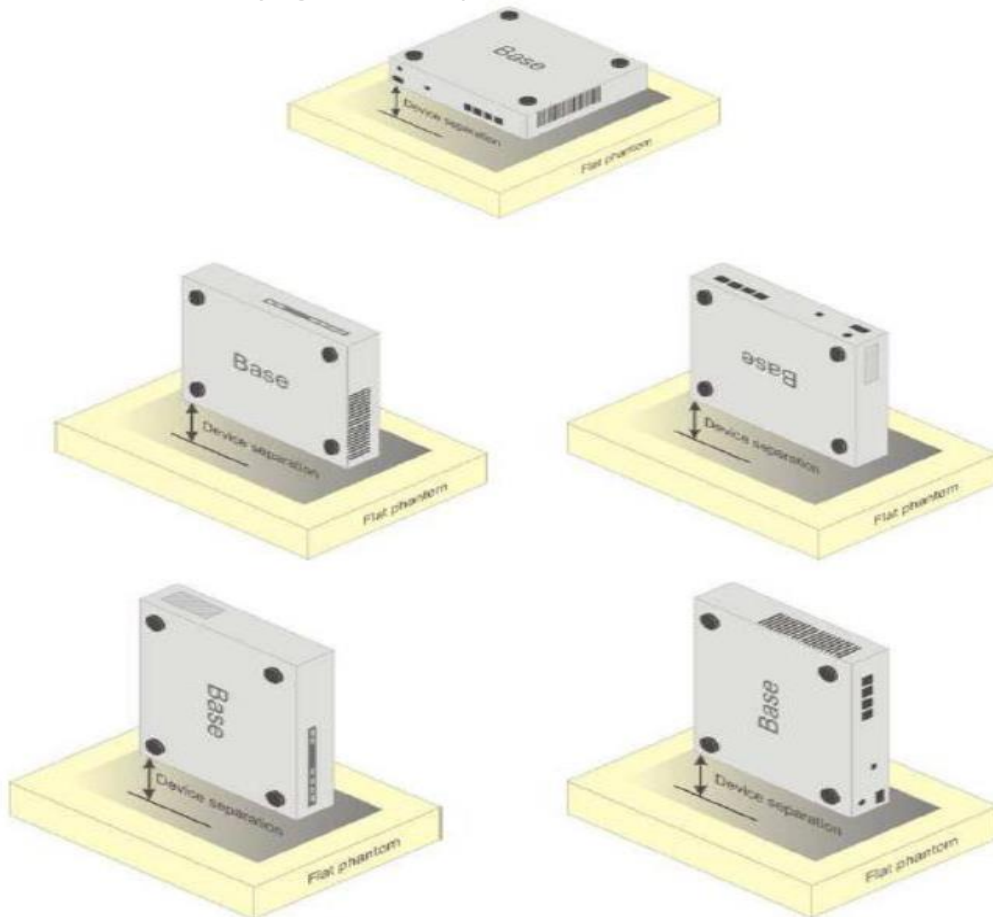
12. EUT Testing Position

12.1 Body Position

Desktop device

A typical example of a desktop device is a wireless enabled desktop computer placed on a table or desk when used.

The DUT shall be positioned at the distance and in the orientation to the phantom that corresponds to the intended use as specified by the manufacturer in the user instructions. For devices that employ an external antenna with variable positions, tests shall be performed for all antenna positions specified. Picture 14 shows positions for desktop device SAR tests. If the intended use is not specified, the device shall be tested directly against the flat phantom.



Test positions for desktop devices

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.

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

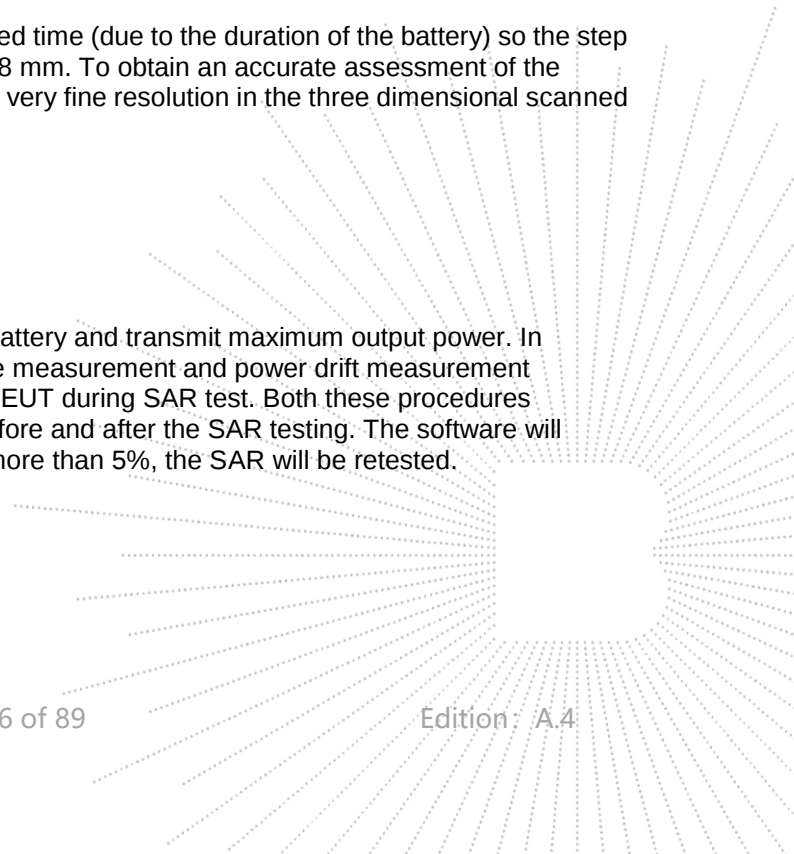
The local SAR inside the phantom is measured using small dipole sensing elements inside a probe body. The probe tip must not be in contact with the phantom surface in order to minimize measurements errors, but the highest local SAR will occur at the surface of the phantom.

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

According KDB 447498 D01 General RF Exposure Guidance v06 Section 4.1 2) states that “Unless it is specified differently in the published RF exposure KDB procedures, these requirements also apply to test reduction and test exclusion considerations. Time-averaged maximum conducted output power applies to SAR and, as required by § 2.1091(c), time-averaged ERP applies to MPE. When an antenna port is not available on the device to support conducted power measurement, such as FRS and certain Part 15 transmitters with built-in integral antennas, the maximum output power allowed for production units should be used to determine RF exposure test exclusion and compliance.”

WLAN 2.4G			
Mode	Frequency	Maximum Conducted Output Power	Tune-up power
	(MHz)	(dBm)	(dBm)
802.11b	2412	15.88	16.0
	2437	15.73	
	2462	15.51	
802.11g	2412	14.44	15.0
	2437	14.53	
	2462	14.73	
802.11n20	2412	13.48	14.0
	2437	13.39	
	2462	13.23	
802.11n40	2422	12.40	13.0
	2437	12.28	
	2452	12.19	

Note:

1. SAR is not required for the following 2.4 GHz OFDM conditions as 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.
2. Per KDB 248227 D01 v02r02, For 802.11b DSSS SAR measurements, 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 for 802.11b DSSS in that exposure configuration. When the reported SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

WLAN 5.1G			
Mode	Frequency	Maximum Conducted Output Power	Tune-up power
	(MHz)	(dBm)	(dBm)
802.11a	5180	15.67	16.0
	5200	15.74	
	5240	15.08	
802.11n20	5180	14.37	15.0
	5200	14.48	
	5240	13.98	
802.11n40	5190	13.32	14.0
	5230	12.17	
802.11nac20	5180	14.55	15.0
	5200	14.47	
	5240	13.76	
802.11nac40	5190	13.14	13.5
	5230	12.24	
802.11nac80	5210	12.45	13.0

WLAN 5.8G			
Mode	Frequency	Maximum Conducted Output Power	Tune-up power
	(MHz)	(dBm)	(dBm)
802.11a	5745	15.34	16.0
	5785	14.13	
	5825	13.23	
802.11n20	5745	14.41	15.0
	5785	13.19	
	5825	12.10	
802.11n40	5755	13.32	14.0
	5795	11.88	
802.11nac20	5745	14.63	15.0
	5785	13.21	
	5825	12.32	
802.11nac40	5755	13.57	14.0
	5795	11.85	
802.11nac80	5775	12.14	12.5

BLE-ANT 1			
Modulation	Frequency (MHz)	Output Power (dBm)	Tune-up power (dBm)
GFSK 1Mbps	2402	4.66	5.0
	2440	4.68	
	2480	4.88	

BLE-ANT 2			
Modulation	Frequency (MHz)	Output Power (dBm)	Tune-up power (dBm)
GFSK 1Mbps	2402	-3.92	-3.5
	2440	-4.31	
	2480	-5.40	

Note:

Per KDB 447498 D01v06, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot \sqrt{f(\text{GHz})}$$

≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR

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

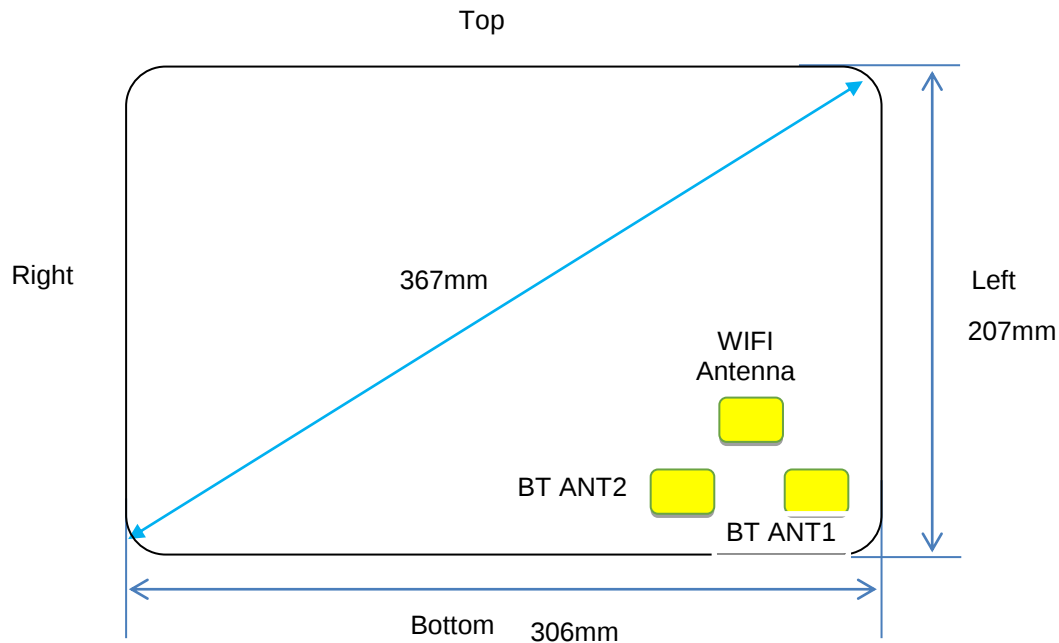
ANT	Bluetooth Turn up Power (dBm)	Bluetooth Turn up Power (mW)	Separation Distance (mm)	Frequency (GHz)	Result	Exclusion Thresholds
1	5.0	3.16	5	2.48	0.996	3.0

ANT	Bluetooth Turn up Power (dBm)	Bluetooth Turn up Power (mW)	Separation Distance (mm)	Frequency (GHz)	Result	Exclusion Thresholds
2	-3.5	0.45	5	2.48	0.141	3.0

Per KDB 447498 D01v06, when the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

According to the calculation results in the table above, BT SAR does not need to be tested.

14.2 Transmit Antennas and SAR Measurement Position



Keyboard Back View

Antenna information:

WIFI2.4G/BT Antenna	TX/RX
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Note:

- 1). Per KDB648474 D04, 10-g extremity SAR is not required when Body-Worn mode 1-g reported SAR < 1.2 W/Kg.
- 2). According to the KDB 616217 D04 SAR for laptop and tablets v01r02, When antennas are incorporated in the keyboard section of a laptop computer, SAR is required for the bottom surface of the keyboard. Provided tablet use conditions are not supported by the laptop computer, SAR tests for bystander exposure from the edges of the keyboard and display screen of laptop computers are generally not required.

Positions for SAR tests; Body mode						
Antennas	Front	Back	Top Side	Bottom Side	Left Side	Right Side
BT	No	No	No	No	No	No
WIFI	No	Yes	No	No	No	No

14.3 Test Results for Standalone SAR Test

The calculated SAR is obtained by the following formula:

$$\text{Reported SAR} = \text{Measured SAR} \times 10^{(P_{\text{target}} - P_{\text{measured}})/10}$$

$$\text{Scaling factor} = 10^{(P_{\text{target}} - P_{\text{measured}})/10}$$

$$\text{Reported SAR} = \text{Measured SAR} \times \text{Scaling factor}$$

Where

P_{target} is the power of manufacturing upper limit;

P_{measured} is the measured power;

Measured SAR is measured SAR at measured power which including power drift)

Reported SAR which including Power Drift and Scaling factor

Duty Cycle

Test Mode	Duty Cycle
WIFI	1:1

SAR Values [WIFI 2.4G]

Ch.	Freq. (MHz)	Service	Test Position	Conducted Power (dBm)	Maximum Allowed Power (dBm)	Power Drift (%)	Scaling Factor	SAR1-g results(W/kg)		Graph Results
								Measured	Reported	
measured / reported SAR numbers - Body (distance 0mm)										
1	2412	802.11b	Back	15.88	16.00	-4.160	1.028	0.146	0.150	Plot 1

SAR Values [WIFI 5G]

Ch.	Freq. (MHz)	Service	Test Position	Condu cted Power (dBm)	Maximum Allowed Power (dBm)	Power Drift (%)	Scaling Factor	SAR1-g results(W/kg)		Graph Results
								Measur ed	Reporte d	
measured / reported SAR numbers - Body (distance 0mm)										
40	5200	802.11a	Back	15.74	16.0	3.170	1.062	0.222	0.236	Plot 2
149	5745	802.11a	Back	15.34	16.0	-3.370	1.164	0.248	0.289	Plot 3

Remark:

1. The value with the bold is the maximum SAR Value of each test band.

2. Per FCC KDB Publication 447498 D01, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg then testing at the other channels is optional for such test configuration(s).

14.4 Standalone SAR Test Exclusion Considerations and Estimated SAR

Per KDB447498 requires when the standalone SAR test exclusion of section 4.3.1 is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to the following to determine simultaneous transmission SAR test exclusion;

- $(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm}) \cdot [\sqrt{f(\text{GHz})/x}] \text{ W/kg}$ for test separation distances $\leq 50 \text{ mm}$;
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 $> 50 \text{ mm}$
- 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 $\leq 1.6 \text{ W/Kg}$. When the sum is greater than the SAR limit, SAR test exclusion is determined by the SAR to peak location separation ratio.

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

Estimated stand alone SAR					
Communication system	Frequency (MHz)	Configuration	Maximum Power (dBm)	Separation Distance (mm)	Estimated SAR1-g (W/kg)
Bluetooth*	2450	Body-worn	N/A	5	N/A

Remark:

1. Bluetooth*- Including Lower power Bluetooth
2. Maximum average power including tune-up tolerance;
3. When the minimum test separation distance is $< 5 \text{ mm}$, a distance of 5 mm is applied to determine SAR test exclusion
4. Body as body use distance is 5 mm from manufacturer declaration of user manual

14.5 Simultaneous TX SAR Considerations

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	WLAN+ BT ANT1+ BT ANT2	Yes

Body Exposure Conditions

Remark:

1. WLAN 2.4G and WLAN 5G share the same antenna, and cannot transmit simultaneously.
2. 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:

- $(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm}) \cdot [\sqrt{f(\text{GHz})/x}] \text{ W/kg}$ for test separation distances $\leq 50 \text{ mm}$;
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 $> 50 \text{ mm}$

Estimated stand alone SAR						
Communication system	Frequency (MHz)	Maximum Power (dBm)	Maximum Power (mW)	Separation Distance (mm)	X	Estimated SAR1-g (W/kg)
BLE-ANT	2480	5.0	3.16	5	7.5	0.133

Estimated stand alone SAR						
Communication system	Frequency (MHz)	Maximum Power (dBm)	Maximum Power (mW)	Separation Distance (mm)	X	Estimated SAR1-g (W/kg)
BLE-ANT2	2480	-3.5	0.45	5	7.5	0.019

Note:

1. Bluetooth*- Including Lower power Bluetooth
2. Maximum average power including tune-up tolerance;
3. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

3. Simultaneous transmission of maximum SAR sum calculation.

Test Position	WLAN 2.4G	BT-ANT1	BT-ANT2	Summed SAR (W/kg)	SAR1-g Limit (W/kg)	Peak location separation ratio
	Scaled SAR (W/kg)	Scaled SAR (W/kg)	Scaled SAR (W/kg)			
Back	0.150	0.133	0.019	0.302	1.6	N/A

Test Position	WLAN 5G	BT-ANT1	BT-ANT2	Summed SAR (W/kg)	SAR1-g Limit (W/kg)	Peak location separation ratio
	Scaled SAR (W/kg)	Scaled SAR (W/kg)	Scaled SAR (W/kg)			
Back	0.289	0.133	0.019	0.441	1.6	N/A

TC
3C
PPR
測

14.6 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 .

14.7 General description of test procedures

1. The DUT is tested using CMU 200 communications testers as controller unit to set test channels and maximum output power to the DUT, as well as for measuring the conducted peak power.
2. Test positions as described in the tables above are in accordance with the specified test standard.
3. Tests in body position were performed in that configuration, which generates the highest time based averaged output power (see conducted power results).
4. WiFi was tested in 802.11b/g/n mode with 1 Mbit/s and 6 Mbit/s. According to KDB 248227 the SAR testing for 802.11g/n is not required since 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. Required WiFi test channels were selected according to KDB 248227
6. According to FCC KDB pub 248227 D01, When there are multiple test channels with the same measured maximum output power, the channel closest to mid-band frequency is selected for SAR measurement and when there are multiple test channels with the same measured maximum output power and equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.
7. According to IEEE 1528 the SAR test shall be performed at middle channel. Testing of top and bottom channel is optional.
8. According to KDB 447498 D01 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
9. IEEE 1528 require the middle channel to be tested first. This generally applies to wireless devices that are designed to operate in technologies with tight tolerances for maximum output power variations across channels in the band.

15. Test Plots

15.1 System Performance Check

System check at 2450 MHz

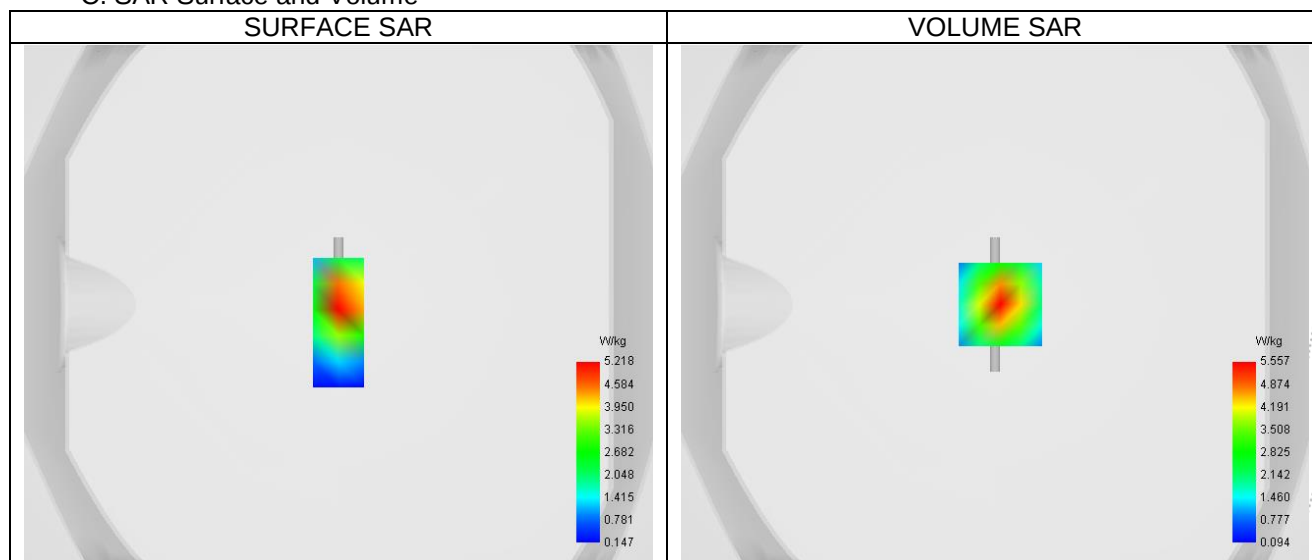
A. Experimental conditions.

In power	100mw
Probe	SN EPG0373
ConvF	3.96
Area Scan	dx=10mm dy=10mm, Adaptive 2 max
Zoom Scan	5x5x7, dx=5mm dy=5mm dz=5mm, Very fast
Phantom	Validation plane
Device Position	Dipole
Band	CW2450
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. Permittivity

Frequency (MHz)	2450.000
Relative permittivity (real part)	39.725
Relative permittivity (imaginary part)	13.207
Conductivity (S/m)	1.819

C. SAR Surface and Volume



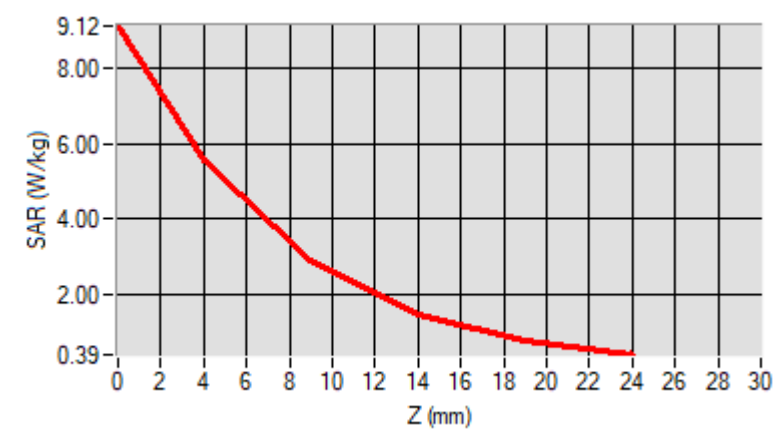
D. SAR 1g & 10g

SAR 10g (W/Kg)	2.534
SAR 1g (W/Kg)	5.376
Variation (%)	2.560
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

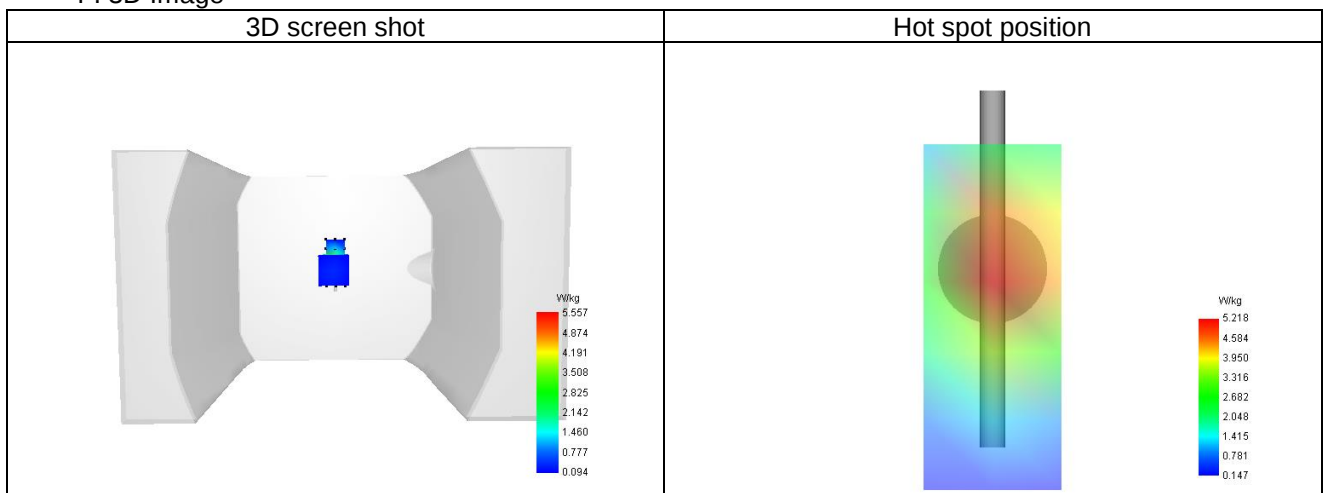
E. Z Axis Scan

Z (mm)	0.00	4.00	9.00	14.00	19.00
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SAR (W/Kg)	9.121	5.557	2.866	1.459	0.770
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F. 3D Image



System check at 5200 MHz

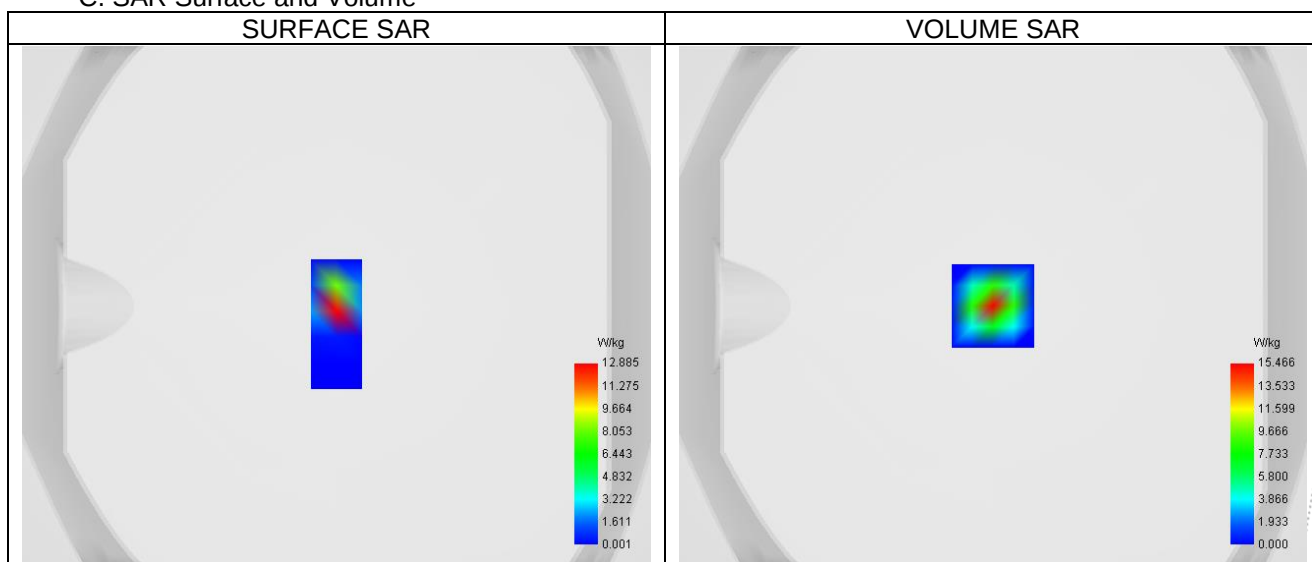
A. Experimental conditions.

Power	100MW
Probe	SN EPG0373
ConvF	2.72
Area Scan	dx=10mm dy=10mm, Adaptative 2 max
Zoom Scan	5x5x7,dx=4mm dy=4mm dz=2mm,Very fast
Phantom	Validation plane
Device Position	Dipole
Band	CW5200
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. Permittivity

Frequency (MHz)	5200.000
Relative permittivity (real part)	35.104
Relative permittivity (imaginary part)	16.250
Conductivity (S/m)	4.810

C. SAR Surface and Volume



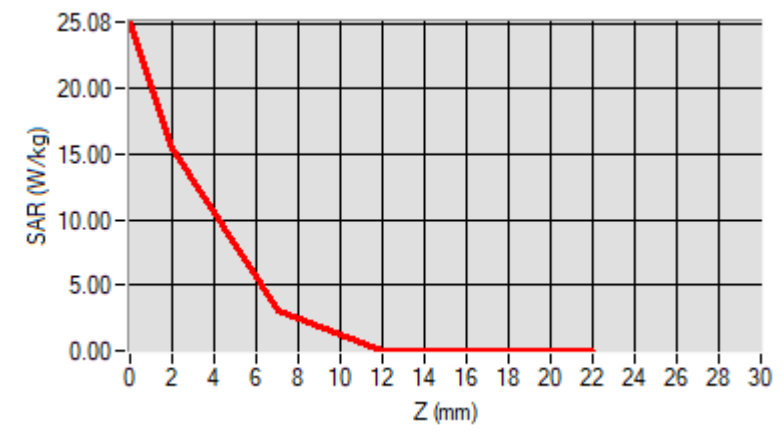
Maximum location: X=0.00, Y=0.00 ; SAR Peak: 25.12 W/kg

D. SAR 1g & 10g

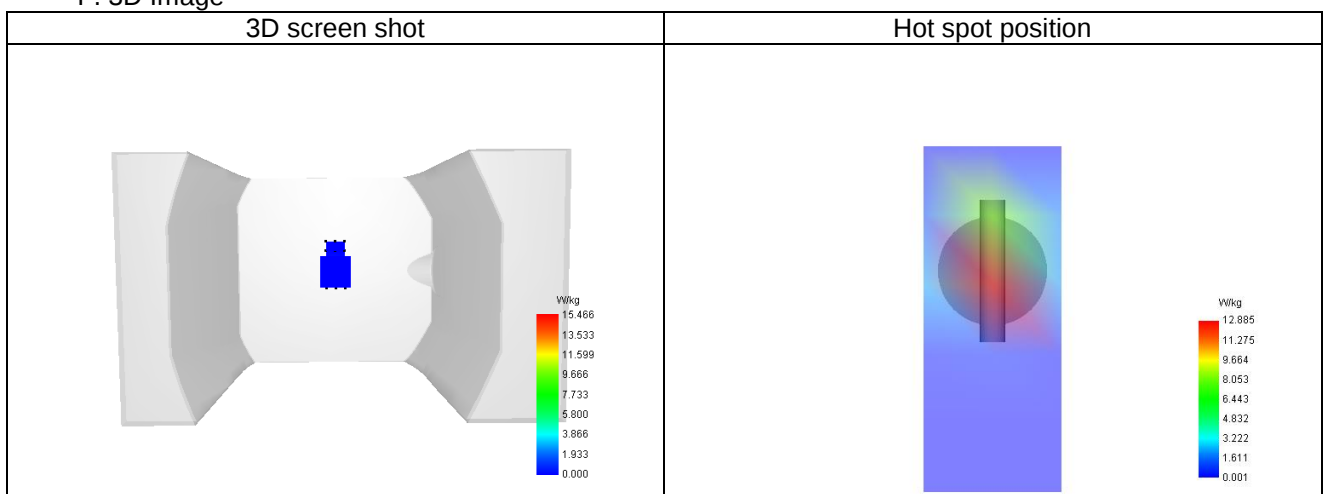
SAR 10g (W/Kg)	2.265
SAR 1g (W/Kg)	8.015
Variation (%)	2.690
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	7.00	12.00	17.00
SAR (W/Kg)	25.083	15.466	3.061	0.009	0.001



F. 3D Image



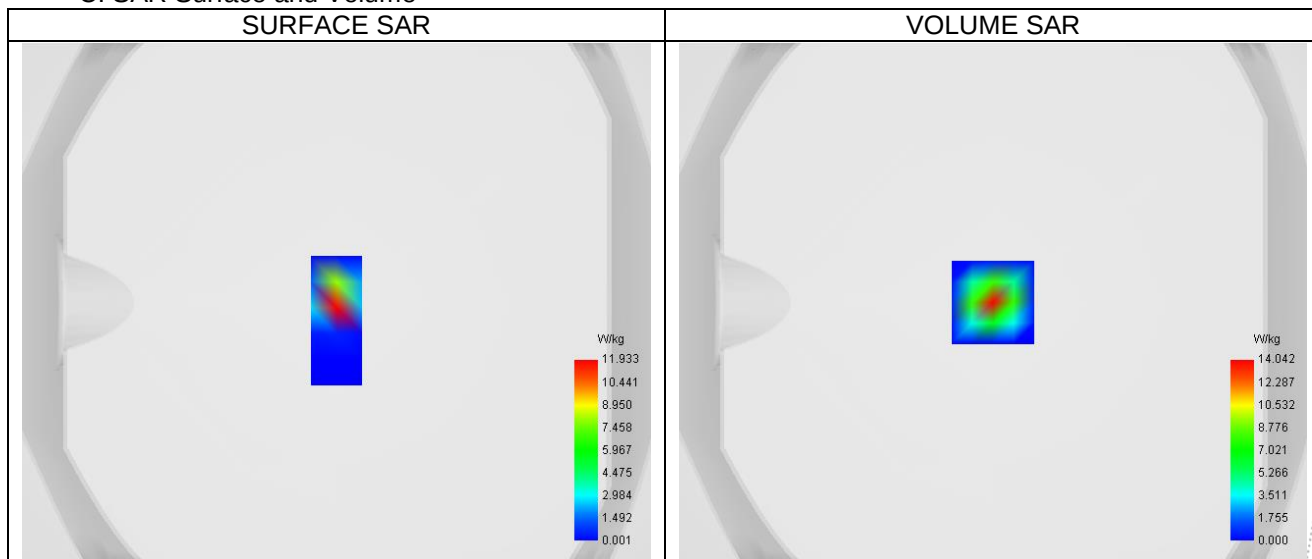
A. Experimental conditions.

Power	100MW
Probe	SN EPG0373
ConvF	2.86
Area Scan	dx=10mm dy=10mm, Adaptative 2 max
Zoom Scan	5x5x7,dx=4mm dy=4mm dz=2mm,Very fast
Phantom	Validation plane
Device Position	Dipole
Band	CW5800
Channels	Middle
Signal	CW (Crest factor: 1.0)

B. Permittivity

Frequency (MHz)	5800.000
Relative permittivity (real part)	34.512
Relative permittivity (imaginary part)	16.250
Conductivity (S/m)	5.165

C. SAR Surface and Volume



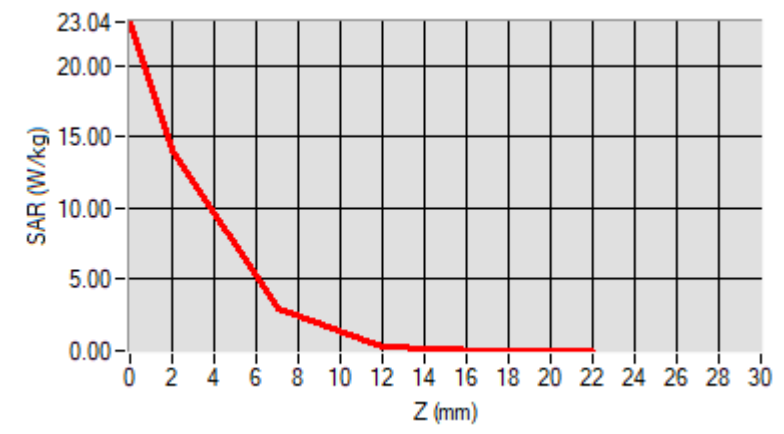
Maximum location: X=0.00, Y=0.00 ; SAR Peak: 23.75 W/kg

D. SAR 1g & 10g

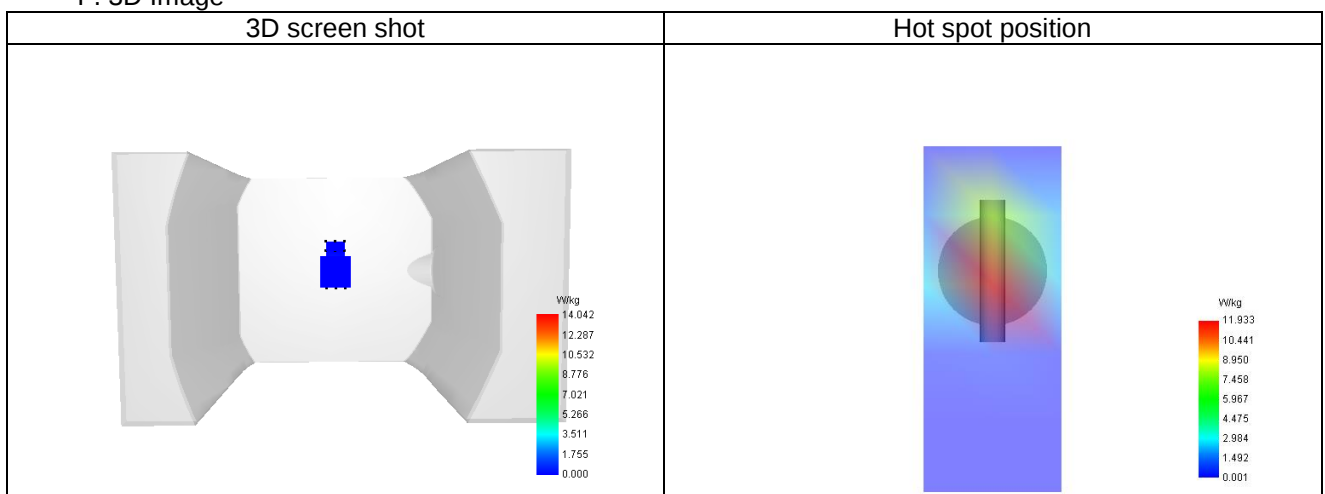
SAR 10g (W/Kg)	2.131
SAR 1g (W/Kg)	7.356
Variation (%)	1.020
Horizontal validation criteria: minimum distance (mm)	0.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	0.000000

E. Z Axis Scan

Z (mm)	0.00	2.00	7.00	12.00	17.00
SAR (W/Kg)	23.040	14.042	2.899	0.275	0.008



F. 3D Image



15.2 SAR Test Graph Results

SAR plots for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination according to FCC KDB 865664 D02

Plot 1

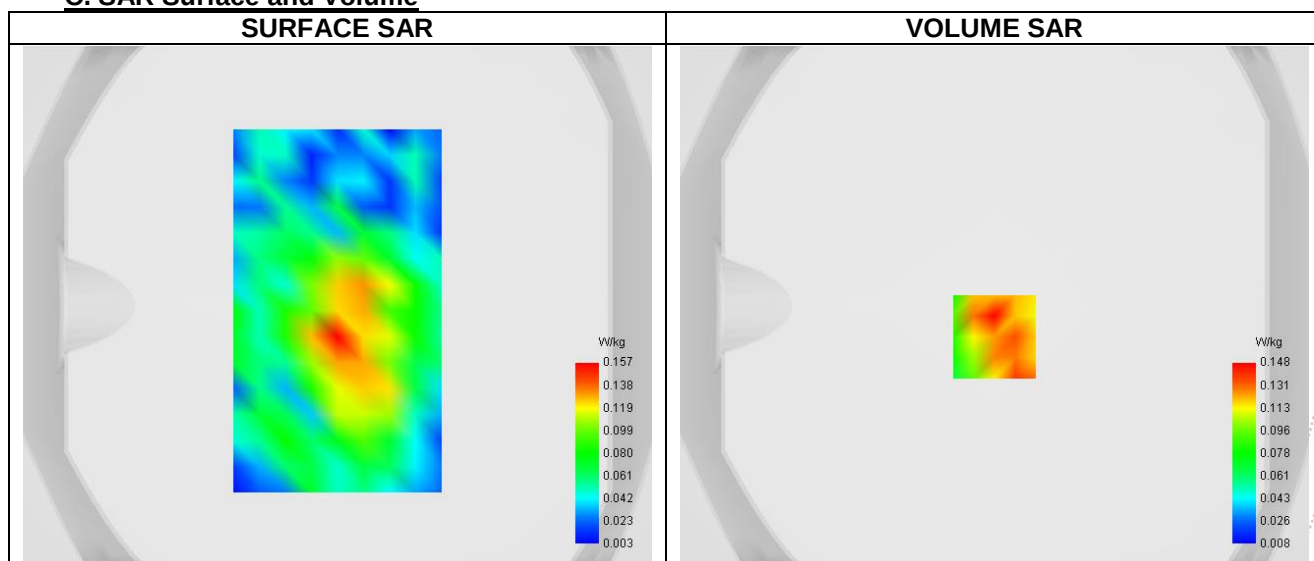
A. Experimental conditions.

Probe	SN 25/22 EPG0373
ConvF	3.96
Area Scan	surf_sam_plan.txt
Zoom Scan	5x5x7,dx=5mm dy=5mm dz=5mm,Complete
Phantom	Validation plane
Device Position	Body
Band	IEEE 802.11b ISM
Channels	Low (1)
Signal	IEEE802.b (Crest factor: 1.0)

B. Permittivity

Frequency (MHz)	2412.000
Relative permittivity (real part)	39.843
Relative permittivity (imaginary part)	13.207
Conductivity (S/m)	1.792

C. SAR Surface and Volume



Maximum location: X=0.00, Y=-12.00 ; SAR Peak: 0.27 W/kg

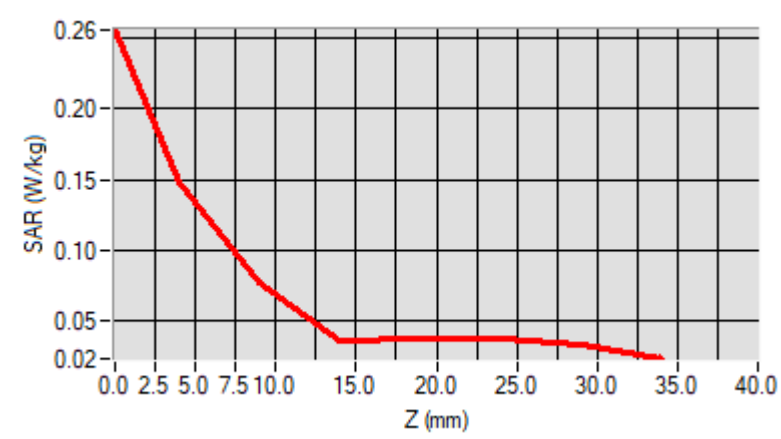
D. SAR 1g & 10g

SAR 10g (W/Kg)	0.084
SAR 1g (W/Kg)	0.146
Variation (%)	-4.160
Horizontal validation criteria: minimum distance (mm)	17.888544
Vertical validation criteria: SAR ratio M2/M1 (%)	53.439623

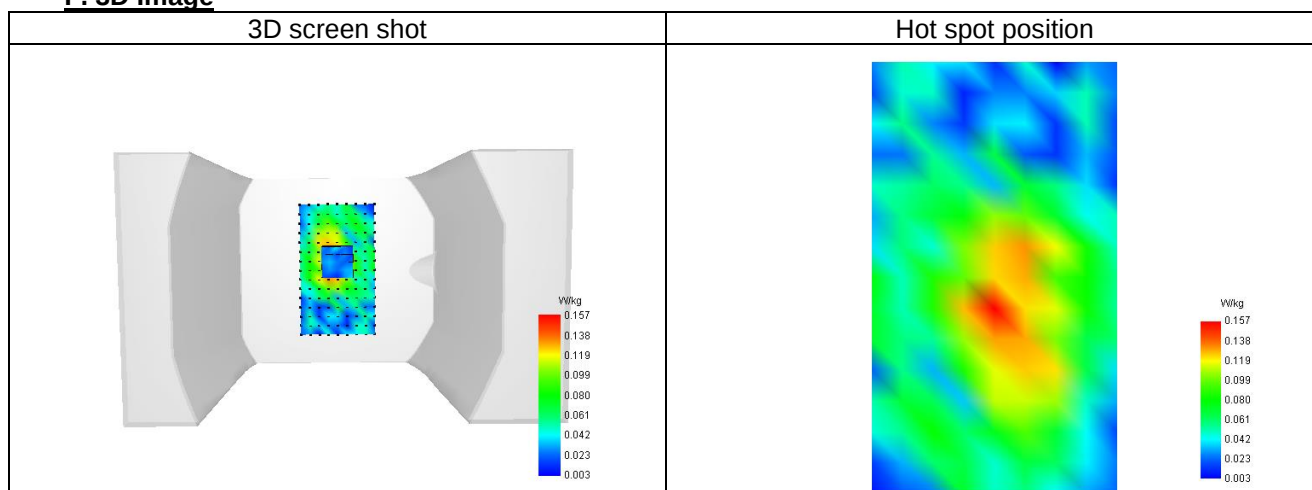
E. Z Axis Scan

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
--------	------	------	------	-------	-------	-------	-------

SAR (W/Kg)	0.256	0.148	0.078	0.035	0.038	0.038	0.033
------------	-------	-------	-------	-------	-------	-------	-------



F. 3D Image



SHENZHEN

Plot 2

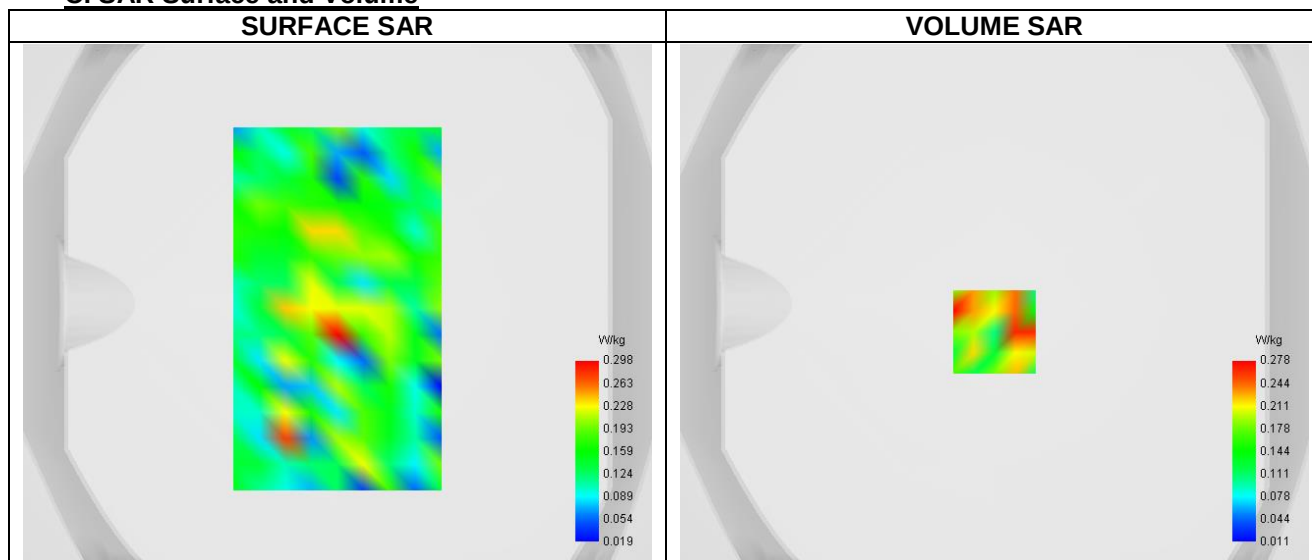
A. Experimental conditions.

Probe	SN 25/22 EPG0373
ConvF	2.72
Area Scan	surf_sam_plan.txt
Zoom Scan	5x5x7,dx=4mm dy=4mm dz=2mm,Complete
Phantom	Validation plane
Device Position	Body
Band	IEEE 802.11a
Channels	Middle (40)
Signal	IEEE802.a (Crest factor: 1.0)

B. Permittivity

Frequency (MHz)	5200.000
Relative permittivity (real part)	35.104
Relative permittivity (imaginary part)	16.250
Conductivity (S/m)	4.810

C. SAR Surface and Volume



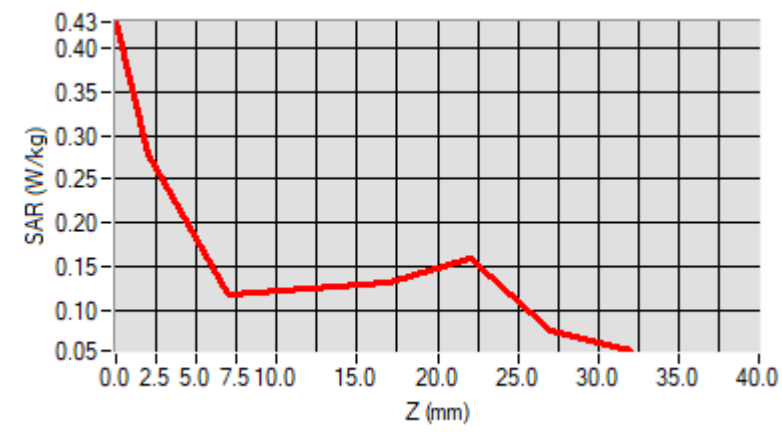
Maximum location: X=0.00, Y=-11.00 ; SAR Peak: 0.48 W/kg

D. SAR 1g & 10g

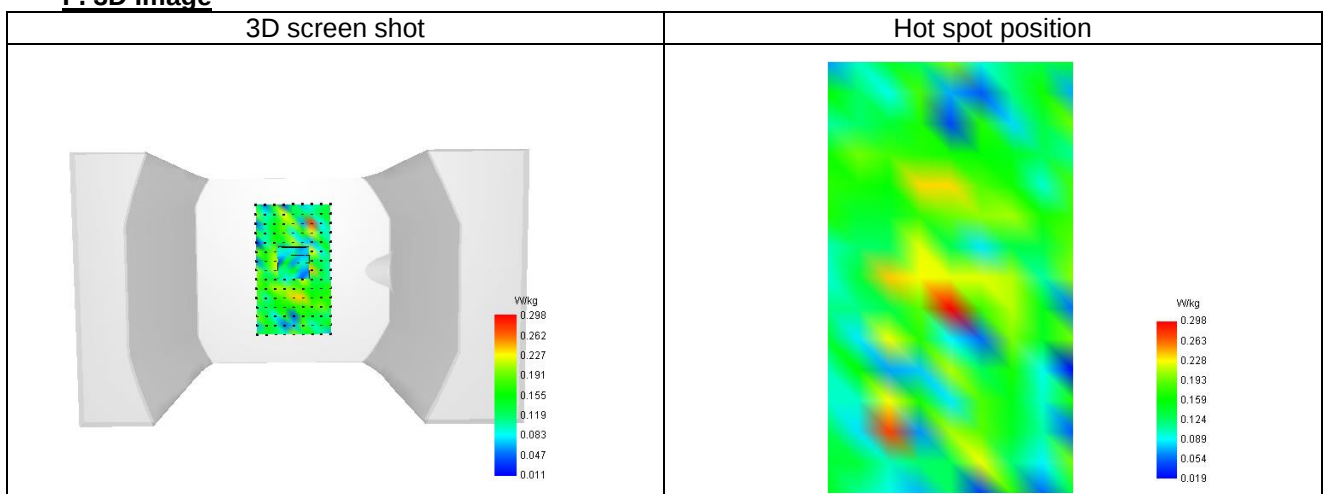
SAR 10g (W/Kg)	0.139
SAR 1g (W/Kg)	0.222
Variation (%)	3.170
Horizontal validation criteria: minimum distance (mm)	16.000000
Vertical validation criteria: SAR ratio M2/M1 (%)	60.415791

E. Z Axis Scan

Z (mm)	0.00	2.00	7.00	12.00	17.00	22.00	27.00
SAR (W/Kg)	0.429	0.278	0.118	0.125	0.133	0.159	0.078



F. 3D Image



Plot 3

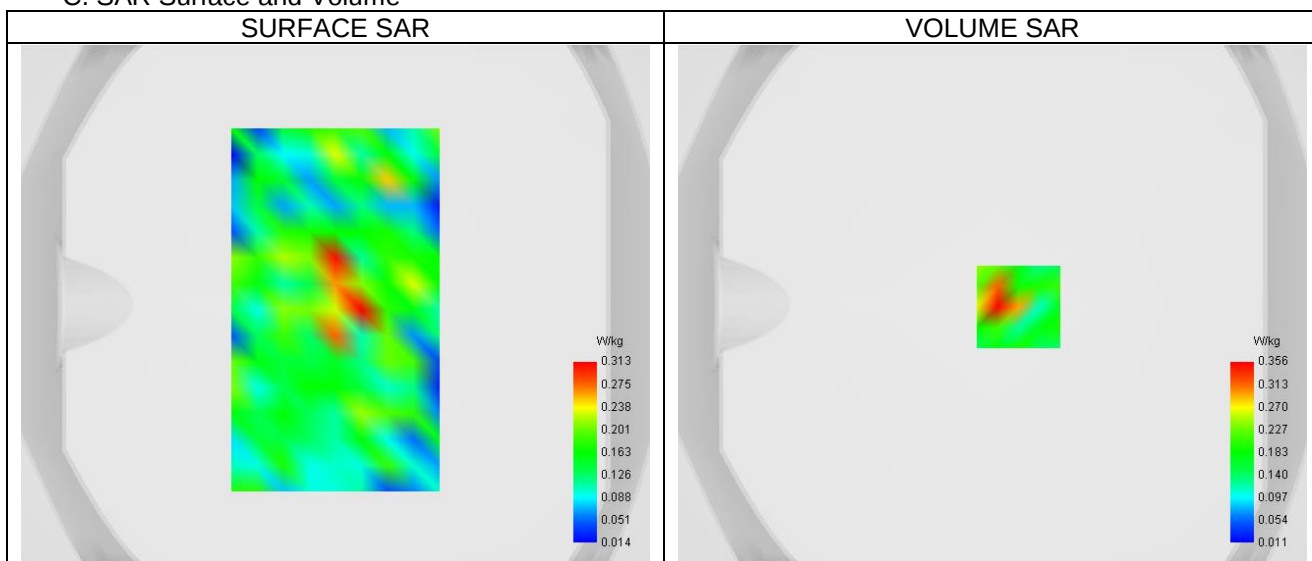
A. Experimental conditions.

Probe	SN 25/22 EPG0373
ConvF	2.86
Area Scan	surf_sam_plan.txt
Zoom Scan	5x5x7,dx=4mm dy=4mm dz=2mm,Complete
Phantom	Validation plane
Device Position	Body
Band	IEEE 802.11a
Channels	Low (149)
Signal	IEEE802.a (Crest factor: 1.0)

B. Permittivity

Frequency (MHz)	5745.000
Relative permittivity (real part)	34.802
Relative permittivity (imaginary part)	16.250
Conductivity (S/m)	4.698

C. SAR Surface and Volume



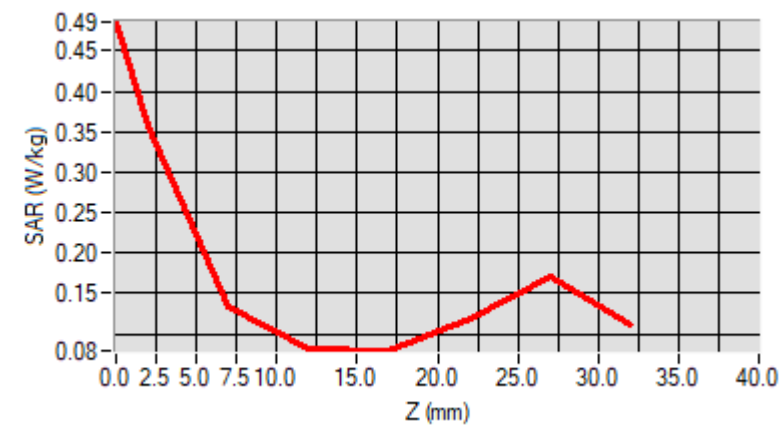
Maximum location: X=10.00, Y=-1.00 ; SAR Peak: 0.58 W/kg

D. SAR 1g & 10g

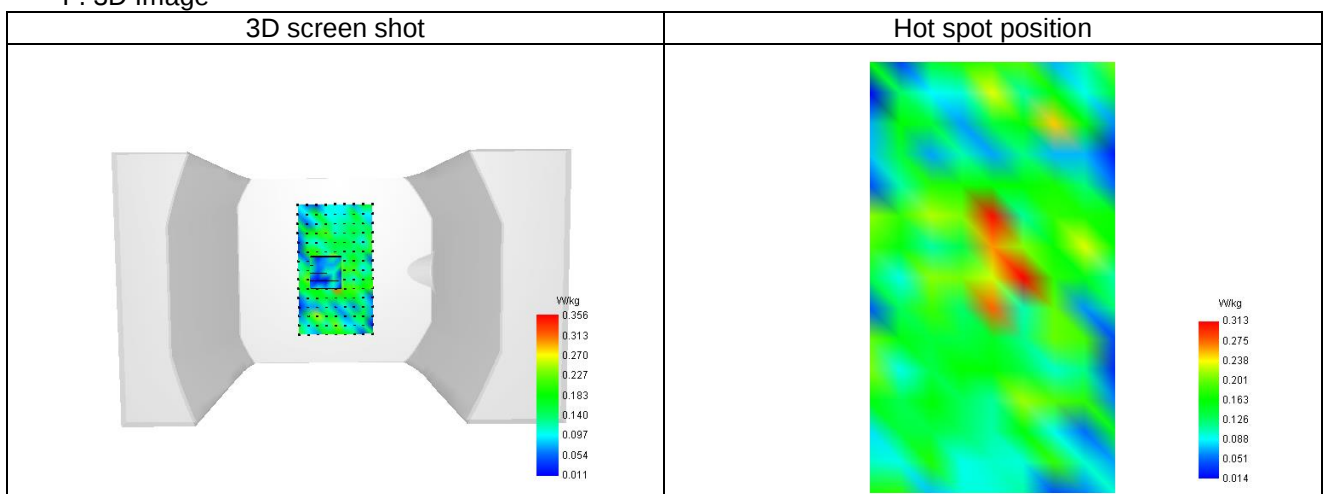
SAR 10g (W/Kg)	0.137
SAR 1g (W/Kg)	0.248
Variation (%)	-3.370
Horizontal validation criteria: minimum distance (mm)	11.313708
Vertical validation criteria: SAR ratio M2/M1 (%)	34.245347

E. Z Axis Scan

Z (mm)	0.00	2.00	7.00	12.00	17.00	22.00	27.00
SAR (W/Kg)	0.486	0.356	0.133	0.080	0.079	0.119	0.170



F. 3D Image



16. CALIBRATION CERTIFICATES

Probe-EPGO373 Calibration Certificate
SID2450Dipole Calibration Certificate
SID5000Dipole Calibration Certificate

CO., LTD.

**COMOSAR E-Field Probe Calibration Report**

Ref : ACR.180.5.22.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.: SN 25/22 EPG0373

Calibrated at MVG
Z.I. de la pointe du diable
Technopôle Brest Iroise – 295 avenue Alexis de Rochon
29280 PLOUZANE - FRANCE

Calibration date: 06/29/2022



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

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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.180.5.22.BES.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme Le Gall	Measurement Responsible	6/30/2022	
<i>Checked & approved by:</i>	Jérôme Luc	Technical Manager	6/30/2022	
<i>Authorized by:</i>	Yann Toutain	Laboratory Director	6/30/2022	

2022.06.30
13:38:42 +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	Jérôme Le Gall	6/30/2022	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	SN 25/22 EPG0373
Product Condition (new / used)	New
Frequency Range of Probe	0.15 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.234 MΩ Dipole 2: R2=0.195 MΩ Dipole 3: R3=0.250 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	2 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	2.5 mm
Distance between dipoles / probe extremity	1 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 affect. All calibrations / measurements performed meet the fore mentioned standards.

3.1 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.

3.2 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.

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3.3 LOWER DETECTION LIMIT

The lower detection limit was assessed using the same measurement set up as used for the linearity measurement. The required lower detection limit is 10 mW/kg.

3.4 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°).

3.1 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 *zoom-scan* 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., $\delta \approx 14 \text{ mm}$ 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 SAR uncertainty[%] for scanning distances larger than 4mm is 1.0% Limit ,2%).

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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 an E-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ci	Standard Uncertainty (%)
Expanded uncertainty 95 % confidence level k = 2					14 %

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

5.1 SENSITIVITY IN AIR

Normx dipole 1 (μV/(V/m) ²)	Normy dipole 2 (μV/(V/m) ²)	Normz dipole 3 (μV/(V/m) ²)
1.19	0.77	1.05

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
108	109	110

Calibration curves $e_i=f(V)$ (i=1,2,3) allow to obtain E-field value using the formula:

$$E = \sqrt{E_1^2 + E_2^2 + E_3^2}$$

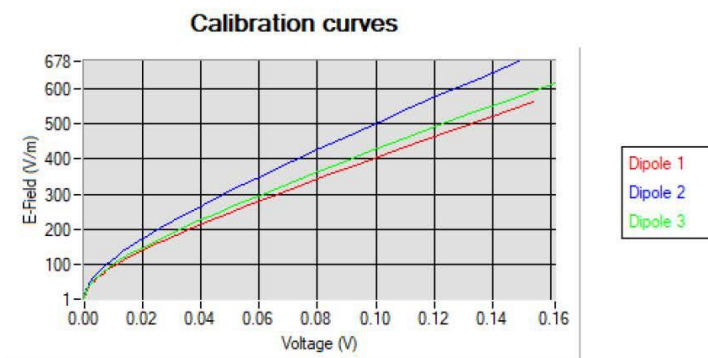
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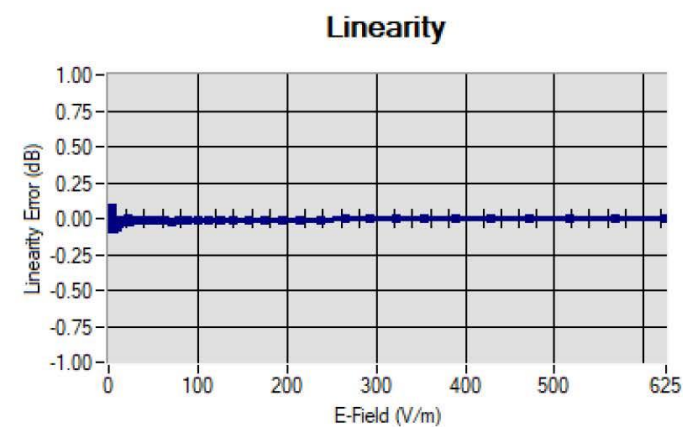
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COMOSAR E-FIELD PROBE CALIBRATION REPORT

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5.2 LINEARITY



Linearity: $\pm 1.77\%$ ($\pm 0.08\text{dB}$)

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