FCC SAR EVALUATION REPORT

In accordance with the requirements of
FCC 47 CFR Part 2(2.1093), ANSI/IEEE C95.1-1992 and
IEEE Std 1528-2013

Product Name： Tablet PC

Trademark： REBEOSOII

Model Name： ES1058

Family Model： G11

FCC ID： 2BA9S-G11

Report No.： S23041403503001

Prepared for

Epudo(Hongkong)Digital Technology Limited

ROOM 803, CHEVALIER HOUSE 45-51 CHATHAM ROAD SOUTH, TSIM SHA TSUI,KL

Prepared by

Shenzhen NTEK Testing Technology Co., Ltd.
1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street,
Bao'an District, Shenzhen 518126 P.R.China.
Tel. 400-800-6106, 0755-2320 0050, 0755-2320 0090
Website: http://www.ntek.org.cn

TEST RESULT CERTIFICATION

Applicant's name.....: Epudo(Hongkong)Digital Technology Limited

Address.....: ROOM 803, CHEVALIER HOUSE 45-51 CHATHAM ROAD SOUTH, TSIM SHA TSUI,KL

Manufacturer's Name.....: Epudo(DongGuan)Digital Technology Co.Ltd

Address.....: No.5 Plant,Huanan Science Park 5th Road,Tianxin Village,Tangxia Town,Dongguan,China

Product description

Product name.....: Tablet PC

Trademark .....: REBEOSOII

Model Name .....: ES1058

Family Model.....: G11

Standards.....: FCC 47 CFR Part 2(2.1093)
ANSI/IEEE C95.1-1992
IEEE Std 1528-2013
Published RF exposure KDB procedures

This device described above has been tested by Shenzhen NTEK. In accordance with the measurement methods and procedures specified in IEEE Std 1528-2013 and KDB 865664 D01. Testing has shown that this device is capable of compliance with localized specific absorption rate (SAR) specified in FCC 47 CFR Part 2(2.1093) and ANSI/IEEE C95.1-1992. The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

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Test Sample Number..... S230414035003

Date of Test

Date (s) of performance of tests.....: May 04, 2023 ~ May 10, 2023

Date of Issue .....: May 15, 2023

Test Result .....: **Pass**

Prepared By (Test Engineer) : Jack Li
(Jack Li)

Approved By (Lab Manager) : Alex
(Alex Li)

※ ※ Revision History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	May 15, 2023	Jack Li

TABLE OF CONTENTS

1. General Information 6
   1.1. RF exposure limits 6
   1.2. Statement of Compliance 7
   1.3. EUT Description 7
   1.4. Test specification(s) 9
   1.5. Ambient Condition 9
2. SAR Measurement System 10
   2.1. SATIMO SAR Measurement Set-up Diagram 10
   2.2. Robot 11
   2.3. E-Field Probe 12
      2.3.1. E-Field Probe Calibration 12
   2.4. SAM phantoms 13
      2.4.1. Technical Data 14
   2.5. Device Holder 15
   2.6. Test Equipment List 16
3. SAR Measurement Procedures 18
   3.1. Power Reference 18
   3.2. Area scan & Zoom scan 18
   3.3. Description of interpolation/extrapolation scheme 20
   3.4. Volumetric Scan 20
   3.5. Power Drift 20
4. System Verification Procedure 21
   4.1. Tissue Verification 21
      4.1.1. Tissue Dielectric Parameter Check Results 22
   4.2. System Verification Procedure 23
      4.2.1. System Verification Results 24
5. SAR Measurement variability and uncertainty 25
   5.1. SAR measurement variability 25
   5.2. SAR measurement uncertainty 25
6. RF Exposure Positions 26
   1.3. Tablet host platform exposure conditions 26
7. RF Output Power 27
   7.1. WLAN & Bluetooth Output Power 27
      7.1.1. Output Power Results Of WLAN 27
      7.1.2. Output Power Results Of Bluetooth 29
8. Antenna Location 30
9. Stand-alone SAR test exclusion 33
10. SAR Results 34
   10.1. SAR measurement results 34

10.1.1. SAR measurement Result of WLAN 2.4G 34
10.1.2. SAR measurement Result of WLAN 5.2G 34
10.1.3. SAR measurement Result of WLAN 5.3G 34
10.1.4. SAR measurement Result of WLAN 5.6G 35
10.1.5. SAR measurement Result of WLAN 5.8G 35
10.2. SAR Summation Scenario.....35
11. Appendix A. Photo documentation 35
12. Appendix B. System Check Plots.....36
13. Appendix C. Plots of High SAR Measurement.....47
14. Appendix D. Calibration Certificate 58

1. General Information

1.1. RF exposure limits

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

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

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

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

NOTE: ***Whole-Body SAR*** is averaged over the entire body, ***partial-body SAR*** is averaged over any 1 gram of tissue defined as a tissue volume in the shape of a cube. ***SAR for hands, wrists, feet and ankles*** is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

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).

General Population/Uncontrolled Environments:

Are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

NOTE
TRUNK LIMIT
1.6 W/kg
APPLIED TO THIS EUT

1.2. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for ES1058/G11 are as follows.

Band	Max Reported SAR Value(W/kg)
	1-g Body (Separation distance of 0mm)
WLAN 2.4G	1.349
WLAN 5.2G	0.133
WLAN 5.3G	0.161
WLAN 5.6G	0.185
WLAN 5.8G	0.124

Note: The Max Simultaneous Tx is calculated based on the same configuration and test position.
This 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 C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2013 & KDB 865664 D01.

1.3. EUT Description

Device Information			
Product Name	Tablet PC		
Trade Name	REBEOSOII		
Model Name	ES1058		
Family Model	G11		
Model Difference	All models are the same circuit and RF module,except the model name.		
FCC ID	2BA9S-G11		
Device Phase	Identical Prototype		
Exposure Category	General population / Uncontrolled environment		
Antenna	FPCB Antenna		
Battery	DC 3.7V, 5000mAh,18.5Wh		
HW Version	BND-W863-W V1.0		
SW Version	G11_V1.0_20230425		
Device Operating Configurations			
Supporting Mode(s)	WLAN 2.4G/5G, Bluetooth		
Test Modulation	WLAN(DSSS/OFDM), Bluetooth(GFSK, π/4-DQPSK, 8DPSK)		
Device Class	B		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	WLAN 2.4G	2412-2462	
	WLAN 5.2G	5180-5240	
	WLAN 5.3G	5260-5320	

	WLAN 5.6G	5500-5700
	WLAN 5.8G	5745-5825
	Bluetooth	2402-2480

1.4. Test specification(s)

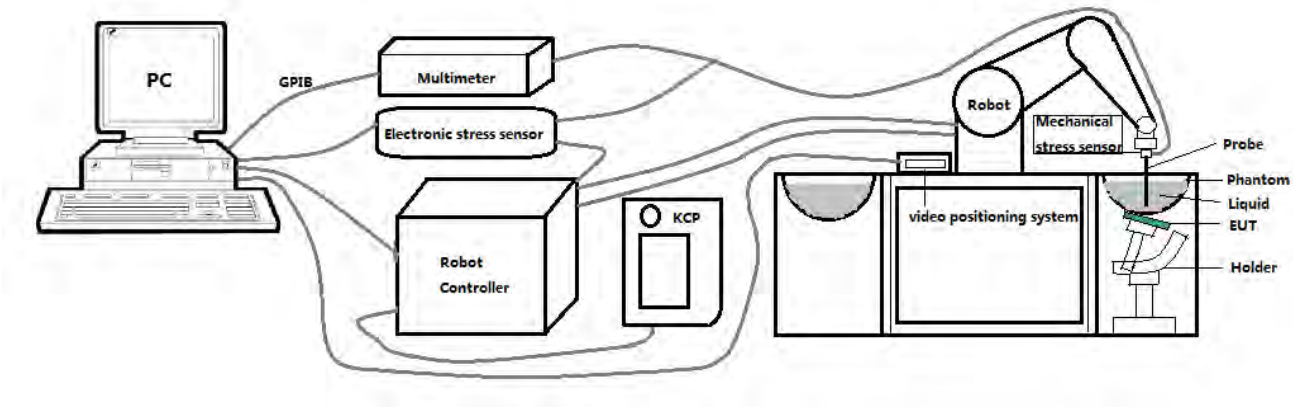
FCC 47 CFR Part 2(2.1093)
ANSI/IEEE C95.1-1992
IEEE Std 1528-2013
KDB 865664 D01 SAR measurement 100 MHz to 6 GHz
KDB 865664 D02 RF Exposure Reporting
KDB 447498 D01 General RF Exposure Guidance
KDB 248227 D01 802.11 Wi-Fi SAR
KDB 616217 D04 SAR for laptop and tablets

1.5. Ambient Condition

Ambient temperature	20°C – 24℃
Relative Humidity	30% – 70%

2. SAR Measurement System

2.1. SATIMO SAR Measurement Set-up Diagram



These measurements were performed with the automated near-field scanning system OPENSAR from SATIMO. The system is based on a high precision robot (working range: 901 mm), which positions the probes with a positional repeatability of better than ±0.03 mm. The SAR measurements were conducted with dosimetric probe (manufactured by SATIMO), designed in the classical triangular configuration and optimized for dosimetric evaluation.

The first step of the field measurement is the evaluation of the voltages induced on the probe by the device under test. Probe diode detectors are nonlinear. Below the diode compression point, the output voltage is proportional to the square of the applied E-field; above the diode compression point, it is linear to the applied E-field. The compression point depends on the diode, and a calibration procedure is necessary for each sensor of the probe.

The Keithley multimeter reads the voltage of each sensor and send these three values to the PC. The corresponding E field value is calculated using the probe calibration factors, which are stored in the working directory. This evaluation includes linearization of the diode characteristics. The field calculation is done separately for each sensor. Each component of the E field is displayed on the "Dipole Area Scan Interface" and the total E field is displayed on the "3D Interface"

2.2. Robot

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

- High precision (repeatability ±0.03 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

2.3. E-Field Probe

This E-field detection probe is composed of three orthogonal dipoles linked to special Schottky diodes with low detection thresholds. The probe allows the measurement of electric fields in liquids such as the one defined in the IEEE and CENELEC standards.

For the measurements the Specific Dosimetric E-Field Probe SN 08/16 EPGO287 with following specifications is used

- Dynamic range: 0.01-100 W/kg
- Tip Diameter : 2.5 mm
- Distance between probe tip and sensor center: 1 mm
- Distance between sensor center and the inner phantom surface: 2 mm (repeatability better than ±1 mm).
- Probe linearity: ±0.08 dB
- Axial isotropy: ±0.01 dB
- Hemispherical Isotropy: ±0.01 dB
- Calibration range: 650MHz to 5900MHz for head & body simulating liquid.
- Lower detection limit: 8mW/kg

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

2.3.1. E-Field Probe Calibration

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

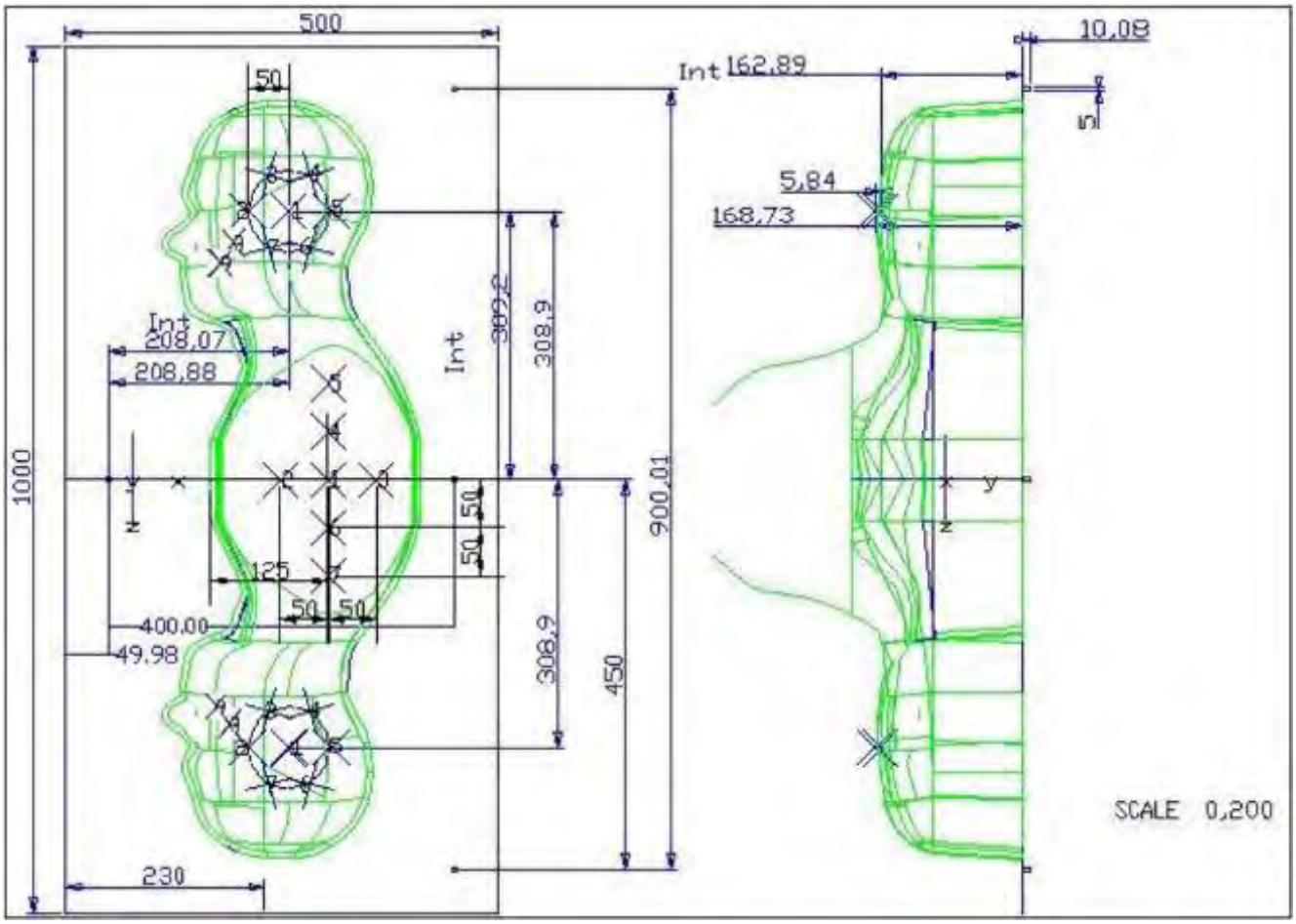
2.4. SAM phantoms

Photo of SAM phantom SN 16/15 SAM119

The SAM phantom is used to measure the SAR relative to people exposed to electro-magnetic field radiated by mobile phones.

2.4.1. Technical Data

Serial Number	Shell thickness	Filling volume	Dimensions	Positionner Material	Permittivity	Loss Tangent
SN 16/15 SAM119	2 mm ±0.2 mm	27 liters	Length:1000 mm Width:500 mm Height:200 mm	Gelcoat with fiberglass	3.4	0.02

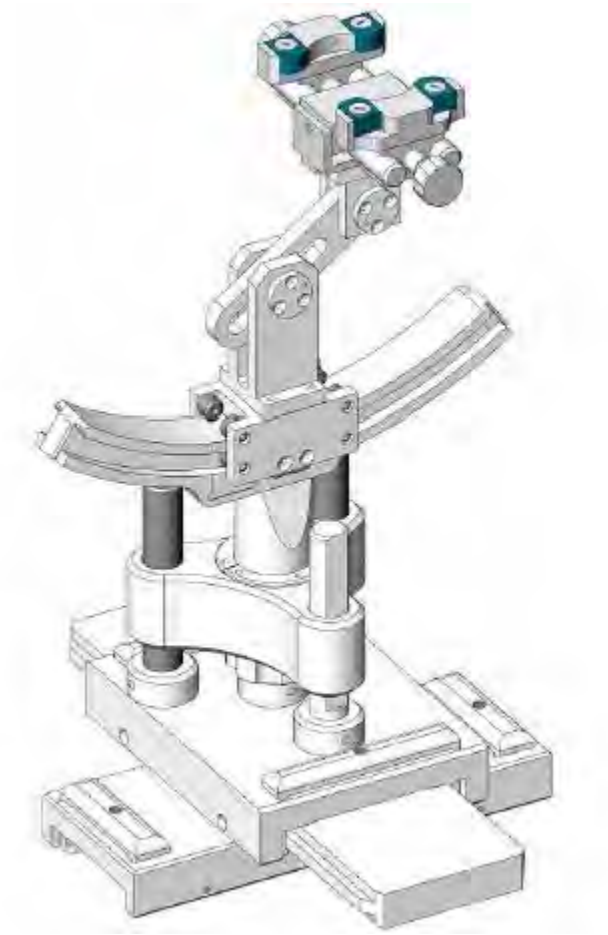


Serial Number	Left Head(mm)		Right Head(mm)		Flat Part(mm)	
SN 16/15 SAM119	2	2.02	2	2.08	1	2.09
	3	2.05	3	2.06	2	2.06
	4	2.07	4	2.07	3	2.08
	5	2.08	5	2.08	4	2.10
	6	2.05	6	2.07	5	2.10
	7	2.05	7	2.05	6	2.07
	8	2.07	8	2.06	7	2.07
	9	2.08	9	2.06	-	-

The test, based on ultrasonic system, allows measuring the thickness with an accuracy of 10 µm.

2.5. 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 degree.



Serial Number	Holder Material	Permittivity	Loss Tangent
SN 16/15 MSH100	Delrin	3.7	0.005

2.6. Test Equipment List

This table gives a complete overview of the SAR measurement equipment.

Devices used during the test described are marked ☒

	Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
					Last Cal.	Due Date
☒	MVG	E FIELD PROBE	SSE2	SN 08/16 EPGO287	Jan. 10, 2023	Jan. 09, 2024
☐	MVG	750 MHz Dipole	SID750	SN 03/15 DIP 0G750-355	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	835 MHz Dipole	SID835	SN 03/15 DIP 0G835-347	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	900 MHz Dipole	SID900	SN 03/15 DIP 0G900-348	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	1800 MHz Dipole	SID1800	SN 03/15 DIP 1G800-349	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	1900 MHz Dipole	SID1900	SN 03/15 DIP 1G900-350	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	2000 MHz Dipole	SID2000	SN 03/15 DIP 2G000-351	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	2300 MHz Dipole	SID2300	SN 03/16 DIP 2G300-358	Mar. 01, 2021	Feb. 28, 2024
☒	MVG	2450 MHz Dipole	SID2450	SN 03/15 DIP 2G450-352	Mar. 01, 2021	Feb. 28, 2024
☐	MVG	2600 MHz Dipole	SID2600	SN 03/15 DIP 2G600-356	Mar. 01, 2021	Feb. 28, 2024
☒	MVG	5000 MHz Dipole	SWG5500	SN 13/14 WGA 33	Mar. 01, 2021	Feb. 28, 2024
☒	MVG	Liquid measurement Kit	SCLMP	SN 21/15 OCPG 72	NCR	NCR
☒	MVG	Power Amplifier	N.A	AMPLISAR_28/14_003	NCR	NCR
☒	KEITHLEY	Millivoltmeter	2000	4072790	NCR	NCR
☐	R&S	Universal radio communication tester	CMU200	117858	Jun. 17, 2022	Jun. 16, 2023
☐	R&S	Wideband radio communication tester	CMW500	103917	Jun. 17, 2022	Jun. 16, 2023
☒	HP	Network	8753D	3410J01136	Jun. 17,	Jun. 16,

		Analyzer			2022	2023
☒	Agilent	MXG Vector Signal Generator	N5182A	MY47070317	Jun. 16, 2022	Jun. 15, 2023
☒	Agilent	Power meter	E4419B	MY45102538	Jun. 17, 2022	Jun. 16, 2023
☒	Agilent	Power sensor	E9301A	MY41495644	Jun. 17, 2022	Jun. 16, 2023
☒	Agilent	Power sensor	E9301A	US39212148	Jun. 17, 2022	Jun. 16, 2023
☒	MCLI/USA	Directional Coupler	CB11-20	0D2L51502	Jul. 17, 2020	Jul. 16, 2023
☒	N/A	Thermometer	N/A	LES-085	Mar. 27, 2023	Mar. 26, 2026
☒	MVG	SAM Phantom	SSM2	SN 16/15 SAM119	NCR	NCR
☒	MVG	Device Holder	SMPPD	SN 16/15 MSH100	NCR	NCR
☒	Shenzhen Tianxu Communication Technology Co., Ltd.	Human Simulating Liquid	Head 2450	Head 2450	NCR	NCR
☒	Shenzhen Tianxu Communication Technology Co., Ltd.	Human Simulating Liquid	Head 5200	Head 5200	NCR	NCR
☒	Shenzhen Tianxu Communication Technology Co., Ltd.	Human Simulating Liquid	Head 5400	Head 5400	NCR	NCR
☒	Shenzhen Tianxu Communication Technology Co., Ltd.	Human Simulating Liquid	Head 5600	Head 5600	NCR	NCR
☒	Shenzhen Tianxu Communication Technology Co., Ltd.	Human Simulating Liquid	Head 5800	Head 5800	NCR	NCR

3. SAR Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

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

(b) Read the WWAN RF power level from the base station simulator.

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

(d) Connect EUT RF port through RF cable to the power meter, and measure WLAN/Bluetooth output power.

<SAR measurement>

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

(b) Place the EUT in the positions as Appendix A demonstrates.

(c) Set scan area, grid size and other setting on the OPENSAR software.

(d) Measure SAR results for the highest power channel on each testing position.

(e) Find out the largest SAR result on these testing positions of each band.

(f) Measure SAR results for other channels in worst SAR testing position if the reported 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

3.1. Power Reference

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

3.2. Area scan & Zoom scan

The area scan is a 2D scan to find the hot spot location on the DUT. The zoom scan is a 3D scan above the hot spot to calculate the 1g and 10g SAR value.

Measurement of the SAR distribution with a grid of 8 to 16 mm * 8 to 16 mm and a constant distance to the inner surface of the phantom. Since the sensors cannot directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With these values the area of the maximum SAR is calculated by an interpolation scheme. Around this point, a cube of 30 * 30 *30 mm or 32 * 32 * 32 mm is assessed by measuring 5 or 8 * 5 or 8 * 4 or 5 mm. With these data, the peak spatial-average SAR value can be calculated.

From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that will not be within the zoom scan of other peaks; additional peaks shall be measured only when the primary peak is within 2 dB of the SAR compliance limit (e.g., 1 W/kg for 1,6 W/kg 1 g limit, or 1,26 W/kg for 2 W/kg, 10 g limit).

Area scan & Zoom scan scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

			≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: 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 ≤ 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 1st 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	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
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 draft standard IEEE P1528-2011 for details.

* When zoom scan is required and the *reported* SAR from the *area scan based 1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

3.3. Description of interpolation/extrapolation scheme

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 minimise 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 1 mm 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 10 grams and 1 gram requires a very fine resolution in the three dimensional scanned data array.

3.4. Volumetric Scan

The volumetric scan consists to a full 3D scan over a specific area. This 3D scan is useful form multi Tx SAR measurement. Indeed, it is possible with OpenSAR to add, point by point, several volumetric scan to calculate the SAR value of the combined measurement as it is define in the standard IEEE1528 and IEC62209.

3.5. Power Drift

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In OpenSAR 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 V/m. If the power drifts more than ±5%, the SAR will be retested.

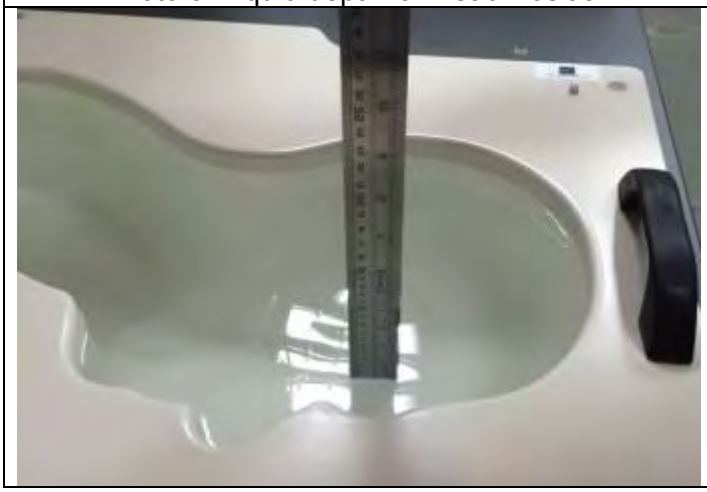
4. System Verification Procedure

4.1. Tissue Verification

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Ingredients (% of weight)	Head Tissue									
Frequency Band (MHz)	750	835	900	1800	1900	2000	2450	2600	5200	5800
Water	34.40	34.40	34.40	55.36	55.36	57.87	57.87	57.87	65.53	65.53
NaCl	0.79	0.79	0.79	0.35	0.35	0.16	0.16	0.16	0.00	0.00
1,2-Propanediol	64.81	64.81	64.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Triton X-100	0.00	0.00	0.00	30.45	30.45	19.97	19.97	19.97	24.24	24.24
DGBE	0.00	0.00	0.00	13.84	13.84	22.00	22.00	22.00	10.23	10.23
Ingredients (% of weight)	Body Tissue									
Frequency Band (MHz)	750	835	900	1800	1900	2000	2450	2600	5200	5800
Water	50.30	50.30	50.30	69.91	69.91	71.88	71.88	71.88	79.54	79.54
NaCl	0.60	0.60	0.60	0.13	0.13	0.16	0.16	0.16	0.00	0.00
1,2-Propanediol	49.10	49.10	49.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Triton X-100	0.00	0.00	0.00	9.99	9.99	19.97	19.97	19.97	11.24	11.24
DGBE	0.00	0.00	0.00	19.97	19.97	7.99	7.99	7.99	9.22	9.22

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid depth from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm.

Photo of Liquid depth for Head Position	Photo of Liquid depth for Body Position
	

4.1.1. Tissue Dielectric Parameter Check Results

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectric parameter are within the tolerances of the specified target values. The measured conductivity and relative permittivity should be within ±5% of the target values.

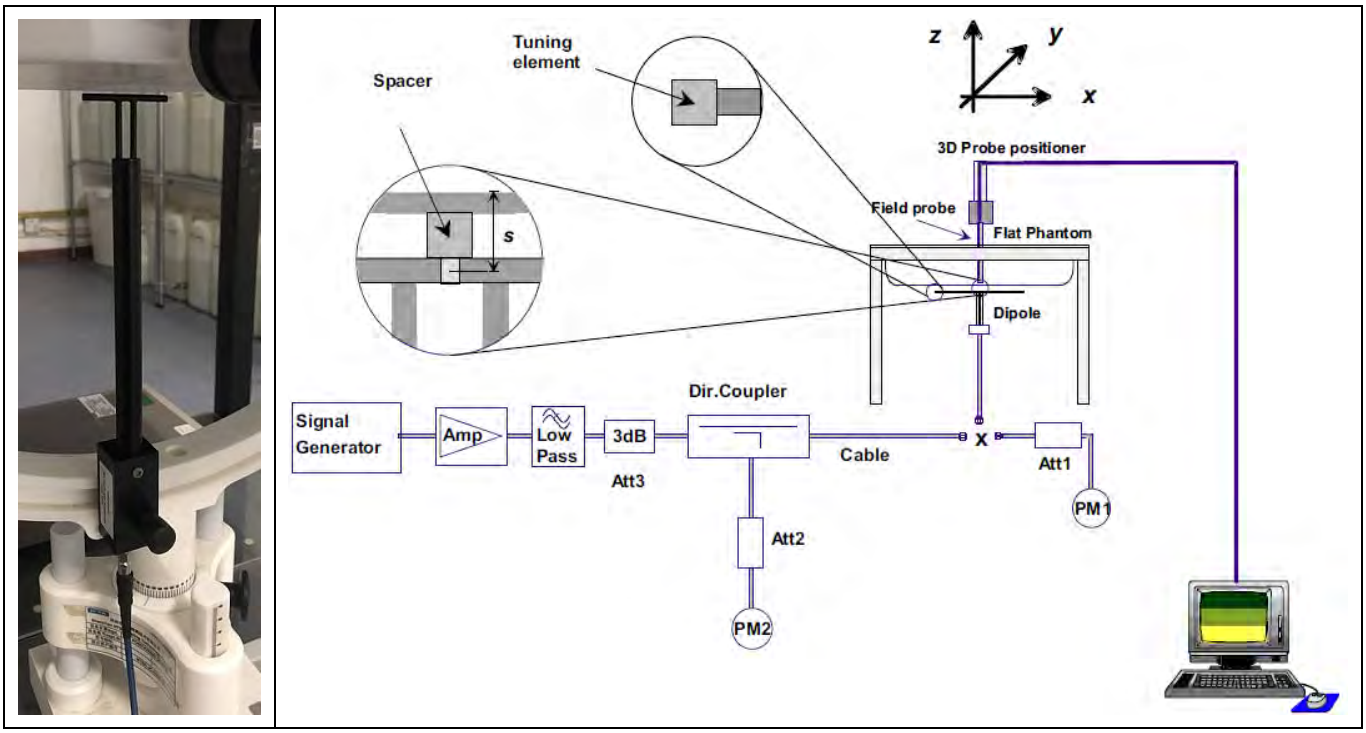
Tissue Type	Measured Frequency (MHz)	Target Tissue		Measured Tissue		Liquid Temp.	Test Date
		εr (±5%)	σ (S/m) (±5%)	εr	σ (S/m)		
Head 2450	2450	39.20 (37.24~41.16)	1.80 (1.71~1.89)	38.07	1.77	21.5 °C	May. 06, 2023
Head 5200	5200	36.00 (34.20~37.80)	4.66 (4.43~4.89)	35.54	4.64	21.5 °C	May. 04, 2023
Head 5400	5400	35.80 (34.01~37.59)	4.86 (4.62~5.10)	35.64	4.88	21.8 °C	May. 09, 2023
Head 5600	5600	35.50 (33.73~37.28)	5.07 (4.82~5.32)	34.19	4.92	21.6 °C	May. 10, 2023
Head 5800	5800	35.30 (33.54~37.07)	5.27 (5.01~5.53)	34.12	5.14	21.9 °C	May. 05, 2023

NOTE: The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.

4.2. System Verification Procedure

The system verification is performed for verifying the accuracy of the complete measurement system and performance of the software. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 100mW (below 5GHz) or 100mW (above 5GHz). To adjust this power a power meter is used. The power sensor is connected to the cable before the system verification to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the system verification to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test (result on plot).

The system verification is shown as below picture:



4.2.1. System Verification Results

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

System Verification	Target SAR (1W) (±10%)		Measured SAR (Normalized to 1W)		Liquid Temp.	Test Date
	1-g (W/Kg)	10-g (W/Kg)	1-g (W/Kg)	10-g (W/Kg)		
2450MHz	53.69 (48.33~59.05)	23.94 (21.55~26.33)	50.53 (-5.89%)	23.70 (-1.00%)	21.5 °C	May. 06, 2023
5200MHz	162.34 (146.11~178.57)	55.42 (49.88~60.96)	163.09 (0.46%)	53.51 (-3.81%)	21.5 °C	May. 04, 2023
5400MHz	168.48 (151.64~185.32)	57.03 (51.33~62.73)	177.06 (5.09%)	57.02 (-0.02%)	21.8 °C	May. 09, 2023
5600MHz	174.92 (157.43~192.41)	58.63 (52.77~64.49)	186.14 (6.41%)	53.73 (-8.36%)	21.6 ℃	May. 10, 2023
5800MHz	178.89 (161.01~196.77)	59.32 (53.39~65.25)	183.66 (2.67%)	64.76 (9.17%)	21.9 °C	May. 05, 2023

5. SAR Measurement variability and uncertainty

5.1. SAR measurement variability

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
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.

5.2. SAR measurement uncertainty

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

6. RF Exposure Positions

1.3. Tablet host platform exposure conditions

Refer to KDB616217 D04, when the modular approach is used, transmitters and modules must be initially tested for standalone operations in generic host conditions according to the following minimum test separation distance and antenna installation requirements for incorporation in the tablet platform. The separation distance required for incorporation in qualified hosts is described in KDB 447498; item 5) of section 4.1 and item 1) of section 5.2.2 etc.

- ≤ 5 mm between the antenna and user for both back surface and edge exposure conditions
- the antennas used by the host must have been tested for equipment approval or qualify for SAR test exclusion
- the antenna polarization, physical orientation, rotation and installation configurations used by the host must have been tested for compliance or qualify for test exclusion
- when the *SAR Test Exclusion Threshold* in KDB 447498 applies, a *test separation distance* of 5 mm is required to determine test exclusion for the tablet platform

The antennas embedded in tablets are typically ≤ 5mm from the outer housing. The required antenna to user test separation distance is a “not to exceed test” distance required to apply the modular approach. Instead of the typical zero gap tablet edge test requirement between the edge of a tablet and the user, when an antenna has been tested at ≤ 5 mm according to the modular approach it can be incorporated into tablets with at least twice the tested distance from the outer housing of the tablet edge; otherwise, the tablet edge zero gap test requirement applies. When the dedicated host approach is applied, the back surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom.

7. RF Output Power

7.1. WLAN & Bluetooth Output Power

7.1.1. Output Power Results Of WLAN

Mode	Channel	Frequency (MHz)	Tune-up (dBm)	Output Power (dBm)
802.11b	1	2412	16.00	15.74
	6	2437	16.00	15.27
	11	2462	16.00	15.58
802.11g	1	2412	14.00	13.12
	6	2437	14.00	13.84
	11	2462	14.00	13.00
802.11n HT20	1	2412	12.50	12.02
	6	2437	12.50	11.80
	11	2462	12.50	11.86
802.11n HT40	3	2422	12.00	11.61
	6	2437	12.00	11.89
	9	2452	12.00	11.58

NOTE: Power measurement results of WLAN 2.4G.

Mode	Channel	Frequency (MHz)	Tune-up (dBm)	Output Power (dBm)
802.11a	36	5180	10.00	9.66
	40	5200	10.00	9.77
	48	5240	10.00	9.58
802.11n HT20	36	5180	10.00	9.52
	40	5200	10.00	9.65
	48	5240	10.00	9.45
802.11n HT40	38	5190	9.50	9.29
	46	5230	9.50	9.45
802.11ac VHT20	36	5180	10.00	9.52
	40	5200	10.00	9.61
	48	5240	10.00	9.83
802.11ac VHT40	38	5190	9.50	9.11
	46	5230	9.50	9.46
802.11ac VHT80	42	5210	9.00	8.78

NOTE: Power measurement results of WLAN 5.2G.

Mode	Channel	Frequency (MHz)	Tune-up (dBm)	Output Power (dBm)
802.11a	52	5260	10.50	10.24
	56	5280	10.50	9.83
	64	5320	10.50	10.08
802.11n HT20	52	5260	10.50	10.12
	56	5280	10.50	9.73
	64	5320	10.50	9.94
802.11n HT40	54	5270	10.50	9.75
	62	5310	10.50	10.26
802.11ac VHT20	52	5260	10.50	10.13
	56	5280	10.50	9.73
	64	5320	10.50	9.95
802.11ac VHT40	54	5270	10.50	9.77
	62	5310	10.50	10.30
802.11ac VHT80	58	5290	9.50	9.48

NOTE: Power measurement results of WLAN 5.3G.

Mode	Channel	Frequency (MHz)	Tune-up (dBm)	Output Power (dBm)
802.11a	100	5500	10.50	9.54
	120	5600	10.50	10.07
	140	5700	10.50	9.78
802.11n HT20	100	5500	10.50	9.35
	120	5600	10.50	10.16
	140	5700	10.50	9.64
802.11n HT40	102	5510	10.50	9.01
	118	5590	10.50	9.80
802.11ac VHT20	134	5670	10.50	10.16
	100	5500	10.50	9.34
	120	5600	10.50	10.13
802.11ac VHT40	140	5700	10.50	9.65
	102	5510	10.50	9.73
802.11ac VHT80	118	5590	10.50	9.89

NOTE: Power measurement results of WLAN 5.6G.

Mode	Channel	Frequency (MHz)	Tune-up (dBm)	Output Power (dBm)

802.11a	149	5745	10.50	9.88
	157	5785	10.50	9.91
	165	5825	10.50	10.41
802.11n HT20	149	5745	10.00	9.71
	157	5785	10.00	9.84
	165	5825	10.00	9.76
802.11n HT40	151	5755	10.50	10.32
	159	5795	10.50	9.89
802.11ac VHT20	149	5745	10.50	9.80
	157	5785	10.50	9.24
	165	5825	10.50	10.25
802.11ac VHT40	151	5755	10.50	10.22
	159	5795	10.50	9.87
802.11ac VHT80	155	5775	10.50	10.12

NOTE: Power measurement results of WLAN 5.8G.

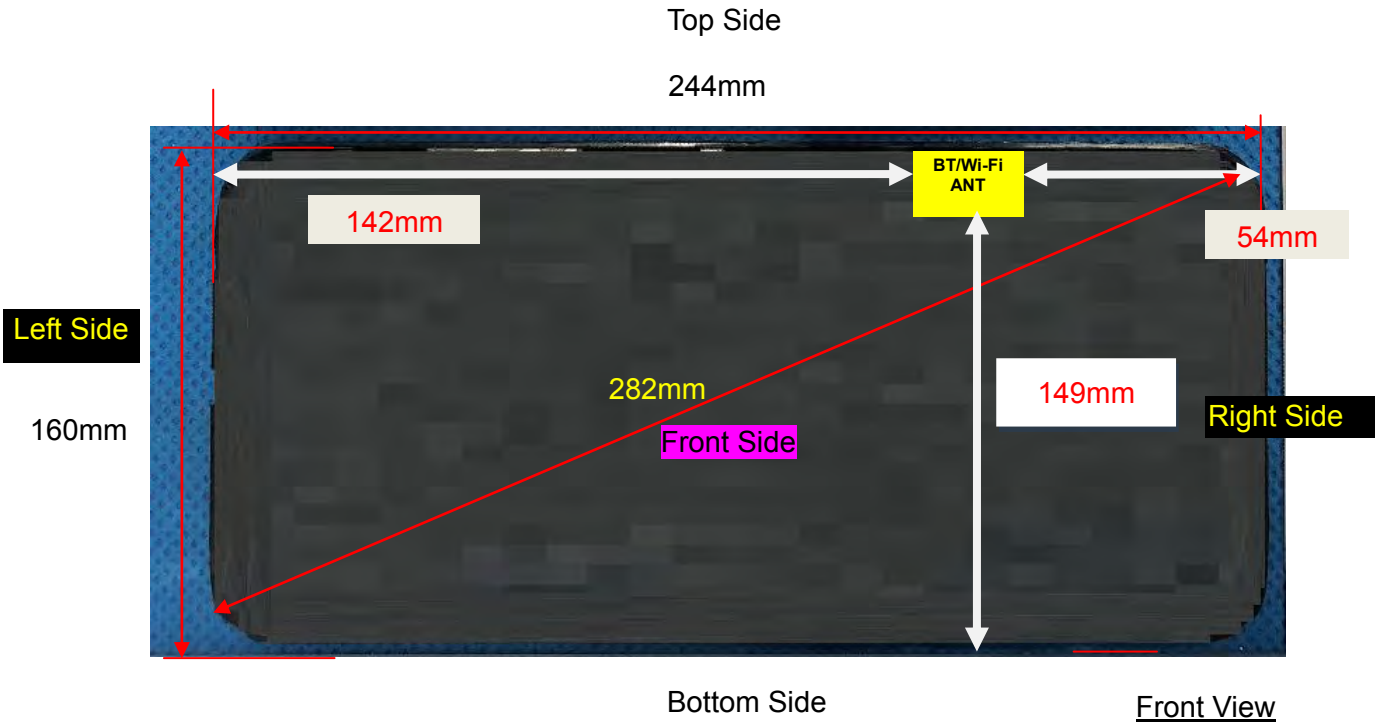
7.1.2. Output Power Results Of Bluetooth

	Output Power (dBm)				
	Channel	Tune-up (dBm)	Data Rates		
			1M	2M	3M
BR+EDR	0CH	9.00	8.88	8.65	8.62
	39CH	9.00	8.38	8.33	8.29
	78CH	9.00	8.95	8.67	8.73

	Channel	Tune-up (dBm)	Output Power (dBm)
			1M
BLE	0CH	7.00	6.52
	19CH	8.00	7.20
	39CH	8.00	7.05

NOTE: Power measurement results of Bluetooth

8. Antenna Location



Note: Since the confidentiality request of EUT，the antenna location example diagram see as above.

Distance of the Antenna to the EUT surface/edge						
Antennas	Front Side	Back Side	Left Side	Right Side	Top Side	Bottom Side
WLAN & Bluetooth	5	5	160	54	5	149

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

Positions for SAR tests		
Test separation distances ≤ 50 mm		
Exposure Positions	Tune-up Maximum power of WLAN 2.4G	
	16.00dBm	
Front Side	Antenna to user(mm)	5
	SAR exclusion threshold	12.49
	SAR testing required?	YES
Back Side	Antenna to user(mm)	5
	SAR exclusion threshold	12.49
	SAR testing required?	YES
Top Side	Antenna to user(mm)	5
	SAR exclusion threshold	12.49
	SAR testing required?	YES
Exposure Positions	Tune-up Maximum power of WLAN 5.2G	
	10.00dBm	

Front Side	Antenna to user(mm)	5
	SAR exclusion threshold	4.58
	SAR testing required?	YES
Back Side	Antenna to user(mm)	5
	SAR exclusion threshold	4.58
	SAR testing required?	YES
Top Side	Antenna to user(mm)	5
	SAR exclusion threshold	4.58
	SAR testing required?	YES
Exposure Positions	Tune-up Maximum power of WLAN 5.3G	
	10.50dBm	
Front Side	Antenna to user(mm)	5
	SAR exclusion threshold	5.18
	SAR testing required?	YES
Back Side	Antenna to user(mm)	5
	SAR exclusion threshold	5.18
	SAR testing required?	YES
Top Side	Antenna to user(mm)	5
	SAR exclusion threshold	5.18
	SAR testing required?	YES
Exposure Positions	Tune-up Maximum power of WLAN 5.6G	
	10.50dBm	
Front Side	Antenna to user(mm)	5
	SAR exclusion threshold	5.36
	SAR testing required?	YES
Back Side	Antenna to user(mm)	5
	SAR exclusion threshold	5.36
	SAR testing required?	YES
Top Side	Antenna to user(mm)	5
	SAR exclusion threshold	5.36
	SAR testing required?	YES
Exposure Positions	Tune-up Maximum power of WLAN 5.8G	
	10.50dBm	
Front Side	Antenna to user(mm)	5
	SAR exclusion threshold	5.42
	SAR testing required?	YES
Back Side	Antenna to user(mm)	5
	SAR exclusion threshold	5.42
	SAR testing required?	YES
Top Side	Antenna to user(mm)	5

	SAR exclusion threshold	5.42
	SAR testing required?	YES

NOTE: Refer to section 4.3.1 of KDB 447498 D01.

Positions for SAR tests		
Test separation distances > 50 mm		
Exposure Positions	Tune-up Maximum power of WLAN 2.4G	
	16.00 dBm	39.81 mW
Left Side	Antenna to user(mm)	160
	SAR exclusion threshold(mW)	1196
	SAR testing required?	NO
Right Side	Antenna to user(mm)	54
	SAR exclusion threshold(mW)	136
	SAR testing required?	NO
Bottom Side	Antenna to user(mm)	149
	SAR exclusion threshold(mW)	1086
	SAR testing required?	NO
Exposure Positions	Tune-up Maximum power of WLAN 5.2G	
	10.50 dBm	11.22 mW
Front Side	Antenna to user(mm)	160
	SAR exclusion threshold(mW)	1166
	SAR testing required?	NO
Back Side	Antenna to user(mm)	54
	SAR exclusion threshold(mW)	106
	SAR testing required?	NO
Top Side	Antenna to user(mm)	149
	SAR exclusion threshold(mW)	1056
	SAR testing required?	NO
Exposure Positions	Tune-up Maximum power of WLAN 5.3G	
	10.50 dBm	11.22 mW
Front Side	Antenna to user(mm)	160
	SAR exclusion threshold(mW)	1166
	SAR testing required?	NO
Back Side	Antenna to user(mm)	54
	SAR exclusion threshold(mW)	106
	SAR testing required?	NO
Top Side	Antenna to user(mm)	149
	SAR exclusion threshold(mW)	1056
	SAR testing required?	NO
Exposure Positions	Tune-up Maximum power of WLAN 5.6G	

	10.50 dBm	11.22 mW
Front Side	Antenna to user(mm)	160
	SAR exclusion threshold(mW)	1165
	SAR testing required?	NO
Back Side	Antenna to user(mm)	54
	SAR exclusion threshold(mW)	105
	SAR testing required?	NO
Top Side	Antenna to user(mm)	149
	SAR exclusion threshold(mW)	1055
	SAR testing required?	NO
Exposure Positions	Tune-up Maximum power of WLAN 5.8G	
	11.00 dBm	12.59 mW
Front Side	Antenna to user(mm)	160
	SAR exclusion threshold(mW)	1162
	SAR testing required?	NO
Back Side	Antenna to user(mm)	54
	SAR exclusion threshold(mW)	102
	SAR testing required?	NO
Top Side	Antenna to user(mm)	149
	SAR exclusion threshold(mW)	1052
	SAR testing required?	NO

NOTE: Refer to section 4.3.1 of KDB 447498 D01.

9. Stand-alone SAR test exclusion

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

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)]·[$\sqrt{f_{(GHZ)}}$] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where:

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

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

Mode	P_{max} (dBm)	P_{max} (mW)	Distance (mm)	f (GHz)	Calculation Result	SAR Exclusion threshold	SAR test exclusion
Bluetooth	9.00	7.94	5	2.480	2.5	3	Yes

NOTE: Standalone SAR test exclusion for Bluetooth.

10. SAR Results

10.1. SAR measurement results

10.1.1. SAR measurement Result of WLAN 2.4G

Test Position of Body with 0mm	Test channel /Freq.	Test Mode	SAR Value (W/kg)		Power Drift (±5%)	Conducted power (dBm)	Tune-up power (dBm)	Scaled SAR 1g (W/Kg)	Date	Plot
			1-g	10-g						
Front Side	1/2412	802.11b	0.678	0.288	-0.12	15.74	16.00	0.720	2023/5/06	
Back Side	1/2412	802.11b	1.271	0.552	1.58	15.74	16.00	1.349	2023/5/06	1#
Back Side	6/2437	802.11b	1.097	0.481	0.85	15.27	16.00	1.298	2023/5/06	
Back Side	11/2462	802.11b	1.016	0.451	1.23	15.58	16.00	1.119	2023/5/06	
BackSide Repeated	1/2412	802.11b	1.250	0.542	0.36	15.74	16.00	1.327	2023/5/06	
Top Side	1/2412	802.11b	0.342	0.142	2.19	15.74	16.00	0.363	2023/5/06	

NOTE: Body SAR test results of WLAN 2.4G

10.1.2. SAR measurement Result of WLAN 5.2G

Test Position of Body with 0mm	Test channel /Freq	Mode	SAR Value (W/kg)		Power Drift(%)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR 1-g (W/Kg)	Date	Plot
			1-g	10-g						
Front Side	48/5240	802.11ac VHT20	0.078	0.018	0.02	9.83	10.00	0.081	2023/5/04	
Back Side	48/5240	802.11ac VHT20	0.128	0.030	2.13	9.83	10.00	0.133	2023/5/04	2#
Top Side	48/5240	802.11ac VHT20	0.064	0.014	-1.14	9.83	10.00	0.067	2023/5/04	

NOTE: Body SAR test results of WLAN 5.2G

10.1.3. SAR measurement Result of WLAN 5.3G

Test Position of Body with 0mm	Test channel /Freq	Mode	SAR Value (W/kg)		Power Drift(%)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR 1-g (W/Kg)	Date	Plot
			1-g	10-g						
Front Side	62/5310	802.11ac VHT40	0.095	0.021	3.16	10.30	10.50	0.099	2023/5/09	
Back Side	62/5310	802.11ac VHT40	0.154	0.036	-1.29	10.30	10.50	0.161	2023/5/09	3#
Top Side	62/5310	802.11ac VHT40	0.017	0.015	-2.97	10.30	10.50	0.018	2023/5/09	

NOTE: Body SAR test results of WLAN 5.3G

10.1.4. SAR measurement Result of WLAN 5.6G

Test Position of Body with 0mm	Test channel /Freq	Mode	SAR Value (W/kg)		Power Drift(%)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR 1-g (W/Kg)	Date	Plot
			1-g	10-g						
Front Side	120/5600	802.11 n	0.109	0.023	3.75	10.16	10.50	0.118	2023/5/10	
Back Side	120/5600	802.11 n	0.171	0.038	-0.21	10.16	10.50	0.185	2023/5/10	4#
Top Side	120/5600	802.11 n	0.019	0.017	-0.99	10.16	10.50	0.021	2023/5/10	

NOTE: Body SAR test results of WLAN 5.6G

10.1.5. SAR measurement Result of WLAN 5.8G

Test Position of Body with 0mm	Test channel /Freq	Mode	SAR Value (W/kg)		Power Drift(%)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR 1-g (W/Kg)	Date	Plot
			1-g	10-g						
Front Side	165/5825	802.11 a	0.077	0.017	2.96	10.41	10.50	0.079	2023/5/05	
Back Side	165/5825	802.11 a	0.121	0.027	-1.87	10.41	10.50	0.124	2023/5/05	5#
Top Side	165/5825	802.11 a	0.015	0.013	2.05	10.41	10.50	0.015	2023/5/05	

NOTE: Body SAR test results of WLAN 5.8G

10.2. SAR Summation Scenario

NO simultaneous transmissions are possible for this device of Bluetooth and WLAN2.4/5G

11. Appendix A. Photo documentation

Refer to appendix Test Setup photo---SAR

12. Appendix B. System Check Plots

Table of contents
MEASUREMENT 1 System Performance Check - 2450MHz
MEASUREMENT 2 System Performance Check - 5200MHz
MEASUREMENT 3 System Performance Check - 5400MHz
MEASUREMENT 4 System Performance Check - 5600MHz
MEASUREMENT 5 System Performance Check - 5800MHz

MEASUREMENT 1

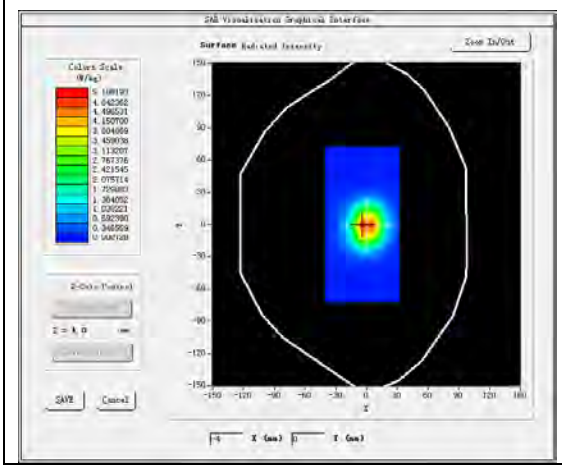
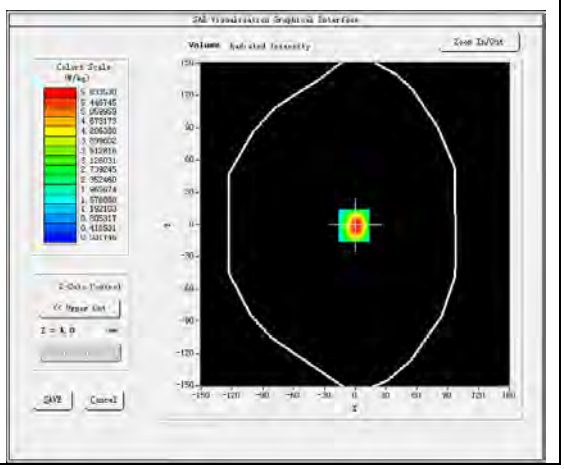
Date of measurement: 6/5/2023

A. Experimental conditions.

Area Scan	dx=12mm dy=12mm, h= 5.00 mm
ZoomScan	7x7x7,dx=5mm dy=5mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	CW2450
Channels	Middle
Signal	CW (Crest factor: 1.0)
ConvF	1.98

B. SAR Measurement Results

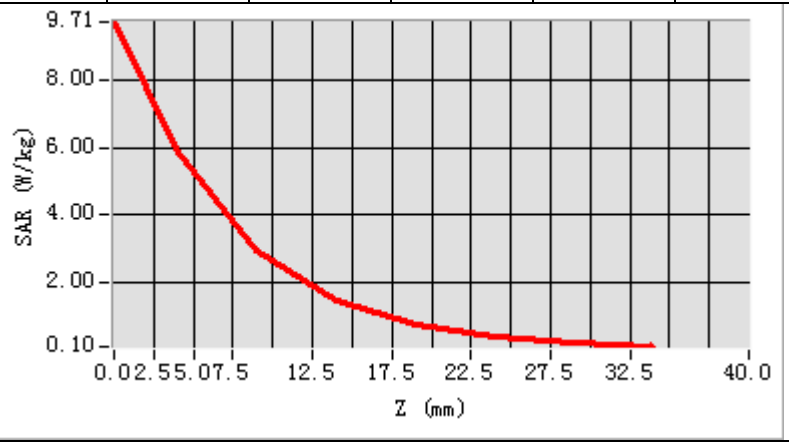
Frequency (MHz)	2450.000000
Relative permittivity (real part)	38.070413
Relative permittivity (imaginary part)	12.978579
Conductivity (S/m)	1.766529
Variation (%)	1.770000

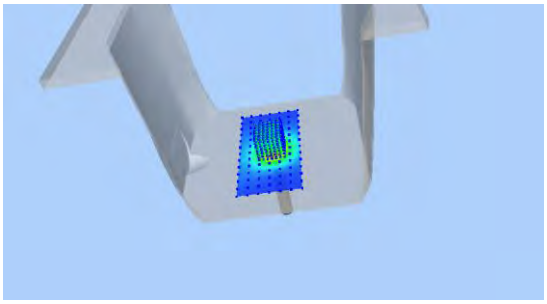
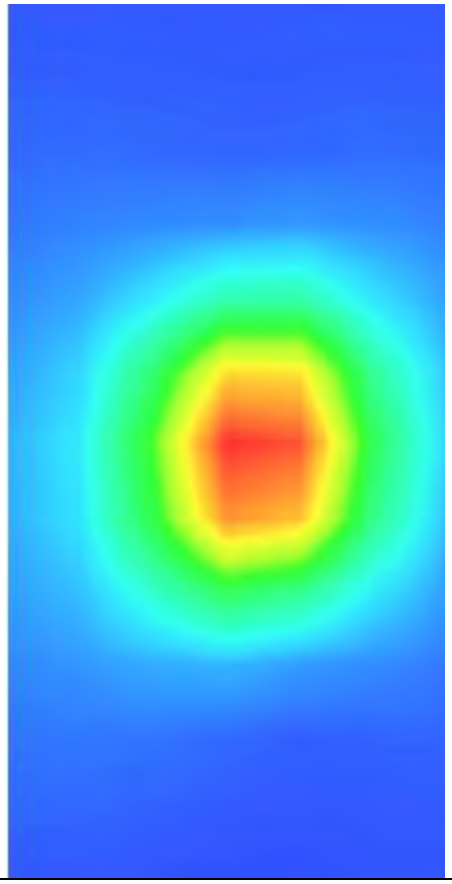
SURFACE SAR	VOLUME SAR
	

Maximum location: X=-1.00, Y=-1.00
SAR Peak: 9.83 W/kg

SAR 10g (W/Kg)	2.370267
SAR 1g (W/Kg)	5.053338

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	9.7167	5.8317	2.9202	1.4698	0.7421	0.3729	0.1922



3D screen shot	Hot spot position
	

MEASUREMENT 2

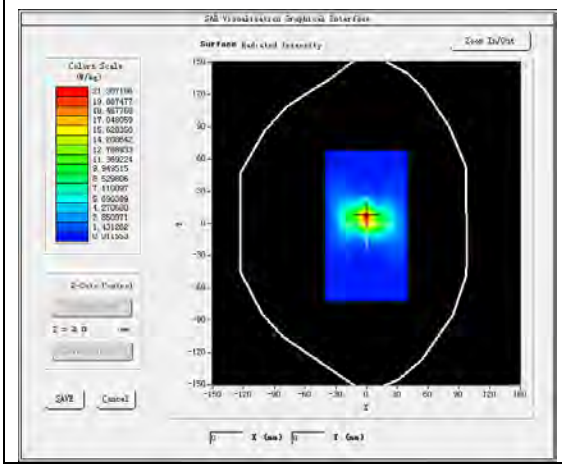
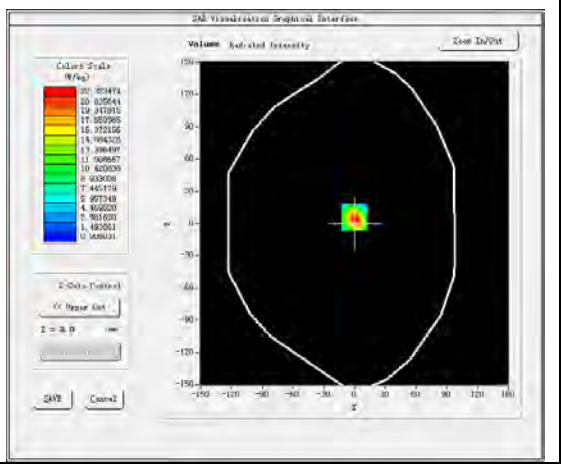
Date of measurement: 4/5/2023

A. Experimental conditions.

Area Scan	dx=10mm dy=10mm, h= 2.00 mm
ZoomScan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Dipole
Band	CW5200
Channels	Middle
Signal	CW (Crest factor: 1.0)
ConvF	1.80

B. SAR Measurement Results

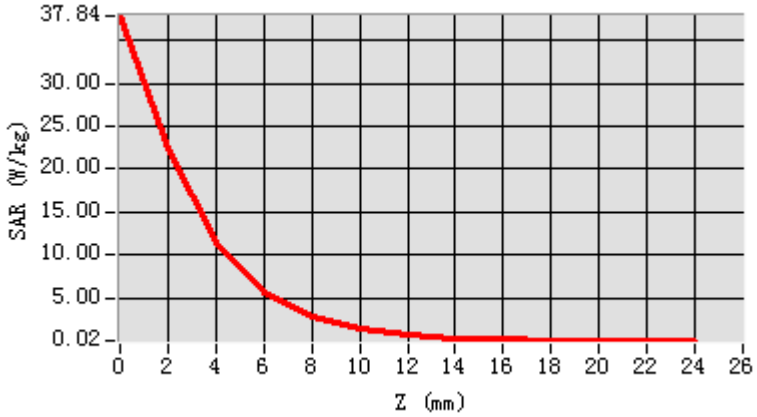
Frequency (MHz)	5200.000000
Relative permittivity (real part)	35.539641
Relative permittivity (imaginary part)	16.044266
Conductivity (S/m)	4.635010
Variation (%)	1.750000

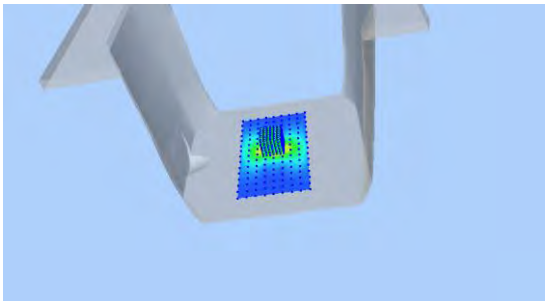
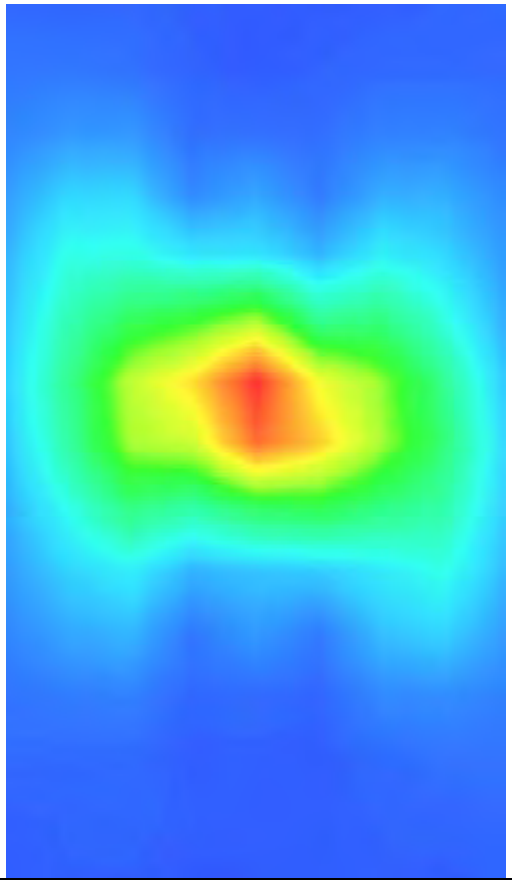
SURFACE SAR	VOLUME SAR
	

Maximum location: X=0.00, Y=6.00
SAR Peak: 40.06 W/kg

SAR 10g (W/Kg)	5.351331
SAR 1g (W/Kg)	16.309173

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)	37.882	22.335	11.332	5.6656	2.8210	1.4068	0.7164	0.3614	0.1897	0.1034	0.0556	0.0306



3D screen shot	Hot spot position
	

MEASUREMENT 3

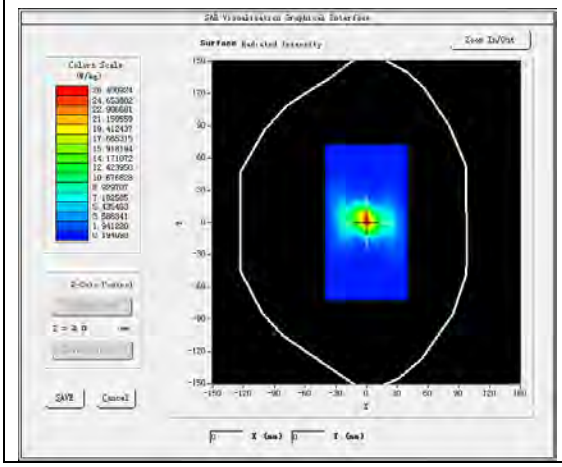
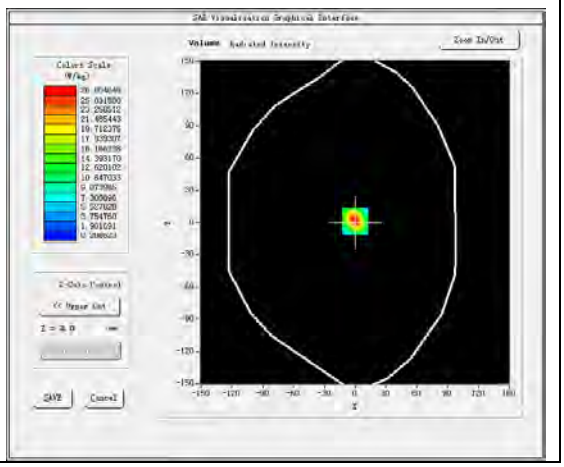
Date of measurement: 9/5/2023

A. Experimental conditions.

Area Scan	dx=10mm dy=10mm, h= 2.00 mm
ZoomScan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Dipole
Band	CW5400
Channels	Middle
Signal	CW (Crest factor: 1.0)
ConvF	2.05

B. SAR Measurement Results

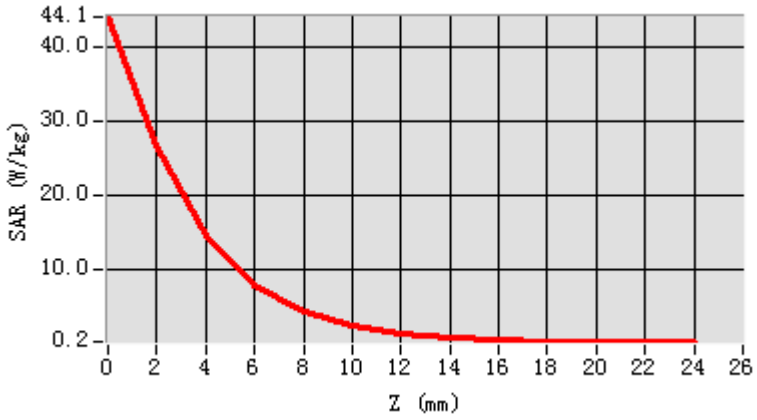
Frequency (MHz)	5400.000000
Relative permittivity (real part)	35.637135
Relative permittivity (imaginary part)	16.281785
Conductivity (S/m)	4.884536
Variation (%)	-0.700000

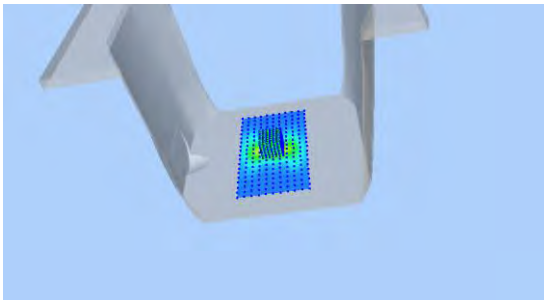
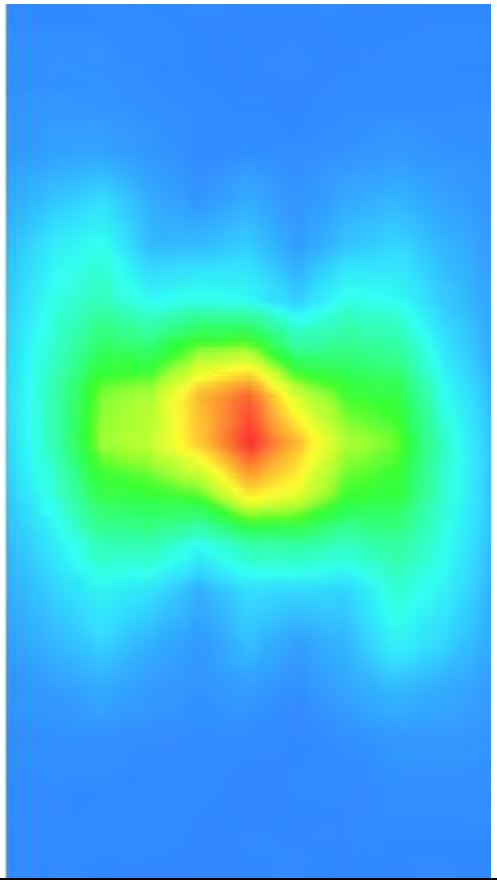
SURFACE SAR	VOLUME SAR
	

Maximum location: X=0.00, Y=1.00
SAR Peak: 46.18 W/kg

SAR 10g (W/Kg)	5.702369
SAR 1g (W/Kg)	17.706356

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)	44.074	26.875	14.612	7.8109	4.2226	2.3238	1.3237	0.7813	0.5004	0.3745	0.2803	0.2613



3D screen shot	Hot spot position
	

MEASUREMENT 4

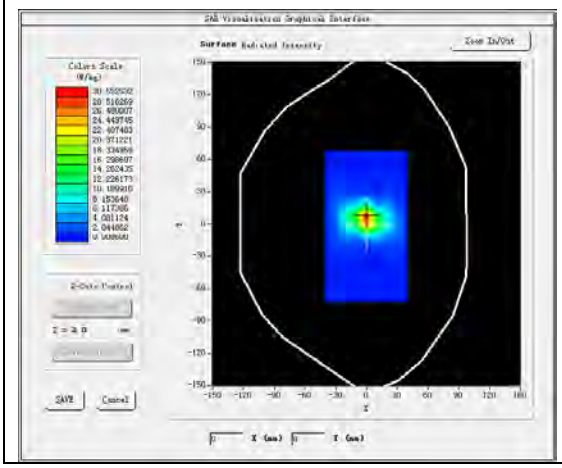
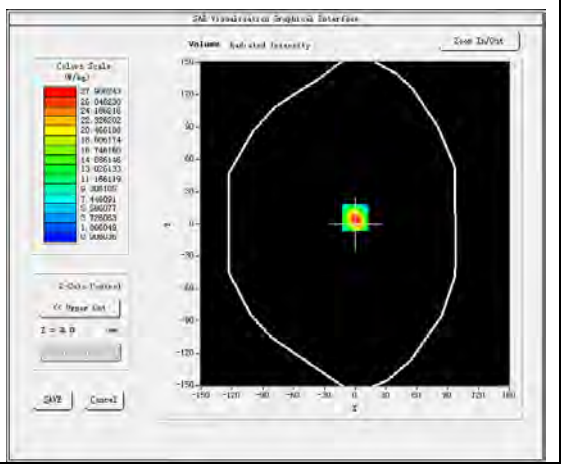
Date of measurement: 10/5/2023

A. Experimental conditions.

Area Scan	dx=10mm dy=10mm, h= 2.00 mm
ZoomScan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Dipole
Band	CW5600
Channels	Middle
Signal	CW (Crest factor: 1.0)
ConvF	2.16

B. SAR Measurement Results

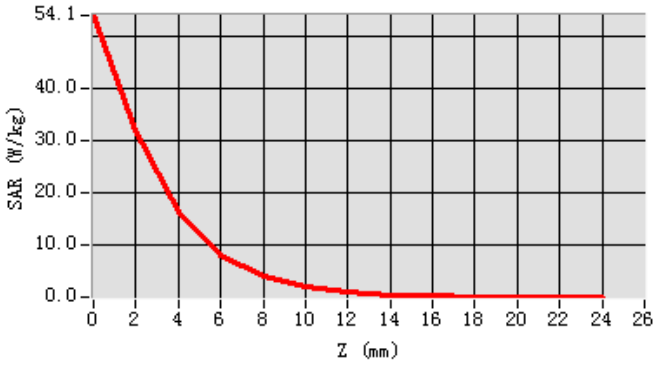
Frequency (MHz)	5600.000000
Relative permittivity (real part)	34.189276
Relative permittivity (imaginary part)	15.802475
Conductivity (S/m)	4.916326
Variation (%)	-2.480000

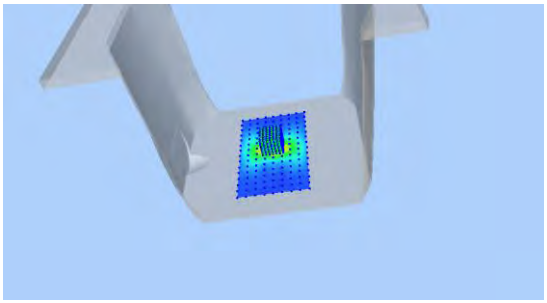
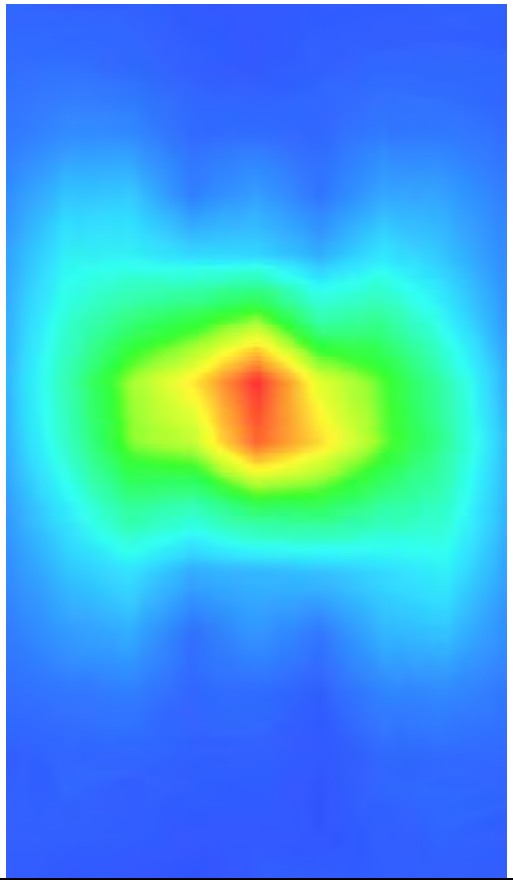
SURFACE SAR	VOLUME SAR
	

Maximum location: X=0.00, Y=6.00
SAR Peak: 51.23 W/kg

SAR 10g (W/Kg)	5.373030
SAR 1g (W/Kg)	18.614274

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)	54.193	31.965	16.377	8.1767	4.0825	3.8155	1.0324	0.4639	0.2755	0.1340	0.0731	0.0561



3D screen shot	Hot spot position
	

MEASUREMENT 5

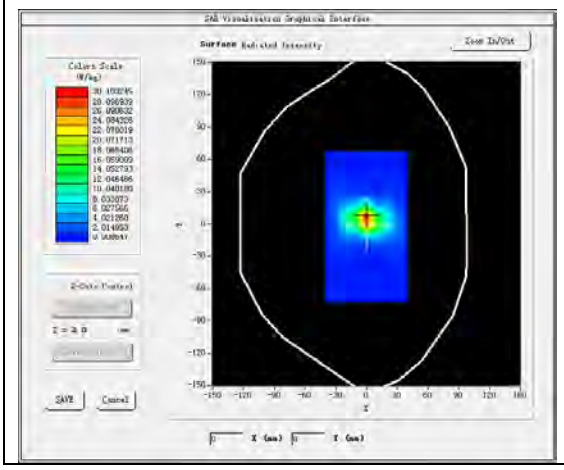
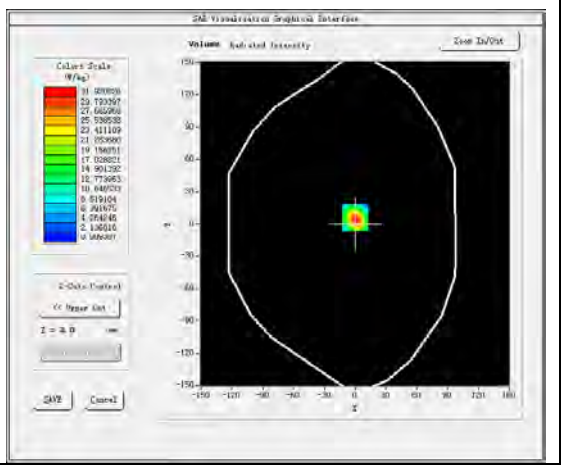
Date of measurement: 5/5/2023

A. Experimental conditions.

Area Scan	dx=10mm dy=10mm, h= 2.00 mm
ZoomScan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Dipole
Band	CW5800
Channels	Middle
Signal	CW (Crest factor: 1.0)
ConvF	2.07

B. SAR Measurement Results

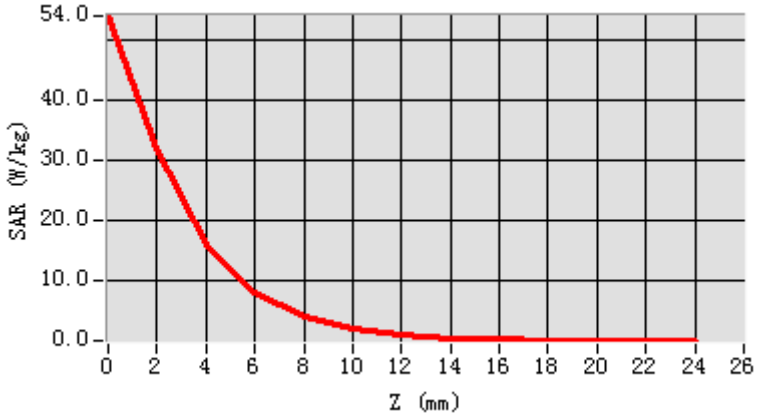
Frequency (MHz)	5800.000000
Relative permittivity (real part)	34.118558
Relative permittivity (imaginary part)	15.945827
Conductivity (S/m)	5.138100
Variation (%)	-0.630000

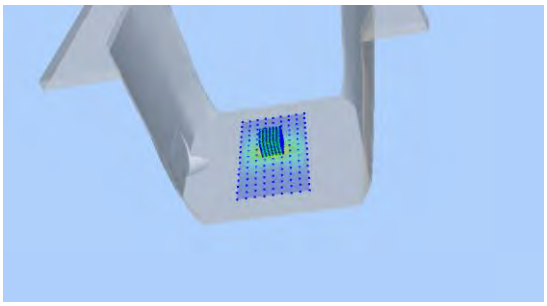
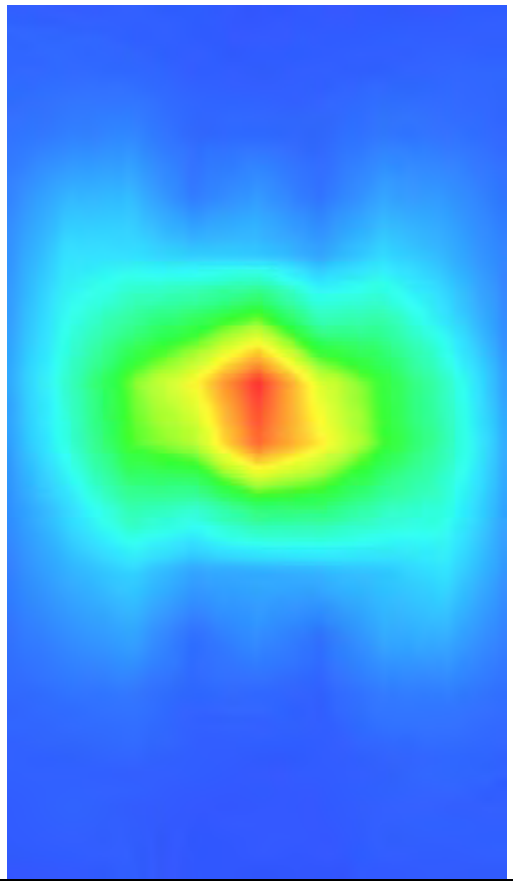
SURFACE SAR	**VOLUME SAR**
	

Maximum location: X=0.00, Y=6.00
SAR Peak: 57.37 W/kg

SAR 10g (W/Kg)	6.476102
SAR 1g (W/Kg)	18.366336

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)	54.037	31.920	16.180	8.1747	4.0878	2.0524	1.0388	0.5144	0.2732	0.1585	0.0756	0.0407



3D screen shot	Hot spot position
	

13. Appendix C. Plots of High SAR Measurement

Table of contents
MEASUREMENT 1 WLAN 2.4G Body
MEASUREMENT 2 WLAN 5.2G Body
MEASUREMENT 3 WLAN 5.3G Body
MEASUREMENT 4 WLAN 5.6G Body
MEASUREMENT 5 WLAN 5.8G Body

MEASUREMENT 1

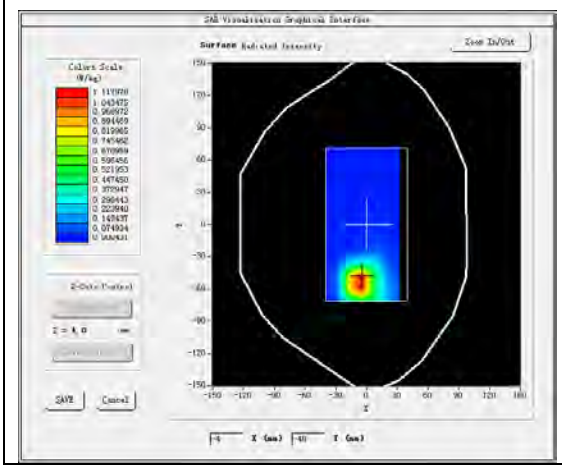
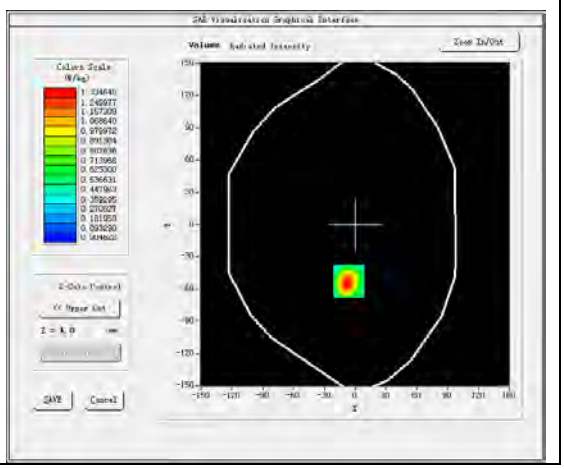
Date of measurement: 6/5/2023

A. Experimental conditions.

Area Scan	dx=12mm dy=12mm, h= 5.00 mm
ZoomScan	7x7x7,dx=5mm dy=5mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	IEEE 802.11b ISM
Channels	Low
Signal	IEEE802.11b (Crest factor: 1.0)
ConvF	1.98

B. SAR Measurement Results

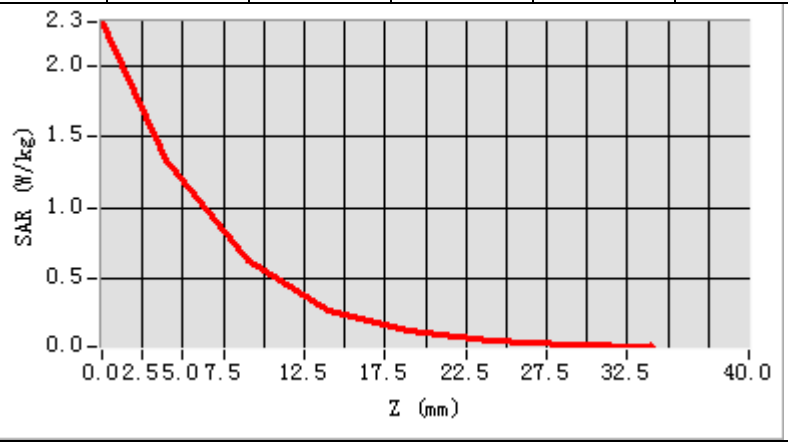
Frequency (MHz)	2412.000000
Relative permittivity (real part)	38.167113
Relative permittivity (imaginary part)	12.927779
Conductivity (S/m)	1.732322
Variation (%)	1.580000

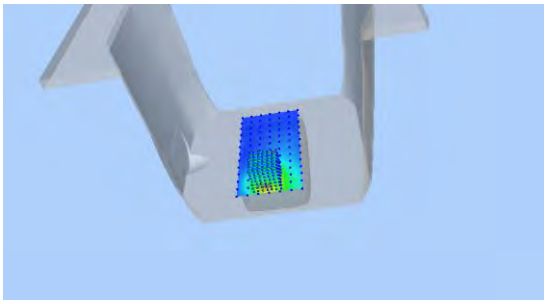
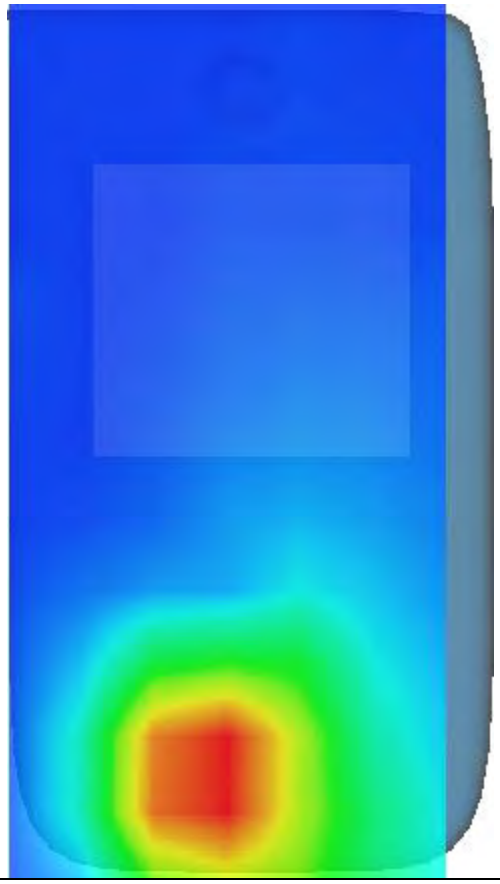
SURFACE SAR	**VOLUME SAR**
	

Maximum location: X=-6.00, Y=-53.00
SAR Peak: 2.46 W/kg

SAR 10g (W/Kg)	0.551746
SAR 1g (W/Kg)	1.270955

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	2.3155	1.3346	0.6225	0.2712	0.1293	0.0618	0.0298



3D screen shot	Hot spot position
	

MEASUREMENT 2

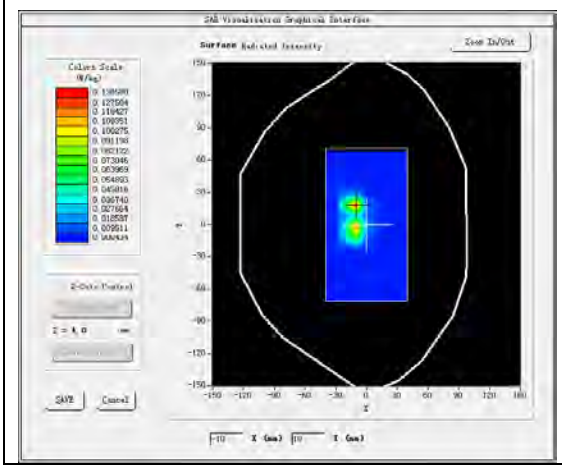
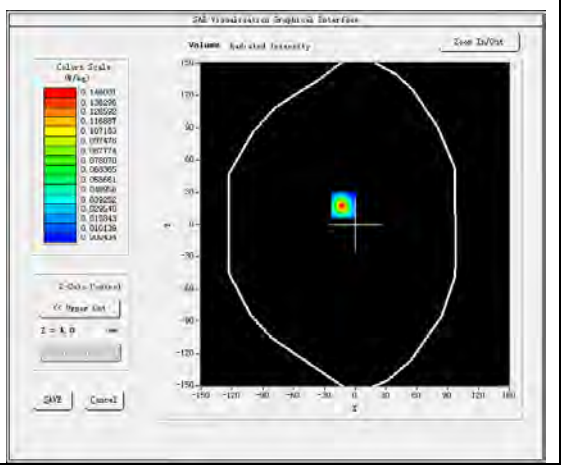
Date of measurement: 4/5/2023

A. Experimental conditions.

Area Scan	dx=10mm dy=10mm, h= 2.00 mm
ZoomScan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	IEEE 802.11ac U-NII
Channels	High
Signal	IEEE802.11ac (Crest factor: 1.0)
ConvF	1.80

B. SAR Measurement Results

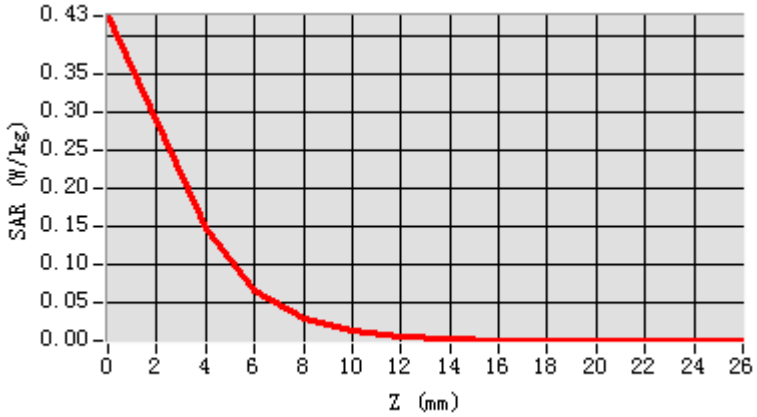
Frequency (MHz)	5240.000000
Relative permittivity (real part)	35.385117
Relative permittivity (imaginary part)	16.055651
Conductivity (S/m)	4.673978
Variation (%)	2.130000

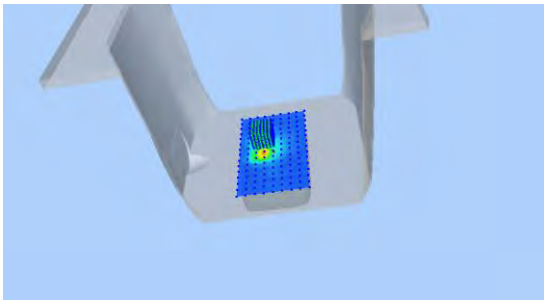
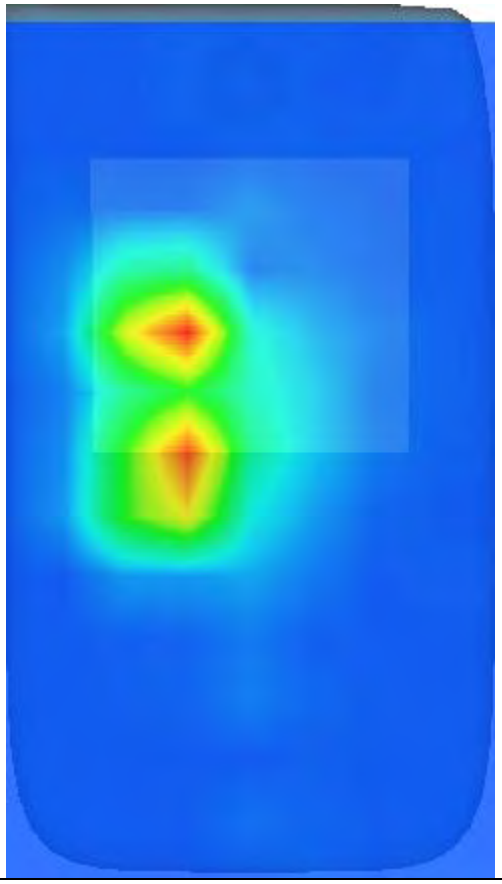
SURFACE SAR	VOLUME SAR
	

Maximum location: X=-11.00, Y=18.00
SAR Peak: 0.43 W/kg

SAR 10g (W/Kg)	0.029598
SAR 1g (W/Kg)	0.127952

Z (mm)	0.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00
SAR (W/Kg)	0.4252	0.1460	0.0666	0.0303	0.0140	0.0057	0.0027	0.0012	0.0006	0.0004	0.0004	0.0004



3D screen shot	Hot spot position
	

MEASUREMENT 3

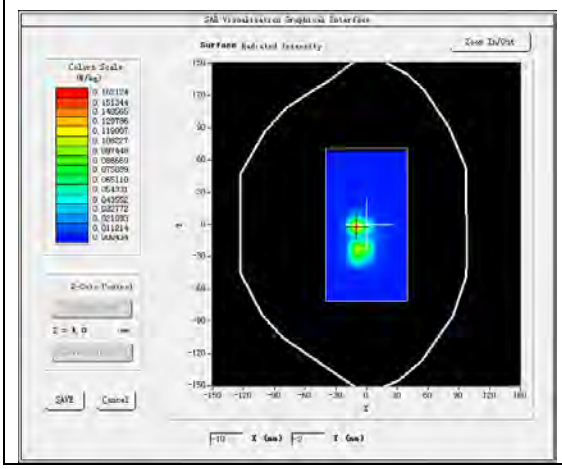
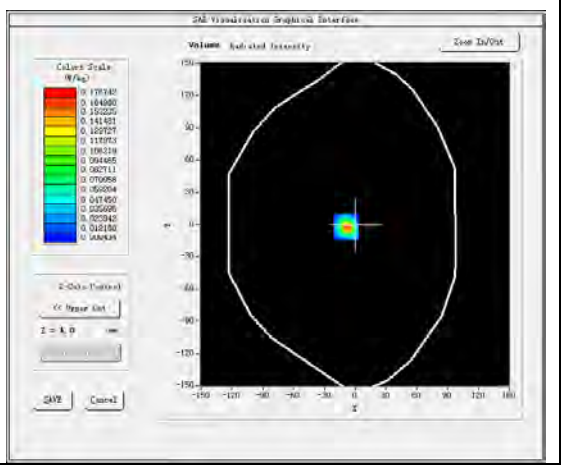
Date of measurement: 9/5/2023

A. Experimental conditions.

Area Scan	dx=10mm dy=10mm, h= 2.00 mm
ZoomScan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	IEEE 802.11ac U-NII
Channels	Middle
Signal	IEEE802.11ac (Crest factor: 1.0)
ConvF	2.05

B. SAR Measurement Results

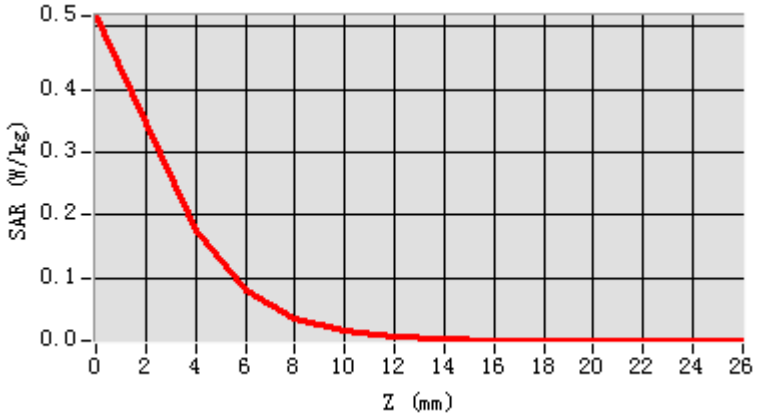
Frequency (MHz)	5310.000000
Relative permittivity (real part)	35.903882
Relative permittivity (imaginary part)	16.150689
Conductivity (S/m)	4.764453
Variation (%)	-1.290000

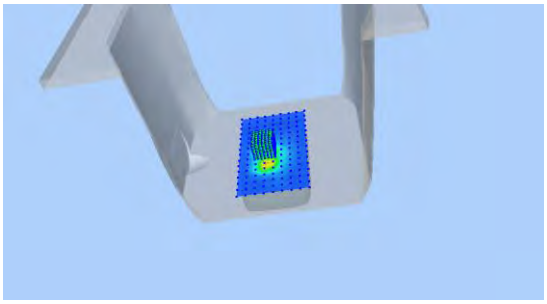
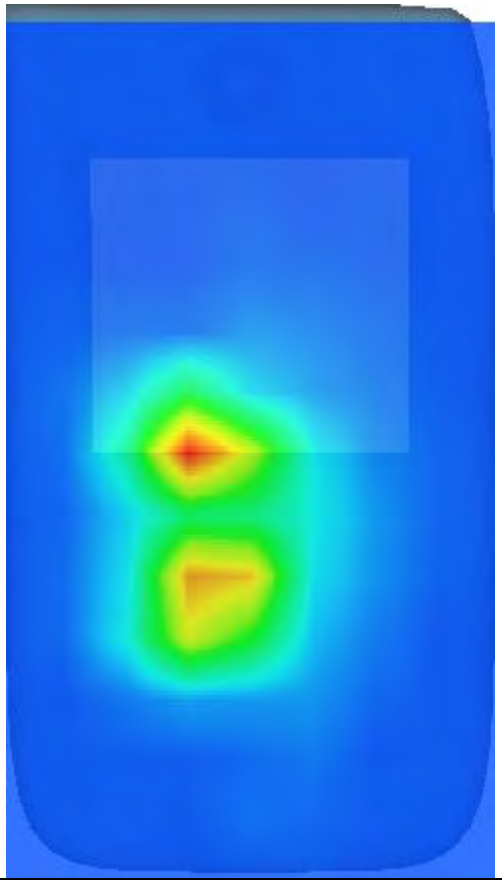
SURFACE SAR	VOLUME SAR
	

Maximum location: X=-9.00, Y=-2.00
SAR Peak: 0.51 W/kg

SAR 10g (W/Kg)	0.035580
SAR 1g (W/Kg)	0.153680

Z (mm)	0.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00
SAR (W/Kg)	0.5162	0.1767	0.0799	0.0367	0.0163	0.0069	0.0029	0.0014	0.0006	0.0004	0.0004	0.0005



3D screen shot	Hot spot position
	

MEASUREMENT 4

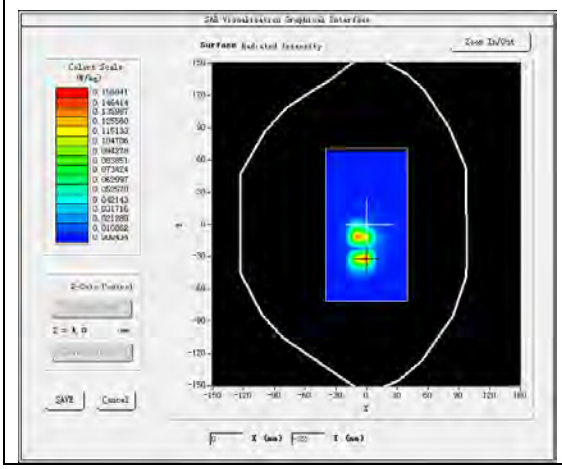
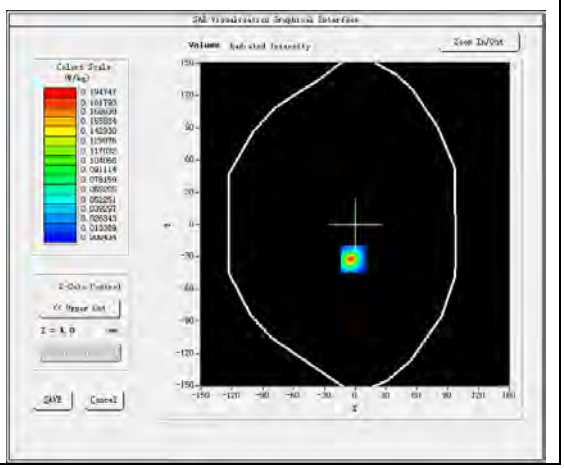
Date of measurement: 10/5/2023

A. Experimental conditions.

Area Scan	dx=10mm dy=10mm, h= 2.00 mm
ZoomScan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	IEEE 802.11n U-NII
Channels	Middle
Signal	IEEE802.11n (Crest factor: 1.0)
ConvF	2.16

B. SAR Measurement Results

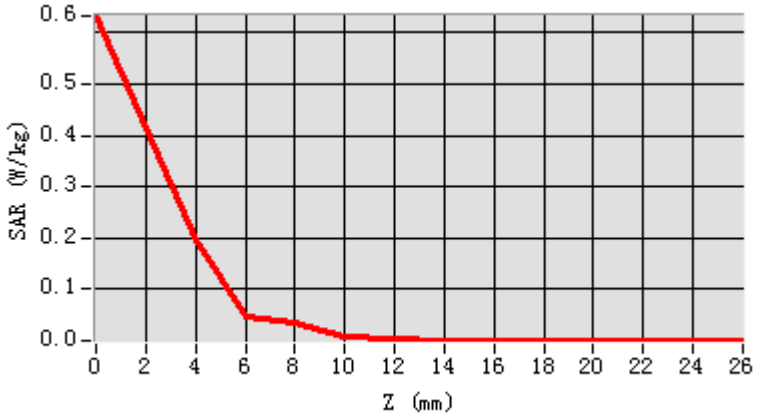
Frequency (MHz)	5600.000000
Relative permittivity (real part)	34.189276
Relative permittivity (imaginary part)	15.802475
Conductivity (S/m)	4.916326
Variation (%)	-0.210000

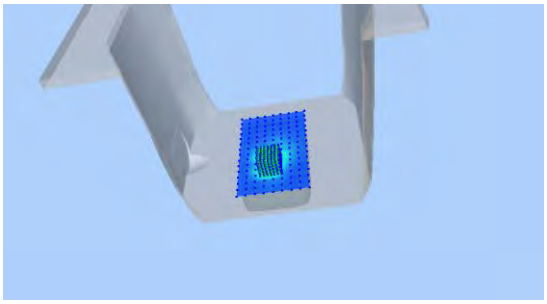
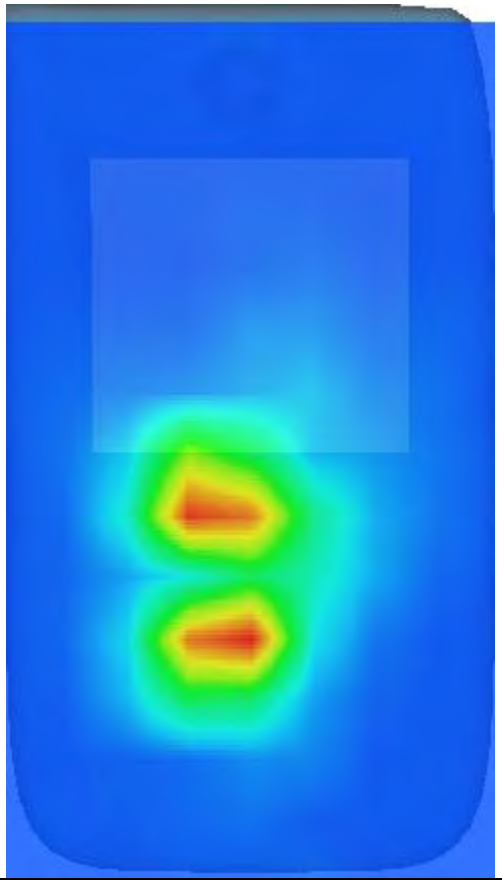
SURFACE SAR	**VOLUME SAR**
	

Maximum location: X=-2.00, Y=-32.00
SAR Peak: 0.60 W/kg

SAR 10g (W/Kg)	0.038407
SAR 1g (W/Kg)	0.171452

Z (mm)	0.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00
SAR (W/Kg)	0.6325	0.1947	0.0487	0.0357	0.0090	0.0060	0.0010	0.0009	0.0005	0.0004	0.0004	0.0004



3D screen shot	Hot spot position
	

MEASUREMENT 5

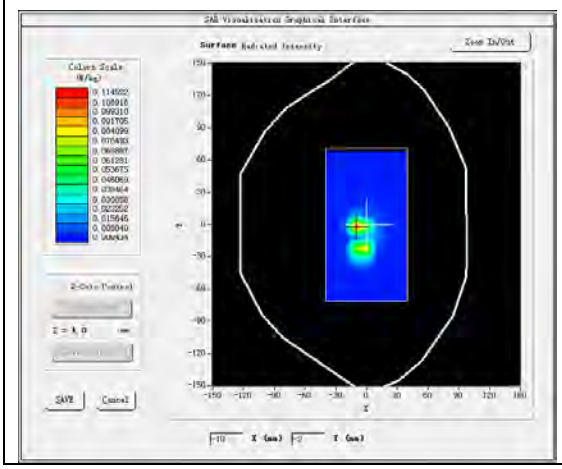
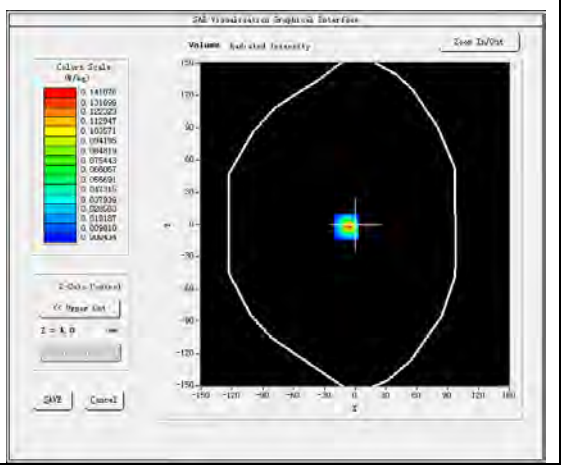
Date of measurement: 5/5/2023

A. Experimental conditions.

Area Scan	dx=10mm dy=10mm, h= 2.00 mm
ZoomScan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	IEEE 802.11a U-NII
Channels	High
Signal	IEEE802.11a (Crest factor: 1.0)
ConvF	2.07

B. SAR Measurement Results

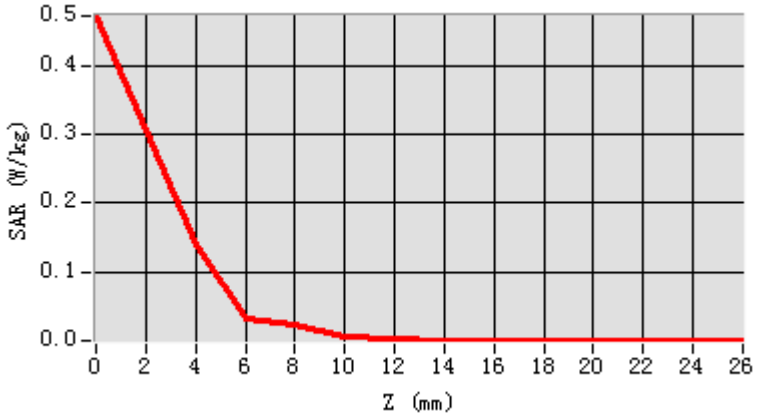
Frequency (MHz)	5825.000000
Relative permittivity (real part)	34.052469
Relative permittivity (imaginary part)	15.926758
Conductivity (S/m)	5.154076
Variation (%)	-1.870000

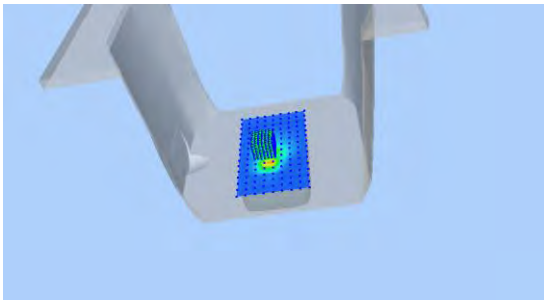
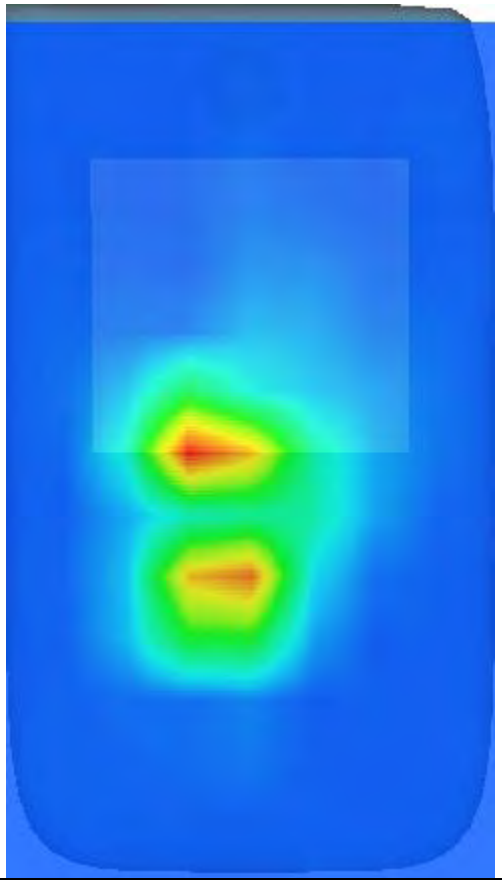
SURFACE SAR	**VOLUME SAR**
	

Maximum location: X=-9.00, Y=-2.00
SAR Peak: 0.43 W/kg

SAR 10g (W/Kg)	0.026504
SAR 1g (W/Kg)	0.121285

Z (mm)	0.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00
SAR (W/Kg)	0.4716	0.1411	0.0311	0.0230	0.0054	0.0034	0.0011	0.0008	0.0004	0.0004	0.0004	0.0004



3D screen shot	Hot spot position
	

14. Appendix D. Calibration Certificate

Table of contents
E Field Probe - SN 08/16 EPGO287
2450 MHz Dipole - SN 03/15 DIP 2G450-352
5000-6000 MHz Dipole - SN 13/14 WGA 33
Extended Calibration Certificate

COMOSAR E-Field Probe Calibration Report

Ref : ACR.60.1.21.MVGB.A

SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

BUILDING E, FENDA SCIENCE PARK, SANWEI COMMUNITY, XIXIANG STREET, BAO'AN DISTRICT, SHENZHEN GUANGDONG, CHINA

MVG COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 08/16 EPGO287

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon

29280 PLOUZANE - FRANCE

Calibration date: 01/10/2023

Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

Summary:

This document presents the method and results from an accredited COMOSAR 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).

COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.60.1.21.MVGB.A

	Name	Function	Date	Signature
Prepared by :	Jérôme Luc	Technical Manager	1/10/2023	
Checked by :	Jérôme Luc	Technical Manager	1/10/2023	
Approved by :	Yann Toutain	Laboratory Director	1/10/2023	Yann Toutain 2023.01.10 11:27:33 +01'00'

	Customer Name
Distribution :	SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

Issue	Name	Date	Modifications
A	Jérôme Luc	1/10/2023	Initial release

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TABLE OF CONTENTS

1 Device Under Test 4
2 Product Description 4
2.1 General Information 4
3 Measurement Method 4
3.1 Linearity 4
3.2 Sensitivity 5
3.3 Lower Detection Limit 5
3.4 Isotropy 5
3.1 Boundary Effect 5
4 Measurement Uncertainty 6
5 Calibration Measurement Results 6
5.1 Sensitivity in air 6
5.2 Linearity 7
5.3 Sensitivity in liquid 8
5.4 Isotropy 9
6 List of Equipment 10

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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 08/16 EPGO287
Product Condition (new / used)	Used
Frequency Range of Probe	0.15 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.211 MΩ Dipole 2: R2=0.199 MΩ Dipole 3: R3=0.199 MΩ

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

MVG's COMOSAR E field Probes are built in accordance to the IEEE 1528, FCC KDB865664 D01, CENELEC EN62209 and CEI/IEC 62209 standards.

Figure 1 – *MVG COMOSAR Dosimetric E field Dipole*

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 IEEE 1528, FCC KDB865664 D01, CENELEC EN62209 and CEI/IEC 62209 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.

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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.

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:

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

where

$\mathrm{SAR}_{\mathrm{uncertainty}}$	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., $\delta \approx 14$ mm at 3 GHz;
$\Delta\mathrm{SAR}_{be}$	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.

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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 IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 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)
0.72	0.66	0.77

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
107	110	110

Calibration curves ei=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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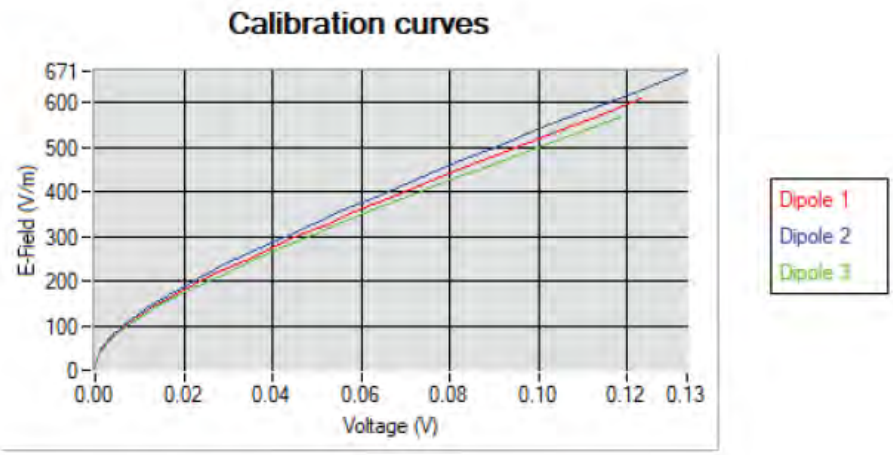
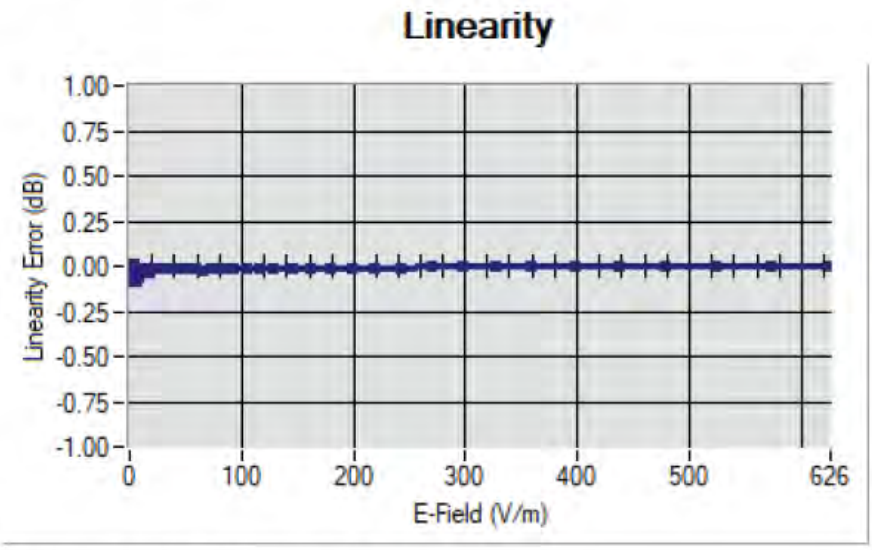


5.2 LINEARITY



Linearity:+/-1.90% (+/-0.08dB)

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5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz +/- 100MHz)	ConvF
HL750	750	1.49
HL850	835	1.50
HL900	900	1.61
HL1800	1800	1.73
HL1900	1900	1.91
HL2000	2000	1.97
HL2300	2300	1.92
HL2450	2450	1.98
HL2600	2600	1.87
HL3300	3300	1.79
HL3500	3500	1.85
HL3700	3700	1.79
HL3900	3900	2.07
HL4200	4200	2.21
HL4600	4600	2.25
HL4900	4900	2.05
HL5200	5200	1.80
HL5400	5400	2.05
HL5600	5600	2.16
HL5800	5800	2.07

LOWER DETECTION LIMIT: 8mW/kg

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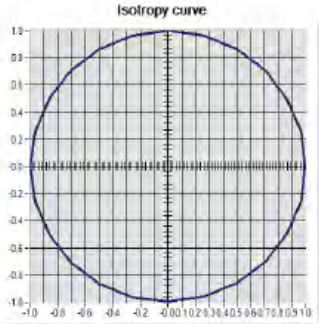
5.4 ISOTROPY

HL1800 MHz



Isotropy: +/-0.24% (+/-0.01dB)

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6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
Flat Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rohde & Schwarz ZVM	100203	05/2022	05/2025
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	05/2022	05/2025
Multimeter	Keithley 2000	1160271	02/2022	02/2025
Signal Generator	Rohde & Schwarz SMB	106589	04/2022	04/2025
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	NI-USB 5680	170100013	05/2022	05/2025
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44220687	05/2020	05/2023

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SAR Reference Dipole Calibration Report

Ref : ACR.60.8.21.MVGB.A

SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

BUILDING E, FENDA SCIENCE PARK, SANWEI COMMUNITY, XIXIANG STREET, BAO'AN DISTRICT, SHENZHEN GUANGDONG, CHINA

MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2450 MHZ

SERIAL NO.: SN 03/15 DIP2G450-352

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon

29280 PLOUZANE - FRANCE

Calibration date: 03/01/2021

Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed at MVG, using the COMOSAR test bench. The test results covered by accreditation are traceable to the International System of Units (SI).

SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.60.8.21.MVGB.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Technical Manager	3/1/2021	
Checked by :	Jérôme LUC	Technical Manager	3/1/2021	
Approved by :	Yann Toutain	Laboratory Director	3/1/2021	Yann Toutain 2021.03.01 13:13:40 +01'00'

	Customer Name
Distribution :	SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

Issue	*Name*	*Date*	*Modifications*
A	Jérôme LE GALL	3/1/2021	Initial release

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TABLE OF CONTENTS

1 Introduction 4
2 Device Under Test 4
3 Product Description 4
3.1 General Information 4
4 Measurement Method 5
4.1 Return Loss Requirements 5
4.2 Mechanical Requirements 5
5 Measurement Uncertainty 5
5.1 Return Loss 5
5.2 Dimension Measurement 5
5.3 Validation Measurement 5
6 Calibration Measurement Results 6
6.1 Return Loss and Impedance 6
6.2 Mechanical Dimensions 6
7 Validation measurement 7
7.1 Measurement Condition 7
7.2 Head Liquid Measurement 7
7.3 Measurement Result 8
8 List of Equipment 10

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1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR 2450 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID2450
Serial Number	SN 03/15 DIP2G450-352
Product Condition (new / used)	Used

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.

Figure 1 – *MVG COMOSAR Validation Dipole*

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4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimension's frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness. A direct method is used with a ISO17025 calibrated caliper.

5 MEASUREMENT UNCERTAINTY

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.

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Loss
400-6000MHz	0.08 LIN

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

Length (mm)	Expanded Uncertainty on Length
0 - 300	0.20 mm
300 - 450	0.44 mm

5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty

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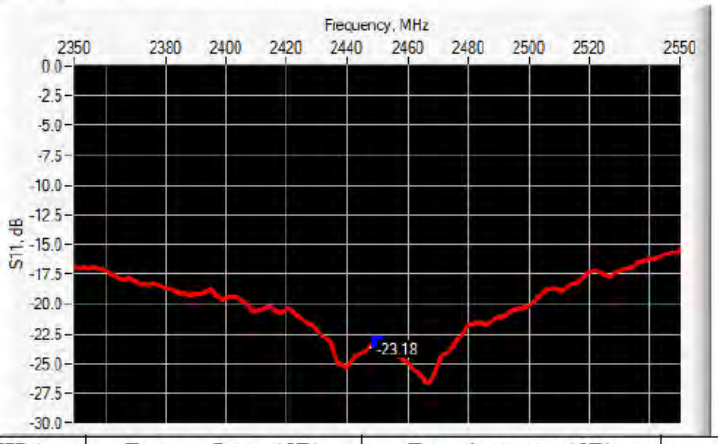
1 g	19 % (SAR)
10 g	19 % (SAR)

6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	-23.18	-20	56.3 Ω - 2.9 jΩ

6.2 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h mm		d mm	
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1 %.		6.35 ±1 %.	
450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
750	176.0 ±1 %.		100.0 ±1 %.		6.35 ±1 %.	
835	161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
900	149.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %.		3.6 ±1 %.	
1640	79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.	
1750	75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.	
1800	72.0 ±1 %.		41.7 ±1 %.		3.6 ±1 %.	
1900	68.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.	
1950	66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
2100	61.0 ±1 %.		35.7 ±1 %.		3.6 ±1 %.	
2300	55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
2450	51.5 ±1 %.	-	30.4 ±1 %.	-	3.6 ±1 %.	-

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2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
3500	37.0±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7±1 %.		26.4 ±1 %.		3.6 ±1 %.	

7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

7.1 MEASUREMENT CONDITION

Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Head Liquid Values: eps' : 41.9 sigma : 1.88
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=5mm/dy=5mm/dz=5mm
Frequency	24502450 MHz
Input power	20 dBm
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

7.2 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε,')		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 ±10 %		0.87 ±10 %	
450	43.5 ±10 %		0.87 ±10 %	
750	41.9 ±10 %		0.89 ±10 %	
835	41.5 ±10 %		0.90 ±10 %	
900	41.5 ±10 %		0.97 ±10 %	
1450	40.5 ±10 %		1.20 ±10 %	
1500	40.4 ±10 %		1.23 ±10 %	
1640	40.2 ±10 %		1.31 ±10 %	
1750	40.1 ±10 %		1.37 ±10 %	
1800	40.0 ±10 %		1.40 ±10 %	
1900	40.0 ±10 %		1.40 ±10 %	
1950	40.0 ±10 %		1.40 ±10 %	
2000	40.0 ±10 %		1.40 ±10 %	

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2100	39.8 ±10 %		1.49 ±10 %	
2300	39.5 ±10 %		1.67 ±10 %	
2450	39.2 ±10 %	41.9	1.80 ±10 %	1.88
2600	39.0 ±10 %		1.96 ±10 %	
3000	38.5 ±10 %		2.40 ±10 %	
3500	37.9 ±10 %		2.91 ±10 %	

7.3 MEASUREMENT RESULT

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	
1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4	53.69 (5.37)	24	23.94 (2.39)
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	

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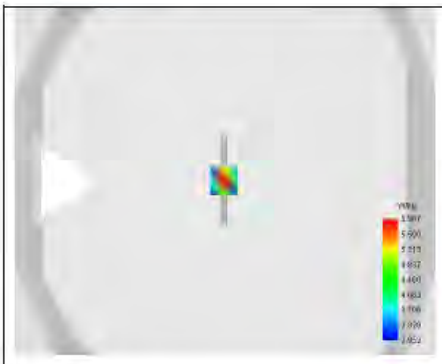

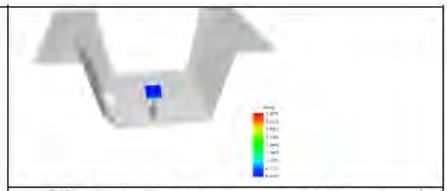

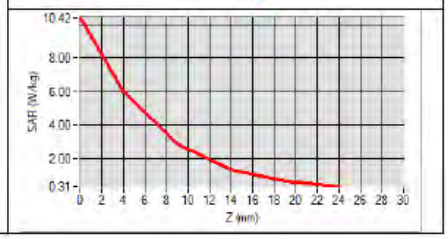

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8 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
SAM Phantom	MVG	SN-13/09-SAM68	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rohde & Schwarz ZVM	100203	05/2019	05/2022
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	05/2019	05/2022
Calipers	Mitutoyo	SN 0009732	10/2019	10/2022
Reference Probe	MVG	EPGO333 SN 41/18	05/2020	05/2021
Multimeter	Keithley 2000	1160271	02/2020	02/2023
Signal Generator	Rohde & Schwarz SMB	106589	04/2019	04/2022
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	NI-USB 5680	170100013	05/2019	05/2022
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44220687	05/2020	05/2023

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SAR Reference Waveguide Calibration Report

Ref : ACR.60.10.21.MVGB.A

SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

BUILDING E, FENDA SCIENCE PARK, SANWEI COMMUNITY, XIXIANG STREET,

BAO'AN DISTRICT, SHENZHEN GUANGDONG, CHINA

SATIMO COMOSAR REFERENCE WAVEGUIDE

FREQUENCY: 5000-6000 MHZ

SERIAL NO.: SN 13/14 WGA33

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon

29280 PLOUZANE - FRANCE

Calibration date: 03/01/2021

Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

Summary:

This document presents the method and results from an accredited SAR reference waveguide calibration performed at MVG, using the COMOSAR test bench. The test results covered by accreditation are traceable to the International System of Units (SI).

SAR REFERENCE WAVEGUIDE CALIBRATION REPORT

Ref: ACR.60.10.21.MVGB.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme Luc	Technical Manager	3/1/2021	
Checked by :	Jérôme Luc	Technical Manager	3/1/2021	
Approved by :	Yann Toutain	Laboratory Director	3/1/2021	Yann Toutain 2021.03.01 13:15:44 +01'00'

	Customer Name
Distribution :	SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

Issue	*Name*	*Date*	*Modifications*
A	Jérôme Luc	3/1/2021	Initial release

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TABLE OF CONTENTS

1 Introduction 4
2 Device Under Test 4
3 Product Description 4
3.1 General Information 4
4 Measurement Method 4
4.1 Return Loss Requirements 4
4.2 Mechanical Requirements 4
5 Measurement Uncertainty 5
5.1 Return Loss 5
5.2 Dimension Measurement 5
5.3 Validation Measurement 5
6 Calibration Measurement Results 5
6.1 Return Loss 5
6.2 Mechanical Dimensions 6
7 Validation measurement 6
7.1 Head Liquid Measurement 8
7.2 Measurement Result 8
8 List of Equipment 11

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1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528 and CEI/IEC 62209 standards for reference waveguides used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR 5000-6000 MHz REFERENCE WAVEGUIDE
Manufacturer	MVG
Model	SWG5500
Serial Number	SN 13/14 WGA33
Product Condition (new / used)	Used

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Waveguides are built in accordance to the IEEE 1528 and CEI/IEC 62209 standards.

4 MEASUREMENT METHOD

The IEEE 1528 and CEI/IEC 62209 standards provide requirements for reference waveguides used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 RETURN LOSS REQUIREMENTS

The waveguide used for SAR system validation measurements and checks must have a return loss of -8 dB or better. The return loss measurement shall be performed with matching layer placed in the open end of the waveguide, with the waveguide and matching layer in direct contact with the phantom shell as outlined in the fore mentioned standards. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

4.2 MECHANICAL REQUIREMENTS

The IEEE 1528 and CEI/IEC 62209 standards specify the mechanical dimensions of the validation waveguide, the specified dimensions are as shown in Section 6.2. Figure 1 shows how the dimensions relate to the physical construction of the waveguide. A direct method is used with a ISO17025 calibrated caliper.

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5 MEASUREMENT UNCERTAINTY

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.

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Loss
400-6000MHz	0.08 LIN

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

Length (mm)	Expanded Uncertainty on Length
0 - 300	0.20 mm

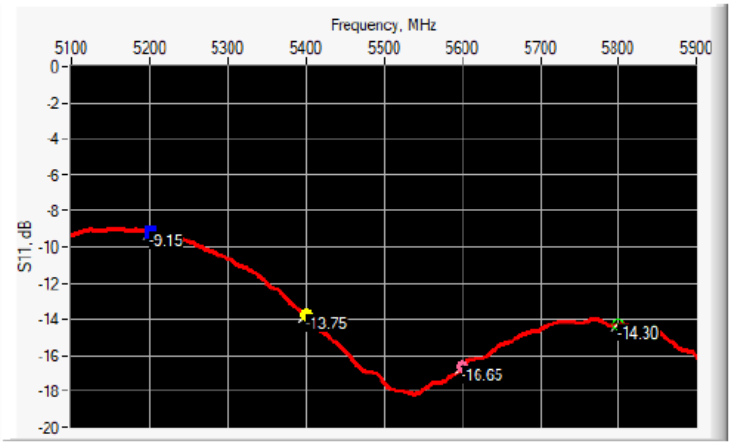
5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	19 % (SAR)
10 g	19 % (SAR)

6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS



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Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
5200	-9.15	-8	21.17 Ω + 13.26 jΩ
5400	-13.75	-8	68.57 Ω + 6.68 jΩ
5600	-16.65	-8	35.76 Ω - 2.15 jΩ
5800	-14.30	-8	54.74 Ω + 18.27 jΩ

6.2 MECHANICAL DIMENSIONS

Frequency (MHz)	L (mm)		W (mm)		Lf (mm)		Wf (mm)	
	Required	Measured	Required	Measured	Required	Measured	Required	Measured
5800	40.39 ± 0.13	-	20.19 ± 0.13	-	81.03 ± 0.13	-	61.98 ± 0.13	-

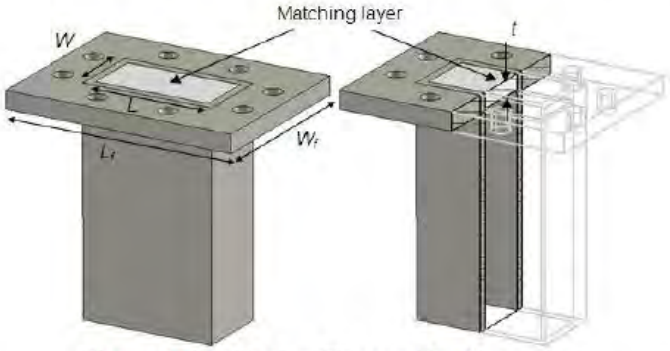

Figure 1: Validation Waveguide Dimensions

7 VALIDATION MEASUREMENT

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference waveguide meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed with the matching layer placed in the open end of the waveguide, with the waveguide and matching layer in direct contact with the phantom shell.

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Measurement Condition

Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Head Liquid Values 5200 MHz: eps' :34.06 sigma : 4.70 Head Liquid Values 5400 MHz: eps' :33.39 sigma : 4.91 Head Liquid Values 5600 MHz: eps' :32.77 sigma : 5.13 Head Liquid Values 5800 MHz: eps' :32.40 sigma : 5.34
Distance between dipole waveguide and liquid	0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=4mm/dy=4m/dz=2mm
Frequency	5200 MHz 5400 MHz 5600 MHz 5800 MHz
Input power	20 dBm
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

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7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (εr')		Conductivity (σ) S/m	
	required	measured	required	measured
5000	36.2 ±10 %		4.45 ±10 %	
5100	36.1 ±10 %		4.56 ±10 %	
5200	36.0 ±10 %	34.06	4.66 ±10 %	4.70
5300	35.9 ±10 %		4.76 ±10 %	
5400	35.8 ±10 %	33.39	4.86 ±10 %	4.91
5500	35.6 ±10 %		4.97 ±10 %	
5600	35.5 ±10 %	32.77	5.07 ±10 %	5.13
5700	35.4 ±10 %		5.17 ±10 %	
5800	35.3 ±10 %	32.40	5.27 ±10 %	5.34
5900	35.2 ±10 %		5.38 ±10 %	
6000	35.1 ±10 %		5.48 ±10 %	

7.2 MEASUREMENT RESULT

At those frequencies, the target SAR value can not be generic. Hereunder is the target SAR value defined by Satimo, within the uncertainty for the system validation. All SAR values are normalized to 1 W net power. In bracket, the measured SAR is given with the used input power.

Frequency (MHz)	1 g SAR (W/kg)		10 g SAR (W/kg)	
	required	measured	required	measured
5200	159.00	162.34 (16.23)	56.90	55.42 (5.54)
5400	166.40	168.48 (16.85)	58.43	57.03 (5.70)
5600	173.80	174.92 (17.49)	59.97	58.63 (5.86)
5800	181.20	178.89 (17.89)	61.50	59.32 (5.93)

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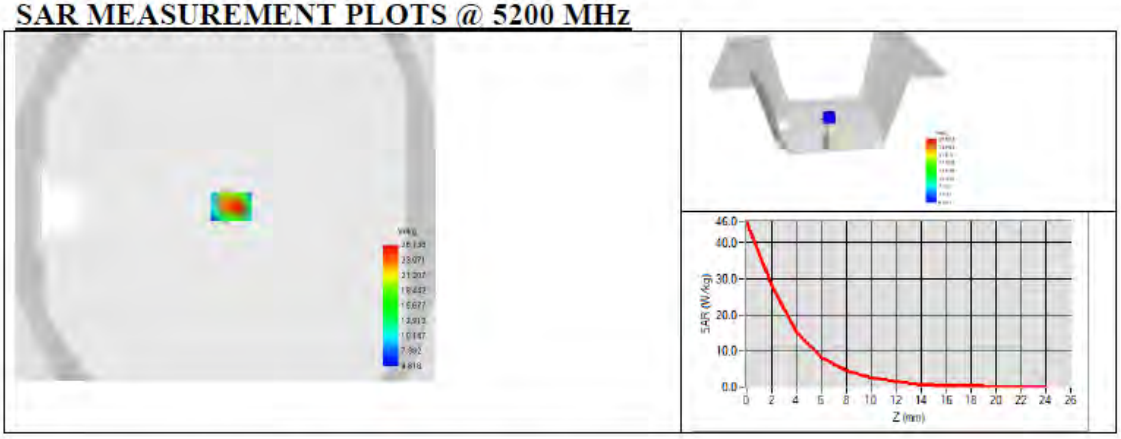
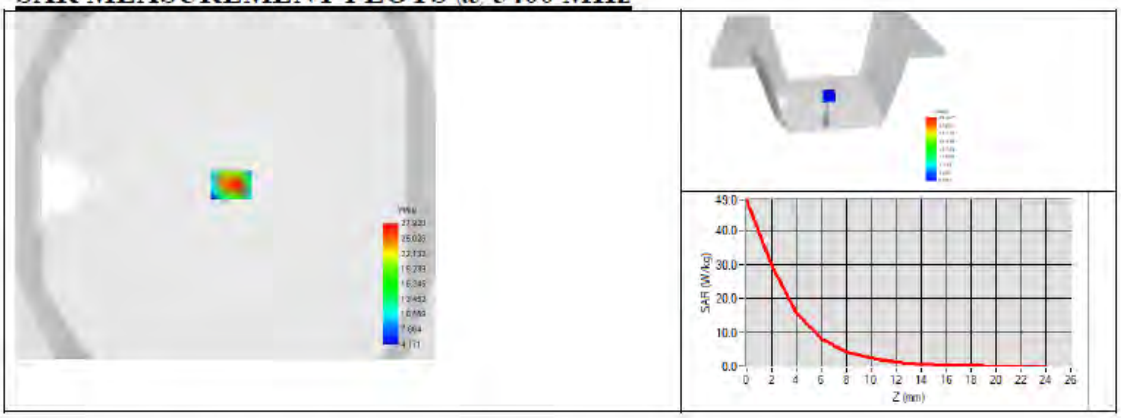
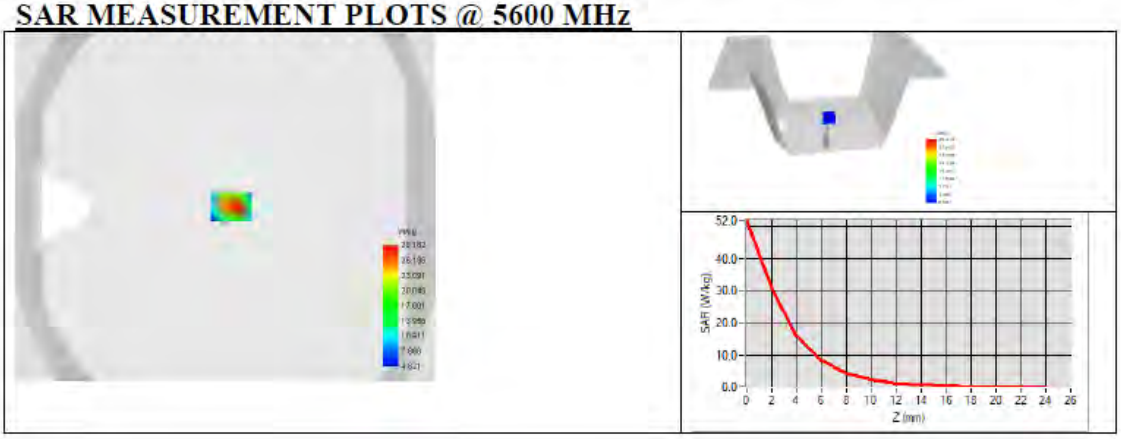
SAR MEASUREMENT PLOTS @ 5200 MHz



SAR MEASUREMENT PLOTS @ 5400 MHz



SAR MEASUREMENT PLOTS @ 5600 MHz



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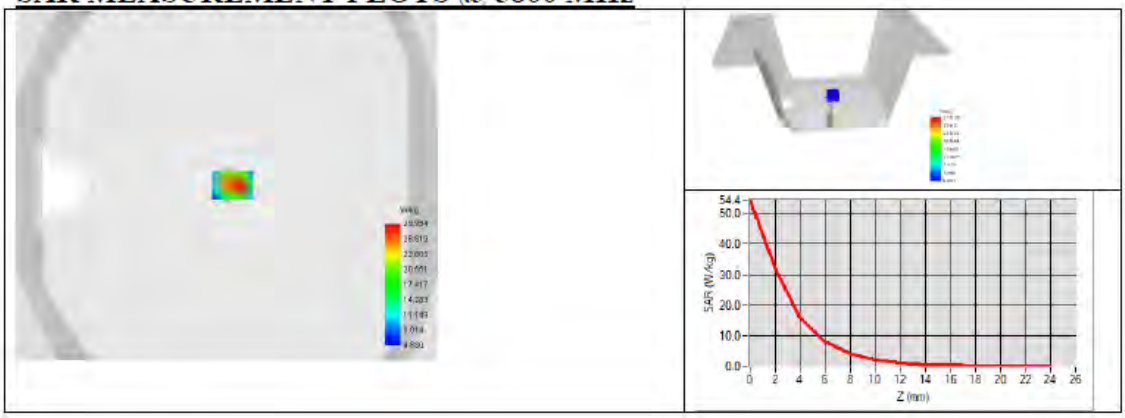
SAR MEASUREMENT PLOTS @ 5800 MHz



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8 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
Flat Phantom	MVG	SN-13/09-SAM68	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rohde & Schwarz ZVM	100203	05/2019	05/2022
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	05/2019	05/2022
Calipers	Mitutoyo	SN 0009732	10/2019	10/2022
Reference Probe	MVG	EPGO333 SN 41/18	05/2020	05/2021
Multimeter	Keithley 2000	1160271	02/2020	02/2023
Signal Generator	Rohde & Schwarz SMB	106589	04/2019	04/2022
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	NI-USB 5680	170100013	05/2019	05/2022
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44220687	05/2020	05/2023

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<Justification of the extended calibration>

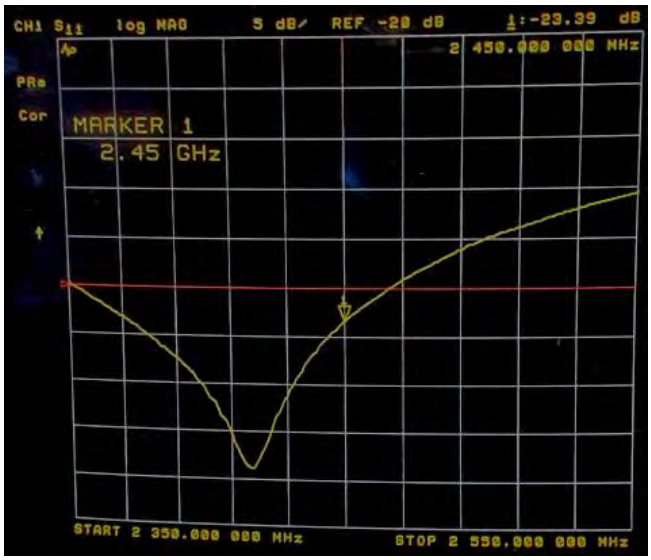
If dipoles are verified in return loss (<-20dB, within 20% of prior calibration for below 3GHz, and <-8dB, within 20% of prior calibration for 5GHz to 6GHz), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

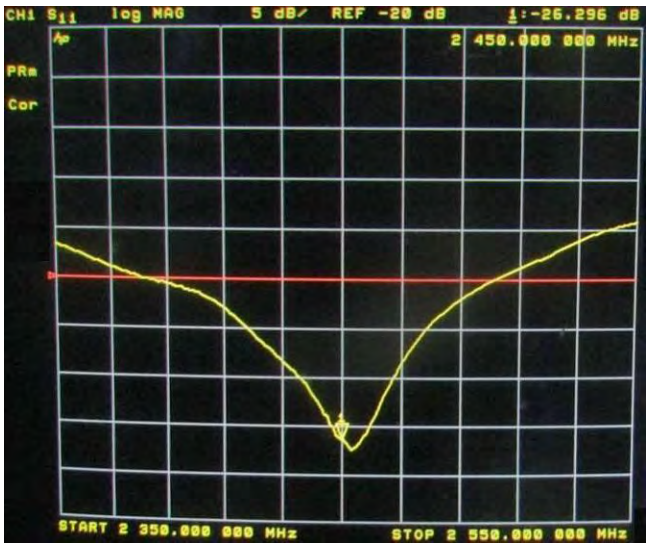
<Head 2450MHz>

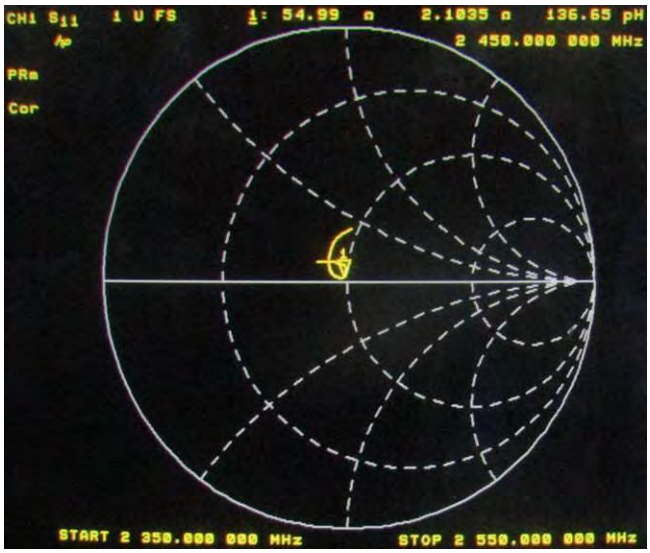
Return Loss (dB)	Delta (%)	Impedance	Delta(ohm)	Date of Measurement
-23.18	-	56.30	-	Mar. 01, 2021
-23.39	0.91	56.342	0.042	Feb. 28, 2022
-26.296	13.44	54.99	1.310	Feb. 20, 2023

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data





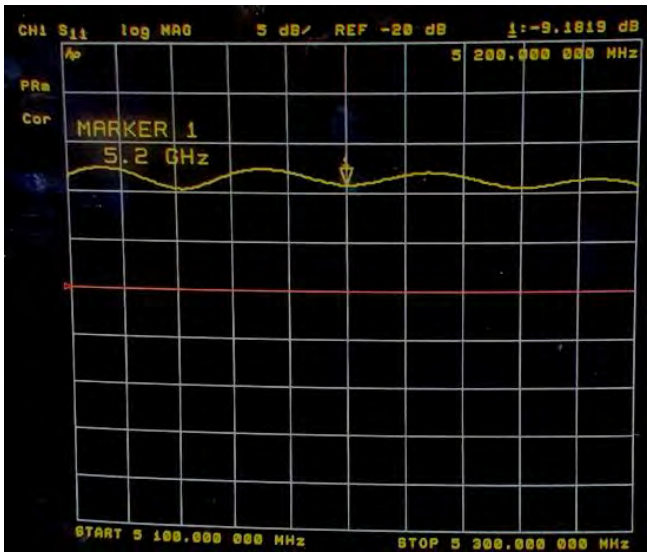


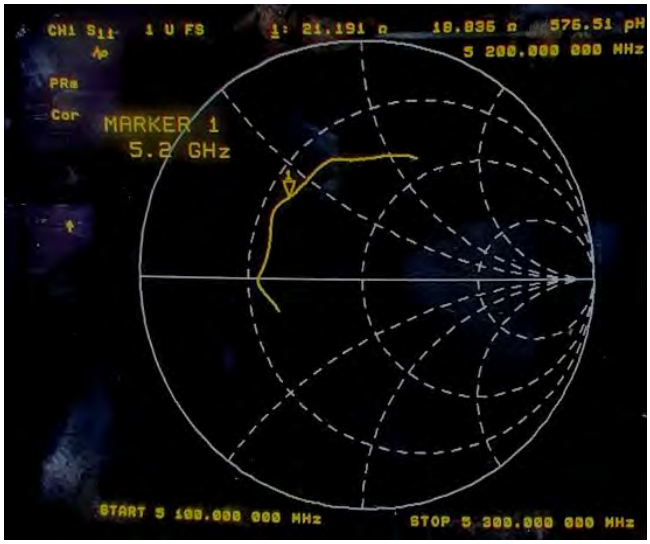
<Head 5200MHz>

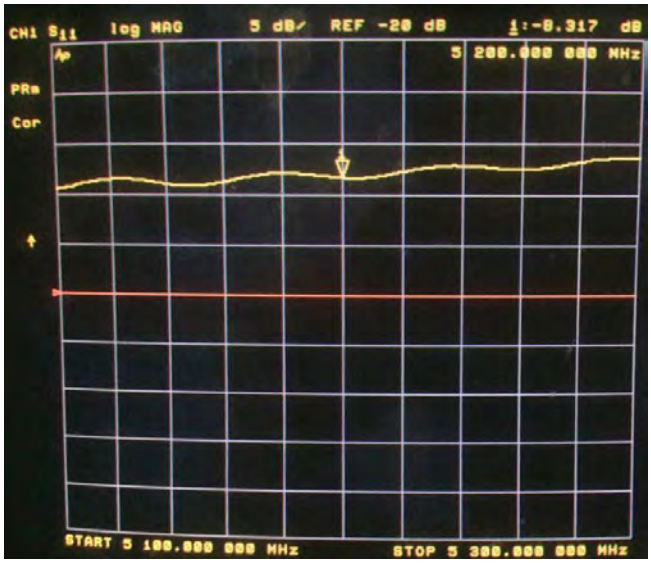
Return Loss (dB)	Delta (%)	Impedance	Delta(ohm)	Date of Measurement
-9.15	-	21.17	-	Mar. 01, 2021
-9.1819	0.35	21.191	0.021	Feb. 28, 2022
-8.317	9.10	25.673	4.503	Feb. 20, 2023

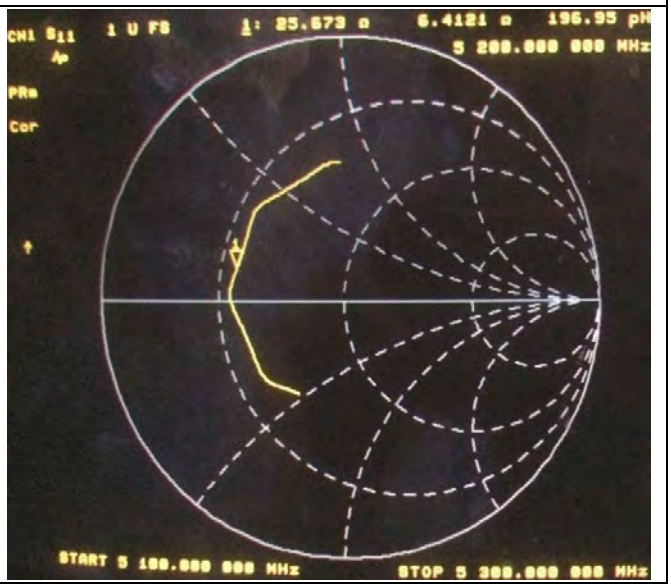
The return loss is <-8dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data







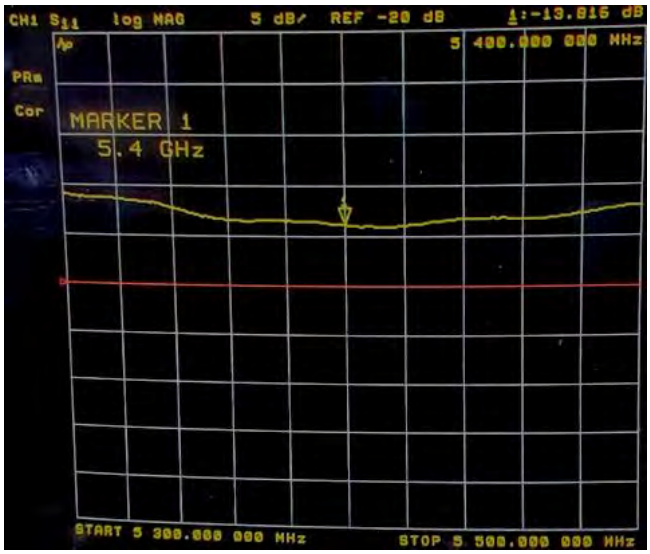


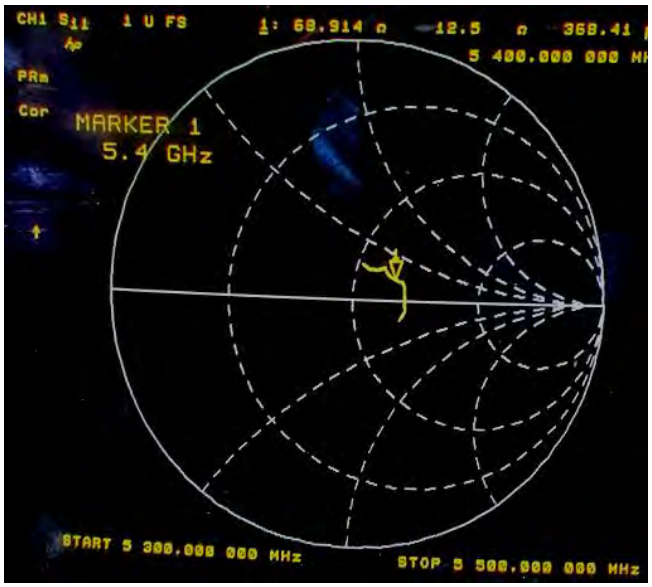
<Head 5400MHz>

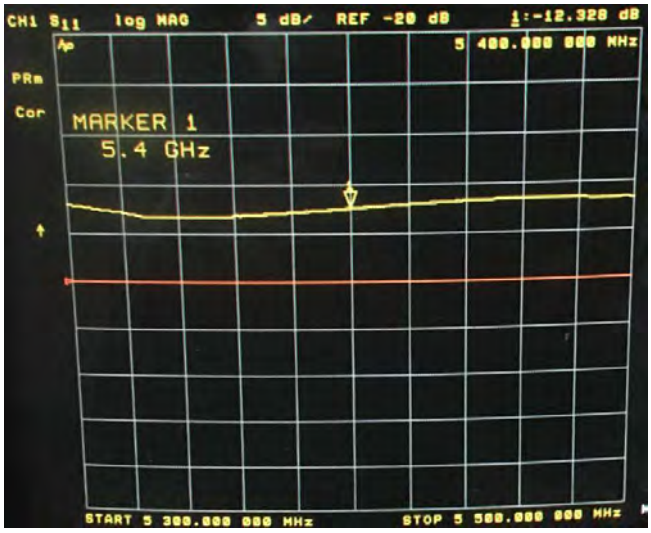
Return Loss (dB)	Delta (%)	Impedance	Delta(ohm)	Date of Measurement
-13.75	-	68.57	-	Mar. 01, 2021
-13.816	0.48	68.914	0.344	Feb. 28, 2022
-12.328	10.34	73.094	4.524	Feb. 20, 2023

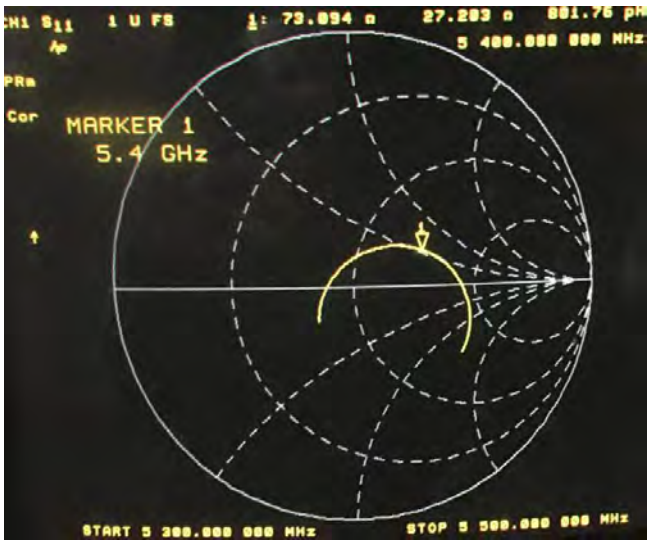
The return loss is <-8dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data







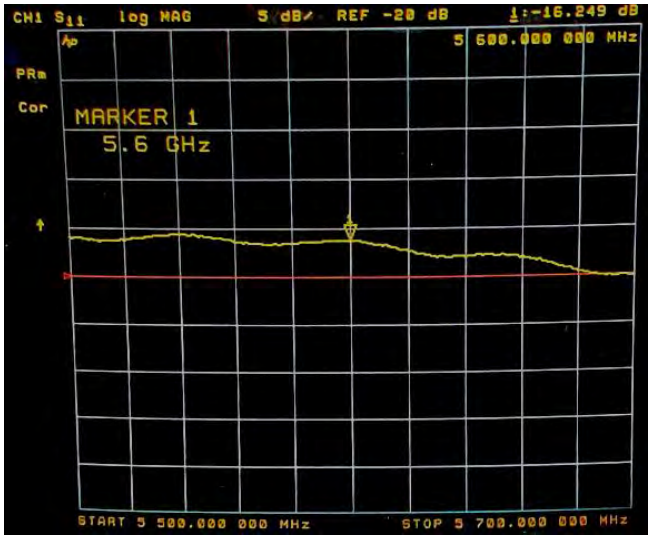


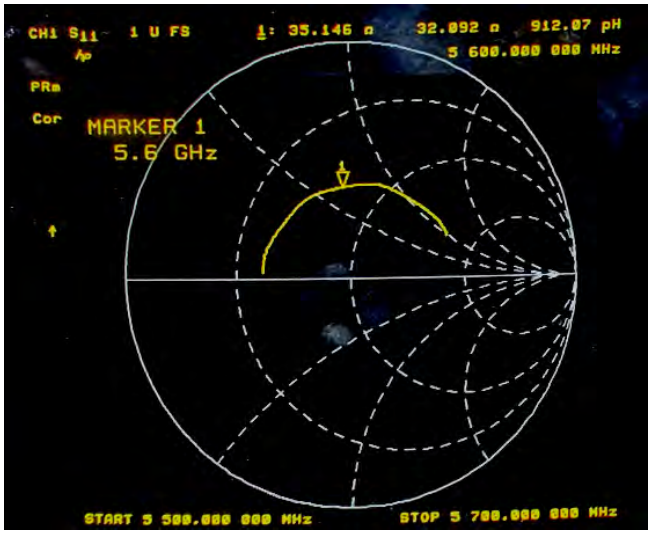
<Head 5600MHz>

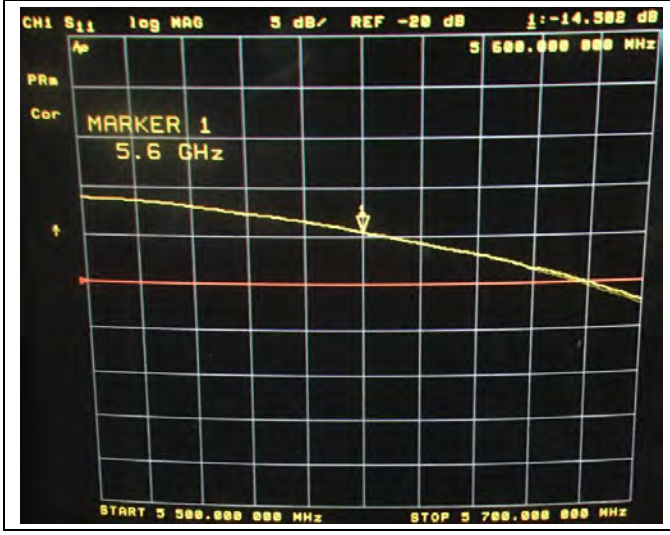
Return Loss (dB)	Delta (%)	Impedance	Delta(ohm)	Date of Measurement
-16.65	-	35.76	-	Mar. 01, 2021
-16.249	2.41	35.146	0.614	Feb. 28, 2022
-14.502	12.9	33.526	2.234	Feb. 20, 2023

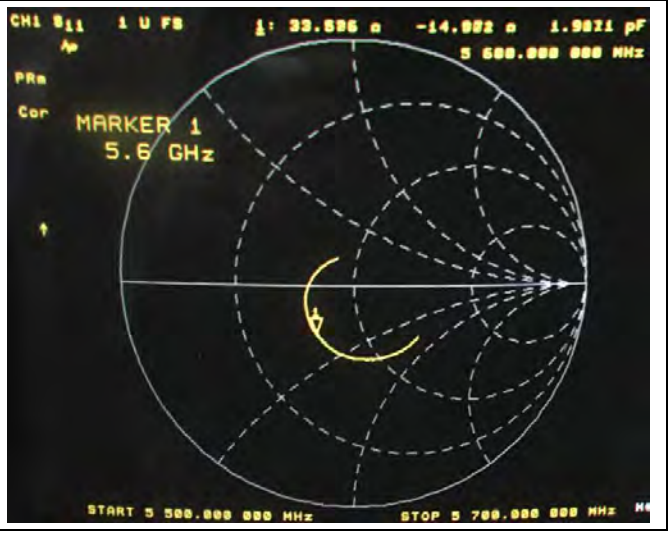
The return loss is <-8dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data







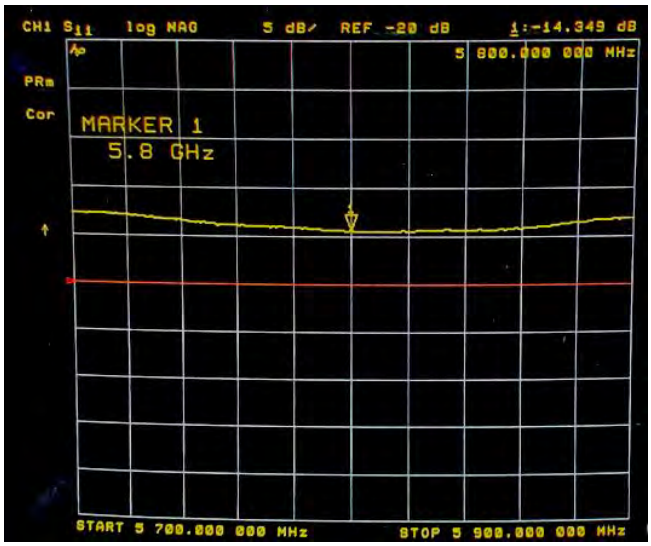


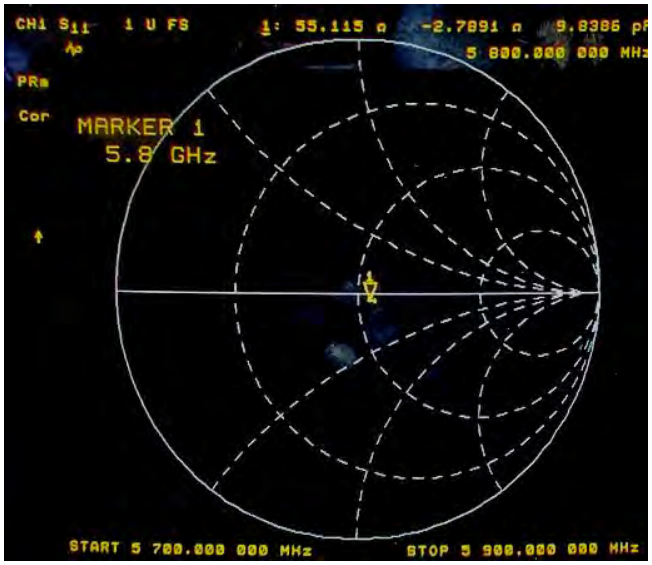
<Head 5800MHz>

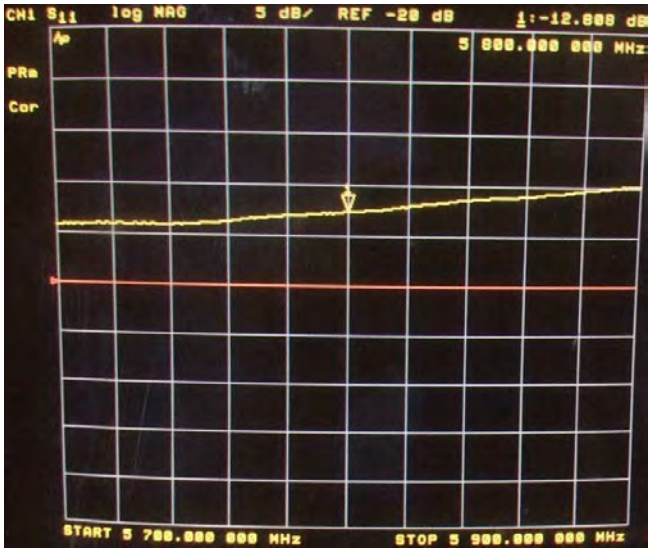
Return Loss (dB)	Delta (%)	Impedance	Delta(ohm)	Date of Measurement
-14.30	-	54.74	-	Mar. 01, 2021
-14.349	0.34	55.115	0.375	Feb. 28, 2022
-12.808	10.43	55.289	0.549	Feb. 27, 2023

The return loss is <-8dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data







END