SAR TEST REPORT

Report No.:	20250117G01473X-W3
Product Name:	Remote Control
Model Name:	G20,G20Pro, G20/G20Pro,GR01
Trade Name:	SKYDROID
Brand Name:	SKYDROID
FCC ID:	2ATGZQZYZG20
Applicant:	Quanzhou SKYDROID Technology Co., Ltd.
Address:	2nd Floor, Building A, Yucheng Base, Fengze District, Quanzhou City, Fujian Province, China
Test Date:	2025/01/20~2025/01/21
Issued by:	CCIC Southern Testing Co., Ltd.
Lab Location:	Electronic Testing Building, No.43, Shahe Road, Xili Street, Nanshan District, Shenzhen, Guangdong, China
	Tel: 86-755-26627338 **E-Mail:** manager@ccic-set.com

Test Report

Applicant:	Quanzhou SKYDROID Technology Co., Ltd.
Applicant Address:	2nd Floor, Building A, Yucheng Base, Fengze District, Quanzhou City, Fujian Province, China
Manufacturer:	Quanzhou SKYDROID Technology Co., Ltd.
Manufacturer Address:	2nd Floor, Building A, Yucheng Base, Fengze District, Quanzhou City, Fujian Province, China
Test Standards:	**FCC 47 CFR Part 2(2.1093):** Radiofrequency Radiation Exposure Evaluation: Portable Devices **ANSI/IEEE C95.1–2019:** Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz **IEEE 1528–2013:** IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques **IEC/IEEE 62209-1528:2020:** Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices –Part 1528: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz)
Test Result:	Pass

Tested by:	Carl Wei	2025-01-22
	Carl Wei, Test Engineer	
Reviewed by:	Sun Jiaohui	2025-01-22
	Sun Jiaohui, Senior Engineer	
Approved by:	Chris You	2025-01-22
	Chris You, Manager	

Contents

1. Administrative Data

1.1 Testing Laboratory

Test Site:	CCIC Southern Testing Co., Ltd.
Address:	Electronic Testing Building, No.43, Shahe Road, Xili Street, Nanshan District, Shenzhen, Guangdong, China
A2LA Lab Code:	CCIC-SET is a third party testing organization accredited by A2LA according to ISO/IEC 17025:2017. The accreditation certificate number is 5721.01
FCC Registration:	CCIC Southern Testing Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintained in our files. Designation Number: CN1283, valid time is until Iune.30, 2025.
ISED Registration:	CCIC-SET Laboratory has been registered by Certification and Engineering Bureau of Industry Canada for the performance of radiated measurements with Registration No. 11185A, CAB Identifier: CN0064, valid time is until June 30, 2025.
Test Environment Condition:	Temperature (°C): 18°C ~25°C Relative Humidity (%): 35%~75% RH Atmospheric Pressure (kPa): 86KPa-106KPa

1.2 List of test Equipment

This table is a complete overview of the SAR measurement equipment. Devices used during the test described are marked ☒.

	EQUIPMENT	Model	Serial number	Calibration Date	Due Date
☒	SAR Probe	SSE2	3723-EPGO-433	2024/04/17	2025/04/16
☒	Dipole	SID2450	SN 09/13 DIP2G450-220	2023/05/24	2026/05/23
☒	Dipole	SWG5500	SN15/15 WGA39	2023/05/25	2026/05/24
☒	Multimeter	Keithley-2000	4014020	2025/01/14	2026/01/13
☒	Network Analyzer	ZVB8	100343	2024/10/22	2025/10/21
☒	PC 3.5 Fixed Match Calibration Kit	ZV-Z32	100571	2025/01/14	2026/01/13
☒	Dielectric Probe Kit	SCLMP	SN 09/13 OCPG51	2025/01/14	2026/01/13
☒	Signal Generator	SMB 100A	177649	2025/01/06	2026/01/05
☒	Amplifier	Nucletudes	143060	2025/01/14	2026/01/13
☒	Directional Coupler	DC6180A	305827	2024/06/02	2025/06/01
☒	Power Meter	NRP2	103434	2024/06/19	2025/06/18

2. Equipment Under Test (EUT)

Identification of the Equipment under Test

Device type :	portable device	
Exposure category:	uncontrolled environment / general population	
Product Name:	Remote Control	
Brand Name:	/	
Model Name:	G20,G20Pro, G20/G20Pro,GR01	
Operating Band(s):	2.4/5.8G SRD,WIFI2.4G, WIFI5G, Bluetooth	
Test Band(s):	2.4/5.8G SRD,WIFI2.4G, WIFI5G,	
Test modulation:	2.4/5.8G SRD(DSSS, OFDM), WIFI 2.4G(DSSS, OFDM), WIFI 5G(OFDM)	
Tested frequency range(s)	transmitter frequency range	receiver frequency range
SRD:	2411~2466 MHz	
	5750-5820 MHz	
WIFI:	2412-2462 MHz	
	5725-5850 MHz	
Hardware version :	/	
Software version :	/	
Antenna type :	2.4/5.8G SRD: External antenna BT/WIFI: PIFA Antenna	
MAX. SAR Value:	Body-support : 0.707 W/Kg(1g-0mm,Limit:1.6W/Kg)	

Note:

1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

3. SAR Summary

Highest Standalone SAR Summary

Exposure Position	Frequency Band	Scaled 1g-SAR(W/kg)	Highest Scaled 1g-SAR(W/kg)
Body-support (0mm Gap)	5.8G WIFI	0.707	0.707
	2.4G WIFI	0.432	0.432
	5.8G SRD	0.628	0.628
	2.4G SRD	0.419	0.419

4. Specific Absorption Rate (SAR)

4.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

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

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

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

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

$$\mathrm{SAR} = C\frac{\delta T}{\delta t}$$

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

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

where σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the rms electrical field strength.

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

4.2 Applicable Standards and Limits

4.2.1 Applicable Standards

FCC 47 CFR Part 2 (2.1093)	Radiofrequency Radiation Exposure Evaluation: Portable Devices
ANSI/IEEE C95.1–2019	Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz
IEEE 1528–2013	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
IEC/IEEE 62209-1528:2020	Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices –Part 1528: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz)
KDB 248227 D01	v02r02 802.11 WIFI SAR
KDB 447498 D01	v06 General RF Exposure Guidance

4.2.2 RF exposure Limits

Human Exposure	**Uncontrolled Environment General Population**
Spatial Peak SAR* (Brain/Body)	1.60 mW/g
Spatial Average SAR** (Whole Body)	0.08 mW/g
Spatial Peak SAR*** (Limbs)	4.00 mW/g

The limit applied in this test report is shown in bold letters.

Notes:

* The Spatial Peak value of the SAR averaged over any 1 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time

** The Spatial Average value of the SAR averaged over the whole body.

*** The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

4.3 Phantoms

The phantom used for all tests i.e. for both system checks and device testing, was the twin-headed "SAM Phantom", manufactured by SATIMO. The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region, where shell thickness increases to 6mm).

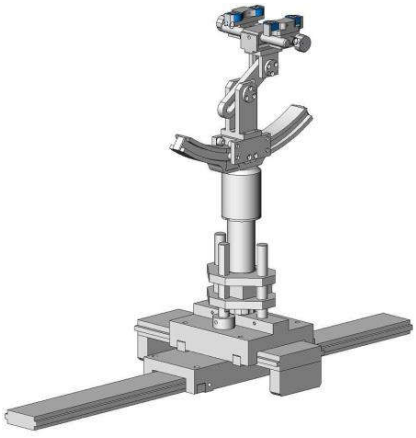
System checking was performed using the flat section, whilst Head SAR tests used the left and right head profile sections. Body SAR testing also used the flat section between the head profiles.

SAM Twin Phantom

4.4 Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SATIMO as an integral part of the COMOSAR test system.

The device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.



Device holder

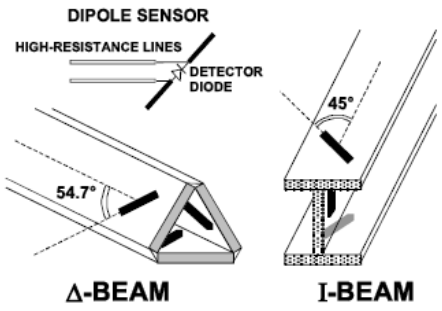
4.5 Probe Specification

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available.
Frequency	700 MHz to 3 GHz; Linearity: ± 0.5 dB (700 MHz to 3 GHz)
Directivity	± 0.25 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	1.5 µW/g to 100 mW/g; Linearity: ± 0.5 dB
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 5 mm Distance from probe tip to dipole centers: <2.7 mm
Application	General dosimetry up to 3 GHz Dosimetry in strong gradient fields Compliance tests of mobile phones
Compatibility	COMOSAR

Isotropic E-Field Probe

The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change.

The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



5. Tissue check and recommend Dielectric Parameters

5.1 Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness Power drifts in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations described in Reference [12] and extrapolated according to the head parameters specified in P1528.

Frequency (MHz)	Tissue	
	Real part of the complex relative permittivity, ε_r	Conductivity, σ(S/m)
30	55	0.75
150	52.3	0.76
300	45.3	0.87
450	43.5	0.87
750	41.9	0.89
835	41.5	0.9
900	41.5	0.97
1450	40.5	1.2
1800	40	1.4
1900	40	1.4
1950	40	1.4
2000	40	1.4
2100	39.8	1.49
2450	39.2	1.8
2600	39	1.96
3000	38.5	2.4
3500	37.9	2.91
4000	37.4	3.43
4500	36.8	3.94
5000	36.2	4.45
5200	36	4.66
5400	35.8	4.86
5600	35.5	5.07
5800	35.3	5.27
6000	35.1	5.48

5.2 Simulate liquid

Liquid check results:

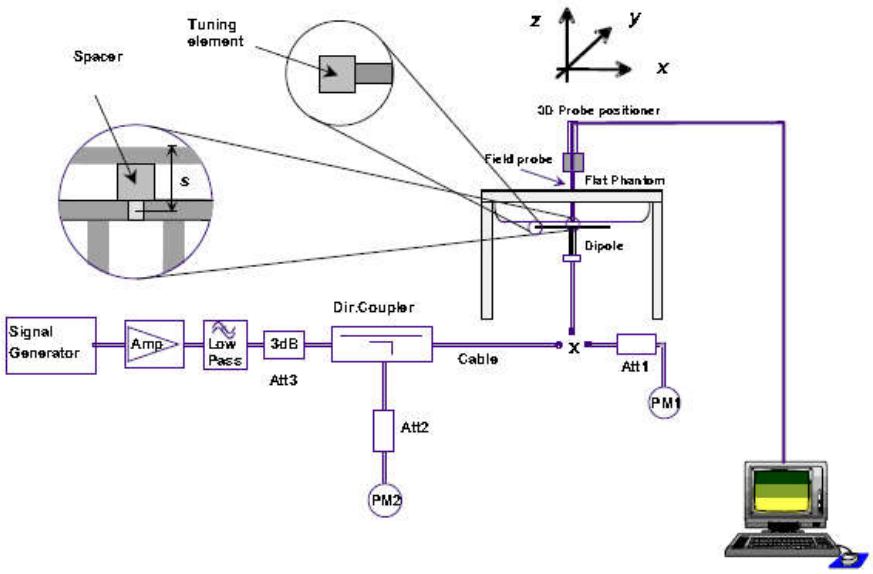
Table 3: Dielectric Performance of Tissue Simulating Liquid

/	Frequency	Permittivity ε	Conductivity σ (S/m)	Liquid Temp. (℃)	Test Date
Target value	2450MHz	39.2±5% (37.24~41.16)	1.80±5% (1.71~1.89)	22.6	2025/01/20
Validation value		39.65	1.84		
Target value	5800MHz	35.3±5% (33.535~37.065)	5.27±5% (5.0065~5.5335)	22.5	2025/01/21
Validation value		34.14	5.25		

SAR System validation

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of ±10%. The validation results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

The following procedure, recommended for performing validation tests using box phantoms is based on the procedures described in the IEEE standard P1528. Setup according to the setup diagram below:



With the SG and Amp and with directional coupler in place, set up the source signal at the relevant frequency and use a power meter to measure the power at the end of the SMA cable that you intend to connect to the balanced dipole. Adjust the SG to make this, say, 0.01W (10 dBm). If this level is too high to read directly with the power meter sensor, insert a calibrated attenuator (e.g. 10 or 20 dB) and make a suitable correction to the power meter reading.

Note 1: In this method, the directional coupler is used for monitoring rather than setting the exact feed power level. If, however, the directional coupler is used for power measurement, you should check the frequency range and power rating of the coupler and measure the coupling factor (referred to output) at the test frequency using a VNA.

Note 2: Remember that the use of a 3dB attenuator (as shown in Figure 8.1 of P1528) means that you need an RF amplifier of 2 times greater power for the same feed power. The other issue is the cable length. You might get up to 1dB of loss per meter of cable, so the cable length after the coupler needs to be quite short.

Note 3: For the validation testing done using CW signals, most power meters are suitable. However, if you are measuring the output of a modulated signal from either a signal generator or a handset, you must ensure that the power meter correctly reads the modulated signals.

The measured 1-gram averaged SAR values of the device against the phantom are provided in Tables 5 and Table 6. The body phantom were full of the body tissue simulating liquid. The EUT was supplied with full-charged battery for each measurement.

The distance between the back of the EUT and the bottom of the flat phantom is 10 mm (taking into account of the IEEE 1528 and the place of the antenna).

Table 4: system validation (1g)

System Check Results

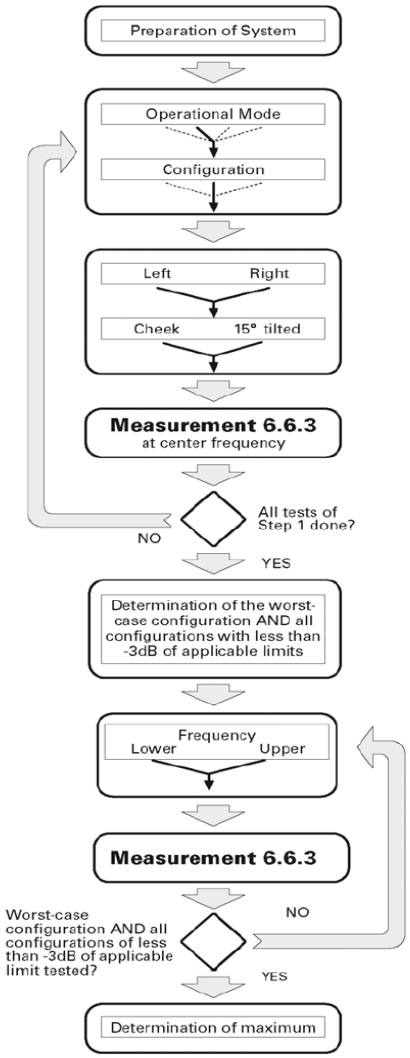
Frequency	Duty cycle	Target value（1-g）(W/Kg)	10mW Test value（1-g）(W/Kg)	Test SAR Normalized to 1W(w/Kg)	Test Date
2450MHz	1:1	51.74 W/kg±10% (46.566~56.914)	0.5368	53.68	2025/01/20
5800MHz	1:1	174.67 W/kg±10% (157.203~192.137)	1.7196	171.96	2025/01/21

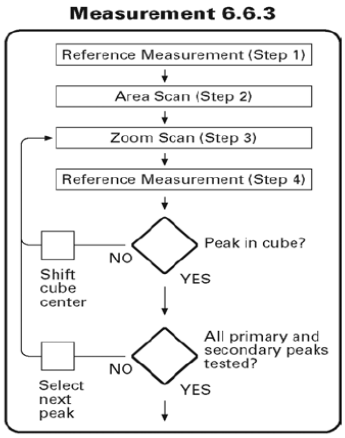
Note:

1. Target value was referring to the measured value in the calibration certificate of reference dipole.
2. All SAR values are normalized to 1W forward power.

6. SAR measurement procedure

The SAR test against the head phantom was carried out as follow:





Establish a call with the maximum output power with a base station simulator, the connection between the EUT and the base station simulator is established via air interface.

After an area scan has been done at a fixed distance of 2mm from the surface of the phantom on the source side, a 3D scan is set up around the location of the maximum spot SAR. First, a point within the scan area is visited by the probe and a SAR reading taken at the start of testing. At the end of testing, the probe is returned to the same point and a second reading is taken. Comparison between these start and end readings enables the power drift during measurement to be assessed.

Above is the scanning procedure flow chart and table from the IEEEp1528 standard. This is the procedure for which all compliant testing should be carried out to ensure that all variations of the device position and transmission behavior are tested.

7. Conducted RF Output Power

2.4G SRD Power

Frequency (MHz)	Antenna	Conducted Power (dBm) 10MHz	Total Power (dBm) 20MHz	Max. Tune up	Verdict
2411	Ant1	14.15	13.67	15	Pass
2433	Ant1	13.12	13.00	15	Pass
2466	Ant1	15.19	15.21	16	Pass
2411	Ant2	15.52	15.29	16	Pass
2433	Ant2	14.68	14.04	16	Pass
2466	Ant2	14.81	14.67	16	Pass

5.8G SRD Power

Frequency (MHz)	Antenna	Conducted Power (dBm) 10MHz	Max. Tune up
5750	Ant1	15.82	17
5780	Ant1	18.28	19
5820	Ant1	18.14	19
5750	Ant2	17.72	18
5780	Ant2	17.25	18
5820	Ant2	18.41	19
Frequency (MHz)	**Antenna**	**Conducted Power (dBm) 20MHz**	**Max. Tune up**
5750	Ant1	12.57	13
5780	Ant1	12.68	13
5820	Ant1	12.76	13
5750	Ant2	13.57	14
5780	Ant2	11.1	12
5820	Ant2	11.71	12

WIFI 2.4G Output power

Mode	Channel/Freq.(MHz)	Output Power (dBm)	Max. Tune up(dBm)
802.11b	1/2412	13.97	15
	7/2437	15.35	16
	11/2462	15.31	16
802.11g	1/2412	12.84	14
	7/2437	14.8	16
	11/2462	15.14	16
802.11n20	1/2412	15.79	16
	7/2437	17.36	18
	11/2462	17.4	18
802.11n40	3/2422	15.11	16
	6/2437	16.33	17
	9/2452	16.26	17

WIFI 5.8G U-NII-3 Output power

Mode	Channel/Freq.(MHz)	Output Power (dBm)	Max. Tune up(dBm)
802.11a	149/5745.0	15.32	16
	157/5785.0	14.57	16
	165/5825.0	14.43	16
802.11n20	149/5745.0	14.68	16
	157/5785.0	16.83	17
	165/5825.0	16.95	17
802.11n40	151/5755.0	16.58	17
	159/5795.0	16.96	17
802.11ac20	149/5745.0	17.85	18
	157/5785.0	17.91	18
	165/5825.0	17.78	18
802.11ac40	151/5755.0	17.61	18
	159/5795.0	17.39	18
802.11ac80	155/5775.0	20.22	21

Bluetooth Output power

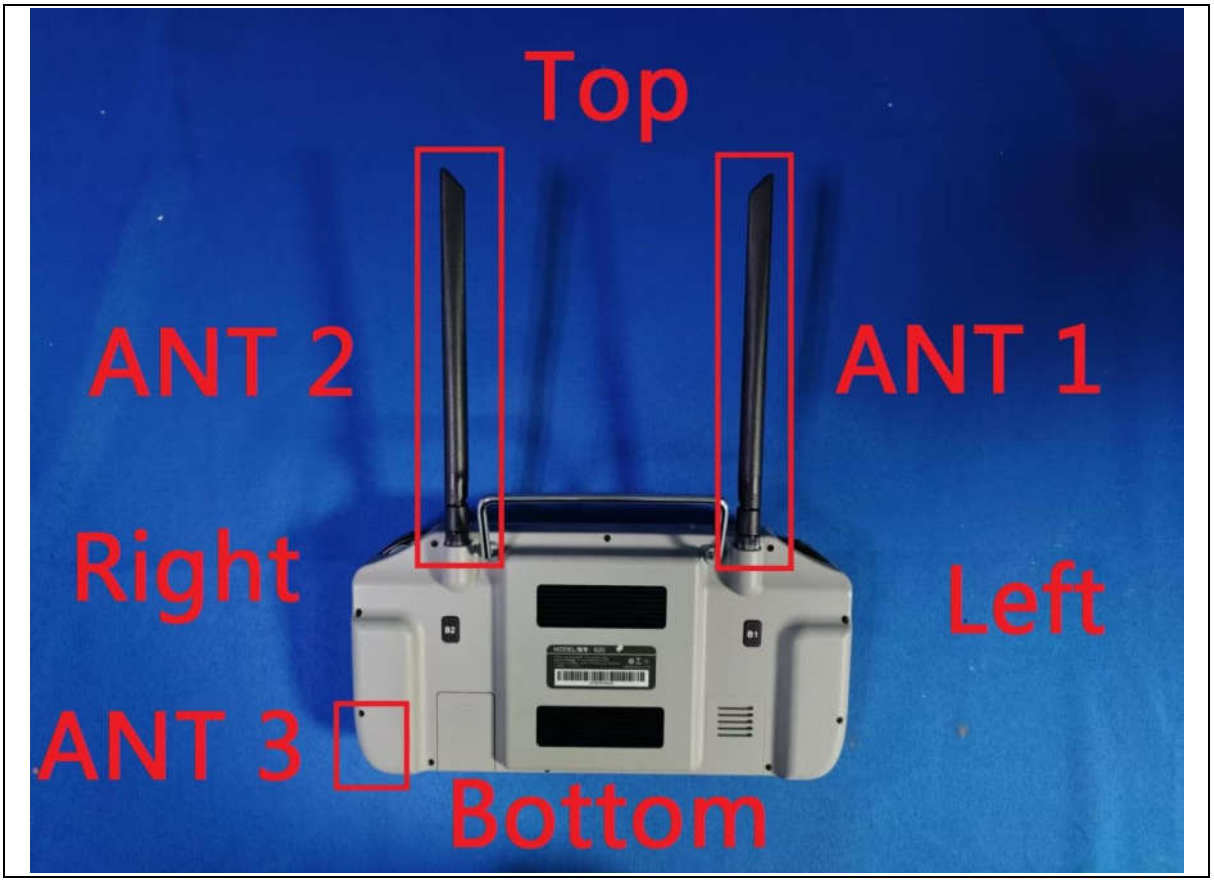
Mode	Channel/Freq.(MHz)	Output Power (dBm)	Max. Tune up(dBm)
1DH5	1/2402	0.21	2
	39/2441	0.50	2
	79/2480	0.69	2
2DH5	1/2402	1.04	2
	39/2441	1.31	2
	79/2480	1.55	2
3DH5	1/2402	1.43	2
	39/2441	1.70	2
	79/2480	1.95	2
BLE 1M	1/2402	0.45	2
	19/2441	0.56	2
	39/2480	0.85	2
BLE 2M	1/2402	0.31	2
	19/2441	0.55	2
	39/2480	0.99	2

Note:

1. Per KDB 248227 D01v02r02, choose the highest output power channel to test SAR and determine further SAR exclusion.
2. When the minimum *test separation distance* is < 5 mm, a distance of 5 mm according is applied to determine SAR test exclusion.
3. Per KDB 447498 D01v06, the 1-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
   [(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR, where
   - f(GHz) is the RF channel transmit frequency in GHz
   - Power and distance are rounded to the nearest mW and mm before calculation
   - The result is rounded to one decimal place for comparison

Channel	Frequency (GHz)	Max. tune-up Power (dBm)	Max. Power (mW)	Test distance (mm)	Result	exclusion thresholds for 1-g SAR
CH 01	2480.0	2	1.58	5	0.496	3.0

8. Antenna Location:



9. Test Results

Results overview of 2.4G SRD

20MHz BW

Body-support(0mm)	Channel /Frequency	ANT	SAR Value (W/kg)10-g	Power drift(%)	Scaled Factor	Scaled SAR (W/Kg)1-g	Limit (W/kg)	SAR Plot.
Top	2411	ANT1	0.307	2.05	1.199	0.368	1.6	/
Top	2466	ANT2	**0.375**	1.61	1.117	**0.419**	1.6	1

Results overview of 5.8G SRD

10MHz BW

Body-support(0mm)	Channel /Frequency	ANT	SAR Value (W/kg)10-g	Power drift(%)	Scaled Factor	Scaled SAR (W/Kg)1-g	Limit (W/kg)	SAR Plot.
Top	5820	ANT2	**0.548**	3.10	1.146	**0.628**	1.6	2
Top	5780	ANT1	0.480	1.95	1.181	0.567	1.6	/

Results overview of WIFI 2.4G

ANT 3

Body-support(0mm)	Channel /Frequency	Mode	SAR Value (W/kg)1-g	Power drift(%)	Scaled Factor	Scaled SAR (W/Kg)1-g	Limit (W/kg)	SAR Plot.
Front Upward	6/2437.0	802.11n20	0.047	-0.27	1.159	0.054	1.6	/
Back Upward	6/2437.0	802.11n20	0.132	1.42	1.159	0.153	1.6	/
Left	6/2437.0	802.11n20	<0.001	/	1.159	<0.001	1.6	/
Right	6/2437.0	802.11n20	0.369	-0.70	1.159	0.428	1.6	/
Top	6/2437.0	802.11n20	<0.001	/	1.159	<0.001	1.6	/
Bottom	6/2437.0	802.11n20	0.179	0.96	1.159	0.207	1.6	/
Right	1/2412.0	802.11n20	0.311	-2.05	1.050	0.326	1.6	/
Right	11/2462.0	802.11n20	**0.376**	0.36	1.148	**0.432**	1.6	3

Results overview of WIFI 5G U-NII 3

ANT 3

Body-support (0mm)	Channel /Frequency	Mode	SAR Value (W/kg)1-g	Power drift(%)	Scaled Factor	Scaled SAR (W/Kg)1-g	Limit (W/kg)	SAR Plot.
Front Upward	157/5785.0	802.11ac20	0.094	1.18	1.112	0.105	1.6	/
Back Upward	157/5785.0	802.11ac20	0.289	-0.75	1.112	0.321	1.6	/
Left	157/5785.0	802.11ac20	<0.001	/	1.112	<0.001	1.6	/
Right	157/5785.0	802.11ac20	**0.636**	0.27	1.112	**0.707**	1.6	4
Top	157/5785.0	802.11ac20	<0.001	/	1.112	<0.001	1.6	/
Bottom	157/5785.0	802.11ac20	0.445	-0.69	1.112	0.495	1.6	/
Right	149/5745.0	802.11ac20	0.585	0.51	1.084	0.634	1.6	/
Right	165/5825.0	802.11ac20	0.521	2.05	1.194	0.622	1.6	/

Note:

1. The maximum SAR value of each test band is marked bold.
2. When the 1-g SAR for the mid-band channel or the channel with the highest output power satisfy the following conditions, testing of the other channels in the band is not required. (Per KDB 447498 D01 General RF Exposure Guidance v06)
   - ≤ 0.8 W/kg, when the transmission band is ≤ 100 MHz
   - ≤ 0.6 W/kg, when the transmission band is between 100 MHz and 200 MHz
   - ≤ 0.4 W/kg, when the transmission band is ≥ 200 MHz
3. *: Due the antenna location and antenna performance results the SAR value lower than the lowest system limit, then we show “<0.001 W/Kg” in the report.

10. Simultaneous Transmissions Analysis

Localized Specific Absorption Rate (SAR) of this portable wireless device has been measured in all cases requested by the relevant standards cited in Clause 6 of this report. Maximum localized SAR is **below** exposure limits specified in the relevant standards.

Simultaneous SAR

No.	Simultaneous Tx Combination	Body
1	2.4 SRD MIMO	Support
2	5.8 SRD MIMO	Support
3	BT/WIFI+SRD	Not support
4	BT+WIFI	Not support

Applicable Multiple Scenario Evaluation

Position 1gSAR(W/kg)		2.4GSRD ANT 1	2.4GSRD ANT 2	5.8GSRD ANT 1	5.8GSRD ANT 2
		1	2	3	4
Body-support 0mm distance	Top	0.368	0.418	0.628	0.567

Position 1gSAR(W/kg)		Simultaneous SAR		Max Simultaneous SAR
		1+2	3+4	
Body-support 0mm distance	Top	0.786	1.195	1.195

11. Measurement Uncertainty

No.	Uncertainty Component	Type	Uncertainty Value (%)	Probability Distribution	k	ci	Standard Uncertainty (%) ui(%)	Degree of freedom Veff or vi
	Measurement System							
1	- Probe Calibration	B	5.8	N	1	1	5.8	∞
2	- Axial isotropy	B	3.5	R	$\sqrt{3}$	0.5	1.43	∞
3	—Hemispherical Isotropy	B	5.9	R	$\sqrt{3}$	0.5	2.41	∞
4	- Boundary Effect	B	1	R	$\sqrt{3}$	1	0.58	∞
5	- Linearity	B	4.7	R	$\sqrt{3}$	1	2.71	∞
6	- System Detection Limits	B	1.0	R	$\sqrt{3}$	1	0.58	∞
7	Modulation response	B	3	N	1	1	3.00	
8	- Readout Electronics	B	0.5	N	1	1	0.50	∞
9	- Response Time	B	1.4	R	$\sqrt{3}$	1	0.81	∞
10	- Integration Time	B	3.0	R	$\sqrt{3}$	1	1.73	∞
11	- RF Ambient Conditions	B	3.0	R	$\sqrt{3}$	1	1.73	∞
12	- Probe Position Mechanical tolerance	B	1.4	R	$\sqrt{3}$	1	0.81	∞
13	- Probe Position with respect to Phantom Shell	B	1.4	R	$\sqrt{3}$	1	0.81	∞
14	- Extrapolation, Interpolation and Integration Algorithms for Max. SAR evaluation	B	2.3	R	$\sqrt{3}$	1	1.33	∞
	Uncertainties of the DUT							

15	- Position of the DUT	A	2.6	N	$\sqrt{3}$	1	2.6	5
16	- Holder of the DUT	A	3	N	$\sqrt{3}$	1	3.0	5
17	- Output Power Variation – SAR drift measurement	B	5.0	R	$\sqrt{3}$	1	2.89	∞
Phantom and Tissue Parameters								
18	- Phantom Uncertainty(shape and thickness tolerances)	B	4	R	$\sqrt{3}$	1	2.31	∞
19	Uncertainty in SAR correction for deviation(in permittivity and conductivity)	B	2	N	1	1	2.00	
20	- Liquid Conductivity Target – tolerance	B	2.5	R	$\sqrt{3}$	0.6	1.95	∞
21	- Liquid Conductivity – measurement Uncertainty)	B	4	N	$\sqrt{3}$	1	0.92	9
22	- Liquid Permittivity Target tolerance	B	2.5	R	$\sqrt{3}$	0.6	1.95	∞
23	- Liquid Permittivity – measurement uncertainty	B	5	N	$\sqrt{3}$	1	1.15	∞
Combined Standard Uncertainty				RSS			10.63	
Expanded uncertainty (Confidence interval of 95 %)				K=2			21.26	

Uncertainty component	Uncertainty ±%	Probability distributions	Factor	Ci (1 g)	Ci (10 g)	Standard Uncertainty ±% ,(1 g)	Standard Uncertainty ±%, (10 g)
Measurement System errors							
Probe calibration	5.8	N	2	1	1	2.90	2.90
Probe calibration drift	1.7	R	$\sqrt{3}$	1	1	0.98	0.98
Probe linearity and detection Limit	4.7	R	$\sqrt{3}$	1	1	2.71	2.71
Broadband signal	2.8	R	$\sqrt{3}$	1	1	1.62	1.62
Probe isotropy	3.5	R	$\sqrt{3}$	1	1	2.02	2.02
Other probe and data acquisition errors	2.4	N	1	1	1	2.40	2.40
RF ambient and noise	1.8	N	1	1	1	1.80	1.80
Probe positioning errors	0.008	N	1	0.5	0.5	0.00	0.00
Data processing errors	4.0	N	1	1	1	4.00	4.00
Phantom and Device Errors							
Measurement of phantom conductivity (σ)	2.5	N	1	0.78	0.71	1.95	1.78
Temperature effects (medium)	5.4	R	$\sqrt{3}$	0.78	0.71	2.40	2.20
Shell permittivity	14.0	R	$\sqrt{3}$	0.5	0.5	4.00	4.00
Distance between the radiating element of the DUT and the phantom medium	2.0	N	1	2	2	4.00	4.00
Repeatability of positioning the DUT or source against the phantom	1.0	N	1	1	1	1.00	1.00
Device holder effects	3.0	N	1	1	1	3.0	3.0
Effect of operating mode on probe sensitivity	2.4	R	$\sqrt{3}$	1	1	1.39	1.39
Time-average SAR	1.7	R	$\sqrt{3}$	1	1	0.98	0.98
Variation in SAR due to drift in output of DUT	2.6	N	1	1	1	2.60	2.60
Validation antenna uncertainty (validation measurement only)	0.0	N	1	1	1	0.00	0.00
Uncertainty in accepted power	0.0	N	1	1	1	0.00	0.00

(validation measurement only)							
Correction to the SAR results							
Phantom deviation from target (ε' , σ)	1.9	N	1	1	0.84	1.9	1.6
SAR scaling	0.0	R	$\sqrt{3}$	1	1	0.0	0.0
Combined uncertainty						12.07%	11.92%
Coverage Factor for 95 %						K=2	K=2
Extended uncertainty						24.14%	23.84%

Frequency range: 150MHz-7500MHz

12. System Check Uncertainty

No.	Uncertainty Component	Type	Uncertainty Value (%)	Probability Distribution	k	ci	Standard Uncertainty (%) ui(%)	Degree of freedom Veff or vi
	Measurement System							
1	- Probe Calibration	B	5.8	N	1	1	5.8	∞
2	- Axial isotropy	B	3.5	R	$\sqrt{3}$	0.5	1.43	∞
3	—Hemispherical Isotropy	B	5.9	R	$\sqrt{3}$	0.5	2.41	∞
4	- Boundary Effect	B	1	R	$\sqrt{3}$	1	0.58	∞
5	- Linearity	B	4.7	R	$\sqrt{3}$	1	2.71	∞
6	- System Detection Limits	B	1	R	$\sqrt{3}$	1	0.58	∞
7	Modulation response	B	0	N	1	1	0.00	
8	- Readout Electronics	B	0.5	N	1	1	0.50	∞
9	- Response Time	B	0.00	R	$\sqrt{3}$	1	0.00	∞
10	- Integration Time	B	1.4	R	$\sqrt{3}$	1	0.81	∞
11	- RF Ambient Conditions	B	3.0	R	$\sqrt{3}$	1	1.73	∞
12	- Probe Position Mechanical tolerance	B	1.4	R	$\sqrt{3}$	1	0.81	∞
13	- Probe Position with respect to Phantom Shell	B	1.4	R	$\sqrt{3}$	1	0.81	∞
14	- Extrapolation, Interpolation and Integration Algorithms for Max. SAR evaluation	B	2.3	R	$\sqrt{3}$	1	1.33	∞
	Uncertainties of the DUT							

15	Deviation of experimental source from numberical source	A	4	N	1	1	4.00	5
16	Input Power and SAR drift measurement	A	5	R	$\sqrt{3}$	1	2.89	5
17	Dipole Axis to Liquid Distance	B	2	R	$\sqrt{3}$	1	1.2	∞
Phantom and Tissue Parameters								
18	- Phantom Uncertainty(shape and thickness tolerances)	B	4	R	$\sqrt{3}$	1	2.31	∞
19	Uncertainty in SAR correction for deviation(in permittivity and conductivity)	B	2	N	1	1	2.00	
20	- Liquid Conductivity Target – tolerance	B	2.5	R	$\sqrt{3}$	0.6	1.95	∞
21	- Liquid Conductivity – measurement Uncertainty)	B	4	N	$\sqrt{3}$	1	0.92	9
22	- Liquid Permittivity Target tolerance	B	2.5	R	$\sqrt{3}$	0.6	1.95	∞
23	- Liquid Permittivity – measurement uncertainty	B	5	N	$\sqrt{3}$	1	1.15	∞
Combined Standard Uncertainty				RSS			10.15	
Expanded uncertainty (Confidence interval of 95 %)				K=2			20.29	

ANNEX A: SAR Test Setup

Photo 1: Measurement System SATIMO	Photo 2: Liquid deep(15cm)

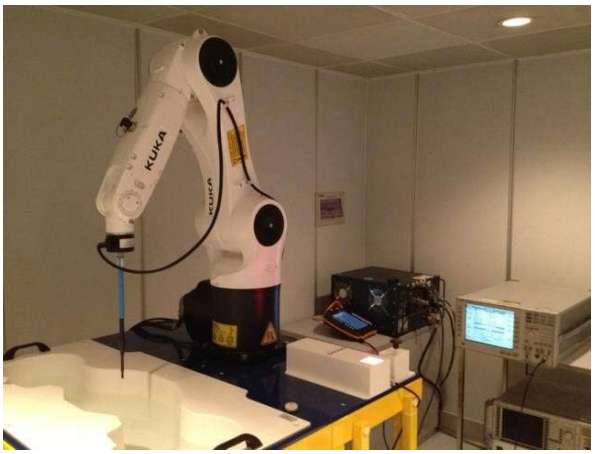



Photo 3: Front 0mm	Photo 4: Back 0mm
	
Photo 3: Left 0mm	Photo 3: Right 0mm
	

Photo 7: Top 0mm	Photo 8: Bottom 0mm
	

EUT Front View	EUT Back View
	

ANNEX B: System Check Plots

System Performance Check (2450MHz)

Type: Validation measurement

Date of measurement: 01/20/2025

A. Experimental conditions.

E-Field Probe	SATIMO 3723-EPGO-433
Area Scan	dx=8mm dy=8mm
Zoom Scan	7x7x7,dx=5mm dy=5mm dz=5mm
Phantom	Validation plane
Device Position	Dipole
Band	2450MHz
Channels	Middle
Signal	CW(Crest factor: 1.0)

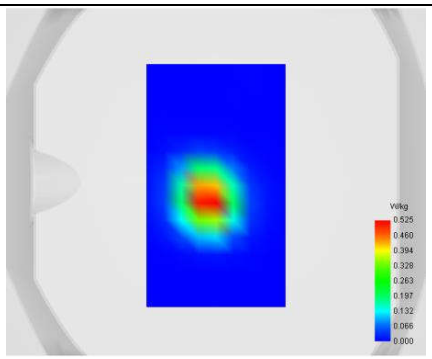
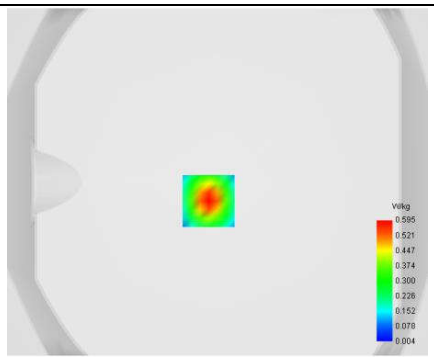
B. SAR Measurement Results

Frequency (MHz)	2450
Relative permittivity (real part)	39.65
Conductivity (S/m)	1.84
Variation (%)	0.18

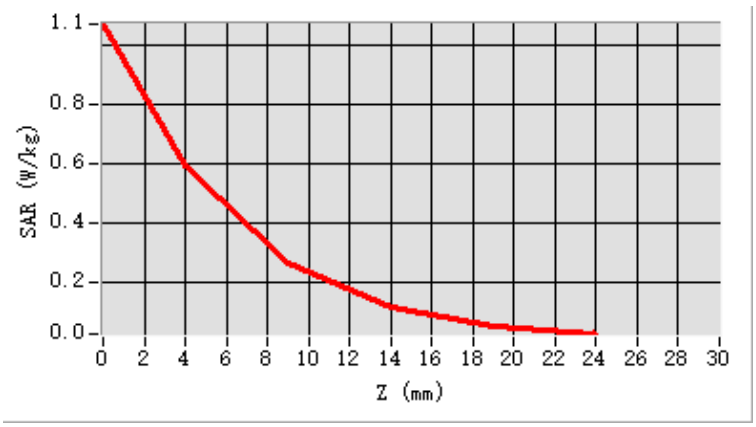
Maximum location: X=5.00, Y=-11.00

SAR Peak: 1.07 W/kg

SAR 10g (W/Kg)	0.241164
SAR 1g (W/Kg)	0.536817

SURFACE SAR	**VOLUME SAR**
	

Z Axis Scan



System Performance Check (5800MHz)

Type: Validation measurement

Date of measurement: 01/21/2025

A. Experimental conditions.

E-Field Probe	SATIMO 3723-EPGO-433
Area Scan	dx=8mm dy=8mm
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Dipole
Band	5800MHz
Channels	Middle
Signal	CW(Crest factor: 1.0)

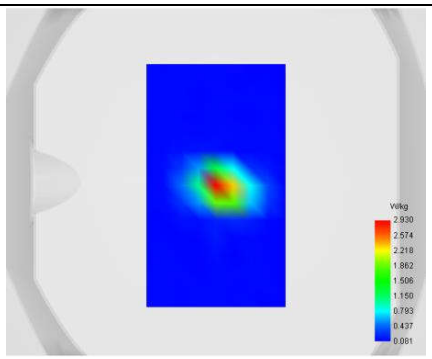
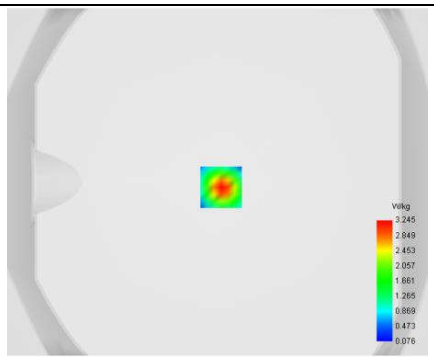
B. SAR Measurement Results

Frequency (MHz)	5800
Relative permittivity (real part)	34.14
Conductivity (S/m)	5.25
Variation (%)	0.04

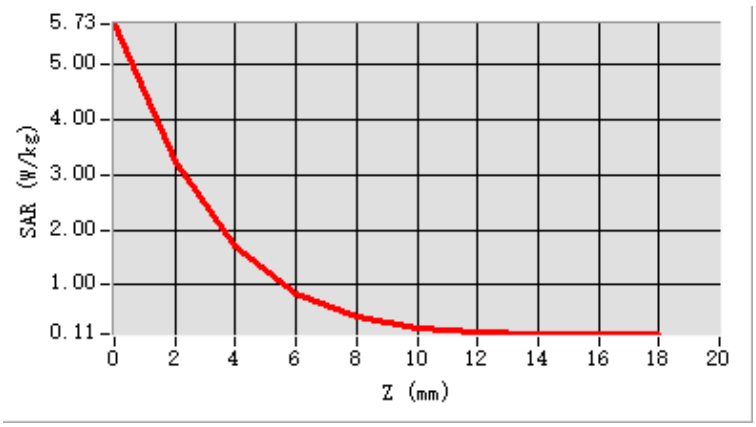
Maximum location: X=2.00, Y=-3.00

SAR Peak: 5.73 W/kg

SAR 10g (W/Kg)	0.587261
SAR 1g (W/Kg)	1.719569

SURFACE SAR	**VOLUME SAR**
	

Z Axis Scan



ANNEX C: SAR Test Plots

Testing result (2.4G SRD ANT 2, Top, High, 0mm)

Type: phone measurement

Date of measurement: 01/20/2025

A. Experimental conditions.

E-Field Probe	SATIMO 3723-EPGO-433
Area Scan	dx=12mm dy=12mm
Zoom Scan	7x7x7,dx=5mm dy=5mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	WIFI 802.11b
Channels	High
Signal	(Crest factor: 1.0)

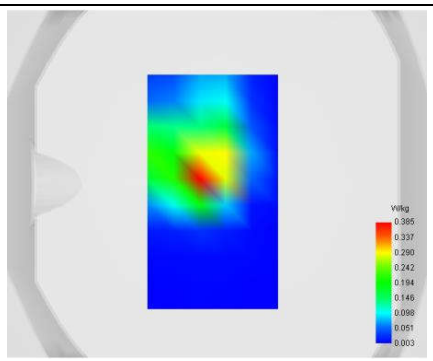
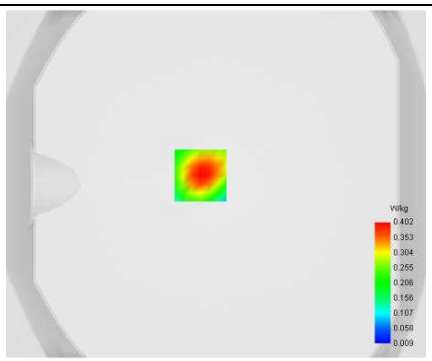
B. SAR Measurement Results

Frequency (MHz)	2466
Relative permittivity (real part)	39.63
Conductivity (S/m)	1.85
Variation (%)	1.61

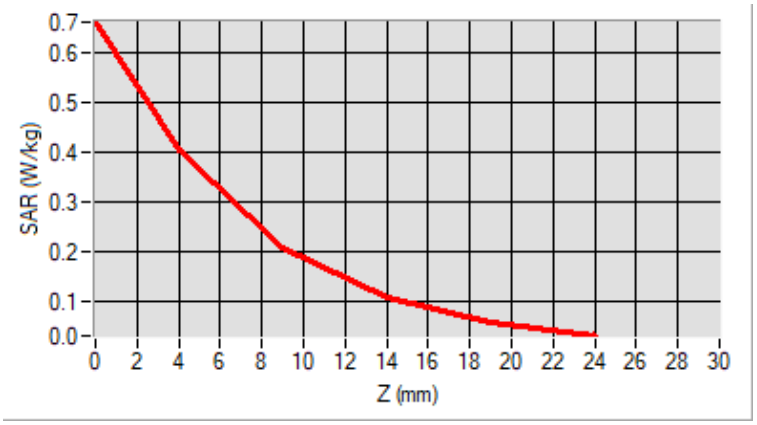
Maximum location: X=-9.00, Y=5.00

SAR Peak: 0.71 W/kg

SAR 10g (W/Kg)	0.192579
SAR 1g (W/Kg)	0.374508

SURFACE SAR	**VOLUME SAR**
	

Z Axis Scan



Testing result (5.8G SRD ANT 2, Top 0mm)

Type: phone measurement

Date of measurement: 01/21/2025

A. Experimental conditions.

E-Field Probe	SATIMO 3723-EPGO-433
Area Scan	dx=10mm dy=10mm
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	WIFI 802.11a
Channels	High
Signal	OFDM(Crest factor: 1.0)

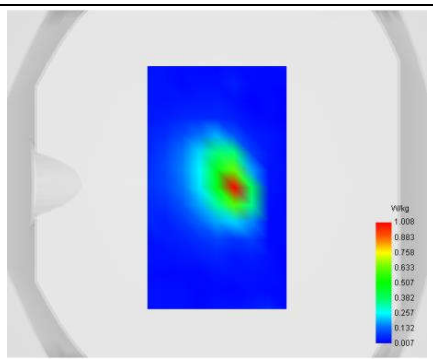
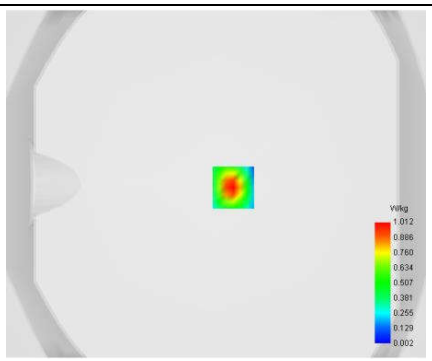
B. SAR Measurement Results

Frequency (MHz)	5820.0
Relative permittivity (real part)	34.11
Conductivity (S/m)	5.26
Variation (%)	3.10

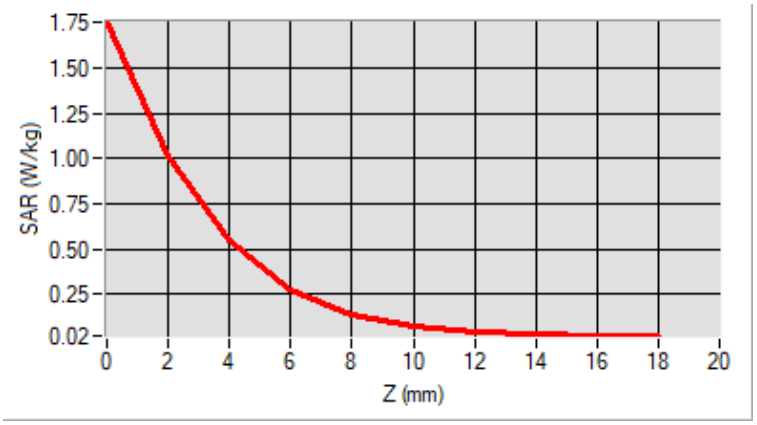
Maximum location: X=10.00, Y=-2.00

SAR Peak: 1.75 W/kg

SAR 10g (W/Kg)	0.182019
SAR 1g (W/Kg)	0.548248

SURFACE SAR	**VOLUME SAR**
	

Z Axis Scan



Testing result (WIFI 2.4G 802.11n20, Right, High, 0mm)

Type: phone measurement

Date of measurement: 01/20/2025

A. Experimental conditions.

E-Field Probe	SATIMO 3723-EPGO-433
Area Scan	dx=12mm dy=12mm
Zoom Scan	7x7x7,dx=5mm dy=5mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	WIFI 802.11n20
Channels	High
Signal	DSSS(Crest factor: 1.0)

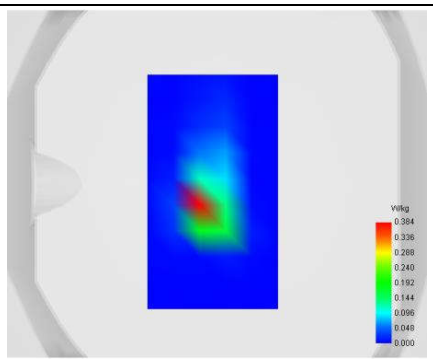
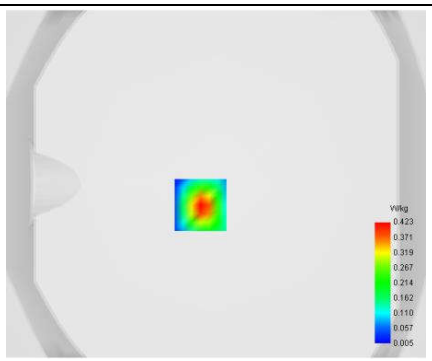
B. SAR Measurement Results

Frequency (MHz)	2462.0
Relative permittivity (real part)	39.63
Conductivity (S/m)	1.85
Variation (%)	0.36

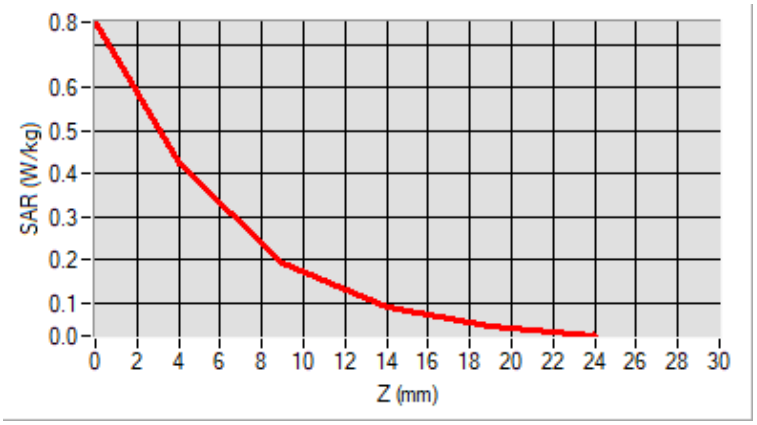
Maximum location: X=-9.00, Y=-12.00

SAR Peak: 0.81 W/kg

SAR 10g (W/Kg)	0.162946
SAR 1g (W/Kg)	0.375516

SURFACE SAR	**VOLUME SAR**
	

Z Axis Scan



Testing result (WIFI U-NII 3 802.11ac20 Right, Middle, 0mm)

Type: phone measurement

Date of measurement: 01/21/2025

A. Experimental conditions.

E-Field Probe	SATIMO 3723-EPGO-433
Area Scan	dx=10mm dy=10mm
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2mm
Phantom	Validation plane
Device Position	Body
Band	WIFI 802.11ac20
Channels	Middle
Signal	OFDM(Crest factor: 1.0)

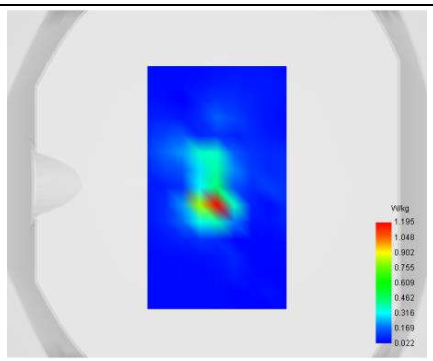
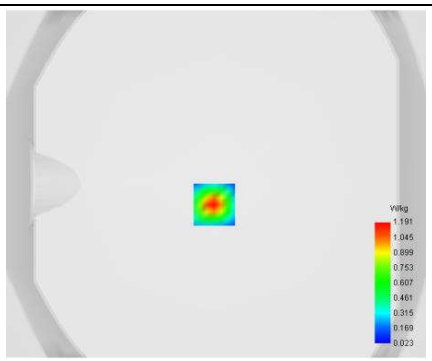
B. SAR Measurement Results

Frequency (MHz)	5785.0
Relative permittivity (real part)	35.60
Conductivity (S/m)	5.18
Variation (%)	0.27

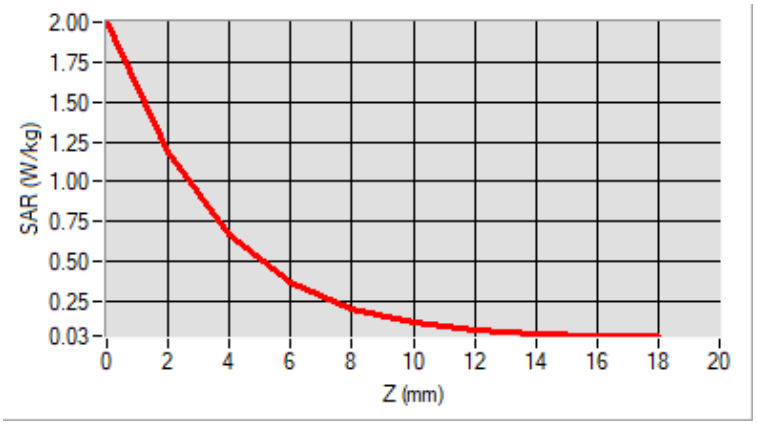
Maximum location: X=-1.00, Y=-12.00

SAR Peak: 2.00 W/kg

SAR 10g (W/Kg)	0.206208
SAR 1g (W/Kg)	0.635799

SURFACE SAR	**VOLUME SAR**
	

Z Axis Scan



ANNEX D: Calibration Certificate

COMOSAR E-Field Probe Calibration Report

Ref : ACR.108.10.24.BES.A

CCIC SOUTHERN TESTING CO., LTD

ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD, XILI STREET, NANSHAN DISTRICT

SHENZHEN, GUANGDONG, CHINA

MVG COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: 3723-EPGO-433

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon

29280 PLOUZANE - FRANCE

Calibration date: 04/17/2024

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

Summary:

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

COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.108.10.24.BES.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Cyrille ONNEE	Measurement Responsible	4/17/2024	
Checked & approved by:	Jérôme Luc	Technical Manager	4/17/2024	
Authorized by:	Yann Toutain	Laboratory Director	4/18/2024	

Yann Toutain ID
Signature numérique de Yann Toutain ID
Date : 2024.04.18 09:37:52 +02'00'

	Customer Name
Distribution :	CCIC SOUTHERN TESTING CO., LTD

Issue	*Name*	*Date*	*Modifications*
A	Cyrille ONNEE	4/17/2024	Initial release

TABLE OF CONTENTS

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE2
Serial Number	3723-EPGO-433
Product Condition (new / used)	New
Frequency Range of Probe	0.15 GHz-7.5GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.174 MΩ Dipole 2: R2=0.169 MΩ Dipole 3: R3=0.187 MΩ

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

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

Figure 1 – *MVG COMOSAR Dosimetric E field Probe*

Probe Length	330 mm
Length of Individual Dipoles	2 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	2.5 mm
Distance between dipoles / probe extremity	1 mm

3 MEASUREMENT METHOD

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

3.1 SENSITIVITY

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

3.2 LINEARITY

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

3.3 ISOTROPY

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

3.4 BOUNDARY EFFECT

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

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

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

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.

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

4 MEASUREMENT UNCERTAINTY

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

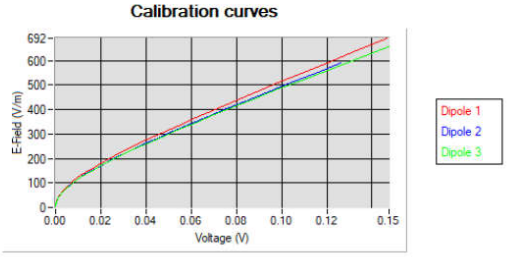
The estimated expanded uncertainty (k=2) in calibration for SAR (W/kg) is +/-11% for the frequency range 150-450MHz.
The estimated expanded uncertainty (k=2) in calibration for SAR (W/kg) is +/-14% for the frequency range 600-7500MHz.

5 CALIBRATION RESULTS

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

5.1 CALIBRATION IN AIR

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



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

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

where
Vi=voltage readings on the 3 channels of the probe
DCPi=diode compression point given below for the 3 channels of the probe
Normi=dipole sensitivity given below for the 3 channels of the probe

Normx dipole 1 (μV/(V/m)^2)	Normy dipole 2 (μV/(V/m)^2)	Normz dipole 3 (μV/(V/m)^2)
0.72	0.80	0.79

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
108	106	114

5.2 CALIBRATION IN LIQUID

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

$$ConvF = \frac{E^2_{liquid}}{E^2_{air}}$$

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

$$E^2_{liquid} = \frac{\rho\, SAR}{\sigma}$$

where
σ=the conductivity of the liquid
ρ=the volumetric density of the liquid
SAR=the SAR measured from the formula that depends on the setup used. The SAR formulas are given below

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

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

where
c=the specific heat for the liquid
dT/dt=the temperature rises over the time

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

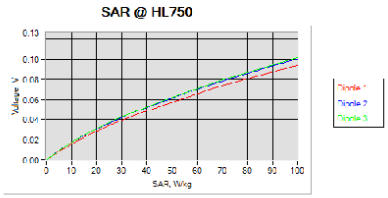
$$SAR = \frac{4Pw}{ab\delta} e^{\frac{-2z}{\delta}}$$

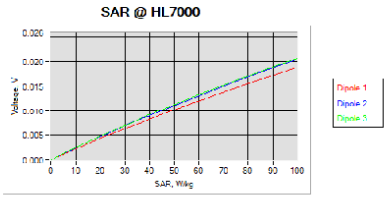
where
a=the larger cross-sectional of the waveguide
b=the smaller cross-sectional of the waveguide
δ=the skin depth for the liquid in the waveguide
Pw=the power delivered to the liquid

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

Liquid	Frequency (MHz*)	ConvF
HL750	750	1.97
HL850	835	1.72
HL900	900	1.88
HL1500	1500	2.04
HL1800	1800	2.20
HL1900	1900	2.41
HL2000	2000	2.44
HL2300	2300	2.53
HL2450	2450	2.62
HL2600	2600	2.44
HL3300	3300	2.35
HL3500	3500	1.99
HL3700	3700	2.17
HL3900	3900	2.35
HL4200	4200	2.47
HL4600	4600	2.46
HL5250	5250	1.57
HL5600	5600	2.06
HL5750	5750	1.29
HL6500	6500	2.20
HL7000	7000	2.19

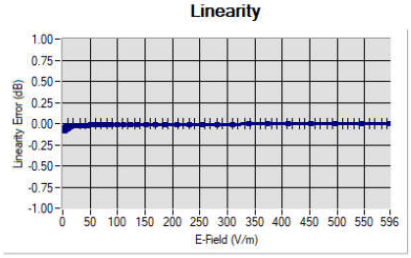
(*) Frequency validity is +/-50MHz below 600MHz, +/-100MHz from 600MHz to 6GHz and +/-700MHz above 6GHz



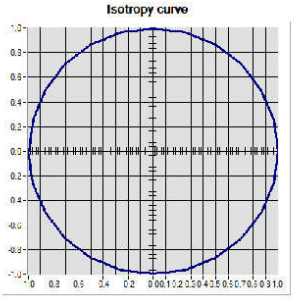


6 VERIFICATION RESULTS

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



Linearity:+/-1.97% (+/-0.09dB)



Isotropy:+/-0.19% (+/-0.01dB)

7 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
CALIPROBE Test Bench	Version 2	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rohde & Schwarz ZVM	100203	08/2021	08/2024
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	07/2022	07/2025
Multimeter	Keithley 2000	4013982	02/2023	02/2026
Signal Generator	Rohde & Schwarz SMB	106589	03/2022	03/2025
Amplifier	MVG	MODU-023-C-0002	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	NI-USB 5680	170100013	06/2021	06/2026
USB Sensor	Keysight U2000A	SN: MY62340002	10/2022	10/2025

Directional Coupler	Krytar 158020	131467	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Fluoroptic Thermometer	LumaSense Luxtron 812	94264	09/2022	09/2025
Coaxial cell	MVG	SN 32/16 COAXCELL_1	Validated. No cal required.	Validated. No cal required.
Waveguide	MVG	SN 32/16 WG2_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_0G600_1	Validated. No cal required.	Validated. No cal required.
Waveguide	MVG	SN 32/16 WG4_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_0G900_1	Validated. No cal required.	Validated. No cal required.
Waveguide	MVG	SN 32/16 WG6_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_1G500_1	Validated. No cal required.	Validated. No cal required.
Waveguide	MVG	SN 32/16 WG8_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_1G800B_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_1G800H_1	Validated. No cal required.	Validated. No cal required.
Waveguide	MVG	SN 32/16 WG10_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_3G500_1	Validated. No cal required.	Validated. No cal required.
Waveguide	MVG	SN 32/16 WG12_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_5G000_1	Validated. No cal required.	Validated. No cal required.
Waveguide	MVG	SN 32/16 WG14_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_7G000_1	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44225320	06/2021	06/2024

SID2450 Dipole Calibration Report

SAR Reference Dipole Calibration Report

Ref : ACR.144.13.23.BES.A

CCIC SOUTHERN TESTING CO., LTD
ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD, XILI STREET, NANSHAN DISTRICT
SHENZHEN, GUANGDONG, CHINA
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 2450 MHZ
SERIAL NO.: SN 09/13 DIP2G450-220

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

Calibration date: 05/24/2023

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 in MVG using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.144.13.23.BES.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme Luc	Technical Manager	5/24/2023	
Checked & approved by:	Jérôme Luc	Technical Manager	5/24/2023	
Authorized by:	Yann Toutain	Laboratory Director	5/24/2023	

Yann Toutain ID
Signature numérique de Yann Toutain ID
Date : 2023.05.24 15:56:02 +02'00'

	Customer Name
Distribution :	CCIC SOUTHERN TESTING CO., LTD

Issue	*Name*	*Date*	*Modifications*
A	Jérôme Luc	5/24/2023	Initial release

TABLE OF CONTENTS

1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 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 09/13 DIP2G450-220
Product Condition (new / used)	Used

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards. The product is designed for use with the COMOSAR test bench only.

Figure 1 – *MVG COMOSAR Validation Dipole*

4 MEASUREMENT METHOD

4.1 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

4.2 S11 PARAMETER REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a S11 of -20 dB or better. The S11 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.

4.3 SAR REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

5 MEASUREMENT UNCERTAINTY

5.1 MECHANICAL DIMENSIONS

For the measurement in the range 0-300mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.20 mm with respect to measurement conditions.

For the measurement in the range 300-450mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.44 mm with respect to measurement conditions.

5.2 S11 PARAMETER

The estimated expanded uncertainty (k=2) in calibration for the S11 parameter in linear is +/-0.08 with respect to measurement conditions.

5.3 SAR

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty for validation measurements.

The estimated expanded uncertainty (k=2) in calibration for the 1g and 10g SAR measurement in W/kg is +/-19% with respect to measurement conditions.

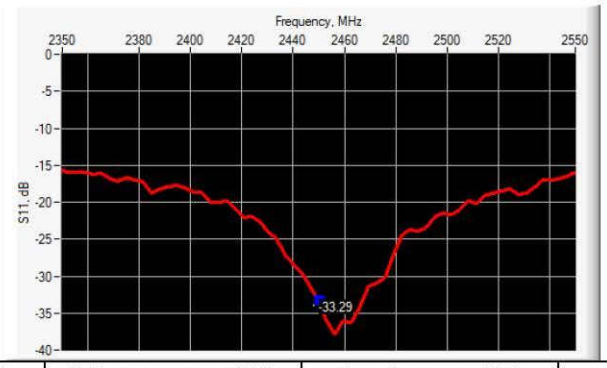
6 CALIBRATION RESULTS

6.1 MECHANICAL DIMENSIONS

L mm		h mm		d mm	
Measured	**Required**	**Measured**	**Required**	**Measured**	**Required**
-	51.50 +/- 2%	-	30.40 +/- 2%	-	3.60 +/- 2%

6.2 S11 PARAMETER

6.2.1 S11 parameter in Head Liquid



Frequency (MHz)	S11 parameter (dB)	Requirement (dB)	Impedance
2450	-33.29	-20	52.1Ω + 0.8jΩ

6.3 SAR

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

6.3.1 SAR with Head Liquid

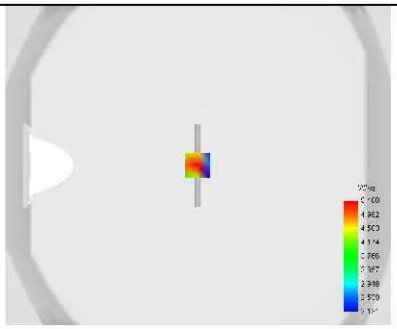
The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

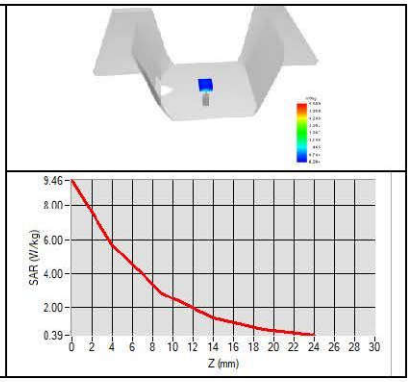
SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.144.13.23.BES.A

Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Head Liquid Values: eps' : 40.7 sigma : 1.94
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	2450 MHz
Input power	20 dBm
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

Frequency	1g SAR (W/kg)			10g SAR (W/kg)		
	Measured	Measured normalized to 1W	Target normalized to 1W	Measured	Measured normalized to 1W	Target normalized to 1W
2450 MHz	5.17	51.74	52.40	2.38	23.75	24.00





7 LIST OF EQUIPMENT

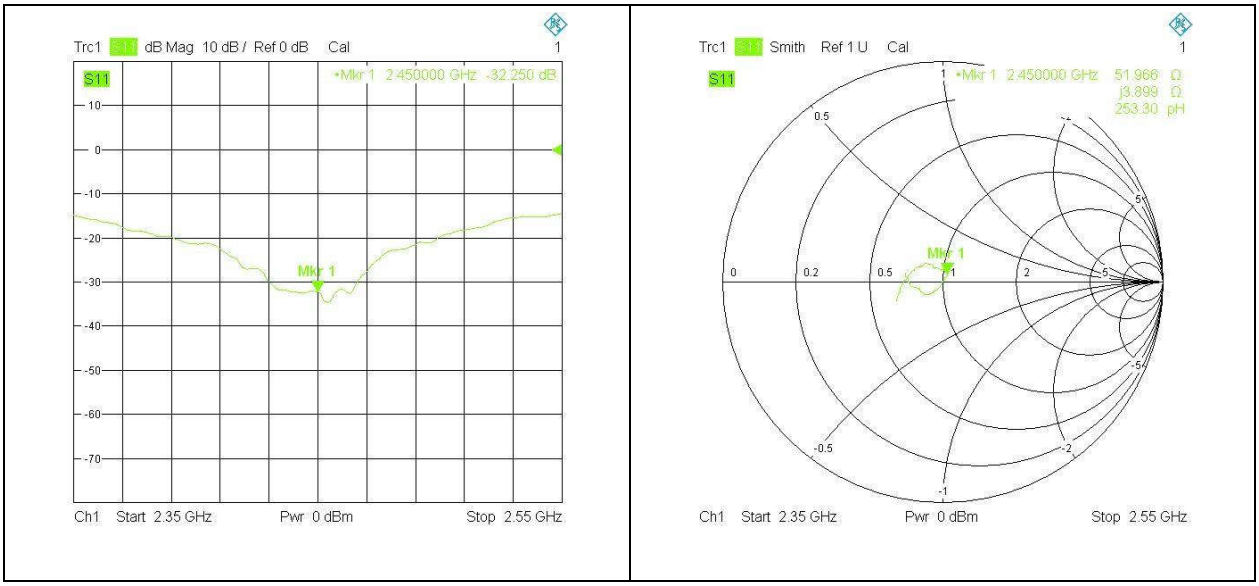
Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
SAM Phantom	MVG	SN 13/09 SAM68	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rohde & Schwarz ZVM	100203	08/2021	08/2024
Network Analyzer	Agilent 8753ES	MY40003210	10/2019	10/2023
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	07/2022	07/2025
Network Analyzer – Calibration kit	HP 85033D	3423A08186	06/2021	06/2027
Calipers	Mitutoyo	SN 0009732	11/2022	11/2025
Reference Probe	MVG	SN 41/18 EPGO333	09/2022	09/2023
Multimeter	Keithley 2000	4013982	02/2023	02/2026
Signal Generator	Rohde & Schwarz SMB	106589	03/2022	03/2025
Amplifier	MVG	MODU-023-C-0002	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	NI-USB 5680	170100013	06/2021	06/2024
Power Meter	Keysight U2000A	SN: MY62340002	10/2022	10/2025
Directional Coupler	Krytar 158020	131467	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44225320	06/2021	06/2024

Head 2450MHz				
Date of Measurement	**Return Loss (dB)**	**Delta (%)**	**Impedance**	**Delta(ohm)**
2023.05.24	-33.29	-	52.1	-
2024.05.21	-32.25	3.12	51.966	-0.134

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 2450MHz



SID5G Dipole Calibration Report

SAR Reference Waveguide Calibration Report

Ref : ACR.145.20.23.BES.A

CCIC SOUTHERN TESTING CO., LTD
ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD, XILI STREET, NANSHAN DISTRICTSHENZHEN, GUANGDONG, CHINAMVG
COMOSAR REFERENCE WAVEGUIDE
FREQUENCY: 5000-6000 MHZ
SERIAL NO.: SN 15/15 WGA39

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

Calibration date: 05/25/2023

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).

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SAR REFERENCE WAVEGUIDE CALIBRATION REPORT Ref: ACR.145.20.23.BES.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme Luc	Technical Manager	5/25/2023	
Checked & approved by:	Jérôme Luc	Technical Manager	5/25/2023	
Authorized by:	Yann Toutain	Laboratory Director	5/25/2023	

Yann Toutain ID

Signature numérique de Yann Toutain ID
Date : 2023.05.25 16:30:59 +02'00'

	Customer Name
Distribution :	CCIC SOUTHERN TESTING CO., LTD

Issue	*Name*	*Date*	*Modifications*
A	Jérôme Luc	5/25/2023	Initial release

TABLE OF CONTENTS

1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 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 15/15 WGA39
Product Condition (new / used)	Used

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

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

4 MEASUREMENT METHOD

4.1 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

4.2 S11 PARAMETER REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a S11 of -8 dB or better. The S11 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.

4.3 SAR REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

5 MEASUREMENT UNCERTAINTY

5.1 MECHANICAL DIMENSIONS

The estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/- 0.20 mm with respect to measurement conditions.

5.2 S11 PARAMETER

The estimated expanded uncertainty (k=2) in calibration for the S11 parameter in linear is +/-0.08 with respect to measurement conditions.

5.3 SAR

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty for validation measurements.

The estimated expanded uncertainty (k=2) in calibration for the 1g and 10g SAR measurement in W/kg is +/-19% with respect to measurement conditions.

6 CALIBRATION RESULTS

6.1 MECHANICAL DIMENSIONS

Frequency (MHz)	L (mm)		W (mm)		L_f (mm)		W_f (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	-

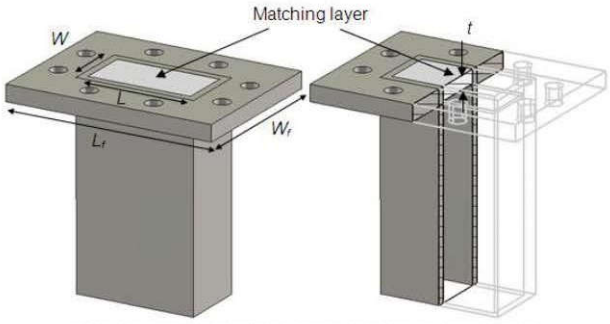
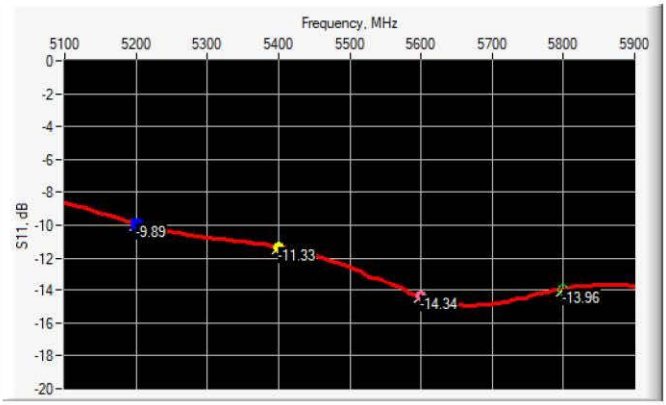


Figure 1: Validation Waveguide Dimensions

6.2 S11 PARAMETER

6.2.1 S11 parameter In Head Liquid



Frequency (MHz)	S11 parameter (dB)	Requirement (dB)	Impedance
5200	-9.89	-8	26.75 Ω - 8.37 jΩ
5400	-11.33	-8	58.18 Ω + 29.31 jΩ
5600	-14.34	-8	48.03 Ω - 19.07 jΩ
5800	-13.96	-8	37.90 Ω + 13.07 jΩ

6.3 SAR

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

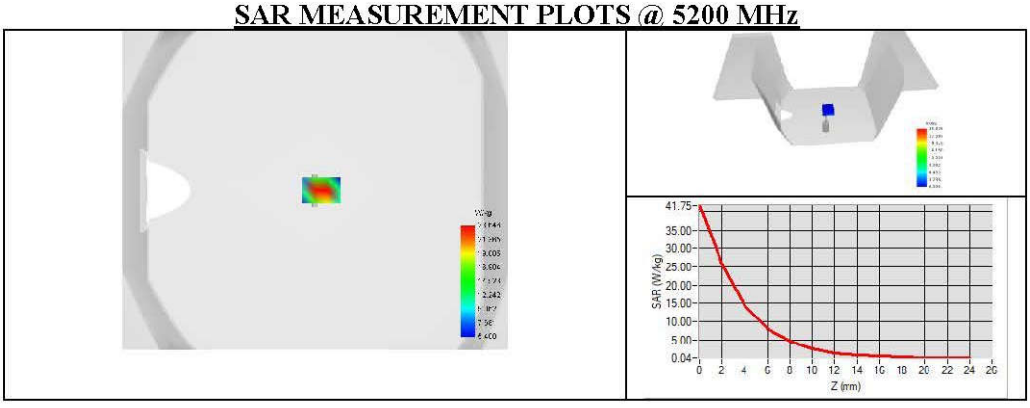
6.3.1 SAR With Head Liquid

At those frequencies, the target SAR value can not be generic. Hereunder is the target SAR value defined by MVG, 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.

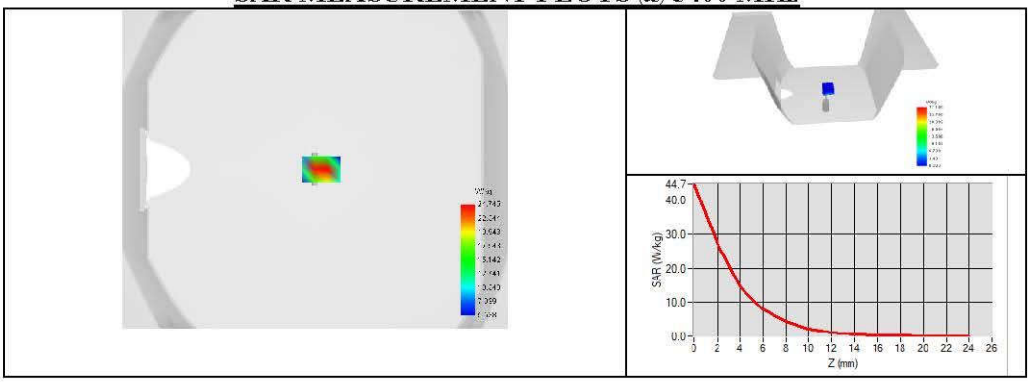
Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Head Liquid Values 5200 MHz: eps' :34.01 sigma : 4.86 Head Liquid Values 5400 MHz: eps' :33.40 sigma : 5.09 Head Liquid Values 5600 MHz: eps' :32.71 sigma : 5.32 Head Liquid Values 5800 MHz: eps' :32.12 sigma : 5.57
Distance between 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 %

Frequency (MHz)	1 g SAR (W/kg)			10 g SAR (W/kg)		
	Measured	Measured normalized to 1W	Target normalized to 1W	Measured	Measured normalized to 1W	Target normalized to 1W
5200	15.30	152.95	159.00	5.37	53.70	56.90
5400	15.99	159.94	166.40	5.57	55.71	58.43
5600	16.66	166.59	173.80	5.77	57.66	59.97
5800	17.47	174.67	181.20	6.00	59.99	61.50

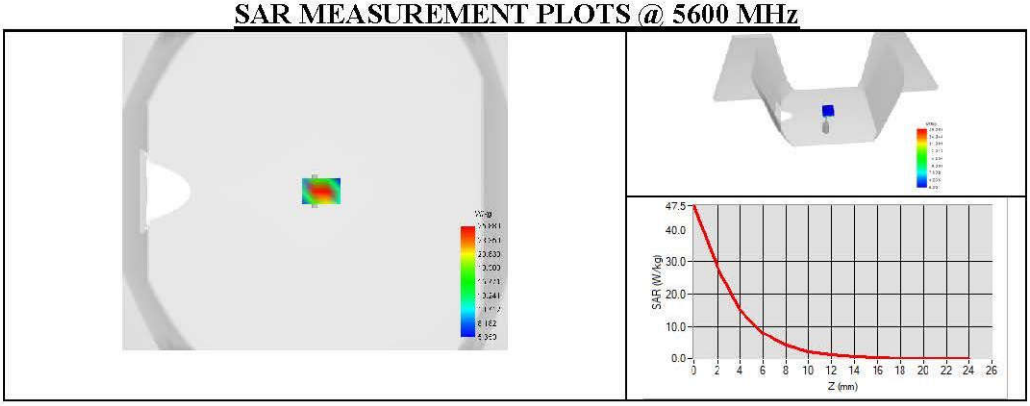
SAR MEASUREMENT PLOTS @ 5200 MHz



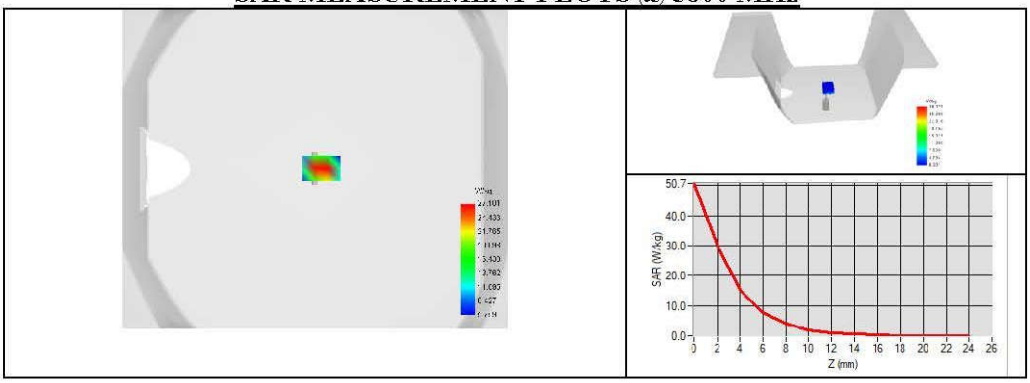
SAR MEASUREMENT PLOTS @ 5400 MHz



SAR MEASUREMENT PLOTS @ 5600 MHz



SAR MEASUREMENT PLOTS @ 5800 MHz



7 LIST OF EQUIPMENT

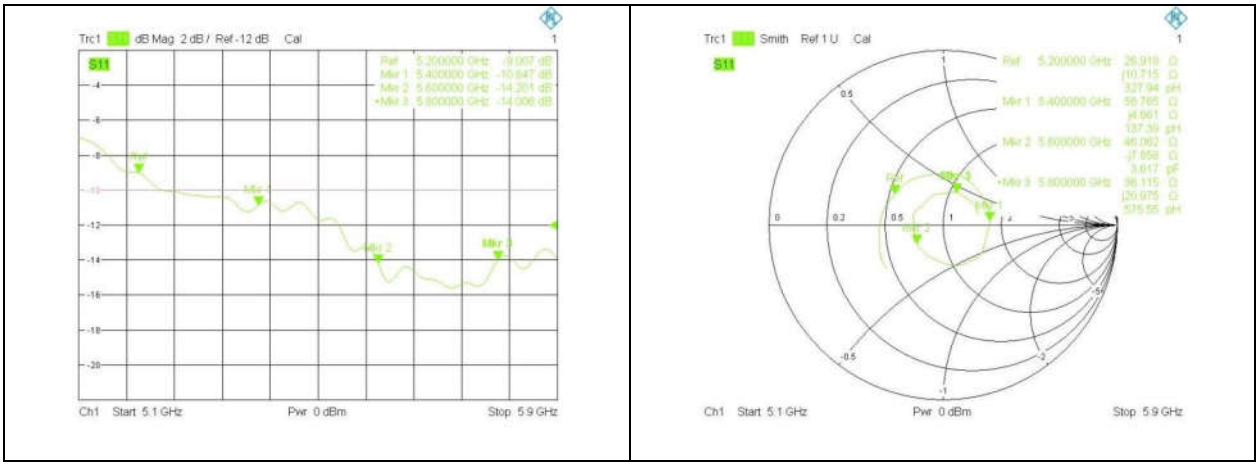
Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
SAM Phantom	MVG	SN 13/09 SAM68	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rohde & Schwarz ZVM	100203	08/2021	08/2024
Network Analyzer	Agilent 8753ES	MY40003210	10/2019	10/2023
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	07/2022	07/2025
Network Analyzer – Calibration kit	HP 85033D	3423A08186	06/2021	06/2027
Calipers	Mitutoyo	SN 0009732	11/2022	11/2025
Reference Probe	MVG	SN 41/18 EPGO333	09/2022	09/2023
Multimeter	Keithley 2000	4013982	02/2023	02/2026
Signal Generator	Rohde & Schwarz SMB	106589	03/2022	03/2025
Amplifier	MVG	MODU-023-C-0002	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	NI-USB 5680	170100013	06/2021	06/2024
Power Meter	Keysight U2000A	SN: MY62340002	10/2022	10/2025
Directional Coupler	Krytar 158020	131467	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44225320	06/2021	06/2024

Head 5-6GHz					
Date of Measurement	**Frequency (MHz)**	**Return Loss (dB)**	**Delta (%)**	**Impedance**	**Delta(ohm)**
2023.05.25	5800	-13.96	-	37.90	-
2024.05.14	5800	-14.01	-0.35	36.12	1.78

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 5-6GHz



—End of the Report—