SAR TEST REPORT

for

Mettler-Toledo (ChangZhou) Measurement Technology Ltd

Wireless Module

Model No.: MTxP240303ANT1

Brand: N/A

FCC ID: 2ALAI24MT106

IC ID: 25883-MT24103

The MAX SAR(1g)	
Body SAR	0.196W/Kg

Test distance: 0mm

Prepared for : Mettler-Toledo (ChangZhou) Measurement Technology Ltd
No. 111 Taihu West Road, Changzhou City, Jiangsu Province, China

Prepared By : Audix Technology (Shenzhen) Co., Ltd.
No. 6, Kefeng Road, Science & Technology Park,
Nanshan District, Shenzhen, Guangdong, China

Tel: (0755) 26639496
Fax: (0755) 26632877

Report Number : ACS-SF24004
Date of Test : Apr.22~25, 2024
Date of Report : Jul.17, 2024

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SAR TEST REPORT

Applicant	:	Mettler-Toledo (ChangZhou) Measurement Technology Ltd
Manufacturer	:	Mettler-Toledo (ChangZhou) Measurement Technology Ltd
Product	:	Wireless Module
Model No.	:	MTxP240303ANT1
Brand	:	N/A
Test Voltage	:	DC 3.3V

Measurement Standard Used:

· FCC 47 CFR Part 2 (2.1093)
· IEEE C95.1-1999
· IEC/IEEE 62209-1528: 2020
· IEC62209-1:2016
· IEC62209-2:2010
· FCC OET Bulletin 65 Supplement C (Edition 01-01)
· RSS-102 ISSUE 5: 2015+A1: 2021
· FCC KDB 447498 D01 v06
· FCC KDB 447498 D04 v01
· FCC KDB 865664 D01/D02
· FCC KDB 248227 D01 v02r02

The device described above is tested by Audix Technology (Shenzhen) Co., Ltd. to determine the maximum emission levels emanating from the device and the severe levels of the device can endure and its performance criterion. The test results are contained in this test report and Audix Technology (Shenzhen) Co., Ltd. is assumed full responsibility for the accuracy and completeness of test. This report contains data that are not covered by the NVLAP accreditation. Also, this report shows that the EUT is technically compliant with the FCC and RSS-102 test requirement.

This report applies to single evaluation of one sample of above mentioned product. And shall not be reproduced in part without written approval of Audix Technology (Shenzhen) Co., Ltd..

Date of Test : Apr.22~25, 2024 Report of date: Jul.17, 2024

Prepared by : Jasmine Ning
Jasmine Ning / Assistant

Reviewed by : Thomas Chen
Thomas Chen / Assistant Manager

AUDIX® 信華科技（深圳）有限公司
Audix Technology (Shenzhen) Co., Ltd.
EMC 部門報告專用章
Stamp only for EMC Dept. Report
Signature: Sunny Lu

Approved & Authorized Signer :
Sunny Lu / Manager

REPORT REVISION HISTORY

Edition No.	Revision	Issue Date	Report No.
Original	Initial issue of report	Jul.17, 2024	ACS-SF24004

1. GENERAL INFORMATION

1.1.Description of Equipment Under Test

Applicant	Mettler-Toledo (ChangZhou) Measurement Technology Ltd
Applicant Address	No. 111 Taihu West Road, Changzhou City, Jiangsu Province, China
Manufacturer	Mettler-Toledo (ChangZhou) Measurement Technology Ltd
Manufacturer Address	No. 111 Taihu West Road, Changzhou City, Jiangsu Province, China
Product	Wireless Module
Model No.	MTxP240303ANT1
Brand	N/A
FCC ID	2ALAI24MT106
IC ID	25883-MT24103
HVIN	MTxP240303ANT1
Sample Type	Prototype production
Date of Receipt	Apr.20, 2024
Date of Test	Apr.22~25, 2024

1.2.Feature of Equipment Under Test

Product Feature & Specification		
Product	Wireless Module	
Model No.	MTxP240303ANT1	
Power Source	☐ Commercial Power	AC V, Hz A
	☒ External Power Source	DC 3.3V
	☐ Li-ion Battery	DC V, mAh
	☐ UM battery	DC V
2.4GHz Wi-Fi		
Support Modes	802.11b/g/n20	
Frequency Range	2412-2462MHz	
Type of Modulation	802.11b(DSSS): CCK, QPSK, BPSK; 802.11g/n(OFDM): 64QAM,16QAM, QPSK, BPSK	
Data Rate	802.11b: 1/2/5.5/11 Mbps; 802.11g: 6/9/12/18/24/36/48/54 Mbps; 802.11n: up to 86.0Mbps	
Channel Separation	5MHz	
5GHz Wi-Fi		
Support Modes	802.11a/n20/n40	
Frequency Range	5180-5240MHz, 5260-5320MHz, 5500-5700 MHz, 5745-5825MHz	
Type of Modulation	802.11a/n (OFDM): QPSK, BPSK, 16QAM, 64QAM	
Data Rate	802.11a: 6/9/12/18/24/36/48/54 Mbps; 802.11n: up to 300Mbps;	
Channel Separation	5MHz	
Antenna System		

No.	Model	Antenna Type	Range (MHz)	Peak Gain(dBi)
1.	AC-Q24-50ZDB	Dipole	2400-2483.5	2.7
			5150-5250	-1.3
			5250-5350	-1.1
			5500-5700	1.3
			5700-5825	0.8
2.	AC-Q58-50ZDB	Dipole	2400-2483.5	1.3
			5150-5250	4.8
			5250-5350	5.0
			5500-5700	5.4
			5700-5825	5.1

Note: The WIFI 2.4G and WIFI 5G can not tramsmit simulately.

2. GENERAL DESCRIPTION

2.1.Product Description For EUT

[None]

2.2.Applied Standards

The Specific Absorption Rate (SAR) testing specification, method and procedure for this device is in accordance with the following standards:

- FCC 47 CFR Part 2 (2.1093)
- IEEE C95.1-1999
- IEC/IEEE 62209-1528: 2020
- IEC62209-1:2016
- IEC62209-2:2010
- FCC OET Bulletin 65 Supplement C (Edition 01-01)
- RSS-102 ISSUE 5: 2015+A1: 2021
- FCC KDB 447498 D04 v01
- FCC KDB 865664 D01/D02
- FCC KDB 248227 D01 v02r02

2.3.Device Category and SAR Limits

This device belongs to portable device category because its radiating structure is allowed to be used within 20 centimeters of the body of the user. Limit for General Population/Uncontrolled exposure should be applied for this device, it is 1.6 W/kg as averaged over any 1 gram of tissue.

2.4.Test Conditions

2.4.1. Ambient Condition

Ambient Temperature	20 to 24 ℃
Humidity	< 60 %

2.4.2. Test Configuration

The distance between the EUT and the antenna of the emulator is larger than 50 cm and the output power radiated from the emulator antenna is at least 30dB smaller than the output power of EUT. The EUT was set from the emulator to radiate maximum output power during all tests.

2.5.Exposure Positions Consideration

Sides for SAR tests						
Band	Body					
	Back	Front	Top	Bottom	Left	Right
WiFi 2.4GHz	√	√	√	×	√	√
WiFi 5GHz	√	√	√	×	√	√

Note: The bottom of the EUT is connected with a wire, so the bottom test cannot be carried out.

2.6.Standalone SAR Test Exclusion Considerations

Standalone 1-g head or body SAR evaluation by measurement or numerical simulation is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied. The 1-g SAR test exclusion threshold 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

According to the KDB447498 appendix A, the SAR test exclusion threshold for 2450MHz at 5mm test separation distances is 3mW, 5.8GHz is 1mW

Table B.2—Example Power Thresholds (mW)

	Distance (mm)										
		5	10	15	20	25	30	35	40	45	50
Frequency (MHz)	300	39	65	88	110	129	148	166	184	201	217
	450	22	44	67	89	112	135	158	180	203	226
	835	9	25	44	66	90	116	145	175	207	240
	1900	3	12	26	44	66	92	122	157	195	236
	2450	3	10	22	38	59	83	111	143	179	219
	3600	2	8	18	32	49	71	96	125	158	195
	5800	1	6	14	25	40	58	80	106	136	169

2.7.Block Diagram of connection between EUT and simulators

EUT

(EUT: Wireless Module)

2.8.Test Equipments

Item	Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date	Calibration Body	Cal Method (Note)
1.	DASY5 SAR Test System	Speag	TX60 L speag	F09/5B1H1/01	NCR	NCR	NCR	N/A
2.	Power meter	Anritsu	ML2487A	6K00003262	2023.06.26	2024.06.25	CCIC	c)
3.	Power sensor	Anritsu	MA2491A	0332516	2023.06.26	2024.06.25	CCIC	c)
4.	Dipole Validation Kits	Speag	D2450V2	862	2023.05.18	2026.05.17	SPEAG	c)
5.	Dipole Validation Kits	Speag	D5GHzV2	1102	2023.05.19	2026.05.18	SPEAG	c)
6.	Attenuator	N/A	1527	001	2023.09.15	2024.09.14	CCIC	d)
7.	ENA SERIES NETWORK ANALYZER	Agilent	E5071C	MY46316760	2023.09.15	2024.09.14	CCIC	c)
8.	Date Acquisition Electronics	Speag	DAE4	899	2023.05.17	2024.05.16	CCTL	c)
9.	E-Field Probe	Speag	EX3DV4	3767	2023.06.12	2024.06.11	CCTL	c)
10.	Signal Generator	Rohde & Schwarz	SMB100A	181375	2024.03.16	2025.03.15	CCIC	c)
11.	Attenuator	N/A	1527	002	2023.09.15	2024.09.14	CCIC	c)
12.	Test Software	Schmid&Partner Englinnering AG	DASY5	52.8.7.1137	NCR	NCR	NCR	N/A
Note: NCR means no calibration required(calibrated with system).								

Note1: Calibration Method

a): Calibration conducted by the National Institute of Information and Communications Technology～ NICT～ or a designated calibration agency under Article 102-18 paragraph (1)～ TELEC Engeneering Center, Intertek Japan K.K., Keysight Technologies, Inc～.

b): Correction conducted pursuant to the provisions of Article 135 or Article 144 of the Measurement Law (Law No. 51 of 1992)～Japan Calibration Service Syste～

c): Calibration conducted in foreign countries, which shall be equivalent to the calibration conducted by the NICT or a designated calibration agency under Article 102-18 paragraph (1)～ TELEC Engeneering Center, Intertek Japan K.K., Keysight Technologies, Inc～.

d): Calibration conducted by using other equipment that listed above from a) to c)

Note2: CCIC (Shenzhen) Metrology & Testing Service Co.,Ltd

Addr : ShengHui Hongxing Chuangzhi Square, Tongren Road, TianliaoCommunity, Yutang Street, Guangming District, Shenzhen

2.9.Laboratory Environment

Temperature	Min:20℃,Max.25℃
Relative humidity	Min. = 45%, Max. = 70%
Note: Ambient noise is checked and found very low and in compliance with requirement of standards.	

2.10.Measurement Uncertainty

Test Item	Uncertainty
Uncertainty for SAR test	1g: ±21.2
	10g: ±20.7
Uncertainty for test site temperature and humidity	±0.6℃

Source	Type	Uncertainly Value (%)	Probability Distribution	K	C1(1g)	C1(10g)	Standard uncertaint y uI(%)1g	Standard uncertaint y uI(%)10g	Degree of freedom Veff or Vi
Measurement system repetivity	A	0.5	N	1		1	0.5	0.5	9
Probe calibration	B	5.9	N	1	1	1	5.9	5.9	∞
Isotropy	B	4.7	R	√3	1	1	2.7	2.7	∞
Linearity	B	4.7	R	√3	1	1	2.7	2.7	∞
Probe modulation response	B	0	R	√3	1	1	0	0	∞
Detection limits	B	1.0	R	√3	1	1	0.6	0.6	∞
Boundary effect	B	1.9	R	√3	1	1	1.1	1.1	∞
Readout electronics	B	1.0	N	1	1	1	1.0	1.0	∞
Response time	B	0	R	√3	1	1	0	0	∞
Integration time	B	4.32	R	√3	1	1	2.5	2.5	∞
RF ambient conditions – noise	B	0	R	√3	1	1	0	0	∞
RF ambient conditions – reflections	B	3	R	√3	1	1	1.73	1.73	∞
Probe positioner mech. restrictions	B	0.4	R	√3	1	1	0.2	0.2	∞
Probe positioning with respect to phantom shell	B	2.9	R	√3	1	1	1.7	1.7	∞
Post-processing	B	0	R	√3	1	1	0	0	∞
Test sample related									
Device holder uncertainty	A	2.94	N	1	1	1	2.94	2.94	M-1
Test sample positioning	A	4.1	N	1	1	1	4.1	4.1	M-1
Power scaling	B	5.0	R	√3	1	1	2.9	2.9	∞
Drift of output power (measured SAR drift)	B	5.0	R	√3	1	1	2.9	2.9	∞
Phantom and set-up									
Phantom uncertainty (shape and thickness tolerances)	B	4.0	R	√3	1	1	2.3	2.1	∞
Algorithm for correcting SAR for deviations in permittivity and conductivity	B	1.9	N	1	1	0,84	1,9	1,6	∞
Liquid conductivity (meas.)	A	0.55	N	1	0.78	0.71	0.24	0.21	M-1
Liquid permittivity (meas.)	A	0.19	N	1	0.23	0.26	0.09	0.06	M
Liquid permittivity – temperature uncertainty	A	5.0	R	√3	0,78	0,71	1.4	1.1	∞
Liquid conductivity – temperature uncertainty	A	5.0	R	√3	0.23	0,26	1.2	0.8	∞
Combined standard uncertainty	$u_c' = \sqrt{\sum_{i=1}^{23} c_i^2 u_i^2}$						10.57	10.32	
Expanded uncertainty (95 % conf. interval)	$u_e = 2u_c$		N	K=2			21.14	20.64	

3. MEASURE PROCEDURES

3.1.General description of test procedures

For the 802.11b/g SAR body tests, a communication link is set up with the test mode software for WIFI mode test. During the test, at the each test frequency channel, the EUT is operated at the RF continuous emission mode. Each channel should be tested at the lowest data rate. Testing at higher data rates is not required when the maximum average output power is less than 0.25dB higher than those measured at the lowest data rate.SAR is not required for 802.11g channels when the maximum average output power is less than 0.25dB higher than that measured on the corresponding 802.11b channels. The same test procedure for 802.11a/n/ac mode

4. SAR MEASUREMENTS SYSTEM

4.1.SAR Measurement Set-up

DASY5 system for performing compliance tests consists of the following items:

(1) A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
(2) A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage It issue simulating liquid. The probe is equipped with an optical surface detector system.
(3) A data acquisition electronic (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
(4) A unit to operate the optical surface detector which is connected to the EOC.
(5) The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.
(6) The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows 2003.
(7) DASY5 software and SEMCAD data evaluation software.
(8) Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
(9) The generic twin phantom enabling the testing of left-hand and right-hand usage.
(10) The device holder for handheld mobile phones.
(11) Tissue simulating liquid mixed according to the given recipes.
(12) System validation dipoles allowing to validate the proper functioning of the system.

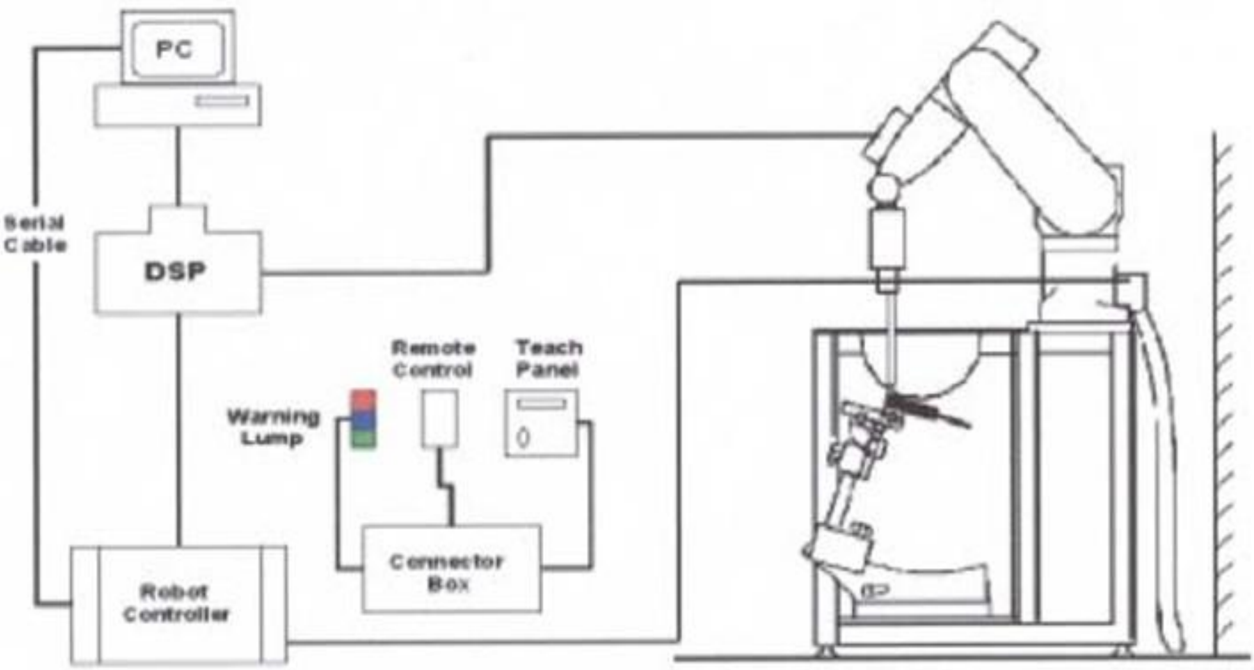


Figure 4.1 SAR Lab Test Measurement Set-up

4.2.ELI Phantom

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid.
Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points.
The phantom is compatible with all SPEAG dosimetric probes and dipoles.

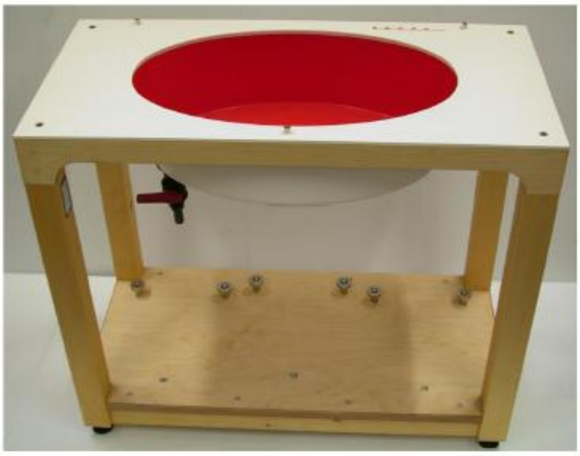


Figure 4.2 Top View of Twin Phantom

Material	Vinylester, glass fiber reinforced (VE-GF)
Liquid Compatibility	Compatible with all SPEAG tissue simulating liquids (incl. DGBE type)
Shell Thickness	2.0 ± 0.2 mm (bottom plate)
Dimensions	Major axis: 600 mm Minor axis: 400 mm
Filling Volume	approx. 30 liters
Wooden Support	SPEAG standard phantom table

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

*Water-sugar based liquid
*Glycol based liquids

4.3.Device Holder for SAM Twin Phantom

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

The DASY5 device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (EPR).

Thus the device needs no repositioning when changing the angles.

The DASY5 device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity ε_r=3 and loss tangent δ = 0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

Figure 4.3 Device Holder

4.4.DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

Figure 4.4 EX3DV4 E-field Probe

4.4.1. EX3DV4 Probe Specification

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available
Frequency	10 MHz to > 6 GHz Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	10 µW/g to > 100 mW/g Linearity: ± 0.2dB (noise: typically < 1 µW/g)
Dimensions	Overall length: PRS-T2 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.

4.5.E-field Probe Calibration

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than ±10%. The spherical isotropy was evaluated and found to be better than ± 0.25dB. The sensitivity parameters (Norm X, Norm Y, Norm Z), the diode compression parameter (DCP) and the conversion factor (Conv F) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a wave guide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

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

Where: Δt = Exposure time (30 seconds),
C = Heat capacity of tissue (brain or muscle),
ΔT = Temperature increase due to RF exposure.
Or

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

Where:
σ = Simulated tissue conductivity,
ρ = Tissue density (kg/m3).

4.6.Scanning procedure

The DASY5 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

The ”reference“ and ”drift“ measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the EUT’s output power and should vary max. ± 5 %.

The ”surface check“ measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ± 0.1mm). To prevent wrong results tests are only executed when the liquid is free of air bubbles.

The difference between the optical surface detection and the actual surface depends on the Probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within ± 30°.)

Area Scan
The Area Scan is used as a fast scan in two dimensions to find the area of high field values before running a detailed measurement around the hot spot. Before starting the area scan a grid spacing of 15 mm x 15 mm is set. During the scan the distance of the probe to the phantom remains unchanged.

After finishing area scan, the field maxima within a range of 2 dB will be ascertained.
Zoom Scan
Zoom Scans are used to estimate the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default Zoom Scan is done by 7x7x7 points within a cube whose base is centered around the maxima found in the preceding area scan.

Spatial Peak Detection
The procedure for spatial peak SAR evaluation has been implemented and can determine values of masses of 1g and 10g, as well as for user-specific masses. The DASY5 system allows evaluations that combine measured data and robot positions, such as:
· maximum search
· extrapolation
· boundary correction
· peak search for averaged SAR

During a maximum search, global and local maxima searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard’s method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation. Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Zoom Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Sheppard's method for extrapolation. For a grid using 7x7x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1g and 10g cubes.

A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube 7x7x7 scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 5mm steps.

5. DATA STORAGE AND EVALUATION

5.1.Data Storage

The DASY5 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension ".DA4". The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

5.2.Data Evaluation by SEMCAD

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

Probe parameters: - Sensitivity Normi, ai0, ai1, ai2
- Conversion factor ConvFi
- Diode compression point Dcpi

Device parameters: - Frequency
- Crest factor cf

Media parameters: - Conductivity
- Density

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY5 components. In the direct measuring mode of the millimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used. The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics.
If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot cf / dcp_i$$

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

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

cf = crest factor of exciting field (DASY parameter)

dcp_i = diode compression point (DASY parameter)

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

E-field probes: Ei = (Vi / Normi · ConvF)1/2

H-field probes: Hi = (Vi)1/2 · (ai0 + ai1 f + ai2f2) / f

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

Normi = sensor sensitivity of channel i (i = x, y, z)

ConvF = sensitivity enhancement in solution

aij = sensor sensitivity factors for H-field probes

f = carrier frequency [GHz]

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

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

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

Etot = (Ex2+ EY2+ Ez2)1/2

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

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

with

SAR = local specific absorption rate in mW/g

Etot = total field strength in V/m

= conductivity in [mho/m] or [Siemens/m]

= equivalent tissue density in g/cm3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid. The power flow density is calculated assuming the excitation field to be a free space field.

Ppwe = Etot2 / 3770 or Ppwe = Htot2 · 37.7

with Ppwe = equivalent power density of a plane wave in mW/cm2

Etot = total electric field strength in V/m

Htot = total magnetic field strength in A/m

6. SYSTEM CHECK

The manufacturer calibrates the probes annually. Dielectric parameters of the tissue simulates were measured every day using the dielectric probe kit and the network analyzer. A system check measurement was made following the determination of the dielectric parameters of the simulates, using the dipole validation kit. A power level of 250 mW was supplied to the dipole antenna, which was placed under the flat section of the twin SAM phantom. The system check results (dielectric parameters and SAR values) are given in the ANNEX A.

System check results have to be equal or near the values determined during dipole calibration with the relevant liquids and test system (±10 %).

System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.

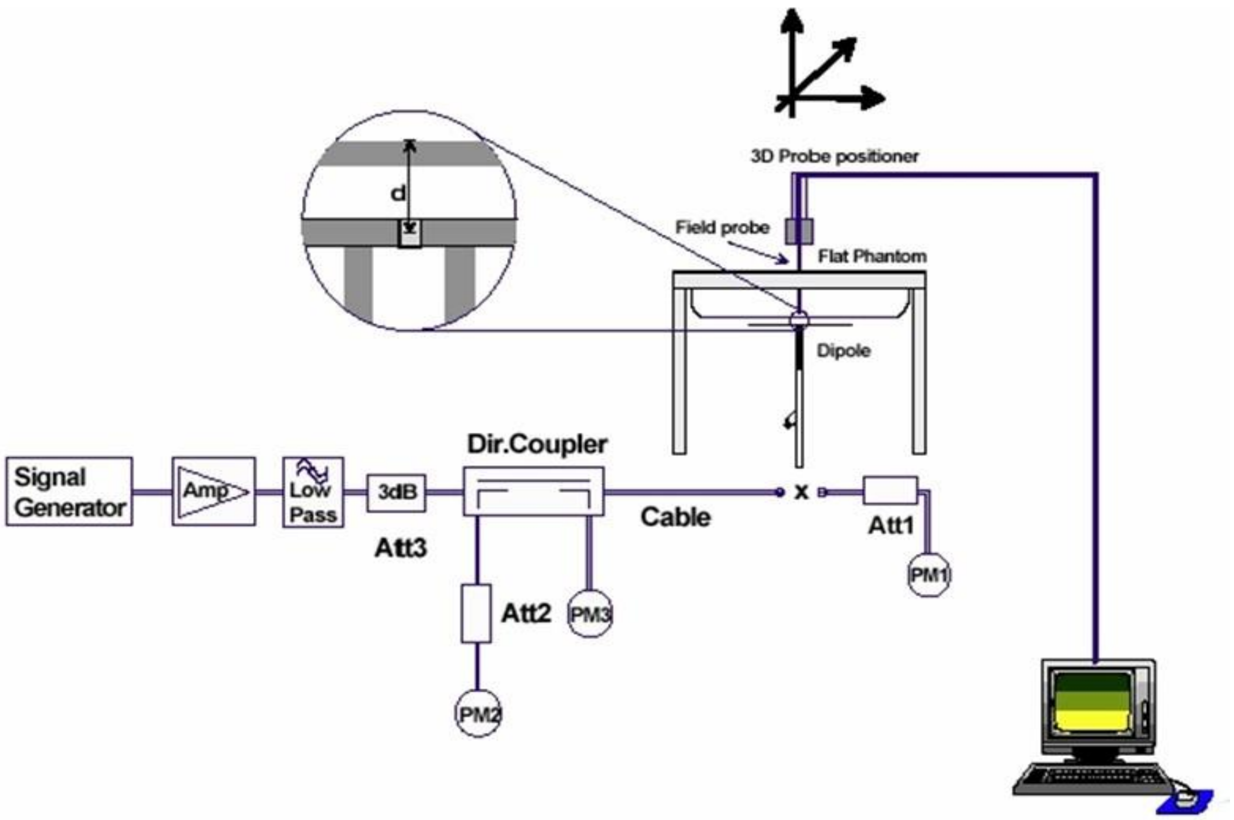


Figure 6.1: System Check Set-up

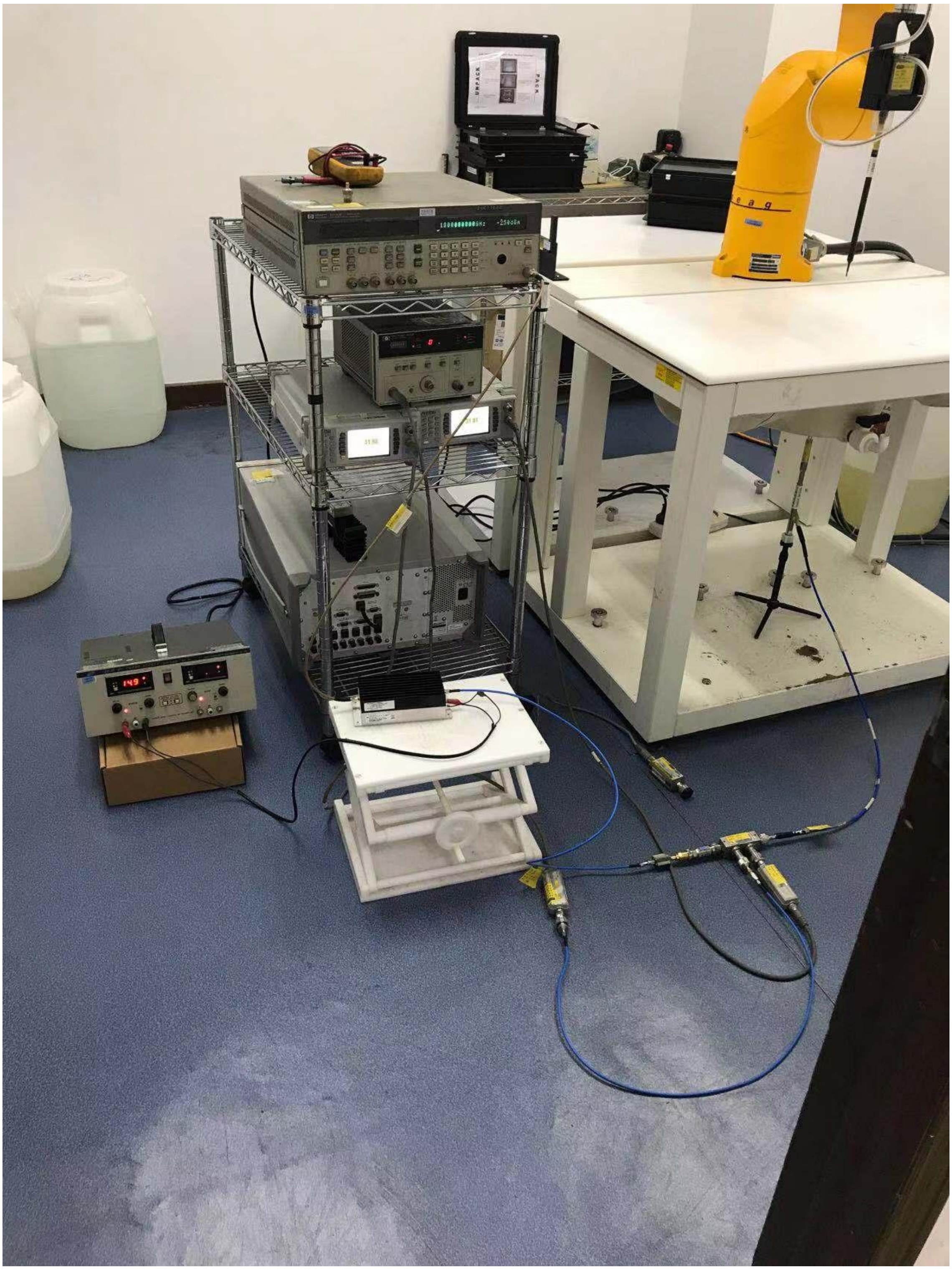


Figure 6.3: photos of system

7. TEST RESULTS

7.1.Output power

(WIFI 2.4GHz)

Mode	Channel	Frequency (MHz)	**Maximum conducted (average) Output Power (dBm)**	Limit
802.11b	1	2412	**11.94**	30 dBm
	6	2437	**11.84**	30 dBm
	11	2462	**11.88**	30 dBm
802.11g	1	2412	**11.66**	30 dBm
	6	2437	**11.6**	30 dBm
	11	2462	**11.65**	30 dBm
802.11n20	1	2412	**11.65**	30 dBm
	6	2437	**11.66**	30 dBm
	11	2462	**11.67**	30 dBm

(WIFI 5GHz)
FCC

Modulation	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)	Maximum Conducted Output Power (dBm)	Limit (dBm)
802.11a	36	5180	**7.87**	**7.94**	24
	40	5200	**7.84**	**7.91**	24
	48	5240	**7.69**	**7.76**	24
	52	5260	**6.3**	**6.37**	24
	60	5300	**7.07**	**7.14**	24
	64	5320	**7.15**	**7.22**	24
	100	5500	**6.6**	**6.67**	24
	120	5600	**6.87**	**6.94**	24
	140	5700	**6.83**	**6.9**	24
	149	5745	**7.75**	**7.82**	30
	157	5785	**7.38**	**7.45**	30
	165	5825	**6.66**	**6.73**	30

Modulation	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)	Maximum Conducted Output Power (dBm)	Limit (dBm)
802.11n20	36	5180	**7.65**	**7.82**	24
	40	5200	**7.7**	**7.87**	24
	48	5240	**7.37**	**7.54**	24
	52	5260	**5.94**	**6.11**	24
	60	5300	**6.8**	**6.97**	24
	64	5320	**6.89**	**7.06**	24
	100	5500	**6.51**	**6.68**	24
	120	5600	**6.6**	**6.77**	24
	140	5700	**6.37**	**6.54**	24
	149	5745	**7.5**	**7.67**	30
	157	5785	**7.09**	**7.26**	30
	165	5825	**6.4**	**6.57**	30

Modulation	Channel	Frequency (MHz)	**Average Conducted Output Power (dBm)**	**Maximum Conducted Output Power (dBm)**	Limit (dBm)
802.11n40	38	5190	**7.13**	**7.46**	24
	46	5230	**7.18**	**7.51**	24
	54	5270	**5.17**	**5.5**	24
	62	5310	**5.85**	**6.18**	24
	102	5510	**6.08**	**6.41**	24
	118	5590	**6.11**	**6.44**	24
	134	5670	**6.38**	**6.71**	24
	151	5755	**7.33**	**7.66**	30
	159	5795	**6.93**	**7.26**	30

IC

Modulation	Channel	Frequency (MHz)	**Average Conducted Output Power (dBm)**	**Maximum Conducted Output Power (dBm)**	Limit (dBm)
11a	52	5260	**6.3**	**6.37**	23.4
	60	5300	**7.07**	**7.14**	23.4
	64	5320	**7.15**	**7.22**	23.4
	100	5500	**6.6**	**6.67**	23.4
	116	5580	**6.72**	**6.79**	23.4
	140	5700	**6.83**	**6.9**	23.4
	149	5745	**7.75**	**7.82**	30
	157	5785	**7.38**	**7.45**	30
	165	5825	**6.66**	**6.73**	30

Modulation	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)	Maximum Conducted Output Power (dBm)	Limit (dBm)
802.11n-HT20	52	5260	**5.94**	**6.11**	23.6
	60	5300	**6.8**	**6.97**	23.6
	64	5320	**6.89**	**7.06**	23.6
	100	5500	**6.51**	**6.68**	23.6
	116	5580	**6.53**	**6.7**	23.6
	140	5700	**6.37**	**6.54**	23.6
	149	5745	**7.5**	**7.67**	30
	157	5785	**7.09**	**7.26**	30
	165	5825	**6.4**	**6.57**	30

Modulation	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)	Maximum Conducted Output Power (dBm)	Limit (dBm)
802.11n-HT40	54	5270	**5.17**	**5.5**	24
	62	5310	**5.85**	**6.18**	24
	102	5510	**6.08**	**6.41**	24
	110	5550	**6.12**	**6.45**	24
	134	5670	**6.38**	**6.71**	24
	151	5755	**7.33**	**7.66**	30
	159	5795	**6.93**	**7.26**	30

7.2.System Check & Tissue simulating liquid

Frequency	Description	SAR		Dielectric Parameters (±10% for window)		Temp
		1g	10g	εr	σ(s/m)	℃
2450MHz	Recommended value	13.5 10.962-16.038	6.29 5.11377-7.46623	39.2 35.28-43.12	1.80 1.62-1.98	/
	Measurement value 2024-04-22	12.29	5.63	39.440	1.818	22.05
5250MHz	Recommended value	7.88 5.95728-9.80272	2.23 1.69034-2.76966	35.9 32.31-39.49	4.71 4.239-5.181	/
	Measurement value 2024-04-25	8.14	2.38	35.49	4.52	22.03
5600MHz	Recommended value	8.20 6.1992 – 10.2008	2.32 1.75856 – 2.88144	35.5 31.95- 39.05	5.07 4.563 - 5.577	/
	Measurement value 2024-04-23	7.42	2.14	35.134	4.851	
5750MHz	Recommended value	7.75 5.859-9.641	2.17 1.64486-2.69514	35.4 31.86-38.94	5.22 4.698-5.742	/
	Measurement value 2024-04-24	7.4	2.17	35.211	5.29	22.02

Test Laboratory: Audix SAR Lab Date: 22/04/2024

CW 2450

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:862

Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Communication System PAR: 0 dB

Medium parameters used: f = 2450 MHz; $\sigma = 1.818$ S/m; $\varepsilon_r = 39.440$; $\rho = 1000$ kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

- Probe: ES3DV3 - SN3166; ConvF(4.73, 4.73, 4.73); Calibrated: 27/06/2022;
- Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn899; Calibrated: 17/05/2023
- Phantom: SAM1; Type: SAM; Serial: TP-1543
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/CW 2450MHz/Area Scan (61x71x1): Interpolated grid: dx=2.000 mm, dy=2.000 mm

Maximum value of SAR (interpolated) = 13.845 W/kg

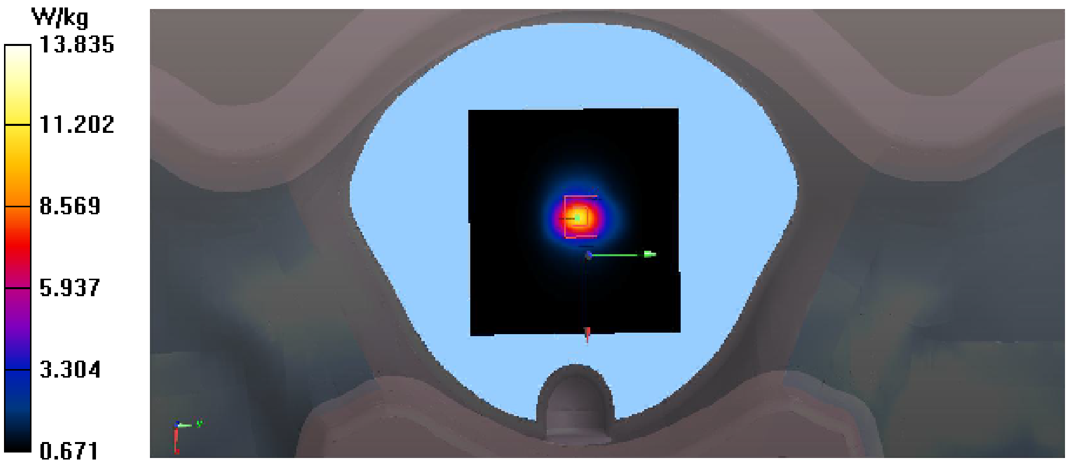
Configuration/CW 2450MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 89.31 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 27.22 W/kg

SAR(1 g) = 12.29 W/kg; SAR(10 g) = 5.63 W/kg

Maximum value of SAR (measured) = 13.835 W/kg



Test Laboratory: Audix SAR Lab Date: 25/04/2024

CW 5250

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1102

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5250 MHz;Communication System PAR: 0 dB

Medium parameters used: f = 5250 MHz; $\sigma = 4.52$ S/m; $\varepsilon_r = 35.49$; $\rho = 1000$ kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3767; ConvF(5.55, 5.55, 5.55); Calibrated: 12/06/2023;
- Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn899; Calibrated: 17/05/2023
- Phantom: SAM1; Type: SAM; Serial: TP-1543
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/CW 5250MHz/Area Scan (61x71x1): Interpolated grid: dx=2.000 mm, dy=2.000 mm

Maximum value of SAR (interpolated) = 5.58 W/kg

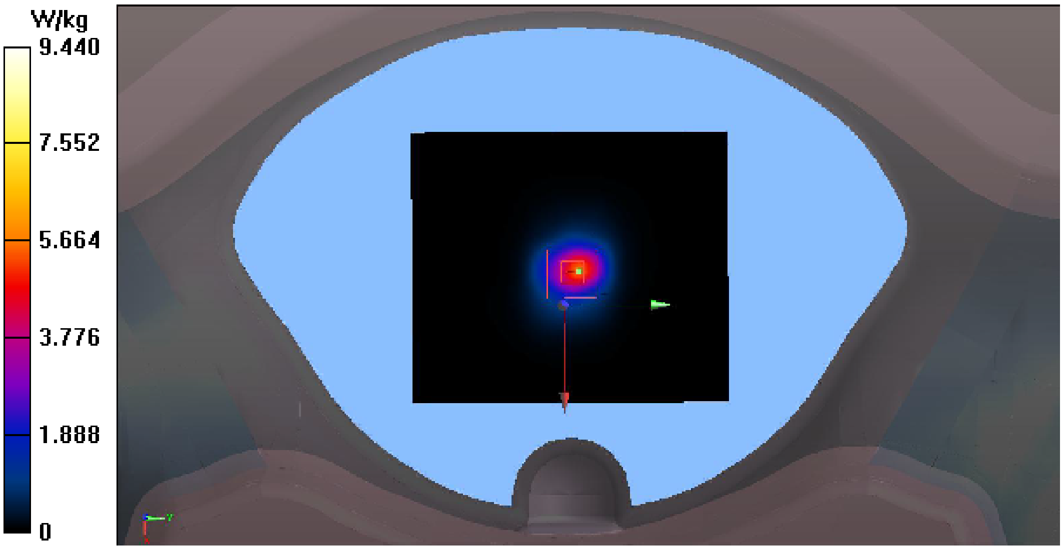
Configuration/CW 5250MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 46.05 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 28.7 W/kg

SAR(1 g) = 8.14 W/kg; SAR(10 g) = 2.38 W/kg

Maximum value of SAR (measured) = 9.44 W/kg



Test Laboratory: Audix SAR Lab Date: 23/04/2024

CW 5600

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1102

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5600 MHz;Communication System PAR: 0 dB

Medium parameters used: f = 5600 MHz; $\sigma = 4.851$ S/m; $\varepsilon_r = 35.134$; $\rho = 1000$ kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3767; ConvF(4.97, 4.97, 4.97); Calibrated: 12/06/2023;
- Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn899; Calibrated: 17/05/2023
- Phantom: SAM1; Type: SAM; Serial: TP-1543
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/CW 5600MHz/Area Scan (61x71x1): Interpolated grid: dx=2.000 mm, dy=2.000 mm

Maximum value of SAR (interpolated) = 5.41 W/kg

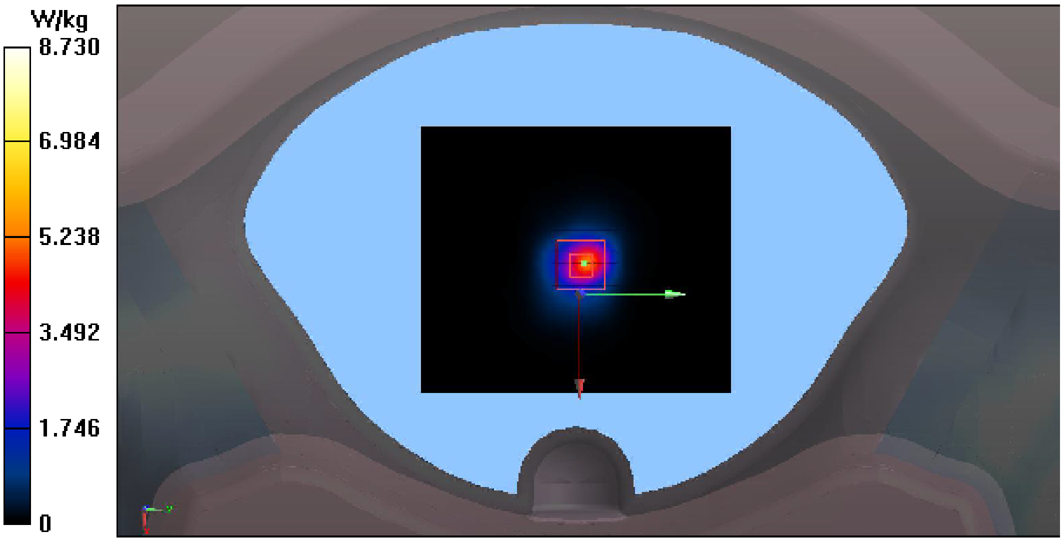
Configuration/CW 5600MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 39.96 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 27.2 W/kg

SAR(1 g) = 7.42 W/kg; SAR(10 g) = 2.14 W/kg

Maximum value of SAR (measured) = 8.73 W/kg



Test Laboratory: Audix SAR Lab Date: 24/04/2024

CW 5750

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1102

Communication System: UID 0, CW (0); Communication System Band: D5GHz (5000.0 - 6000.0 MHz); Frequency: 5750 MHz;Communication System PAR: 0 dB

Medium parameters used: f = 5750 MHz; $\sigma = 5.29$ S/m; $\varepsilon_r = 35.211$; $\rho = 1000$ kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3767; ConvF(4.92, 4.92, 4.92); Calibrated: 12/06/2023;
- Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn899; Calibrated: 17/05/2023
- Phantom: SAM1; Type: SAM; Serial: TP-1543
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/CW 5750MHz/Area Scan (61x71x1): Interpolated grid: dx=2.000 mm, dy=2.000 mm

Maximum value of SAR (interpolated) = 5.24 W/kg

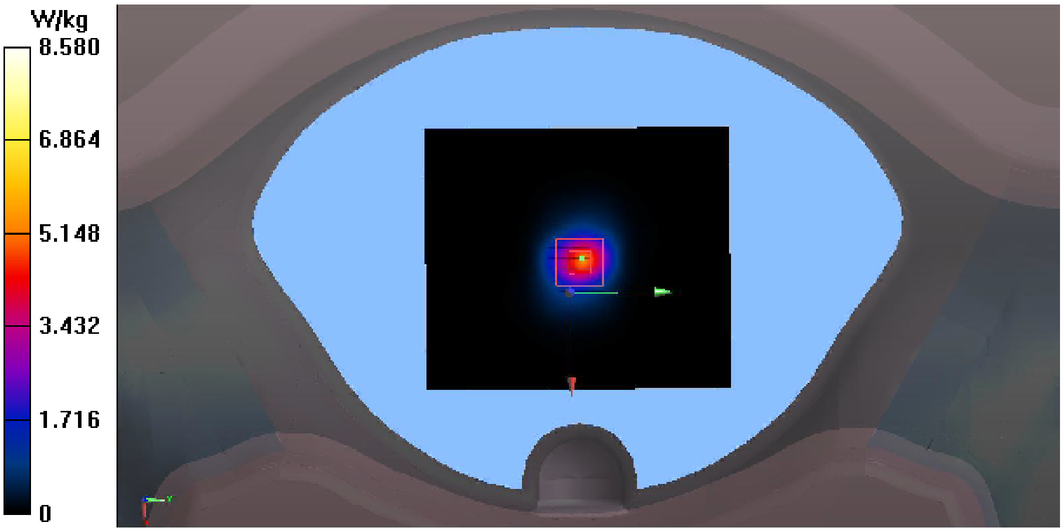
Configuration/CW 5750MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 40.21 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 27.0 W/kg

SAR(1 g) = 7.4 W/kg; SAR(10 g) = 2.17 W/kg

Maximum value of SAR (measured) = 8.58 W/kg



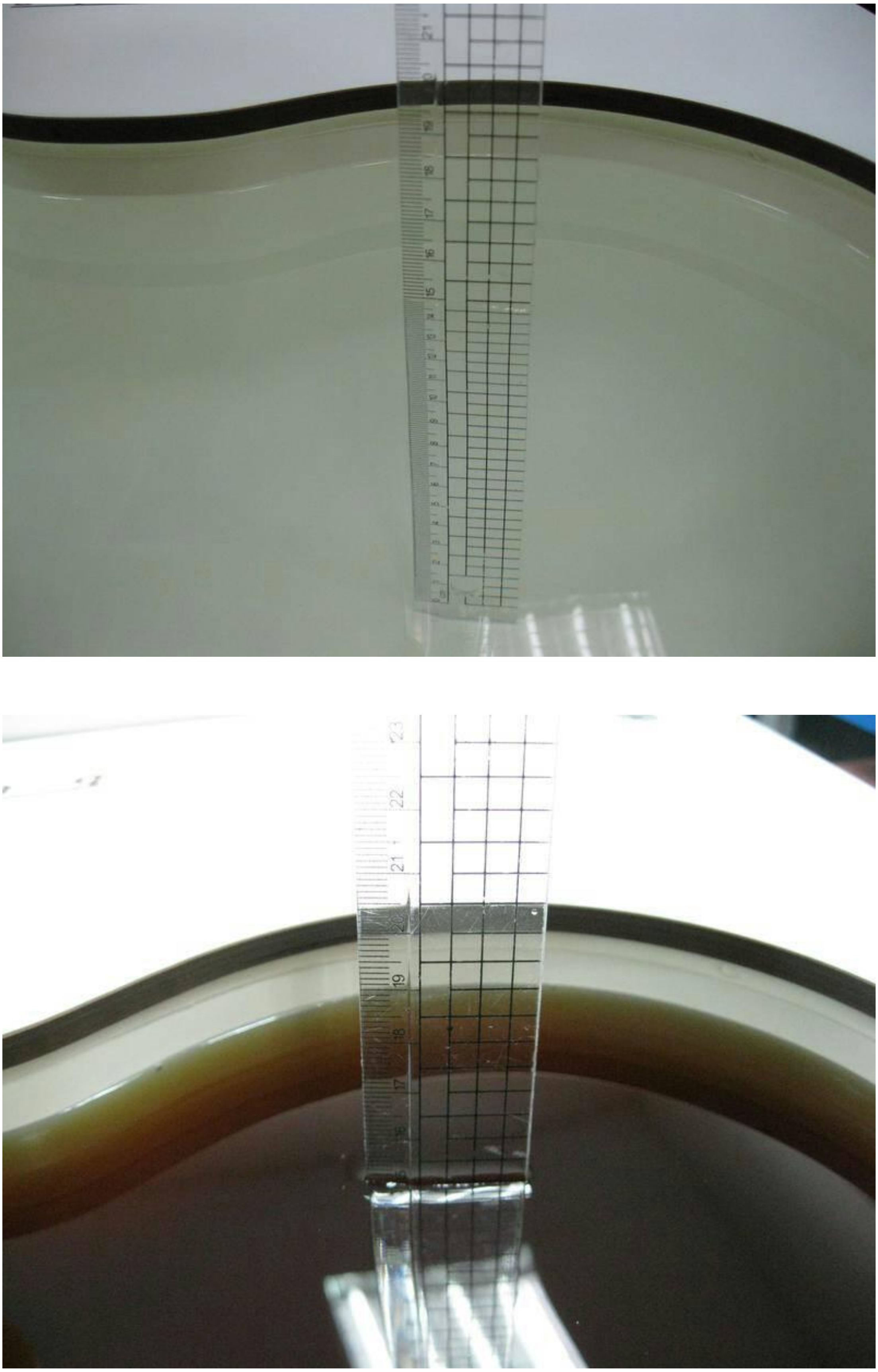


Figure 4.4: Liquid depth in the Flat Phantom

7.3.Test Results

Test Mode: WIFI 2.4GHz

SAR Test Record For WIFI 2.4G

Test Position	Test CH	Duty Cycle	Measure SAR 1g(W/kg)	Measure SAR 10g(W/kg)	Conducted Power(dBm)	Tune up Power(dBm)	Factor	Scaled Final SAR 1g	Scaled Final SAR 10g	power drift
Top	1	0.9827	0.058	0.027	11.94	12	1.013911386	0.060	0.028	0.03
Top	6	0.9827	0.058	0.028	11.84	12	1.037528416	0.061	0.030	-0.06
Top	11	0.9827	0.058	0.028	11.88	12	1.028016298	0.061	0.029	0.02
right	1	0.9827	0.00133	0.000655	11.94	12	1.013911386	0.001	0.001	0.03
left	1	0.9827	0.00111	0.000571	11.94	12	1.013911386	0.001	0.001	0.11
front	1	0.9827	0.000911	0.000566	11.94	12	1.013911386	0.001	0.001	0.12
back	1	0.9827	0.000855	0.000113	11.94	12	1.013911386	0.001	0.000	0.01
Conclusion: PASS										
Note: Factor= Tune up AV Power(W)/Measured Power(W) Scaled SAR-1= Measured SAR*Factor Scaled-Final= Scaled SAR-1*(1/Duty Cycle)										

Test Mode: WIFI 5GHz-Band 1

SAR Test Record For WIFI 5G Band1

Test Position	Test CH	Duty Cycle	Measure SAR 1g(W/kg)	Measure SAR 10g(W/kg)	Conducted Power(dBm)	Tune up Power(dBm)	Factor	Scaled Final SAR 1g	Scaled Final SAR 10g	power drift
Top	38	0.9269	0.098	0.033	7.46	8	1.132	0.120	0.040	0.12
Top	46	0.9269	0.099	0.034	7.51	8	1.119	0.120	0.041	0
right	46	0.9269	0.0034	0.00112	7.51	8	1.119	0.004	0.001	0
left	46	0.9269	0.00211	0.00101	7.51	8	1.119	0.003	0.001	0.01
back	46	0.9269	0.00101	0.000915	7.51	8	1.119	0.001	0.001	0.12
front	46	0.9269	0.00122	0.000854	7.51	8	1.119	0.001	0.001	-0.13
Conclusion: PASS										
Note: Factor= Tune up AV Power(W)/Measured Power(W) Scaled SAR-1= Measured SAR*Factor Scaled-Final= Scaled SAR-1*(1/Duty Cycle)										

Test Mode: WIFI 5GHz- Band 2

SAR Test Record For WIFI 5G Band2

Test Position	Test CH	Duty Cycle	Measure SAR 1g(W/kg)	Measure SAR 10g(W/kg)	Conducted Power(dBm)	Tune up Power(dBm)	Factor	Scaled Final SAR 1g	Scaled Final SAR 10g	power drift
Top	54	0.9269	0.102	0.034	5.5	8	1.77827941	0.196	0.065	0.11
Top	62	0.9269	0.107	0.036	6.18	8	1.52054753	0.176	0.059	0.04
right	62	0.9269	0.00401	0.00211	6.18	8	1.52054753	0.007	0.003	0.01
left	62	0.9269	0.00211	0.00101	6.18	8	1.52054753	0.003	0.002	0.11
front	62	0.9269	0.00135	0.000911	6.18	8	1.52054753	0.002	0.001	0.02
back	62	0.9269	0.00208	0.00111	6.18	8	1.52054753	0.003	0.002	0.13
Conclusion: PASS										
Note: Factor= Tune up AV Power(W)/Measured Power(W) Scaled SAR-1= Measured SAR*Factor Scaled-Final= Scaled SAR-1*(1/Duty Cycle)										

Test Mode: WIFI 5GHz- Band 3

SAR Test Record For WIFI 5G Band3

Test Position	Test CH	Duty Cycle	Measure SAR 1g(W/kg)	Measure SAR 10g (W/kg)	Conducted Power (dBm)	Tune up Power (dBm)	Factor	Scaled Final SAR 1g	Scaled Final SAR 10g	power drift
Top	102	0.9269	0.112	0.038	6.41	8	1.442115352	0.174	0.059	0.16
Top	110(IC Only)	0.9269	0.114	0.039	6.44	8	1.432187899	0.176	0.060	-0.14
Top	118(FCC Only)	0.9269	0.115	0.039	6.12	8	1.541700453	0.191	0.065	-0.03
Top	134	0.9269	0.124	0.042	6.71	8	1.345860354	0.180	0.061	0.19
right	110(IC Only)	0.9269	0.00433	0.00201	6.44	8	1.432187899	0.007	0.003	0.11
left	110(IC Only)	0.9269	0.00211	0.00101	6.44	8	1.432187899	0.003	0.002	0.15
front	110(IC Only)	0.9269	0.00134	0.00075	6.44	8	1.432187899	0.002	0.001	0.14
back	110(IC Only)	0.9269	0.00208	0.00111	6.44	8	1.432187899	0.003	0.002	0.13
right	102	0.9269	0.00422	0.00211	6.41	8	1.442115352	0.007	0.003	0.04
left	102	0.9269	0.00205	0.000977	6.41	8	1.442115352	0.003	0.002	-0.13
front	102	0.9269	0.00122	0.0065	6.41	8	1.442115352	0.002	0.010	0.14
back	102	0.9269	0.00222	0.00101	6.41	8	1.442115352	0.003	0.002	0.15
Conclusion: PASS										
Note: Factor= Tune up AV Power(W)/Measured Power(W) Scaled SAR-1= Measured SAR*Factor Scaled-Final= Scaled SAR-1*(1/Duty Cycle)										

Test Mode: WIFI 5GHz- Band 4

SAR Test Record For WIFI 5G Band4

Test Position	Test CH	Duty Cycle	Measure SAR 1g(W/kg)	Measure SAR 10g(W/kg)	Conducted Power(dBm)	Tune up Power(dBm)	Factor	Scaled Final SAR 1g	Scaled Final SAR 10g	power drift
Top	151	0.9269	0.125	0.042	7.66	8	1.081	0.146	0.049	0.15
Top	159	0.9269	0.122	0.041	7.26	8	1.186	0.156	0.052	-0.01
right	151	0.9269	0.00455	0.00211	7.66	8	1.081	0.005	0.002	0.11
left	151	0.9269	0.00311	0.00252	7.66	8	1.081	0.004	0.003	0.15
front	151	0.9269	0.00265	0.00122	7.66	8	1.081	0.003	0.001	0.17
back	151	0.9269	0.00211	0.00104	7.66	8	1.081	0.002	0.001	0.18
Conclusion: PASS										

Note:
Factor= Tune up AV Power(W)/Measured Power(W)
Scaled SAR-1= Measured SAR*Factor
Scaled-Final= Scaled SAR-1*(1/Duty Cycle)