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 valuesbefore running a detailed measurement around the hot spot. Before starting the area scan a gridspacing of 15 mm x 15 mm is set. During the scan the distance of the probe to the phantom remainsunchanged.

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 theevaluation 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 Shepard'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 thedata 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: - SensitivityNormi, ai0, ai1, ai2
- Conversion factorConvFi
- Diode compression pointDcpi

Device parameters: - Frequency f
- 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 multimeter 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 ***Vi*** = compensated signal of channel i(i = x, y, z)

Ui = 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.

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

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 weremeasured 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.

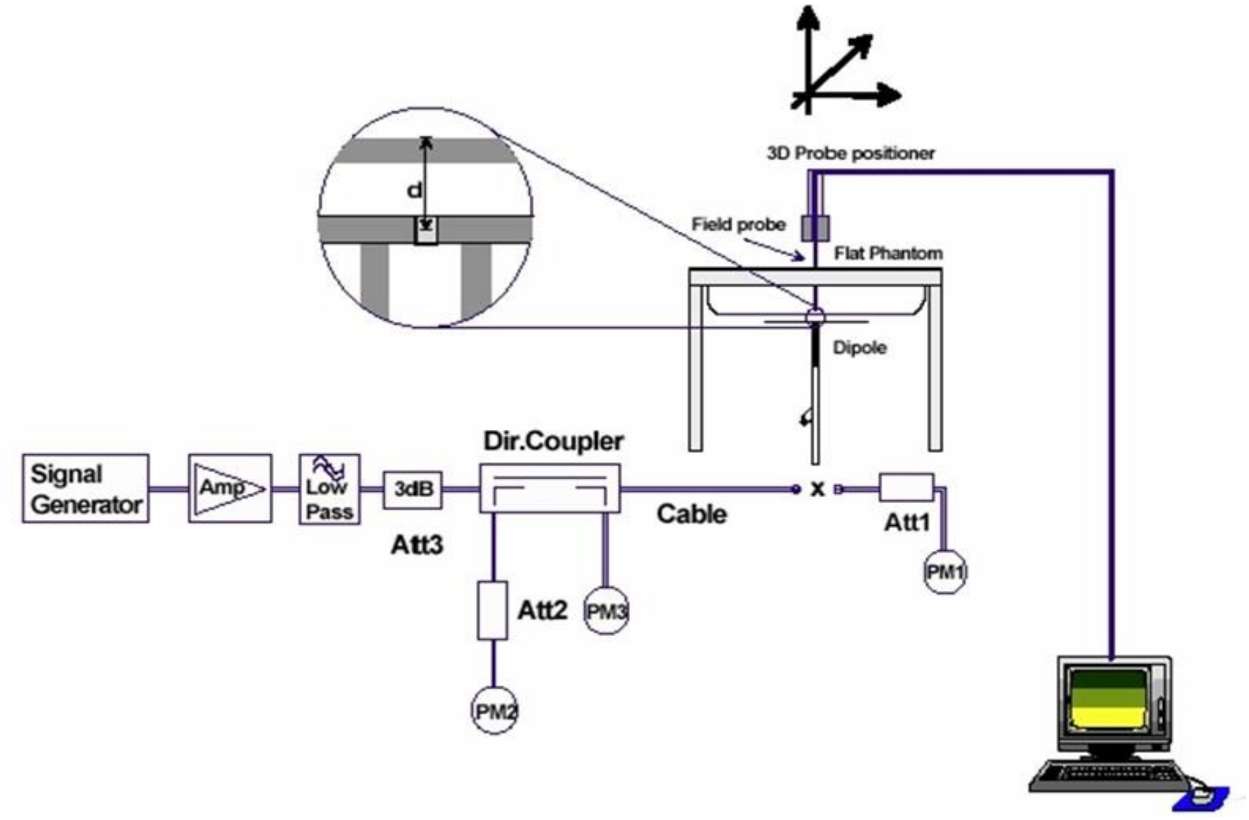


Figure 6.1: System Check Set-up

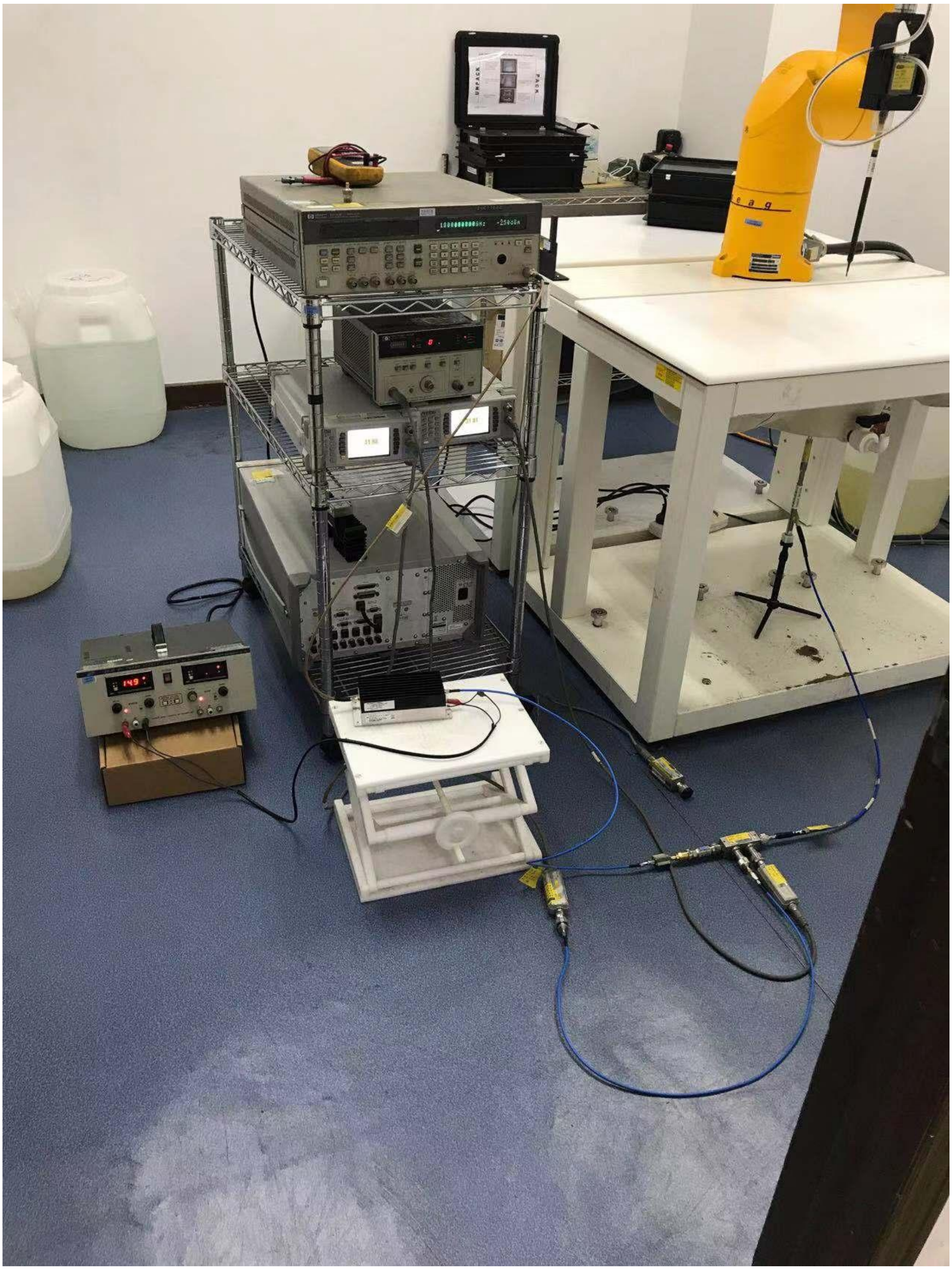


Figure 6.3: photos of system

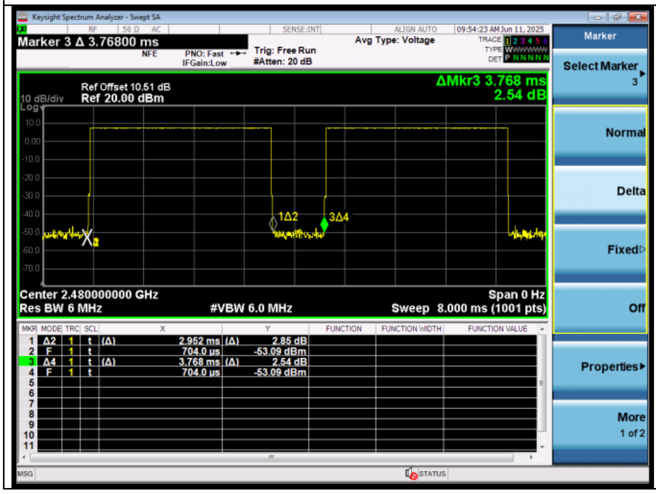
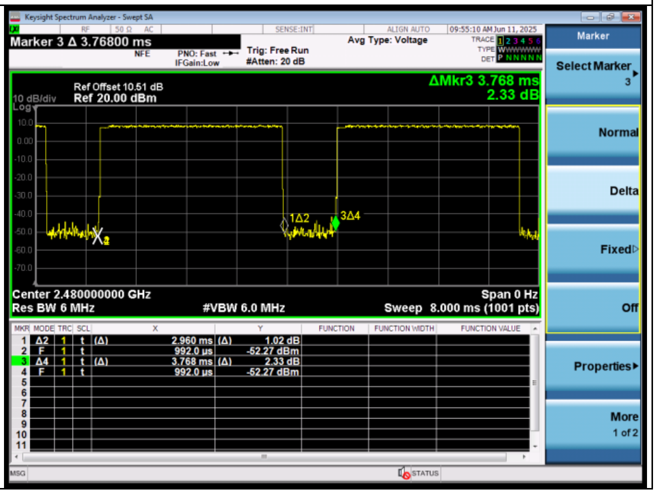
7. TEST RESULTS

7.1. Output power

(BDR+EDR)

Test Mode	Frequency	Power Setting	AV power (dBm)
GFSK	2402	Default	7.115
	2441	Default	6.863
	2480	Default	6.038
8-DPSK	2402	Default	5.906
	2441	Default	4.960
	2480	Default	4.673

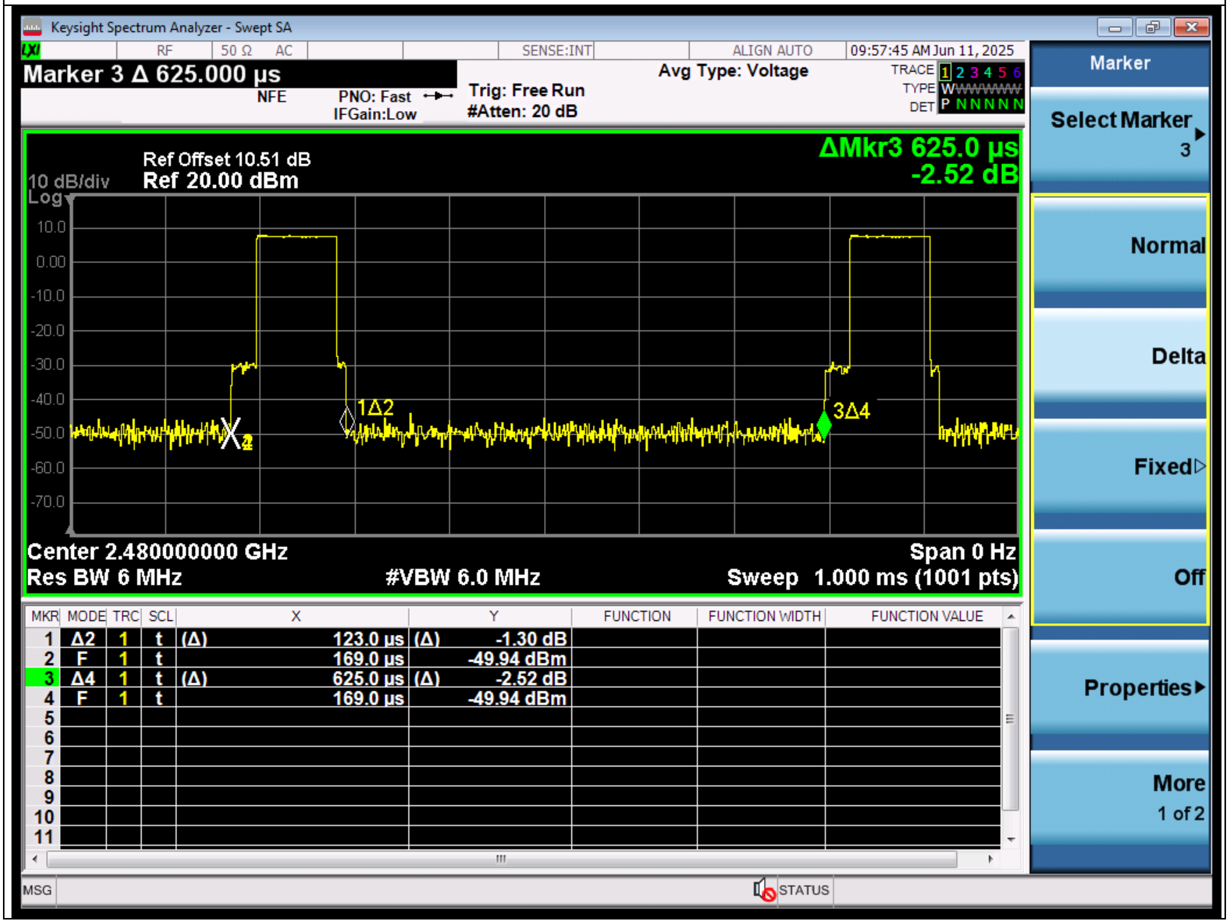
Note: GFSK has the maximum output power, so choose GFSK as the SAR test mode.

GFSK	8-DPSK
	

(BLE-1Mbps)

Test Mode	Frequency	Power Setting	AV power (dBm)
BLE 1M	2402	Default	0.456
	2440	Default	0.080
	2480	Default	-1.760

BLE 1M



(125kHz)

Test Mode	Frequency	Power (mW)
RF ID	125kHz	0.000000869

7.2. System Check for Head Tissue simulating liquid

Frequency	Description	SAR(W/kg)		Dielectric Parameters (±10% window)		Temp
		1g	10g	εr	σ(s/m)	℃
2450MHz	Recommended value	13.5 4.3848-6.4152	6.29 2.45508-2.986492	39.2 35.28-43.12	1.80 1.62-1.98	/
	Measurement value **2025-05-28**	5.47	2.47	39.2	1.8	21.05

Test Laboratory: Audix SAR Lab Date: 28/05/2025

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; σ = 1.8 S/m; ε_r = 39.2; ρ = 1000 kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3767; ConvF(7.6, 7.6, 7.6); Calibrated: 01/08/2024;
- Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn899; Calibrated: 06/06/2024
- Phantom: SAM 1; Type: SAM;
- 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) = 11.7 W/kg

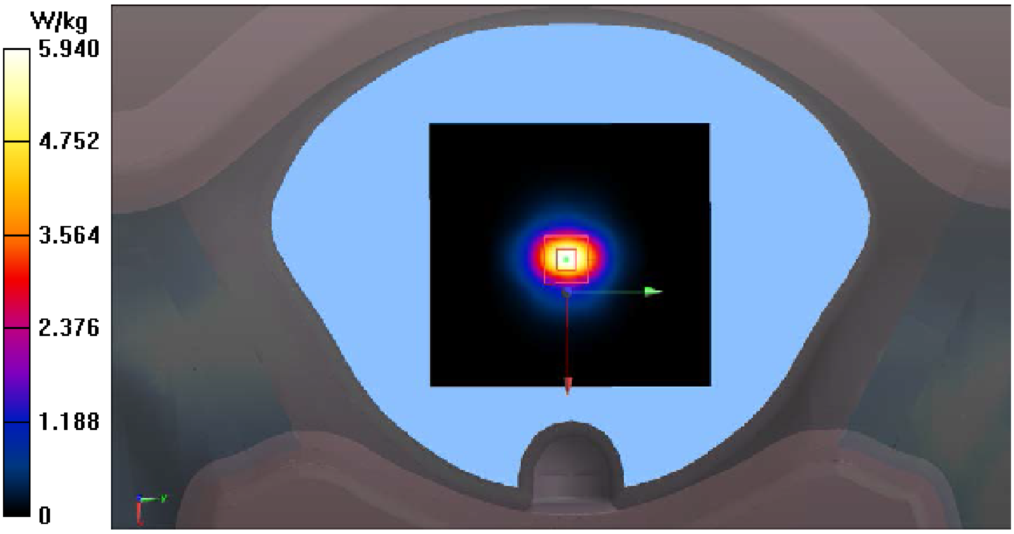
Configuration/CW 2450MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 72.71 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 25.4 W/kg

SAR(1 g) = 5.47 W/kg; SAR(10 g) = 2.47 W/kg

Maximum value of SAR (measured) = 5.94 W/kg



7.3. Dielectric Performance for Tissue simulating liquid

Frequency		Description	Dielectric Parameters (±10% window)		Temp
			εr	σ(s/m)	℃
BDR+EDR	2402MHz	Recommended value	39.2 35.28-43.12	1.80 1.62-1.98	/
		Measurement value **2025-05-28**	38.913	1.828	**21.05**
	2441MHz	Recommended value	39.2 35.28-43.12	1.80 1.62-1.98	/
		Measurement value **2025-05-28**	38.734	1.878	**21.05**
	2480MHz	Recommended value	39.2 35.28-43.12	1.80 1.62-1.98	/
		Measurement value **2025-05-28**	38.579	1.917	**21.05**
BLE 1M	2402MHz	Recommended value	39.2 35.28-43.12	1.80 1.62-1.98	/
		Measurement value **2025-05-28**	38.913	1.828	**21.05**
	2441MHz	Recommended value	39.2 35.28-43.12	1.80 1.62-1.98	/
		Measurement value **2025-05-28**	38.738	1.876	**21.05**
	2480MHz	Recommended value	39.2 35.28-43.12	1.80 1.62-1.98	/
		Measurement value **2025-05-28**	38.579	1.917	**21.05**

7.4. Test Results

(BDR+EDR)

Test Position	distance	Band	Mode	Test CH	SAR(W/kg) 1g	SAR(W/kg) 10g	Power Drift (dB)	Duty cycle	Conducted (dBm)	Tune up (dBm)	Factor	SAR(W/kg) 1g	SAR(W/kg) 10g
Front	0mm	BT	DH5	0	0.00615	0.00507	0.18	0.78	7.115	8	1.226026903	0.01	0.008
Back	0mm	BT	DH5	0	0.00404	0.00391	0.04	0.78	7.115	8	1.052204125	0.008	0.008
Bottom	0mm	BT	DH5	0	0.00173	0.00158	-0.06	0.78	7.115	8	1.052204125	0.004	0.003
Right	0mm	BT	DH5	0	0.00226	0.00204	0.12	0.78	7.115	8	1.052204125	0.006	0.005
Front	0mm	BT	DH5	39	0.00691	0.00574	-0.03	0.78	6.863	8	1.299271763	0.012	0.01
Front	0mm	BT	DH5	78	0.0073	0.00643	-0.17	0.78	6.038	8	1.57108615	0.015	0.013

(BLE 1M)

Test Position	distance	Band	Mode	Test CH	SAR(W/kg) 1g	SAR(W/kg) 10g	Power Drift (dB)	Duty cycle	Conducted (dBm)	Tune up (dBm)	Factor	SAR(W/kg) 1g	SAR(W/kg) 10g
Front	0mm	BT	BLE1M	0	0.00214	0.00129	-0.09	0.2	0.456	1	1.133443823	0.012	0.007
Back	0mm	BT	BLE1M	0	0.000745	0.000512	0.11	0.2	0.456	1	1.407019123	0.004	0.003
Bottom	0mm	BT	BLE1M	0	0.000325	0.000307	-0.14	0.2	0.456	1	1.407019123	0.002	0.001
Right	0mm	BT	BLE1M	0	0.000214	0.000165	0.07	0.2	0.456	1	1.407019123	0.001	0
Front	0mm	BT	BLE1M	19	0.00281	0.00136	-0.03	0.2	0.080	1	1.235947433	0.017	0.008
Front	0mm	BT	BLE1M	39	0.00214	0.00131	-0.08	0.2	-1.76	0	1.499684836	0.016	0.01

Total:

Max 1g SAR		Total	Limit
BT (W/kg)	125K (mW)		
0.02	0.000000869	0.012500869	< 1

Note:
Total=BT/Limit+125K/Limit
125K Limit:1mW/MHz

APPENDIX A

Graph Results
(BDR+EDR & BLE 1M)

BDR+EDR:

Test Laboratory: Audix SAR Lab Date: 28/05/2025

CH0(2402MHz Front)

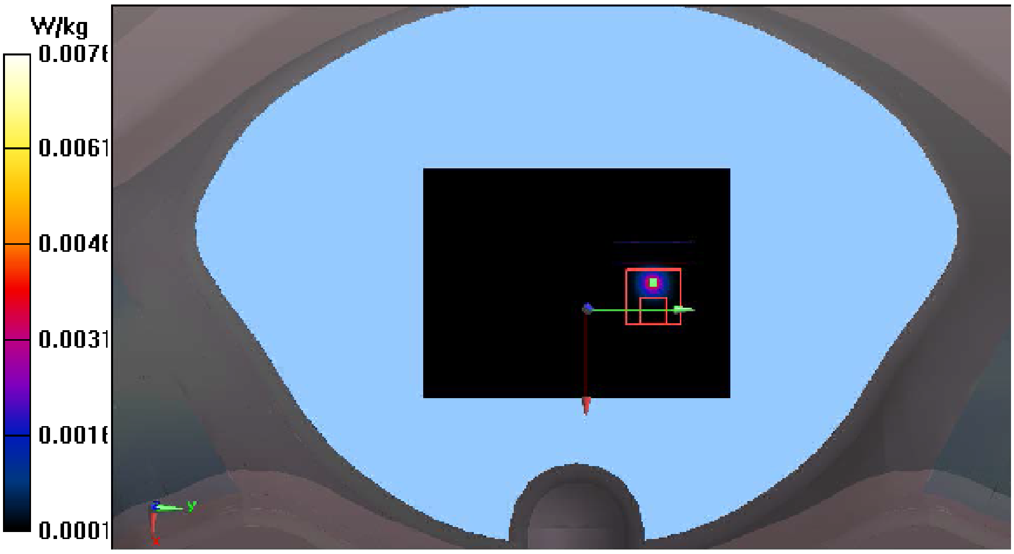
DUT: TrapMan M/N:TM8

Communication System: UID 0, Blue Tooth (0); Communication System Band: Mid;
Frequency: 2402 MHz;Communication System PAR: 0 dB
Medium parameters used: f = 2402 MHz; σ = 1.828 S/m; ε_r = 38.913; ρ = 1000 kg/m^3
Phantom section: Flat Section
DASY5 Configuration:

- Probe: EX3DV4 - SN3767; ConvF(7.6, 7.6, 7.6); Calibrated: 01/08/2024;
- Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn899; Calibrated: 06/06/2024
- Phantom: SAM 1; Type: SAM; Serial: TP-1543
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/CH0(2402MHz Front)/Area Scan (61x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.00167 W/kg

Configuration/CH0(2402MHz Front)/Zoom Scan (5x5x7)/Cube 0:
Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 0.9370 V/m; Power Drift = 0.18 dB
Peak SAR (extrapolated) = 0.000771 W/kg
SAR(1 g) = 0.00615 W/kg; SAR(10 g) = 0.00507 W/kg
Maximum value of SAR (measured) = 0.00701 W/kg



Smallest distance from peaks to all points 3 dB below =8 mm
Ratio of SAR at M2 to SAR at M1=45.8%

Test Laboratory: Audix SAR Lab Date: 28/05/2025

CH39(2441MHz Front)

DUT: TrapMan M/N:TMB

Communication System: UID 0, Blue Tooth (0); Communication System Band: Mid; Frequency: 2441 MHz;Communication System PAR: 0 dB

Medium parameters used (interpolated): f = 2441 MHz; $\sigma = 1.878$ S/m; $\varepsilon_r = 38.734$; $\rho = 1000$ kg/m^3

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN3767; ConvF(7.6, 7.6, 7.6); Calibrated: 01/08/2024;
- Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn899; Calibrated: 06/06/2024
- Phantom: SAM 1; Type: SAM; Serial: TP-1543
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/CH39(2441MHz Front)/Area Scan (61x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.00277 W/kg

Configuration/CH39(2441MHz Front)/Zoom Scan (5x5x7)/Cube 0:

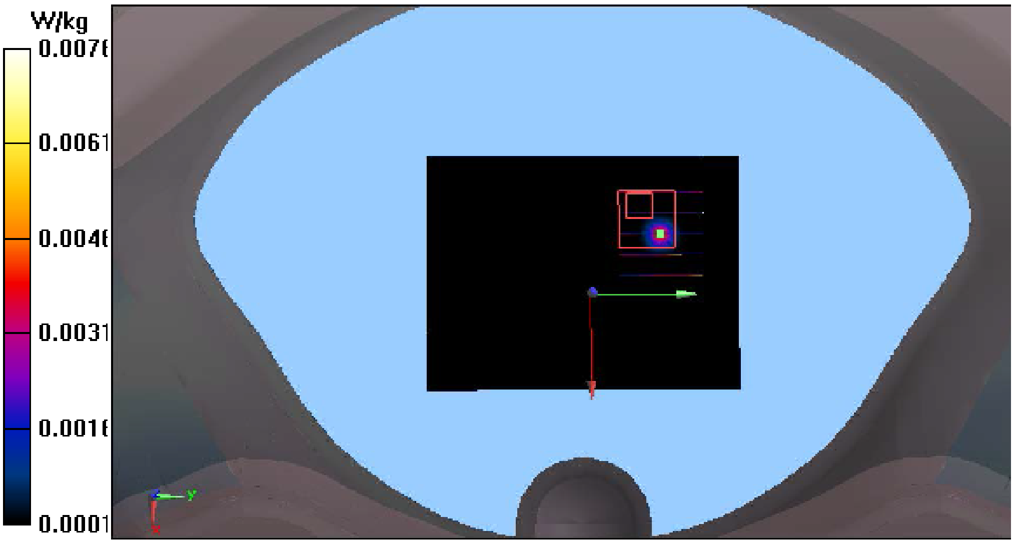
Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 1.065 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 0.00271 W/kg

SAR(1 g) = 0.00691 W/kg; SAR(10 g) = 0.00574 W/kg

Maximum value of SAR (measured) = 0.00771 W/kg



Smallest distance from peaks to all points 3 dB below =8 mm

Ratio of SAR at M2 to SAR at M1=45.3%

Test Laboratory: Audix SAR Lab Date: 28/05/2025

CH78(2480MHz Front)

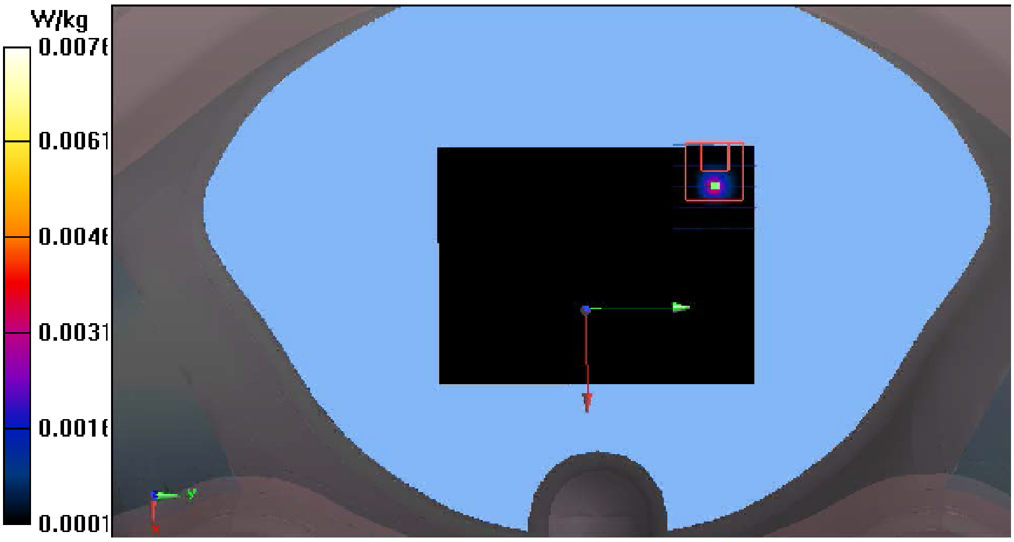
DUT: TrapMan M/N:TMB

Communication System: UID 0, Blue Tooth (0); Communication System Band: Mid;
Frequency: 2480 MHz;Communication System PAR: 0 dB
Medium parameters used: f = 2480 MHz; σ = 1.917 S/m; ε_r = 38.579; ρ = 1000 kg/m^3
Phantom section: Flat Section
DASY5 Configuration:

- Probe: EX3DV4 - SN3767; ConvF(7.6, 7.6, 7.6); Calibrated: 01/08/2024;
- Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn899; Calibrated: 06/06/2024
- Phantom: SAM 1; Type: SAM; Serial: TP-1543
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/CH78(2480MHz Front)/Area Scan (61x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.00394 W/kg

Configuration/CH78(2480MHz Front)/Zoom Scan (5x5x7)/Cube 0:
Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 1.161 V/m; Power Drift = -0.17 dB
Peak SAR (extrapolated) = 0.00222 W/kg
SAR(1 g) = 0.0073 W/kg; SAR(10 g) = 0.00643 W/kg
Maximum value of SAR (measured) = 0.00767 W/kg



Smallest distance from peaks to all points 3 dB below =8 mm
Ratio of SAR at M2 to SAR at M1=45.6%

BLE 1M

Test Laboratory: Audix SAR Lab Date: 28/05/2025

CH0(2402MHz Front)

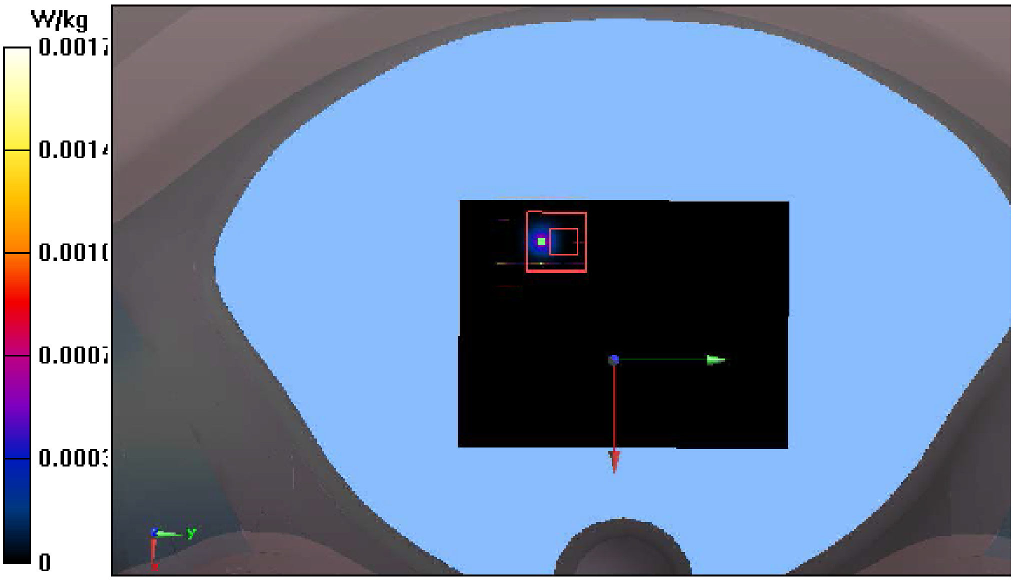
DUT: TrapMan M/N:TMB

Communication System: UID 0, Blue Tooth (0); Communication System Band: Mid;
Frequency: 2402 MHz;Communication System PAR: 0 dB
Medium parameters used: f = 2402 MHz; σ = 1.828 S/m; ε_r = 38.913; ρ = 1000 kg/m^3
Phantom section: Flat Section
DASY5 Configuration:

- Probe: EX3DV4 - SN3767; ConvF(7.6, 7.6, 7.6); Calibrated: 01/08/2024;
- Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn899; Calibrated: 06/06/2024
- Phantom: SAM 1; Type: SAM; Serial: TP-1543
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/CH0(2402MHz Front)/Area Scan (61x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.000721 W/kg

Configuration/CH0(2402MHz Front)/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 0.5170 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 0.00473 W/kg
SAR(1 g) = 0.00214 W/kg; SAR(10 g) = 0.00129 W/kg
Maximum value of SAR (measured) = 0.00179 W/kg



Smallest distance from peaks to all points 3 dB below =8 mm
Ratio of SAR at M2 to SAR at M1=46.3%

Test Laboratory: Audix SAR Lab Date: 28/05/2025

CH19(2440MHz Front)

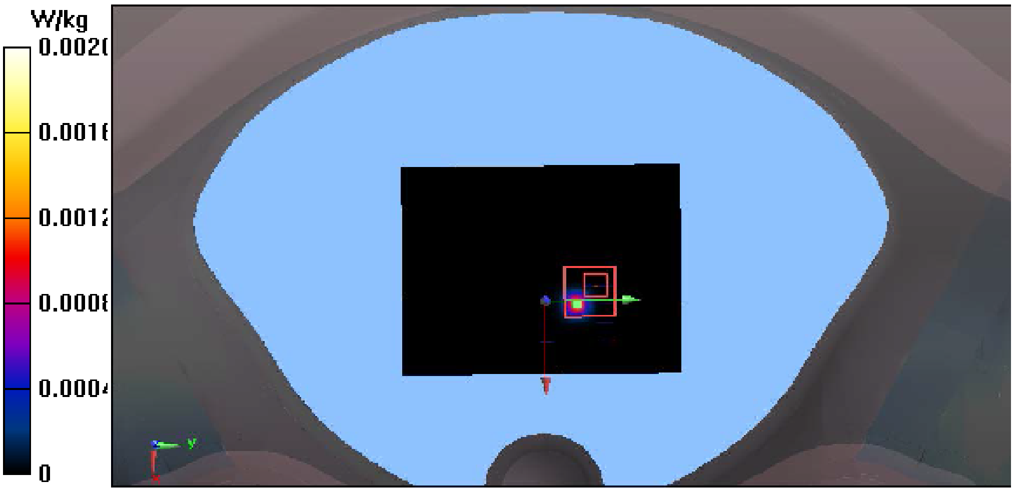
DUT: TrapMan M/N:TMB

Communication System: UID 0, Blue Tooth (0); Communication System Band: Mid;
Frequency: 2440 MHz;Communication System PAR: 0 dB
Medium parameters used: f = 2440 MHz; σ = 1.876 S/m; ε_r = 38.738; ρ = 1000 kg/m^3
Phantom section: Flat Section
DASY5 Configuration:

- Probe: EX3DV4 - SN3767; ConvF(7.6, 7.6, 7.6); Calibrated: 01/08/2024;
- Modulation Compensation:
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn899; Calibrated: 06/06/2024
- Phantom: SAM 1; Type: SAM; Serial: TP-1543
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/CH19(2440MHz Front)/Area Scan (61x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 0.00152 W/kg

Configuration/CH19(2440MHz Front)/Zoom Scan (5x5x7)/Cube 0:
Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 0.7550 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 0.00142 W/kg
SAR(1 g) = 0.00281 W/kg; SAR(10 g) = 0.00136 W/kg
Maximum value of SAR (measured) = 0.00205 W/kg



Smallest distance from peaks to all points 3 dB below =8 mm
Ratio of SAR at M2 to SAR at M1=46.5%