TEST REPORT

No. 24T04N003136-001-SAR

For

Launch Tech Co., Ltd.

SMART TPMS DIAGNOSTIC SYSTEM

Model Name: Creader TPMS 511S V2

With

Hardware Version: V2

Software Version: CRT501S_V2_V100

FCC ID: XUJCRT511SV2

Issued Date: 2025-01-07

Designation Number: CN1210

Note:

Test Laboratory:

SAICT, Shenzhen Academy of Information and Communications Technology

Building G, Shenzhen International Innovation Center, No.1006 Shennan Road, Futian District, Shenzhen, Guangdong, P. R. China 518000.

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REPORT HISTORY

Report Number	Revision	Description	Issue Date
24T04N003136-001-SAR	Rev.0	1st edition	2025-01-07

CONTENTS

1. Summary of Test Report

1.1. Test Items

Description:	SMART TPMS DIAGNOSTIC SYSTEM
Model Name:	Creader TPMS 511S V2
Applicant’s Name:	Launch Tech Co., Ltd.
Manufacturer's Name:	Launch Tech Co., Ltd.

1.2. Test Standards

ANSI C95.1:1992, IEEE Std 1528:2013

1.3. Test Result

Pass. Please refer to “12. Summary of Test Results”

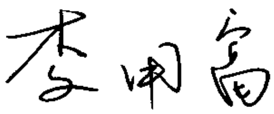
1.4. Testing Location

Address: Building G, Shenzhen International Innovation Center, No.1006 Shennan Road, Futian District, Shenzhen, Guangdong, P. R. China

1.5. Project Data

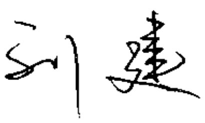
Testing Start Date: 2024-12-11 Testing End Date: 2024-12-31

1.6. Signature



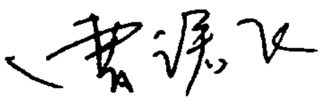
Li Yongfu

(Prepared this test report)



Liu Jian

(Reviewed this test report)



Cao Junfei

(Approved this test report)

2. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for Launch Tech Co., Ltd. SMART TPMS DIAGNOSTIC SYSTEM Creader TPMS 511S V2 are as follows:

Table 2.1: Highest Reported SAR

Equipment Class	Frequency Bands	1g SAR (W/kg)	10g SAR (W/kg)
		Body-worn (Separation 10mm)	Extremity (Separation 0mm)
DSS	Bluetooth	<0.01[1]	0.01
DTS	WLAN 2.4GHz	**0.13**[1]	**0.46**
Maximum Simultaneous Transmission SAR		0.13	0.47
Note1: SAR result at 10mm is used for conservative evaluation.			

This device is in compliance with Specific Absorption Rate (SAR) for general population/ uncontrolled exposure limits (1.6 W/kg for Head/Body 1g SAR, 4.0 W/kg for Extremity 10g SAR) specified in ANSI C95.1:1992.

The measurement together with the test system set-up is described in annex C of this test report. A detailed description of the equipment under test can be found in chapter 4 of this test report.

The highest reported SAR value is obtained at the case of **(Table 2.1)**, Body-worn value is **0.13 W/kg (1g)** and Extremity value is **0.46 W/kg (10g)**.

3. Client Information

3.1. Applicant Information

Company Name:	Launch Tech Co., Ltd.
Address:	Launch Industrial Park, North of Wuhe Rd., Banxuegang, Longgang Shenzhen 518129 China
Contact:	/
Email:	/
Telephone:	/

3.2. Manufacturer Information

Company Name:	Launch Tech Co., Ltd.
Address:	Launch Industrial Park, North of Wuhe Rd., Banxuegang, Longgang Shenzhen 518129 China
Contact:	/
Email:	/
Telephone:	/

4. Equipment under Test (EUT) and Ancillary Equipment (AE)

4.1. About EUT

Description:	SMART TPMS DIAGNOSTIC SYSTEM
Model Name:	Creader TPMS 511S V2
List Model:	Creader TPMS 5011 V2
Condition of EUT as received:	No obvious damage in appearance
Frequency Bands:	Bluetooth, WLAN 2.4GHz
Tested Tx Frequency:	2402 – 2480MHz (Bluetooth)
	2412 – 2462MHz (WLAN 2.4GHz)
Test device Production information:	Production unit
Device type:	Portable device
Antenna type:	Integrated antenna
Product Dimensions:	Long 211.5mm; Wide 99.0mm; Height 34.5mm; Overall Diagonal 191.0mm

*Since the information of samples in this report is provided by the client, the laboratory is not responsible for the authenticity of sample information.

4.2. Internal Identification of EUT used during the test

EUT ID*	SN	HW Version	SW Version	Receipt Date
UT02aa	9860732040060	V2	CRT501S_V2_V100	2024-12-06

*EUT ID: is used to identify the test sample in the lab internally.

Note: It is performed to test SAR with the UT02aa, and conducted power with the UT02aa.

4.3. Internal Identification of AE used during the test

AE ID*	Description	Model	Manufacturer
AE1	Battery	18650 1S2P	ShenZhen EPT Battery Co., Ltd.

*AE ID: is used to identify the test sample in the lab internally.

5. Test Methodology

5.1. Applicable Limit Regulations

ANSI C95.1:1992 IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

It specifies the maximum exposure limit of **1.6 W/kg** as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

5.2. Applicable Measurement Standards

IEEE Std 1528:2013 Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Experimental Techniques.

KDB 447498 D01 General RF Exposure Guidance v06 RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices

KDB 648474 D04 Handset SAR v01r03 SAR Evaluation Considerations for Wireless Handsets.

KDB 941225 D07 UMPC Mini Tablet v01r02 SAR Evaluation Procedures for UMPC Mini-Tablet Devices

KDB 248227 D01 802.11 Wi-Fi SAR v02r02 SAR Guidance for IEEE 802.11 (Wi-Fi) Transmitters.

KDB 865664 D01SAR measurement 100 MHz to 6 GHz v01r04 SAR Measurement Requirements for 100 MHz to 6 GHz

KDB 865664 D02 RF Exposure Reporting v01r02 RF Exposure Compliance Reporting and Documentation Considerations

TCB workshop April 2019; RF Exposure Procedures (Tissue Simulating Liquids)

6. Specific Absorption Rate (SAR)

6.1. 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.

6.2. SAR Definition

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

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

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

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

$$SAR = c\left(\frac{\delta T}{\delta t}\right)$$

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

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

Where: σ is the conductivity of the tissue, ρ is the mass density of tissue and E is the RMS electrical field strength.

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

7. Tissue Simulating Liquids

7.1. Targets for tissue simulating liquid

Table 7.1: Targets for tissue simulating liquid

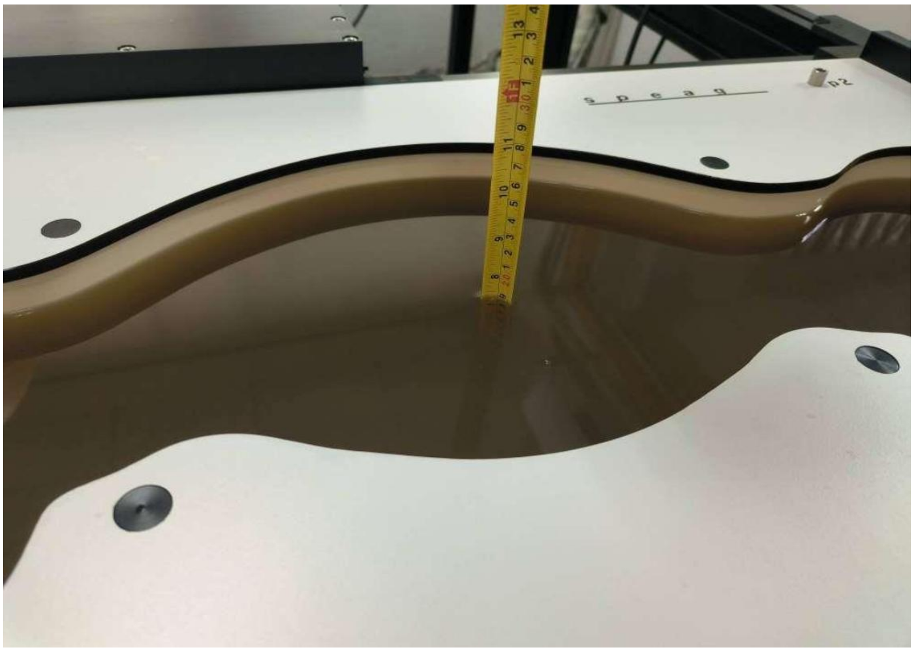
Frequency (MHz)	Liquid Type	Conductivity (σ)	± 5% Range	Permittivity (ε)	± 5% Range
2450	Head	1.80	1.71～1.89	39.2	37.2～41.2

7.2. Dielectric Performance

Table 7.2: Dielectric Performance of Tissue Simulating Liquid

Measurement Date (yyyy-mm-dd)	Frequency (MHz)	Conductivity σ (S/m)	Drift (%)	Permittivity ε	Drift (%)
2024-12-11	2450	1.773	-1.50	39.85	1.66
2024-12-31	2450	1.826	1.44	38.32	-2.24

Note: The liquid temperature is 22.0°C.

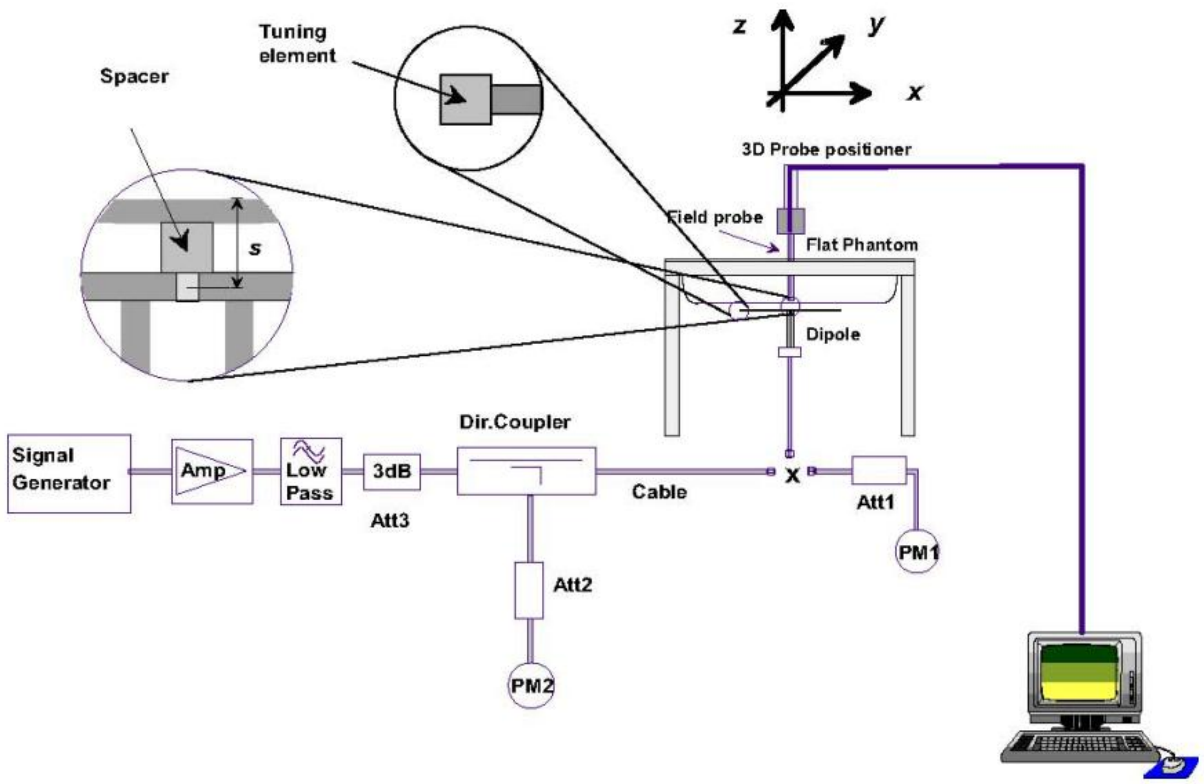


Picture 7.2 Liquid depth in the Flat Phantom (0.6GHz - 7.5GHz)

8. System Check

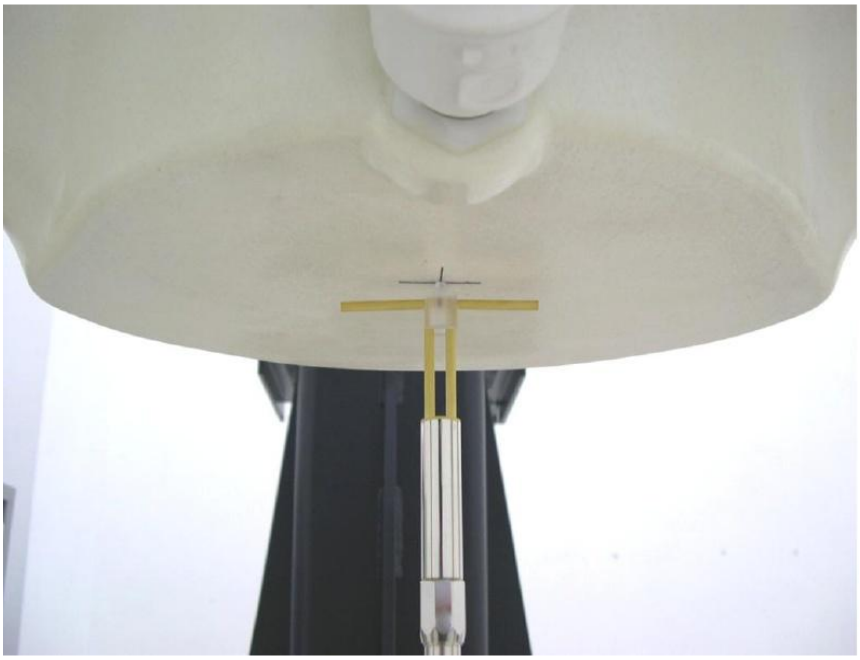
8.1. System Setup

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



Picture 8.1 System Setup for System Evaluation

For the dipole below 3GHz, the output power on dipole port must be calibrated to 20 dBm (100mW) before dipole is connected.
For the dipole above 3GHz, the output power on dipole port must be calibrated to 17 dBm (50mW) before dipole is connected.



Picture 8.2 Photo of Dipole Setup

8.2. System Check

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device.

Table 8.1: System Check of Head

Measurement Date	Frequency (MHz)	Target value (W/kg)		Measured value (W/kg)				Deviation (%)	
				/		Normalize to 1W			
		1 g	10 g	1 g	10 g	1 g	10 g	1 g	10 g
2024-12-11	2450	52.70	24.80	5.10	2.44	51.00	24.40	-3.23	-1.61
2024-12-31	2450	52.70	24.80	5.48	2.56	54.80	25.60	3.98	3.23

9. Measurement Procedures

9.1. Tests to be performed

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in picture 9.1.

Step 1: The tests described in 9.2 shall be performed at the channel that is closest to the center of the transmit frequency band (f_c) for:

a) all device positions (cheek and tilt, for both left and right sides of the SAM phantom, as described in annex D),

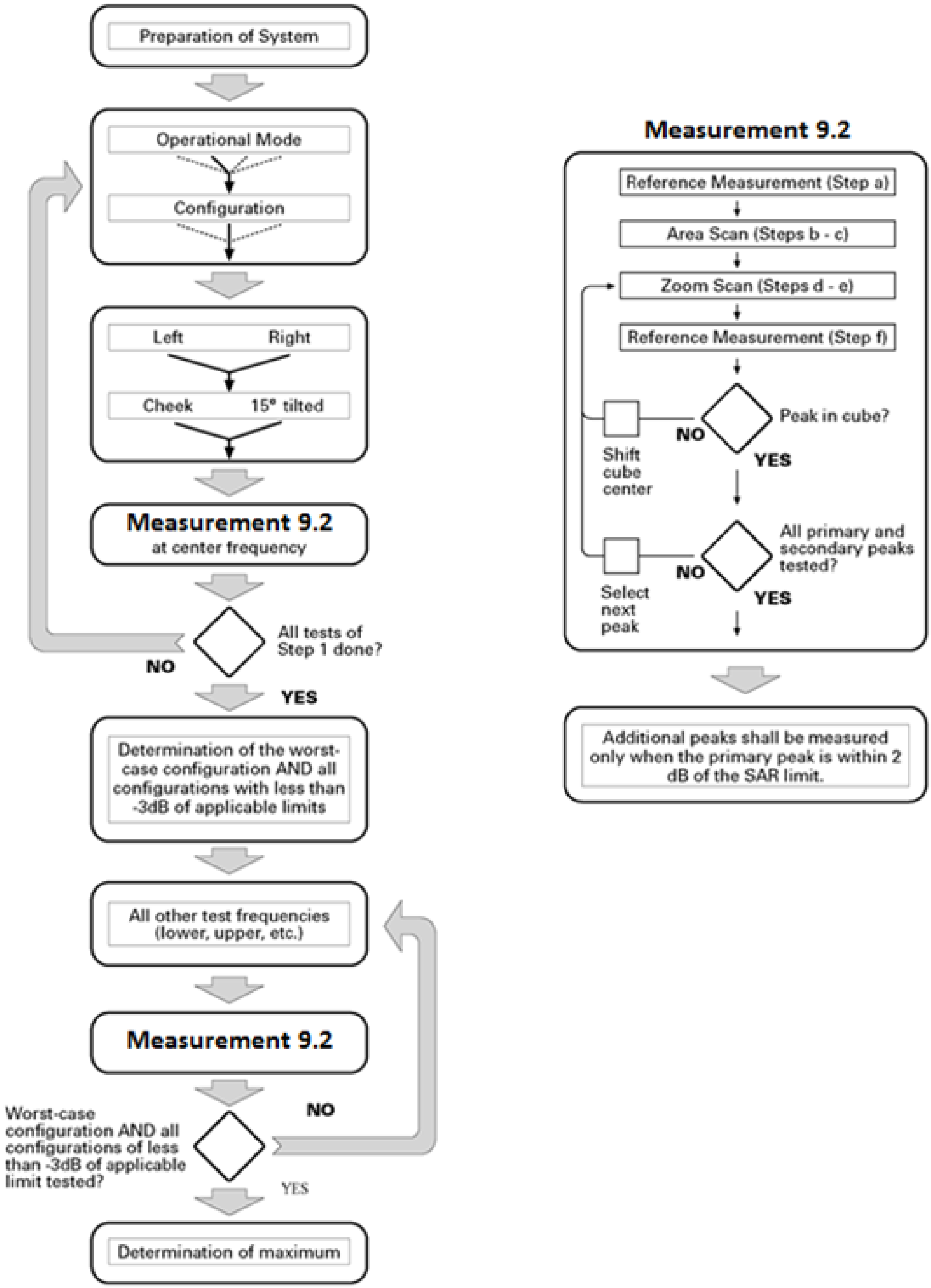
b) all configurations for each device position in a), e.g., antenna extended and retracted, and

c) all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.

If more than three frequencies need to be tested according to 11.1 (i.e., $N_C > 3$), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

Step 2: For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in 9.2 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

Step 3: Examine all data to determine the highest value of the peak spatial-average SAR found in Steps 1 to 2.



Picture 9.1 Block diagram of the tests to be performed

9.2. General Measurement Procedure

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements and fully documented in SAR reports to qualify for TCB approval. Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2013. The results should be documented as part of the system validation records and may be requested to support test results when all the measurement parameters in the following table are not satisfied.

<table>
<tr><td colspan="3"></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">≤ $1.5 \cdot \Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
* When zoom scan is required and the <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

9.3. Bluetooth & WLAN Measurement Procedures for SAR

Normal network operating configurations are not suitable for measuring the SAR of 802.11 transmitters in general. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure that the results are consistent and reliable.

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in a test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

9.4. Power Drift

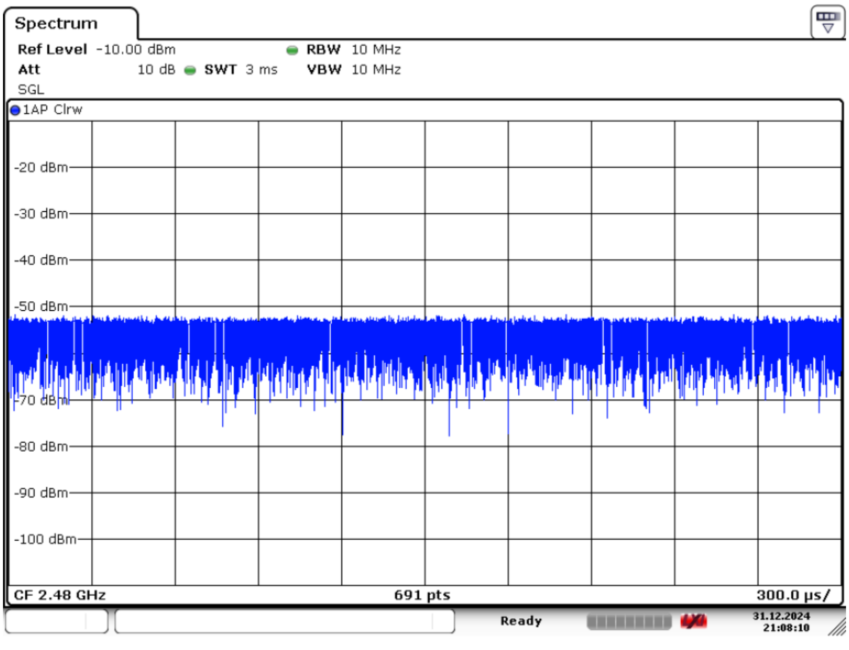
To control the output power stability during the SAR test, DASY5 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Section 12 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

10. Conducted Output Power

Table 10.1: The conducted Power measurement results for Bluetooth

Mode	Channel	Frequency (MHz)	Averaged Power (dBm)	**Tune up (dBm)**
GFSK	0	2402.0	6.16	**7.5**
	39	2441.0	6.36	**7.5**
	78	2480.0	6.38	**7.5**
EDR2M-4_DQPSK	0	2402.0	**7.57**	**8.5**
	39	2441.0	**7.67**	**8.5**
	78	2480.0	**7.53**	**8.5**
BLE 1M	0	2402.0	6.64	**7.5**
	19	2440.0	6.88	**7.5**
	39	2480.0	6.57	**7.5**

Duty factor plot



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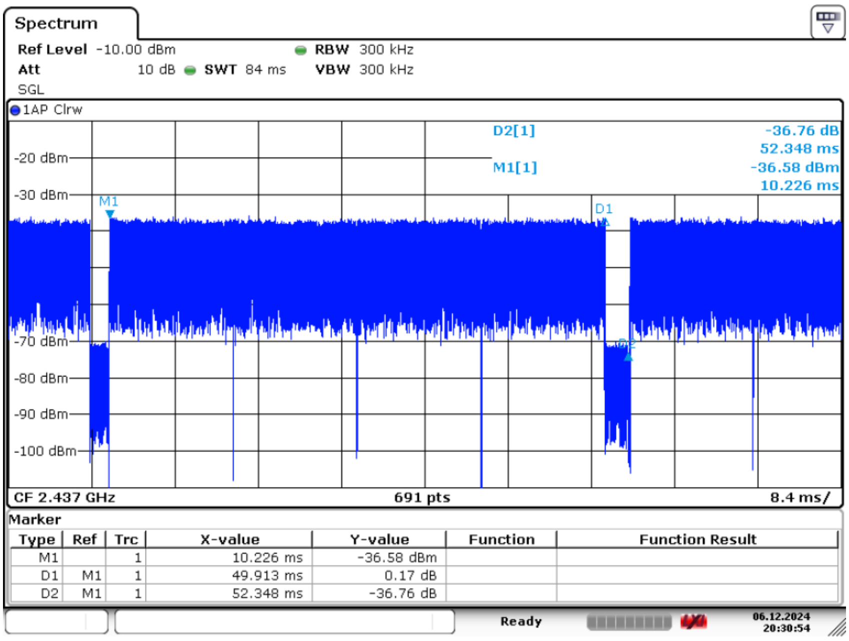
Duty cycle = 100.00%

Table 10.2: The conducted Power measurement results for WLAN 2.4GHz

Mode	Channel	Frequency (MHz)	Averaged Power (dBm)	**Tune up (dBm)**
802.11b	1	2412.0	**17.48**	**18.5**
	6	2437.0	**17.87**	**18.5**
	11	2462.0	**17.43**	**18.5**
802.11g	1	2412.0	16.89	**17.5**
	6	2437.0	16.12	**17.5**
	11	2462.0	16.54	**17.5**
802.11n(20MHz)	1	2412.0	15.68	**16.5**
	6	2437.0	15.28	**16.5**
	11	2462.0	15.40	**16.5**
802.11n(40MHz)	3	2422.0	15.90	**16.5**
	6	2437.0	15.54	**16.5**
	9	2452.0	15.60	**16.5**

Duty factor plot



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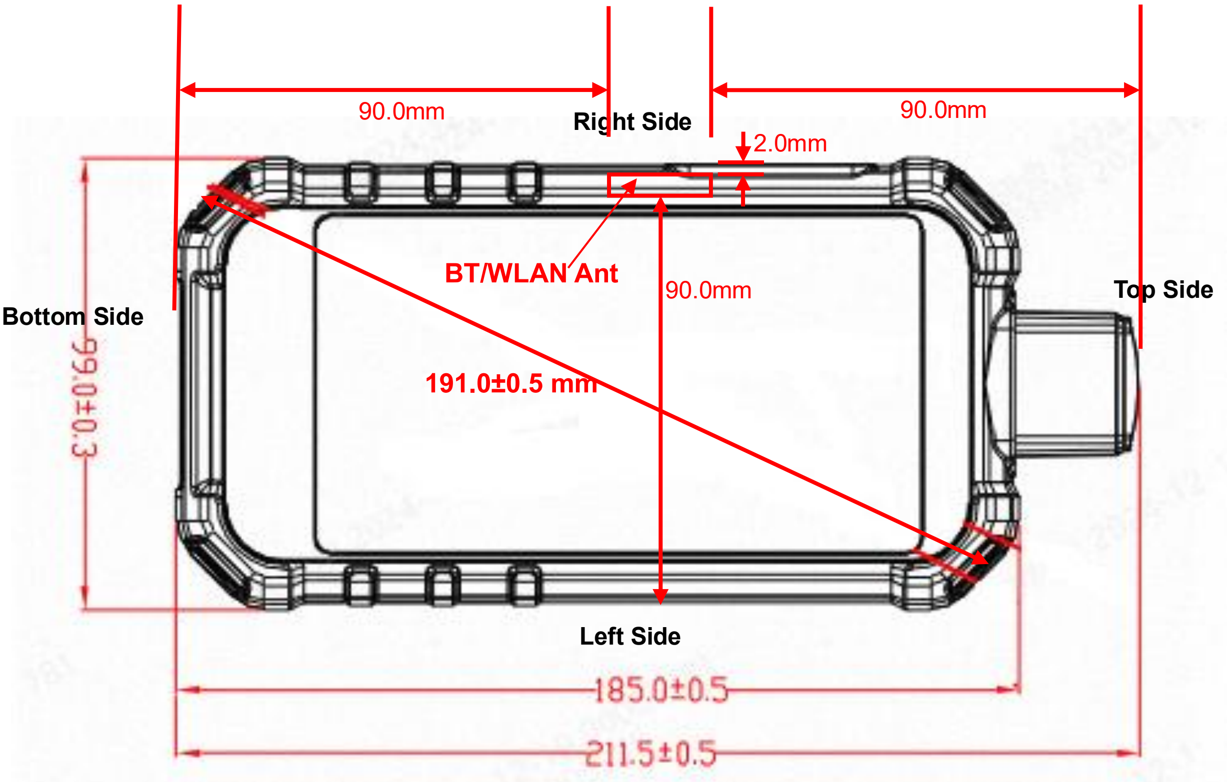
Duty cycle = on time / total time = (49.913 / 52.348) * 100% = 95.35%

11. Simultaneous TX SAR Considerations

11.1. Transmit Antenna Position and Size



Picture 11.1 Antenna Locations (Rear View)

11.2. SAR Measurement Positions

SAR measurement positions						
Antenna	Front	Rear	Left Side	Right Side	Top Side	Bottom Side
WLAN	Yes	Yes	No	Yes	No	No

Antenna	Frequency (GHz)	Test Positions	Test separation distances (mm)	Max. power		Test exclusion thresholds		(≤ 50 mm)	
				(dBm)	(mW)	Body-worn	Extremity SAR	Body-worn	Extremity SAR
Bluetooth	2.402	Front	5	8.5	7.08	2.19	2.19	≤ 3.0	<7.5
	2.402	Rear	5	8.5	7.08	2.19	2.19	≤ 3.0	<7.5
	2.402	Right	5	8.5	7.08	2.19	2.19	≤ 3.0	<7.5
								(> 50 mm)	
	2.402	Left	90	8.5	7.08	/	/	496mW	
	2.402	Top	90	8.5	7.08	/	/	496mW	
	2.402	Bottom	90	8.5	7.08	/	/	496mW	

Antenna	Frequency (GHz)	Test Positions	Test separation distances (mm)	Max. power		Test exclusion thresholds		(≤ 50 mm)	
				(dBm)	(mW)	Body-worn	Extremity SAR	Body-worn	Extremity SAR
WLAN 2.4GHz	2.412	Front	5	18.5	70.79	21.99	21.99	≤ 3.0	<7.5
	2.412	Rear	5	18.5	70.79	21.99	21.99	≤ 3.0	<7.5
	2.412	Right	5	18.5	70.79	21.99	21.99	≤ 3.0	<7.5
								(> 50 mm)	
	2.412	Left	90	18.5	70.79	/	/	496mW	
	2.412	Top	90	18.5	70.79	/	/	496mW	
	2.412	Bottom	90	18.5	70.79	/	/	496mW	

Note:

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

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

$f_{(GHz)}$ is the RF channel transmit frequency in GHz

Power and distance are rounded to the nearest mW and mm before calculation

2. Per KDB 447498 D01v06, for 100 MHz to 6 GHz and *test separation distances* > 50 mm, the 1-g and 10-g *SAR test exclusion thresholds* are determined by the following

1) {[Power allowed at *numeric threshold* for 50 mm in step a)] + [(test separation distance - 50 mm) ·(f(MHz)/150)]} mW, for 100 MHz to 1500 MHz

2) {[Power allowed at *numeric threshold* for 50 mm in step a)] + [(test separation distance - 50 mm) ·10]} mW, for > 1500 MHz and ≤ 6 GHz

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

11.3. Evaluation of Simultaneous

No.	Simultaneous Transmission Configuration
1	Bluetooth + WLAN 2.4GHz

Table 11.1: Maximum Simultaneous Transmission SAR

/	Position	Sum (W/kg)
Highest reported SAR value for Body-worn	Right Side (WLAN 2.4GHz + Bluetooth)	**0.13**
Highest reported SAR value for Extremity	Right Side (WLAN 2.4GHz + Bluetooth)	**0.47**

Note: The test positions of above tables are for the worse case that has been evaluated.

12. Summary of Test Results

According to the client's decision rule in the test registration form, which is "based on the measurement results as the basis of the conformity statement", the test conclusion of this report meets the limit requirements.

The calculated SAR is obtained by the following formula:

$$\text{Calculated SAR} = \text{Measured SAR} \times 10^{(P_{\text{Target}} - P_{\text{Measured}})/10}$$

Where P_{Target} is the power of manufacturing upper limit;

$P_{Measured}$ is the measured power in chapter 10.

12.1. Testing Environment

Temperature:	18°C~25°C
Relative humidity:	30%~70%
Ambient noise & Reflection:	< 0.012 W/kg

12.2. Test Results

Table 12.1: Bluetooth SAR Values

RF Exposure Conditions	Frequency Band	Channel Number	Frequency (MHz)	Mode/RB	Test Position	Distance	Note	Figure No.	EUT Measured Power (dBm)	Tune up (dBm)	Duty Cycle %	Duty Cycle Scaling Factor	Measured SAR 1g (W/kg)	Calculated SAR 1g (W/kg)	Measured SAR 10g (W/kg)	Calculated SAR 10g (W/kg)	Power Drift
Body-worn	Bluetooth	39	2441.0	EDR2M-4_DQPSK	Front	10mm	\	\	7.67	8.50	100.00	1.00	<0.01	**<0.01**	<0.01	**<0.01**	\
Body-worn	Bluetooth	39	2441.0	EDR2M-4_DQPSK	Rear	10mm	\	\	7.67	8.50	100.00	1.00	<0.01	**<0.01**	<0.01	**<0.01**	\
Extremity	Bluetooth	39	2441.0	EDR2M-4_DQPSK	Front	0mm	\	\	7.67	8.50	100.00	1.00	<0.01	**<0.01**	<0.01	**<0.01**	\
Extremity	Bluetooth	39	2441.0	EDR2M-4_DQPSK	Rear	0mm	\	\	7.67	8.50	100.00	1.00	<0.01	**<0.01**	<0.01	**<0.01**	\
Extremity	Bluetooth	39	2441.0	EDR2M-4_DQPSK	Right	0mm	\	\	7.67	8.50	100.00	1.00	0.003	**<0.01**	0.001	**<0.01**	0.07
Extremity	Bluetooth	78	2480.0	EDR2M-4_DQPSK	Right	0mm	\	**1**	7.53	8.50	100.00	1.00	0.012	**0.02**	**0.004**	0.01	-0.05
Extremity	Bluetooth	0	2402.0	EDR2M-4_DQPSK	Right	0mm	\	\	7.57	8.50	100.00	1.00	<0.01	**<0.01**	<0.01	**<0.01**	\

Table 12.2: WLAN 2.4GHz SAR Values

RF Exposure Conditions	Frequency Band	Channel Number	Frequency (MHz)	Mode/RB	Test Position	Distance	Note	Figure No.	EUT Measured Power (dBm)	Tune up (dBm)	Duty Cycle %	Duty Cycle Scaling Factor	Measured SAR 1g (W/kg)	Calculated SAR 1g (W/kg)	Measured SAR 10g (W/kg)	Calculated SAR 10g (W/kg)	Power Drift
Body-worn	WLAN 2.4GHz	6	2437.0	802.11b	Front	10mm	\	\	17.87	18.50	95.35	1.05	0.092	**0.11**	0.046	**0.06**	0.14
Body-worn	WLAN 2.4GHz	6	2437.0	802.11b	Rear	10mm	\	\	17.87	18.50	95.35	1.05	0.042	**0.05**	0.015	**0.02**	0.16
Body-worn	WLAN 2.4GHz	11	2462.0	802.11b	Front	10mm	\	\	17.43	18.50	95.35	1.00	0.053	**0.07**	0.021	**0.03**	-0.13
Body-worn	WLAN 2.4GHz	1	2412.0	802.11b	Front	10mm	\	**2**	17.48	18.50	95.35	1.00	**0.102**	0.13	0.053	**0.07**	0.15
Extremity	WLAN 2.4GHz	6	2437.0	802.11b	Front	0mm	\	\	17.87	18.50	95.35	1.05	0.500	**0.61**	0.197	**0.24**	0.03
Extremity	WLAN 2.4GHz	6	2437.0	802.11b	Rear	0mm	\	\	17.87	18.50	95.35	1.05	0.077	**0.09**	0.041	**0.05**	0.09
Extremity	WLAN 2.4GHz	6	2437.0	802.11b	Right	0mm	\	\	17.87	18.50	95.35	1.00	0.749	**0.87**	0.296	**0.34**	0.14
Extremity	WLAN 2.4GHz	11	2462.0	802.11b	Right	0mm	\	\	17.43	18.50	95.35	1.00	0.397	**0.51**	0.163	**0.21**	0.07
Extremity	WLAN 2.4GHz	1	2412.0	802.11b	Right	0mm	\	**3**	17.48	18.50	95.35	1.00	0.819	**1.04**	**0.365**	0.46	-0.09

Note:

1. According to the KDB 248227 D01, SAR is measured for 2.4GHz 802.11b DSSS using the initial test position procedure.

2. For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

3. According to the KDB 248227 D01, the reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

4. SAR is not required for OFDM because the 802.11b adjusted SAR ≤ 1.2 W/kg.

13. SAR Measurement Variability

SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium.

The following procedures are applied to determine if repeated measurements are required.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.

2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.

3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).

4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

14. Measurement Uncertainty

14.1. Measurement Uncertainty for Normal SAR Tests (300MHz~3GHz)

No.	Error Description	Type	Uncertainty value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement system										
1	Probe calibration	B	11.0	N	2	1	1	5.5	5.5	∞
2	Axial isotropy	B	4.7	R	$\sqrt{3}$	$\sqrt{0.5}$	$\sqrt{0.5}$	4.3	4.3	∞
3	Hemispherical isotropy	B	9.6	R	$\sqrt{3}$	1	1	4.8	4.8	∞
4	Boundary effect	B	1.1	R	$\sqrt{3}$	1	1	0.6	0.6	∞
5	Linearity	B	4.7	R	$\sqrt{3}$	1	1	2.7	2.7	∞
6	Detection limit	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
7	Modulation response	B	4.0	R	$\sqrt{3}$	1	1	2.3	2.3	∞
8	Readout electronics	B	1.0	N	1	1	1	1.0	1.0	∞
9	Response time	B	0.8	R	$\sqrt{3}$	1	1	0.5	0.5	∞
10	Integration time	B	1.7	R	$\sqrt{3}$	1	1	1.0	1.0	∞
11	RF ambient conditions-noise	B	3.0	R	$\sqrt{3}$	1	1	1.7	1.7	∞
12	RF ambient conditions-reflection	B	3.0	R	$\sqrt{3}$	1	1	1.7	1.7	∞
13	Probe positioned mech. restrictions	B	0.35	R	$\sqrt{3}$	1	1	0.2	0.2	∞
14	Probe positioning with respect to phantom shell	B	2.9	R	$\sqrt{3}$	1	1	1.7	1.7	∞
15	Post-processing	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
Test sample related										
16	Test sample positioning	A	3.3	N	1	1	1	3.3	3.3	5
17	Device holder uncertainty	A	3.4	N	1	1	1	3.4	3.4	5
18	Power scaling	B	0	R	$\sqrt{3}$	1	1	0	0	∞
19	Drift of output power	B	5.0	R	$\sqrt{3}$	1	1	2.9	2.9	∞
Phantom and set-up										
20	Phantom uncertainty	B	1.0	R	$\sqrt{3}$	1	1	0.6	0.6	∞
21	Algorithm for correcting SAR for deviations in permittivity and conductivity	B	1.9	N	1	1	0.84	1.9	1.6	∞
22	Liquid conductivity (target)	B	5.0	R	$\sqrt{3}$	0.64	0.43	1.8	1.2	∞
23	Liquid conductivity (meas.)	A	1.3	N	1	0.64	0.43	0.83	0.56	9
24	Liquid permittivity (target)	B	5.0	R	$\sqrt{3}$	0.6	0.49	1.7	1.4	∞
25	Liquid permittivity (meas.)	A	1.6	N	1	0.6	0.49	0.96	0.78	9
Combined standard uncertainty, $u_c' = \sqrt{\sum_{i=1}^{25} c_i^2 u_i^2}$								11.2	11.0	95.5
Expanded uncertainty (Confidence interval of 95 %), $u_e = 2u_c$								22.4	22.0	

15. Main Test Instruments

Table 15.1: List of Main Instruments

No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	E5071C	MY46103759	2024-11-12	One year
02	Dielectric probe	85070E	MY44300317	/	/
03	Power meter	E4418B	MY50000366	2024-12-09	One year
04	Power sensor	E9304A	MY50000188	2024-12-09	One year
05	Power meter	NRP	102603	2023-12-28 & 2024-12-17	One year
06	Power sensor	NRP-Z51	102211		One year
07	Signal Generator	E8257D	MY47461211	2024-01-12	One year
08	Amplifier	VTL5400	0404	/	/
09	DAE	DAE4	1790	2024-06-06	One year
10	E-field Probe	EX3DV4	7683	2024-07-03	One year
11	Dipole Validation Kit	D2450V2	873	2024-09-26	Three years
12	Thermometer	51II	99250045	2024-11-21	One year
13	Software	DASY5	/	/	/

ANNEX A: Graph Results

Bluetooth Extremity

Date: 2024-12-31

Electronics: DAE4 Sn1790

Medium: Head 2450MHz

Medium parameters used: f = 2480 MHz; σ = 1.861 S/m; ε_r = 38.223; ρ = 1000 kg/m^3

Communication System: UID 0, BT (0) Frequency: 2480 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN7683 ConvF (7.87, 7.49, 7.34)

Right Side Ch.78/Area Scan (61x151x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.0343 W/kg

Right Side Ch.78/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 1.622 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 0.0310 W/kg

SAR(1 g) = 0.012 W/kg; SAR(10 g) = 0.00409 W/kg

Maximum value of SAR (measured) = 0.0212 W/kg

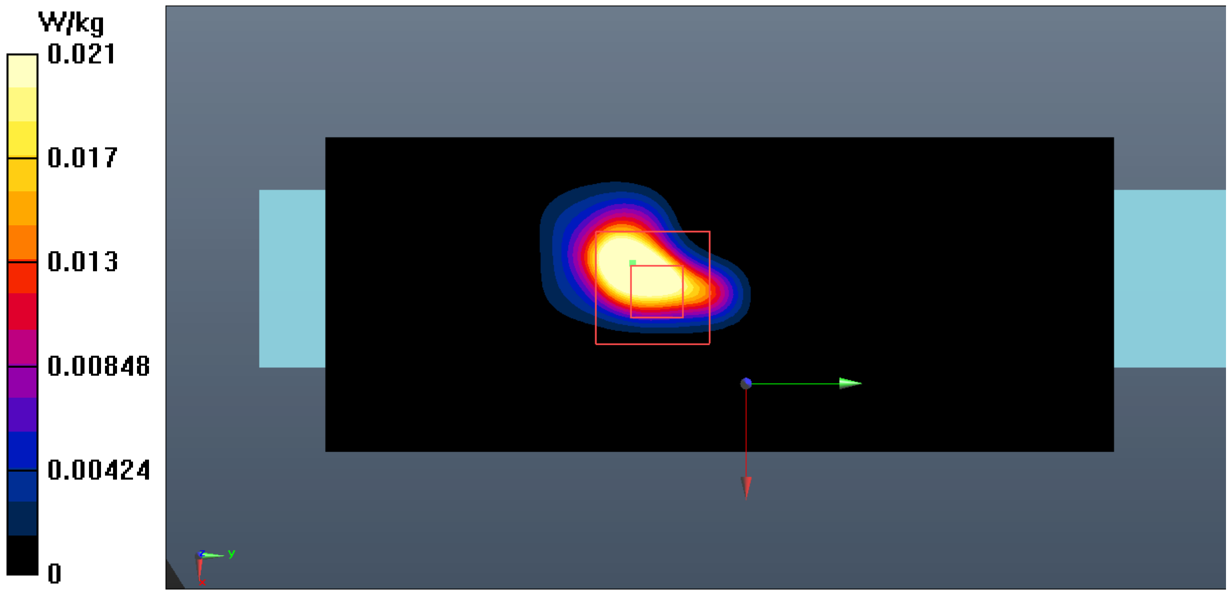


Fig.1 Bluetooth Extremity

WLAN 2.4GHz Body
Date: 2024-12-11
Electronics: DAE4 Sn1790
Medium: Head 2450MHz
Medium parameters used: f = 2412 MHz; σ = 1.728 S/m; εr = 39.97; ρ = 1000 kg/m^3
Communication System: UID 0, WLAN (0) Frequency: 2412 MHz Duty Cycle: 1:1
Probe: EX3DV4 - SN7683 ConvF (7.87, 7.49, 7.34)

Front Side Ch.1/Area Scan (111x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.172 W/kg

Front Side Ch.1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 1.056 V/m; Power Drift = 0.15 dB
Peak SAR (extrapolated) = 0.187 W/kg
SAR(1 g) = 0.102 W/kg; SAR(10 g) = 0.053 W/kg
Maximum value of SAR (measured) = 0.141 W/kg

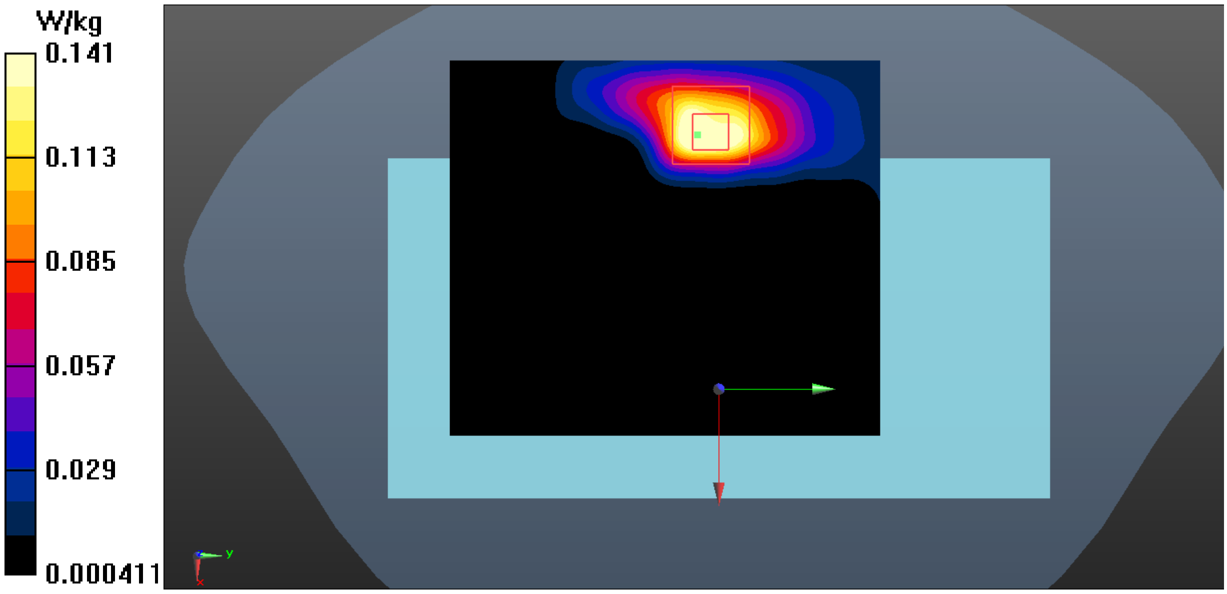


Fig.2 WLAN 2.4GHz Body

WLAN 2.4GHz Extremity
Date: 2024-12-11
Electronics: DAE4 Sn1790
Medium: Head 2450MHz
Medium parameters used: f = 2412 MHz; σ = 1.728 S/m; εr = 39.97; ρ = 1000 kg/m^3
Communication System: UID 0, WLAN (0) Frequency: 2412 MHz Duty Cycle: 1:1
Probe: EX3DV4 - SN7683 ConvF (7.87, 7.49, 7.34)

Right Side Ch.1/Area Scan (61x151x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.30 W/kg

Right Side Ch.1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.169 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 1.69 W/kg
SAR(1 g) = 0.819 W/kg; SAR(10 g) = 0.365 W/kg
Maximum value of SAR (measured) = 1.21 W/kg

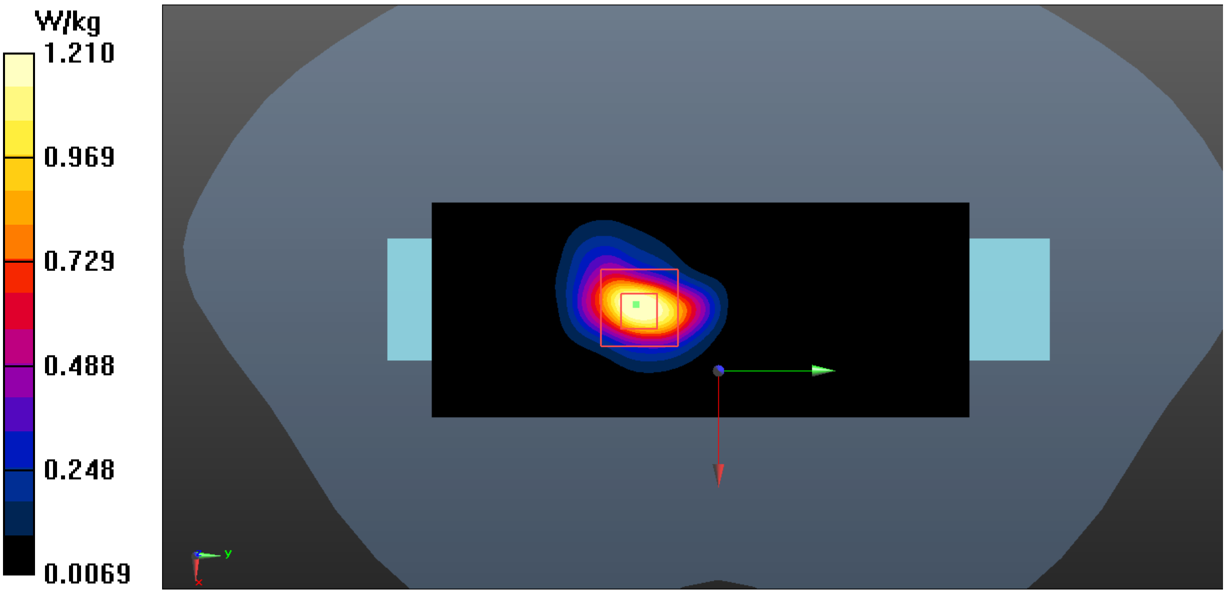


Fig.3 WLAN 2.4GHz Extremity

ANNEX B: System Check Results

2450MHz

Date: 2024-12-11

Electronics: DAE4 Sn1790

Medium: Head 2450MHz

Medium parameters used: f = 2450 MHz; σ = 1.773 S/m; ε_r = 39.845; ρ = 1000 kg/m^3

Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN7683 ConvF (7.87, 7.49, 7.34)

System Validation/Area Scan (81x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 65.545 V/m; Power Drift = 0.08 dB

SAR(1 g) = 5.19 W/kg; SAR(10 g) = 2.47 W/kg

Maximum value of SAR (interpolated) = 7.17 W/kg

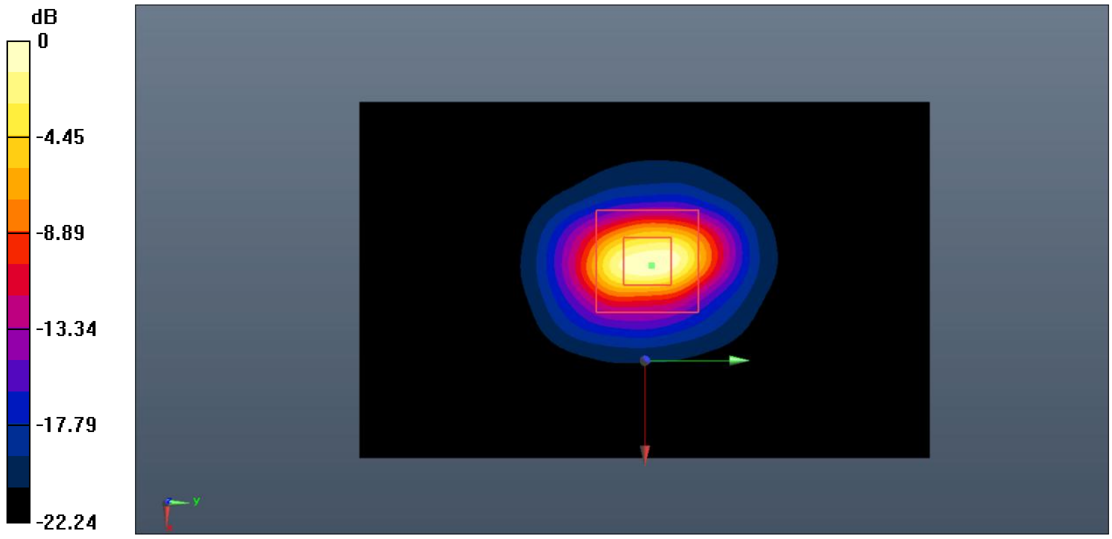
System Validation/Zoom Scan (7x7x7)/Cube0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 65.545 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 13.3 W/kg

SAR(1 g) = 5.10 W/kg; SAR(10 g) = 2.44 W/kg

Maximum value of SAR (measured) = 7.22 W/kg



0 dB = 7.22 W/kg = 8.59 dB W/kg

Fig.B.1. Validation 2450MHz 100mW

2450MHz

Date: 2024-12-31

Electronics: DAE4 Sn1790

Medium: Head 2450MHz

Medium parameters used: f = 2450 MHz; σ = 1.826 S/m; ε_r = 38.322; ρ = 1000 kg/m^3

Communication System: CW Frequency: 2450 MHz Duty Cycle: 1:1

Probe: EX3DV4 - SN7683 ConvF (7.87, 7.49, 7.34)

System Validation/Area Scan (81x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Reference Value = 68.149 V/m; Power Drift = 0.13 dB

SAR(1 g) = 5.34 W/kg; SAR(10 g) = 2.50 W/kg

Maximum value of SAR (interpolated) = 7.28 W/kg

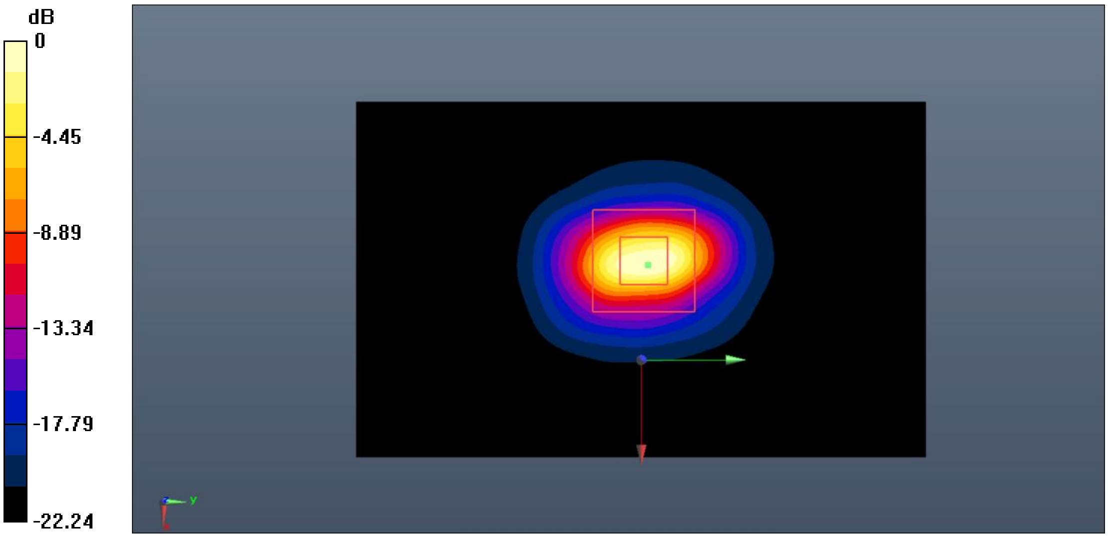
System Validation/Zoom Scan (7x7x7)/Cube0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 68.149 V/m; Power Drift = 0.13 dB

Peak SAR (extrapolated) = 14.5 W/kg

SAR(1 g) = 5.48 W/kg; SAR(10 g) = 2.56 W/kg

Maximum value of SAR (measured) = 7.34 W/kg



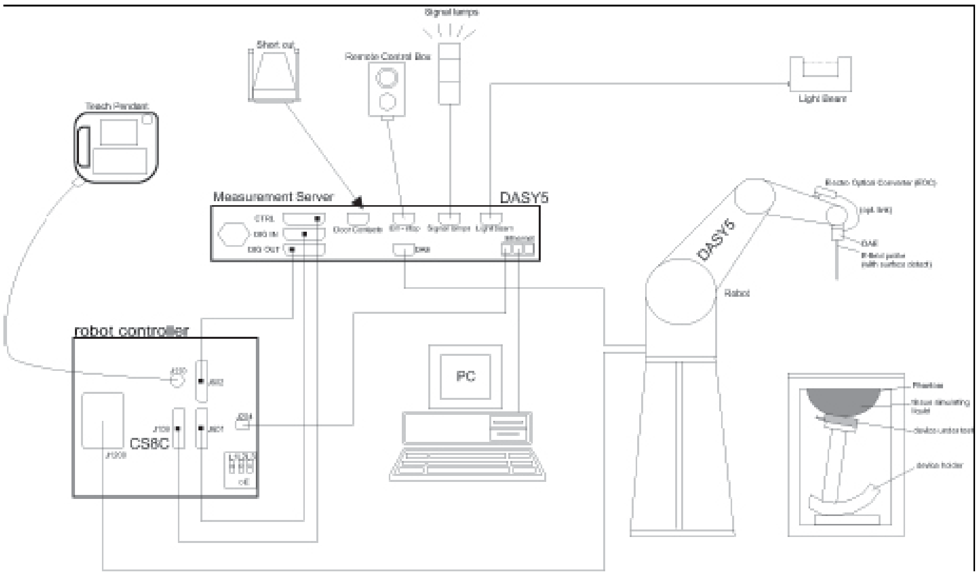
0 dB = 7.34 W/kg = 8.66 dB W/kg

Fig.B.2. Validation 2450MHz 100mW

ANNEX C: SAR Measurement Setup

C.1. Measurement Set-up

DASY5 system for performing compliance tests is illustrated above graphically. This system consists of the following items:



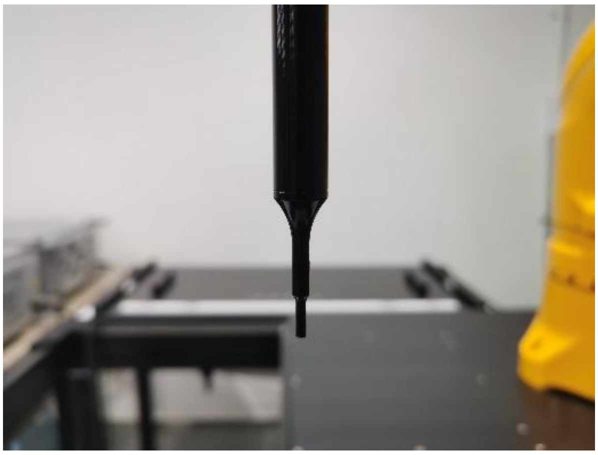
Picture C.1 SAR Lab Test Measurement Set-up

- A standard high precision 6-axis robot (Stäubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (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.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as
- warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

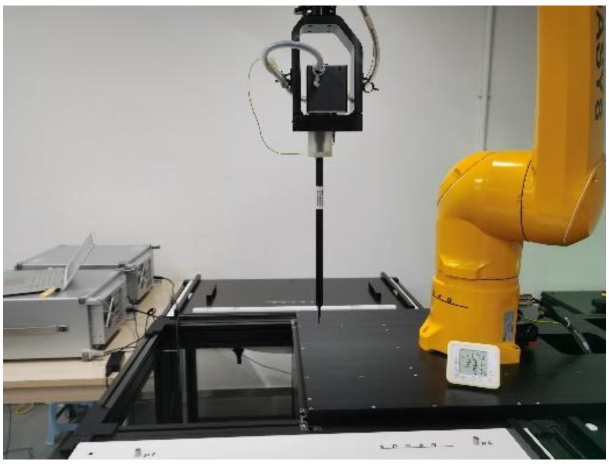
C.2. DASY E-field Probe System

The SAR measurements were conducted with the dosimetric probe designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multifiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY5 OR DASY8 software reads the reflection durning a software approach and looks for the maximum using 2ndord curve fitting. The approach is stopped at reaching the maximum.

Probe Specifications:	
Model:	EX3DV4
Frequency Range:	10 MHz - 6.0 GHz
Calibration:	In head simulating tissue at Frequencies from 750 up to 5750 MHz
Linearity:	± 0.2 dB (30 MHz to 6 GHz)
Dynamic Range:	10 mW/kg - 100 W/kg
Probe Length:	337 mm
Probe Tip Length:	20 mm
Body Diameter:	12 mm
Tip Diameter:	2.5 mm
Tip-Center:	1 mm
Application:	SAR Dosimetry Testing / Compliance tests of mobile phones / Dosimetry in strong gradient fields



Picture C.2: Near-field Probe



Picture C.3: E-field Probe

C.3. E-field Probe Calibration

Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm^2) using an RF Signal generator, TEM cell, and RF Power Meter.

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and inn a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/ cm^2.

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

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

Where:

Δt = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

ΔT = Temperature increase due to RF exposure.

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

Where:

σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m^3).

C.4. Other Test Equipment

C.4.1. Data Acquisition Electronics (DAE)

The data acquisition electronics consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

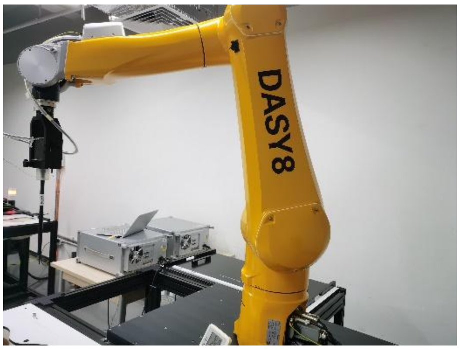
Picture C.4: DAE

C.4.2. Robot

The SPEAG DASY system uses the high precision robots (DASY5: RX90L) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability 0.02mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements (brushless synchron motors; no stepper motors)
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)

Picture C.5: DASY 5



Picture C.6: DASY 8

C.4.3. Measurement Server

The Measurement server is based on a PC/104 CPU broad with CPU (DASY5: 400 MHz, Intel Celeron), chipdisk (DASY5:128MB), RAM (DASY5:128MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O broad, which is directly connected to the PC/104 bus of the CPU broad.

The measurement server performs all real-time data evaluation of field measurements and surface detection, controls robot movements and handles safety operation. The PC operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with an expansion port which is reserved for future applications. Please note that this expansion port does not have a standardized pinout, and therefore only devices provided by SPEAG can be connected. Devices from any other supplier could seriously damage the measurement server.

Picture C.7: Server for DASY 5

Picture C.8: Server for DASY 8

C.4.4. Device Holder for 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 at 5mm distance, a positioning uncertainty of ±0.5mm would produce a SAR uncertainty of ±20%. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY 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.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity ε=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.

<Laptop Extension Kit>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin-SAM and ELI phantoms.