SAR EVALUATION REPORT

For

Zebra Technologies, Corporation

2833 Junction Avenue Suite 100
San Jose, CA, United States, 95134

FCC ID: UZ7RE40
IC: 109AN-RE40

Report Type:	Product Type:
Class II Permissive Change	RFID Module

Prepared By:	Kevin Chau RF Test Engineer
Report Number:	R2311293-SAR
Report Date:	2024-08-20
Reviewed By:	Alexandrae Duran RF Project Engineer

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CERTIFICATE #3297.02

<table>
<tr><th colspan="4">Summary of Test Results</th></tr>
<tr><td rowspan="6">EUT Information</td><td>EUT Description</td><td colspan="2">The EUT is an RFID module transmitting in the band of 902.75 MHz – 927.25 MHz</td></tr>
<tr><td>Tested Model</td><td colspan="2">RE40</td></tr>
<tr><td>FCC ID/IC:</td><td colspan="2">FCC ID: UZ7RE40
IC: 109AN-RE40</td></tr>
<tr><td>Serial Number</td><td colspan="2">R2311293-1</td></tr>
<tr><td>Test Dates:</td><td colspan="2">2024-07-11</td></tr>
<tr><td>Accessories:</td><td colspan="2">None</td></tr>
<tr><td>Frequency (MHz)</td><td>SAR Type</td><td>Max. SAR Level(s) Reported 10-g (W/kg)</td><td>FCC/IC Limit 10-g SAR (W/kg)</td></tr>
<tr><td>914.75</td><td>10g</td><td>0.00</td><td>4.0</td></tr>
<tr><td rowspan="7">Applicable Standards</td><td colspan="3">FCC 47 CFR part 2.1093
Radiofrequency radiation exposure evaluation: portable devices</td></tr>
<tr><td colspan="3">FCC 47 CFR part 1.1310
Radiofrequency radiation exposure limits.</td></tr>
<tr><td colspan="3">RSS-102 Issue 6
Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)</td></tr>
<tr><td colspan="3">ANSI/IEEE C95.1: 2019
IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields,3 kHz to 300 GHz.</td></tr>
<tr><td colspan="3">ANSI/IEEE C95.3: 2021
IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to SuchFields,100 kHz-300 GHz.</td></tr>
<tr><td colspan="3">IEC/IEEE 62209-1528
Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-worn wireless communication devices – Human models, instrumentation and procedures (Frequency range of 4MHz to 10GHz).</td></tr>
<tr><td colspan="3">KDB procedures
KDB 447498 D01 General RF Exposure Guidance v06
KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
KDB 865664 D02 RF Exposure Reporting v01r02</td></tr>
<tr><td colspan="4">Note: This wireless device has been shown to be capable of compliance for localized specific absorption rate (SAR) for General Population/Uncontrolled Exposure limits specified in FCC 47 CFR part 2.1093 and has been tested in accordance with the measurement procedures specified in IEC/IEEE 62209-1528 and RF exposure KDB procedures.
The results and statements contained in this report pertain only to the device(s) evaluated.</td></tr>
</table>

TABLE OF CONTENTS

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2311293-SAR	Original Report	2024-08-20

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test report has been compiled on behalf of *Zebra Technologies Corporation*, and their product model: RE40, *FCC ID: UZ7RE40 , IC: 109AN-RE40*, which henceforth is referred to as the EUT (Equipment Under Test). The EUT is an RFID Module. The EUT operates in the frequency range: 902.75 MHz – 927.25 MHz.

Test EUT Technical Specification

Item	Description
Operational Modes	900MHz: ASK
Frequency Range (MHz)	902.75 MHz – 927.25 MHz
Maximum Conducted Power (dBm)	26.32
Device Power Source	7.2 V Rechargeable Li-ion battery
Power Source Manufacturer	Zebra Technologies Corporation
Device Normal Operation	Hand-held

The test data gathered are from typical production sample, model number: RE40 with S/N: *R2311293-1* provided by BACL.

2 Test Facility

Bay Area Compliance Laboratories Corp. (BACL) is:

A- *An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2017 by A2LA (Test Laboratory Accreditation Certificate Number 3297.02),* in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2005 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025:2005 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

B- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.03)*** to certify

- - For the USA (Federal Communications Commission):
    1- All Unlicensed radio frequency devices within FCC Scopes A1, A2, A3, and A4;
    2- All Licensed radio frequency devices within FCC Scopes B1, B2, B3, and B4;
    3- All Telephone Terminal Equipment within FCC Scope C.
- For the Canada (Innovation, Science and Economic development Canada - ISEDC):
    1- All Scope 1-Licence-Exempt Radio Frequency Devices;
    2- All Scope 2-Licensed Personal Mobile Radio Services;
    3- All Scope 3-Licensed General Mobile & Fixed Radio Services;
    4- All Scope 4-Licensed Maritime & Aviation Radio Services;
    5- All Scope 5-Licensed Fixed Microwave Radio Services
    6- All Broadcasting Technical Standards (BETS) in the Category I Equipment Standards List.

For Singapore (Infocomm Media Development Authority - IMDA):
    1 All Line Terminal Equipment: All Technical Specifications for Line Terminal Equipment – Table 1 of IDA MRA Recognition Scheme: 2011, Annex 2
    2. All Radio-Communication Equipment: All Technical Specifications for Radio-Communication Equipment – Table 2 of IDA MRA Recognition Scheme: 2011, Annex 2

- For the Hong Kong Special Administrative Region:
    1 All Radio Equipment, per KHCA 10XX-series Specifications;
    2 All GMDSS Marine Radio Equipment, per HKCA 12XX-series Specifications;
    3 All Fixed Network Equipment, per HKCA 20XX-series Specifications.
- For Japan:
    1 MIC Telecommunication Business Law (Terminal Equipment):
        - All Scope A1 - Terminal Equipment for the Purpose of Calls;
        - All Scope A2 - Other Terminal Equipment
    2 Radio Law (Radio Equipment):
        - All Scope B1 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 1 of the Radio Law
        - All Scope B2 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 2 of the Radio Law
        - All Scope B3 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 3 of the Radio Law

C- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.01)*** to certify Products to USA's Environmental Protection Agency (EPA) ENERGY STAR Product Specifications for:

1 Electronics and Office Equipment:
- for Telephony (ver. 3.0)
- for Audio/Video (ver. 3.0)
- for Battery Charging Systems (ver. 1.1)

- for Set-top Boxes & Cable Boxes (ver. 4.1)
- for Televisions (ver. 6.1)
- for Computers (ver. 6.0)
- for Displays (ver. 6.0)
- for Imaging Equipment (ver. 2.0)
- for Computer Servers (ver. 2.0)

2 Commercial Food Service Equipment
- for Commercial Dishwashers (ver. 2.0)
- for Commercial Ice Machines (ver. 2.0)
- for Commercial Ovens (ver. 2.1)
- for Commercial Refrigerators and Freezers

3 Lighting Products
- For Decorative Light Strings (ver. 1.5)
- For Luminaires (including sub-components) and Lamps (ver. 1.2)
- For Compact Fluorescent Lamps (CFLs) (ver. 4.3)
- For Integral LED Lamps (ver. 1.4)

4 Heating, Ventilation, and AC Products
- for Residential Ceiling Fans (ver. 3.0)
- for Residential Ventilating Fans (ver. 3.2)

5 Other
- For Water Coolers (ver. 3.0)

D. A NIST Designated Phase-I and Phase-II Conformity Assessment Body (CAB) for the following economies and regulatory authorities under the terms of the stated MRAs/Treaties:

- Australia: ACMA (Australian Communication and Media Authority) – APEC Tel MRA -Phase I;
- Canada: (Innovation, Science and Economic development Canada - ISEDC) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;
- Chinese Taipei (Republic of China – Taiwan):
  - BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
  - NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
  - EMC Directive 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
  - Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
  - Low Voltage Directive (LVD) 2014/35/EU
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA) APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Media Development Authority - IMDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter
- USA:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC;
  - Nationally Recognized Test Laboratory (NRTL) – US OSHA
- Vietnam: APEC Tel MRA -Phase I

3 Reference and Guidelines

3.1 SAR Limits

The Report and Order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. SAR limits are listed in the table below. The regulatory limits referenced are:

FCC:
Title 47 (85 FR 18145, Apr. 1, 2020) § 1.1310 (b), (c), (d)

IC:
RSS-102 Issue 6 (December 15 2023) § 5.2.2

This report describes the methodology and results of experiments performed on wireless data terminal. The objective was to determine if there is RF radiation, and what is the extent of radiation with respect to safety limits if radiation is found. SAR (Specific Absorption Rate) is the measure of RF exposure determined by the amount of RF energy absorbed by human body (or its parts) – to determine how the RF energy couples to the body or head which is a primary health concern for body worn devices. The limit below which the exposure to RF is considered safe by regulatory bodies in North America is 1.6 W/kg average over 1 gram of tissue mass.

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak FCC/IC (averaged over any 1 g of tissue)	1.6	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

General Population/Uncontrolled Environments are defined as locations where there is the exposure of individual who have no knowledge or control of their exposure.

General Population/Uncontrolled environments Spatial Peak limit 1.6 W/kg (FCC/IC over 1 g) applied to the EUT in this application for the worst case consideration.

4 Equipment List and Calibration

4.1 Equipment List & Calibration Info

Type/Model	Cal. Due Date	S/N
DASY8 Professional Dosimetric System	NCR	N/A
Robot TX2-90XL	NCR	F22/0045543/A/001
Robot Controller CS9spe-TX2-90	NCR	F22/0045543/C/001
Pendant Control Box SP2	NCR	D21144508A
Robot Remote Control Box	NCR	N/A
HP Z4 G4 Workstation	NCR	CZC2297ZQN
HP E27q G4 LED Backlit Monitor	NCR	CNK21105WB
SPEAG DAE4	2025-02-24	1724
DASY8 Measurement Server	NCR	N/A
SPEAG E-Field Probe EX3DV4	2025-04-12	7783
SPEAG Dipole Antenna D900V2	2024-08-23	122
SPEAG ELI V8.0 Phantom	NCR	2074
Head Tissue Simulating Liquid HBBL600-10000V6	Each Time	221222-1
HP Power Sensor 8481A	2024-11-06	US37290516
HP Power Sensor 8481A	2024-11-06	1926A28848
Agilent Power Meter E4419B EPM	2025-04-25	GB40202944
Dielectric Probe Kit SPEAG DAK-3.5 Probe	NCR	851
Agilent Network Analyzer E5071C	N/A	MY46107188
HEWLETT PACKARD 779D Directional Coupler	NCR	1144/05102
HEWLETT PACKARD 778D Directional Coupler	NCR	14900
Agilent MXG Signal Generator N5183A	2024-10-31	MY50140453

Note: NCR=No Calibration Required

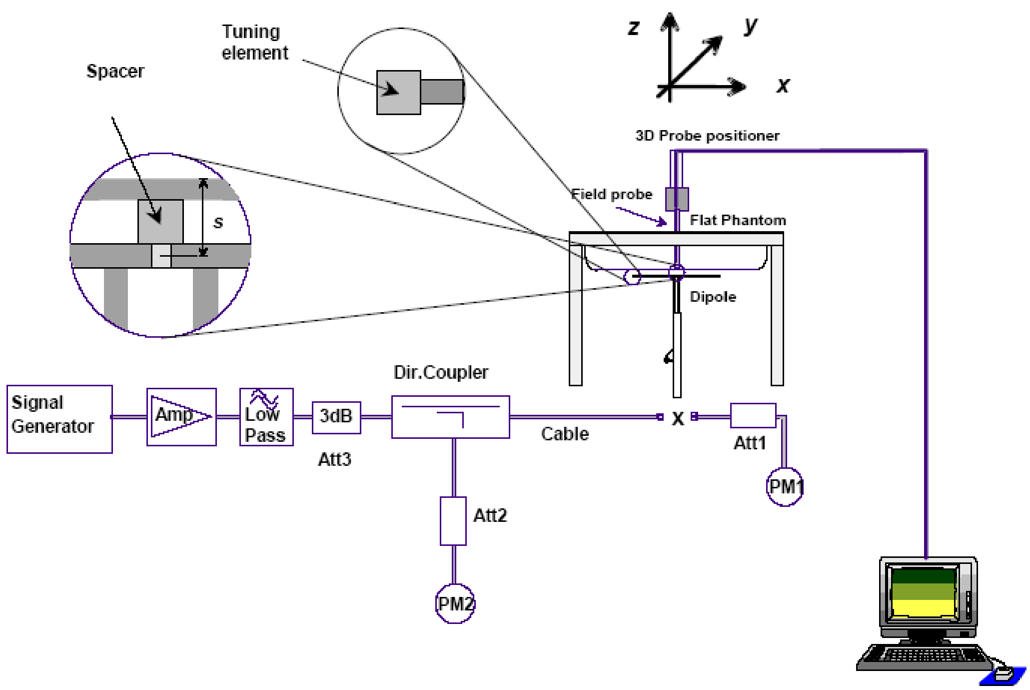
Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

5 SAR Measurement System Verification

5.1 System Accuracy Verification

SAR system verification is required to confirm measurement accuracy. The system verification must be performed for each frequency band. System verification must be performed before each series of SAR measurements.

5.2 System Setup Block Diagram



5.3 Liquid and System Validation

900MHz

Date	Simulant	Freq. [MHz]	Parameters	Liquid Temp [ºC]	Input Power (mW)	Target Value	Measured Value	Deviation [%]	Limits [%]
2024-07-11	Head	900	ε_r	23.45	-	41.5	40.8	-1.69	± 10
			σ	23.45	-	0.97	0.884	-8.87	± 10
			Parameters	**Liquid Temp [ºC]**	**Input Power (mW)**	**Target Value (W/kg)**	**Measured Value (W/kg)**	**Deviation [%]**	**Limits [%]**
			1g SAR	23.45	100	11.0	1.11	0.91	± 10
			10g SAR	23.45	100	7.04	0.719	2.13	± 10

Note: Use of less strict deviation requires use of correction algorithm. This algorithm is employed when necessary.

εr = relative permittivity, σ = conductivity and ρ=1000 kg/m3

Note[1]: Normalization calculation is $N = M * (1 / (10^{(P / 10)} / 1000))$

Where:

N is the 1g/10g SAR W/kg normalized to 1W
M is the measured 1g/10g SAR in W/kg
P is the input power in dBm

Note[1]: Deviation calculation is $D = 100 * ((N – T) / T)$

Where:

D is the deviation in %
N is the 1g/10g SAR W/kg normalized to 1W
T is the target 1g/10g SAR in W/kg

6 EUT Test Strategy and Methodology

6.1 Test position for body-support device and other configurations

A typical example of a body supported device is a wireless enabled laptop device that among other orientations may be supported on the thighs of a sitting use. To represent this orientation, the device shall be positioned with its base against the flat phantom. Other orientations may be specified by the manufactures in the user instructions. If the intended use is not specified, the device shall be tested directly against the flat phantom in all usable orientations.

The screen portion of the device shall be in an open position at a 90° angle, or at an operating angle specified for intended use by the manufacturer in the operating instructions. Where a body supported device has an integral screen required for normal operation, then the screen-side will not need to be tested if it ordinarily remains 200 mm from the body. Where a screen mounted antenna is present, this position shall be repeated with the screen against the flat phantom, if this is consistent with the intended use.

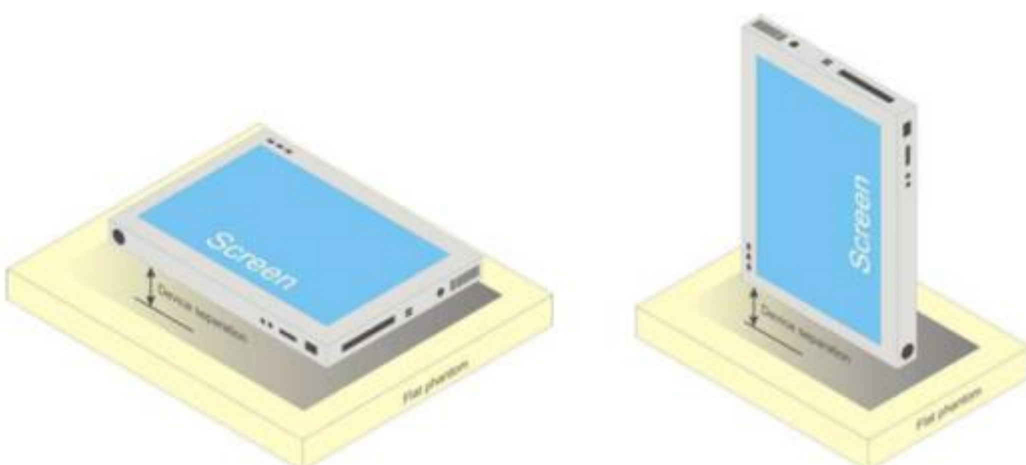
Other devices that fall into this category include tablet type portable computers and credit card transaction authorization terminals, point-of-sale and/or inventory terminals. Where these devices may be torso or limb-supported, the same principles for body-supported devices are applied.

The example in Figure b) shows a tablet from factor portable computer for which SAR should be separately assessed with

a) Each surface and
b) The separation distances

Positioned against the flat phantom that correspond to the intended use as specified by the manufacturer. If the intended use is not specified in the user instructions, the device shall be tested directly against the flat phantom in all usable orientations.

Some body-supported devices may allow testing with an external power supply (e.g. a.c. adapter) supplemental to the battery, but it shall be verified and documented in the measurement report that SAR is still conservative

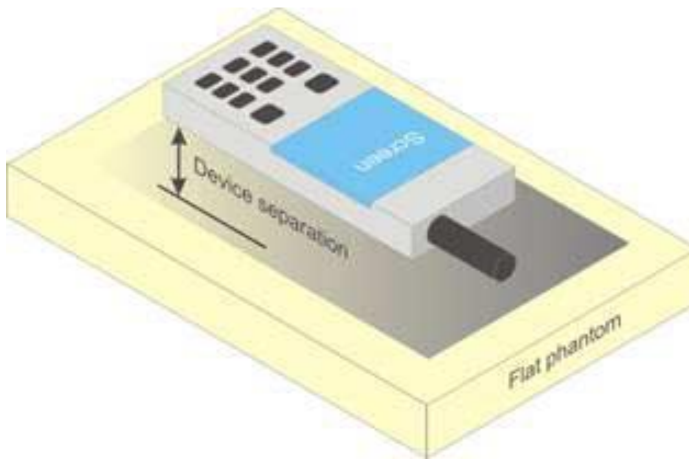


b) Tablet form factor portable computer

6.2 Test positions for body-worn and other configurations

Body-worn operating configurations should be tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in normal use configurations. Devices with a headset output should be tested with a headset connected to the device. When multiple accessories that do not contain metallic components are supplied with the device, the device may be tested with only the accessory that dictates the closest spacing to the body. When multiple accessories that contain metallic components are supplied with the device, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component (e.g., the same metallic belt-clip used with different holsters with no other metallic components), only the accessory that dictates the closest spacing to the body must be tested.

Body-worn accessories may not always be supplied or available as options for some devices that are intended to be authorized for body-worn use. A separation distance of 1.5 cm between the back of the device and a flat phantom is recommended for testing body-worn SAR compliance under such circumstances. Other separation distances may be used, but they should not exceed 2.5 cm. In these cases, the device may use body-worn accessories that provide a separation distance greater than that tested for the device provided however that the accessory contains no metallic components.



6.3 Test Methodology

IEC/IEEE 62209-1528:2020
KDB 447498 D01 General RF Exposure Guidance v06
KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04

7 DASY8 SAR Evaluation Procedure

7.1 Power Reference Measurement

The Power Reference Measurement and Power Drift Measurement jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. By default, the Minimum distance of probe sensors to surface is 4mm. This distance can be modified by the user, but cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties.

7.2 Fast Area Scan

Fast Area Scan is a novel scan available in DASY8. The sensor voltages are sampled continuously while the robot is moving which reduces the scan duration to <30 s for most configurations. It has been developed for the two purposes described below.

Determination of Power Reference Location: The Fast Area Scan provides an easy time, efficient and accurate way to define the optimal power reference location. The location of the power reference and power drift measurements for the subsequent Area, Fast Volume and Zoom Scans will be automatically set at the maximum of the Fast Area Scan.

psSAR1g/8g/10g Assessment: The Fast Area Scan is mainly used to assess psSAR1 g/8 g/10 g values.

- The post processing algorithm used for regular Area Scans is applied to Fast Area Scans as well to compute psSAR1 g/8 g/10 g values.

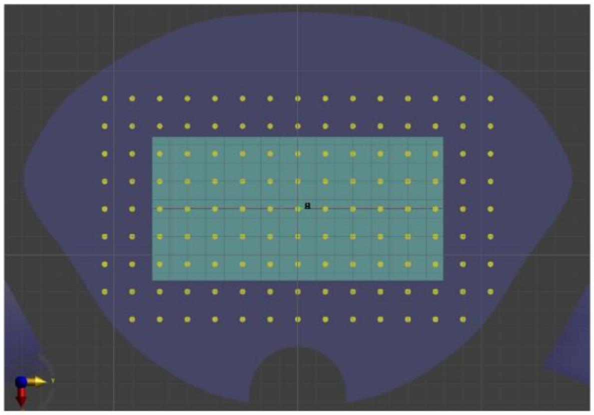
- The measured pattern of the given test configuration is compared to the ones measured previously in the project. If a similar pattern shape (matching configuration) is found, a scaling factor defined as difference in amplitude of the two configurations is computed. The Area Scan and Zoom Scan results available for the matching configuration are then scaled to assess the psSAR1 g/8 g/10 g of the measured configuration.

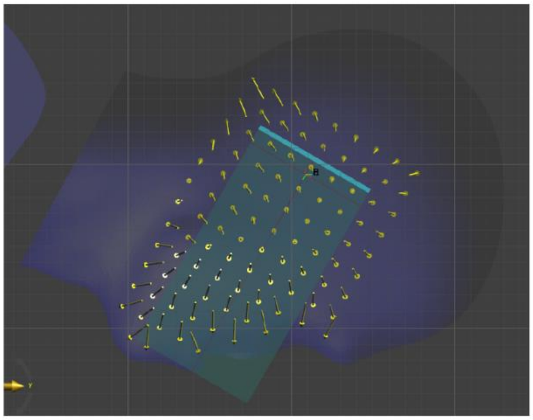
7.3 Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in DASY52 software can find the maximum locations even in relatively coarse grids.

The scanning area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the Area Scan's property sheet is brought-up, grid settings can be edited by a user. When an Area Scan has measured all reachable points, it computes the field maxima found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE 1528, EN 50361 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly (see Section 3.3.2.14 Zoom Scan for details). After measurement is completed, all maxima and their coordinates are listed in the Results property page. The maximum selected in the list is highlighted in the 3-D view. For the secondary maxima returned from an Area Scan, the user can specify a lower limit (peak SAR value), in addition to the Find secondary maxima within x dB condition.

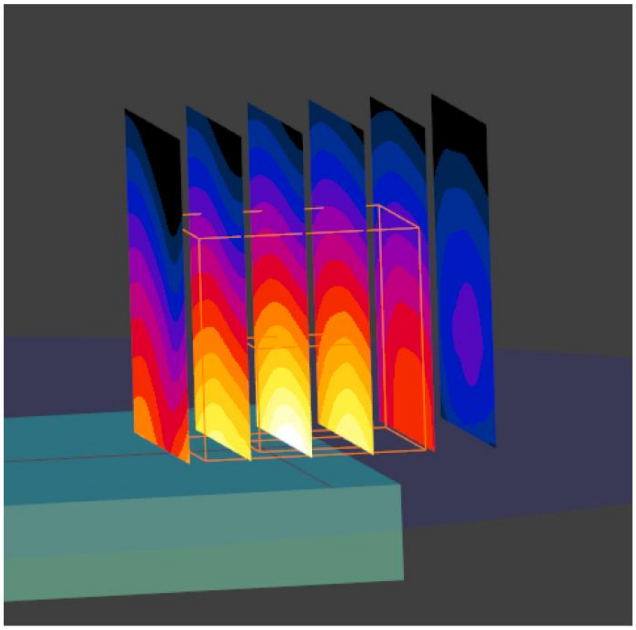
After measurement is completed, all maxima and their coordinates are listed in the Results property page. The maximum selected in the list is highlighted in the 3-D view. For the secondary maxima returned from an Area Scan, the user can specify a lower limit (peak SAR value), in addition to the Find secondary maxima within x dB condition. Only the primary maximum and any secondary maxima within x dB from the primary maximum and above this limit will be measured.





7.4 Zoom Scan

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default Zoom Scan measures 5 x 5 x 7 points within a cube whose base faces are centered around the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.



7.5 Power drift measurement

The Power Drift Measurement job measures the field at the same location as the most recent power reference measurement job within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

7.6 Z-Scan

The Z Scan job measures points along a vertical straight line. The line runs along the Z axis of a one-dimensional grid. A user can anchor the grid to the section reference point, to any defined user point or to the current probe location. As with any other grids, the local Z axis of the anchor location establishes the Z axis of the grid.

8 Description of Test System

These measurements were performed with the automated near-field scanning system DASY8 from Schmid & Partner Engineering AG (SPEAG) which is the sixth generation of the system shown in the figure hereinafter:

The system is based on a high precision robot (working range greater than 1.45m), which positions the probes with a positional repeatability of better than ±0.02mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit.

The SAR measurements were conducted with the dosimetric probe, designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure with accuracy of better than ±10%. The spherical isotropy was evaluated with the procedure and found to be better than ±0.25dB.

8.1 IEEE 62209-1528 Table 2 -- Dielectric properties of the tissue-equivalent medium

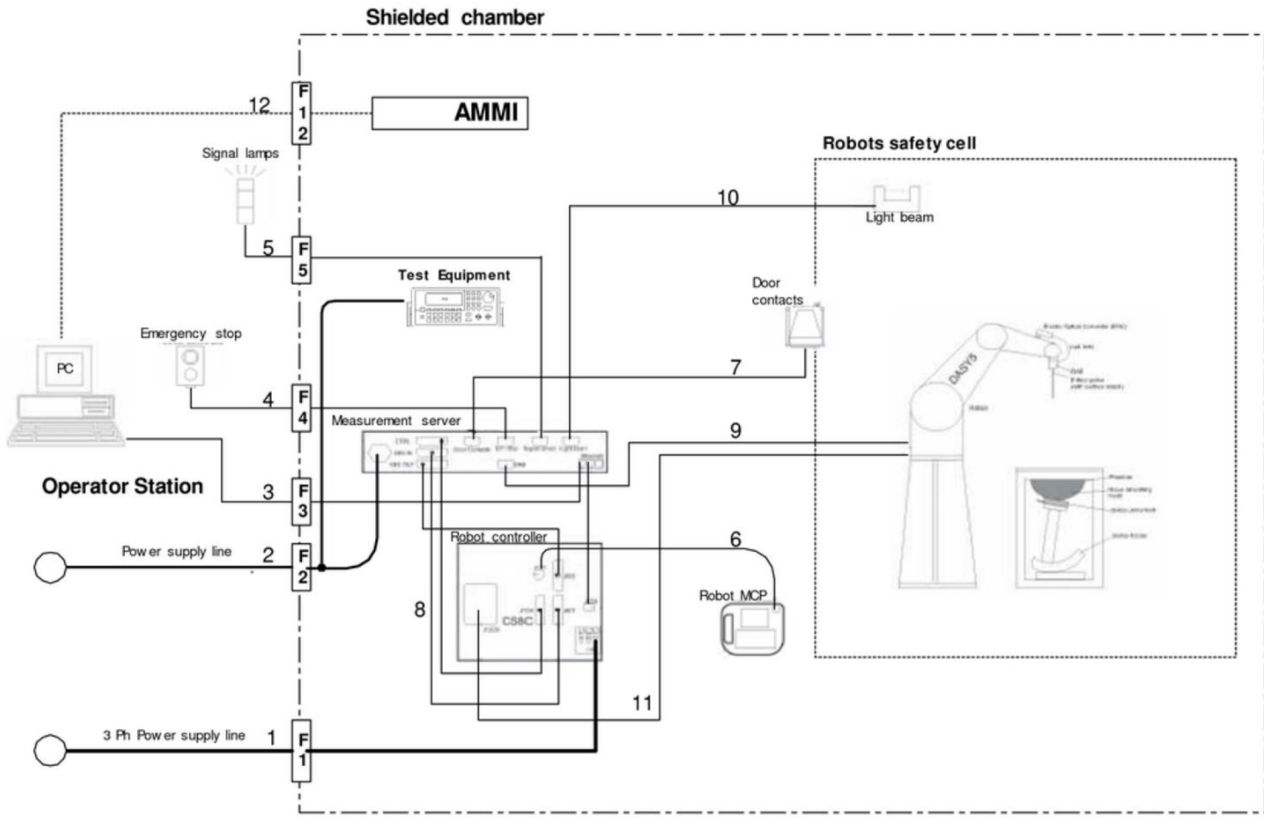
Table 2 – Dielectric properties of the tissue-equivalent medium

Frequency MHz	Real part of the complex relative permittivity, ε_r'	Conductivity, σ S/m	Penetration depth (E-field), δ mm
4	*55,0*	*0,75*	293,0
13	*55,0*	*0,75*	165,5
30	55,0	0,75	112,8
150	52,3	0,76	62,0
300	45,3	0,87	46,1
450	43,5	0,87	43,0
750	*41,9*	*0,89*	39,8
835	41,5	0,90	39,0
900	41,5	0,97	36,2
1 450	40,5	1,20	28,6
1 800	40,0	1,40	24,3
1 900	40,0	1,40	24,3
1 950	40,0	1,40	24,3
2 000	40,0	1,40	24,3
2 100	*39,8*	*1,49*	22,8
2 450	39,2	1,80	18,7
2 600	*39,0*	*1,96*	17,2
3 000	38,5	2,40	14,0
3 500	*37,9*	*2,91*	11,4
4 000	*37,4*	*3,43*	10,0
4 500	*36,8*	*3,94*	9,7

Frequency MHz	Real part of the complex relative permittivity, ε_r'	Conductivity, σ S/m	Penetration depth (E-field), δ mm
5 000	*36,2*	*4,45*	1,5
5 200	*36,0*	*4,66*	8,4
5 400	*35,8*	*4,86*	8,1
5 600	*35,5*	*5,07*	7,5
5 800	35,3	5,27	7,3
6 000	*35,1*	*5,48*	7,0
6 500	*34,5*	*6,07*	6,7
7 000	*33,9*	*6,65*	6,4
7 500	*33,3*	*7,24*	6,1
8 000	*32,7*	*7,84*	5,9
8 500	*32,1*	*8,46*	5,3
9 000	*31,6*	*9,08*	4,8
9 500	*31,0*	*9,71*	4,4
10 000	*30,4*	*10,40*	4,0

NOTE For convenience, permittivity and conductivity values are linearly interpolated for frequencies that are not a part of the original data from Drossos et al. [2]. They are shown in italics in Table 2. The italicized values are linearly interpolated (below 5 800 MHz) or extrapolated (above 5 800 MHz) from the non-italicized values that are immediately above and below these values.

8.2 Measurement System Diagram



The DASY8 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot arm (Stäubli TX2-90XL) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).

- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.

- A data acquisition electronics (DAE4) 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 between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected 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.

- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.

- A computer operating Windows 10 or Windows 11.

• DASY8 software.

• Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.

• The Twin SAM V8.0 phantom enabling testing left-hand and right-hand usage.

• The ELI V8.0 phantom.

• The device holder for handheld mobile phones.

• Tissue simulating liquid mixed according to the given recipes.

• Validation dipole kits allowing system validation.

8.3 System Components

• DASY8 Measurement Server
• Data Acquisition Electronics
• Probes
• Light Beam Unit
• Medium
• SAM Twin V8.0 Phantom
• ELI V8.0 Phantom
• Device Holder for SAM Twin Phantom
• System Validation Kits
• Robot

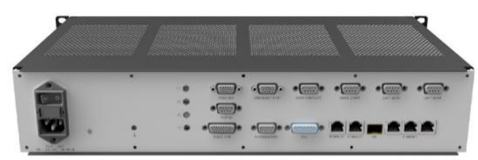
8.4 DASY8 Measurement Server

The DASY8 Measurement Server (see Figure 3.3.1) handles all time critical tasks such as:

• Acquisition of measurement data
• Detection of phantom surface
• Control of robot movements
• Supervision of safety features.

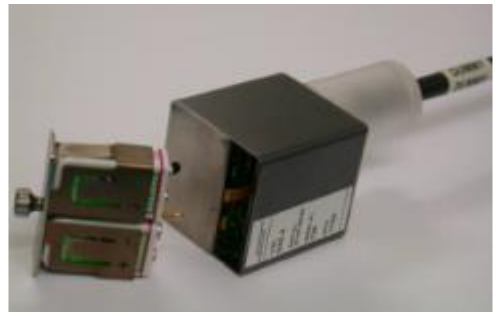
The measurement server performs all real-time data evaluations of field measurements and surface detection, controls robot movements, and handles safety operations. The PC operating system cannot interfere with these time-critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program controlled robot movements.

(a) Front panel



(b) Back panel

8.5 Data Acquisition Electronics



The data acquisition electronics DAE4 consists 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 and 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.

8.6 Probes

The DASY system can support many different probe types.

Dosimetric Probes: These probes are specially designed and calibrated for use in liquids with high permittivities. They should not be used in air, since the spherical isotropy in air is poor (±2 dB). The dosimetric probes have special calibrations in various liquids at different frequencies.

Free Space Probes: These are electric and magnetic field probes specially designed for measurements in free space. The z-sensor is aligned to the probe axis and the rotation angle of the x-sensor is specified.
This allows the DASY system to automatically align the probe to the measurement grid for field component measurement. The free space probes are generally not calibrated in liquid. (The H-field probes can be used in liquids without any change of parameters.)

Temperature Probes: Small and sensitive temperature probes for general use. They use a completely different parameter set and different evaluation procedures. Temperature rise features allow direct SAR evaluations with these probes.

8.7 EX3DV4 Probe Specification

Construction Symmetrical design with triangular core
Built-in shielding against static charges. Calibrated at frequencies of 450 MHz, 600 MHz, 750 MHz, 835 MHz, 900 MHz, 1750 MHz, 1900 MHz, 2300 MHz, 2450 MHz, 2600 MHz, 5250 MHz, 5600 MHz, and 5750 MHz.

Dimensions Overall length: 337 mm; Tip length: 20 mm;
Body diameter: 12mm; Tip diameter: 2.5 mm
Typical distance from probe tip to dipole centers: 1 mm

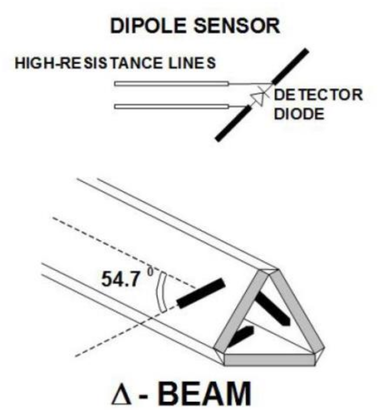


Figure 3.11.1: Typical SAR Probe Construction

8.8 E-Field Probe Calibration Process

Each probe is calibrated according to a dosimetric assessment procedure described in [6] with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in [7] and found to be better than +/-0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) 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 waveguide 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 dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

8.9 Data Evaluation psSAR1g/8/10g Computation

The DASY8 post-processing 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.

Voltage to SAR Conversion

The measured voltages are not directly proportional to SAR and must be linearized. The formulas below are based on [1].

The measured voltage is first linearized using the (a, b, c, d) set of parameters specific to the communication system and sensor:

$$V_{\text{compi}} = U_i + U_i^2 \cdot \frac{10^{\frac{d}{10}}}{dcp_i} \tag{1.2.1}$$

with
- V_{compi} = compensated voltage of channel i (µV) (i = x,y,z)
- U_i = input voltage of channel i (µV) (i = x,y,z)
- d = PMR factor d (dB) (Probe parameter)
- dcp_i = diode compression point of channel i (µV) (Probe parameter, i = x,y,z)

$$V_{\text{compi}_{\text{dB}\sqrt{\mu\text{V}}}} = 10 \cdot \log_{10}(V_{\text{compi}}) \tag{1.2.2}$$

$$\text{corr}_i = a_i \cdot e^{-\left(\frac{V_{\text{compi}_{\text{dB}\sqrt{\mu\text{V}}}} - b_i}{c_i}\right)^2} \tag{1.2.3}$$

with
- corr_i = correction factor of channel i (dB) (i = x,y,z)
- $V_{\text{compi}_{\text{dB}\sqrt{\mu\text{V}}}}$ = compensated voltage of channel i (dB$\sqrt{\mu\text{V}}$) (i = x,y,z)
- a_i = PMR factor a of channel i (dB) (Probe parameter, i = x,y,z)
- b_i = PMR factor b of channel i (dB$\sqrt{\mu\text{V}}$) (Probe parameter, i = x,y,z)
- c_i = PMR factor c of channel i (Probe parameter, i = x,y,z)

The voltage $V_{i_{\text{dB}\sqrt{\mu\text{V}}}}$ is the linearized voltage in dB$\sqrt{\mu\text{V}}$:

$$V_{i_{\text{dB}\sqrt{\mu\text{V}}}} = V_{\text{compi}_{\text{dB}\sqrt{\mu\text{V}}}} - \text{corr}_i \tag{1.2.4}$$

with $V_{i_{\mathrm{dB}\sqrt{\mu V}}}$ = linearized voltage of channel i (dB$\sqrt{\mu\mathrm{V}}$) (i = x,y,z)
$V_{\mathrm{compi}_{\mathrm{dB}\sqrt{\mu V}}}$ = compensated voltage of channel i (dB$\sqrt{\mu\mathrm{V}}$) (i = x,y,z)
Corr_i = correction factor of channel i (dB) (i = x,y,z)

Finally, the linearized voltage is converted in μV:

$$V_i = 10^{\frac{V_{i_{\mathrm{dB}\sqrt{\mu V}}}}{10}} \tag{1.2.5}$$

with V_i = linearized voltage of channel i (µV) (i = x,y,z)
$V_{i_{\mathrm{dB}\sqrt{\mu V}}}$ = linearized voltage of channel i (dB$\sqrt{\mu\mathrm{V}}$) (i = x,y,z)

The E-field data for each channel are calculated using the linearized voltage:

$$E\text{-field probes:} \qquad E_i = \sqrt{\frac{V_i}{\mathrm{Norm}_i \cdot \mathrm{ConvF}}} \tag{1.2.6}$$

with V_i = linearized voltage of channel i (i = x,y,z)
Norm_i = sensor sensitivity (µV/(V/m)^2) of channel i (i = x,y,z)
ConvF = sensitivity enhancement in solution
E_i = electric field strength of channel i in V/m

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

$$E_{\mathrm{tot}} = \sqrt{E_x^2 + E_y^2 + E_z^2} \tag{1.2.7}$$

The E-field value is used to calculate SAR:

$$\mathrm{SAR} = E_{\mathrm{tot}}^2 \cdot \frac{\sigma}{\rho \cdot 1'000} \tag{1.2.8}$$

with SAR = local specific absorption rate in W/kg
E_{tot} = total field strength in V/m
σ = conductivity in [Ω/m] or [S/m]
ρ = equivalent tissue density in g/cm^3

The simulated tissue density is normally set to 1 to account for the actual density of brain or body tissue rather than the density of the simulating lossy liquid.

Although the permittivity is not used in the SAR calculation, the two quantities (permittivity and conductivity) influence the actual coupling of energy into the phantom.

8.10 Light Beam Unit

The light beam unit allows automatic “tooling” of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, so that the robot coordinates are valid for the probe tip. The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.

8.11 Tissue Simulating Liquids

Parameters

The parameters of the tissue simulating liquid strongly influence the SAR in the liquid. The parameters for the different frequencies are defined in the corresponding compliance standards

Parameter measurements

The following measurement system was applied for measuring the dielectric parameters of liquids:

- The open coax test method (e.g., SPEAG DAK-3.5 Probe dielectric probe kit) is easy to use, but has only moderate accuracy. It is calibrated with open, short, and deionized water and the calibrations a critical process.

8.12 SAR Phantoms

SPEAG phantoms are built with high manufacturing standards. The shells have a very tight tolerance of less than 0.2 mm, and they are fully compliant with the SAR standards and national regulations in the frequency range of 4 MHz–10 GHz. Full computer-aided design (CAD) information have been predefined in the DASY8 software, enabling fast and easy usage.

They are compatible with the following SPEAG tissue simulating liquids:

- Oil-based broadband liquids can be left permanently in the phantom. Always cover the liquid when the system is not in use to prevent changes in liquid parameters due to water evaporation.

- Sugar-water-based liquids can be left permanently in the phantom. Always cover the liquid when the system is not in use to prevent changes in liquid parameters due to water evaporation.

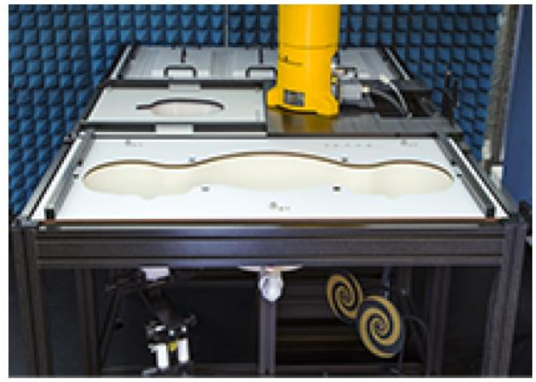
- DGBE-based liquids should only be used in SAM-Twin, ELI, Modular Flat, and BST phantoms. As DGBE is a softener for most plastics, the liquid should be removed from the phantom, and the phantom should be dried when the system is not in use.

The provided cover prevents the TSL from evaporating. It reduces required TSL maintenance and increases the life span. It must be placed on top of the phantom when not in use.

In DASY8, phantoms are placed in a platform slot. The position of the slot relative to the robot is taught using the three reference points (P1, P2, P3) located on top of the phantom table (see instructions in Section 4.1.6).

8.13 SAM Twin Phantom

The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm). It has three measurement areas, also called phantom sections, Left Head, Right Head, and Flat:

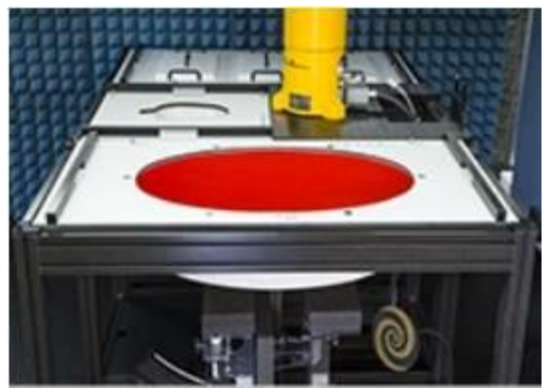


• Left Head, Right Head to test exposure on the head. Please note that if the location of the peak is located in the upper part of the chin, the Chin20 phantoms should be used.

• Flat to test exposure of small body-worn/hand-held devices (smartphones. . .). For larger devices (tablets, laptops) or measurements at low frequencies, the ELI phantom must be used.

8.14 ELI Phantom

The ELI phantom is optimized for compliance testing of large handheld and body-mounted wireless devices (tablets, laptops) or for evaluating transmitters operating at low frequencies.



The size of the phantom, including top plate is 1.0×0.5m (1 full DASY8 platform slot). The filling volume is approximately 25 L.

8.15 System Validation Kits

Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. For that purpose a well-defined SAR distribution in the flat section of the SAM twin phantom or ELI phantom is produced.

System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder. Dipoles are available for the variety of frequencies between 300MHz and 6 GHz (dipoles for other frequencies or media and other calibration conditions are available upon request).

The dipoles are highly symmetric and matched at the center frequency for the specified liquid and distance to the flat phantom (or flat section of the SAM-twin phantom). The accurate distance between the liquid surface and the dipole center is achieved with a distance holder that snaps on the dipole.

8.16 Robot

BACL's DASY8 system uses the Stäubli TX2-90XL high precision industrial robots. This robot has many features:

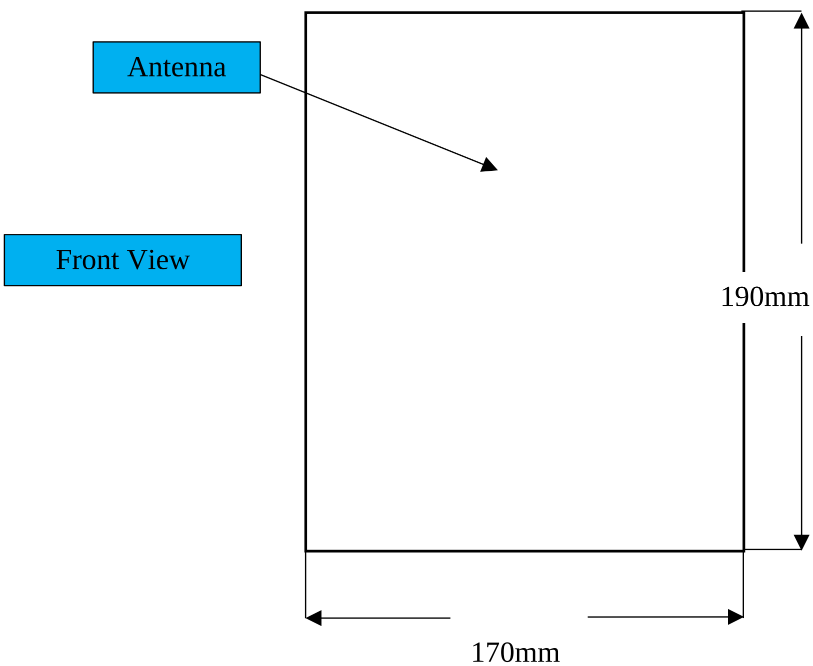
- High precision (repeatability 0.02mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance-free due to direct drive gears; no belt drives)
- Jerk-free straight movements (brushless synchronous motors; no stepper motors)
- Low ELF interference (the closed metallic construction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

BACL's DASY8 system uses the SP2 controller with S/N D21144508A.

9 SAR Measurement Consideration, Exclusion and Reduction

9.1 SAR Consideration

EUT Mechanical Configuration



Note: the diagram above is only to show antenna location, and it doesn't represent the shape of the host device or the antenna. Please refer to the EUT photos exhibit for detailed information.

Multiple positions were tested to find the position that has highest RF exposure level. The EUT was transmitting at its center frequency. Configurations: EUT parallel in relation to the phantom for the Front, Back, Left Side, Right Side, Top and Bottom side positions. Please refer to the EUT setup photographs for all test positions described here.

9.2 SAR Reduction

900MHz

Mode	Positions	Frequency (MHz)	Result
RFID	Back Side	902.75	Reduced
		914.75	Tested
		927.25	Reduced
	Front Side	902.75	Reduced
		914.75	Tested
		927.25	Reduced
	Top Side	902.75	Reduced
		914.75	Tested
		927.25	Reduced
	Bottom Side	902.75	Reduced
		914.75	Tested
		927.25	Reduced
	Left Side	902.75	Reduced
		914.75	Tested
		927.25	Reduced
	Right Side	902.75	Reduced
		914.75	Tested
		927.25	Reduced

Per 447498 D01 General RF Exposure Guidance v06 reduction guidance: ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz.

10 SAR Measurement Results

This page summarizes the results of the performed diametric evaluation. The plots with the corresponding SAR distributions, which detail information about the location of the maximum SAR with respect to the device, is in Annex E.

10.1 Test Environmental Conditions

Temperature:	23.4° C
Relative Humidity:	53 %
ATM Pressure:	102.1 kPa

Testing was performed by Kevin Chau in the SAR chamber on 2024-07-11.

10.2 Standalone SAR Results

900MHz

Separation Distance @ 0mm 10g									
EUT Position	**Frequency (MHz)**	**Phantom**	**Output Power (dBm)**	**Rated Power (dBm)**	**Scaled**	**Measured SAR (W/kg) 10g Tissue**	**Scaled SAR (W/kg) 10g Tissue**	**Limit (W/kg) 10g Tissue**	**Plot #**
RFID (ASK)									
Back	902.75	ELI Flat	26.01	27.3	1.35	-	-	4.0	-
	914.75		26.32	27.3	1.25	0.00	0.00	4.0	1
	927.25		25.90	27.3	1.38	-	-	4.0	-
Front	902.75		26.01	27.3	1.35	-	-	4.0	-
	914.75		26.32	27.3	1.25	0.00	0.00	4.0	2
	927.25		25.90	27.3	1.38	-	-	4.0	-
Top	902.75		26.01	27.3	1.35	-	-	4.0	-
	914.75		26.32	27.3	1.25	0.00	0.00	4.0	3
	927.25		25.90	27.3	1.38	-	-	4.0	-
Bottom	902.75		26.01	27.3	1.35	-	-	4.0	-
	914.75		26.32	27.3	1.25	0.00	0.00	4.0	4
	927.25		25.90	27.3	1.38	-	-	4.0	-
Left	902.75		26.01	27.3	1.35	-	-	4.0	-
	914.75		26.32	27.3	1.25	0.00	0.00	4.0	5

	927.25		25.90	27.3	1.38	-	-	4.0	-
Right	902.75		26.01	27.3	1.35	-	-	4.0	-
	914.75		26.32	27.3	1.25	0.00	0.00	4.0	6
	927.25		25.90	27.3	1.38	-	-	4.0	-
Repeat	-		-	-	-	-	-	4.0	-

11 Annex A – Measurement Uncertainty

The uncertainty budget has been determined for the DASY8 measurement system and is given in the following tables.

DASY8 Uncertainty Budget
According to IEC/IEEE 62209-1528, Specific Phantoms
(Frequency band: 300 MHz–3 GHz range)

Symbol	Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) (1 g)	(c_i) (10 g)	Std. Unc. (1 g)	Std. Unc. (10 g)
Measurement System Errors								
CF	Probe Calibration	±12.0%	N	2	1	1	±6.0%	±6.0%
CF_{drift}	Probe Calibration Drift	±1.7%	R	$\sqrt{3}$	1	1	±1.0%	±1.0%
LIN	Probe Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%
BBS	Broadband Signal	±3.0%	R	$\sqrt{3}$	1	1	±1.7%	±1.7%
ISO	Probe Isotropy	±9.6%	R	$\sqrt{3}$	1	1	±5.5%	±5.5%
DAE	Other Probe+Electronic	±0.3%	N	1	1	1	±0.3%	±0.3%
AMB	RF Ambient	±1.8%	N	1	1	1	±1.8%	±1.8%
Δ_{sys}	Probe Positioning	±0.006 mm	N	1	0.14	0.14	±0.5%	±0.5%
DAT	Data Processing	±8.7%	N	1	1	1	±8.7%	±8.7%
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.)^{DAK}	±2.5%	N	1	0.78	0.71	±2.0%	±1.8%
LIQ(T_σ)	Conductivity (temp.)^{BB}	±3.3%	R	$\sqrt{3}$	0.78	0.71	±1.5%	±1.4%
EPS	Phantom Permittivity	±14.0%	R	$\sqrt{3}$	0	0	±0%	±0%
DIS	Distance DUT – TSL	±2.0%	N	1	2	2	±4.0%	±4.0%
D_{xyz}	Device Positioning	±1.0%	N	1	1	1	±1.0%	±1.0%
H	Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%
MOD	DUT Modulation^m	±2.4%	R	$\sqrt{3}$	1	1	±1.4%	±1.4%
TAS	Time-average SAR	±1.7%	R	$\sqrt{3}$	1	1	±1.0%	±1.0%
RF_{drift}	DUT drift	±2.5%	N	1	1	1	±2.5%	±2.5%
VAL	Val Antenna Unc.^{val}	±0.0%	N	1	1	1	±0%	±0%
RF_{in}	Unc. Input Power^{val}	±0.0%	N	1	1	1	±0%	±0%
Correction to the SAR results								
C(ε, σ)	Deviation to Target	±1.9%	N	1	1	0.84	±1.9%	±1.6%
C(R)	SAR scaling^p	±0%	R	$\sqrt{3}$	1	1	±0%	±0%
u(ΔSAR)	Combined Uncertainty						±14.3%	±14.3%
U	**Expanded Uncertainty**						±28.7%	±28.5%

Table 6.4.1: Worst-Case uncertainty budget for DASY8 assessed according to IEC/IEEE 62209-1528 [4]. The budget is valid for the frequency range 300 MHz–3 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller. All listed error components have v_{eff} equal to ∞.

Footnote details: ^{m} SMC calibration is a new method for determining the total deviation from linearity. The uncertainty is $\leq$ 2.4% for psSAR1 g/10 g $\leq$2 W/kg, $\leq$ 4.8% for psSAR1 g/10 g $\leq$4 W/kg and $\leq$ 9.6% for psSAR1 g/10 g $\leq$10 W/kg (see modulation calibration parameter uncertainty in the probe calibration certificate); ^{BB} if SPEAG's broad-band liquids (BBL) are used that have low temperature coefficients; ^{DAK} if SPEAG's high precision dielectric probe kit (DAK) is applied; ^{p} if power scaling is used, error item "SAR Scaling" must be adjusted accordingly; ^{val} only applies in case of validation measurements.

DASY8 Uncertainty Budget

According to IEC/IEEE 62209-1528, Specific Phantoms
(Frequency band: 3 GHz–6 GHz range)

Symbol	Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) (1 g)	(c_i) (10 g)	Std. Unc. (1 g)	Std. Unc. (10 g)
Measurement System Errors								
CF	Probe Calibration	±13.1%	N	2	1	1	±6.55%	±6.55%
CF_{drift}	Probe Calibration Drift	±1.7%	R	$\sqrt{3}$	1	1	±1.0%	±1.0%
LIN	Probe Linearity	±4.7%	R	$\sqrt{3}$	1	1	±2.7%	±2.7%
BBS	Broadband Signal	±2.6%	R	$\sqrt{3}$	1	1	±1.5%	±1.5%
ISO	Probe Isotropy	±9.6%	R	$\sqrt{3}$	1	1	±5.5%	±5.5%
DAE	Other Probe+Electronic	±0.3%	N	1	1	1	±0.3%	±0.3%
AMB	RF Ambient	±1.8%	N	1	1	1	±1.8%	±1.8%
Δ_{sys}	Probe Positioning	±0.005 mm	N	1	0.29	0.29	±0.8%	±0.8%
DAT	Data Processing	±8.7%	N	1	1	1	±8.7%	±8.7%
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.)^{DAK}	±2.5%	N	1	0.78	0.71	±2.0%	±1.8%
LIQ(T_σ)	Conductivity (temp.)^{BB}	±3.4%	R	$\sqrt{3}$	0.78	0.71	±1.5%	±1.4%
EPS	Phantom Permittivity	±14.0%	R	$\sqrt{3}$	0.25	0.25	±2.0%	±2.0%
DIS	Distance DUT – TSL	±2.0%	N	1	2	2	±4.0%	±4.0%
D_{xyz}	Device Positioning	±1.0%	N	1	1	1	±1.0%	±1.0%
H	Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%
MOD	DUT Modulation^{m}	±2.4%	R	$\sqrt{3}$	1	1	±1.4%	±1.4%
TAS	Time-average SAR	±1.7%	R	$\sqrt{3}$	1	1	±1.0%	±1.0%
RF_{drift}	DUT drift	±2.5%	N	1	1	1	±2.5%	±2.5%
VAL	Val Antenna Unc.^{val}	±0.0%	N	1	1	1	±0%	±0%
RF_{in}	Unc. Input Power^{val}	±0.0%	N	1	1	1	±0%	±0%
Correction to the SAR results								
C(ε, σ)	Deviation to Target	±1.9%	N	1	1	0.84	±1.9%	±1.6%
C(R)	SAR scaling^{p}	±0%	R	$\sqrt{3}$	1	1	±0%	±0%
u(ΔSAR)	Combined Uncertainty						±14.7%	±14.6%
U	**Expanded Uncertainty**						±29.4%	±29.3%

Table 6.4.2: Worst-Case uncertainty budget for DASY8 assessed according to IEC/IEEE 62209-1528 [4]. The budget is valid for the frequency range 3 GHz–6 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller. All listed error components have v_{eff} equal to ∞.

Footnote details: ^{m} SMC calibration is a new method for determining the total deviation from linearity. The uncertainty is $\leq$ 2.4% for psSAR1 g/10 g $\leq$2 W/kg, $\leq$ 4.8% for psSAR1 g/10 g $\leq$4 W/kg and $\leq$ 9.6% for psSAR1 g/10 g $\leq$10 W/kg (see modulation calibration parameter uncertainty in the probe calibration certificate); ^{BB} if SPEAG's broad-band liquids (BBL) are used that have low temperature coefficients; ^{DAK} if SPEAG's high precision dielectric probe kit (DAK) is applied; ^{p} if power scaling is used, error item "SAR Scaling" must be adjusted accordingly; ^{val} only applies in case of validation measurements.

12 Annex B – Probe Calibration Certificates

In Collaboration with speag CALIBRATION LABORATORY

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中国认可 国际互认 校准 CALIBRATION CNAS L0570 CAICT

Client **BACL** **Certificate No: 24J02Z000153**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN : 7783

Calibration Procedure(s): FF-Z11-004-02
Calibration Procedures for Dosimetric E-field Probes

Calibration date: April 12, 2024

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	106277	19-Oct-23(CTTL, No.J23X11026)	Oct-24
Power sensor NRP8S	104291	19-Oct-23(CTTL, No.J23X11026)	Oct-24
Power sensor NRP8S	104292	19-Oct-23(CTTL, No.J23X11026)	Oct-24
Reference 10dBAttenuator	18N50W-10dB	19-Jan-23(CTTL, No.J23X00212)	Jan-25
Reference 20dBAttenuator	18N50W-20dB	19-Jan-23(CTTL, No.J23X00211)	Jan-25
Reference Probe EX3DV4	SN 7464	22-Jan-24(SPEAG, No.EX-7464_Jan24)	Jan-25
DAE4	SN 1555	24-Aug-23(SPEAG, No.DAE4-1555_Aug23)	Aug-24
Secondary Standards	**ID #**	**Cal Date(Calibrated by, Certificate No.)**	**Scheduled Calibration**
SignalGenerator MG3700A	6201052605	12-Jun-23(CTTL, No.J23X05434)	Jun-24
SignalGenerator APSIN26G	181-33A6D0700-1959	26-Mar-24(CTTL, No.24J02X002468)	Mar-25
Network Analyzer E5071C	MY46110673	10-Jan-23(CTTL, No.J23X00104)	Jan-24
Reference 10dBAttenuator	BT0520	11-May-23(CTTL, No.J23X04061)	May-25
Reference 20dBAttenuator	BT0267	11-May-23(CTTL, No.J23X04062)	May-25
OCP DAK-12	SN 1174	25-Oct-23(SPEAG, No.OCP-DAK12-1174_Oct23)	Oct-24

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Jun	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: April 17, 2024

Certificate No: 24J02Z000153 Page 1 of 22

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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7783

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm(μV/(V/m)²)[A]	0.55	0.65	0.61	±10.0%
DCP(mV)[B]	111.5	111.9	108.4	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max Dev.	Max Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	193.7	±2.2%	±4.7%
		Y	0.0	0.0	1.0		215.4		
		Z	0.0	0.0	1.0		202.1		
10352-AAA	Pulse Waveform (200Hz, 10%)	X	1.43	60.29	6.63	10.00	60	±3.2%	±9.6%
		Y	1.63	61.08	6.67		60		
		Z	1.42	60.00	5.75		60		
10353-AAA	Pulse Waveform (200Hz, 20%)	X	0.83	60.00	5.50	6.99	80	±2.6%	±9.6%
		Y	0.84	60.00	5.04		80		
		Z	6.00	68.00	7.00		80		
10354-AAA	Pulse Waveform (200Hz, 40%)	X	4.00	68.00	7.00	3.98	95	±3.1%	±9.6%
		Y	0.27	131.29	0.87		95		
		Z	0.04	136.57	0.37		95		
10355-AAA	Pulse Waveform (200Hz, 60%)	X	0.29	60.00	3.98	2.22	120	±1.9%	±9.6%
		Y	13.66	114.63	9.85		120		
		Z	2.40	157.31	19.70		120		
10387-AAA	QPSK Waveform, 1 MHz	X	0.50	60.00	8.57	1.00	150	±3.6%	±9.6%
		Y	0.49	60.28	8.99		150		
		Z	0.71	68.85	14.98		150		
10388-AAA	QPSK Waveform, 10 MHz	X	1.06	61.12	9.82	0.00	150	±1.3%	±9.6%
		Y	1.17	62.68	11.18		150		
		Z	1.55	68.85	15.49		150		
10396-AAA	64-QAM Waveform, 100 kHz	X	1.67	62.05	13.69	3.01	150	±1.0%	±9.6%
		Y	1.74	63.86	15.22		150		
		Z	1.88	67.35	18.37		150		
10414-AAA	WLAN CCDF, 64-QAM, 40MHz	X	3.61	64.77	13.82	0.00	150	±3.3%	±9.6%
		Y	3.71	65.18	14.35		150		
		Z	4.00	67.08	15.95		150		

Note: For details on UID parameters see Appendix

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution Corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of Norm X, Y, Z do not affect the E^2-field uncertainty inside TSL (see Page 5).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainly is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7783

Sensor Model Parameters

	C1 fF	C2 fF	α V^{-1}	T1 $ms.V^{-2}$	T2 $ms.V^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
X	8.64	62.11	32.29	4.12	0.00	4.90	0.51	0.00	1.01
Y	9.56	68.77	32.59	3.58	0.00	4.90	0.39	0.00	1.01
Z	9.76	70.98	33.88	1.84	0.00	4.90	0.39	0.00	1.01

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	96.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	9mm
Tip Diameter	2.5mm
Probe Tip to Sensor X Calibration Point	1mm
Probe Tip to Sensor Y Calibration Point	1mm
Probe Tip to Sensor Z Calibration Point	1mm
Recommended Measurement Distance from Surface	1.4mm