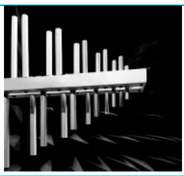
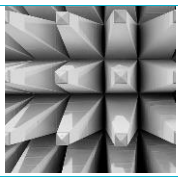




TEST REPORT

Test Report No.: 1-8038-24-01-02_TR1-R02

Deutsche Akkreditierungsstelle
D-PL-12047-01-00

Testing Laboratory

cetecom advanced GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: https://cetecomadvanced.com
e-mail: mail@cetecomadvanced.com

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS).
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12047-01-00.
FCC designation number: DE0002

Applicant

Leica Geosystems AG
Heinrich-Wild-Straße
9435 Heerbrugg/SWITZERLAND

Phone: +41 71 727 3131

Contact: Collin Pang
e-mail: collin.pang@leica-geosystems.com

Manufacturer

Leica Geosystems AG
Heinrich-Wild-Straße
9435 Heerbrugg/SWITZERLAND

Test Standards

FCC - Title 47 CFR Part 2	§ 2.1093 Radiofrequency radiation exposure evaluation: portable devices.
ANSI/IEEE C95.1-1992	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
IEEE Std 1528-2013	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item:	Field Controller
Device type:	portable device
Model name:	**Field Controller Win EC7 / CS20 Basic**
S/N serial number:	2495072
FCC-ID:	RFD-CSNGP
Hardware status:	V1.2
Software status:	v7.07.19.1040033
Frequency:	see technical details
Antenna:	integrated antenna
Battery option:	integrated battery
Test sample status:	identical prototype
Exposure category:	general population / uncontrolled environment

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test Report authorised:

cn=Alexander Hnatovskiy, o=cetecom advanced GmbH, ou=HNA-230601, email=alexander.hnatovskiy@cetecomadvanced.com, c=DE
2024.06.03 13:22:34 +02'00'

Alexander Hnatovskiy
Lab Manager
Radio Labs

Test performed:

cn=Marco Scigliano, o=cetecom advanced GmbH, ou=SCI-230601, email=Marco.Scigliano@cetecomadvanced.com, c=DE
2024.06.03 11:46:33 +02'00'

Marco Scigliano
Testing Manager
Radio Labs

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom advanced GmbH does not assume responsibility for any conclusions and generalisations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of cetecom advanced GmbH.
This test report is electronically signed and valid without handwriting signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.
The testing service provided by cetecom advanced GmbH has been rendered under the current "General Terms and Conditions for cetecom advanced GmbH".
cetecom advanced GmbH will not be liable for any loss or damage resulting from false, inaccurate, inappropriate or incomplete product information provided by the customer.
Under no circumstances does the cetecom advanced GmbH test report include any endorsement or warranty regarding the functionality, quality or performance of any other product or service provided.
Under no circumstances does the cetecom advanced GmbH test report include or imply any product or service warranties from cetecom advanced GmbH, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by cetecom advanced GmbH.
All rights and remedies regarding vendor's products and services for which cetecom advanced GmbH has prepared this test report shall be provided by the party offering such products or services and not by cetecom advanced GmbH.
In no case this test report can be considered as a Letter of Approval.

2.2 Application details

Date of receipt of order:	2022-10-07
Date of receipt of test item:	2022-09-26
Start of test:	2022-10-28
End of test:	2022-10-28

2.3 Statement of compliance

The SAR values found for the Field Controller Win EC7 / CS20 Basic Field Controller are below the maximum recommended levels of 1.6 W/Kg or 4 W/kg as averaged over any 1 g or 10 g tissue according to the FCC rule §2.1093 for General Population/Uncontrolled exposure.

2.4 Technical details

Band tested for this test report	Technology	Lowest transmit frequency/MHz	Highest transmit frequency/MHz	Lowest receive Frequency/MHz	Highest receive Frequency/MHz	Kind of modulation	Power Class	Tested power control level	Test channel low	Test channel middle	Test channel high	Maximum P_{avg}/dBm
☒	WLAN	2412	2462	2412	2462	CCK OFDM	--	max	1	6	11	8.2
☐	BT EDR	2402	2480	2402	2480	GFSK	3	max	0	39	78	0.5
☐	BT LE	2402	2480	2402	2480	GFSK	3	max	0	19	39	0.5

2.5 Transmitter and Antenna Operating Configurations

Simultaneous transmission conditions
WLAN 2450 MHz + BT EDR / BT LE

Table 1: Simultaneous transmission conditions

3 Test standards/ procedures references

Test Standard	Version	Test Standard Description
FCC - Title 47 CFR Part 2	-/-	§ 2.1093 Radiofrequency radiation exposure evaluation: portable devices.
ANSI/IEEE C95.1-1992	1992-04-27	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
IEEE Std 1528-2013	2013-06-14	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

FCC KDBs:

KDB 865664D01v01	August 7, 2015	FCC OET SAR measurement requirements 100 MHz to 6 GHz
KDB 865664D02v01	October 23, 2015	RF Exposure Compliance Reporting and Documentation Considerations
KDB 447498D01v06	October 23, 2015	Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies
KDB 648474D04v01	October 23, 2015	SAR Evaluation Considerations for Wireless Handsets
KDB 248227D01v02	October 23, 2015	SAR Measurement Procedures for 802.11 a/b/g Transmitters
KDB 616217D04v01	October 23, 2015	SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers.

3.1 RF exposure limits

RF Exposure levels according CFR 47 – Part 1, §1.1310:

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Spatial Peak SAR* (Brain and Trunk)	**1.60 W/kg**	8.00 W/kg
Spatial Average SAR** (Whole Body)	0.08 W/kg	0.40 W/kg
Spatial Peak SAR*** (Hands/Feet/Ankle/Wrist)	**4.00 W/kg**	20.00 W/kg

Table 2: RF exposure limits (100 kHz to 6 GHz)

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

Notes:

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

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

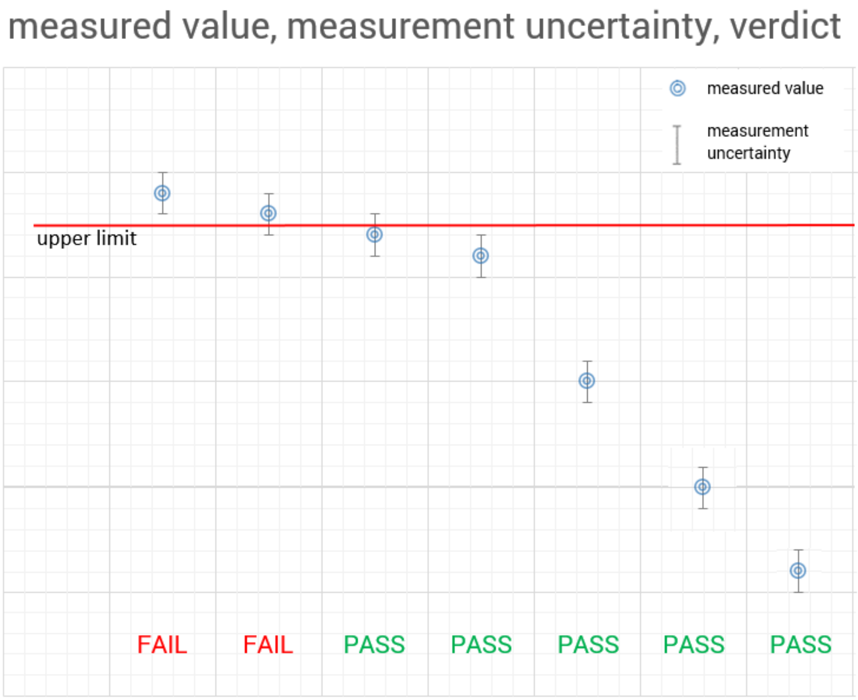
*** The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

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

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.
The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 20% that the decision might be wrong."



5 Summary of Measurement Results

☒	**No deviations from the technical specifications ascertained**			
☐	Deviations from the technical specifications ascertained			
Maximum SAR_{1g} value reported (W/kg)				
		BT	**DTS**	**limit**
body worn 0 mm distance		**0.024**	**0.118**	**1.6**
collocated situations	**ΣSAR_{1g} evaluation BT & DTS**	**0.142**		**1.6**
Maximum SAR_{10g} value reported (W/kg)				
		BT	**DTS**	**limit**
extremity 0 mm distance		**0.011**	**0.068**	**4.0**
collocated situations	**ΣSAR_{10g} evaluation BT & DTS**	**0.079**		**4.0**

6 Test Environment

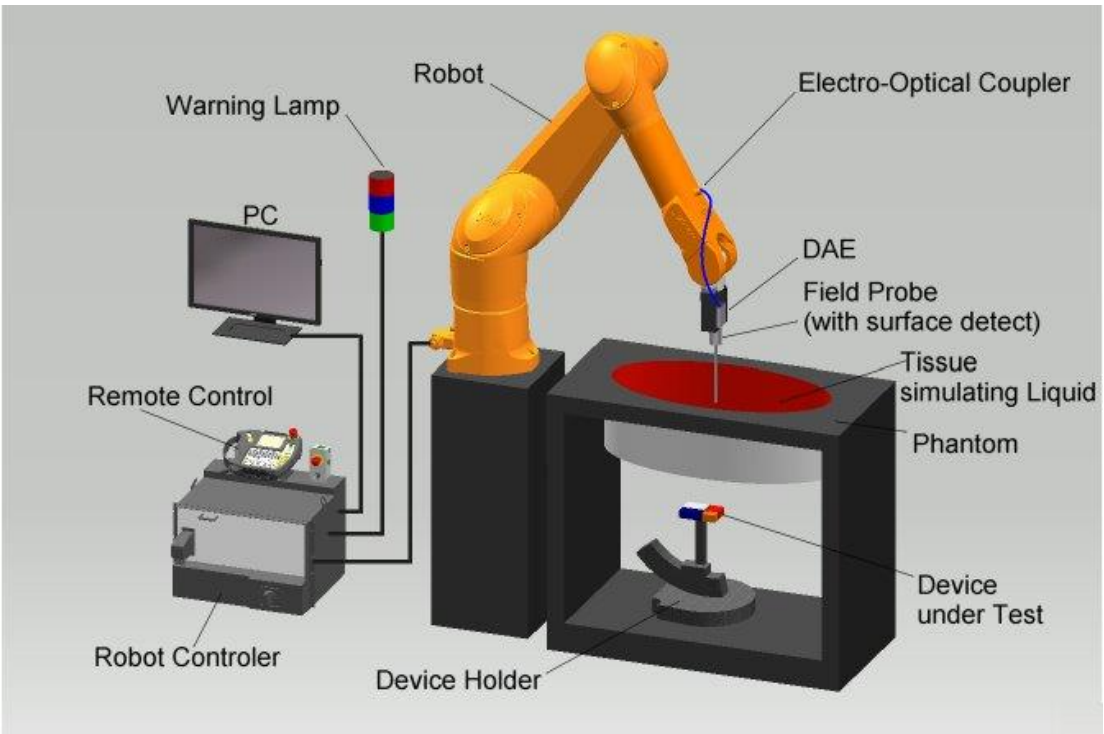
Ambient temperature:	20 – 24 °C
Tissue Simulating liquid:	20 – 24 °C
Relative humidity content:	40 – 50 %
Air pressure:	not relevant for this kind of testing
Power supply:	230 V / 50 Hz

NOTE: For the SAR measurements the exact temperature values for each test are shown in the SAR result tables and are also at the bottom of each measurement plot.

7 Test Set-up

7.1 Measurement system

7.1.1 System Description



- The DASY system for performing compliance tests consists of the following items:
- A standard high precision 6-axis robot (Stäubli RX/TX family) with controller 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.
- A data acquisition electronic (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY measurement server.
- The DASY measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows.
- DASY software and SEMCAD data evaluation software.
- Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
- The generic twin phantom enabling the testing of left-hand and right-hand usage.
- The triple flat and eli phantom for the testing of handheld and body-mounted wireless devices.
- The device holder for handheld mobile phones and mounting device adaptor for laptops
- Tissue simulating liquid mixed according to the given recipes.
- System check dipoles allowing to validate the proper functioning of the system.

7.1.2 Test environment

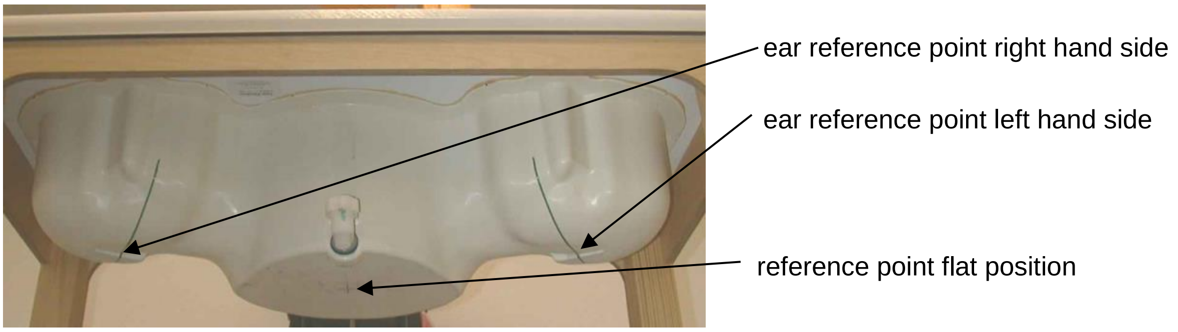
The DASY measurement system is placed in a laboratory room within an environment which avoids influence on SAR measurements by ambient electromagnetic fields and any reflection from the environment. The pictures at the beginning of the photo documentation show a complete view of the test environment. The system allows the measurement of SAR values larger than 0.005 W/kg.

7.1.3 Probe description

Isotropic E-Field Probe EX3DV4 for Dosimetric Measurements	
Technical data according to manufacturer information	
Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available.
Frequency	10 MHz to >6 GHz (dosimetry); Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic range	10 µW/g to > 100 W/kg; Linearity: ± 0.2 dB (noise: typically<1 µW/g)
Dimensions	Overall length: 337 mm (Tip: 20mm) Tip length: 2.5 mm (Body: 12mm) Typical distance from probe tip to dipole centers: 1mm
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.

7.1.4 Phantom description

The used SAM Phantom meets the requirements specified in FCC KDB865664 D01 for Specific Absorption Rate (SAR) measurements.
The phantom consists of a fibreglass shell integrated in a wooden table. It allows left-hand and right-hand head as well as body-worn measurements with a maximum liquid depth of 18 cm in head position and 22 cm in planar position (body measurements). The thickness of the Phantom shell is 2 mm +/- 0.1 mm.



7.1.5 Device holder description

The DASY device holder has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. This device holder is used for standard mobile phones or PDA’s only. If necessary an additional support of polystyrene material is used.

Larger DUT’s (e.g. notebooks) cannot be tested using this device holder. Instead a support of bigger polystyrene cubes and thin polystyrene plates is used to position the DUT in all relevant positions to find and measure spots with maximum SAR values.
Therefore those devices are normally only tested at the flat part of the SAM.

7.1.6 Scanning 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, unless further guidance has been provided by the FCC. 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 KDB 865664 D01 and 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><th colspan="3"></th><th>≤ 3 GHz</th><th>> 3 GHz</th></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 mm ± 1 mm</td><td>$\frac{1}{2} \cdot \delta \cdot \ln(2)$ mm ± 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">≤ $1.5 \cdot \Delta z_{Zoom}(n-1)$ mm</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 IEEE Std 1528-2013 for details.
* When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB Publication 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>

Area scan

All antennas and radiating structures that may contribute to the measured SAR or influence the SAR distribution must be included in the area scan. When applicable, partially overlapping area scans may be considered. The areas of the transmitter(s), antenna(s) and host device, when projected onto the phantom, must be within the area scan measurement region. The area scan measurement resolution must enable the extrapolation algorithms of the SAR system to correctly identify the peak SAR location(s) for subsequent zoom scan measurements to correctly determine the 1-g SAR. Area scans are performed at a constant distance from the phantom surface, determined by the measurement frequencies. When a measured peak is closer than ½ the zoom scan volume dimension (x, y) from the edge of the area scan region, unless the entire peak and gram-averaging volume are both captured within the zoom scan volume, the area scan must be repeated by shifting and expanding the area scan region to ensure all peaks are away from the area scan boundary. When a test device orientation has a small projected area on the phantom; for example, the side edges of a handset or USB dongles, the area scan measurement resolutions must be less than ½ of the corresponding zoom scan dimensions for the device surface being measured. When the *area scan based 1-g SAR estimation* of KDB Publication 447498 is applied, the area scan resolution must be less than or equal to the corresponding dimensions of the device surface being measured. Regardless of whether zoom scan or *1-g SAR estimation* is used, at least one measurement point must be on the device. Reducing the measurement resolution of a smaller scan region generally requires the similar number of measurement points as compared to applying larger measurement resolutions to larger scan regions.

Zoom scan

Except when *area scan based 1-g SAR estimation* applies, a zoom scan measurement is required at the highest peak SAR location determined in the area scan to determine the 1-g SAR. When the 1-g SAR of the highest peak is within 2 dB of the SAR limit, additional zoom scans are required for other peaks within 2 dB of the highest peak that have not been included in any zoom scan to ensure there is no increase in SAR. The zoom scan volume must be larger than the required minimum dimensions described above. There must be at least one measurement point within the first 5 mm from the phantom surface for measurements ≤ 3 GHz, two measurement points for measurements ≤ 5 GHz and three measurement points for measurements above 5 GHz. When graded grids are used, which only applies in the direction normal to the phantom surface, the initial grid separation closest to the phantom surface and subsequent graded grid increment ratios must satisfy the required protocols above. The 1-g SAR averaging volume must be fully contained within the zoom scan measurement volume boundaries; otherwise, the measurement must be repeated by shifting or expanding the zoom scan volume. The similar requirements also apply to 10-g SAR measurements.

7.1.7 Comparison of DASY 52 NEO and cDASY6/DASY8

CTC advanced actually uses both systems side by side and the main differences of the DASY52 NEO and cDASY6/DASY8 system are system operation, reporting tools and measurement speed. DASY 52 still uses the DASY measurement software which has further in-depth options to adapt measurements to sophisticated test setups. For the reporting of the measurement results the companion software SEMCAD X is used. cDASY6/DASY8 is a different measurement system that is especially aimed to speed up standardized compliant measurements with high repeatability and less freedom of usability. It makes it possible to handle and rate compliance tests for a standardized product like a mobile phone in one place and it provides its own backend for reporting. The higher measurement speed is bought for the cost of less flexibility in the measurement setup and adding further sophisticated maintenance as it is necessary to perform regular mother scans.

Feature comparison:		
	DASY 52 (NEO)	cDASY6/DASY8
Warning feature for Zoom Scan according IEC 62209-2 AMD1 (graded Grid conditions)*	yes**	yes
Graded Grids for Area and Zoom Scan supported	yes**	yes
Measurement software	DASY 52 NEO	cDASY6/DASY8
Reporting tool	SEMCAD X post processor	cDASY6/DASY8 integrated post processor
Collusion detection to set probe to surface distance	yes	yes
Mother scans	no	yes

*) A warning appears if the stricter zoom scan criteria as defined in IEEE Std 1528-2013 are violated using the actual zoom scan settings. In these cases a re-measurement with graded grid is performed and the result plot is updated with the information about the graded grid. This approach guarantees that the difference between the positions with maximum SAR to any adjacent point both horizontally and vertically is below the defined thresholds and that the SAR evaluation is correct.
(respecting both the 3 dB and the 30% criteria from section 6.3.1 d) of IEC 62209-2 AMD1.)

**) features were added with version: DASY52 - 52.10.2(1504) to satisfy IEC 62209-2 AMD1.

NOTE:
As outlined in the **TCB Workshop Nov 2019**, the 3dB and 30% criteria are adopted from IEC 62209-2 AMD1 and will be part of the new SAR measurement procedures in the FCC KDB 865664. Those shall be implemented instantly to avoid measuring errors.

7.1.8 Spatial Peak SAR Evaluation

Both DASY5 V5.2 and cDASY6/DASY8 Module SAR software include all numerical procedures necessary to evaluate the spatial peak SAR values. Based on the IEEE 1528 standard, a new algorithm has been implemented. The spatial-peak SAR can be computed over any required mass.
The base for the evaluation is a "cube" measurement in a volume of $30mm^3$ below 3GHz or $22mm^3$ above 3GHz. The measured volume must include the 1 g and 10 g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan. If the 10g cube or both cubes are not entirely inside the measured volumes, the system issues a warning regarding the evaluated spatial peak values within the post-processing engine. This means that if the measured volume is shifted, higher values might be possible. To get the correct values a finer measurement grid for the area scan is used. In complicated field distributions, a large grid spacing for the area scan might miss some details and give an incorrectly interpolated peak location. Both DASY5 V5.2 and cDASY6/DASY8 Module SAR allow to automatically extend the grid to make sure that both cubes are inside the measured volume.

The entire evaluation of the spatial peak values is performed within the application in case of cDASY6/DASY8 Module SAR software or within Post-processing engine (SEMCAD X) for DASY5 V5.2. The system always gives the maximum values for the 1 g and 10 g cubes. The cDASY6/DASY8 software allow to automatically extend the grid to make sure that both cubes are inside the measured volume. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

1. extraction of the measured data (grid and values) from the Zoom Scan
2. calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. generation of a high-resolution mesh within the measured volume
4. interpolation of all measured values from the measurement grid to the high-resolution grid
5. extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. calculation of the averaged SAR within masses of 1 g and 10 g The significant parts are outlined in more detail within the following sections.

Interpolation, Extrapolation and Detection of Maxima

The probe is calibrated at the center of the dipole sensors which is located 1 to 2.7mm away from the probe tip. During measurements, the probe stops shortly above the phantom surface, depending on the probe and the surface detecting system. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated.

The choice of the coordinate system defining the location of the measurement points has no influence on the uncertainty of the interpolation, Maxima Search and extrapolation routines. The interpolation, extrapolation and maximum search routines are all based on the modified Quadratic Shepard's method [Robert J. Renka, "Multivariate Interpolation Of Large Sets Of Scattered Data", University of North Texas ACM Transactions on Mathematical Software, vol. 14, no. 2, June 1988, pp. 139-148.].

Thereby, the interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation. The cDASY6/DASY8 routines construct a once-continuously differentiable function that interpolates the measurement values as follows:

- For each measurement point a trivariate (3-D) / bivariate (2-D) quadratic is computed. It interpolates the measurement values at the data point and forms a least-square fit to neighbouring measurement values.
- the spatial location of the quadratic with respect to the measurement values is attenuated by an inverse distance weighting. This is performed since the calculated quadratic will fit measurement values at nearby points more accurate than at points located further away.
- After the quadratics are calculated at all measurement points, the interpolating function is calculated as a weighted average of the quadratics.

There are two control parameters that govern the behavior of the interpolation method.

One specifies the number of measurement points to be used in computing the least-square fits for the local quadratics. These measurement points are the ones nearest the input point for which the quadratic is being computed.

The second parameter specifies the number of measurement points that will be used in calculating the weights for the quadratics to produce the final function. The input data points used there are the ones nearest the point at which the interpolation is desired. Appropriate defaults are chosen for each of the control parameters.

The trivariate quadratics that have been previously computed for the 3-D interpolation and whose input data are at the closest distance from the phantom surface, are used in order to extrapolate the fields to the surface of the phantom.

In order to determine all the field maxima in 2-D (Area Scan) and 3-D (Zoom Scan), the measurement grid is refined by a default factor of 10 (area) and 5 (zoom), respectively, and the interpolation function is used to evaluate all field values between corresponding measurement points. Subsequently, a linear search is applied to find all the candidate maxima. In a last step, non physical maxima are removed and only those maxima which are within 2 dB of the global maximum value are retained.

Important: To be processable by the interpolation/extrapolation scheme, the Area Scan requires at least6 measurement points. The Zoom Scan requires at least 10 measurement points to allow the application of these algorithms.

In the Area Scan, the gradient of the interpolation function is evaluated to find all the extrema of the SAR distribution. The uncertainty on the locations of the extrema is less than 1/20 of the grid size. Only local maxima within 2 dB of the global maximum are searched and passed for the Zoom Scan measurement.

In the Zoom Scan, the interpolation function is used to extrapolate the Peak SAR from the lowest measurement points to the inner phantom surface (the extrapolation distance). The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

Averaging and Determination of spatial Peak SAR

Within DASY5 V5.2 software, the interpolated data is used to average the SAR over the 1g and 10g cubes by spatially discretizing the entire measured volume. The resolution of this spatial grid is around 1mm and chosen such that the cube side length is a multiple of the resolution. The resulting volumes are defined as cubical volumes containing the appropriate tissue parameters that are centered at the location. The location is defined as the center of the incremental volume.

The spatial-peak SAR must be evaluated in cubical volumes containing a mass that is within 5% of the required mass. The cubical volume centered at each location, as defined above, should be expanded in all directions until the desired value for the mass is reached, with no surface boundaries of the averaging volume extending beyond the outermost surface of the considered region. In addition, the cubical volume should not consist of more than 10% of non-liquid volume. If these conditions are not satisfied, then the center of the averaging volume is moved to the next location.

Reference is kept of all locations used and those not used for averaging the SAR. All average SAR values are finally assigned to the centered location in each valid averaging volume. All locations included in an averaging volume are marked as used to indicate that they have been used at least once. If a location has been marked as used, but has never been the center of a cube, the highest averaged SAR value of all other cubical volumes which have used this location for averaging is assigned to this location. For the case of an unused location, a new averaging volume must be constructed which will have the unused location centered at one surface of the cube. The remaining five surfaces are expanded evenly in all directions until the required mass is enclosed, regardless of the amount of included air. Of the six possible cubes with one surface centered on the unused location, the smallest cube is used, which still contains the required mass.

If the final cube containing the highest averaged SAR touches the surface of the measured volume, an appropriate warning is issued within the Post-processing engine.

Within cDASY6/DASY8 Module SAR software, the measured grid is interpolated to a high resolution grid, where the resolution is around 1mm and chosen such that the cube volume is a multiple of the resolution. Points which are outside of the measured grid are masked out and set to zero. Then, the antiderivative of the interpolated grid is computed by using a Gaussian quadrature consecutively for all spatial dimensions.

The antiderivative is used to compute all cube averages of the volume with the same resolution as the interpolated grid. The maximum of these SAR averages is reported. If the cube containing the maximum averaged SAR touches the surface of the measured volume, an appropriate warning is issued within the Post-processing engine.

7.1.9 Data Storage and Evaluation

Data Storage

The DASY software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension ".DA4", ".DA5x". The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

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

Data Evaluation by SEMCAD

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

Probe parameters:	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion factor	$ConvF_i$
	- Diode compression point	Dcpi
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics.

If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

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

with	V_i	= compensated signal of channel i	(i = x, y, z)
	U_i	= input signal of channel i	(i = x, y, z)
	cf	= crest factor of exciting field	(DASY parameter)
	dcp_i	= diode compression point	(DASY parameter)

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

E-field probes: $$E_i = (V_i / Norm_i \cdot ConvF)^{1/2}$$

H-field probes: $$H_i = (V_i)^{1/2} \cdot (a_{i0} + a_{i1}f + a_{i2}f^2)/f$$

with	V_i	= compensated signal of channel i	(i = x, y, z)
	$Norm_i$	= sensor sensitivity of channel i [mV/(V/m)^2] for E-field Probes	(i = x, y, z)
	ConvF	= sensitivity enhancement in solution	
	a_{ij}	= sensor sensitivity factors for H-field probes	
	f	= carrier frequency [GHz]	
	E_i	= electric field strength of channel i in V/m	
	H_i	= magnetic field strength of channel i in A/m	

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

$$E_{tot} = (E_x^2 + E_Y^2 + E_z^2)^{1/2}$$

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

$$SAR = (E_{tot}^2 \cdot \sigma) / (\rho \cdot 1000)$$

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

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

$$P_{pwe} = E_{tot}^2 / 3770 \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

with	P_{pwe}	= equivalent power density of a plane wave in mW/cm^2
	E_{tot}	= total electric field strength in V/m
	H_{tot}	= total magnetic field strength in A/m

Data Evaluation in cDASY6/DASY8

cDASY6/DASY8 features basic evaluation capabilities comparable to the above described SEMCAD evaluation. The main difference is that cDASY6/DASY8 is a stand-alone all-in-one solution whilst SEMCAD is only used to add these features to the DASY5.2 (NEO) platform. The final results are fully comparable no matter if they were generated by DASY5.2(NEO) + SEMCAD or in cDASY6/DASY8 directly.

7.1.10 Tissue simulating liquids: dielectric properties

The following materials are used for producing the tissue-equivalent materials.

HBBL600-10000MHz Simulating Liquid, Manufactured by SPEAG:

Ingredients	(% by weight)
Water	50-65%
Mineral oil	10-30%
Emulsifiers	8-25%
Sodium salt	0-1.5%

Table 3: Tissue dielectric properties

7.1.11 Tissue simulating liquids: parameters

Freq. (MHz)	Target tissue		Measurement tissue					Measurement date
	Permittivity	Conductivity [S/m]	Permittivity	Dev. %	Conductivity ε"	Conductivity [S/m]	Dev. %	
2402	39.28	1.76	40.5	3.0	12.97	1.73	-1.4	2022-10-28
2412	39.27	1.77	40.5	3.1	12.97	1.74	-1.5	
2437	39.22	1.79	40.4	3.1	12.97	1.76	-1.7	
2442	39.21	1.79	40.4	3.1	12.97	1.76	-1.7	
2450	39.20	1.80	40.4	3.1	12.97	1.77	-1.8	
2462	39.20	1.81	40.4	3.1	12.98	1.78	-1.9	
2472	39.19	1.82	40.4	3.1	12.98	1.79	-2.1	
2480	39.19	1.83	40.4	3.0	12.99	1.79	-2.2	

Table 4: Parameter of the tissue simulating liquid

Note: The dielectric properties have been measured using the contact probe method at 22°C.

7.1.12 Measurement uncertainty evaluation for SAR test

DASY6/8 Uncertainty Budget According to IEEE Std 1528-2013 (Frequency band: 300 MHz - 3 GHz range)								
Symbol	Error Description	Uncertainty Value	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)
Measurement System Errors								
CF	Probe Calibration Repeat.	± 12,0 %	Normal	2	1	1	± 6,0 %	± 6,0 %
CFdrift	Probe Calibration Drift	± 1,7 %	Rectangular	√ 3	1	1	± 1,0 %	± 1,0 %
LIN	Probe linearity	± 4,7 %	Rectangular	√ 3	1	1	± 2,7 %	± 2,7 %
BBS	Broadband Signal	± 3,0 %	Rectangular	√ 3	1	1	± 1,7 %	± 1,7 %
ISO	Probe Isotropy (axial)	± 7,6 %	Rectangular	√ 3	1	1	± 4,4 %	± 4,4 %
DAE	Data Acquisition	± 0,3 %	Normal	1	1	1	± 0,3 %	± 0,3 %
AMB	RF Ambient	± 1,8 %	Normal	1	1	1	± 1,8 %	± 1,8 %
Δ_{sys}	Probe Positioning	± 0,006 mm	Normal	1	0,14	0,14	± 0,1 %	± 0,1 %
DAT	Data Processing	± 1,2 %	Normal	1	1	1	± 1,2 %	± 1,2 %
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.)[DAK]	± 2,5 %	Normal	1	0,78	0,71	± 2,0 %	± 1,8 %
LIQ(Tσ)	Conductivity (temp.)[BB]	± 3,3 %	Rectangular	√ 3	0,78	0,71	± 1,5 %	± 1,4 %
EPS	Phantom Permittivity	± 14,0 %	Rectangular	√ 3	0	0	± 0,0 %	± 0,0 %
DIS	Distance DUT - TSL	± 2,0 %	Normal	1	2	2	± 4,0 %	± 4,0 %
D_{xyz}	Device Positioning	± 1,0 %	Normal	1	1	1	± 1,0 %	± 1,0 %
H	Device Holder	± 3,6 %	Normal	1	1	1	± 3,6 %	± 3,6 %
MOD	DUT Modulation[m]	± 2,4 %	Rectangular	√ 3	1	1	± 1,4 %	± 1,4 %
TAS	Time-average SAR	± 1,7 %	Rectangular	√ 3	1	1	± 1,0 %	± 1,0 %
RF_{drift}	DUT drift	± 2,5 %	Normal	1	1	1	± 2,5 %	± 2,5 %
VAL	Val Antenna Unc.[val]	± 0,0 %	Normal	1	1	1	± 0,0 %	± 0,0 %
RF_{in}	Unc. Input Power[val]	± 0,0 %	Normal	1	1	1	± 0,0 %	± 0,0 %
Correction to the SAR results								
C(ε, σ)	Deviation to Target	± 1,9 %	Normal	1	1	0,84	± 1,9 %	± 1,6 %
C(R)	SAR scaling[p]	± 0,0 %	Rectangular	√ 3	1	1	± 0,0 %	± 0,0 %
u(ΔSAR)	**Combined Uncertainty**						± 11,0 %	± 10,9 %
U	**Expanded Uncertainty**						**± 21,9 %**	**± 21,7 %**

Table 5: Measurement uncertainties

Worst-Case uncertainty budget for DASY6/8 assessed according to IEEE Std 1528-2013. The budget is valid for the frequency range 300MHz - 3 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller. All listed error components have ϑ_{eff} equal to ∞.

Footnote details:

[m] SMC calibration is a new method for determining the total deviation from linearity. The uncertainty is ≤ 2.4% for psSAR ≤ 2 W/kg, ≤ 4.8% for psSAR1g/10g ≤ 4 W/kg and ≤ 9.6% for psSAR1g/10g ≤ 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.

7.1.13 Measurement uncertainty evaluation for System Check

Repeatability Budget for System Check (Frequency band: 300MHz - 6GHz range) with DASY6/8 System								
Symbol	Error Description	Uncertainty Value	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)
Measurement System Errors								
CF	Probe Calibration Repeat.	± 3.6 %	Normal	2	2	1	± 5.1 %	± 2.5 %
CFdrift	Probe Calibration Drift	± 1.7 %	Rectangular	√ 3	1	1	± 1.0 %	± 1.0 %
LIN	Probe linearity	± 4.7 %	Rectangular	√ 3	0	0	± 0.0 %	± 0.0 %
BBS	Broadband Signal	± 0.0 %	Rectangular	√ 3	0	0	± 0.0 %	± 0.0 %
ISO	Probe Isotropy (axial)	± 4.7 %	Rectangular	√ 3	0	0	± 0.0 %	± 0.0 %
DAE	Data Acquisition	± 0.3 %	Normal	1	0	0	± 0.0 %	± 0.0 %
AMB	RF Ambient	± 0.6 %	Normal	1	0	0	± 0.0 %	± 0.0 %
Δ_{sys}	Probe Positioning	± 0.2 %	Normal	1	0.33	0.33	± 0.1 %	± 0.1 %
DAT	Data Processing	± 0.0 %	Normal	1	1	1	± 0.0 %	± 0.0 %
Phantom and Device Errors								
LIQ(σ)	Conductivity (meas.)[DAK]	± 2.5 %	Normal	1	0.78	0.71	± 2.0 %	± 1.8 %
LIQ(Tσ)	Conductivity (temp.)[BB]	± 3.4 %	Rectangular	√ 3	0.78	0.71	± 1.5 %	± 1.4 %
EPS	Phantom Permittivity	± 14.0 %	Rectangular	√ 3	0	0	± 0.0 %	± 0.0 %
DIS	Distance Phantom - DUT	± 1.0 %	Normal	1	2	2	± 2.0 %	± 2.0 %
MOD	DUT Modulation[m]	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %
TAS	Time-average SAR	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %
VAL	Validation antenna	± 0.0 %	Normal	1	1	1	± 0.0 %	± 0.0 %
P_{in}	Accepted power	± 1.2 %	Normal	1	1	1	± 1.2 %	± 1.2 %
Correction to the SAR results								
C(ε, σ)	Deviation to Target	± 1.9 %	Normal	1	1	0.84	± 1.9 %	± 1.6 %
u(ΔSAR)	**Combined Uncertainty**						± 6.5 %	± 4.5 %
U	**Expanded Uncertainty**						± **13.0** %	± **9.1** %

Table 6: Repeatability of the system check (300MHz - 6 GHz).

All listed error components have v_{eff} equal to ∞.

Footnote details:

[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.

Note: Worst case probe calibration uncertainty has been applied for all probes used during the measurements.

7.1.14 System check

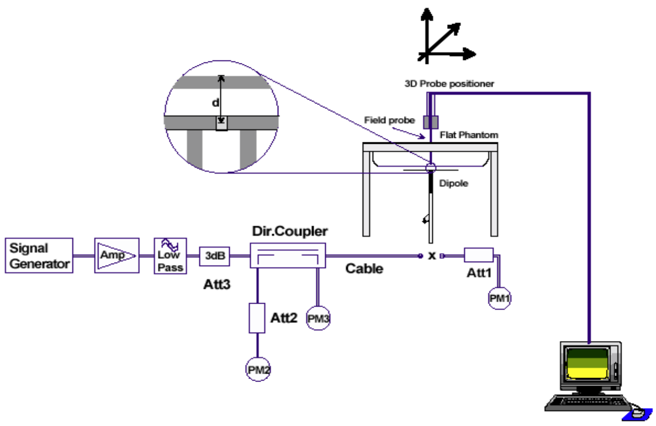
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The following table shows system check results for all frequency bands and tissue liquids used during the tests (plot(s) see annex A).

System performence check (1000 mW)										
System validation Kit	Probe	Frequency	Target SAR_{1g}	Target SAR_{10g}	Measured SAR_{1g}	SAR_{1g}	Measured SAR_{10g}	SAR_{10g}	Measured date
		MHz	W/kg (+/- 10%)		W/kg	dev.	W/kg	dev.	
D2450V2 S/N: 710	EX3DV4 S/N: 3944	2450	51.80	24.10	51.10	-1.4%	23.70	-1.7%	2022-10-28

Table 7: Results system check

7.1.15 System check procedure

The system check is performed by using a validation dipole which is positioned parallel to the planar part of the SAM phantom at the reference point. The distance of the dipole to the SAM phantom is determined by a plexiglass spacer. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 100 mW or 50 mW if used Powersource1. To adjust this power a power meter is used. The power sensor is connected to the cable before the system check to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the validation to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test (result on plot).
System check results have to be equal or near the values determined during dipole calibration (target SAR in table above) with the relevant liquids and test system.



7.1.16 System validation

The system validation is performed in a similar way as a system check. It needs to be performed once a SAR measurement system has been established and allows an evaluation of the system accuracy with all components used together with the specified system. It has to be repeated at least once a year or when new system components are used (DAE, probe, phantom, dipole, liquid type).
In addition to the procedure used during system check a system validation also includes checks of probe isotropy, probe modulation factor and RF signal.

8 Detailed Test Results

8.1 Conducted power measurements

8.1.1 Conducted average power measurements WLAN 2.4 GHz

802.11b		maximum average conducted output power [dBm]			
Band	**Ch**	**1Mbps**	**2Mbps**	**5.5Mbps**	**11Mbps**
2450MHz	1	7.9	7.1	6.4	5.3
	6	8.1	7.4	6.7	5.6
	11	8.2	7.5	6.8	5.7

Table 8: Test results conducted power measurement 802.11b

802.11g		maximum average conducted output power [dBm]							
Band	**Ch**	**6Mbps**	**9Mbps**	**12Mbps**	**18Mbps**	**24Mbps**	**36Mbps**	**48Mbps**	**54Mbps**
2450MHz	1	3.0	2.2	1.3	0.3	-0.3	-1.5	-2.7	-3.1
	6	3.3	2.5	1.7	0.6	0.0	-1.2	-2.4	-2.8
	11	3.4	2.7	1.8	0.8	0.2	-1.1	-2.3	-2.7

Table 9: Test results conducted power measurement 802.11g

802.11n HT-20		maximum average conducted output power [dBm]							
Band	**Ch**	**MCS-0 6.5Mbps**	**MCS-1 13Mbps**	**MCS-2 19.5Mbps**	**MCS-3 26Mbps**	**MCS-4 39Mbps**	**MCS-5 52Mbps**	**MCS-6 58.5Mbps**	**MCS-7 65Mbps**
2450MHz	1	1.4	-3.1	2.2	0.3	2.9	2.1	1.3	-0.2
	6	1.7	-2.8	2.5	0.6	3.2	2.5	1.6	0.2
	11	1.8	-2.7	2.6	0.7	3.3	2.6	1.7	0.3

Table 10: Test results conducted power measurement 802.11n HT-20

8.1.2 Conducted average power measurements Bluetooth Classic 2.4 GHz

Channel	Frequency (MHz)	Average power (dBm)		
		GFSK	π/4 DQPSK	8-DPSK
0	2402	0.5	-2.6	-2.6
39	2441	0.2	-3.7	-3.5
78	2480	0.2	**-3.6**	-3.5

Table 11: Test results conducted average power measurement BLUETOOTH CLASSIC 2.4 GHz

8.1.3 Conducted average power measurements Bluetooth LE 2.4 GHz

Channel	Frequency (MHz)	Average power (dBm)
		GFSK
0	2402	0.5
19	2440	0.5
39	2480	0.2

Table 12: Test results conducted average power measurement BLUETOOTH LE 2.4 GHz

8.1.4 Standalone SAR Test Exclusion according to FCC KDB 447498 D01

Standalone SAR test exclusion considerations for **body** position							
Communication system	freq. (MHz)	distance (mm)	P_{avg}* (dBm)	P_{avg}* (mW)	**$threshold_{1g}$ comparison value**	**SAR_{1g} test exclusion thresholds**	SAR_{1g} test exclusion
WLAN 2450	2450	5	8.2	6.6	2.1	3.0	yes
BT BR/EDR (GFSK)	2450	5	0.5	1.1	0.4	3.0	yes
BT LE	2450	5	0.5	1.1	0.4	3.0	yes

Table 13: Standalone SAR test exclusion considerations in **body position**

P_{avg}* - maximum possible output power declared by manufacturer

The **1-g SAR test exclusion thresholds** for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:
[(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]×[√f(GHz)] ≤ **3.0** for 1-g SAR and ≤ **7.5** for 10-g extremity SAR, where:

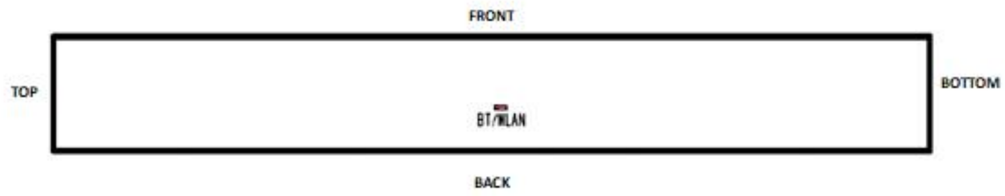
- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

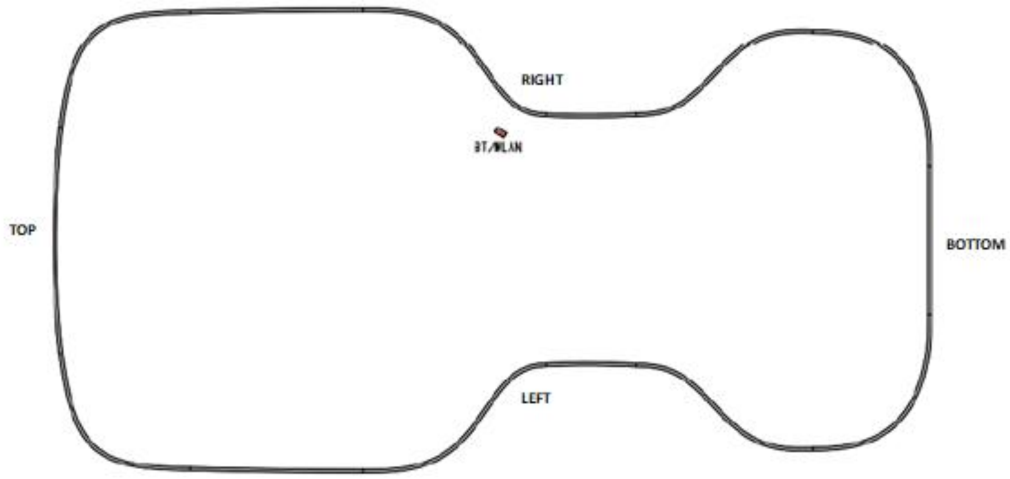
When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

8.1.5 SAR measurement positions

SAR measurement positions							
mode	front	back	left edge	right edge	top edge	bottom edge	limb (R)*
WLAN 2450	yes	yes	no	yes	no	no	yes
BT EDR / LE	yes	yes	no	yes	no	no	yes

*) limb (R) measured on the left phantom neck, to get the closest fit to the EUT form.





Distances from the BT / WLAN antenna to the corresponding side:

Side:	front	back	left edge	right edge	top edge	bottom edge
Distance: [mm]	13	31.6	107	37	137	136

Adjacent edge SAR test exclusion considerations						
Communication system	freq. (MHz)	P_{avg}* (dBm)	P_{avg}* (mW)	distance (mm)	**exclusion threshold$_{1g}$ (mW)**	SAR test exclusion
WLAN 2450	2450	8.2	**6.6**	3.5	**6.7**	yes
Bluetooth 2450	2450	0.5	**1.1**	1.0	**1.9**	yes

Table 14: Adjacent edge SAR test exclusion considerations according to KDB 447498 D01v05

8.2 SAR test results

8.2.1 General description of test procedures

- The DUT is tested using a test software to control test channels and maximum output power of the DUT.
- Test positions as described in the tables below are in accordance with the specified test standard.
- WLAN was tested in 802.11b mode with 1 MBit/s.
- Required WLAN test channels were selected according to KDB 248227
- For body worn operation, this device has been tested and meets FCC RF exposure guidelines when
- The DUT was tested using a CBT communication tester in BT-test mode to adjust maximum output power, test channels and operating mode.
  (GFSK - DH5 - STATIC PBRS - 76% duty cycle)

8.2.2 Results overview

measured / extrapolated SAR numbers - WLAN 2450 MHz														
Ch.	Freq. (MHz)	test cond.	Position	cond. P_{max} (dBm)		SAR_{1g} (W/kg)			SAR_{10g} (W/kg)			power drift (dB)	liquid (°C)	dist. (mm)
				decl.*	meas.	meas.	extrap.	100% DF	meas.	extrap.	100% DF			
Body worn														
6	2437	1Mbit/s	front	9.0	8.1	**0.094**	**0.116**	**0.118**	0.050	0.062	0.063	0.05	21.3	0
6	2437	1Mbit/s	back	9.0	8.1	0.005	0.006	0.006	0.003	0.004	0.004	0.08	21.3	0
Limb worn														
6	2437	1Mbit/s	front	9.0	8.1	0.094	0.116	0.118	0.050	0.062	0.063	0.05	21.3	0
6	2437	1Mbit/s	back	9.0	8.1	0.005	0.006	0.006	0.003	0.004	0.004	0.08	21.3	0
6	2437	1Mbit/s	right	9.0	8.1	0.031	0.038	0.039	0.017	0.021	0.021	-0.03	21.3	0
1	2412	1Mbit/s	limb (R)	9.0	7.9	0.028	0.036	0.037	0.015	0.019	0.020	0.01	21.3	0
6	2437	1Mbit/s	hand	9.0	8.1	0.101	0.124	0.127	**0.054**	**0.066**	**0.068**	0.03	21.3	0
11	2462	1Mbit/s	hand	9.0	8.2	0.012	0.014	0.015	0.006	0.007	0.007	-0.04	21.3	0

Table 15: Test results SAR WLAN 2450 MHz

measured / extrapolated SAR numbers – BT EDR 2450 MHz												
Ch.	Freq. (MHz)	test cond.	Position	cond. P_{max} (dBm)		SAR_{1g} (W/kg)		SAR_{10g} (W/kg)		power drift (dB)	liquid (°C)	dist. (mm)
				decl.*	meas.	meas.	extrap.	meas.	extrap.			
Body worn												
0	2402	DH5	front	2.0	0.5	**0.017**	**0.024**	0.008	0.011	-0.05	21.3	0
0	2402	DH5	back	2.0	0.5	0.000	0.000	0.000	0.000	0.00	21.3	0
Limb worn												
0	2402	DH5	front	2.0	0.5	0.017	0.024	**0.008**	**0.011**	-0.05	21.3	0
0	2402	DH5	back	2.0	0.5	0.000	0.000	0.000	0.000	0.00	21.3	0
0	2402	DH5	right	2.0	0.5	0.006	0.008	0.003	0.004	-0.15	21.3	0
0	2402	DH5	limb (R)	2.0	0.5	0.000	0.000	0.000	0.000	0.00	21.3	0

Table 16: Test results SAR BT EDR 2450 MHz

NOTE:
limb (R) was measured on the left hand neck of the SAM phantom, to fit as close as possible to the EUT form. Details can be seen in 1-8038-24-01-02_TR1-A101-R01_Photos.

8.2.3 Multiple Transmitter Information

The following tables list information which is relevant for the decision if a simultaneous transmit evaluation is necessary according to FCC KDB 447498D01 General RF Exposure Guidance v05.

reported SAR_{1g} **WLAN and BT 2.4GHz**, **ΣSAR** evaluation		
SAR_{max} /W/kg		**ΣSAR_{1g}** <1.6W/kg
WLAN	BT	
0.118	0.024	0.142
reported SAR_{10g} **WLAN and BT 2.4GHz**, **ΣSAR** evaluation		
SAR_{max} /W/kg		**ΣSAR_{10g}** <1.6W/kg
WLAN	BT	
0.068	0.011	0.079

Table 17: SAR_{max} WLAN and Bluetooth 2450MHz, ΣSAR evaluation

Conclusion:

ΣSAR_{1g} < 1.6 W/kg, therefore simultaneous transmissions SAR measurement with the enlarged zoom scan measurement and volume scan post-processing procedures is **not** required.

9 Test equipment and ancillaries used for tests

To simplify the identification of the test equipment and/or ancillaries which were used, the reporting of the relevant test cases only refer to the test item number as specified in the table below.

Equipment	Type	Manufacturer	Serial No.	Last Calibration	Frequency (months)
Dosimetric E-Field Probe	EX3DV4	Schmid & Partner Engineering AG	3944	May 17, 2022	12
2450 MHz System Validation Dipole	D2450V2	Schmid & Partner Engineering AG	710	May 11, 2022	36
Data acquisition electronics	DAE3V1	Schmid & Partner Engineering AG	477	May 16, 2022	12
Software	cDASY6 V16.0.0.116	Schmid & Partner Engineering AG	---	N/A	--
SAM Twin Phantom V8.0	QD 000 P40 C	Schmid & Partner Engineering AG	2061	N/A	--
Network Analyser 300 kHz to 6 GHz	8753ES	Agilent Technologies)*	US39174 436	December 14, 2021	24
Dielectric Assessment Kit (DAK)	DAK 200MHz – 20GHz Package	Schmid & Partner Engineering AG	1127	N/A	--
Signal Generator	SML03	Rohde & Schwarz	102519	December 06, 2021	12
RF Power Amplifier	BLMA 0760-6 (6 Watt)	BONN Elektronik	1510273	N/A	--
Power Meter	NRP	Rohde & Schwarz	101367	December 07, 2021	12
Power Meter Sensor	NRP Z22	Rohde & Schwarz	100227	December 06, 2021	12
Power Meter Sensor	NRP Z22	Rohde & Schwarz	100234	December 06, 2021	12
Directional Coupler	778D	Hewlett Packard	19171	December 06, 2021	12
Digital Thermometer	DTM 3000 Spezial	Schmid & Partner Engineering AG	3195	March 30, 2022	24
Simulating Liquid	HBBL600-10000MHz	Schmid & Partner Engineering AG	--	Liquid described in detail in separate chapter 7.1.10 and 7.1.11 of this test report	

)* : Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

10 Observations

No observations exceeding those reported with the single test cases have been made.

Annex A: System performance check

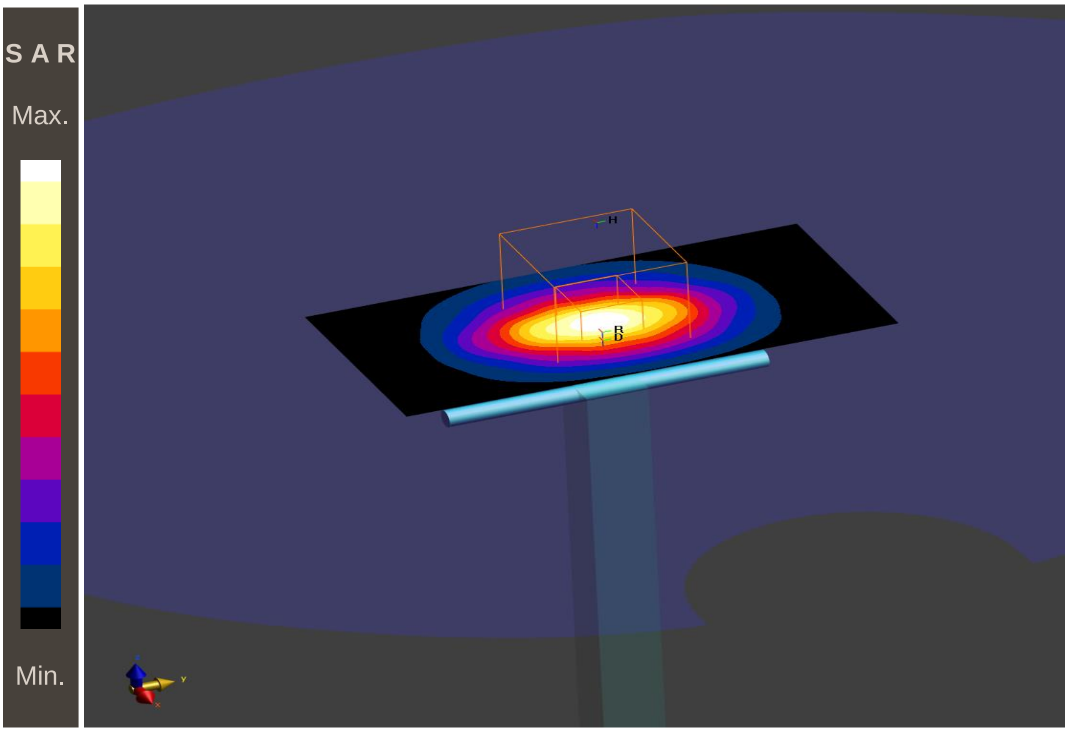
Date/Time: 2022-10-28, 07:34 2022-10-28, 07:42

SystemPerformanceCheck-D2450 HSL 2022-10-28

DUT: Dipole; Type: D2450V2; Serial: SN710
Communication System: CW; Communication System Frequency: 2450.0 MHz
Medium parameters used: f = 2450.0 MHz, σ = 1.77 S/m; ε_r=40.4; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(7.97, 7.97, 7.97); Calibrated: 2022-05-17
- Sensor-Surface: 1.4 mm
- DAE: DAE3 Sn477; Calibrated: 2022-05-16
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 2061;
- Software: cDASY6 (16.0.0.116)

HBBL-600-10000/2450.0MHz/Area Scan (10.0 x 10.0 x 1.0) :
Grid Extents [mm]: 40.0 x 80.0
Maximum value of SAR (interpolated) - SAR(1 g) = 5.08 W/kg; SAR(10 g) = 2.32 W/kg

HBBL-600-10000/2450.0MHz/Zoom Scan (5.0 x 5.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Power Drift = 0.09 dB
SAR(1 g) = 5.11 W/kg; SAR(10 g) = 2.37 W/kg



Additional information:
ambient temperature: 21.2°C; liquid temperature: 21.3°C;

Annex B: DASY measurement results

SAR plots for **the highest measured SAR** in each exposure configuration, wireless mode and frequency band combination according to FCC KDB 865664 D02

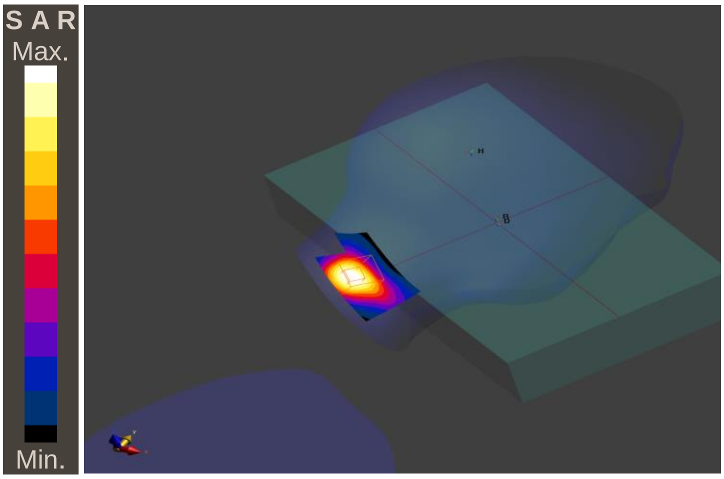
Date/Time: 2022-10-28, 14:04 2022-10-28, 14:16

IEC-IEEE 62209-1528-WLAN

DUT: Swiss Technology; Type: CS20 Basic; Serial: 2495072
Communication System: IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle); Communication System Band: WLAN 2.4GHz; Communication System Frequency: 2437.0 MHz
Medium parameters used: f = 2437.0 MHz, σ = 1.76 S/m; ε_r=40.4; ρ= 1000 kg/m3
Phantom Section: LeftHead
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(7.97, 7.97, 7.97); Calibrated: 2022-05-17
- Sensor-Surface: 1.4mm
- DAE: DAE3 Sn477; Calibrated: 2022-05-16
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 2061;
- Software: cDASY6 (16.0.0.116)

HBBL-600-10000/CHEEK, 0 mm - Channel 6/Area Scan (10.0 x 10.0 x 1.0) :
Grid Extents [mm]: 60.0 x 60.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.098 W/kg; SAR(10 g) = 0.052 W/kg

HBBL-600-10000/CHEEK, 0 mm - Channel 6/Zoom Scan (5.0 x 5.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Graded Grid: Ratio 1.5 - Distance Sensor to Surface 1.4 mm
Power Drift = 0.03 dB
SAR(1 g) = 0.101 W/kg; SAR(10 g) = 0.054 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: 13.6
M1/M2%: 85.5



Additional information:
position or distance of DUT to SAM: 0 mm
ambient temperature: 21.2°C; liquid temperature: 21.3°C;

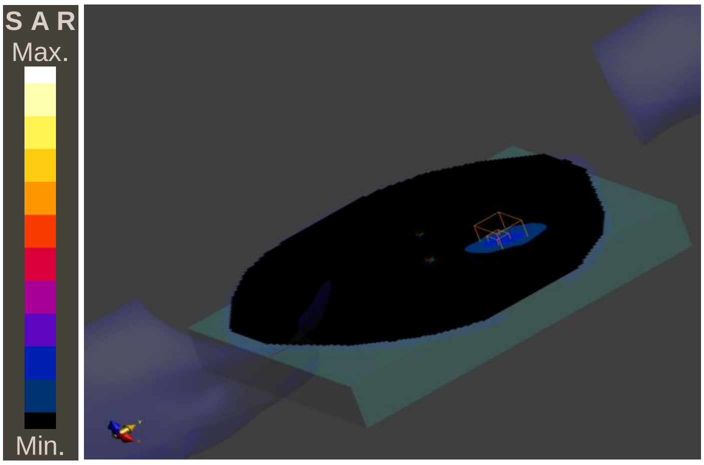
Date/Time: 2022-10-28, 16:26 2022-10-28, 16:37

IEC-IEEE 62209-1528-BT

DUT: Swiss Technology; Type: CS20 Basic; Serial: 2495072
Communication System: IEEE 802.15.1 Bluetooth (GFSK, DH5); Communication System Band: ISM 2.4 GHz Band; Communication System Frequency: 2402.0 MHz
Medium parameters used: f = 2402.0 MHz, σ = 1.73 S/m; ε_r=40.5; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(7.97, 7.97, 7.97); Calibrated: 2022-05-17
- Sensor-Surface: 1.4mm
- DAE: DAE3 Sn477; Calibrated: 2022-05-16
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 2061;
- Software: cDASY6 (16.0.0.116)

HBBL-600-10000/FRONT, 0 mm - Channel 0/Area Scan (10.0 x 10.0 x 1.0) :
Grid Extents [mm]: 60.0 x 60.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.017 W/kg; SAR(10 g) = 0.009 W/kg

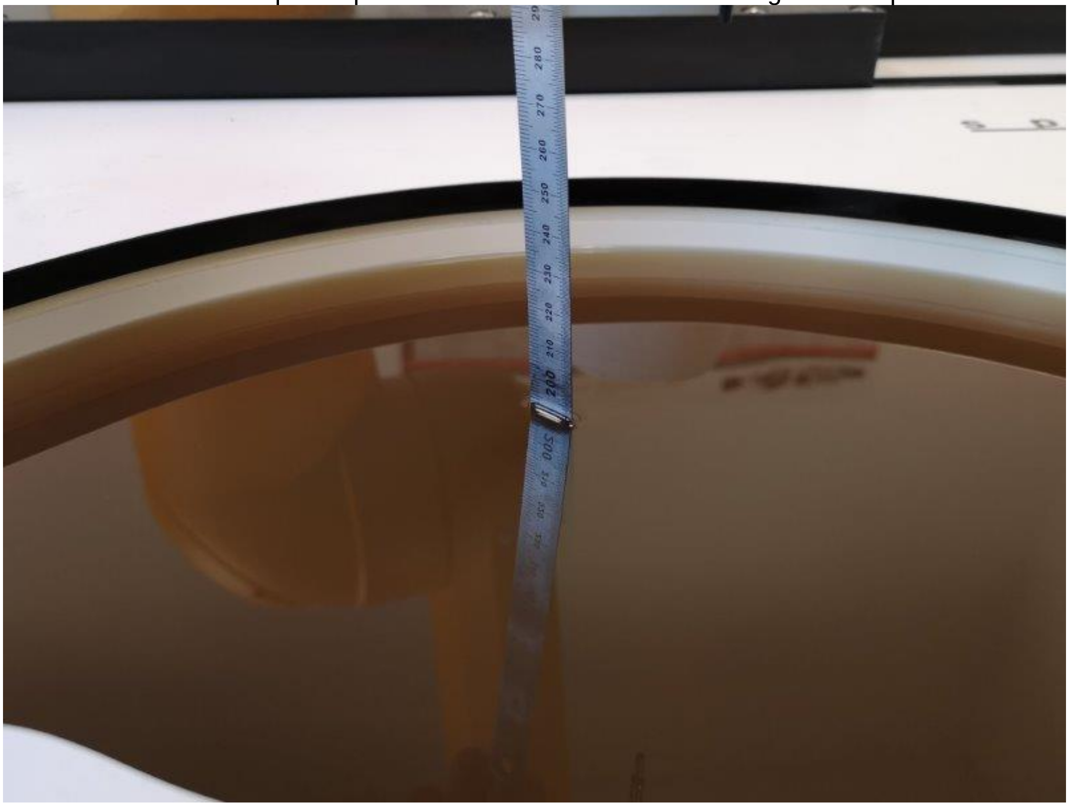
HBBL-600-10000/FRONT, 0 mm - Channel 0/Zoom Scan (5.0 x 5.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Graded Grid: Ratio 1.5 - Distance Sensor to Surface 1.4 mm
Power Drift = -0.29 dB
SAR(1 g) = 0.017 W/kg; SAR(10 g) = 0.008 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: > 15.0
M1/M2%: 87.0



Additional information:
position or distance of DUT to SAM: 0 mm
ambient temperature: 23.2°C; liquid temperature: 21.3°C;

Annex B.1: Liquid depth

Photo 1: Liquid depth HBBL600-10000MHz Simulating Head Liquid



Annex C: Photo documentation

Photo documentation is described in the additional document:
1-8038-24-01-03_TR1-A101-R01_Photos

Annex D: Calibration parameters

Calibration parameters are described in the additional document:
1-8038-24-01-03_TR1-A201-R01_Caldata

Annex E: Document History

Version	Applied Changes	Date of Release
	Initial Release	2024-05-17
-R02	Corrected standards on page 1 and 6, scan description on page 12, uncertainty description on page 21	2024-05-29

Annex F: Further Information

Glossary

DTS	-	Distributed Transmission System
DUT	-	Device under Test
EUT	-	Equipment under Test
FCC	-	Federal Communication Commission
FCC ID	-	Company Identifier at FCC
HW	-	Hardware
N/A	-	not applicable
OET	-	Office of Engineering and Technology
SAR	-	Specific Absorption Rate
S/N	-	Serial Number
SW	-	Software