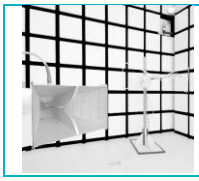
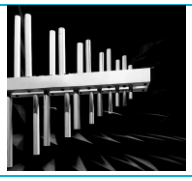
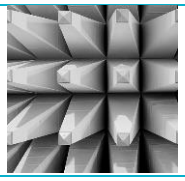

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TEST REPORT

Test Report No.: 1-8714-24-01-06_TR1-R01

ilac-MRA

DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-00

BNetzA-CAB-02/21-102

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.
ISED Testing Laboratory Recognized Listing Number: DE0001
FCC designation number: DE0002

Applicant

RISO KAGAKU CORPORATION
Riso Research and Design Center, 2-8-1 Gakuen-minami, Tsukuba-shi
305-0818 Ibaraki/JAPAN
Contact: Takashi Isozaki
e-mail: tisozaki@riso.co.jp

Manufacturer

RISO KAGAKU CORPORATION
Riso Research and Design Center, 2-8-1 Gakuen-minami, Tsukuba-shi
305-0818 Ibaraki/JAPAN

Combined Test report, applicable for:

☒ EC ☒ FCC ☒ ISED

Test Item

Kind of test item:	RFID module
Device type:	fixed device
Model name:	**068-50043**
S/N serial number:	ITEM NO8-1
FCC-ID:	RPARFR61
ISED Number:	4819A-RFR61
PMN:	068-50043
HVIN:	068-50043
HMN:	-/-
FVIN:	-/-
Hardware status:	068-50043
Software status:	V3.0000
Frequency:	13.56 MHz RFID
Antenna:	integrated antenna
Power supply:	4.75 V to 5.25 V DC by power supply
Test sample status:	identical prototype
Exposure category:	general population / uncontrolled environment

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.

Test Report authorised:

cn=Alexander Hnatovskiy, o=cetecom advanced GmbH, ou=HNA-230601, email=alexander.hnatovskiy@cetecomadvanced.com, c=DE
2025.03.11 12:02:02 +01'00'

Alexander Hnatovskiy
Lab Manager
Radio Labs

Test performed:

Marco Scigliano

cn=Marco Scigliano, o=cetecom advanced GmbH, ou=SCI-230601, email=Marco.Scigliano@cetecomadvanced.com, c=DE
2025.03.11 11:45:43 +01'00'

Marco Scigliano
Testing Manager
Radio Labs

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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.
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In no case this test report can be considered as a Letter of Approval.

2.2 Application details

Date of receipt of order:	2024-10-07
Date of receipt of test item:	2025-02-03
Start of test:	2025-02-10
End of test:	2025-02-10

2.3 Statement of compliance

The SAR values found for the 068-50043 RFID module are below the maximum recommended levels listed in section 3.

3 Test standard/s:

Test Standard	Version	Test Standard Description
FCC – CFR 47 § 2.1093	--	Radiofrequency radiation exposure evaluation: portable devices.
RSS-102 Issue 6	2023-12	Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
RSS-102 Supplementary Procedures SPR-002	2022-10	SPR-002 — Supplementary Procedure for Assessing Compliance of Equipment Operating from 3 kHz to 10 MHz with RSS-102
Canada's Safety Code No. 6	2015-06	Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz
RSS-102.SAR.MEAS Issue 1 Amendment 1	15.12.2023	Measurement Procedure for Assessing Specific Absorption Rate (SAR) Compliance in Accordance with RSS-102
IEEE Std. C95-3	2002	IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave
IEC/IEEE 62209-1528-2020	2020-10-19	Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Part 1528: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz)
EN IEC 62311:2020	2020-07-24	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz)

REMARK:
IEEE/IEC 62209-1528 implements all the measurement methods from EN 62209-2 release 2010 (including AMD 1 from 2019) adding further details and extends the SAR measurements range down to 4 MHz. The used measurement methodology full-fills all necessities for EN 62209-2 (30MHz to 6 GHz SAR) and fully complies to IEEE/IEC 62209-1528 (4MHz to 10GHz) which also is needed for future Power density measurements (7 to 10GHz). The necessary statement of notified body is added in Annex F: SAR measurements between 4 MHz and 30 MHz of this test report on page 31.

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

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3.1 RF exposure limits

In this report the RF Exposure levels of 1999/519/EC (1999)[1)] as well as the CFR 47 – Part 1, §1.1310 / RSS 102 Issue 06 / safety Code 6 are applied to ensure the compliance with EC, FCC , ISED and futher regimes.

Limit according	1999/519/EC	CFR 47 – Part 1, §1.1310	RSS 102 Issue 06 / safety Code 6
Human Exposure	Uncontrolled Environment General Population		
Spatial Peak SAR* (Head and trunk)	**2.00 W/kg**	**1.60 W/kg**	**1.60 W/kg**
Spatial Average SAR** (Whole Body)	0.08 W/kg	0.08 W/kg	0.08 W/kg
Spatial Peak SAR*** (Hands/Feet/Ankle/Wrist)	**4.00 W/kg**		
Regimes	EC	FCC	ISED

Table 1: RF exposure limits

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

Notes:

* The Spatial Peak value of the SAR averaged over any 1/10 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.

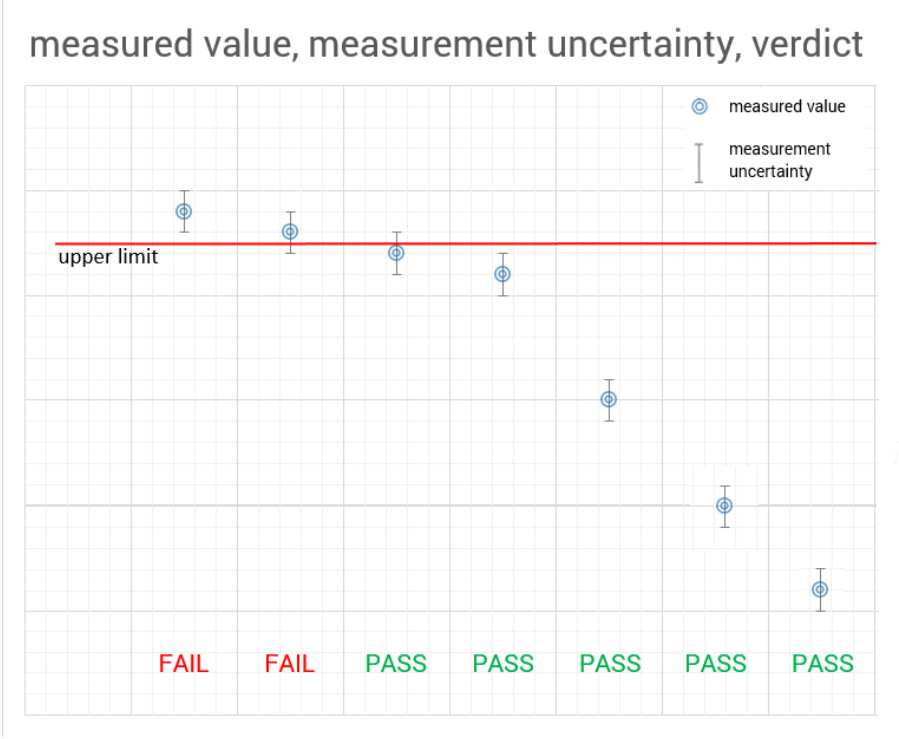
Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

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).

[1)] according to the European Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (Official Journal L 199 of 30 July 1999)

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 value (W/kg) for EC:		
	reported	**limit**
10g SAR for body with 0mm distance:	**0.047**	**2**
10g SAR for Hands/Feet/Ankle/Wrist with 0mm distance:	**0.047**	**4**
Maximum SAR value (W/kg) for FCC:		
	reported	**limit**
1g SAR for body with 0mm distance:	**0.073**	**1.6**
10g SAR for Hands/Feet/Ankle/Wrist with 0mm distance:	**0.047**	**4**
Maximum SAR value (W/kg) for ISED:		
	reported	**limit**
1g SAR for body with 0mm distance:	**0.073**	**1.6**
10g SAR for Hands/Feet/Ankle/Wrist with 0mm distance:	**0.047**	**4**

6 Test Environment

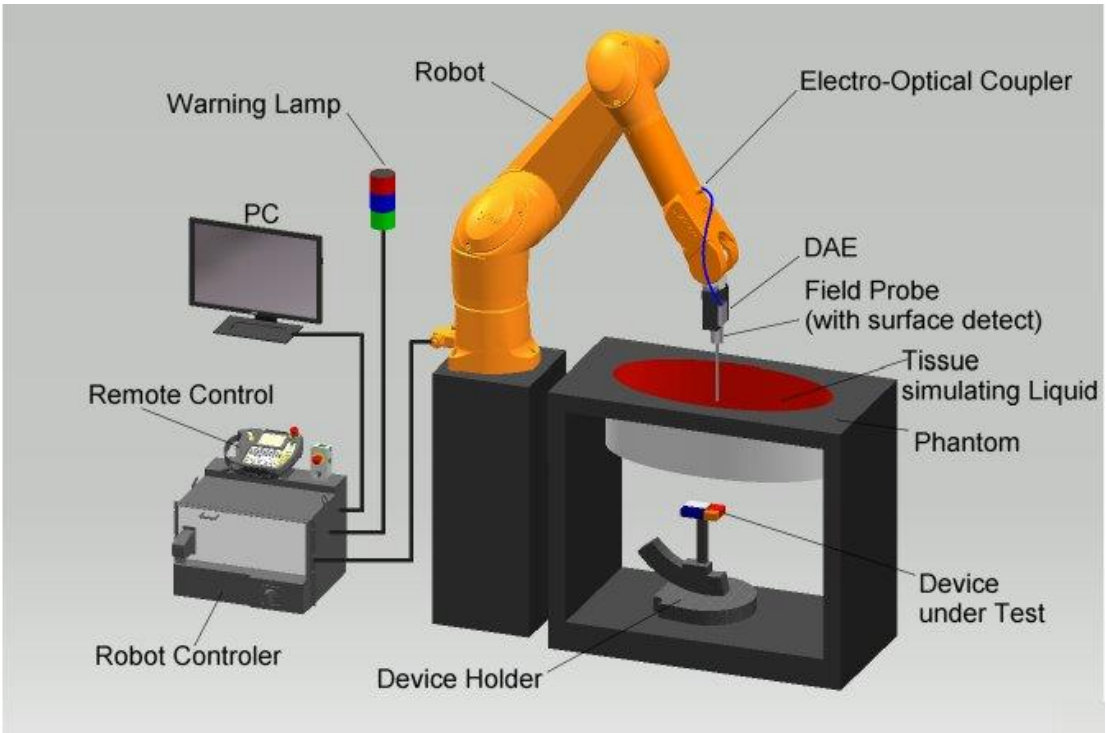
Ambient temperature:	20 – 24 °C
Tissue Simulating liquid:	20 – 24 °C
Relative humidity content:	40 – 50 %
Air pressure:	not relevant for this kind of testing
Power supply:	230 V / 50 Hz

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.

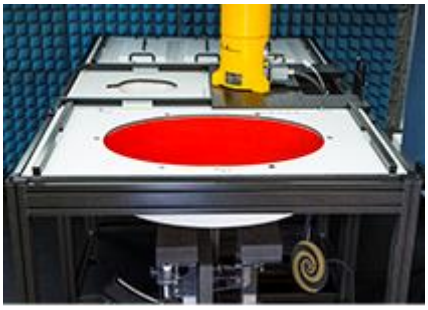
7.1.2 Test environment

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%.

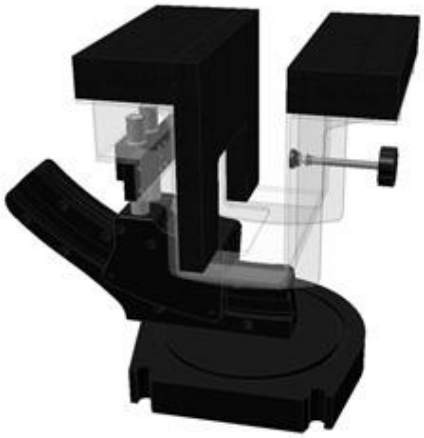
7.1.4 Phantom description



The used ELI Phantom is fully compatible with the IEC/IEEE 62209-1528 and all known tissue stimulating liquids. It meets the requirements specified in KDB865664 D01 for Specific Absorption Rate (SAR) measurements and is fully compatible with the standard IEC 62209-2. The phantom consists of a fibreglass shell integrated in a wooden table. The ELI phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 4MHz to 10 GHz.

7.1.5 Laptop Extension Kit for Device holder

SPEAG released a simple but effective extension for their Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc).



The extension is lightweight and made of POM, PET-G acrylic glass and foam. It fits easily on the upper part of the Mounting Device in place of the phone positioner.
Larger DUT's 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.

7.1.6 Scanning procedure

- The DASY installation includes predefined files with recommended procedures for measurements and system check. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.
- The „reference“ and „drift“ measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max. +/- 5 %.
- The highest integrated SAR value is the main concern in compliance test applications. These values can mostly be found at the inner surface of the phantom and cannot be measured directly due to the sensor offset in the probe. To extrapolate the surface values, the measurement distances to the surface must be known accurately. A distance error of 0.5mm could produce SAR errors of 6% at 1800 MHz. Measurements can be performed in a fixed plane or by following an arbitrary surface.
- For an automatic and accurate detection of the phantom surface, the DASY system uses Mechanical Surface Detection:

  Mechanical Surface Detection
  Mechanical surface detection uses the probe collision detector built into the DAE. It is extremely accurate if the probe is normal to the surface (0.05 mm). For angled probes, the distance increases, because the detection is at the edge of the probe tip. It can be used in any liquid with any kind of probe. If the surface is strongly angled with respect to the probe, the probe slides along the surface and is defected sideways. The second switch system in the DAE will detect this situation and the probe will move backward until the touch condition is cleared. However, there will be some remaining uncertainty in the final probe position. In the job description, the desired distance from the probe sensors to the phantom surface can be entered. The detection is always at touch, but the probe will move backward from the surface the indicated distance before starting the measurement.

  Mother Scan in cDASY6/DASY8 Module SAR
  The cDASY6/DASY8 Module SAR provides the possibility to do a Mother Scan in which a high resolution Area Scan is done in the phantom filled with liquid to a fixed level using a special teaching probe. This mother scan data is used to recreate the phantom inner surface in software, and all future area and/or zoom scans, and a surface detection check is no longer required.

- The „area scan“ measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The scan uses different grid spacings for different frequency measurements. Standard grid spacing for head measurements in frequency ranges ≤ 2GHz is 15 mm in x- and y-dimension. For higher frequencies a finer resolution is needed, thus for the grid spacing is reduced according the following table:

Area scan grid spacing for different frequency ranges	
Frequency range	Grid spacing
≤ 2 GHz	≤ 15 mm
2 – 4 GHz	≤ 12 mm
4 – 6 GHz	≤ 10 mm

  Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation. Results of this coarse scan are shown in annex B.

- A „zoom scan" measures the field in a volume around the 2D peak SAR value acquired in the previous „coarse" scan. It uses a fine meshed grid where the robot moves the probe in steps along all the 3 axis (x, y and z-axis) starting at the bottom of the Phantom. The grid spacing for the cube measurement is varied according to the measured frequency range, the dimensions are given in the following table:

Zoom scan grid spacing and volume for different frequency ranges			
Frequency range	Grid spacing for x, y axis	Grid spacing for z axis	Minimum zoom scan volume
≤ 2 GHz	≤ 8 mm	≤ 5 mm	≥ 30 mm
2 – 3 GHz	≤ 5 mm*	≤ 5 mm	≥ 28 mm
3 – 4 GHz	≤ 5 mm*	≤ 4 mm	≥ 28 mm
4 – 5 GHz	≤ 4 mm*	≤ 3 mm	≥ 25 mm
5 – 6 GHz	≤ 4 mm*	≤ 2 mm	≥ 22 mm

* 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.

- DASY provides an auto-extending feature to expand the size of the measurement area of the zoom scan as long as the maximum is found too close to the edge of the measured range, which eliminates the need to re-measure cubes whose maximum is found on the boundary of the defined measurement cube.

- To meet the requirements of **IEC / IEEE 62209-1528** it is necessary to perform graded grid measurements to avoid measurement mistakes. (First defined in IEC 62209-2 AMD1 from 2019)

  Below 3 GHz it defines:
  Horizontal grid step ≤ 8mm
  Vertical grid step ≤ 5mm for uniform spacing

  For variable spacing in vertical direction the maximum distance between the two closest measured points to the phantom shell (M1 and M2) shall be ≤ 4 mm and the spacing between farther points shall increase by a factor ≤ 1.5. Zoom Scan size ≤ 30 mm by 30 mm by 30 mm.

  Above 3 GHz it defines:
  Horizontal grid step ≤ (24/*f* [GHz]) mm
  Vertical grid step ≤ (10/(*f* [GHz] − 1)) mm for uniform spacing

  For variable spacing in vertical direction the maximum distance between the two closest measured points to the phantom shell (M1 and M2) shall be ≤ (12/*f* [GHz]) mm and the spacing between farther points shall increase by a factor ≤ 1.5. Zoom Scan size ≤ 22 mm by 22 mm by 22 mm.

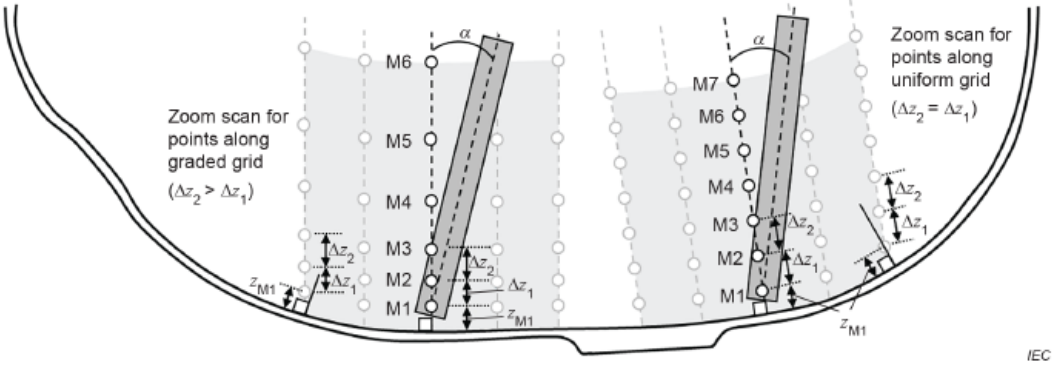
  If the zoom scan measured as defined above complies with both of the following criteria, or if the peak spatial-average SAR is below 0.1 W/kg, no additional measurements are needed:

  1) the smallest horizontal distance from the local SAR peaks to all points 3 dB below the SAR peak shall be larger than the horizontal grid steps in both *x* and y directions (Δx, Δy). This shall be checked for the measured zoom scan plane conformal to the phantom at the distance z_{M1}. The minimum distance shall be recorded in the SAR test report;
  2) the ratio of the SAR at the second measured point (M2) to the SAR at the closest measured point (M1) at the *x*-*y* location of the measured maximum SAR value shall be at least 30 %. This ratio (in %) shall be recorded in the SAR test report.

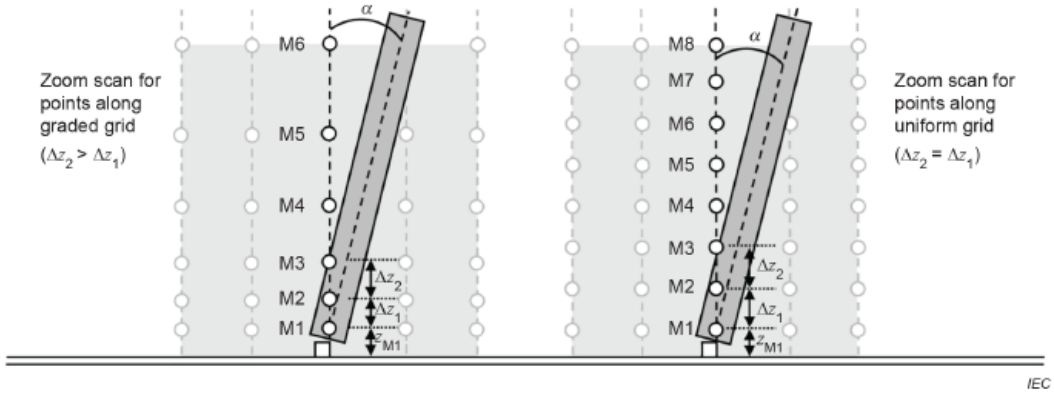
If one or both of the above criteria are not met, the zoom scan measurement shall be repeated using a finer resolution while keeping the other zoom scan parameters compatible with the basic requirements for zoom scans.

New horizontal and vertical grid steps shall be determined from the measured SAR distribution so that the above criteria are met. Compliance with the above two criteria shall be demonstrated for the new measured zoom scan. The size of the higher resolution zoom scan and all other parameters shall apply. The closest point to the phantom shell shall be 2 mm or less for graded grids and the grading factor shall be 1.5 or less. Uncertainties due to field distortion between the media boundary and the dielectric enclosure of the probe should also be minimized, which is achieved if the distance between the phantom surface and physical tip of the probe is larger than the probe tip diameter. Other methods may utilize correction procedures to compensate for boundary effects that enable high precision measurements closer than half the probe tip diameter. For all measurement points, the angle of the probe normal to the flat phantom surface shall be less than 5°. If this cannot be achieved, an additional uncertainty evaluation is required.

Orientation of the probe with respect to the line normal to the phantom surface, shown at two different locations:



a) Head phantom



b) Flat phantom

NOTE M1 to M8 are example measurement points used for extrapolation to the surface. The maximum of the angle α between the evaluation axis and the surface normal line is given in Table 3 and Table 4. The distance z_{M1} is from the phantom shell to the first measurement point M1, and its maximum value is given in Table 3 and Table 4. The distances Δz_i (i = 1, 2, 3, …) are the distances from measurement points M_i to M_{i+1}. For uniform grids, all Δz_i are equal. For graded grids, $\Delta z_{i+1} > \Delta z_i$. The term $R_z = \Delta z_{i+1}/\Delta z_i$ is a ratio with a maximum value given in Table 4. The z-direction corresponds to the vertical direction, the x-direction is horizontal and the y-direction is horizontal into the page.

Figure 20 – Orientation of the probe with respect to the line normal to the phantom surface, for head and flat phantoms, shown at two different locations

NOTE 1: The evaluation of the zoom scan is typically done by the post-processor by interpolation and extrapolation and without reconstruction of the field. More focused induced SAR distributions (e.g., for more localized sources such as capacitively coupled sources) require a more dense grid such that the same integration and extrapolation algorithms can be used for the same assessment uncertainty.

NOTE 2: The minimum ratio of 30 % is derived from the plane wave penetration depth at 6 GHz.

Detailed parameters can be seen in the following table:

Table 4 – Zoom scan parameters

Parameter	DUT transmit frequency being tested	
	$f \leq 3$ GHz	3 GHz < $f \leq$ 10 GHz
Maximum distance between the closest measured points and the phantom surface (z_{M1} in Figure 20 and Table 3, in mm)	5	$\delta \ln(2)/2$ [a]
Maximum angle between the probe axis and the phantom surface normal (α in Figure 20)	5° (flat phantom only) 30° (other phantoms)	5° (flat phantom only) 20° (other phantoms)
Maximum spacing between measured points in the x- and y-directions (Δx and Δy, in mm)	8	$24/f$ [b]
For uniform grids: Maximum spacing between measured points in the direction normal to the phantom shell (Δz_1 in Figure 20, in mm)	5	$10/(f-1)$
For graded grids: Maximum spacing between the two closest measured points in the direction normal to the phantom shell (Δz_1 in Figure 20, in mm)	4	$12/f$
For graded grids: Maximum incremental increase in the spacing between measured points in the direction normal to the phantom shell ($R_z = \Delta z_2/\Delta z_1$ in Figure 20)	1,5	1,5
Minimum edge length of the zoom scan volume in the x- and y-directions (L_z in O.8.3.2, in mm)	30	22
Minimum edge length of the zoom scan volume in the direction normal to the phantom shell (L_h in O.8.3.2 in mm)	30	22
Tolerance in the probe angle	1°	1°

[a] δ is the penetration depth for a plane-wave incident normally on a planar half-space.

[b] This is the maximum spacing allowed, which might not work for all circumstances.

7.1.7 Spatial Peak SAR Evaluation

The cDASY6/DASY8 Module SAR software includes all numerical procedures necessary to evaluate the spatial peak SAR values. Based on the IEC / IEEE 62209-1528 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 30mm³ below 3GHz or 22mm³ 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. The cDASY6/DASY8 Module SAR allows 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. 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 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.

7.1.8 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.

7.1.9 Tissue simulating liquids: dielectric properties

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

HBBL4-250V3 Simulating Head Liquid, Manufactured by SPEAG:

Ingredients	(% by weight)
Water	50-90%
Tween 20	5-50%
Sodium salt	0-2%
Preservatives:	0.03-0.1%

Table 2: Head tissue dielectric properties

7.1.10 Tissue simulating liquids: parameters

Freq. (MHz)	Target head tissue		Measurement **head** tissue					Measurement date
	Permittivity	Conductivity [S/m]	Permittivity	Dev. %	Conductivity ε''	Conductivity [S/m]	Dev. %	
13.00	55.00	0.75	56.0	1.7	975.10	0.705	-6.0	2025-02-10
13.56	55.00	0.75	55.0	-0.2	936.0	0.705	-6.0	

Table 3: Parameter of the head tissue simulating liquid (HSL)

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

*) as the liquid parameters deviation is ≥ ± 5% an extrapolation according IEC / IEEE 62209-1528 chapter 7.8.2 approach 3 is necessary. The DASY software is capable to perform the necessary corrections directly from the tissue and measurement data. The uncertainties in this document have been adjusted accordingly.

For detailed information see chapter 8.2.3 SAR correction for deviations of complex permittivity from targetson page 26.

7.1.11 Measurement uncertainty evaluation for SAR test

DASY6/8 Uncertainty Budget According to IEC/IEEE 62209-1528 (Frequency band: 4 MHz - 300 MHz 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.	± 13.3 %	Normal	2	1	1	± 6.7 %	± 6.7 %
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	± 0.8 %	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
ISO	Probe Isotropy (axial)	± 7.6 %	Rectangular	√3	1	1	± 4.4 %	± 4.4 %
DAE	Data Acquisition	± 0.7 %	Normal	1	1	1	± 0.7 %	± 0.7 %
AMB	RF Ambient	± 1.8 %	Normal	1	1	1	± 1.8 %	± 1.8 %
Δ_{sys}	Probe Positioning	± 0.006 mm	Normal	1	0.04	0.04	± 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]	± 5.4 %	Rectangular	√3	0.78	0.71	± 2.4 %	± 2.2 %
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**						± 11.4 %	± 11.3 %
U	**Expanded Uncertainty**						± **22.8** %	± **22.5** %

Table 4: Measurement uncertainties

Worst-Case uncertainty budget for DASY6/8 assessed according to IEC/IEEE 62209-1528 [4]. The budget is valid for the frequency range 4 MHz - 300 MHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller. All listed error components have ν_{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.

7.1.12 Measurement uncertainty evaluation for System Check

Repeatability Budget for System Check (Frequency band: 4MHz - 300MHz 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.	± 13.3 %	Normal	2	1	1	± 6.7 %	± 6.7 %
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	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %
ISO	Probe Isotropy (axial)	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %
DAE	Data Acquisition	± 0.7 %	Normal	1	1	1	± 0.7 %	± 0.7 %
AMB	RF Ambient	± 0.6 %	Normal	1	1	1	± 0.6 %	± 0.6 %
Δ_{sys}	Probe Positioning	± 0.5 %	Normal	1	0.04	0.04	± 0.0 %	± 0.0 %
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	± 3.2 %	Normal	1	1	1	± 3.2 %	± 3.2 %
P_{in}	Accepted power	± 2.0 %	Normal	1	1	1	± 2.0 %	± 2.0 %
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**						± 9.4 %	± 9.3 %
U	**Expanded Uncertainty**						± **18.8** %	± **18.6** %

Table 5: Repeatability of the system check (4 MHz - 300 MHz).

The RF ambient noise uncertainty has been reduced to ±1.0, considering input power levels are ≥ 250mW.
All listed error components have $\mathcal{V}_{eff}$ 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.

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7.1.13 System check

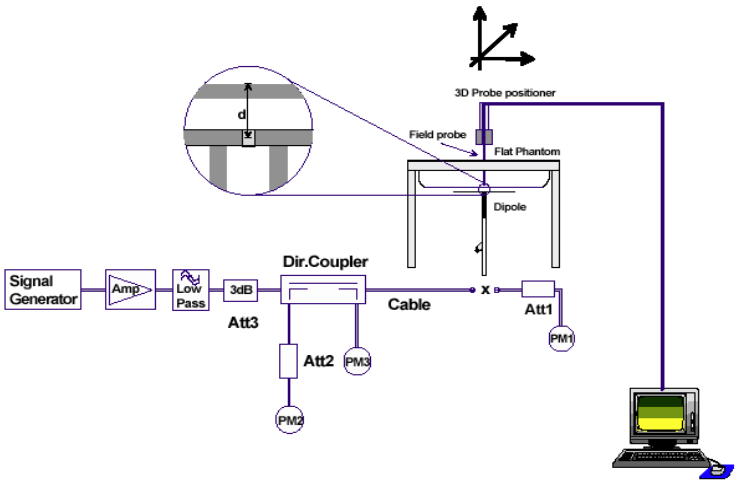
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The following table shows system check results for all frequency bands and tissue liquids used during the tests (plot(s) see annex A).

System performence check (1000 mW)									
System validation Kit	Probe	Frequency	Target SAR_{1g} /mW/g (+/-10%)	Target SAR_{10g} /mW/g (+/- 10%)	Measured SAR_{1g} / mW/g	SAR_{1g} dev.	Measured SAR_{10g} / mW/g	SAR_{10g} dev.	Measured date
CLA 13 S/N: 1026	EX3DV4 S/N: 3944	13 MHz	0.46	0.29	0.44	-5.0%	0.28	-4.4%	2025-02-10

Table 6: Results system check

7.1.14 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.



Instead of a regular dipole antenna the loop antenna CLA 13 is used (Picture below):

7.1.15 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.

Frequency (MHz)	DASY SW	Dipole Type /SN	Probe Type / SN	Calibrated signal type(s)	DAE unit Type / SN	validation
13	cDASY6 V16.4.0.5005	CLA13 / 1026	EX3DV4 / 3944	CW	DAE4 / 477	2025-02-10

8 Detailed Test Results

8.1 Module description

The implemented Processor has a Max power dissipation between 150 to 500 mW
(according customer specification).

Declared max. power: 500 mW = 26.98 dBm
Declared min. power: 150 mW = 21.76 dBm

NOTE:
A conducted sample is unreasonable for the EUT regarding 5.34 MHz feature. The antenna is designed by wired. It is a loop antenna type with 2 turns of track. The radiated power (Electric field) is very weak because there is not a real radiated element. That is why the antenna gain is very low (compared with a dipole antenna of the same frequency) and difficult to measure (Gain is << 0dBi).

Instead the declared min. and max. power values of the module are used to upscale the SAR value according worst case conditions, what results in a overestimation of the reported SAR value. If the EUT still surpasses the restrictions, it is safe to assume that the EUT is not capable of producing SAR values above the reported SAR.

8.2 SAR test results

8.2.1 General description of test procedures

- For RFID tests the EUT was set to permanent active scanning (13.56MHz).
- For the extrapolation of the reported SAR (extrapolated), the following formula was used:

$$SAR_{reported} = \frac{decl.max.}{decl.min.} \cdot SAR_{meas.}$$

8.2.2 Results overview

Freq. (MHz)	Position	decl. P_{max} (dBm)		SAR_{1g} (W/kg)		SAR_{10g} (W/kg)		power drift (dB)	liquid (°C)	dist. (mm)
		max.	min.	meas.	extrap.	meas.	extrap.			
13.56	back	27.0	21.8	0.022	**0.073**	0.014	**0.047**	-0.13	21.5	0

Table 7: Test results SAR 13.56 MHz

*) reported SAR value, up scaled from the distance between min. and max. declared module power (see chapter 8.2.1. above)

8.2.3 SAR correction for deviations of complex permittivity from targets

The max reported SAR values are once more corrected wherever the deviation of the liquid parameters is larger than ± 5%.

According IEC / IEEE 62209-1528 chapter 7.8.2 SAR correction formula
there is a linear relationship between the percentage change in SAR (denoted ΔSAR) and the percentage change in the permittivity and conductivity from the target values (denoted $\Delta\varepsilon_r$ and Δσ, respectively).
The relationship is given by:

$$\Delta SAR = c_\varepsilon \Delta\varepsilon_r + c_\sigma \Delta\sigma$$

where
$c_\varepsilon = \partial(\Delta SAR)\ \partial(\Delta\varepsilon)$ is the coefficient representing the sensitivity of SAR to permittivity where SAR is normalized to output power;
$c_\sigma = \partial(\Delta SAR)\ \partial(\Delta\sigma)$ is the coefficient representing the sensitivity of SAR to conductivity, where SAR is normalized to output power.

The values of c_ε and c_σ have a simple relationship with frequency that can be described using polynomial equations. For dipole antennas at frequencies from 4 MHz to 6 GHz, the **1 g averaged SAR** c_ε and c_σ are given by

$c_\varepsilon = -7.854\times10^{-4} \times f^3 + 9.402\times10^{-3} \times f^2 - 2.742\times10^{-2} \times f - 0.2026$
$c_\sigma = 9.804\times10^{-3} \times f^3 - 8.661\times10^{-2} \times f^2 + 2.981\times10^{-2} \times f + 0.7829$

where f is the frequency in GHz. Above 6 GHz, the sensitivity is non-varying with frequency due to the small penetration depth; the values of $c_\varepsilon = -0{,}198$ and $c_\sigma = 0$ shall be used.

For frequencies from 4 MHz to 6 GHz, the **10 g averaged SAR** c_ε and c_σ are given by:

$c_\varepsilon = 3.456\times10^{-3} \times f^3 - 3.531\times10^{-2} \times f^2 + 7.675\times10^{-2} \times f - 0.1860$
$c_\sigma = 4.479\times10^{-3} \times f^3 - 1.586\times10^{-2} \times f^2 - 0.197\,2 \times f + 0.7717$

where f is the frequency in GHz. Above 6 GHz, the sensitivity is non-varying with frequency due to the small penetration depth; the values of $c_\varepsilon = -0{,}250$ and $c_\sigma = 0$ shall be used.

NOTE:
The Tables in the uncertainties of this report are updated accordingly with the values from table 6 – Root-mean-squared error SAR correction formula as a function of the maximum change in permittivity or conductivity:

Max. change in ε_r or σ	RMS uncertainty for SAR_{1g} %	RMS uncertainty for SAR_{10g} %
±5 %	1.2	0.97
±10 %	1.9	1.6

NOTE:
The DASY software is capable of directly correcting the measured values according to the above-described procedure, fully compliant to IEC / IEEE 62209-1528, so that no further evaluation is necessary.

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 21, 2024	12
13 MHz System Validation Dipole	CLA 13	Schmid & Partner Engineering AG	1026	January 27, 2025	36
Data acquisition electronics	DAE4	Schmid & Partner Engineering AG	477	May 22, 2024	12
Software	V16.4.0.5005	Schmid & Partner Engineering AG	---	N/A	--
Phantom ELI 8.0	QD OVA 004 AA	Schmid & Partner Engineering AG	2101	N/A	--
Network Analyser 300 kHz to 6 GHz	8753ES	Agilent Technologies)*	US39174 436	December 14, 2023	24
Dielectric Assessment Kit (DAK12)	DAK 4MHz – 600MHz Package	Schmid & Partner Engineering AG	1179	N/A	--
Signal Generator	SML03	Rohde & Schwarz	102519	December 05, 2023	24
RF Power Amplifier	ZHL-42	Mini circuits	N/A	N/A	--
Power Meter	NRP	Rohde & Schwarz	101367	December 05, 2024	12
Power Meter Sensor	NRP Z22	Rohde & Schwarz	100227	December 03, 2024	12
Power Meter Sensor	NRP Z22	Rohde & Schwarz	100234	December 03, 2024	12
Directional Coupler	778D	Hewlett Packard	19171	December 05, 2024	12

)* : 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: 2025-02-10, 11:43 2025-02-10, 11:49

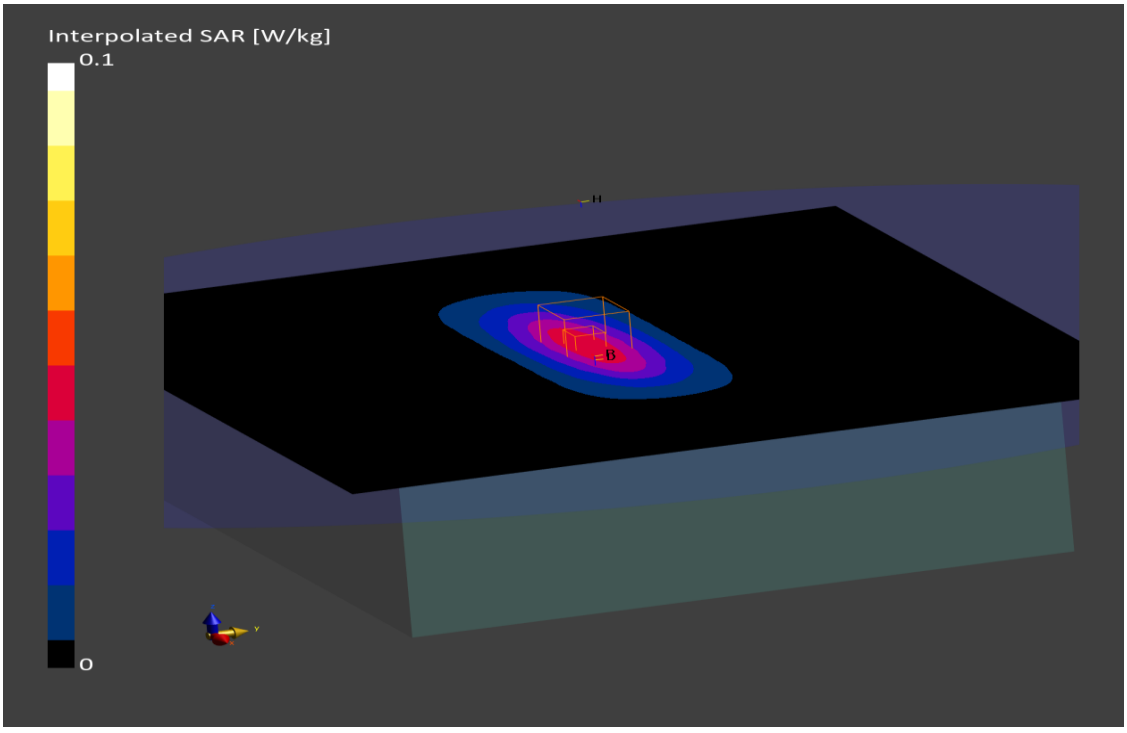
SystemPerformanceCheck-D13 HSL

DUT: Dipole; Type: CLA13; Serial: SN1026

Communication System: CW; Communication System Frequency: 13.0 MHz
Medium parameters used: f = 13.0 MHz, σ = 0.705 S/m; ε_r=56.0; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 8
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(17.78, 17.78, 17.78); Calibrated: 2024-05-21
- Sensor-Surface: 1.4 mm
- DAE: DAE4 Sn477; Calibrated: 2024-05-22
- Phantom: ELI V8.0 (20deg probe tilt); Serial: 2101;
- Software: DASY8 Module SAR V16.4.0.5005

HBBL4-250V3/13.0MHz/Area Scan (15.0 x 15.0 x 1.0) :
Grid Extents [mm]: 270.0 x 270.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.045 W/kg; SAR(10 g) = 0.037 W/kg

HBBL4-250V3/13.0MHz/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
SPCPower = 20 dBm
Power Drift = 0.02 dB
SAR(1 g) = 0.044 W/kg; SAR(10 g) = 0.028 W/kg



Additional information:
ambient temperature: 21.9°C; liquid temperature: 21.5°C;

Annex B: DASY measurement results

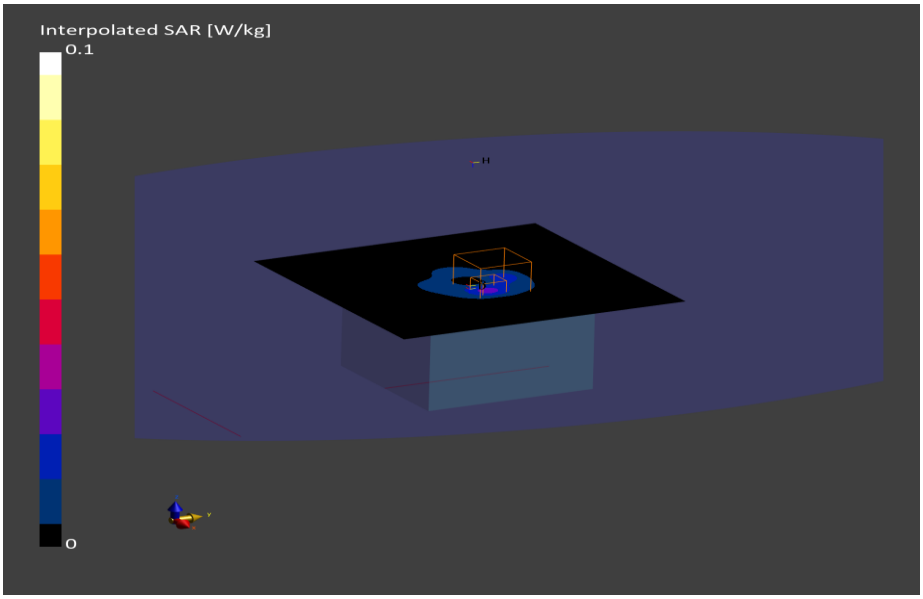
Date/Time: 2025-02-10, 15:20 2025-02-10, 15:34

IEC_IEEE 62209-1528 RFID 13.56 MHz

DUT: RFID module; Type: 068-50043; Serial: ITEM NO8-1
Communication System: CW; Communication System Band: Custom Band; Communication System Frequency: 13.5 MHz
Medium parameters used: f = 13.5 MHz, σ = 0.705 S/m; ε_r=55.0; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 8
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(17.78, 17.78, 17.78); Calibrated: 2024-05-21
- Sensor-Surface: 1.4mm
- DAE: DAE4 Sn477; Calibrated: 2024-05-22
- Phantom: ELI V8.0 (20deg probe tilt); Serial: 2101;
- Software: DASY8 Module SAR V16.4.0.5005

HBBL4-250V3/BACK, 5 mm - Channel 13500/Area Scan (15.0 x 15.0 x 1.0) :
Grid Extents [mm]: 120.0 x 120.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.022 W/kg; SAR(10 g) = 0.014 W/kg

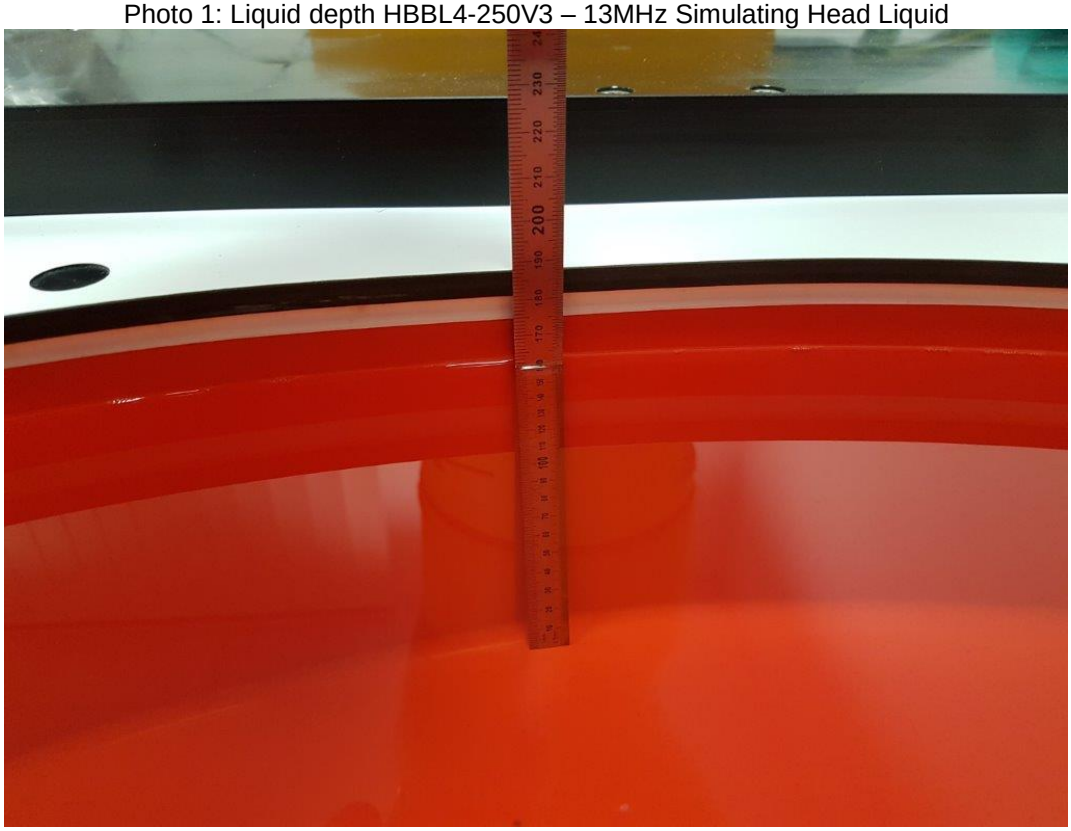
HBBL4-250V3/BACK, 5 mm - Channel 13500/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Graded Grid: Ratio 1.4 - Distance Sensor to Surface 1.4 mm
Power Drift = -0.14 dB
SAR(1 g) = 0.022 W/kg; SAR(10 g) = 0.014 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: 5.3
M2/M1 [%]: 53.0



Additional information:
position or distance of DUT to SAM: 5 mm
ambient temperature: 21.9°C; liquid temperature: 21.5°C;

Annex B.1: Liquid depth

Photo 1: Liquid depth HBBL4-250V3 – 13MHz Simulating Head Liquid



Annex C: Photo documentation

Photo documentation is described in the additional document:
1-8714-24-01-06_TR1-A101-R01_Photos

Annex D: Calibration parameters

Calibration parameters are described in the additional document:
1-8714-24-01-06_TR1-A201-R01_Caldata

Annex E: RSS-102 Annex A

ISEDRF documents are described in the additional document:
1-8714-24-01-06_TR1-A301-R01_RSS-102 Annex A

Annex F: NB Statement for acceptance of IEC/IEEE 62209-1528 and EN/IEC 62311:2020 for RED 2014/53/EU

SAR measurements between 4 MHz and 30 MHz

cetecom advanced GmbH · Untertuerkheimer Str. 6-10 · 66117 Saarbruecken · Germany

Technical evaluation of SAR measurement standard IEC/IEEE 62209-1528 and EN IEC 62311:2020

After evaluation of technology and available measurement methods it was found that the most state-of-the-art measurement method for wireless applications in frequency range 4 – 30 MHz is described in unified SAR measurement standard IEC/IEEE 62209-1528, which inter alia incorporates the measurement methods of IEC 62209-1:2016/ EN 62209-1:2016 and IEC 62209-2:2010/EN 62209-2:2010.

EN/ IEC/IEEE 62209-1528, which is planned to replace IEC 62209-1:2016/ EN 62209-1:2016, respectively IEC 62209-2:2010/ EN 62209-2:2010, extends the minimum frequency from 30 MHz (IEC 62209-2:2010/ EN 62209-2:2010), respectively 300 MHz (IEC 62209-1:2016/ EN 62209-1:2016) down to 4 MHz, considering the relevant measurement methods.
As EN IEC 62311:2020 inter alia refers to IEC 62209-1:2016/ EN 62209-1:2016, respectively IEC 62209-2:2010/ EN 62209-2:2010 it is therefore to assume the replacement will also be considered for this reference.

It is therefore to assume the measurement results gained from measurements using methods according to IEC/IEEE 62209-1528 for evaluated frequency range cover the requirements of EN IEC 62311:2020 and may show compliance to Directive 2014/53/EU (RED) article 3.1a) Health which refer to SAR limits listed in table below:

Guideline / Standard	SAR limit, SAR_{max} W/kg	Averaging mass, m g	P_{max} mW	Exposure tier	Region of Body
ICNIRP	2	10	20	General public	Head and trunk
	4	10	40	General public	Limbs
	10	10	100	Occupational	Head and trunk
	20	10	200	Occupational	Limbs

Source: IEC 62479:2010, table A.1

cetecom advanced GmbH

cn=Uwe Nauerz,
o=cetecom advanced GmbH, ou=NAU-230601, email=uwe.nauerz@cetecomadvanced.com, c=DE
2024.04.09 10:35:18 +02'00'

Uwe Nauerz / Notified Body RED

Managing Director: Andreas Ehre
Registered: Local Court of Saarbruecken
Reg.-No.: HRB 11298
VAT-IN: DE119671605
Tax ID: 05/112/5792/0297

cetecom advanced GmbH
Untertuerkheimer Str. 6-10
66117 Saarbruecken
Germany

Tel.: +49 (0) 681 598 0
Fax: +49 (0) 681 598 9075
mail@cetecomadvanced.com
www.cetecomadvanced.com/

Annex G: Document History

Version	Applied Changes	Date of Release
	Initial Release	2025-03-06

Annex H: Further Information

Glossary

BW	-	Bandwidth
DTS	-	Distributed Transmission System
DUT	-	Device under Test
EUT	-	Equipment under Test
FCC	-	Federal Communication Commission
FCC ID	-	Company Identifier at FCC
HW	-	Hardware
Inv. No.	-	Inventory number
ISED	-	Innovation, Science and Economic Development Canada
SAR	-	Specific Absorption Rate
S/N	-	Serial Number
SW	-	Software