
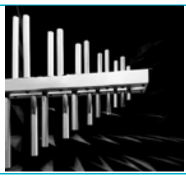
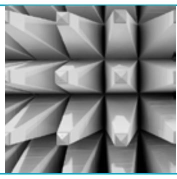

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test Report No.: 1-4869/22-02-03

Testing Laboratory

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Accredited Test 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 starting with the registration number: D-PL-12076-01.

Applicant

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93055 Regensburg/GERMANY

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Manufacturer

Continental Automotive Technologies GmbH
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93055 Regensburg/GERMANY

Test Standards

IEC/IEEE 62209-1528-2020	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)
RSS-102 Issue 5	Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

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

Test Item

Kind of test item:	Intelligent Antenna Module
Device type:	portable device
Model name:	**BSRF_EA_RW0**
S/N serial number:	22991129087089
FCC-ID:	KR5-BSRFEARW0
IMEI-Number:	358835770000815
Hardware status:	C4.2
Software status:	V19.06
Module information:	BL28RW-RD1
Frequency:	see technical details
Antenna:	integrated antenna
Power option:	12 V DC
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:

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Marco Scigliano
Testing Manager
Radio Communications

1 Table of contents

2 General information

2.1 Notes and disclaimer

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2.2 Application details

Date of receipt of order:	2022-10-13
Date of receipt of test item:	2022-11-18
Start of test:	2022-12-05
End of test:	2023-04-18

2.3 Statement of compliance

The SAR values found for the BSRF_EA_RW0 Intelligent Antenna Module are below the maximum recommended levels of 1.6 W/Kg as averaged over any 1 g tissue according to the FCC rule §2.1093, the ANSI/IEEE C 95.1:1992, the NCRP Report Number 86 for uncontrolled environment, according to the Health Canada's Safety Code 6 and the Industry Canada Radio Standards Specification RSS-102 for General Population/Uncontrolled exposure.
For body worn operation, this device has been tested with 15 mm distance.

Accreditation	Description	
D-PL-12076-01-01	SAR / EMF – EN and FCC https://www.dakks.de/files/data/as/pdf/D-PL-12076-01-01.pdf	ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-01
D-PL-12076-01-04	Telecommunication and EMC Canada https://www.dakks.de/files/data/as/pdf/D-PL-12076-01-04e.pdfhttps://www.dakks.de/as/ast/d/D-PL-12076-01-04e.pdf	ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-04

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	GPRS/EGPRS mobile station class	GPRS/EGPRS multislot class	(E)GPRS voice mode or DTM	Test channel low	Test channel middle	Test channel high	Maximum output power/dBm)*
☐	GSM	880.2	914.8	925.2	959.8	GMSK 8-PSK	4 E2	5	B	33	no	975	37	124	31.3
☐	GSM DCS	1710.2	1784.8	1805.2	1879.8	GMSK 8-PSK	1 E2	0	B	33	no	512	698	885	29.2
☒	GSM cellular	824.2	848.8	869.2	893.8	GMSK 8-PSK	4 E2	5	B	33	no	128	190	251	31.7
☒	GSM PCS	1850.2	1909.8	1930.2	1989.8	GMSK 8-PSK	1 E2	0	B	33	no	512	661	810	29.4
☐	UMTS FDD I	1922.4	1977.6	2112.4	2167.6	QPSK	3	max	--	--	--	9612	9750	9888	22.1
☒	UMTS FDD II	1852.4	1907.6	1932.4	1987.6	QPSK	3	max	--	--	--	9262	9400	9538	21.8
☒	UMTS FDD IV	1712.4	1752.6	2112.4	2152.6	QPSK	3	max	--	--	--	1312	1412	1513	21.7
☒	UMTS FDD V	826.4	846.6	871.4	891.6	QPSK	3	max	--	--	--	4132	4182	4233	22.4
☐	UMTS FDD VIII	882.4	912.6	927.4	957.6	QPSK	3	max	--	--	--	2712	2788	2863	22.3
☐	LTE FDD 1	1920	1980	2110	2170	QPSK	3	max	--	--	--	18100	18300	18500	22.5
☒	LTE FDD 2	1850	1910	1930	1990	QPSK	3	max	--	--	--	18700	18900	19100	21.7
☐	LTE FDD 3	1710	1785	1805	1880	QPSK	3	max	--	--	--	19300	19575	19850	22.4
☒	LTE FDD 4	1710	1755	2110	2155	QPSK	3	max	--	--	--	20050	20175	20300	21.8
☒	LTE FDD 5	824	849	869	894	QPSK	3	max	--	--	--	20450	20525	20600	22.3
☒	LTE FDD 7	2500	2570	2620	2690	QPSK	3	max	--	--	--	20850	21100	21350	20.4
☐	LTE FDD 8	880	915	925	960	QPSK	3	max	--	--	--	21500	21625	21750	22.5
☐	LTE FDD 20	832	862	791	821	QPSK	3	max	--	--	--	24250	24300	24350	22.6
☐	LTE FDD 28	703	748	758	803	QPSK	3	max	--	--	--	27310	27435	27560	22.9
☒	WLAN US	2412	2462	2412	2462	CCK OFDM	--	max	--	--	--	1	6	11	17.4
☒	WLAN	5180	5240	5180	5240	OFDM	--	max	--	--	--	38	40/44	46	10.3
☒	WLAN	5745	5825	5745	5825	OFDM	--	max	--	--	--	--	--	165	4.3

)*: measured slotted peak power for GSM, averaged max. RMS power for UMTS, LTE, WLAN.

Module information:

• 3GPP Rel. 10
• LTE FDD CAT4 (up to 50-Mbps UL/150-Mbps DL)
• UMTS: HSUPA CAT 6 (up to 5.76-Mbps), HSPA CAT24 (up to 21-Mbps)
• GSM: EGPRS Rel-10 236.5kbps (MSC33)
• VoLTE - HD Voice

2.5 Transmitter and Antenna Operating Configurations

Simultaneous transmission conditions		
GSM / GPRS / EDGE	+	WLAN 2.4GHz
GSM / GPRS / EDGE	+	WLAN 5GHz
UMTS / HSPA	+	WLAN 2.4GHz
UMTS / HSPA	+	WLAN 5GHz
LTE	+	WLAN 2.4GHz
LTE	+	WLAN 5GHz

Table 1: Simultaneous transmission conditions

3 Test standards/ procedures references

Test Standard	Version	Test Standard Description
RSS-102 Issue 5	2015-03	Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
RSS-102 Supplementary Procedures SPR-001	2011-01	SAR testing requirements with regard to bystanders for Lap Top Type Computers with antennas built-in on display screen (Laptop Mode / Tablet Mode)
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
IEEE Std. C95-3	2002	IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave
IEEE Std. C95-1	2005	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
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)

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 941225D01v03	October 23, 2015	SAR Measurements Procedures for 3G Devices
KDB 941225D05v02	October 23, 2015	SAR for LTE Devices
KDB 941225D05Av01	October 23, 2015	LTE Rel. 10 KDB Inquiry Sheet
KDB 248227D01v02	October 23, 2015	SAR Measurement Procedures for 802.11 a/b/g Transmitters

3.1 RF exposure limits

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

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.

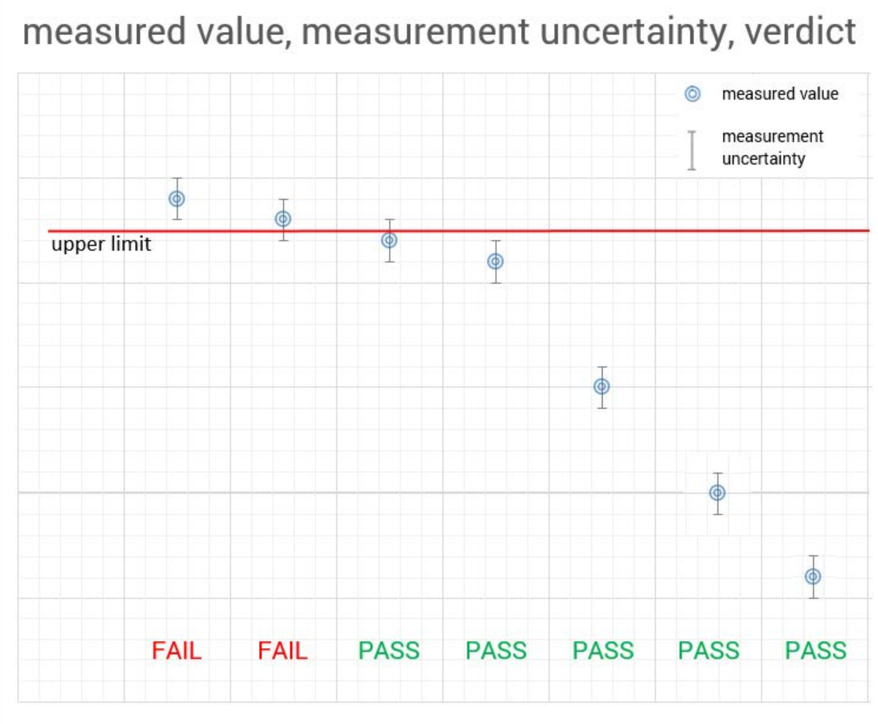
*** The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

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 value reported for 1g (W/kg)				
		PCB	**DTS**	**UNII**
body worn 15 mm distance		**0.490**	**0.296**	**0.363**
collocated situations	**ΣSAR evaluation PCB & DTS**	**0.786**		
collocated situations	**ΣSAR evaluation PCB & UNII**	**0.854**		

	distance	SAR [W/kg]	
frequency band:	[mm]	reported	limit
GSM 835MHz	15	0.358	1.6
GSM 1900MHz	15	0.148	1.6
UMTS FDD II 1900MHz	15	0.170	1.6
UMTS FDD IV 1750MHz	15	0.209	1.6
UMTS FDD V 835MHz	15	0.490	1.6
LTE FDD 2 1900MHz	15	0.237	1.6
LTE FDD 4 1750MHz	15	0.159	1.6
LTE FDD 5 835MHz	15	0.392	1.6
LTE FDD 7 2600MHz	15	0.150	1.6
WLAN 2.4GHz	15	0.296	1.6
WLAN 5GHz	15	0.363	1.6
max:	15	**0.490**	1.6

6 Test Environment

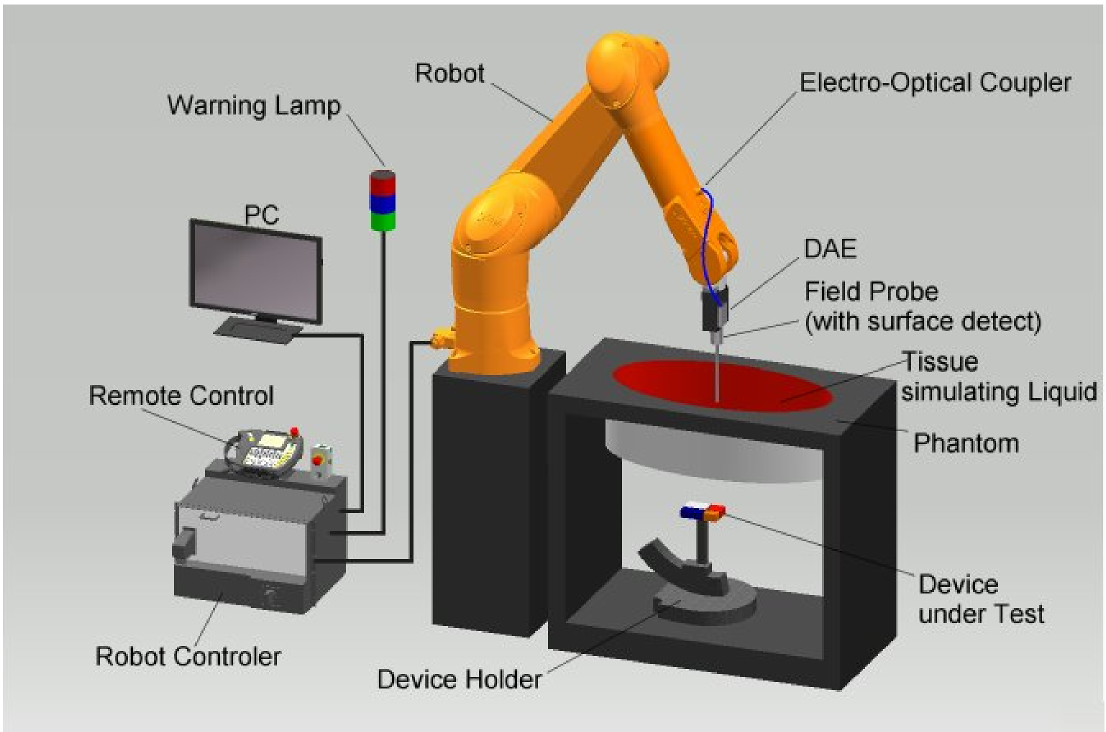
Ambient temperature:	20 – 24 °C
Tissue Simulating liquid:	20 – 24 °C
Relative humidity content:	40 – 50 %
Air pressure:	not relevant for this kind of testing
Power supply:	230 V / 50 Hz

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

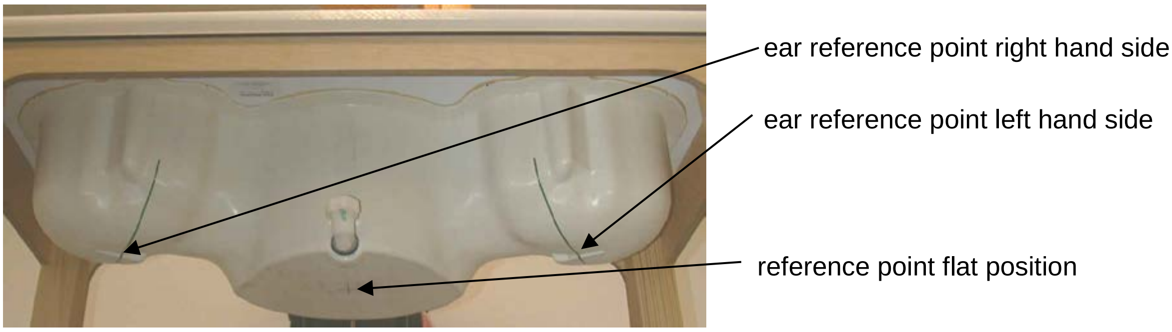
The DASY measurement system is placed in a laboratory room within an environment which avoids influence on SAR measurements by ambient electromagnetic fields and any reflection from the environment. The pictures at the beginning of the photo documentation show a complete view of the test environment.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



Triple Modular Phantom consists of three identical modules which can be installed and removed separately without emptying the liquid. It includes three reference points for phantom installation. Covers prevent evaporation of the liquid. Phantom material is resistant to DGBE based tissue simulating liquids.

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 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
  While the DASY5 V5.2 SAR system uses the mechanical surface detection at each point of the Area Scan / Zoom Scan, 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 62209-2 AMD1 from 2019** it is necessary to perform graded grid measurements to avoid measurement mistakes.

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.

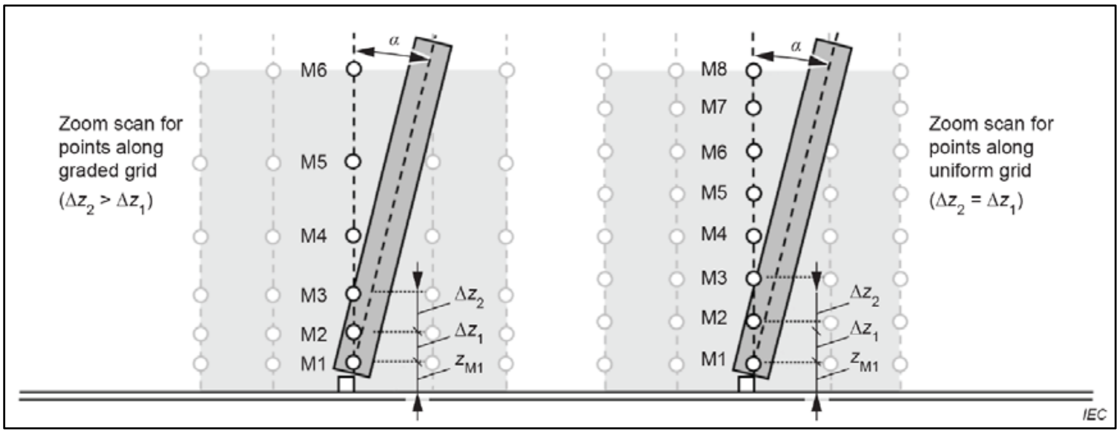
<u>If the zoom scan measured as defined above complies with both of the following criteria, or if the peak spatial-average SAR is below 0.1 W/kg, no additional measurements are needed:</u>

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:



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 called the probe angle. The distance z_{M1} is from the phantom shell to the first measurement point M1, and its maximum value is 1.4mm fixed for the DASY system equipped with an EX-Probe. The distances Δz_i (i = 1, 2, 3, ...) are the distances from measurement points M_i to M_{i-1}. For uniform grids, Δz_i are equal. For graded grids, $\Delta z_{i+1} > \Delta z_i$. $R_z = \Delta z_{i+1}/\Delta z_i$ is a ratio with a maximum value (defined in the table below). The z direction corresponds to the vertical direction, the x direction is horizontal and the y direction is horizontal into the page.

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 8 – Zoom scan parameters

Parameter	DUT transmit frequency being tested	
	$f \leq 3$ GHz	3 GHz < $f \leq 6$ GHz
Maximum distance between the closest measured points and the phantom surface (z_{M1} in Figure 14 and Table 2, in mm)	5	δ ln(2)/2 [a]
Maximum angle between the probe axis and the flat phantom surface normal (α in Figure 14)	5°	5°
Maximum spacing between measured points in the *x*- and *y*-directions (Δx and Δy, in mm)	8	$24/f$ [b,c]
For uniform grids: Maximum spacing between measured points in the direction normal to the phantom shell (Δz_1 in Figure 14, 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 14, 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 14)	1,5	1,5
Minimum edge length of the zoom scan volume in the *x*- and *y*-directions (L_z in 7.2.5.3, in mm)	30	22
Minimum edge length of the zoom scan volume in the direction normal to the phantom shell (L_h in 7.2.5.3, 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 may not work for all circumstances.

[c] f is the frequency in GHz.

Table M.1 – Minimum probe requirements as a function of frequency and parameters of the tissue equivalent liquid

1	2	3	4	5	6	7	8
Frequency MHz	Relative permittivity	Conductivity S/m	Wavelength in the medium (λ) mm	Plane wave Skin Depth (δ) mm	Maximum Diameter mm	50 % Distance for M1 ($z_{50\%} = \delta\, ln(2)/2$) mm	Min. distance for M1 (z_{M1}) mm
300	45,3	0,87	148,6	46,1	8,0	16,0	5,0
450	43,5	0,87	101,1	42,9	8,0	14,9	5,0
750	41,9	0,89	61,8	39,8	8,0	13,8	5,0
835	41,5	0,9	55,8	38,9	8,0	13,5	5,0
900	41,5	0,97	51,7	36,1	8,0	12,5	5,0
1 450	40,5	1,20	32,5	28,6	8,0	9,9	5,0
1 800	40,0	1,40	26,4	24,3	8,0	8,4	5,0
2 000	40,0	1,40	23,7	24,2	8,0	8,4	5,0
2 450	39,2	1,80	19,6	18,7	6,5	6,5	5,0
2 600	39,0	1,96	18,5	17,2	6,2	5,9	5,0
3 000	38,5	2,40	16,1	13,9	5,4	4,8	5,0
4 000	37,4	3,43	12,3	9,6	4,1	3,3	3,3
5 000	36,2	4,45	10,0	7,3	3,3	2,5	2,5
5 200	36,0	4,66	9,6	7,0	3,2	2,4	2,4
5 400	35,8	4,86	9,3	6,7	3,1	2,3	2,3
5 600	35,5	5,07	9,0	6,4	3,0	2,2	2,2
5 800	35,3	5,27	8,7	6,1	2,9	2,1	2,1
6 000	35,1	5,48	8,4	5,9	2,8	2,0	2,0

Further probe parameters can be seen in Annex M of IEC 62209-2.

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 IEC 62209-2 AMD1 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.

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/cm³

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

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

with	P_{pwe}	= equivalent power density of a plane wave in mW/cm²
	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 Head Liquid, Manufactured by SPEAG:

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

Table 3: Head tissue dielectric properties

7.1.11 Tissue simulating liquids: parameters

Liquid **HSL**	Freq. (MHz)	Target head tissue		Measurement **head** tissue					Measurement date
		Permittivity	Conductivity [S/m]	Permittivity	Dev. %	Conductivity ε''	Conductivity [S/m]	Dev. %	
835	824	41.55	0.90	42.4	2.0	18.45	0.85	-5.9	2022-12-12
	825	41.55	0.90	42.4	2.0	18.44	0.85	-5.9	
	829	41.53	0.90	42.4	2.1	18.38	0.85	-5.7	
	835	41.50	0.90	42.4	2.1	18.29	0.85	-5.6	
	837	41.50	0.90	42.4	2.1	18.26	0.85	-5.7	
	844	41.50	0.91	42.4	2.1	18.16	0.85	-6.3	
	847	41.50	0.91	42.3	2.0	18.11	0.85	-6.5	
	849	41.50	0.92	42.3	2.0	18.08	0.85	-6.7	
1750	1712	40.13	1.35	40.8	1.8	12.96	1.23	-8.5	
	1720	40.11	1.35	40.8	1.8	12.95	1.24	-8.5	
	1732	40.10	1.36	40.8	1.8	12.93	1.25	-8.5	
	1747	40.08	1.37	40.8	1.8	12.91	1.25	-8.4	
	1750	40.07	1.37	40.8	1.8	12.91	1.26	-8.4	
	1752	40.07	1.37	40.8	1.8	12.90	1.26	-8.4	
1900	1850	40.00	1.40	40.7	1.8	12.78	1.32	-6.0	
	1852	40.00	1.40	40.7	1.8	12.78	1.32	-5.9	
	1860	40.00	1.40	40.7	1.8	12.77	1.32	-5.6	
	1880	40.00	1.40	40.7	1.7	12.75	1.33	-4.7	
	1900	40.00	1.40	40.7	1.6	12.73	1.35	-3.9	
	1905	40.00	1.40	40.7	1.6	12.72	1.35	-3.7	
	1908	40.00	1.40	40.6	1.6	12.72	1.35	-3.6	
	1910	40.00	1.40	40.6	1.6	12.72	1.35	-3.5	
1750	1712	40.13	1.35	39.6	-1.4	13.95	1.33	-1.6	2023-02-22
	1720	40.11	1.35	39.6	-1.4	13.93	1.33	-1.6	
	1732	40.10	1.36	39.6	-1.3	13.89	1.34	-1.6	
	1747	40.08	1.37	39.5	-1.3	13.86	1.35	-1.7	
	1750	40.07	1.37	39.5	-1.3	13.85	1.35	-1.7	
	1752	40.07	1.37	39.5	-1.3	13.84	1.35	-1.7	
1900	1850	40.00	1.40	39.4	-1.4	13.64	1.40	0.2	
	1852	40.00	1.40	39.4	-1.4	13.63	1.40	0.3	
	1860	40.00	1.40	39.4	-1.4	13.62	1.41	0.7	
	1880	40.00	1.40	39.4	-1.5	13.58	1.42	1.5	
	1900	40.00	1.40	39.4	-1.6	13.55	1.43	2.3	
	1905	40.00	1.40	39.4	-1.6	13.54	1.44	2.5	
	1908	40.00	1.40	39.4	-1.6	13.54	1.44	2.6	
	1910	40.00	1.40	39.4	-1.6	13.53	1.44	2.7	

Liquid **HSL**	Freq. (MHz)	Target head tissue		Measurement **head** tissue					Measurement date
		Permittivity	Conductivity [S/m]	Permittivity	Dev. %	Conductivity ε"	[S/m]	Dev. %	
2450	2412	39.27	1.77	39.6	0.9	13.00	1.74	-1.2	2023-02-15
	2437	39.22	1.79	39.6	1.0	12.98	1.76	-1.6	
	2450	39.20	1.80	39.6	1.0	12.96	1.77	-1.8	
	2462	39.20	1.81	39.6	0.9	12.95	1.77	-2.2	
2600	2510	39.12	1.87	40.8	4.3	13.14	1.84	-1.6	2023-04-18
	2535	39.09	1.89	40.8	4.3	13.14	1.85	-2.1	
	2560	39.06	1.92	40.7	4.3	13.15	1.87	-2.5	
	2600	39.01	1.96	40.7	4.3	13.16	1.90	-3.1	
5GHz	5180	36.02	4.64	34.3	-4.9	14.91	4.30	-7.4	2023-02-15
	5200	36.00	4.66	34.2	-4.9	14.92	4.32	-7.4	
	5220	35.98	4.68	34.2	-5.0	14.93	4.34	-7.3	
	5240	35.96	4.70	34.1	-5.1	14.94	4.36	-7.3	
	5800	35.30	5.27	32.8	-7.0	15.14	4.88	-7.3	
	5825	35.28	5.30	32.8	-7.0	15.16	4.91	-7.3	

Table 4: Parameter of the head tissue simulating liquid
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 8.2.4 SAR correction for deviations of complex permittivity from targetson page 60.

7.1.12 Measurement uncertainty evaluation for SAR test

DASY6/8 Uncertainty Budget According to IEC/IEEE 62209-1528 (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 DASY8 assessed according to IEC/IEEE 62209-1528 [4]. 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 υ_{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.

Symbol	Error Description	Uncertainty Value	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)
DASY6 Uncertainty Budget According to IEC/IEEE 62209-1528 (Frequency band: 3 GHz - 6 GHz range)								
Measurement System Errors								
CF	Probe Calibration Repeat.	± 13.1 %	Normal	2	1	1	± 6.6 %	± 6.6 %
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	± 2.6 %	Rectangular	√3	1	1	± 1.5 %	± 1.5 %
ISO	Probe Isotropy (axial)	± 7.6 %	Rectangular	√3	1	1	± 4.4 %	± 4.4 %
DAE	Data Acquisition	± 1.2 %	Normal	1	1	1	± 1.2 %	± 1.2 %
AMB	RF Ambient	± 1.8 %	Normal	1	1	1	± 1.8 %	± 1.8 %
Δ_{sys}	Probe Positioning	± 0.005 mm	Normal	1	0.29	0.29	± 0.2 %	± 0.2 %
DAT	Data Processing	± 2.3 %	Normal	1	1	1	± 2.3 %	± 2.3 %
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	0.25	0.25	± 2.0 %	± 2.0 %
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**						± 11.6 %	± 11.6 %
U	**Expanded Uncertainty**						**± 23.3 %**	**± 23.1 %**

Table 6: Measurement uncertainties

Worst-Case uncertainty budget for DASY6 assessed according to IEC/IEEE 62209-1528 [4]. The budget is valid for the frequency range 3 GHz – 6 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller. All listed error components have 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.

7.1.13 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 7: 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

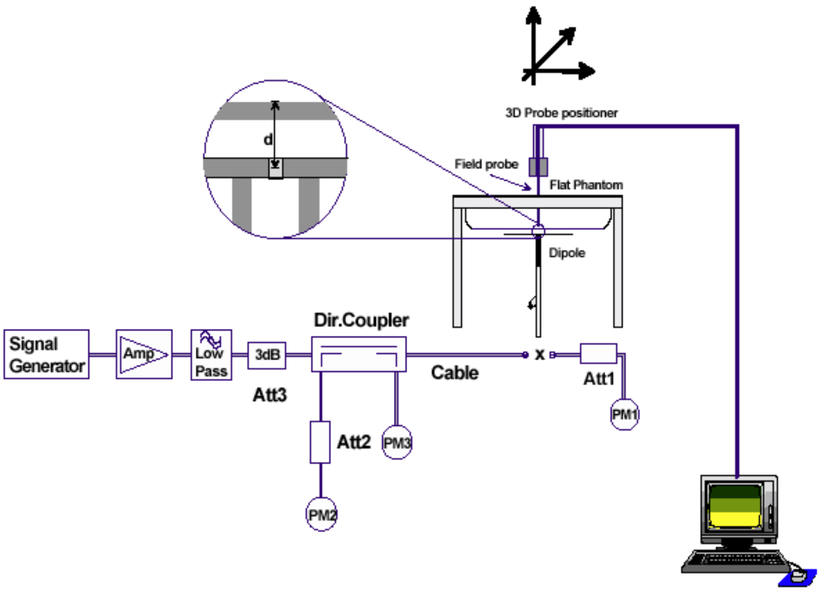
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE 1528. The following table shows system check results for all frequency bands and tissue liquids used during the tests (plot(s) see annex A).

System performence check (1000 mW)									
System validation Kit	Probe	Frequency	Target SAR_{1g} /W/kg (+/- 10%)	Target SAR_{10g} /W/kg (+/- 10%)	Measured SAR_{1g} / W/kg	SAR_{1g} dev.	Measured SAR_{10g} / W/kg	SAR_{10g} dev.	Measured date
D835V2 S/N: 4d153	EX3DV4 S/N: 3944	835 MHz HSL	9.43	6.17	9.18	-2.7%	6.06	-1.8%	2022-12-12
D835V2 S/N: 4d153	EX3DV4 S/N: 3944	835 MHz HSL	9.43	6.17	9.15	-3.0%	6.04	-2.1%	2022-12-13
D1750V2 S/N: 1093	EX3DV4 S/N: 3944	1750 MHz HSL	37.20	19.50	34.60	-7.0%	18.60	-4.6%	2022-12-13
D1750V2 S/N: 1093	EX3DV4 S/N: 3944	1750 MHz HSL	37.20	19.50	37.30	0.3%	20.10	3.1%	2023-02-22
D1900V2 S/N: 5d009	EX3DV4 S/N: 3944	1900 MHz HSL	38.90	20.30	38.00	-2.3%	19.90	-2.0%	2022-12-13
D1900V2 S/N: 5d009	EX3DV4 S/N: 3944	1900 MHz HSL	38.90	20.30	41.10	5.7%	21.70	6.9%	2023-02-22
D2450V2 S/N: 710	EX3DV4 S/N: 3944	2450 MHz HSL	51.80	24.10	52.50	1.4%	24.50	1.7%	2023-02-15
D2600V2 S/N: 1040	EX3DV4 S/N: 3944	2600 MHz HSL	57.60	25.40	52.60	-8.7%	23.70	-6.7%	2023-04-18
D5GHzV2 S/N: 1055	EX3DV4 S/N: 3944	5200 MHz HSL	80.30	22.80	77.40	-3.6%	22.30	-2.2%	2023-02-15
D5GHzV2 S/N: 1055	EX3DV4 S/N: 3944	5800 MHz HSL	82.40	23.10	82.00	-0.5%	23.00	-0.4%	2023-02-15

Table 8: 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 1000 mW for frequencies below 2 GHz or 100 mW for frequencies above 2 GHz. 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

For the measurements the Rohde & Schwarz Radio Communication Tester CMU 200 and CMW500 were used.
The output power was measured using an integrated RF connector and attached RF cable.
The conducted output power was also checked before and after each SAR measurement. The resulting power values were within a 0.2 dB tolerance of the values shown below.

Note: CMU200 measures GSM peak and average output power for active timeslots.
For SAR the time based average power is relevant. The difference in-between depends on the duty cycle of the TDMA signal:

No. of timeslots	***1***	***2***	***3***	***4***
Duty Cycle	1 : 8	1: 4	1 : 2.66	1 : 2
time based avg. power compared to slotted avg. power	- 9.03 dB	- 6.02 dB	- 4.26 dB	- 3.01 dB

The signalling modes differ as follows :

mode	***coding scheme***	***modulation***
GPRS	CS1 to CS4	GMSK
EGPRS (EDGE)	MCS1 to MCS4	GMSK
EGPRS (EDGE)	MCS5 to MCS9	8PSK

Apart from modulation change (GMSK/8PSK) coding schemes differ in code rate without influence on the RF signal. Therefore one coding scheme per mode was selected for conducted power measurements.

8.1.1 Conducted power measurements GSM 850 MHz

Conducted output power GSM 850 MHz (dBm)							
SN:		**Slotted avg. power**			**Time based avg. power**		
TS	mod.	CH 128	CH 190	CH 251	CH 128	CH 190	CH 251
		824.2 MHz	836.6 MHz	848.8 MHz	824.2 MHz	836.6 MHz	848.8 MHz
1	GMSK	31.7	31.7	31.5	22.67	22.67	22.47
2	**GMSK**	**30.7**	**30.7**	**30.5**	**24.68**	**24.68**	**24.48**
3	GMSK	28.9	28.8	28.5	24.64	24.54	24.24
4	GMSK	27.6	27.6	27.4	24.59	24.59	24.39
1	8PSK	25.8	25.9	25.6	16.77	16.87	16.57
2	8PSK	24.8	24.7	24.4	18.78	18.68	18.38
3	8PSK	23.2	23.1	22.8	18.94	18.84	18.54
4	8PSK	22.1	21.9	22.0	19.09	18.89	18.99

Table 9: Test results conducted power measurement GSM 850 MHz

8.1.2 Conducted power measurements GSM 1900 MHz

Conducted output power GSM 1900 MHz (dBm)							
SN:		**Slotted avg. power**			**Time based avg. power**		
TS	mod.	CH 512	CH 661	CH 810	CH 512	CH 661	CH 810
		1850.2 MHz	1880.0 MHz	1909.8 MHz	1850.2 MHz	1880.0 MHz	1909.8 MHz
1	GMSK	29.4	28.8	29.1	20.37	19.77	20.07
2	GMSK	27.9	27.6	27.8	21.88	21.58	21.78
3	**GMSK**	**26.2**	**26.1**	**26.1**	**21.94**	**21.84**	**21.84**
4	GMSK	23.9	23.6	23.8	20.89	20.59	20.79
1	8PSK	25.5	25.2	25.3	16.47	16.17	16.27
2	8PSK	25.0	24.6	24.7	18.98	18.58	18.68
3	8PSK	23.2	23.0	23.0	18.94	18.74	18.74
4	8PSK	21.7	21.5	21.6	18.69	18.49	18.59

Table 10: Test results conducted power measurement GSM 1900 MHz

8.1.3 Conducted power measurements UMTS FDD II (1950 MHz)

Max. RMS output power FDD II (1900MHz) / dBm			
	Channel / frequency		
mode	9262 / 1852.4 MHz	9400 / 1880.0 MHz	9538 / 1907.6 MHz
RMC 12.2 kbit/s	**21.8**	**21.8**	**21.3**
RMC 64 kbit/s	21.2	21.4	21.0
RMC 144 kbit/s	21.4	21.7	21.2
RMC 384 kbit/s	21.7	21.2	21.2
AMR 4.75 kbit/s	21.7	21.7	21.2
AMR 5.15 kbit/s	21.8	21.8	21.2
AMR 5.9 kbit/s	21.8	21.7	21.2
AMR 6.7 kbit/s	21.7	21.8	21.2
AMR 7.4 kbit/s	21.8	21.8	21.3
AMR 7.95 kbit/s	21.7	21.7	21.2
AMR 10.2 kbit/s	21.7	21.8	21.3
AMR 12.2 kbit/s	21.8	21.7	21.2
HSDPA Sub test 1	**21.7**	**21.7**	**21.2**
HSDPA Sub test 2	20.9	20.9	20.3
HSDPA Sub test 3	20.3	20.4	19.9
HSDPA Sub test 4	20.4	20.3	19.9
HSUPA Sub test 1	21.7	21.7	21.3
HSUPA Sub test 2	20.9	20.8	20.4
HSUPA Sub test 3	20.3	20.4	19.9
HSUPA Sub test 4	20.4	20.3	19.8
HSUPA Sub test 5	**21.7**	**21.7**	**21.2**

Table 11: Test results conducted power measurement UMTS FDD II 1950 MHz.

8.1.4 Conducted power measurements UMTS FDD IV (1700 MHz)

Max. RMS output power FDD IV (1700MHz) / dBm			
	Channel / frequency		
mode	1312 / 1712.4 MHz	1412 / 1732.4 MHz	1513 / 1752.6 MHz
RMC 12.2 kbit/s	**21.3**	**21.7**	**21.6**
RMC 64 kbit/s	21.1	21.5	21.4
RMC 144 kbit/s	21.1	21.4	21.3
RMC 384 kbit/s	21.2	21.4	21.3
AMR 4.75 kbit/s	21.7	21.7	21.2
AMR 5.15 kbit/s	21.8	21.7	21.3
AMR 5.9 kbit/s	21.8	21.7	21.3
AMR 6.7 kbit/s	21.8	21.8	21.3
AMR 7.4 kbit/s	21.7	21.7	21.3
AMR 7.95 kbit/s	21.7	21.8	21.2
AMR 10.2 kbit/s	21.8	21.8	21.3
AMR 12.2 kbit/s	21.7	21.7	21.3
HSDPA Sub test 1	**21.7**	**21.7**	**21.3**
HSDPA Sub test 2	20.9	20.9	20.3
HSDPA Sub test 3	20.4	20.3	19.9
HSDPA Sub test 4	20.3	20.3	19.8
HSUPA Sub test 1	21.8	21.7	21.2
HSUPA Sub test 2	20.9	20.9	20.4
HSUPA Sub test 3	20.3	20.3	19.8
HSUPA Sub test 4	20.3	20.4	19.9
HSUPA Sub test 5	**21.8**	**21.8**	**21.3**

Table 12: Test results conducted power measurement UMTS FDD IV 1700 MHz.

8.1.5 Conducted power measurements UMTS FDD V (850 MHz)

Max. RMS output power 850 MHz (FDD V) / dBm			
	Channel / frequency		
mode	4132 / 826.4 MHz	4182 / 836.6 MHz	4233 / 846.6 MHz
RMC 12.2 kbit/s	**22.4**	**22.3**	**22.3**
RMC 64 kbit/s	22.3	22.1	22.2
RMC 144 kbit/s	22.1	22.3	22.1
RMC 384 kbit/s	22.1	22.1	22.1
AMR 4.75 kbit/s	21.8	21.7	21.3
AMR 5.15 kbit/s	21.7	21.8	21.3
AMR 5.9 kbit/s	21.8	21.7	21.3
AMR 6.7 kbit/s	21.8	21.8	21.2
AMR 7.4 kbit/s	21.7	21.8	21.2
AMR 7.95 kbit/s	21.7	21.8	21.2
AMR 10.2 kbit/s	21.8	21.7	21.2
AMR 12.2 kbit/s	21.7	21.7	21.3
HSDPA Sub test 1	**21.7**	**21.7**	**21.2**
HSDPA Sub test 2	20.8	20.9	20.4
HSDPA Sub test 3	20.3	20.4	19.8
HSDPA Sub test 4	20.3	20.4	19.9
HSUPA Sub test 1	21.8	21.8	21.3
HSUPA Sub test 2	20.9	20.8	20.4
HSUPA Sub test 3	20.3	20.3	19.8
HSUPA Sub test 4	20.4	20.3	19.9
HSUPA Sub test 5	**21.7**	**21.8**	**21.3**

Table 13: Test results conducted power measurement UMTS FDD V 850 MHz.

8.1.6 Test-set-up information for WCDMA / HSPDA / HSUPA

a) WCDMA RMC

In RMC (reference measurement channel) mode the conducted power at 4 different bit rates was measured. They correspond with the used spreading factors as follows:

Bit rate	***12.2 kbit/s***	***64 kbit/s***	***144 kbit/s***	***384 kbit/s***
Spreading factor (SF)	64	16	8	4

In RMC mode only DPCCH and DPDCH are active. As bit rate changes do not influence the relative power of any code channel the measured RMS output power remains on the same level which is set to maximum by TPC (Transmit power control) pattern type 'All 1'.

b) HSDPA

HSDPA adds the HS-DPCCH in uplink as a control channel for high speed data transfer in downlink.
In HSDPA mode 4 sub-tests are defined by 3GPP 34.121 according to the following table:

Sub-test	**β_c**	**β_d**	**β_d (SF)**	**β_c/β_d**	**$\beta_{hs}^{(1)}$**	**CM(dB)$^{(2)}$**
1	2/15	15/15	64	2/15	4/15	0.0
2	12/15$^{(3)}$	15/15$^{(3)}$	64	12/15$^{(3)}$	24/15	1.0
3	15/15	8/15	64	15/8	30/15	1.5
4	15/15	4/15	64	15/4	30/15	1.5

Note 1: Δ_{ACK}, Δ_{NACK}, Δ_{CQI} = 8 $\Longleftrightarrow$ $A_{hs} = \beta_{hs}/\beta_c = 30/15$ $\Longleftrightarrow$ $\beta_{hs} = 30/15 * \beta_c$
Note 2 : CM = 1 for $\beta_c/\beta_d = 12/15$, $\beta_{hs}/\beta_c = 24/15$
Note 3 : For subtest 2 the β_c/β_d ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1,TF1) to $\beta_c = 11/15$ and β_d = 15/15

Table 14: Sub-tests for UMTS Release 5 HSDPA

The β_c and β_d gain factors for DPCCH and DPDCH were set according to the values in the above table, β_{hs} for HS-DPCCH is set automatically to the correct value when Δ_{ACK}, Δ_{NACK}, Δ_{CQI} = 8. The variation of the β_c/β_d ratio causes a power reduction at sub-tests 2 - 4.
The measurements were performed with a Fixed Reference Channel (FRC) and H-Set 1 QPSK.

Parameter	***Value***
Nominal average inf. bit rate	534 kbit/s
Inter-TTI Distance	3 TTI's
Number of HARQ Processes	2 Processes
Information Bit Payload	3202 Bits
MAC-d PDU size	336 Bits
Number Code Blocks	1 Block
Binary Channel Bits Per TTI	4800 Bits
Total Available SMLs in UE	19200 SMLs
Number of SMLs per HARQ Process	9600 SMLs
Coding Rate	0.67
Number of Physical Channel Codes	5

Table 15: settings of required H-Set 1 QPSK acc. to 3GPP 34.121

c) DC-HSDPA (3GPP Release 8)

Dual Cell – HSDPA has been signalized using the following settings for connection setup:

Parameter During Connection Setup	Value
P-CPICH_Ec/Ior	-10 dB
P-CCPCH	-12
SCH_Ec/Ior	-12
PICH_Ec/Ior	-15
HS-PDSCH	off
HS-SCCH_1	off
DPCH_Ec/Ior	-5
OCNS_Ec/Ior	-3.1

Table 16: Downlink Physical Channels according to 3GPP 34.121 Table E.5.0

The fixed reference channel has been set to H-set 12 according to 3GPP TS 34.121 Table C.8.1.12:

Parameter	Unit	Value
Nominal Average Inf. Bit Rate	kbit/s	60
Inter-TTI Distance	TTI's	1
Information Bit Payload (N_{INF})	Bits	120
Number Code Blocks	Blocks	1
Binary Channel Bits Per TTI	Bits	960
Total Available SML's in UE	SML's	19200
Number of SML's per HARQ Process	SML's	3200
Coding Rate		0.15
Number of Physical Channel Codecs	Codecs	1
Modulation		QPSK
Note 1: The RMC is intended to be used for DC-HSDPA mode and both cells shall transmit with identical parameters as listed in the table. Note 2: Maximum number of transmission is limited to 1, i.e., retransmission is not allowed. The redundancy and constellation version 0 shall be used.		

Table 17: H-Set 12 QPSK configuration

The same Sub-test settings as for Release 5 HSDPA were used for the tests.

d) HSUPA

In HSUPA mode additional code channels (E-DPCCH, E-DPDCHn) are added for data transfer in uplink at higher bit rates.

5 sub-tests are defined by 3GPP 34.121 according to the following table:

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{hs} (1)	β_{ec}	β_{ed}	β_{ec} (SF)	β_{ed} (code)	CM (2) (dB)	MPR (dB)	AG (4) Index	E-TFCI
1	11/15 (3)	15/15 (3)	64	11/15 (3)	22/15	209/225	1039/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	β_{ed1}:47/15 β_{ed2}:47/15	4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15 (4)	15/15 (4)	64	15/15 (4)	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1: Δ_{ACK}, Δ_{NACK}, Δ_{CQI} = 8 $\Longleftrightarrow$ A_{hs} = β_{hs}/β_c = 30/15 $\Longleftrightarrow$ β_{hs} = 30/15 * β_c
Note 2 : CM = 1 for β_c/β_d = 12/15, β_{hs}/β_c = 24/15. For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference
Note 3 : For subtest 1 the β_c/β_d ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1,TF1) to β_c = 10/15 and β_d = 15/15
Note 4 : For subtest 5 the β_c/β_d ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1,TF1) to β_c = 14/15 and β_d = 15/15
Note 5 : Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g
Note 6 : β_{ed} can not be set directly; it is set by Absolute Grant Value

Table 18: Subtests for UMTS Release 6 HSUPA

To achieve the settings above some additional procedures were defined by 3GPP 34.121. Those have been included in an application note for the CMU200 and were exactly followed:

- Test mode connection (BS signal tab):
RMC 12.2 kbit/s + HSPA 34.108 with loop mode 1
- HS-DSCH settings (BS signal tab):
- FRC with H-set 1 QPSK
- ACK-NACK repetition factor = 3
- CQI feedback cycle = 4ms
- CQI repetition factor = 2
- HSUPA-specific signalling settings (UE signal tab):
- E-TFCI table index = 0
- E-DCH minimum set E-TFCI = 9
- Puncturing limit non-max = 0.84
- max. number of channelisation codes = 2x SF4
- Initial Serving Grant Value = Off
- HSDPA and HSUPA Gain factors (UE signal tab)

Sub-test	β_c	β_d	Δ_{ACK}, Δ_{NACK}, Δ_{CQI}	ΔE–DPCCH)*
1	10	15	8	6
2	6	15	8	8
3	15	9	8	8
4	2	15	8	5
5	14	15	8	7

)* : β_{ec} and β_{ed} ratios (relative to β_c and β_d) are set by ΔE–DPCCH

- HSUPA Reference E-TFCIs (UE signal tab > HSUPA gain factors):

Sub-test	**1, 2, 4, 5**				
Number of E-TFCIs	5				
Reference E-TFCI	11	67	71	75	81
Reference E-TFCI power offset	4	18	23	26	27

Sub-test	**3**	
Number of E-TFCIs	2	
Reference E-TFCI	11	92
Reference E-TFCI power offset	4	18

- HSUPA-specific generator parameters (BS Signal tab > HSUPA > E-AGCH > AG Pattern)

Sub-test	***Absolute Grant Value (AG Index)***
1	20
2	12
3	15
4	17
5	21

- Power Level settings (BS Signal tab > Node B-settings):
- Level reference: Output Channel Power (Ior)
- Output Channel Power (Ior): -86 dBm

- Downlink Physical Channel Settings (BS signal tab)
- P-CPICH: -10 dB
- S-CPICH: Off
- P-SCH: -15 dB
- S-SCH : -15 dB
- P-CCPCH: -12 dB
- S-CCPCH: -12 dB
- PICH : -15 dB
- AICH : -12 dB
- DPDCH : -10 dB
- HS-SCCH : -8 dB
- HS-PDSCH : -3 dB
- E-AGCH : -20 dB
- E-RGCH/E-HICH - 20 dB
- E-RGCH Active: Off

The settings above were stored once for each sub-test and recalled before the measurement.

HSUPA test procedure:

To reach maximum output power in HSUPA mode the following procedures were followed:

3 different TPC patterns were defined:
Set 1 : Closed loop with target power 10 dBm
Set 2 : Single Pattern+Alternating with binary pattern '11111' for 1 dB steps 'up'
Set 3 : Single Pattern+Alternating with binary pattern '00000' for 1 dB steps 'down'

After recalling a certain HSUPA sub-test the HSUPA E-AGCH graph with E-TFCI event counter is displayed.
After starting with the closed loop command the power is increased in 1 dB steps by activating pattern set 2 until the UE decreases the transmitted E-TFCI.
At this point set 3 is activated once to reduce the output power to the value at which the original E-TFCI, which is required for the sub-test, appears again.

For conducted power measurements the same steps are repeated in the power menu to read out the corresponding maximum RMS output power with the target E-TFCI.
For SAR measurements it is useful to switch to Code Domain Power vs. Time display.
Here the CMU200 shows relative power values (max. and min.) of each code channel which should roughly correspond to the numerators of the gain factors e.g.:

Sub-test	β_c	β_d	β_{hs}	β_{ec}	β_{ed}
5	15	15	30	24	134

By this way a surveillance of signalling conditions is possible to make sure that HSUPA code channels are active during the complete SAR measurement.

8.1.7 Conducted power measurements LTE FDD 2 1880 MHz

Bandwidth (MHz)	Channel / Frequency (MHz)	Resource block allocation	P_{avg} (dBm)	P_{avg} (dBm)
			QPSK	16-QAM
1.4	18607 / 1850.7	1 RB low	21.6	20.5
		1 RB mid	21.6	20.6
		1 RB high	21.6	20.6
		50% RB low	21.4	20.5
		50% RB mid	21.4	20.5
		50% RB high	21.4	20.5
		100% RB	20.5	19.4
	18900 / 1880.0	1 RB low	21.2	20.5
		1 RB mid	21.4	20.6
		1 RB high	21.3	20.4
		50% RB low	21.3	20.3
		50% RB mid	21.3	20.4
		50% RB high	21.4	20.3
		100% RB	20.4	19.4
	19193 / 1909.3	1 RB low	21.5	20.5
		1 RB mid	21.6	20.8
		1 RB high	21.5	20.6
		50% RB low	21.4	20.3
		50% RB mid	21.4	20.4
		50% RB high	21.4	20.4
		100% RB	20.4	19.3
3	18615 / 1851.5	1 RB low	21.5	20.4
		1 RB mid	21.5	20.3
		1 RB high	21.5	20.4
		50% RB low	20.5	19.3
		50% RB mid	20.5	19.4
		50% RB high	20.5	19.4
		100% RB	20.5	19.3
	18900 / 1880.0	1 RB low	21.3	20.3
		1 RB mid	21.2	20.4
		1 RB high	21.4	20.5
		50% RB low	20.4	19.3
		50% RB mid	20.4	19.4
		50% RB high	20.4	19.4
		100% RB	20.4	19.4
	19185 / 1908.5	1 RB low	21.5	20.2
		1 RB mid	21.4	20.4
		1 RB high	21.5	20.4
		50% RB low	20.4	19.2
		50% RB mid	20.4	19.3
		50% RB high	20.3	19.3
		100% RB	20.4	19.3

Bandwidth (MHz)	Channel / Frequency (MHz)	Resource block allocation	P_{avg} (dBm) QPSK	P_{avg} (dBm) 16-QAM
5	18625 / 1852.5	1 RB low	21.2	20.5
		1 RB mid	21.3	20.5
		1 RB high	21.2	20.4
		50% RB low	20.4	19.3
		50% RB mid	20.5	19.4
		50% RB high	20.4	19.3
		100% RB	20.5	19.4
	18900 / 1880.0	1 RB low	21.2	20.5
		1 RB mid	21.3	20.5
		1 RB high	21.3	20.5
		50% RB low	20.4	19.3
		50% RB mid	20.3	19.6
		50% RB high	20.4	19.4
		100% RB	20.4	19.4
	19175 / 1907.5	1 RB low	21.4	20.5
		1 RB mid	21.3	20.6
		1 RB high	21.4	20.6
		50% RB low	20.4	19.4
		50% RB mid	20.5	19.5
		50% RB high	20.5	19.4
		100% RB	20.5	19.3
10	18650 / 1855.0	1 RB low	21.7	20.8
		1 RB mid	21.5	20.5
		1 RB high	21.7	20.7
		50% RB low	20.5	19.5
		50% RB mid	20.4	19.4
		50% RB high	20.4	19.4
		100% RB	20.4	19.3
	18900 / 1880.0	1 RB low	21.6	20.4
		1 RB mid	21.5	20.4
		1 RB high	21.7	20.4
		50% RB low	20.4	19.3
		50% RB mid	20.3	19.4
		50% RB high	20.4	19.3
		100% RB	20.3	19.3
	19150 / 1905.0	1 RB low	21.4	20.5
		1 RB mid	21.5	20.5
		1 RB high	21.4	20.4
		50% RB low	20.4	19.4
		50% RB mid	20.5	19.3
		50% RB high	20.5	19.4
		100% RB	20.4	19.4

Bandwidth (MHz)	Channel / Frequency (MHz)	Resource block allocation	P_{avg} (dBm)	P_{avg} (dBm)
			QPSK	16-QAM
15	18675 / 1857.5	1 RB low	21.4	20.5
		1 RB mid	21.4	20.5
		1 RB high	21.4	20.6
		50% RB low	20.3	19.3
		50% RB mid	20.4	19.3
		50% RB high	20.4	19.4
		100% RB	20.3	19.3
	18900 / 1880.0	1 RB low	21.5	20.3
		1 RB mid	21.5	20.3
		1 RB high	21.6	20.6
		50% RB low	20.4	19.4
		50% RB mid	20.4	19.4
		50% RB high	20.5	19.5
		100% RB	20.4	19.4
	19125 / 1902.5	1 RB low	21.5	20.5
		1 RB mid	21.4	20.4
		1 RB high	21.4	20.6
		50% RB low	20.5	19.4
		50% RB mid	20.5	19.4
		50% RB high	20.5	19.4
		100% RB	20.4	19.4
20	18700 / 1860.0	1 RB low	21.3	20.4
		1 RB mid	**21.5**	20.6
		1 RB high	21.3	20.4
		50% RB low	20.4	19.4
		50% RB mid	20.5	19.5
		50% RB high	20.4	19.5
		100% RB	20.5	19.4
	18900 / 1880.0	1 RB low	21.3	20.4
		1 RB mid	**21.4**	20.6
		1 RB high	21.4	20.7
		50% RB low	20.3	19.4
		50% RB mid	20.4	19.4
		50% RB high	20.5	19.4
		100% RB	20.4	19.4
	19100 / 1900.0	1 RB low	21.6	20.3
		1 RB mid	**21.7**	20.4
		1 RB high	21.6	20.4
		50% RB low	20.5	19.4
		50% RB mid	20.4	19.4
		50% RB high	20.5	19.4
		100% RB	20.5	19.5

Table 19: Test results conducted power measurement LTE FDD 2 1880 MHz.

8.1.8 Conducted power measurements LTE FDD 4 1730 MHz

Bandwidth (MHz)	Channel / Frequency (MHz)	Resource block allocation	P_{avg} (dBm) QPSK	P_{avg} (dBm) 16-QAM
1.4	19957 / 1710.7	1 RB low	21.6	20.6
		1 RB mid	21.6	20.7
		1 RB high	21.6	20.6
		50% RB low	21.4	20.5
		50% RB mid	21.6	20.6
		50% RB high	21.5	20.5
		100% RB	20.5	19.4
	20175 / 1732.5	1 RB low	21.3	20.5
		1 RB mid	21.4	20.5
		1 RB high	21.4	20.4
		50% RB low	21.5	20.3
		50% RB mid	21.5	20.7
		50% RB high	21.5	20.4
		100% RB	20.5	19.3
	20393 / 1754.3	1 RB low	21.5	20.6
		1 RB mid	21.6	20.7
		1 RB high	21.5	20.6
		50% RB low	21.4	20.4
		50% RB mid	21.6	20.6
		50% RB high	21.4	20.6
		100% RB	20.5	19.5
3	19965 / 1711.5	1 RB low	21.5	20.4
		1 RB mid	21.5	20.2
		1 RB high	21.6	20.4
		50% RB low	20.5	19.3
		50% RB mid	20.5	19.5
		50% RB high	20.5	19.3
		100% RB	20.5	19.4
	20175 / 1732.5	1 RB low	21.3	20.5
		1 RB mid	21.3	20.4
		1 RB high	21.5	20.4
		50% RB low	20.4	19.2
		50% RB mid	20.5	19.4
		50% RB high	20.5	19.3
		100% RB	20.4	19.4
	20385 / 1753.5	1 RB low	21.5	20.5
		1 RB mid	21.5	20.6
		1 RB high	21.5	20.5
		50% RB low	20.3	19.3
		50% RB mid	20.5	19.4
		50% RB high	20.5	19.4
		100% RB	20.4	19.4

Bandwidth (MHz)	Channel / Frequency (MHz)	Resource block allocation	P_{avg} (dBm)	P_{avg} (dBm)
			QPSK	16-QAM
5	19975 / 1712.5	1 RB low	21.2	20.4
		1 RB mid	21.2	20.4
		1 RB high	21.3	20.4
		50% RB low	20.5	19.3
		50% RB mid	20.5	19.6
		50% RB high	20.5	19.3
		100% RB	20.3	19.3
	20175 / 1732.5	1 RB low	21.4	20.4
		1 RB mid	21.4	20.5
		1 RB high	21.5	20.6
		50% RB low	20.5	19.4
		50% RB mid	20.5	19.6
		50% RB high	20.5	19.4
		100% RB	20.5	19.4
	20375 / 1752.5	1 RB low	21.2	20.6
		1 RB mid	21.3	20.5
		1 RB high	21.4	20.6
		50% RB low	20.3	19.2
		50% RB mid	20.5	19.5
		50% RB high	20.5	19.3
		100% RB	20.5	19.4
10	20000 / 1715.0	1 RB low	21.4	20.4
		1 RB mid	21.6	20.4
		1 RB high	21.4	20.3
		50% RB low	20.3	19.3
		50% RB mid	20.6	19.5
		50% RB high	20.4	19.4
		100% RB	20.4	19.3
	20175 / 1732.5	1 RB low	21.3	20.4
		1 RB mid	21.4	20.5
		1 RB high	21.3	20.4
		50% RB low	20.4	19.2
		50% RB mid	20.5	19.4
		50% RB high	20.5	19.4
		100% RB	20.4	19.3
	20350 / 1750.0	1 RB low	21.5	20.5
		1 RB mid	1.5	20.6
		1 RB high	21.8	20.7
		50% RB low	20.3	19.2
		50% RB mid	20.6	19.5
		50% RB high	20.3	19.3
		100% RB	20.2	19.2

Bandwidth (MHz)	Channel / Frequency (MHz)	Resource block allocation	**P_{avg} (dBm)** QPSK	**P_{avg} (dBm)** 16-QAM
15	20025 / 1717.5	1 RB low	21.4	20.3
		1 RB mid	21.5	20.4
		1 RB high	21.6	20.4
		50% RB low	20.3	19.3
		50% RB mid	20.5	19.5
		50% RB high	20.5	19.4
		100% RB	20.4	19.4
	20175 / 1732.5	1 RB low	21.2	20.4
		1 RB mid	21.4	20.3
		1 RB high	21.2	20.3
		50% RB low	20.5	19.4
		50% RB mid	20.5	19.4
		50% RB high	20.5	19.4
		100% RB	20.4	19.4
	20325 / 1747.5	1 RB low	21.2	20.3
		1 RB mid	21.3	20.3
		1 RB high	21.3	20.4
		50% RB low	20.3	19.3
		50% RB mid	20.6	19.5
		50% RB high	20.3	19.3
		100% RB	20.3	19.3
20	20050 / 1720.0	1 RB low	21.2	20.4
		1 RB mid	**21.5**	20.7
		1 RB high	21.4	20.7
		50% RB low	20.3	19.3
		50% RB mid	20.6	19.6
		50% RB high	20.5	19.4
		100% RB	20.5	19.4
	20175 / 1732.5	1 RB low	**21.6**	20.2
		1 RB mid	21.6	20.5
		1 RB high	21.4	20.2
		50% RB low	20.4	19.3
		50% RB mid	20.6	19.5
		50% RB high	20.3	19.2
		100% RB	20.3	19.3
	20300 / 1745.0	1 RB low	**21.4**	20.5
		1 RB mid	21.3	20.5
		1 RB high	21.3	20.3
		50% RB low	20.4	19.3
		50% RB mid	20.5	19.5
		50% RB high	20.3	19.2
		100% RB	20.3	19.2

Table 20: Test results conducted power measurement LTE FDD 4 1730 MHz.

8.1.9 Conducted power measurements LTE FDD 5 835 MHz

Bandwidth (MHz)	Channel / Frequency (MHz)	Resource block allocation	P_{avg} (dBm) QPSK	P_{avg} (dBm) 16-QAM
1.4	20407 / 824.7	1 RB low	22.2	21.4
		1 RB mid	22.3	21.4
		1 RB high	22.0	21.2
		50% RB low	22.1	21.1
		50% RB mid	22.2	21.3
		50% RB high	22.1	21.1
		100% RB	21.1	20.1
	20525 / 836.5	1 RB low	22.1	21.1
		1 RB mid	22.2	21.2
		1 RB high	22.1	21.2
		50% RB low	22.0	21.0
		50% RB mid	22.1	21.2
		50% RB high	22.0	21.0
		100% RB	21.1	19.9
	20643 / 848.3	1 RB low	21.8	20.9
		1 RB mid	21.9	21.0
		1 RB high	21.8	20.9
		50% RB low	21.9	20.8
		50% RB mid	22.0	21.0
		50% RB high	21.9	20.8
		100% RB	21.0	19.8
3	20415 / 825.5	1 RB low	22.3	21.1
		1 RB mid	22.1	20.9
		1 RB high	22.2	21.3
		50% RB low	21.1	20.0
		50% RB mid	21.1	20.0
		50% RB high	21.1	20.0
		100% RB	21.1	20.1
	20525 / 836.5	1 RB low	22.2	21.2
		1 RB mid	22.1	20.8
		1 RB high	22.3	20.9
		50% RB low	21.0	20.0
		50% RB mid	21.1	20.0
		50% RB high	21.0	19.9
		100% RB	21.1	20.0
	20635 / 847.5	1 RB low	22.0	20.9
		1 RB mid	21.9	21.0
		1 RB high	21.8	20.8
		50% RB low	21.1	20.0
		50% RB mid	21.0	19.9
		50% RB high	20.9	19.9
		100% RB	21.0	19.9

Bandwidth (MHz)	Channel / Frequency (MHz)	Resource block allocation	P_{avg} (dBm)	P_{avg} (dBm)
			QPSK	16-QAM
5	20425 / 826.5	1 RB low	22.1	21.3
		1 RB mid	22.1	21.2
		1 RB high	22.0	21.2
		50% RB low	21.1	20.0
		50% RB mid	21.1	20.4
		50% RB high	21.2	20.1
		100% RB	21.2	20.2
	20525 / 836.5	1 RB low	21.9	21.0
		1 RB mid	21.9	20.9
		1 RB high	21.9	21.1
		50% RB low	21.0	20.0
		50% RB mid	21.0	20.1
		50% RB high	21.0	20.0
		100% RB	21.0	20.0
	20625 / 846.5	1 RB low	21.8	21.0
		1 RB mid	21.9	21.0
		1 RB high	21.8	21.0
		50% RB low	20.9	19.9
		50% RB mid	21.1	20.2
		50% RB high	20.9	19.9
		100% RB	20.9	19.9
10	20450 / 829.0	1 RB low	22.3	21.2
		1 RB mid	**22.3**	21.5
		1 RB high	22.3	21.2
		50% RB low	21.1	20.1
		50% RB mid	21.2	20.1
		50% RB high	21.0	20.1
		100% RB	21.1	20.1
	20525 / 836.5	1 RB low	22.1	21.1
		1 RB mid	**22.2**	21.1
		1 RB high	22.1	20.8
		50% RB low	21.1	20.0
		50% RB mid	21.2	20.1
		50% RB high	21.1	20.0
		100% RB	21.0	20.0
	20600 / 844.0	1 RB low	21.9	20.9
		1 RB mid	**21.9**	21.0
		1 RB high	21.8	20.9
		50% RB low	21.0	19.9
		50% RB mid	21.1	20.0
		50% RB high	20.9	19.9
		100% RB	21.0	19.9

Table 21: Test results conducted power measurement LTE FDD 5 835 MHz.

8.1.10 Conducted power measurements LTE FDD 7 2600 MHz

Bandwidth (MHz)	Channel / Frequency (MHz)	Resource block allocation	P_{avg} (dBm)	P_{avg} (dBm)
			QPSK	16-QAM
5	20775 / 2502.5	1 RB low	20.3	19.1
		1 RB mid	20.3	19.4
		1 RB high	20.3	19.3
		50% RB low	19.5	18.4
		50% RB mid	19.4	18.3
		50% RB high	19.3	18.4
		100% RB	19.3	18.2
	21100 / 2535.0	1 RB low	20.0	19.3
		1 RB mid	20.1	19.3
		1 RB high	19.9	19.1
		50% RB low	19.0	18.0
		50% RB mid	19.2	18.3
		50% RB high	19.1	18.1
		100% RB	19.0	18.1
	21425 / 2567.5	1 RB low	19.8	18.9
		1 RB mid	19.8	19.0
		1 RB high	19.8	18.8
		50% RB low	18.9	17.8
		50% RB mid	19.1	18.0
		50% RB high	18.9	17.8
		100% RB	18.9	17.9
10	20800 / 2505.0	1 RB low	20.3	19.0
		1 RB mid	20.3	19.3
		1 RB high	20.3	19.1
		50% RB low	19.2	18.2
		50% RB mid	19.3	18.2
		50% RB high	19.1	18.1
		100% RB	19.1	18.1
	21100 / 2535.0	1 RB low	20.2	19.3
		1 RB mid	20.1	19.2
		1 RB high	20.1	19.2
		50% RB low	19.1	18.1
		50% RB mid	19.3	18.2
		50% RB high	19.1	18.0
		100% RB	19.0	18.1
	21400 / 2565.0	1 RB low	20.2	19.2
		1 RB mid	20.3	19.4
		1 RB high	20.2	19.0
		50% RB low	19.0	18.0
		50% RB mid	19.1	18.0
		50% RB high	19.1	18.0
		100% RB	19.0	18.0

Bandwidth (MHz)	Channel / Frequency (MHz)	Resource block allocation	P_{avg} (dBm)	P_{avg} (dBm)
			QPSK	16-QAM
15	20825 / 2507.5	1 RB low	20.4	19.2
		1 RB mid	20.2	19.3
		1 RB high	20.3	19.1
		50% RB low	19.2	18.2
		50% RB mid	19.4	18.2
		50% RB high	19.2	18.1
		100% RB	19.1	18.1
	21100 / 2535.0	1 RB low	20.2	19.3
		1 RB mid	20.1	19.2
		1 RB high	20.0	19.0
		50% RB low	19.1	18.1
		50% RB mid	19.2	18.2
		50% RB high	19.1	18.0
		100% RB	19.0	18.1
	21375 / 2562.5	1 RB low	19.9	19.0
		1 RB mid	19.8	18.8
		1 RB high	19.9	18.9
		50% RB low	19.0	18.0
		50% RB mid	19.0	17.9
		50% RB high	19.0	18.0
		100% RB	18.9	17.9
20	20850 / 2510.0	1 RB low	20.2	19.3
		1 RB mid	**20.3**	19.5
		1 RB high	20.2	19.4
		50% RB low	19.1	18.2
		50% RB mid	19.3	18.2
		50% RB high	19.1	18.2
		100% RB	19.3	18.2
	21100 / 2535.0	1 RB low	**20.4**	19.2
		1 RB mid	20.2	19.2
		1 RB high	20.0	18.7
		50% RB low	19.2	18.2
		50% RB mid	19.2	18.2
		50% RB high	19.1	18.0
		100% RB	19.1	18.1
	21350 / 2560.0	1 RB low	**20.0**	19.0
		1 RB mid	20.0	19.1
		1 RB high	19.8	18.9
		50% RB low	18.9	18.0
		50% RB mid	19.0	17.9
		50% RB high	18.8	17.9
		100% RB	18.9	18.0

Table 22: Test results conducted power measurement LTE FDD 7 2600 MHz.

8.1.11 Justification of SAR measurements in LTE mode

According to Chapter 5 ‘SAR test procedures for LTE devices of FCC KDB Publication 941225 D05 the following test configurations for standalone measurements of the largest channel bandwidth (chapter 5.2) had to be taken into consideration:

5.2.1. QPSK with 1 RB allocation
Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and *required test channel* combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each *required test channel*. When the *reported* SAR is ≤ 0.8 W/kg, testing of the remaining RB offset configurations and *required test channels* is not required for 1 RB allocation; otherwise, SAR is required for the remaining *required test channels* and only for the RB offset configuration with the highest output power for that channel.6 When the *reported* SAR of a *required test channel* is > 1.45 W/kg, SAR is required for all three RB offset configurations for that *required test channel*.

8.1.12 Conducted power measurements WLAN 2450 MHz

802.11b		maximum average conducted output power [dBm]			
Band	**Ch**	**1Mbps**	**2Mbps**	**5.5Mbps**	**11Mbps**
2450MHz	1	15.6	15.3	15.4	15.4
	6	16.1	15.1	15.2	15.2
	11	**17.4**	17.2	17.4	17.3

Table 23: 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	13.2	13.1	13.1	13.3	13.5	13.5	13.5	13.5
	6	13.9	13.9	13.9	14.0	13.2	13.1	14.2	14.1
	11	14.8	14.8	14.7	14.8	14.9	14.9	14.9	14.9

Table 24: 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	13.0	12.9	13.1	13.6	13.5	13.5	13.6	13.5
	6	13.8	13.6	13.8	14.3	14.2	14.2	14.2	14.2
	11	14.6	14.5	14.7	14.9	14.9	14.9	14.9	14.9

Table 25: Test results conducted power measurement 802.11n HT-20

8.1.13 Conducted power measurements WLAN 5 GHz

802.11a		maximum average conducted output power [dBm]							
Band	Ch	6Mbps	9Mbps	12Mbps	18Mbps	24Mbps	36Mbps	48Mbps	54Mbps
5200	36	10.2	10.0	10.0	9.8	9.7	9.4	9.0	8.9
	40	**10.3**	10.1	10.1	10.1	10.0	9.7	9.3	9.2
	44	10.2	10.0	10.0	10.0	9.9	9.6	9.2	9.1
	48	10.1	9.9	9.9	9.9	9.8	9.5	9.1	9.0
5800	149	3.9	3.4	3.4	3.5	3.9	3.8	3.9	3.8
	153	3.9	3.9	3.9	4.0	4.2	4.2	4.2	4.2
	157	4.0	3.8	3.8	4.0	4.3	4.2	4.3	4.2
	161	3.4	3.4	3.4	3.5	3.8	3.5	3.8	3.8
	165	**4.3**	3.7	3.7	3.8	4.2	4.1	4.1	4.1

Table 26: Test results conducted power measurement 802.11a

802.11n HT-20 / 802.11ac VHT-20 maximum average conducted output power [dBm]										
Band [MHz]	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	MCS-8 78Mbps
5200	36	9.9	9.7	9.6	9.9	9.5	9.2	9.1	9.0	9.8
	40	10.0	9.8	9.7	10.0	9.6	9.3	9.2	9.1	9.9
	44	10.0	9.8	9.7	10.0	9.6	9.3	9.2	9.1	9.9
	48	9.9	9.7	9.6	9.9	9.5	9.2	9.1	9.0	9.8
5800	149	3.2	3.1	3.3	3.9	3.9	3.9	3.9	3.9	3.8
	153	3.7	3.6	3.8	4.2	4.2	4.2	4.2	4.3	4.2
	157	3.7	3.6	3.8	4.3	4.3	4.3	4.3	4.3	4.2
	161	3.2	3.1	3.3	3.8	3.8	3.8	3.9	3.8	3.8
	165	3.5	3.4	3.6	4.2	4.1	4.1	4.2	4.1	4.1

Table 27: Test results conducted power measurement 802.11n HT-20 / 802.11ac VHT-20

802.11n HT-40 / 802.11ac VHT-40 maximum average conducted output power [dBm]											
Band [MHz]	Ch	MCS-0 13.5Mbps	MCS-1 27Mbps	MCS-2 40.5Mbps	MCS-3 54Mbps	MCS-4 81Mbps	MCS-5 108Mbps	MCS-6 121.5Mbps	MCS-7 135Mbps	MCS-8 162Mbps	MCS-9 180Mbps
5200	38	10.2	9.8	9.4	9.1	8.7	8.2	8.1	7.9	9.9	9.2
	46	10.3	9.9	9.5	9.2	8.8	8.3	8.2	8.0	10.0	9.3
5800	151	4.2	4.2	4.2	4.3	4.3	4.3	4.3	4.2	4.2	4.2
	159	4.1	4.1	4.1	4.2	4.2	4.2	4.2	4.2	4.2	4.1

Table 28: Test results conducted power measurement 802.11n HT-40 / 802.11ac VHT-40

802.11ac VHT-80 maximum average conducted output power [dBm]											
Band	Ch	MCS-0 29.3Mbps	MCS-1 58.5Mbps	MCS-2 87.8Mbps	MCS-3 117Mbps	MCS-4 175.5Mbps	MCS-5 234Mbps	MCS-6 263.3Mbps	MCS-7 292.5Mbps	MCS-8 351Mbps	MCS-9 390Mbps
5200	42	9.7	9.3	8.9	8.6	8.2	7.7	7.6	7.4	9.4	8.7
5800	155	4.0	4.0	4.0	4.2	4.2	4.1	4.2	4.2	4.1	4.1

Table 29: Test results conducted power measurement 802.11ac VHT-80

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.
- The DUT is tested using CMU 200 or CMW 500 communications testers as controller unit to set test channels and maximum output power to the DUT, as well as for measuring the conducted peak power.
- Test positions as described in the tables below are in accordance with the specified test standard.
- Tests in body position were performed in that configuration, which generates the highest time based averaged output power (see conducted power results).
- UMTS was tested in RMC mode with 12.2 kbit/s and TPC bits set to ‘all 1’.
- Required WLAN test channels were selected according to KDB 248227
- According to IEC/IEEE 62209-1528 the SAR test shall be performed at the channel producing the highest rated output power.
  - o When the width of the transmit frequency band ($\Delta f = f_{high} - f_{low}$) exceeds 1 % of its centre frequency fc, the channels at the lowest and highest frequencies of the transmit band shall also be tested.
  - o When the width of the transmit frequency band exceeds 10 % of its centre frequency. The following formula shall be used to determine the number of channels, N_c, to be tested:

$$\mathrm{Nc} = 2 \times roundup\,[\frac{(fhigh - flow)}{fc}] + 1$$

where
f_c is the centre frequency channel of the transmission band in Hz;
f_{high} is the highest frequency channel of the transmission band in Hz;
f_{low} is the lowest frequency channel of the transmission band in Hz;
N_c is the number of channels

- According to KDB 447498 D01 testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:
  - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
  - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
  - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

8.2.2 Results overview

Ch.	Freq. (MHz)	test cond.	position	cond. P_{max} (dBm)		**SAR_{1g} (W/kg)**		SAR_{10g} (W/kg)		power drift (dB)	liquid (°C)
				decl.*	meas.	meas.	extrap.	meas.	extrap.		
GSM 850											
128	824.2	2 time slots	front	25.0	24.7	0.291	0.313	0.172	0.185	-0.04	21.7
190	836.6	2 time slots	front	25.0	24.7	0.304	0.327	0.180	0.194	-0.03	21.7
251	848.8	2 time slots	front	25.0	24.5	**0.318**	**0.358**	0.188	0.212	-0.13	21.7
128	824.2	2 time slots	left	25.0	24.7	0.029	0.031	0.020	0.022	0.07	21.7
128	824.2	2 time slots	top	25.0	24.7	0.039	0.042	0.027	0.029	0.02	21.7
GSM 1900											
512	1850.2	3 time slots	front	22.5	21.9	0.090	0.102	0.050	0.057	0.00	21.7
661	1880.0	3 time slots	front	22.5	21.8	0.104	0.121	0.058	0.068	0.02	21.7
810	1909.8	3 time slots	front	22.5	21.8	**0.127**	**0.148**	0.071	0.083	0.00	21.7
512	1850.2	3 time slots	left	22.5	21.9	0.013	0.015	0.008	0.009	-0.03	21.7
512	1850.2	3 time slots	top	22.5	21.9	0.004	0.005	0.002	0.002	0.12	21.7
UMTS FDD II											
9262	1852.4	QPSK, 12,2 kbps	front	22.7	21.8	**0.138**	**0.170**	0.076	0.094	0.06	21.7
9400	1880.0	QPSK, 12,2 kbps	front	22.7	21.8	0.125	0.154	0.071	0.087	-0.14	21.7
9538	1907.6	QPSK, 12,2 kbps	front	22.7	21.3	0.112	0.155	0.064	0.088	0.05	21.7
9400	1880.0	QPSK, 12,2 kbps	left	22.7	21.8	0.016	0.020	0.010	0.012	0.13	21.7
9400	1880.0	QPSK, 12,2 kbps	top	22.7	21.8	0.006	0.007	0.003	0.004	-0.18	21.7
UMTS FDD IV											
1312	1712.4	QPSK, 12,2 kbps	front	22.7	21.3	0.121	0.167	0.068	0.094	0.02	21.7
1412	1732.4	QPSK, 12,2 kbps	front	22.7	21.7	0.147	0.185	0.082	0.103	-0.05	21.7
1513	1752.6	QPSK, 12,2 kbps	front	22.7	21.6	**0.162**	**0.209**	0.091	0.117	-0.02	21.7
1412	1732.4	QPSK, 12,2 kbps	left	22.7	21.7	0.016	0.020	0.010	0.013	-0.14	21.7
1412	1732.4	QPSK, 12,2 kbps	top	22.7	21.7	0.008	0.010	0.005	0.006	0.12	21.7
UMTS FDD V											
4132	826.4	QPSK, 12,2 kbps	front	23.6	22.3	0.299	0.403	0.180	0.243	0.05	21.7
4182	836.6	QPSK, 12,2 kbps	front	23.6	22.3	0.352	0.475	0.209	0.282	-0.04	21.7
4233	846.6	QPSK, 12,2 kbps	front	23.6	22.4	**0.372**	**0.490**	0.221	0.291	0.06	21.7
4233	846.6	QPSK, 12,2 kbps	left	23.6	22.4	0.035	0.046	0.024	0.032	-0.17	21.7
4233	846.6	QPSK, 12,2 kbps	top	23.6	22.4	0.043	0.057	0.030	0.040	0.08	21.7
LTE FDD 2 20MHz BW											
18700	1860.0	1RB, 50RB offset	front	22.2	21.5	**0.202**	**0.237**	0.109	0.128	-0.08	21.6
18900	1880.0	1RB, 50RB offset	front	22.2	21.4	0.180	0.216	0.099	0.119	-0.06	21.6
19100	1900.0	1RB, 50RB offset	front	22.2	21.7	0.183	0.205	0.100	0.112	-0.06	21.6
19100	1900.0	1RB, 50RB offset	left	22.2	21.8	0.017	0.019	0.011	0.012	-0.02	21.6
19100	1900.0	1RB, 50RB offset	top	22.2	21.8	0.005	0.005	0.003	0.003	-0.07	21.6
LTE FDD 4 20MHz BW											
20050	1720.0	1RB, 50RB offset	front	22.2	21.5	0.113	0.133	0.065	0.076	0.01	21.6
20175	1732.5	1RB, 0RB offset	front	22.2	21.6	0.117	0.134	0.067	0.077	-0.16	21.6
20300	1745.0	1RB, 0RB offset	front	22.2	21.4	**0.132**	**0.159**	0.076	0.091	-0.04	21.6
20175	1732.5	1RB, 0RB offset	left	22.2	21.9	0.019	0.020	0.012	0.013	-0.03	21.6
20175	1732.5	1RB, 0RB offset	top	22.2	21.9	0.006	0.006	0.003	0.003	0.07	21.6
LTE FDD 5 10MHz BW											
20450	829.0	1RB, 25RB offset	front	23.1	22.3	0.263	0.316	0.157	0.189	0.00	21.4
20525	836.5	1RB, 25RB offset	front	23.1	22.2	**0.302**	0.372	0.182	0.224	-0.17	21.4
20600	844.0	1RB, 25RB offset	front	23.1	21.9	0.297	**0.392**	0.177	0.233	-0.08	21.4
20450	829.0	1RB, 25RB offset	left	23.1	22.4	0.023	0.027	0.016	0.019	-0.11	21.4
20450	829.0	1RB, 25RB offset	top	23.1	22.4	0.033	0.039	0.023	0.027	0.04	21.4

Table 30: Test results body worn SAR WWAN (see max. SAR plot in Annex B.1: SAR results - WWAN page 72)

* - maximum possible output power declared by manufacturer.

Ch.	Freq. (MHz)	test cond.	position	cond. P_{max} (dBm)		**SAR_{1g} (W/kg)**		SAR_{10g} (W/kg)		power drift (dB)	liquid (°C)
				decl.*	meas.	meas.	extrap.	meas.	extrap.		
LTE FDD 7 20MHz BW											
20850	2510.0	1RB, 50RB offset	front	21.8	20.3	0.101	0.143	0.051	0.072	-0.01	21.3
21100	2535.0	1RB, 0RB offset	front	21.8	20.4	**0.109**	**0.150**	0.053	0.073	-0.02	21.3
21350	2560.0	1RB, 0RB offset	front	21.8	20.2	0.097	0.140	0.048	0.069	0.01	21.3
21100	2535.0	1RB, 0RB offset	left	21.8	20.4	0.043	0.059	0.022	0.030	0.07	21.3
21100	2535.0	1RB, 0RB offset	top	21.8	20.4	0.008	0.011	0.004	0.006	-0.05	21.3

Table 31: Test results body worn SAR WWAN (see max. SAR plot in Annex B.1: SAR results - WWAN page 72)

measured / extrapolated SAR numbers - Body worn - WLAN 2450 MHz 15mm													
Ch.	Freq. (MHz)	test cond.	Position	cond. P_{max} (dBm)		SAR_{1g} (W/kg)			SAR_{10g} (W/kg)			P_{drift} (dB)	liquid (°C)
				declared*	meas.	meas.	extrap.	100% DF	meas.	extrap.	100% DF		
11	2462	1Mbit/s	top	17.6	17.4	0.115	0.120	0.123	0.067	0.070	0.072	0.00	21.8
11	2462	1Mbit/s	right	17.6	17.4	0.008	0.008	0.009	0.004	0.004	0.004	0.00	21.8
1	2412	1Mbit/s	front	15.6	14.3	0.183	**0.290**	**0.296**	0.108	0.171	0.175	0.01	21.8
6	2437	1Mbit/s	front	16.1	15.1	0.155	0.219	0.223	0.092	0.130	0.133	0.00	21.8
11	2462	1Mbit/s	front	17.6	17.4	**0.213**	0.223	0.228	0.125	0.131	0.134	0.05	21.8
measured / extrapolated SAR numbers - Body worn - WLAN 5GHz 15mm													
Ch.	Freq. (MHz)	test cond.	Position	cond. P_{max} (dBm)		SAR_{1g} (W/kg)			SAR_{10g} (W/kg)			P_{drift} (dB)	liquid (°C)
				declared*	meas.	meas.	extrap.	100% DF	meas.	extrap.	100% DF		
40	5200	6 MBit/s	right	11.0	10.3	0.073	0.086	0.088	0.031	0.036	0.037	0.00	21.8
40	5200	6 MBit/s	top	11.0	10.3	0.035	0.041	0.042	0.015	0.018	0.018	0.00	21.8
38	5190	13,5Mbps/HT40	front	11.0	10.2	0.231	0.278	0.283	0.091	0.109	0.112	0.02	21.8
40	5200	6 MBit/s	front	11.0	10.3	**0.303**	**0.356**	**0.363**	0.119	0.140	0.143	0.00	21.8
44	5220	6 MBit/s	front	11.0	10.2	0.280	0.337	0.344	0.109	0.131	0.134	0.04	21.8
46	5230	13,5Mbps/HT40	front	11.0	10.3	0.248	0.291	0.297	0.091	0.107	0.109	0.00	21.8
151	5755	13,5Mbps/HT40	front	6.0	4.2	0.026	0.039	0.040	0.008	0.012	0.012	-0.13	21.8
157	5785	6 MBit/s	front	6.0	3.9	0.018	0.029	0.030	0.002	0.003	0.003	-0.05	21.8
165	5825	6 MBit/s	front	6.0	4.3	0.018	0.027	0.027	0.004	0.006	0.006	-0.18	21.8
165	5825	6 MBit/s	right	6.0	4.3	0.012	0.018	0.018	0.005	0.007	0.008	0.05	21.8
165	5825	6 MBit/s	top	6.0	4.3	0.014	0.021	0.021	0.000	0.000	0.000	-0.15	21.8

Table 32: Test results body worn SAR WLAN 2450 MHz (see max. SAR plot Annex B.2: SAR results - WLAN page 81)
* - maximum possible output power declared by manufacturer

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.

Frequency band	Position	SARmax /W/kg		**ΣSAR**
		WWAN	WLAN 2450	<1.6W/kg
GSM 850	front	0.358	0.296	0.654
GSM 1900	front	0.148	0.296	0.444
UMTS FDD II	front	0.170	0.296	0.466
UMTS FDD IV	front	0.209	0.296	0.505
UMTS FDD V	front	0.490	0.296	**0.786**
LTE FDD 2	front	0.237	0.296	0.533
LTE FDD 4	front	0.159	0.296	0.455
LTE FDD 5	front	0.392	0.296	0.687
LTE FDD 7	front	0.150	0.296	0.446

Table 33: SAR_{max} WWAN and **WLAN 2.4GHz**, ΣSAR evaluation

Frequency band	Position	SARmax /W/kg		**ΣSAR**
		WWAN	WLAN5GHz	<1.6W/kg
GSM 850	front	0.358	0.363	0.722
GSM 1900	front	0.148	0.363	0.511
UMTS FDD II	front	0.170	0.363	0.533
UMTS FDD IV	front	0.209	0.363	0.572
UMTS FDD V	front	0.490	0.363	**0.854**
LTE FDD 2	front	0.237	0.363	0.601
LTE FDD 4	front	0.159	0.363	0.522
LTE FDD 5	front	0.392	0.363	0.755
LTE FDD 7	front	0.150	0.363	0.514

Table 34: SAR_{max} WWAN and **WLAN 5GHz**, ΣSAR evaluation

Conclusion:

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

8.2.4 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 17, 2022	12
835 MHz System Validation Dipole	D835V2	Schmid & Partner Engineering AG	4d153	May 7, 2020	36
1750 MHz System Validation Dipole	D1750V2	Schmid & Partner Engineering AG	1093	May 14, 2021	36
1900 MHz System Validation Dipole	D1900V2	Schmid & Partner Engineering AG	5d009	May 8, 2020	36
2450 MHz System Validation Dipole	D2450V2	Schmid & Partner Engineering AG	710	May 11, 2022	36
2600 MHz System Validation Dipole	D2600V2	Schmid & Partner Engineering AG	1040	May 06, 2020	36
5 GHz System Validation Dipole	D5GHzV2	Schmid & Partner Engineering AG	1055	May 18, 2021	36
Data acquisition electronics	DAE3	Schmid & Partner Engineering AG	477	May 16, 2022	12
Software	cDASY6 V16.2.2.1588	Schmid & Partner Engineering AG	---	N/A	--
SAM Twin Phantom V8.0	QD 000 P41 A	Schmid & Partner Engineering AG	1977	N/A	--
Universal Radio Communication Tester	CMU 200	Rohde & Schwarz	106240	December 09, 2020	24
Universal Radio Communication Tester	CMW500	Rohde & Schwarz	170616	September 16, 2021	24
Network Analyser 300 kHz to 6 GHz	8753ES	Agilent Technologies)*	US39174 436	December 14, 2021	24
Dielectric Probe Kit	85033D	Hewlett Packard	3423A060 60	January 04, 2021	12
Dielectric Assessment Kit (DAK)	DAK 200MHz – 20GHz Package	Schmid & Partner Engineering AG	1127	N/A	--
Signal Generator	SML03	Rohde & Schwarz	102519	December 06, 2021	24
RF Power Amplifier	BLMA 0760-6 (6 Watt)	BONN Elektronik	1510273	N/A	--
Microwave Amplifier 2 to 20 GHz	8349B	Hewlett Packard	2644A023 23	N/A	--
Power Meter	NRP	Rohde & Schwarz	101367	December 06, 2022	12
Power Meter Sensor	NRP Z22	Rohde & Schwarz	100227	December 06, 2022	12
Power Meter Sensor	NRP Z22	Rohde & Schwarz	100234	December 06, 2022	12
Directional Coupler	778D	Hewlett Packard	19171	December 06, 2022	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: 2022-12-12, 13:46 2022-12-12, 13:52

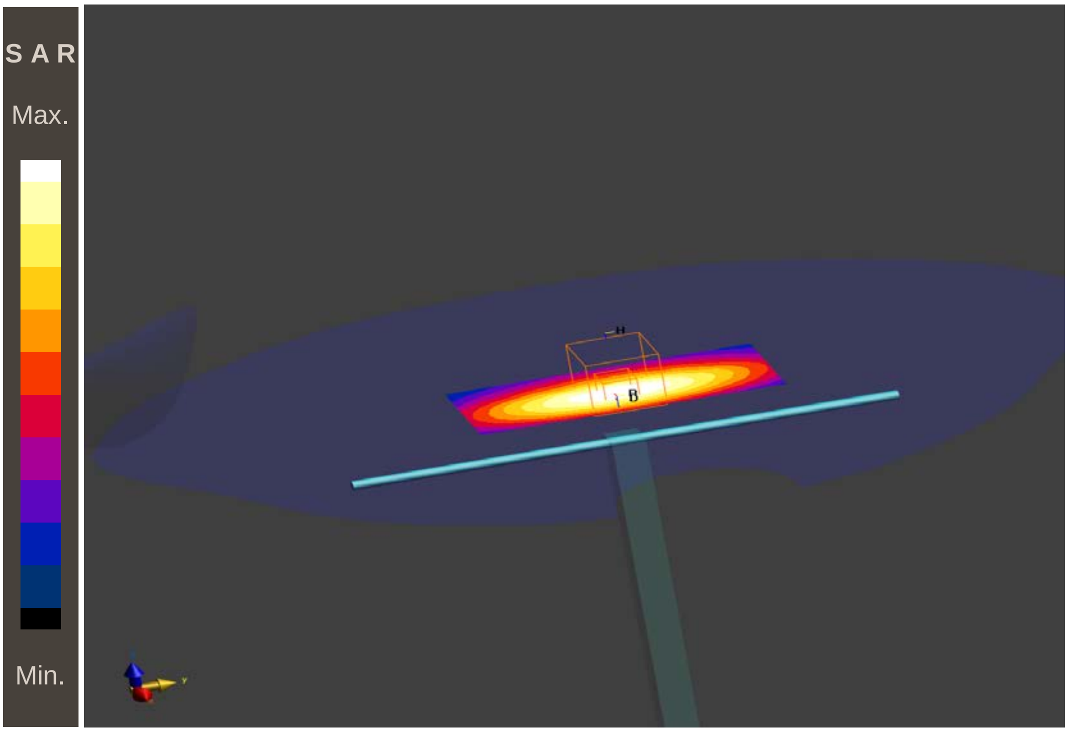
SystemPerformanceCheck-D835

DUT: Dipole; Type: D835V2; Serial: SN4d153

Communication System: CW; Communication System Frequency: 835.0 MHz
Medium parameters used: f = 835.0 MHz, σ = 0.849 S/m; ε_r=42.4; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(10.17, 10.17, 10.17); 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: 1977;
- Software: cDASY6 (16.2.2.1588)

HBBL-600-10000/835.0MHz/Area Scan (10.0 x 15.0 x 1.0) :
Grid Extents [mm]: 40.0 x 90.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.934 W/kg; SAR(10 g) = 0.613 W/kg

HBBL-600-10000/835.0MHz/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Power Drift = 0.03 dB
SAR(1 g) = 0.918 W/kg; SAR(10 g) = 0.606 W/kg



Additional information:
ambient temperature: 22.3°C; liquid temperature: 21.6°C;

Date/Time: 2022-12-13, 15:11 2022-12-13, 15:17

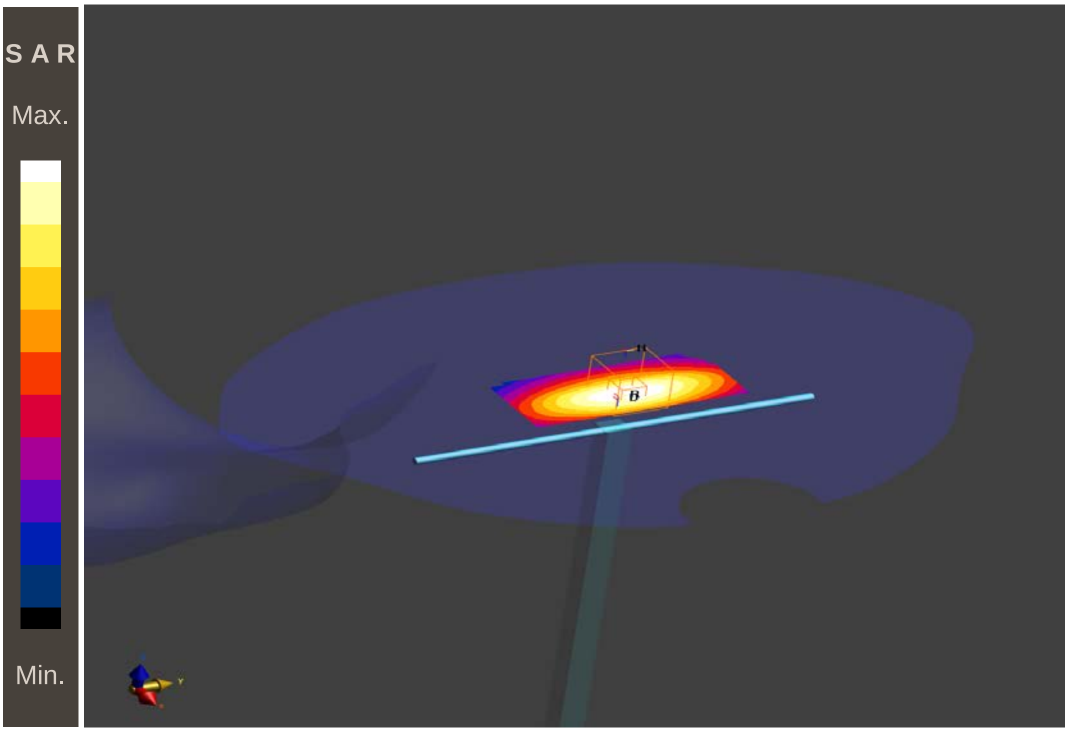
SystemPerformanceCheck-D835

DUT: Dipole; Type: D835V2; Serial: SN4d153

Communication System: CW; Communication System Frequency: 835.0 MHz
Medium parameters used: f = 835.0 MHz, σ = 0.849 S/m; ε_r=42.4; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(10.17, 10.17, 10.17); 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: 1977;
- Software: cDASY6 (16.2.2.1588)

HBBL-600-10000/835.0MHz/Area Scan (10.0 x 15.0 x 1.0) :
Grid Extents [mm]: 40.0 x 90.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.927 W/kg; SAR(10 g) = 0.608 W/kg

HBBL-600-10000/835.0MHz/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Power Drift = 0.01 dB
SAR(1 g) = 0.915 W/kg; SAR(10 g) = 0.604 W/kg



Additional information:
ambient temperature: 22.3°C; liquid temperature: 21.6°C;

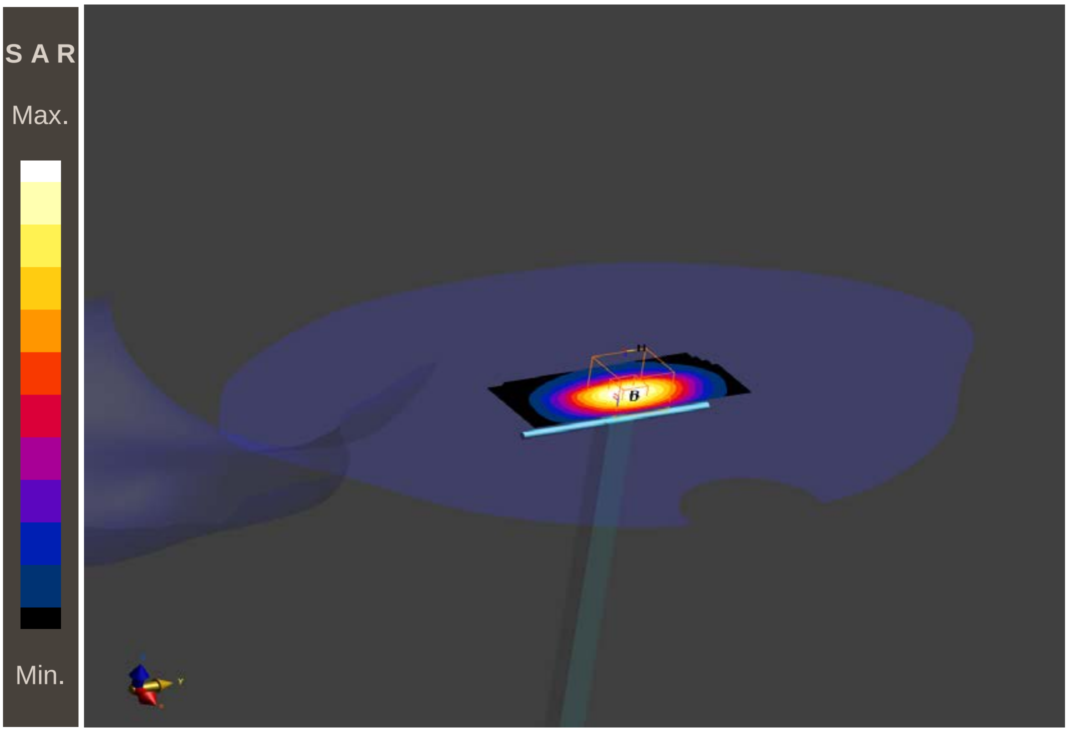
Date/Time: 2022-12-13, 14:56 2022-12-13, 15:02

SystemPerformanceCheck-D1750

DUT: Dipole; Type: D1750V2; Serial: SN1093
Communication System: CW; Communication System Frequency: 1750.0 MHz
Medium parameters used: f = 1750.0 MHz, σ = 1.26 S/m; ε_r=40.8; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(8.58, 8.58, 8.58); 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: 1977;
- Software: cDASY6 (16.2.2.1588)

HBBL-600-10000/1750.0MHz/Area Scan (10.0 x 15.0 x 1.0) :
Grid Extents [mm]: 40.0 x 90.0
Maximum value of SAR (interpolated) - SAR(1 g) = 3.57 W/kg; SAR(10 g) = 1.93 W/kg

HBBL-600-10000/1750.0MHz/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Power Drift = -0.01 dB
SAR(1 g) = 3.46 W/kg; SAR(10 g) = 1.86 W/kg



Additional information:
ambient temperature: 22.7°C; liquid temperature: 21.6°C;

Date/Time: 2023-02-22, 19:08 2023-02-22, 19:14

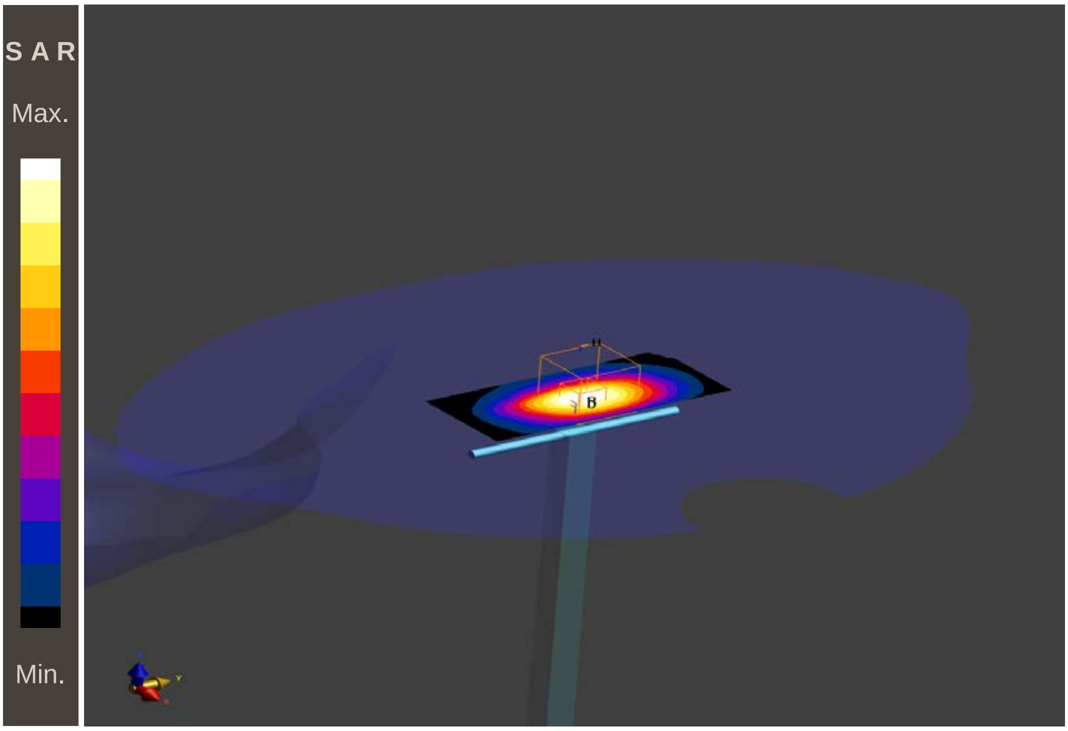
SystemPerformanceCheck-D1750

DUT: Dipole; Type: D1750V2; Serial: SN1093

Communication System: CW; Communication System Frequency: 1750.0 MHz
Medium parameters used: f = 1750.0 MHz, σ = 1.35 S/m; ε_r=39.5; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(8.58, 8.58, 8.58); 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 (16.2.2.1588)

HBBL-600-10000/1750.0MHz/Area Scan (10.0 x 15.0 x 1.0) :
Grid Extents [mm]: 40.0 x 90.0
Maximum value of SAR (interpolated) - SAR(1 g) = 3.93 W/kg; SAR(10 g) = 2.12 W/kg

HBBL-600-10000/1750.0MHz/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Power Drift = -0.02 dB
SAR(1 g) = 3.73 W/kg; SAR(10 g) = 2.01 W/kg



Additional information:
ambient temperature: 22.9°C; liquid temperature: 21.6°C;

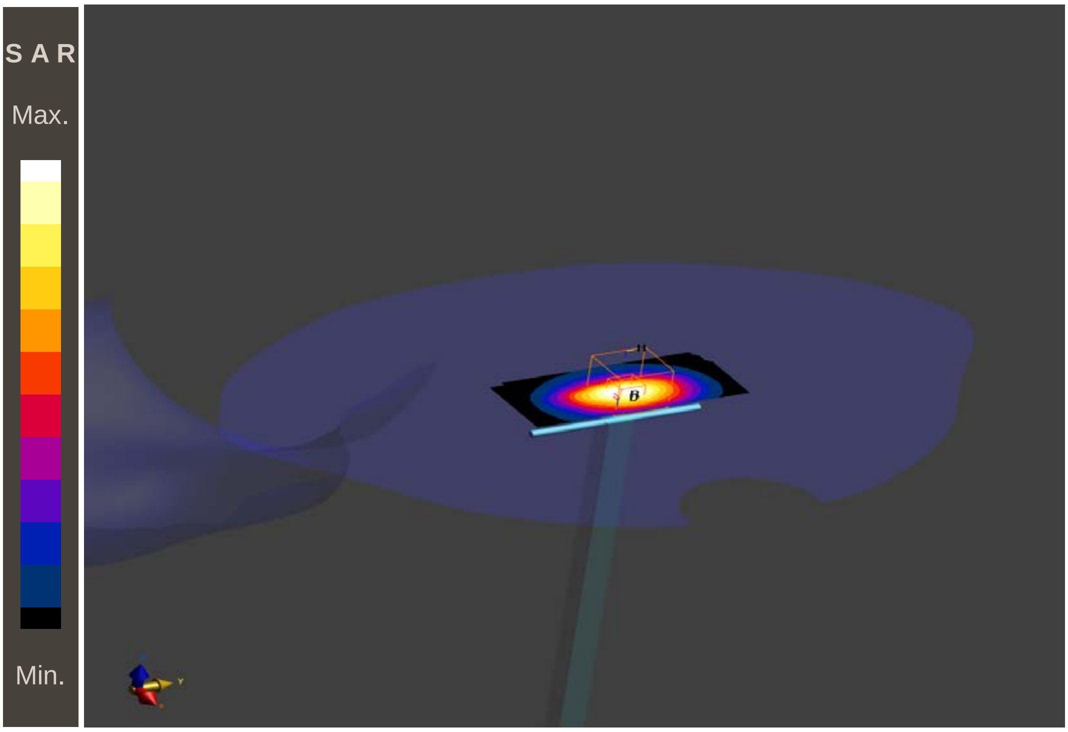
Date/Time: 2022-12-13, 14:37 2022-12-13, 14:43

SystemPerformanceCheck-D1900

DUT: Dipole; Type: D1900V2; Serial: SN5d009
Communication System: CW; Communication System Frequency: 1900.0 MHz
Medium parameters used: f = 1900.0 MHz, σ = 1.35 S/m; ε_r=40.7; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(8.42, 8.42, 8.42); 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: 1977;
- Software: cDASY6 (16.2.2.1588)

HBBL-600-10000/1900.0MHz/Area Scan (10.0 x 15.0 x 1.0) :
Grid Extents [mm]: 40.0 x 90.0
Maximum value of SAR (interpolated) - SAR(1 g) = 3.93 W/kg; SAR(10 g) = 2.05 W/kg

HBBL-600-10000/1900.0MHz/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Power Drift = -0.03 dB
SAR(1 g) = 3.80 W/kg; SAR(10 g) = 1.99 W/kg



Additional information:
ambient temperature: 22.4°C; liquid temperature: 21.6°C;

Date/Time: 2023-02-22, 19:35 2023-02-22, 19:42

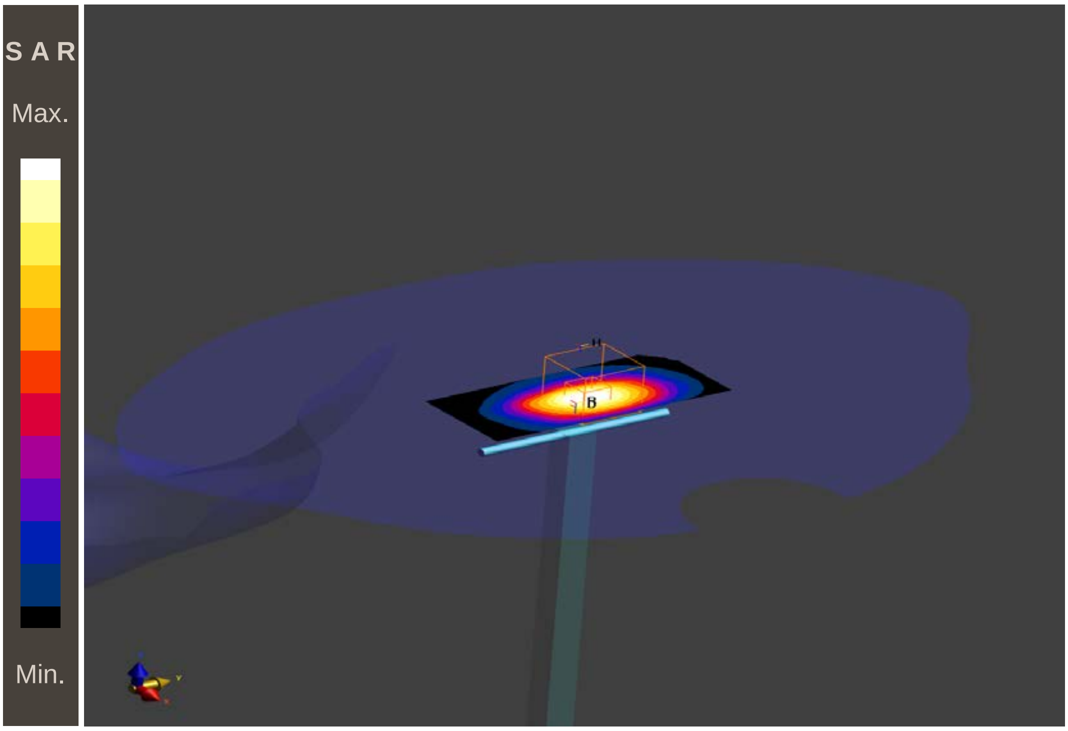
SystemPerformanceCheck-D1900

DUT: Dipole; Type: D1900V2; Serial: SN5d009

Communication System: CW; Communication System Frequency: 1900.0 MHz
Medium parameters used: f = 1900.0 MHz, σ = 1.43 S/m; ε_r=39.4; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(8.42, 8.42, 8.42); 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 (16.2.2.1588)

HBBL-600-10000/1900.0MHz/Area Scan (10.0 x 15.0 x 1.0) :
Grid Extents [mm]: 40.0 x 90.0
Maximum value of SAR (interpolated) - SAR(1 g) = 4.27 W/kg; SAR(10 g) = 2.26 W/kg

HBBL-600-10000/1900.0MHz/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Power Drift = 0.00 dB
SAR(1 g) = 4.11 W/kg; SAR(10 g) = 2.17 W/kg



Additional information:
ambient temperature: 22.9°C; liquid temperature: 21.6°C;

Date/Time: 2023-02-15, 09:50 2023-02-15, 09:58

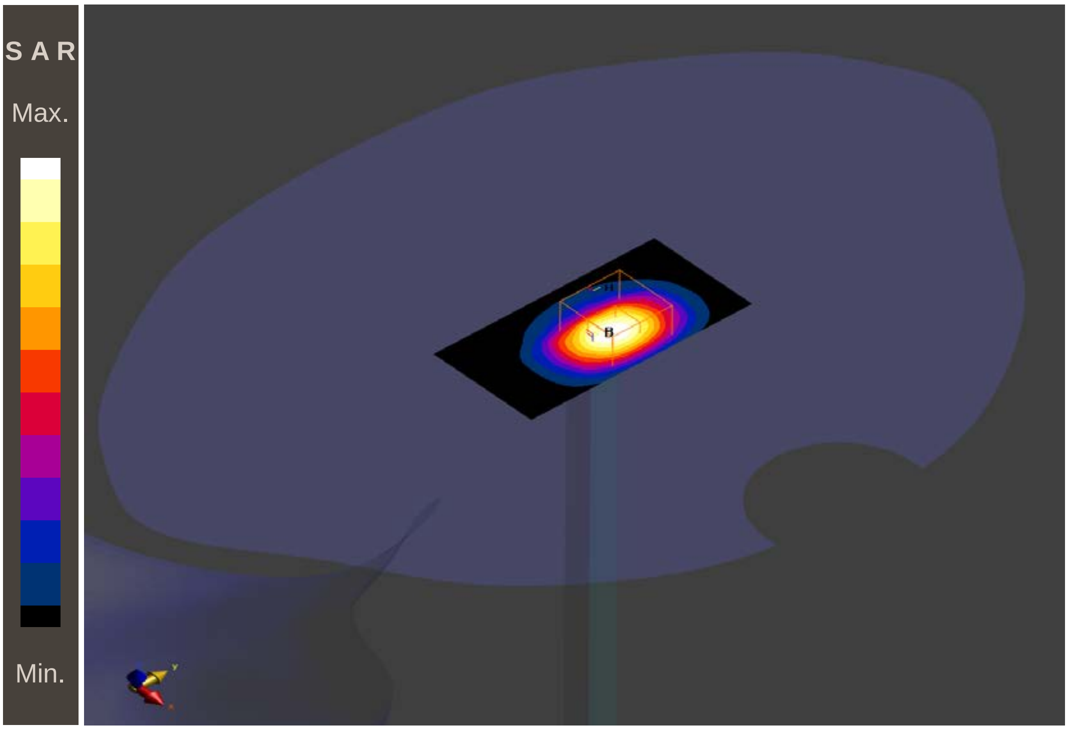
SystemPerformanceCheck-D2450 HSL

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=39.6; 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 (16.2.2.1588)

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) = 5.49 W/kg; SAR(10 g) = 2.64 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 = -0.03 dB
SAR(1 g) = 5.25 W/kg; SAR(10 g) = 2.45 W/kg



Additional information:
ambient temperature: 22.6°C; liquid temperature: 21.8°C;

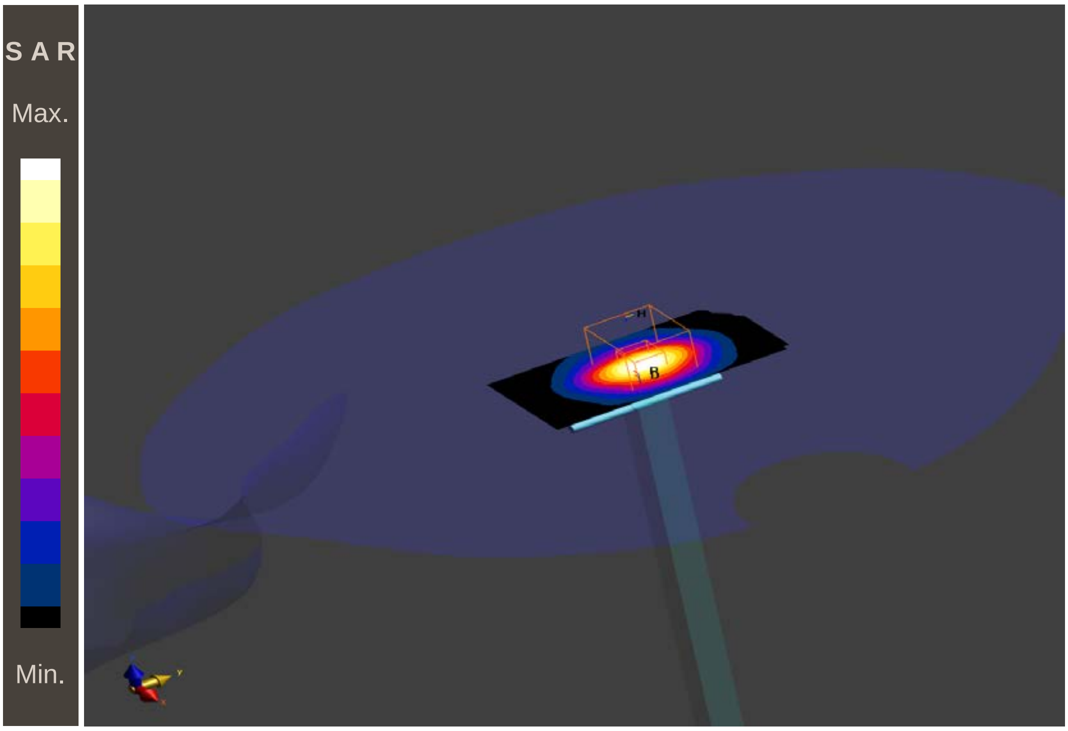
Date/Time: 2023-04-18, 14:04 2023-04-18, 14:12

SystemPerformanceCheck-D2600

DUT: Dipole; Type: D2600V2; Serial: SN1040
Communication System: CW; Communication System Frequency: 2600.0 MHz
Medium parameters used: f = 2600.0 MHz, σ = 1.90 S/m; ε_r=40.7; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(7.75, 7.75, 7.75); 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 (16.2.2.1588)

HBBL-600-10000/2600.0MHz/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) = 5.16 W/kg; SAR(10 g) = 2.30 W/kg

HBBL-600-10000/2600.0MHz/Zoom Scan (5.0 x 5.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Power Drift = 0.13 dB
SAR(1 g) = 5.26 W/kg; SAR(10 g) = 2.37 W/kg



Additional information:
ambient temperature: 23.7°C; liquid temperature: 21.3°C;

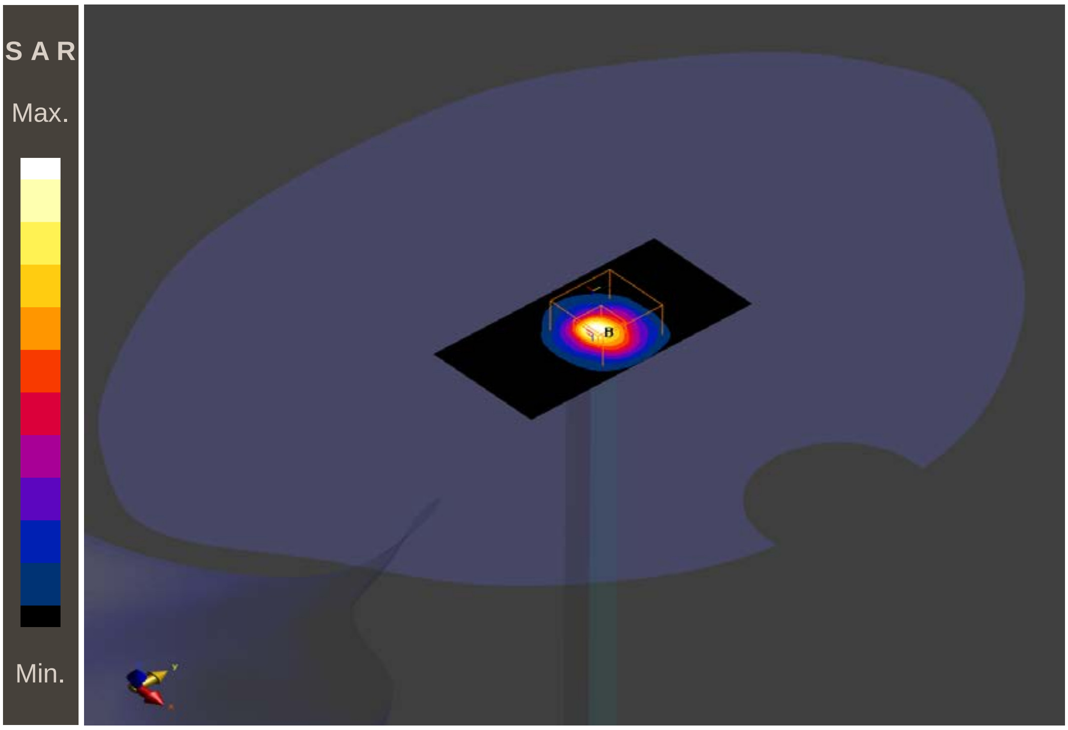
Date/Time: 2023-02-15, 10:08 2023-02-15, 10:18

SystemPerformanceCheck-D5GHz

DUT: Dipole; Type: D5GHzV2; Serial: SN1055
Communication System: CW; Communication System Frequency: 5200.0 MHz
Medium parameters used: f = 5200.0 MHz, σ = 4.32 S/m; ε_r=34.2; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(5.22, 5.22, 5.22); 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 (16.2.2.1588)

HBBL-600-10000/5200.0MHz/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) = 7.47 W/kg; SAR(10 g) = 2.20 W/kg

HBBL-600-10000/5200.0MHz/Zoom Scan (4.0 x 4.0 x 1.4) :
Grid Extents [mm]: 22.0 x 22.0 x 22.0
Power Drift = 0.00 dB
SAR(1 g) = 7.74 W/kg; SAR(10 g) = 2.23 W/kg



Additional information:
ambient temperature: 22.6°C; liquid temperature: 21.8°C;

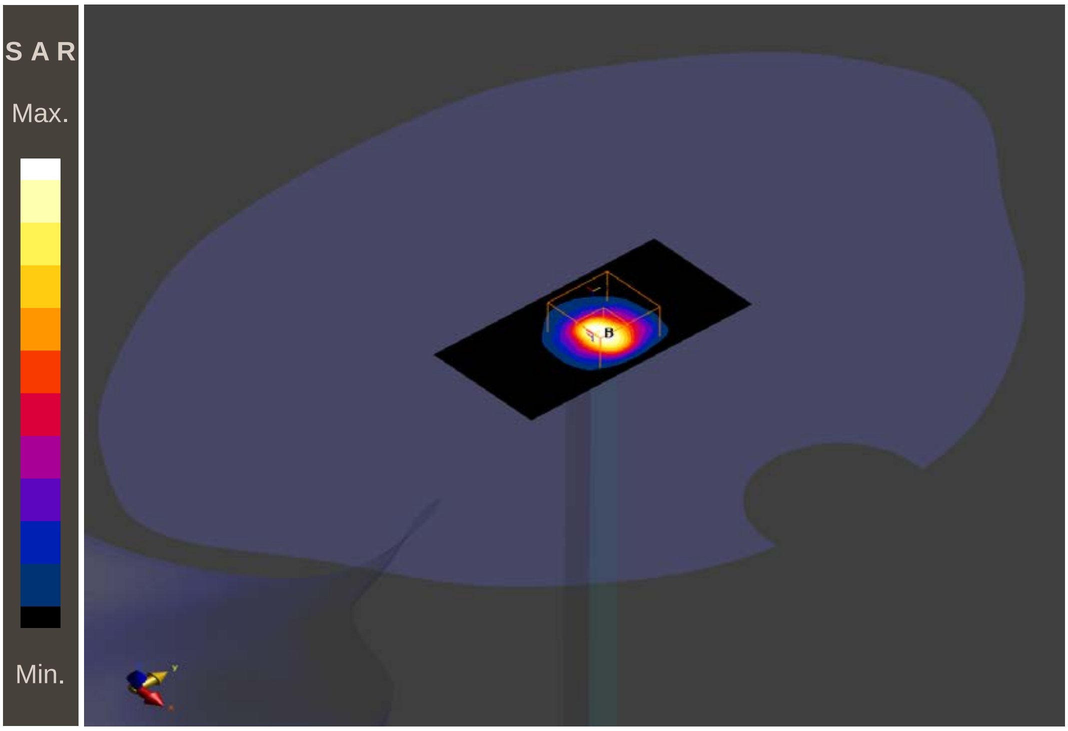
Date/Time: 2023-02-15, 10:32 2023-02-15, 10:41

SystemPerformanceCheck-D5GHz

DUT: Dipole; Type: D5GHzV2; Serial: SN1055
Communication System: CW; Communication System Frequency: 5800.0 MHz
Medium parameters used: f = 5800.0 MHz, σ = 4.88 S/m; ε_r=32.8; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(4.81, 4.81, 4.81); 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 (16.2.2.1588)

HBBL-600-10000/5800.0MHz/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) = 7.25 W/kg; SAR(10 g) = 2.09 W/kg

HBBL-600-10000/5800.0MHz/Zoom Scan (4.0 x 4.0 x 1.4) :
Grid Extents [mm]: 22.0 x 22.0 x 22.0
Power Drift = -0.11 dB
SAR(1 g) = 8.20 W/kg; SAR(10 g) = 2.30 W/kg



Additional information:
ambient temperature: 22.6°C; liquid temperature: 21.8°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

Annex B.1: SAR results - WWAN

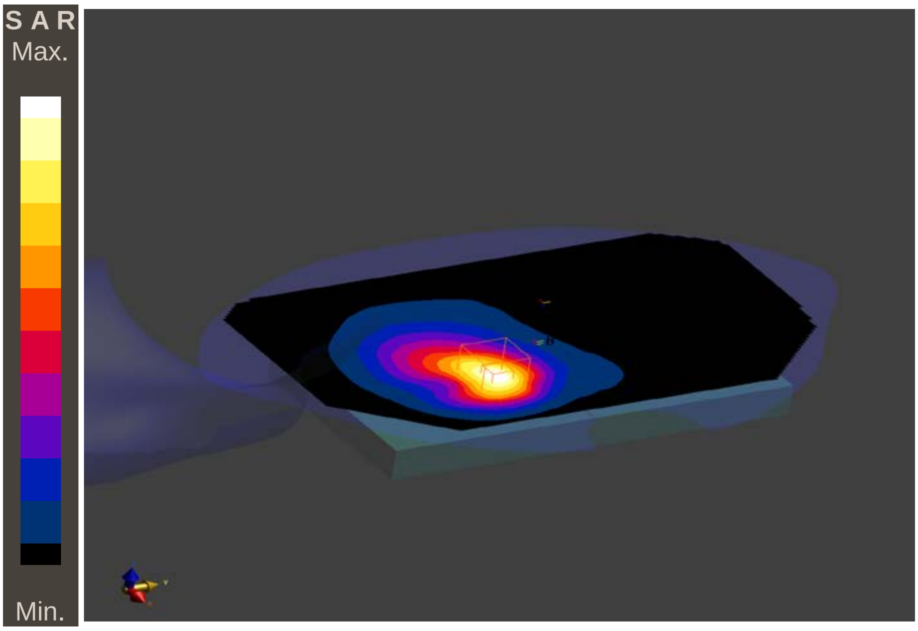
Date/Time: 2022-12-13, 07:54 2022-12-13, 08:02

IEC_IEEE_62209-1528 GSM835 body

DUT: Continental; Type: BSRF EA; Serial: 22991129087089
Communication System: GPRS-FDD (TDMA, GMSK, TN 0-1); Communication System Band: GSM 850;
Communication System Frequency: 848.8 MHz
Medium parameters used: f = 848.8 MHz, σ = 0.854 S/m; ε_r=42.3; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(10.17, 10.17, 10.17); Calibrated: 2022-05-17
- Sensor-Surface: 1.4mm
- DAE: DAE3 Sn477; Calibrated: 2022-05-16
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1977;
- Software: cDASY6 (16.2.2.1588)

HBBL-600-10000/FRONT, 15 mm - Channel 251/Area Scan (15.0 x 15.0 x 1.0) :
Grid Extents [mm]: 60.0 x 60.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.318 W/kg; SAR(10 g) = 0.199 W/kg

HBBL-600-10000/FRONT, 15 mm - Channel 251/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 36.0 x 36.0 x 30.0
Graded Grid: Ratio 1.5 - Distance Sensor to Surface 1.4 mm
Power Drift = -0.13 dB
SAR(1 g) = 0.318 W/kg; SAR(10 g) = 0.188 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: 13.7
M1/M2%: 83.4



Additional information:
position or distance of DUT to SAM: 15 mm
ambient temperature: 22.9°C; liquid temperature: 21.6°C;

Date/Time: 2022-12-13, 10:18 2022-12-13, 10:26

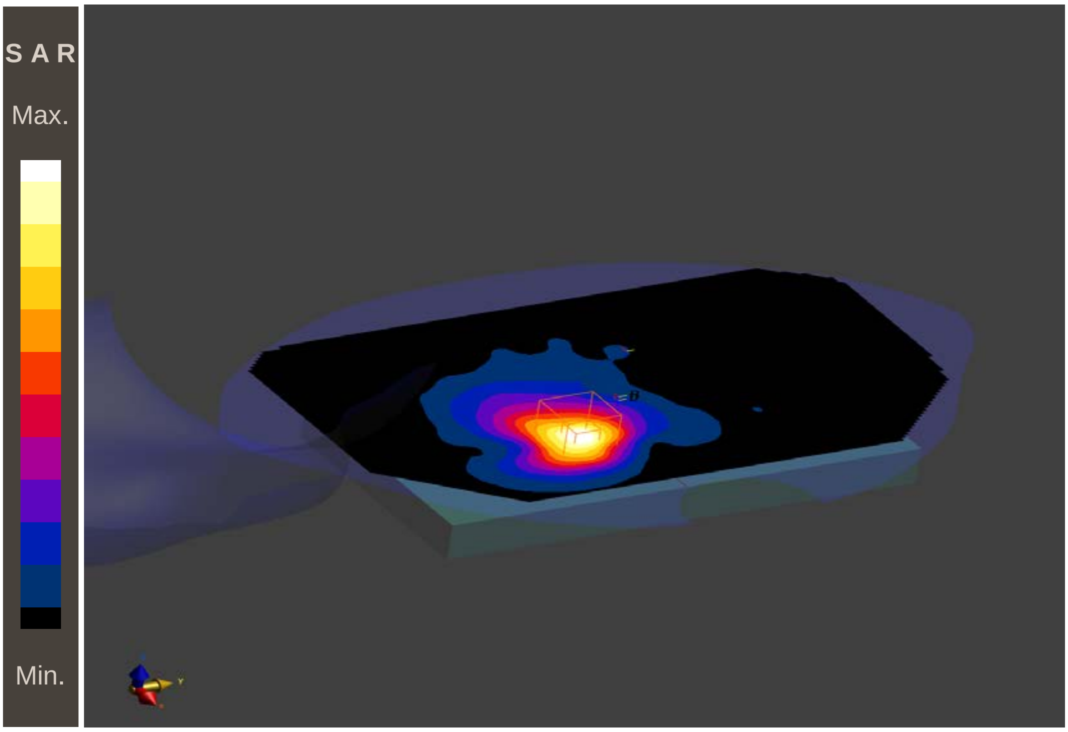
IEC_IEEE_62209-1528 GSM1900 body

DUT: Continental; Type: BSRF EA; Serial: 22991129087089

Communication System: GPRS-FDD (TDMA, GMSK, TN 0-1-2); Communication System Band: PCS 1900;
Communication System Frequency: 1909.8 MHz
Medium parameters used: f = 1909.8 MHz, σ = 1.35 S/m; ε_r=40.6; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(8.42, 8.42, 8.42); Calibrated: 2022-05-17
- Sensor-Surface: 1.4mm
- DAE: DAE3 Sn477; Calibrated: 2022-05-16
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1977;
- Software: cDASY6 (16.2.2.1588)

HBBL-600-10000/FRONT, 15 mm - Channel 810/Area Scan (15.0 x 15.0 x 1.0) :
Grid Extents [mm]: 60.0 x 60.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.123 W/kg; SAR(10 g) = 0.067 W/kg

HBBL-600-10000/FRONT, 15 mm - Channel 810/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 36.0 x 36.0 x 30.0
Graded Grid: Ratio 1.5 - Distance Sensor to Surface 1.4 mm
Power Drift = 0.00 dB
SAR(1 g) = 0.127 W/kg; SAR(10 g) = 0.071 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: 11.9
M1/M2%: 85.2



Additional information:
position or distance of DUT to SAM: 15 mm
ambient temperature: 22.9°C; liquid temperature: 21.6°C;

Date/Time: 2022-12-13, 12:06 2022-12-13, 12:14

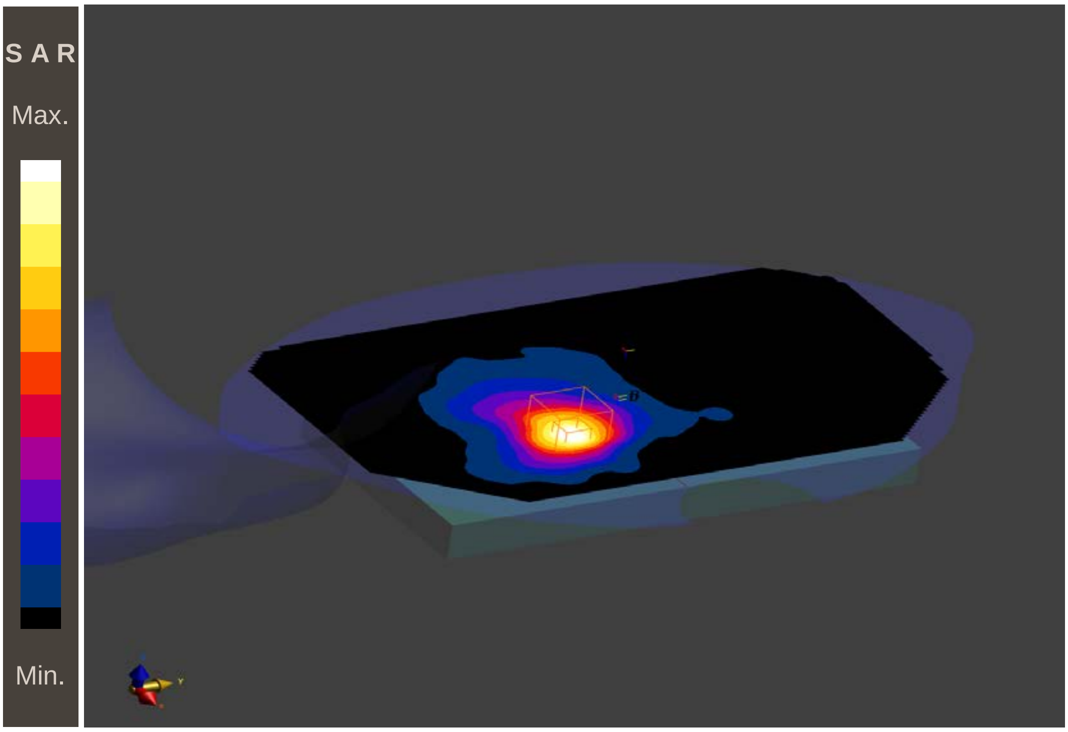
IEC_IEEE_62209-1528 UMTS FDD II body

DUT: Continental; Type: BSRF EA; Serial: 22991129087089

Communication System: UMTS-FDD (WCDMA); Communication System Band: Band 2; Communication System Frequency: 1852.4 MHz
Medium parameters used: f = 1852.4 MHz, σ = 1.32 S/m; ε_r=40.7; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(8.42, 8.42, 8.42); Calibrated: 2022-05-17
- Sensor-Surface: 1.4mm
- DAE: DAE3 Sn477; Calibrated: 2022-05-16
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1977;
- Software: cDASY6 (16.2.2.1588)

HBBL-600-10000/FRONT, 15 mm - Channel 9262/Area Scan (15.0 x 15.0 x 1.0) :
Grid Extents [mm]: 60.0 x 60.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.122 W/kg; SAR(10 g) = 0.069 W/kg

HBBL-600-10000/FRONT, 15 mm - Channel 9262/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 36.0 x 36.0 x 30.0
Graded Grid: Ratio 1.5 - Distance Sensor to Surface 1.4 mm
Power Drift = 0.06 dB
SAR(1 g) = 0.138 W/kg; SAR(10 g) = 0.076 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: 11.9
M1/M2%: 82.6



Additional information:
position or distance of DUT to SAM: 15 mm
ambient temperature: 22.9°C; liquid temperature: 21.6°C;

Date/Time: 2022-12-13, 13:33 2022-12-13, 13:40

IEC_IEEE_62209-1528 UMTS FDD IV body

DUT: Continental; Type: BSRF EA; Serial: 22991129087089

Communication System: UMTS-FDD (WCDMA); Communication System Band: Band 4; Communication System Frequency: 1752.6 MHz

Medium parameters used: f = 1752.6 MHz, σ = 1.26 S/m; ε_r=40.8; ρ= 1000 kg/m3

Phantom Section: Flat

Measurement Standard: DASY 6

DASY Configuration:

- Probe: EX3DV4 - SN3944; ConvF(8.58, 8.58, 8.58); Calibrated: 2022-05-17
- Sensor-Surface: 1.4mm
- DAE: DAE3 Sn477; Calibrated: 2022-05-16
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1977;
- Software: cDASY6 (16.2.2.1588)

HBBL-600-10000/FRONT, 15 mm - Channel 1513/Area Scan (15.0 x 15.0 x 1.0) :

Grid Extents [mm]: 60.0 x 60.0

Maximum value of SAR (interpolated) - SAR(1 g) = 0.153 W/kg; SAR(10 g) = 0.084 W/kg

HBBL-600-10000/FRONT, 15 mm - Channel 1513/Zoom Scan (6.0 x 6.0 x 1.5) :

Grid Extents [mm]: 30.0 x 30.0 x 30.0

Graded Grid: Ratio 1.5 - Distance Sensor to Surface 1.4 mm

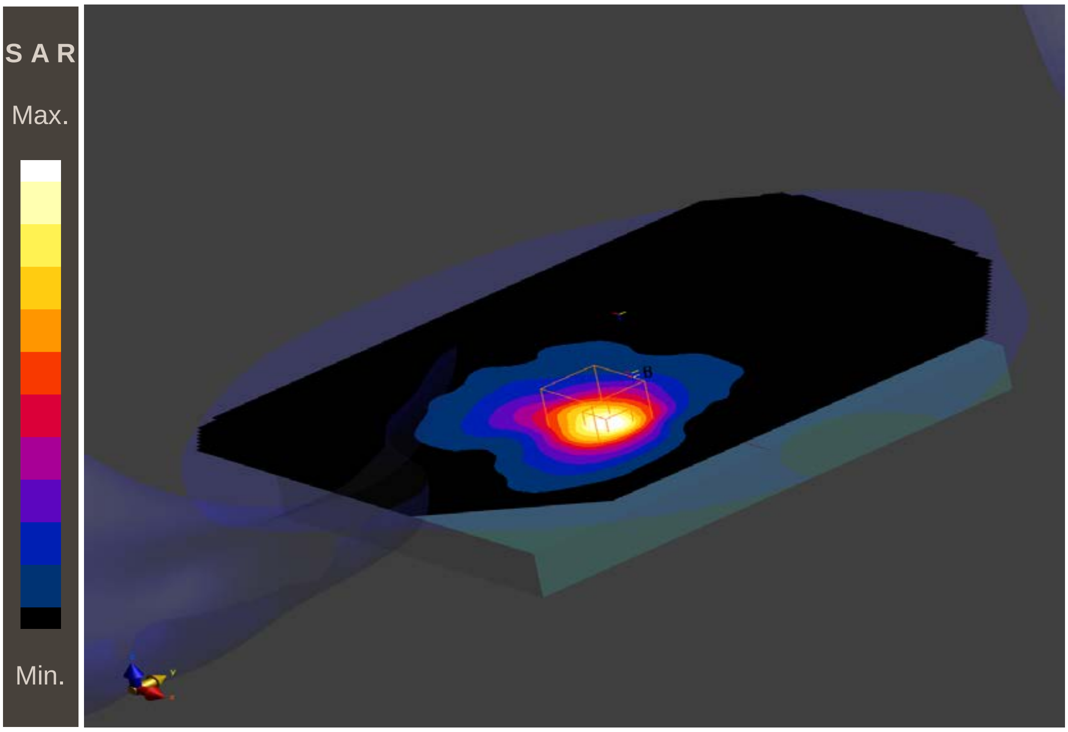
Power Drift = -0.02 dB

SAR(1 g) = 0.162 W/kg; SAR(10 g) = 0.091 W/kg

Additional Info for IEC 62209-2 AMD1:

TDist 3dB Peak [mm]: 11.9

M1/M2%: 83.0



Additional information:

position or distance of DUT to SAM: 15 mm

ambient temperature: 22.9°C; liquid temperature: 21.6°C;

Date/Time: 2022-12-13, 11:48 2022-12-13, 11:56

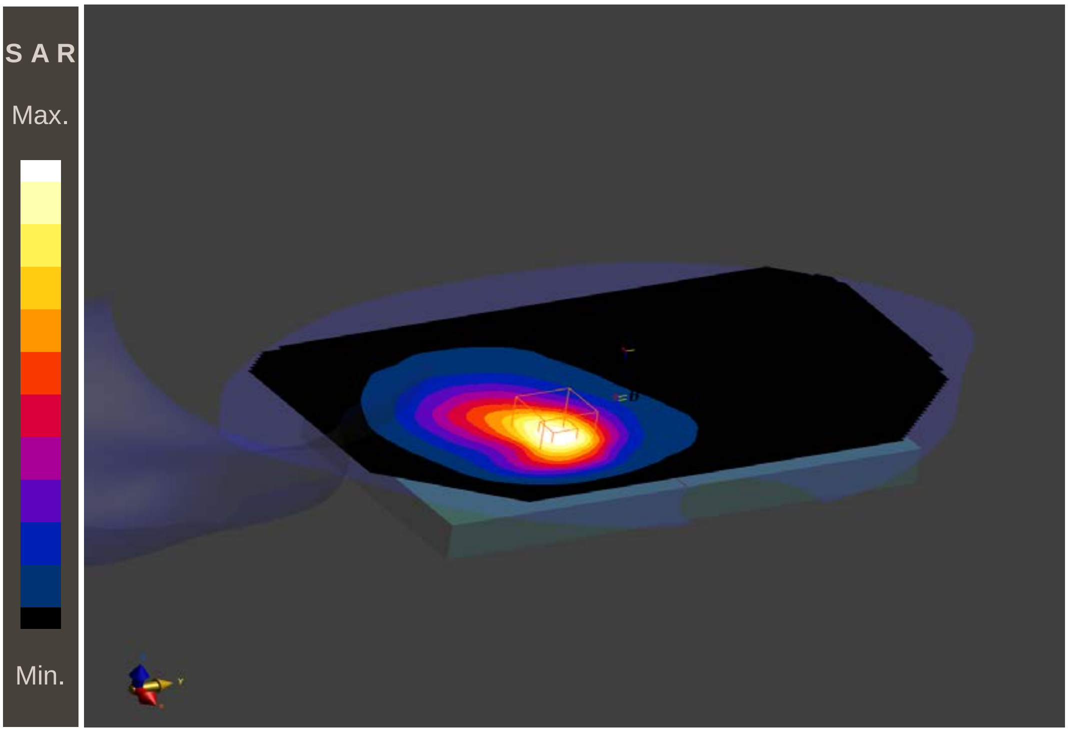
IEC_IEEE_62209-1528 UMTS FDD V body

DUT: Continental; Type: BSRF EA; Serial: 22991129087089

Communication System: UMTS-FDD (WCDMA); Communication System Band: Band 5; Communication System Frequency: 846.6 MHz
Medium parameters used: f = 846.6 MHz, σ = 0.853 S/m; ε_r=42.3; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(10.17, 10.17, 10.17); Calibrated: 2022-05-17
- Sensor-Surface: 1.4mm
- DAE: DAE3 Sn477; Calibrated: 2022-05-16
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1977;
- Software: cDASY6 (16.2.2.1588)

HBBL-600-10000/FRONT, 15 mm - Channel 4233/Area Scan (15.0 x 15.0 x 1.0) :
Grid Extents [mm]: 60.0 x 60.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.372 W/kg; SAR(10 g) = 0.231 W/kg

HBBL-600-10000/FRONT, 15 mm - Channel 4233/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 36.0 x 36.0 x 30.0
Graded Grid: Ratio 1.5 - Distance Sensor to Surface 1.4 mm
Power Drift = 0.06 dB
SAR(1 g) = 0.372 W/kg; SAR(10 g) = 0.221 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: 13.5
M1/M2%: 84.4



Additional information:
position or distance of DUT to SAM: 15 mm
ambient temperature: 22.9°C; liquid temperature: 21.6°C;

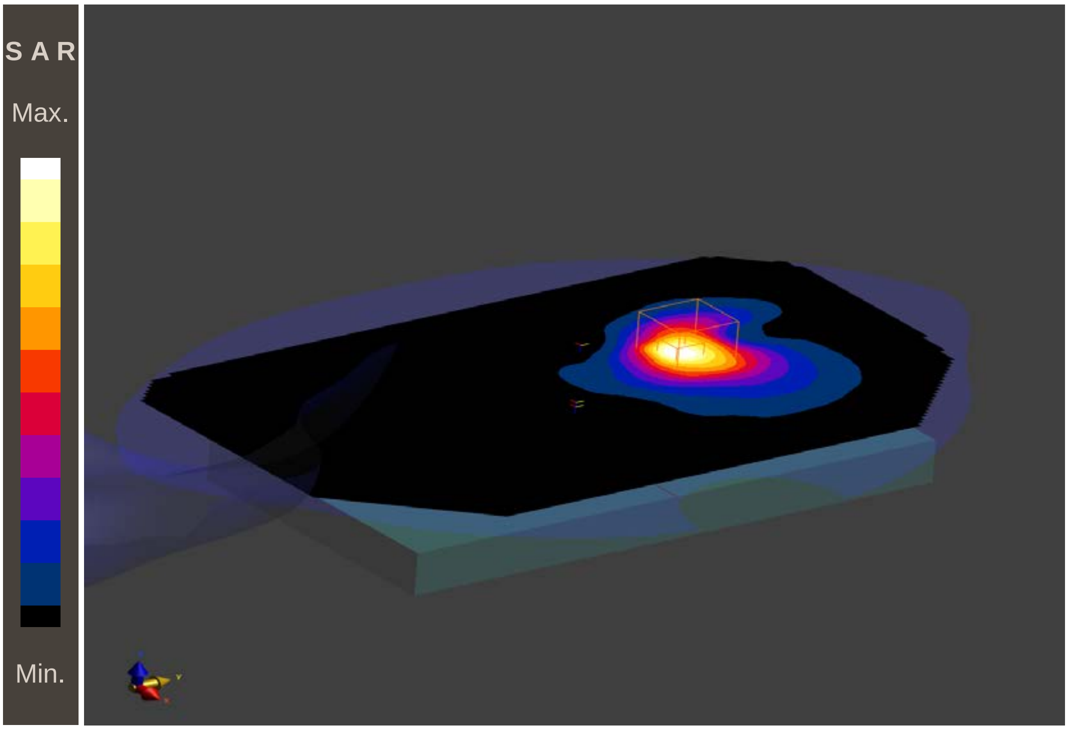
Date/Time: 2023-02-22, 15:21 2023-02-22, 15:29

IEC_IEEE_62209-1528 LTE FDD 2 body

DUT: Continental; Type: BSRF EA; Serial: 22991129087089
Communication System: LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK) RBPosition:Mid AntennaCfg:SISO;
Communication System Band: Band 2; Communication System Frequency: 1860.0 MHz
Medium parameters used: f = 1860.0 MHz, σ = 1.41 S/m; ε_r=39.4; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(8.42, 8.42, 8.42); 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 (16.2.2.1588)

HBBL-600-10000/FRONT, 15 mm - Channel 18700/Area Scan (15.0 x 15.0 x 1.0) :
Grid Extents [mm]: 60.0 x 60.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.179 W/kg; SAR(10 g) = 0.094 W/kg

HBBL-600-10000/FRONT, 15 mm - Channel 18700/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 = -0.08 dB
SAR(1 g) = 0.202 W/kg; SAR(10 g) = 0.109 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: 11.0
M1/M2%: 84.5



Additional information:
position or distance of DUT to SAM: 15 mm (EUT twisted 180° degrees in comparison to other measurements)
ambient temperature: 22.9°C; liquid temperature: 21.6°C;

Date/Time: 2023-02-22, 14:11 2023-02-22, 14:18

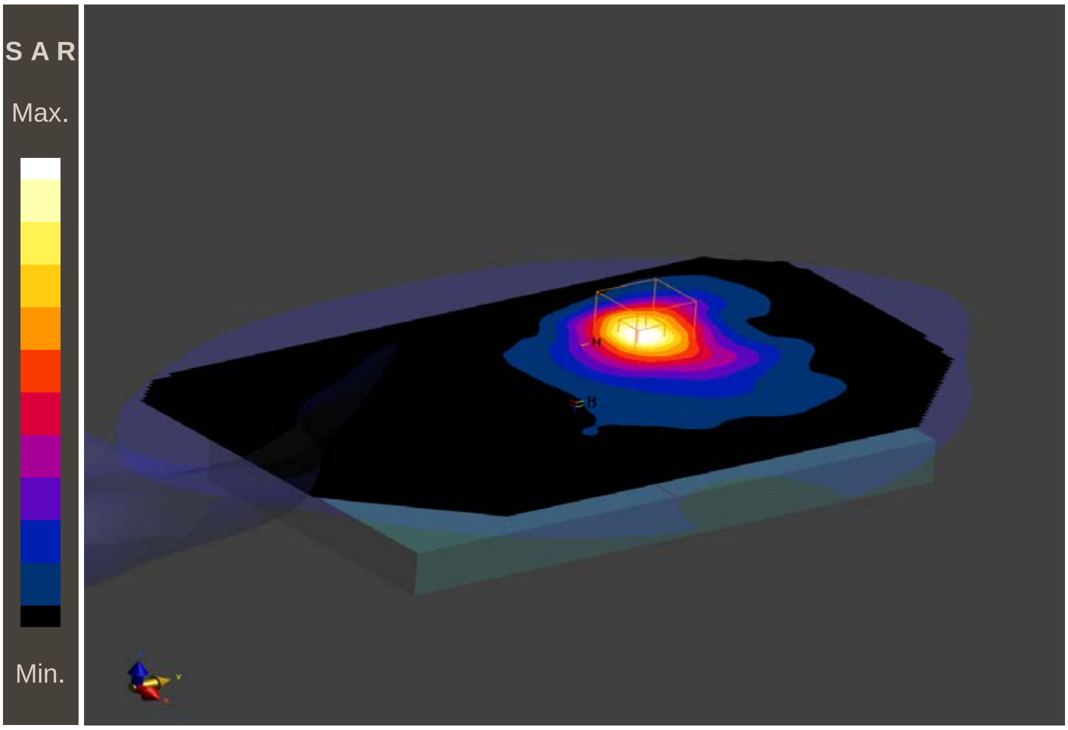
IEC_IEEE_62209-1528 LTE FDD 4 body

DUT: Continental; Type: BSRF EA; Serial: 22991129087089

Communication System: LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK) RBPosition:Low AntennaCfg:SISO;
Communication System Band: Band 4; Communication System Frequency: 1745.0 MHz
Medium parameters used: f = 1745.0 MHz, σ = 1.35 S/m; ε_r=39.5; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(8.58, 8.58, 8.58); 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 (16.2.2.1588)

HBBL-600-10000/FRONT, 15 mm - Channel 20300/Area Scan (15.0 x 15.0 x 1.0) :
Grid Extents [mm]: 60.0 x 60.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.126 W/kg; SAR(10 g) = 0.070 W/kg

HBBL-600-10000/FRONT, 15 mm - Channel 20300/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 30.0 x 30.0 x 30.0
Graded Grid: Ratio 1.5 - Distance Sensor to Surface 1.4 mm
Power Drift = -0.04 dB
SAR(1 g) = 0.132 W/kg; SAR(10 g) = 0.076 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: 12.3
M1/M2%: 82.2



Additional information:
position or distance of DUT to SAM: 15 mm (EUT twisted 180° degrees in comparison to other measurements)
ambient temperature: 22.9°C; liquid temperature: 21.6°C;

Date/Time: 2022-12-12, 15:26 2022-12-12, 15:34

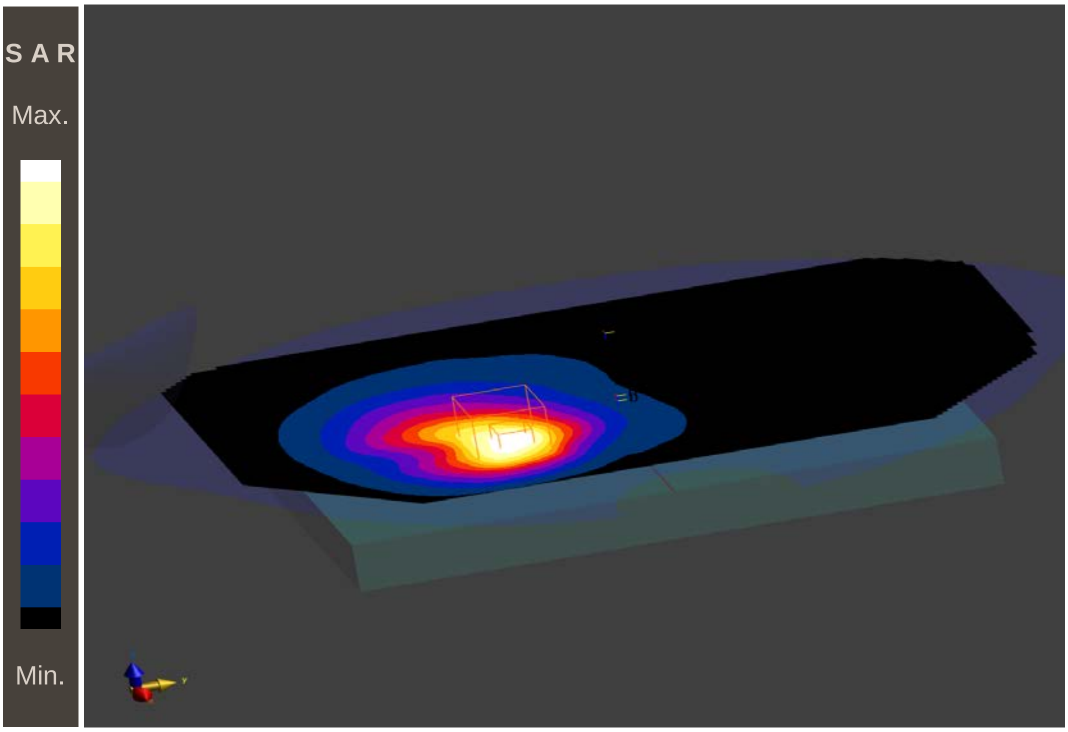
IEC_IEEE_62209-1528 LTE FDD 5 body

DUT: Continental; Type: BSRF EA; Serial: 22991129087089

Communication System: LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK) RBPosition:Mid AntennaCfg:SISO;
Communication System Band: Band 5; Communication System Frequency: 836.5 MHz
Medium parameters used: f = 836.5 MHz, σ = 0.850 S/m; ε_r=42.4; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(10.17, 10.17, 10.17); Calibrated: 2022-05-17
- Sensor-Surface: 1.4mm
- DAE: DAE3 Sn477; Calibrated: 2022-05-16
- Phantom: Twin-SAM V8.0 (30deg probe tilt); Serial: 1977;
- Software: cDASY6 (16.2.2.1588)

HBBL-600-10000/FRONT, 15 mm - Channel 20525/Area Scan (15.0 x 15.0 x 1.0) :
Grid Extents [mm]: 60.0 x 60.0
Maximum value of SAR (interpolated) - SAR(1 g) = 0.307 W/kg; SAR(10 g) = 0.194 W/kg

HBBL-600-10000/FRONT, 15 mm - Channel 20525/Zoom Scan (6.0 x 6.0 x 1.5) :
Grid Extents [mm]: 36.0 x 36.0 x 30.0
Graded Grid: Ratio 1.5 - Distance Sensor to Surface 1.4 mm
Power Drift = -0.17 dB
SAR(1 g) = 0.302 W/kg; SAR(10 g) = 0.182 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: 14.4
M1/M2%: 83.6



Additional information:
position or distance of DUT to SAM: 15 mm
ambient temperature: 22.9°C; liquid temperature: 21.6°C;

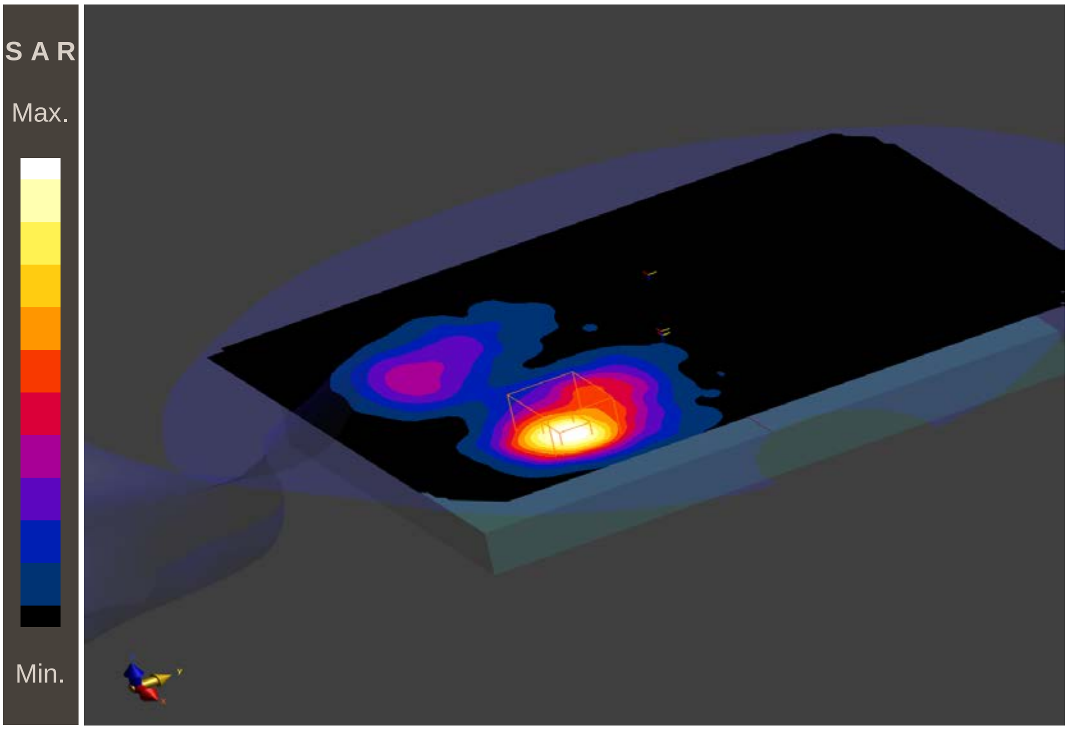
Date/Time: 2023-04-18, 15:36 2023-04-18, 15:59

IEC_IEEE_62209-1528 LTE FDD 7 body

DUT: Continental; Type: BSRF EA; Serial: 22991129087089
Communication System: LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK) RBPosition:Low AntennaCfg:SISO;
Communication System Band: Band 7; Communication System Frequency: 2535.0 MHz
Medium parameters used: f = 2535.0 MHz, σ = 1.85 S/m; ε_r=40.8; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(7.75, 7.75, 7.75); 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 (16.2.2.1588)

HBBL-600-10000/FRONT, 15 mm - Channel 21100/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) = 0.105 W/kg; SAR(10 g) = 0.053 W/kg

HBBL-600-10000/FRONT, 15 mm - Channel 21100/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 = -0.02 dB
SAR(1 g) = 0.109 W/kg; SAR(10 g) = 0.053 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: 10.2
M1/M2%: 83.0



Additional information:
position or distance of DUT to SAM: 15 mm
ambient temperature: 23.9°C; liquid temperature: 21.3°C;

Annex B.2: SAR results - WLAN

Date/Time: 2023-02-15, 13:40 2023-02-15, 13:48

IEC_IEEE_62209-1528-WLAN2.4GHz body

DUT: Continental; Type: BSRF EA; Serial: 22991129087089

Communication System: IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle); Communication System Band: WLAN 2.4GHz; Communication System Frequency: 2462.0 MHz

Medium parameters used: f = 2462.0 MHz, σ = 1.77 S/m; ε_r=39.6; 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 (16.2.2.1588)

HBBL-600-10000/FRONT, 15 mm - Channel 11/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) = 0.215 W/kg; SAR(10 g) = 0.123 W/kg

HBBL-600-10000/FRONT, 15 mm - Channel 11/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

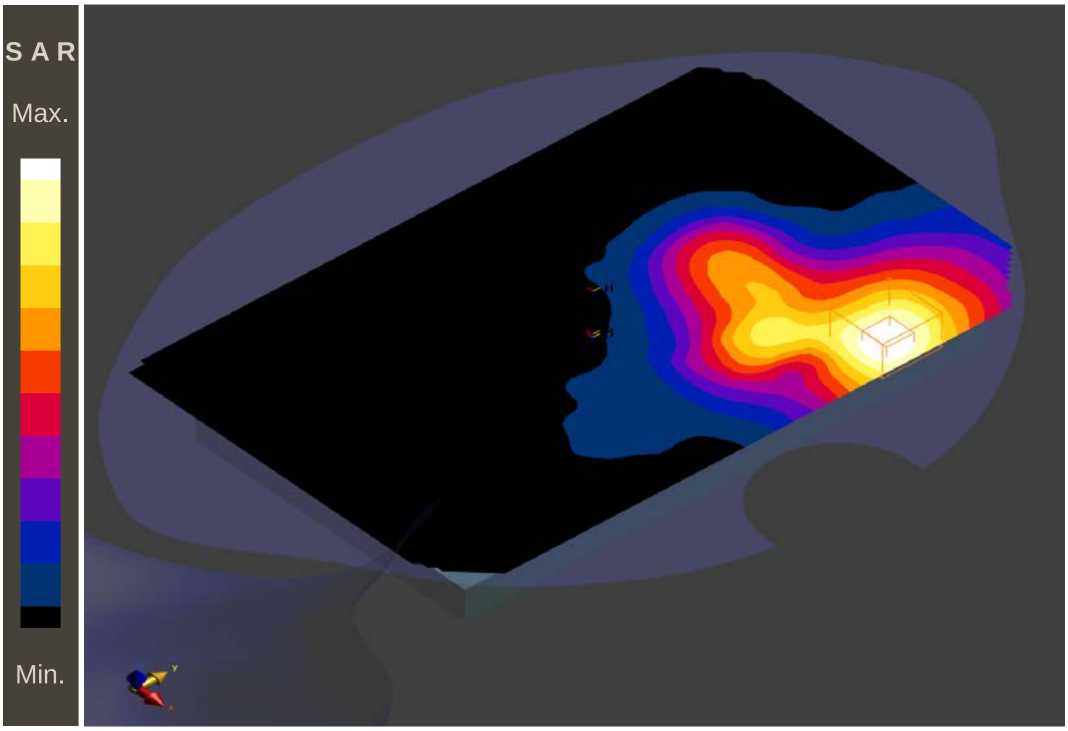
Power Drift = -0.08 dB

SAR(1 g) = 0.213 W/kg; SAR(10 g) = 0.125 W/kg

Additional Info for IEC 62209-2 AMD1:

TDist 3dB Peak [mm]: > 15.0

M1/M2%: 83.2



Additional information:

position or distance of DUT to SAM: 15 mm (EUT twisted 180° degrees in comparison to other measurements)

ambient temperature: 22.6°C; liquid temperature: 21.8°C;

Date/Time: 2023-02-15, 13:57 2023-02-15, 14:11

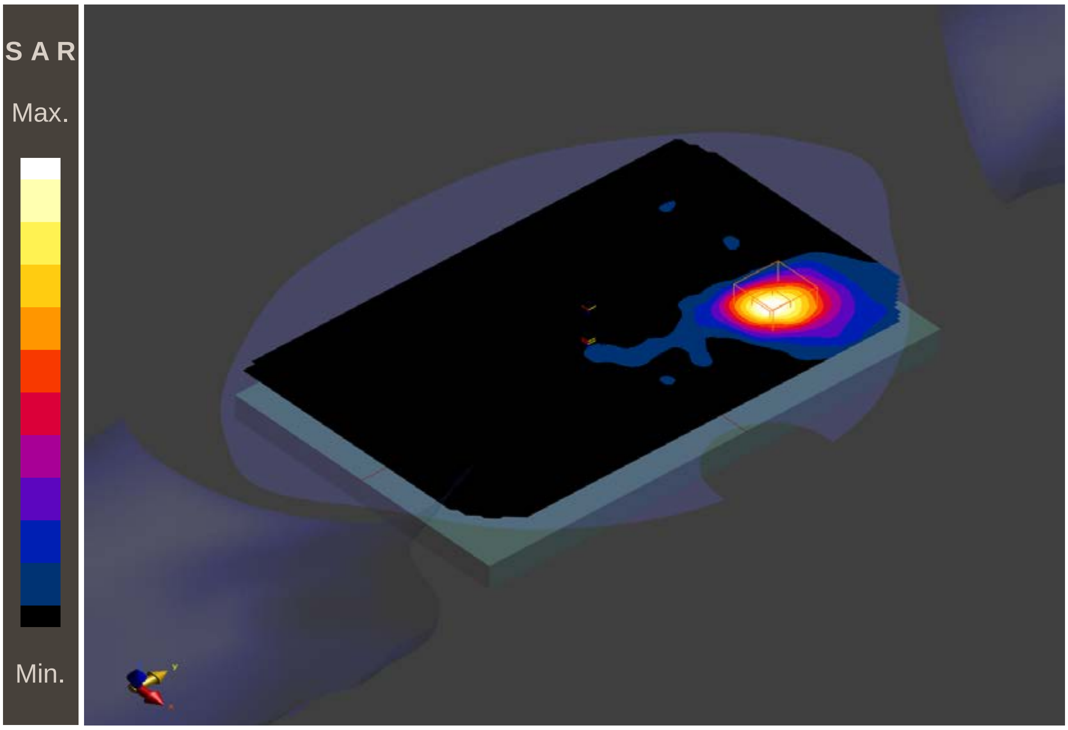
IEC_IEEE_62209-1528-WLAN5GHz body

DUT: Continental; Type: BSRF EA; Serial: 22991129087089

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps, 99pc duty cycle); Communication System Band: WLAN 5GHz; Communication System Frequency: 5200.0 MHz
Medium parameters used: f = 5200.0 MHz, σ = 4.32 S/m; ε_r=34.2; ρ= 1000 kg/m3
Phantom Section: Flat
Measurement Standard: DASY 6
DASY Configuration:
- Probe: EX3DV4 - SN3944; ConvF(5.22, 5.22, 5.22); 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 (16.2.2.1588)

HBBL-600-10000/FRONT, 15 mm - Channel 40/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) = 0.316 W/kg; SAR(10 g) = 0.125 W/kg

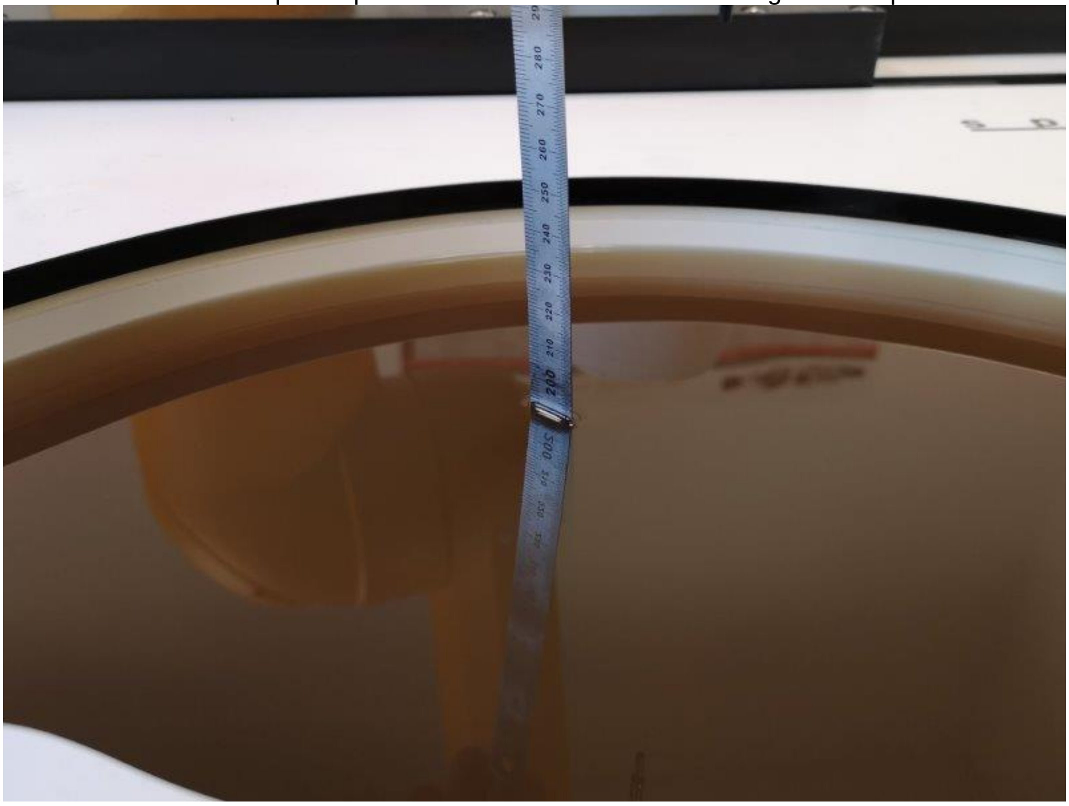
HBBL-600-10000/FRONT, 15 mm - Channel 40/Zoom Scan (4.0 x 4.0 x 1.4) :
Grid Extents [mm]: 24.0 x 24.0 x 22.0
Graded Grid: Ratio 1.4 - Distance Sensor to Surface 1.4 mm
Power Drift = -0.04 dB
SAR(1 g) = 0.303 W/kg; SAR(10 g) = 0.119 W/kg
Additional Info for IEC 62209-2 AMD1:
TDist 3dB Peak [mm]: 10.4
M1/M2%: 67.1



Additional information:
position or distance of DUT to SAM: 15 mm (EUT twisted 180° degrees in comparison to other measurements)
ambient temperature: 22.6°C; liquid temperature: 21.8°C;

Annex B.3: Liquid depth

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



Annex C: Photo documentation

Photo documentation is described in the additional document:

Appendix to test report no. 1-4869/22-02-03 Photo documentation

Annex D: Calibration parameters

Calibration parameters are described in the additional document:

Appendix to test report no. 1-4869/22-02-03
Calibration data, Phantom certificate
and detail information of the DASY System

Annex E: Document History

Version	Applied Changes	Date of Release
	Initial Release	2023-05-02

Annex F: 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
LTE	-	Long Term Evolution
N/A	-	not applicable
PCE	-	Personal Consumption Expenditure
OET	-	Office of Engineering and Technology
RB	-	resource block(s)
SAR	-	Specific Absorption Rate
S/N	-	Serial Number
SW	-	Software
UNII	-	Unlicensed National Information Infrastructure