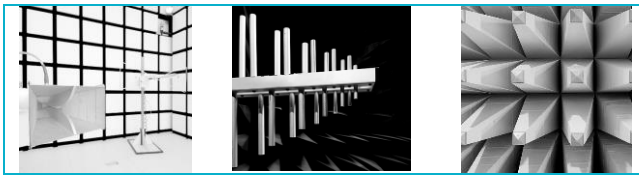

CTC advanced
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BNetzA-CAB-02/21-102

TEST REPORT

Test Report No.: 1-2856/16-01-03

DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-03

Testing Laboratory

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Accredited Test Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-03

Applicant

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Manufacturer

Philips Medizin Systeme Böblingen GmbH
Hewlett-Packard-Strasse 2
71034 Böblingen/GERMANY

Test Standard/s

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

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

Test Item

Kind of test item:	Range Extender for SRR measurements via WLAN
Device type:	portable device
Model name:	IntelliVue CL Transmitter 865221
Product Number:	865221
S/N serial number:	D932Y0201
FCC-ID:	PQC-TRNSBV1
Hardware status:	PW100120BA
Software status:	3.2.0.137 api 3
Frequency:	see technical details
Antenna:	integrated antenna
Battery option:	Integrated battery
Auxiliary equipment:	Laptop computer with control software
Test sample status:	identical prototype
Exposure category:	general population / uncontrolled environment

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

Test Report authorised:

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2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalisations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CTC advanced GmbH.
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In no case this test report can be considered as a Letter of Approval.

2.2 Application details

Date of receipt of order:	2013-02-01
Date of receipt of test item:	2013-10-18
Start of test:	2013-10-22
End of test:	2013-10-29
Person(s) present during the test:	

2.3 Statement of compliance

The SAR values found for the IntelliVue CL Transmitter 865221 Range Extender for SRR measurements via WLAN 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 and meets FCC RF exposure guidelines when used with any accessory that contains no metal and that positions the handset a minimum of 10 mm from the body.

2.4 Technical details

The DUT contains multiple transmitters:

1. IEEE 802.11 a/b/g/n WLAN Module (Model name: WLANBV2-A) with integrated PCB antenna
2. Dual IEEE 802.15.4 Short Range Radio (SRR) transmitter with integrated chip antennas
3. Medical Body Area Network (MBAN)

The transmitters have the following capabilities:

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	Tested power control level	Test channel low	Test channel middle	Test channel high	Max. average output power/dBm
☐	WLAN	2412	2472	2412	2472	CCK OFDM	max	1	7	13	---
☒	WLAN US	2412	2462	2412	2462	CCK OFDM	max	1	6	11	13.7
☒	WLAN	5180	5240	5180	5240	OFDM	max	36	--	--	15.8
☒	WLAN	5260	5320	5260	5320	OFDM	max	--	60	--	15.5
☒	WLAN	5500	5700	5500	5700	OFDM	max	--	112	--	15.7
☒	WLAN	5745	5825	5745	5825	OFDM	max	--	--	161	14.8
☐	SRR 1 ID248	2405MHz … 2480MHz				DSSS	max	--	--	--	5.4
☐	SRR 2 ID251	2405MHz … 2480MHz				DSSS	max	--	--	--	3.9
☐	MBAN 1 ID248	2360MHz … 2400MHz				---	max	--	--	--	7.1
☐	MBAN 2 ID251	2360MHz … 2400MHz				---	max	--	--	--	5.5

Note: SRR (Short Range Radio) was not tested for SAR (output power < 60/f mW)

2.5 Transmitter and Antenna Operating Configurations

Simultaneous transmission conditions		
MBAN + SRR	+	WLAN 2.4GHz
MBAN + SRR	+	WLAN 5GHz

Table 1: Simultaneous transmission conditions

3 Test standards/ procedures references

Test Standard	Version	Test Standard Description
IEEE 1528-2013	2013-06	Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
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 62209-2	2010	Human exposure to radio frequency fields from hand-held and body mounted wireless communication devices. Human models, instrumentation, and procedures. Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)
FCC KDBs:		
KDB 865664D01v01	May 28, 2013	FCC OET SAR measurement requirements 100 MHz to 6 GHz
KDB 865664D02v01	May 28, 2013	RF Exposure Compliance Reporting and Documentation Considerations
KDB 447498D01v05	May 28, 2013	Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies
KDB 648474D04v01	May 28, 2013	SAR Evaluation Considerations for Wireless Handsets
KDB 248227D01v01	May, 2007	SAR Measurement Procedures for 802.11 a/b/g Transmitters
KDB 450824D01v01	January, 2007	SAR Probe Calibration and System Verification considerations for measurements from 150 MHz to 3 GHz
KDB 450824D01v01	March 4, 2012	Dipole Requirements for SAR System Validation and Verification

3.1 RF exposure limits

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

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 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)			
		DTS	**UNII**
body worn front side 10 mm distance		**0.285**	**0.335**
body worn 0 mm distance		**0.743**	**0.302**
collocated situations	**ΣSAR evaluation 10 mm distance**	**0.407**	
	ΣSAR evaluation 0 mm distance	**0.888**	

5 Test Environment

Ambient temperature: 20 – 24 °C
Tissue Simulating liquid: 20 – 24 °C

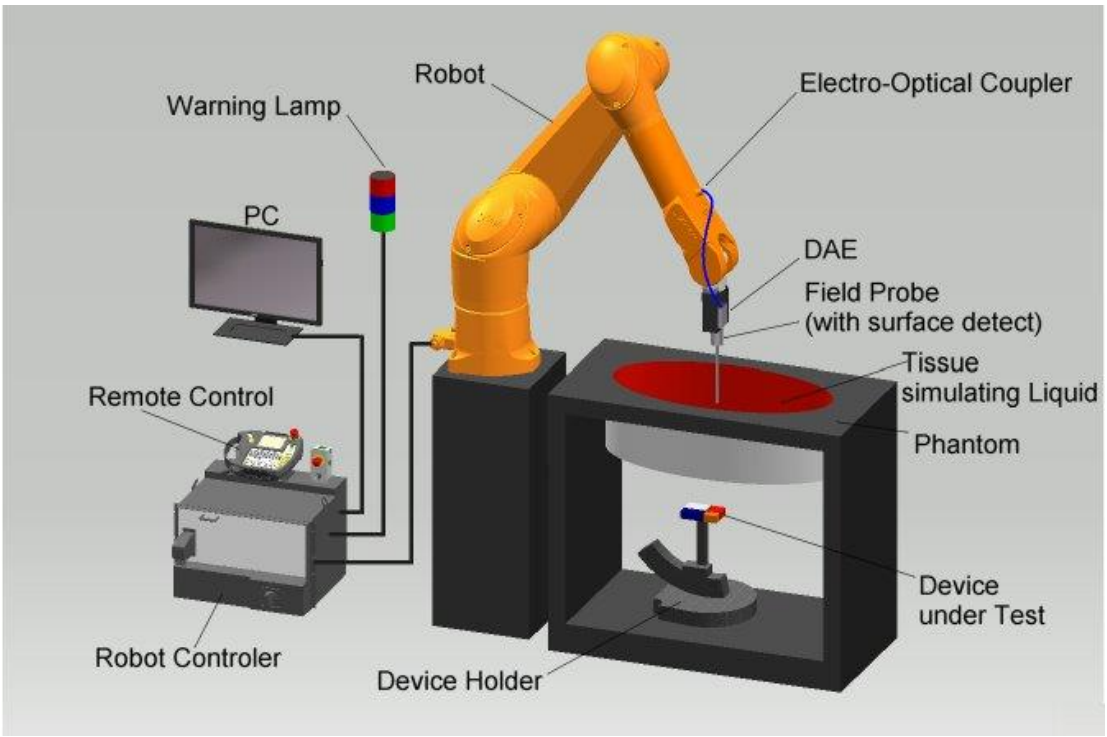
Relative humidity content: 40 – 50 %
Air pressure: not relevant for this kind of testing
Power supply: 230 V / 50 Hz

Exact temperature values for each test are shown in the table(s) under 7.1 and/or on the measurement plots.

6 Test Set-up

6.1 Measurement system

6.1.1 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 7.
- 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.

6.1.2 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 mW/g.

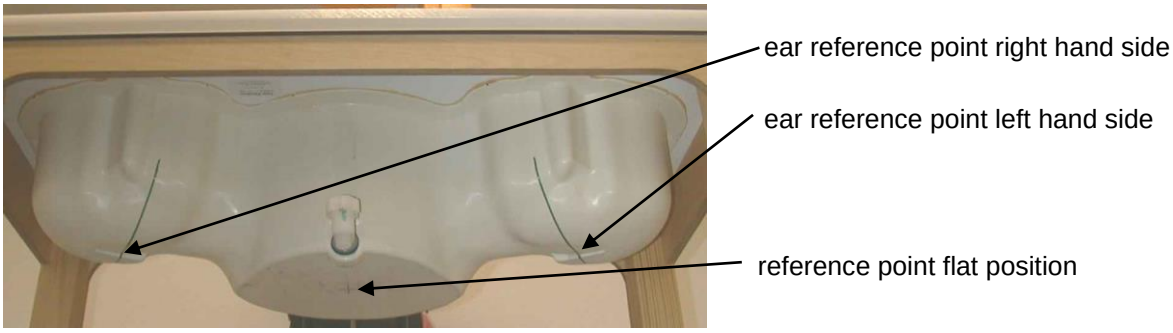
6.1.3 Probe description

Isotropic E-Field Probe ET3DV6 for Dosimetric Measurements

Technical data according to manufacturer information	
Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection system Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycolether)
Calibration	In air from 10 MHz to 2.5 GHz In head tissue simulating liquid (HSL) at 900 (800-1000) MHz and 1.8 GHz (1700-1910 MHz) (accuracy ± 9.5%; k=2) Calibration for other liquids and frequencies upon request
Frequency	10 MHz to 3 GHz (dosimetry); Linearity: ± 0.2 dB (30 MHz to 3 GHz)
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.4 dB in HSL (rotation normal to probe axis)
Dynamic range	5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB
Optical Surface Detection	± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces (ET3DV6 only)
Dimensions	Overall length: 330 mm Tip length: 16 mm Body diameter: 12 mm Tip diameter: 6.8 mm Distance from probe tip to dipole centers: 2.7 mm
Application	General dosimetry up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms (ET3DV6)

6.1.4 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.

6.1.5 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.

6.1.6 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. Using predefined locations for measurements is not accurate enough. Any shift of the phantom (e.g., slight deformations after filling it with liquid) would produce high uncertainties. For an automatic and accurate detection of the phantom surface, the DASY5 system uses the mechanical surface detection. The detection is always at touch, but the probe will move backward from the surface the indicated distance before starting the measurement.

- 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

DASY is also able to perform repeated zoom scans if more than 1 peak is found during area scan. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in annex B. Test results relevant for the specified standard (see section 3) are shown in table form in section 7.

6.1.7 Spatial Peak SAR Evaluation

The spatial peak SAR - value for 1 and 10 g is evaluated after the Cube measurements have been done. The basis of the evaluation are the SAR values measured at the points of the fine cube grid consisting of all points in the three directions x, y and z. The algorithm that finds the maximal averaged volume is separated into three different stages.

- The data between the dipole center of the probe and the surface of the phantom are extrapolated. This data cannot be measured since the center of the dipole is 1 to 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is about 1 mm (see probe calibration sheet). The extrapolated data from a cube measurement can be visualized by selecting ‘Graph Evaluated’.

- The maximum interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1g or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume cannot be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.

- All neighbouring volumes are evaluated until no neighbouring volume with a higher average value is found.

Extrapolation

The extrapolation is based on a least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 3 cm along the z-axis, polynomials of order four are calculated. These polynomials are then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from each other.

Interpolation

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a knot"-condition [W. Gander, Computermathematik, p.141-150] (x, y and z -direction) [Numerical Recipes in C, Second Edition, p.123ff].

Volume Averaging

At First the size of the cube is calculated. Then the volume is integrated with the trapezoidal algorithm. 8000 points (20x20x20) are interpolated to calculate the average.

Advanced Extrapolation

DASY uses the advanced extrapolation option which is able to compensate boundary effects on E-field probes.

6.1.8 Data Storage and Evaluation

Data Storage

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

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [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 mW/g
	E_{tot}	= total field strength in V/m
	σ	= conductivity in [mho/m] or [Siemens/m]
	ρ	= equivalent tissue density in g/cm^3

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

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

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

6.1.9 Tissue simulating liquids: dielectric properties

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

(Liquids used for tests described in section 7. are marked with ☒) :

Ingredients (% of weight)	**Frequency (MHz)**								
frequency band	☐ 450	☐ 750	☐ 835	☐ 900	☐ 1450	☐ 1800	☐ 1900	☒ 2450	☒ 5000
Tissue Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Water	51.16	51.7	52.4	56.0	70.97	69.91	69.91	73.2	64 - 78
Salt (NaCl)	1.49	0.9	1.40	0.76	0.43	0.13	0.13	0.04	2 - 3
Sugar	46.78	47.2	45.0	41.76	0.0	0.0	0.0	0.0	0.0
HEC	0.52	0.0	1.0	1.21	0.0	0.0	0.0	0.0	0.0
Bactericide	0.05	0.1	0.1	0.27	0.0	0.0	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DGBE	0.0	0.0	0.0	0.0	28.60	29.96	29.96	26.7	0.0
Emulsifiers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9 - 15
Mineral Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11 - 18

Table 3: Body tissue dielectric properties

Salt: 99+% Pure Sodium Chloride
Water: De-ionized, 16MΩ+ resistivity
Sugar: 98+% Pure Sucrose
HEC: Hydroxyethyl Cellulose
DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]
Triton X-100(ultra pure): Polyethylene glycol mono [4-(1,1,3,3-tetramethylbutyl)phenyl]ether

6.1.10 Tissue simulating liquids: parameters

Liquid **MSL**	Freq. (MHz)	Target **body** tissue		Measurement **body** tissue				Measurement date
		Permittivity	Conductivity [S/m]	Permittivity	Dev. %	Conductivity [S/m]	Dev. %	
2450	2412	52.7	1.95	51.4	-2.6%	1.93	-0.9%	2013-10-22
	2437	52.7	1.95	51.3	-2.7%	1.96	0.3%	
	2450	52.7	1.95	51.3	-2.7%	1.97	1.2%	
	2462	52.7	1.95	51.2	-2.8%	1.99	2.2%	
5GHz	5180	49.0	5.30	48.0	-2.0%	5.34	0.8%	2013-10-24
	5200	49.0	5.30	48.0	-2.0%	5.34	0.8%	
	5300	48.9	5.40	47.8	-2.3%	5.46	1.1%	
	5500	48.6	5.65	47.3	-2.7%	5.71	1.1%	
	5560	48.6	5.65	47.2	-2.9%	5.78	2.3%	
	5800	48.2	6.00	46.7	-3.1%	6.10	1.7%	
	5805	48.2	6.00	46.7	-3.2%	6.12	2.0%	

Table 4: Parameter of the body tissue simulating liquid
Note: The dielectric properties have been measured using the contact probe method at 22°C.

6.1.11 Measurement uncertainty evaluation for SAR test

Relative DASY5 Uncertainty Budget for SAR Tests								
According to IEEE 1528/2011 and IEC62209-1/2011 (0.3-3GHz range)								
Error Description	Uncertainty Value	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)	v_i^2 or v_{eff}
Measurement System								
Probe calibration	± 6.0 %	Normal	1	1	1	± 6.0 %	± 6.0 %	∞
Axial isotropy	± 4.7 %	Rectangular	√ 3	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√ 3	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary effects	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Probe linearity	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Modulation Response	± 2.4 %	Rectangular	√ 3	1	1	± 1.4 %	± 1.4 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Integration time	± 2.6 %	Rectangular	√ 3	1	1	± 1.5 %	± 1.5 %	∞
RF ambient noise	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
RF ambient reflections	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
Probe positioner	± 0.4 %	Rectangular	√ 3	1	1	± 0.2 %	± 0.2 %	∞
Probe positioning	± 2.9 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
Max. SAR evaluation	± 2.0 %	Rectangular	√ 3	1	1	± 1.2 %	± 1.2 %	∞
Test Sample Related								
Device positioning	± 2.9 %	Normal	1	1	1	± 2.9 %	± 2.9 %	145
Device holder uncertainty	± 3.6 %	Normal	1	1	1	± 3.6 %	± 3.6 %	5
Power drift	± 5.0 %	Rectangular	√ 3	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Set-up								
Phantom uncertainty	± 6.1 %	Rectangular	√ 3	1	1	± 3.5 %	± 3.5 %	∞
SAR correction	± 1.9 %	Rectangular	√ 3	1	0.84	± 1.1 %	± 0.9 %	∞
Liquid conductivity (meas.)	± 5.0 %	Rectangular	√ 3	0.78	0.71	± 2.3 %	± 2.0 %	∞
Liquid permittivity (meas.)	± 5.0 %	Rectangular	√ 3	0.26	0.26	± 0.8 %	± 0.8 %	∞
Temp. Unc. - Conductivity	± 3.4 %	Rectangular	√ 3	0.78	0.71	± 1.5 %	± 1.4 %	∞
Temp. Unc. - Permittivity	± 0.4 %	Rectangular	√ 3	0.23	0.26	± 0.1 %	± 0.1 %	∞
Combined Uncertainty						± 11.3 %	± 11.3 %	330
Expanded Std. Uncertainty						± **22.7** %	± **22.5** %	

Table 5: Measurement uncertainties
Worst-Case uncertainty budget for DASY5 assessed according to IEEE 1528/2011 and IEC 62209-1/2011 draft standards. 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.

Relative DASY5 Uncertainty Budget for SAR Tests								
According to IEC62209-2/2010 (30 MHz - 6 GHz range)								
Error Description	Uncertainty Value	Probability Distribution	Divisor	c_i	c_i	Standard Uncertainty		v_i^2 or v_{eff}
				(1g)	(10g)	± %, (1g)	± %, (10g)	
Measurement System								
Probe calibration	± 6.6 %	Normal	1	1	1	± 6.6 %	± 6.6 %	∞
Axial isotropy	± 4.7 %	Rectangular	√ 3	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√ 3	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary effects	± 2.0 %	Rectangular	√ 3	1	1	± 1.2 %	± 1.2 %	∞
Probe linearity	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Modulation Response	± 2.4 %	Rectangular	√ 3	1	1	± 1.4 %	± 1.4 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Integration time	± 2.6 %	Rectangular	√ 3	1	1	± 1.5 %	± 1.5 %	∞
RF ambient noise	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
RF ambient reflections	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
Probe positioner	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Probe positioning	± 6.7 %	Rectangular	√ 3	1	1	± 3.9 %	± 3.9 %	∞
Post-processing	± 4.0 %	Rectangular	√ 3	1	1	± 2.3 %	± 2.3 %	∞
Test Sample Related								
Device positioning	± 2.9 %	Normal	1	1	1	± 2.9 %	± 2.9 %	145
Device holder uncertainty	± 3.6 %	Normal	1	1	1	± 3.6 %	± 3.6 %	5
Power drift	± 5.0 %	Rectangular	√ 3	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Set-up								
Phantom uncertainty	± 7.9 %	Rectangular	√ 3	1	1	± 4.6 %	± 4.6 %	∞
SAR correction	± 1.9 %	Rectangular	√ 3	1	0.84	± 1.1 %	± 0.9 %	∞
Liquid conductivity (meas.)	± 5.0 %	Rectangular	√ 3	0.78	0.71	± 2.3 %	± 2.0 %	∞
Liquid permittivity (meas.)	± 5.0 %	Rectangular	√ 3	0.26	0.26	± 0.8 %	± 0.8 %	∞
Temp. Unc. - Conductivity	± 3.4 %	Rectangular	√ 3	0.78	0.71	± 1.5 %	± 1.4 %	∞
Temp. Unc. - Permittivity	± 0.4 %	Rectangular	√ 3	0.23	0.26	± 0.1 %	± 0.1 %	∞
Combined Uncertainty						± 12.7 %	± 12.6 %	330
Expanded Std. Uncertainty						± **25.4** %	± **25.3** %	

Table 6: Measurement uncertainties. Worst-Case uncertainty budget for DASY5 assessed according to according to IEC 62209-2/2010 standard. The budget is valid for the frequency range 30MHz - 6 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller.

Relative DASY5 Uncertainty Budget for SAR Tests								
According to IEEE 1528-2003, IEC 62209-1 for the 3-6 GHz range								
Error Description	Uncertainty Value	Probability Distribution	Divisor	c_i	c_i	Standard Uncertainty		v_i^2 or v_{eff}
				(1g)	(10g)	± %, (1g)	± %, (10g)	
Measurement System								
Probe calibration	± 6.6 %	Normal	1	1	1	± 6.6 %	± 6.6 %	∞
Axial isotropy	± 4.7 %	Rectangular	√ 3	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√ 3	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary effects	± 2.0 %	Rectangular	√ 3	1	1	± 1.2 %	± 1.2 %	∞
Probe linearity	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Integration time	± 2.6 %	Rectangular	√ 3	1	1	± 1.5 %	± 1.5 %	∞
RF ambient noise	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
RF ambient reflections	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
Probe positioner	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Probe positioning	± 6.7 %	Rectangular	√ 3	1	1	± 3.9 %	± 3.9 %	∞
Max. SAR evaluation	± 4.0 %	Rectangular	√ 3	1	1	± 2.3 %	± 2.3 %	∞
Test Sample Related								
Device positioning	± 2.9 %	Normal	1	1	1	± 2.9 %	± 2.9 %	145
Device holder uncertainty	± 3.6 %	Normal	1	1	1	± 3.6 %	± 3.6 %	5
Power drift	± 5.0 %	Rectangular	√ 3	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Set-up								
Phantom uncertainty	± 4.0 %	Rectangular	√ 3	1	1	± 2.3 %	± 2.3 %	∞
Liquid conductivity (target)	± 5.0 %	Rectangular	√ 3	0.64	0.43	± 1.8 %	± 1.2 %	∞
Liquid conductivity (meas.)	± 5.0 %	Rectangular	√ 3	0.64	0.43	± 1.8 %	± 1.2 %	∞
Liquid permittivity (target)	± 5.0 %	Rectangular	√ 3	0.6	0.49	± 1.7 %	± 1.4 %	∞
Liquid permittivity (meas.)	± 5.0 %	Rectangular	√ 3	0.6	0.49	± 1.7 %	± 1.4 %	∞
Combined Uncertainty						± 12.1 %	± 11.9 %	330
Expanded Std. Uncertainty						± **24.3** %	± **23.8** %	

Table 7: Measurement uncertainties
Worst-Case uncertainty budget for DASY5 valid for 3G communication signals and frequency range 3 - 6 GHz. Probe calibration error reflects uncertainty of the EX3D probe. For specific tests and configurations, the uncertainty could be considerable smaller.

Relative DASY5 Uncertainty Budget for SAR Tests								
According to IEEE 1528/2011 and IEC62209-1/2011 (3-6GHz range)								
Error Description	Uncertainty Value	Probability Distribution	Divisor	c_i	c_i	Standard Uncertainty		v_i^2 or v_{eff}
				(1g)	(10g)	± %, (1g)	± %, (10g)	
Measurement System								
Probe calibration	± 6.6 %	Normal	1	1	1	± 6.6 %	± 6.6 %	∞
Axial isotropy	± 4.7 %	Rectangular	√ 3	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√ 3	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary effects	± 2.0 %	Rectangular	√ 3	1	1	± 1.2 %	± 1.2 %	∞
Probe linearity	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Modulation Response	± 2.4 %	Rectangular	√ 3	1	1	± 1.4 %	± 1.4 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Integration time	± 2.6 %	Rectangular	√ 3	1	1	± 1.5 %	± 1.5 %	∞
RF ambient noise	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
RF ambient reflections	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
Probe positioner	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Probe positioning	± 6.7 %	Rectangular	√ 3	1	1	± 3.9 %	± 3.9 %	∞
Max. SAR evaluation	± 4.0 %	Rectangular	√ 3	1	1	± 2.3 %	± 2.3 %	∞
Test Sample Related								
Device positioning	± 2.9 %	Normal	1	1	1	± 2.9 %	± 2.9 %	145
Device holder uncertainty	± 3.6 %	Normal	1	1	1	± 3.6 %	± 3.6 %	5
Power drift	± 5.0 %	Rectangular	√ 3	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Set-up								
Phantom uncertainty	± 6.6 %	Rectangular	√ 3	1	1	± 3.8 %	± 3.8 %	∞
SAR correction	± 1.9 %	Rectangular	√ 3	1	0.84	± 1.1 %	± 0.9 %	∞
Liquid conductivity (meas.)	± 5.0 %	Rectangular	√ 3	0.78	0.71	± 2.3 %	± 2.0 %	∞
Liquid permittivity (meas.)	± 5.0 %	Rectangular	√ 3	0.26	0.26	± 0.8 %	± 0.8 %	∞
Temp. Unc. - Conductivity	± 3.4 %	Rectangular	√ 3	0.78	0.71	± 1.5 %	± 1.4 %	∞
Temp. Unc. - Permittivity	± 0.4 %	Rectangular	√ 3	0.23	0.26	± 0.1 %	± 0.1 %	∞
Combined Uncertainty						± 12.4 %	± 12.4 %	330
Expanded Std. Uncertainty						± **24.9** %	± **24.8** %	

Table 8: Measurement uncertainties
Worst-Case uncertainty budget for DASY5 assessed according to IEEE 1528/2011 and IEC 62209-1/2011 draft standards. The budget is valid for the frequency range 3GHz -6GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller.

6.1.12 Measurement uncertainty evaluation for System Check

Uncertainty of a System Performance Check with DASY5 System for the 0.3 - 3 GHz range								
Source of uncertainty	Uncertainty Value	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)	v_i^2 or v_{eff}
Measurement System								
Probe calibration	± 6.0 %	Normal	1	1	1	± 6.0 %	± 6.0 %	∞
Axial isotropy	± 4.7 %	Rectangular	√ 3	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical isotropy	± 0.0 %	Rectangular	√ 3	0.7	0.7	± 0.0 %	± 0.0 %	∞
Boundary effects	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Probe linearity	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
Integration time	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
RF ambient conditions	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
Probe positioner	± 0.4 %	Rectangular	√ 3	1	1	± 0.2 %	± 0.2 %	∞
Probe positioning	± 2.9 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
Max. SAR evaluation	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Test Sample Related								
Dev. of experimental dipole	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
Source to liquid distance	± 2.0 %	Rectangular	√ 3	1	1	± 1.2 %	± 1.2 %	∞
Power drift	± 3.4 %	Rectangular	√ 3	1	1	± 2.0 %	± 2.0 %	∞
Phantom and Set-up								
Phantom uncertainty	± 4.0 %	Rectangular	√ 3	1	1	± 2.3 %	± 2.3 %	∞
SAR correction	± 1.9 %	Rectangular	√ 3	1	0.84	± 1.1 %	± 0.9 %	∞
Liquid conductivity (meas.)	± 5.0 %	Normal	1	0.78	0.71	± 3.9 %	± 3.6 %	∞
Liquid permittivity (meas.)	± 5.0 %	Normal	1	0.26	0.26	± 1.3 %	± 1.3 %	∞
Temp. unc. - Conductivity	± 1.7 %	Rectangular	√ 3	0.78	0.71	± 0.8 %	± 0.7 %	∞
Temp. unc. - Permittivity	± 0.3 %	Rectangular	√ 3	0.23	0.26	± 0.0 %	± 0.0 %	∞
Combined Uncertainty						± 9.1 %	± 8.9 %	330
Expanded Std. Uncertainty						± **18.2** %	± **17.9** %	

Table 9: Measurement uncertainties of the System Check with DASY5 (0.3-3GHz)

Uncertainty of a System Performance Check with DASY5 System for the 3 - 6 GHz range								
Source of uncertainty	Uncertainty Value	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)	v_i^2 or v_{eff}
Measurement System								
Probe calibration	± 6.6 %	Normal	1	1	1	± 6.6 %	± 6.6 %	∞
Axial isotropy	± 4.7 %	Rectangular	√ 3	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical isotropy	± 0.0 %	Rectangular	√ 3	0.7	0.7	± 0.0 %	± 0.0 %	∞
Boundary effects	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Probe linearity	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
Integration time	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
RF ambient conditions	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
Probe positioner	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Probe positioning	± 6.7 %	Rectangular	√ 3	1	1	± 3.9 %	± 3.9 %	∞
Max. SAR evaluation	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Test Sample Related								
Dev. of experimental dipole	± 0.0 %	Rectangular	√ 3	1	1	± 0.0 %	± 0.0 %	∞
Source to liquid distance	± 2.0 %	Rectangular	√ 3	1	1	± 1.2 %	± 1.2 %	∞
Power drift	± 3.4 %	Rectangular	√ 3	1	1	± 2.0 %	± 2.0 %	∞
Phantom and Set-up								
Phantom uncertainty	± 4.0 %	Rectangular	√ 3	1	1	± 2.3 %	± 2.3 %	∞
SAR correction	± 1.9 %	Rectangular	√ 3	1	0.84	± 1.1 %	± 0.9 %	∞
Liquid conductivity (meas.)	± 5.0 %	Normal	1	0.78	0.71	± 3.9 %	± 3.6 %	∞
Liquid permittivity (meas.)	± 5.0 %	Normal	1	0.26	0.26	± 1.3 %	± 1.3 %	∞
Temp. unc. - Conductivity	± 1.7 %	Rectangular	√ 3	0.78	0.71	± 0.8 %	± 0.7 %	∞
Temp. unc. - Permittivity	± 0.3 %	Rectangular	√ 3	0.23	0.26	± 0.0 %	± 0.0 %	∞
Combined Uncertainty						± 10.1 %	± 10.0 %	330
Expanded Std. Uncertainty						± **20.2** %	± **19.9** %	

Table 10: Measurement uncertainties of the System Check with DASY5 (3-6GHz)

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

6.1.13 System check

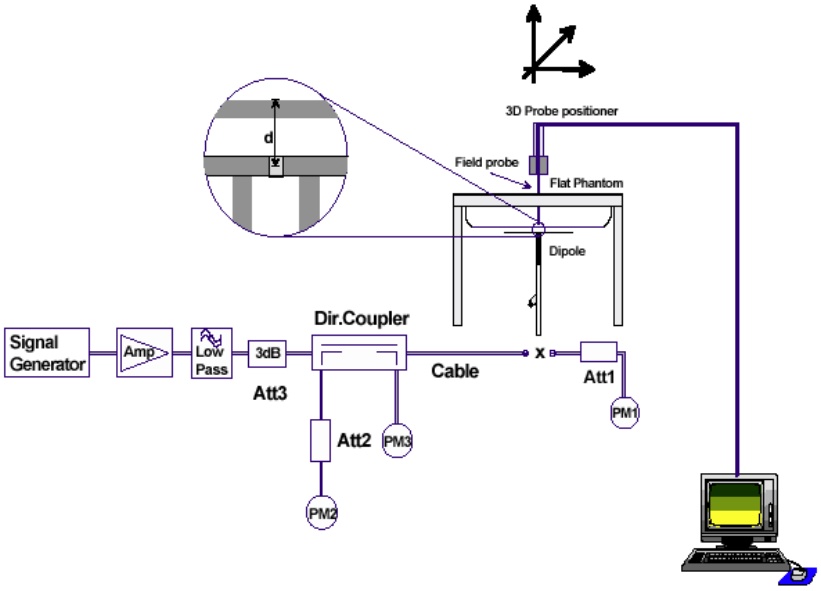
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE 1528. The following table shows system check results for all frequency bands and tissue liquids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

System performence check (1000 mW)								
System validation Kit	Frequency	Target SAR_{1g} (+/- 10%)	Target SAR_{10g} (+/- 10%)	Measured SAR_{1g} mW/g	SAR_{1g} dev. %	Measured SAR_{10g} mW/g	SAR_{10g} dev. %	Measured date
D2450V2 S/N: 710	2450 MHz body	51.20	23.90	54.00	5.5%	24.50	2.5%	2013-10-22
D2450V2 S/N: 710	2450 MHz body	51.20	23.90	54.10	5.7%	24.30	1.7%	2013-10-30
D5GHzV2 S/N: 1055	5200 MHz body	74.20	20.80	73.30	-1.2%	20.50	-1.4%	2013-10-24
D5GHzV2 S/N: 1055	5500 MHz body	77.90	21.70	79.30	1.8%	21.90	0.9%	2013-10-24
D5GHzV2 S/N: 1055	5800 MHz body	73.30	20.20	75.70	3.3%	21.00	4.0%	2013-10-24
D5GHzV2 S/N: 1055	5200 MHz body	74.20	20.80	72.70	-2.0%	20.20	-2.9%	2013-10-29
D5GHzV2 S/N: 1055	5500 MHz body	77.90	21.70	79.40	1.9%	22.10	1.8%	2013-10-29
D5GHzV2 S/N: 1055	5800 MHz body	73.30	20.20	73.60	0.4%	20.30	0.5%	2013-10-29

Table 11: Results system check

6.1.14 System check procedure

The system check is performed by using a validation dipole which is positioned parallel to the planar part of the SAM phantom at the reference point. The distance of the dipole to the SAM phantom is determined by a plexiglass spacer. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 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.



6.1.15 System validation

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

The following table lists the system validations relevant for this test report:

Frequency/ MHz	Liquid type	Probe / SN	DAE type / SN	Dipole type / SN	DASY software	Date
2450	Body	ET3DV6/ 1558	DAE3 / 477	D2450V2 / 710	V52.8	2013-09
5200	Body	EX3DV4/ 3944	DAE3 / 477	D5GHzV2 / 1055	V52.8	2013-09
5300	Body	EX3DV4/ 3944	DAE3 / 477	D5GHzV2 / 1055	V52.8	2013-09
5500	Body	EX3DV4/ 3944	DAE3 / 477	D5GHzV2 / 1055	V52.8	2013-09
5600	Body	EX3DV4/ 3944	DAE3 / 477	D5GHzV2 / 1055	V52.8	2013-09
5800	Body	EX3DV4/ 3944	DAE3 / 477	D5GHzV2 / 1055	V52.8	2013-09

7 Detailed Test Results

7.1 Conducted power measurements

7.1.1 Conducted power measurements WLAN 2.4 GHz

Channel / frequency	modulation	bit rate	time based avg. power
1 / 2412 MHz	CCK	1 MBit/s	**13.3dBm**
6 / 2437 MHz	CCK	1 MBit/s	**13.4dBm**
11 / 2462 MHz	CCK	1 MBit/s	**13.7dBm**
1 / 2412 MHz	OFDM	6 MBit/s	13.2dBm
6 / 2437 MHz	OFDM	6 MBit/s	13.3dBm
11 / 2462 MHz	OFDM	6 MBit/s	13.3dBm
1 / 2412 MHz	OFDM	6.5 MBit/s	8.6dBm
6 / 2437 MHz	OFDM	6.5 MBit/s	13.5dBm
11 / 2462 MHz	OFDM	6.5 MBit/s	9dBm

Table 12: Test results conducted power measurement WLAN 2.4 GHz

7.1.2 Conducted power measurements WLAN 5 GHz

Conducted time based avg. power measurement WLAN 5 GHz (dBm)					
Channel	Frequency (MHz)	modulation	6 MBit/s	6.5 MBit/s	13.5 MBit/s
36	5180	OFDM	**15.8**	14.4	11.2
40	5200	OFDM	15.6	14.7	
44	5220	OFDM	15.0	14.0	15.5
48	5240	OFDM	14.8	13.9	
52	5260	OFDM	15.1	14.1	15.1
56	5280	OFDM	15.4	14.0	
60	5300	OFDM	**15.5**	13.7	13.3
64	5320	OFDM	15.3	14.9	
100	5500	OFDM	15.3	15.2	15.2
104	5520	OFDM	15.5	15.7	
108	5540	OFDM	15.4	15.4	15.6
112	5560	OFDM	**15.7**	15.1	
116	5580	OFDM	15.5	15.1	15.7
120	5600	OFDM	15.1	15.3	
124	5620	OFDM	15.3	15.8	15.7
128	5640	OFDM	15.5	15.7	
132	5660	OFDM	15.6	15.4	15.4
136	5680	OFDM	15.6	15.6	
140	5700	OFDM	15.6	15.7	---
149	5745	OFDM	14.3	14.2	14.2
153	5765	OFDM	14.8	14.8	
157	5785	OFDM	14.5	14.7	14.7
161	5805	OFDM	**14.8**	14.7	
165	5825	OFDM	14.7	14.6	---

Table 13: Test results conducted power measurement WLAN 5 GHz

7.1.3 Standalone SAR Test Exclusion

Standalone SAR test exclusion considerations for **body** position						
Communication system	freq. (MHz)	distance (mm)	P_{avg}* (dBm)	P_{avg}* (mW)	**threshold$_{1\text{-}g}$ comparison value**	SAR test exclusion
WLAN 2450	2450	10	15.0	31.6	4.9	no
WLAN 5.2 GHz	5200	10	16.0	39.8	9.1	no
WLAN 5.3 GHz	5300	10	16.0	39.8	9.2	no
WLAN 5.6 GHz	5600	10	16.0	39.8	9.4	no
WLAN 5.8 GHz	5800	10	15.0	31.6	7.6	no
MBAN 1 ID248	2400	10	7.1	5.1	0.8	yes
MBAN 2 ID251	2400	10	3.9	2.5	0.4	yes
SRR1	2450	10	5.4	3.5	0.5	yes
SRR2	2450	10	3.9	2.5	0.4	yes

Table 14: Standalone SAR test exclusion considerations in **body worn position**

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

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

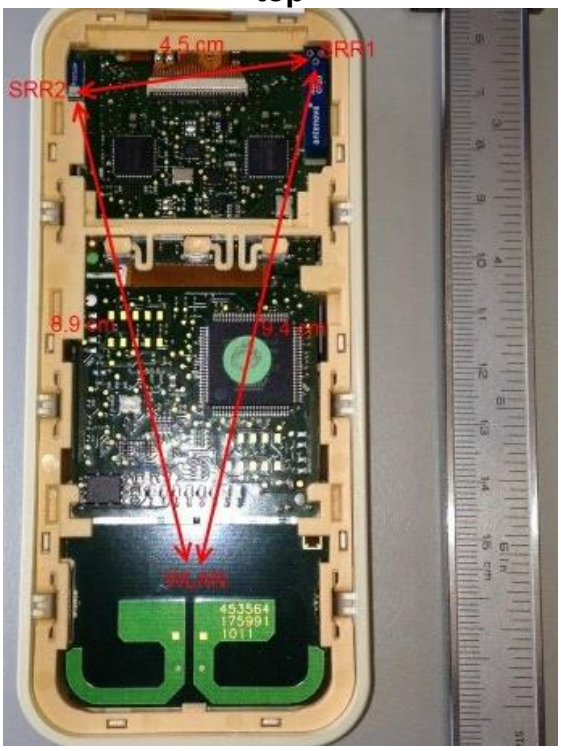
- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

7.1.4 SAR measurement positions

SAR measurement positions						
mode	front	rear	left edge	right edge	top edge	bottom edge
WLAN 2450	yes	yes	yes	yes	no	yes
WLAN 5.2 GHz	yes	yes	yes	yes	no	yes
WLAN 5.3 GHz	yes	yes	yes	yes	no	yes
WLAN 5.6 GHz	yes	yes	yes	yes	no	yes
WLAN 5.8 GHz	yes	yes	yes	yes	no	yes

top

left



right

bottom

Antenna dimensions and separation distances

Note:
The min. 100 mm distance of the WLAN antenna to top side SAR test exclusion for adjacent edge is possible according to KDB 447498 D01v05 chapter 4.3.1 2) or Appendix A/B.

Adjacent edge SAR test exclusion considerations						
Communication system	freq. (MHz)	P_{avg}* (dBm)	P_{avg}* (mW)	distance (mm)	**exclusion threshold$_{1g}$ (mW)**	SAR test exclusion
WLAN 2450	2450	15.0	**31.6**	100.0	**191.7**	yes
WLAN 5.2 GHz	5200	16.0	**39.8**	100.0	**131.6**	yes
WLAN 5.3 GHz	5300	16.0	**39.8**	100.0	**130.3**	yes
WLAN 5.6 GHz	5600	16.0	**39.8**	100.0	**126.8**	yes
WLAN 5.8 GHz	5800	15.0	**31.6**	100.0	**124.6**	yes

Table 15: Adjacent edge SAR test exclusion considerations

7.2 SAR test results

7.2.1 Results overview

measured / extrapolated SAR numbers - WLAN 2450 MHz									
Ch.	Freq. (MHz)	Test condition	distance (mm)	Position	cond. P_{max} (dBm)		SAR_{1g} results(W/kg)		liquid (°C)
					declared*	measured	measured	extrapolated	
1	2412	1Mbit/s	**10**	front	15.0	13.3	0.193	**0.285**	21.6
6	2437	1Mbit/s	10	front	15.0	13.4	0.177	0.256	21.6
11	2462	1Mbit/s	10	front	15.0	13.7	0.139	0.188	21.6
11	2462	1Mbit/s	0	rear	15.0	13.7	0.101	0.136	21.6
11	2462	1Mbit/s	**0**	bottom	15.0	13.7	0.551	**0.743**	21.6
11	2462	1Mbit/s	0	left	15.0	13.7	0.044	0.059	21.6
11	2462	1Mbit/s	0	right	15.0	13.7	0.089	0.120	21.6

Table 16: Test results SAR WLAN 2450 MHz (see max. SAR plots Annex B.1: WLAN 2450 MHz)

* - maximum possible output power declared by manufacturer

measured / extrapolated SAR numbers - Body worn - WLAN 5 GHz									
Ch.	Freq. (MHz)	Test condition	distance (mm)	Position	cond. P_{max} (dBm)		SAR_{1g} results(W/kg)		liquid (°C)
					declared**	measured	measured	extrapolated	
36	5180	6Mbit/s	10	front	16.0	15.8	0.214	0.224	21.2
60	5300	6Mbit/s	10	front	16.0	15.5	0.132	0.148	21.2
112	5560	6Mbit/s	10	front	16.0	15.7	0.224	0.240	21.2
161	5805	6Mbit/s	**10**	front	15.0	14.8	**0.320**	**0.335**	21.2
36	5180	6Mbit/s	0	rear	16.0	15.8	0.035	0.037	21.2
60	5300	6Mbit/s	0	rear	16.0	15.5	0.034	0.038	21.6
112	5560	6Mbit/s	0	rear	16.0	15.7	0.023	0.025	21.6
161	5805	6Mbit/s	0	rear	15.0	14.8	0.036	0.038	21.6
36	5180	6Mbit/s	**0**	bottom	16.0	15.8	0.288	**0.302**	21.2
60	5300	6Mbit/s	0	bottom	16.0	15.5	0.213	0.239	21.6
112	5560	6Mbit/s	0	bottom	16.0	15.7	0.201	0.215	21.6
161	5805	6Mbit/s	0	bottom	15.0	14.8	0.131	0.137	21.6
36	5180	6Mbit/s	0	left	16.0	15.8	0.070	0.073	21.2
60	5300	6Mbit/s	0	left	16.0	15.5	0.081	0.091	21.6
112	5560	6Mbit/s	0	left	16.0	15.7	0.102	0.109	21.6
161	5805	6Mbit/s	0	left	15.0	14.8	0.073	0.076	21.6
36	5180	6Mbit/s	0	right	16.0	15.8	0.099	0.104	21.2
60	5300	6Mbit/s	0	right	16.0	15.5	0.080	0.090	21.6
112	5560	6Mbit/s	0	right	16.0	15.7	0.044	0.047	21.6
161	5805	6Mbit/s	0	right	15.0	14.8	0.035	0.037	21.6

Table 17: Test results body worn SAR WLAN 5 GHz (see max. SAR plots Annex B.2: WLAN 5GHz)
** - maximum possible output power declared by manufacturer

7.2.2 General description of test procedures

- The DUT is tested using the test software 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 above are in accordance with the specified test standard.
- WLAN was tested in 802.11a/b mode with 1 MBit/s and 6 MBit/s. According to KDB 248227 the SAR testing for 802.11g/n is not required since the maximum power of 802.11g/n is less ¼ dB higher than maximum power of 802.11a/b.
- Required WLAN test channels were selected according to KDB 248227
- According to IEEE 1528 the SAR test shall be performed at middle channel. Testing of top and bottom channel is optional.
- 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
- The DUT is tested using the test software to set test channels and maximum output power to the DUT, as well as for measuring the conducted peak power. The followings power settings declared by the manufacturer were used by the control software. All measurements were performed with the specified settings.

Band	Power setting
2.400 – 2.483 GHz	14 dBm
5.180 GHz	14 dBm
5.300 GHz	12 dBm
5.560 GHz	12 dBm
5.805 GHz	11 dBm

7.2.3 Multiple Transmitter Information

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

reported SAR WLAN 2.4GHz / 5GHz, MBAN and SRR, ΣSAR_{1g} evaluation					
Frequency band	Position	SAR_{max} with 10 mm distance / W/kg			**ΣSAR_{1g}**
		WLAN	MBAN	SRR	<1.6W/kg
WLAN 2.4GHz	front	0.285	0.106	0.072	0.357
WLAN 5GHz	front	0.335	0.106	0.072	**0.407**
Frequency band	Position	SAR_{max} with 0 mm distance / W/kg			**ΣSAR_{1g}**
		WLAN	MBAN	SRR	<1.6W/kg
WLAN 2.4GHz	bottom	0.743	0.212	0.145	**0.888**
WLAN 5GHz	bottom	0.302	0.212	0.145	0.447

Table 18: SAR_{max} WLAN and **SRR 2.4GHz**, ΣSAR evaluation.

Minimum antenna separation distance between MAIN WLAN antenna and SRR antenna –110 **mm**

Estimated stand alone SAR_{1g}					
Communication system	freq. (GHz)	distance (mm)	P_{avg} (dBm)	P_{avg} (mW)	$estimated_{1-g}$ (W/kg)
MBAN 1 ID248	2.4	5	7.1	5.1	0.212
MBAN 2 ID251	2.4	5	5.5	3.5	0.147
SRR1	2.45	5	5.4	3.5	0.145
SRR2	2.45	5	3.9	2.5	0.102
MBAN 1 ID248	2.4	10	7.1	5.1	0.106
MBAN 2 ID251	2.4	10	5.5	3.5	0.073
SRR1	2.45	10	5.4	3.5	0.072
SRR2	2.45	10	3.9	2.5	0.051

Table 19: Estimated stand alone SAR_{max} for **SRR** and **MBAN** body

When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:
(*max. power of channel, including* ***tune-up tolerance****, mW*)/(*min. test separation distance, mm*)]·[√f(GHz)/*x*] W/kg for *test separation distances* ≤ 50 mm;
where *x* = 7.5 for 1-g SAR.
When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

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 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	ET3DV6	Schmid & Partner Engineering AG	1558	August 22, 2013	12
Dosimetric E-Field Probe	EX3DV4	Schmid & Partner Engineering AG	3944	August 02, 2013	12
2450 MHz System Validation Dipole	D2450V2	Schmid & Partner Engineering AG	710	August 13, 2012	24
5 GHz System Validation Dipole	D5GHzV 2	Schmid & Partner Engineering AG	1055	August 19, 2013	24
Data acquisition electronics	DAE3V1	Schmid & Partner Engineering AG	477	May 13, 2013	12
Software	DASY52 52.8.7	Schmid & Partner Engineering AG	---	N/A	--
Phantom	SAM	Schmid & Partner Engineering AG	---	N/A	--
Network Analyser 300 kHz to 6 GHz	8753ES	Hewlett Packard)*	US39174436	February 24, 2012	24
Dielectric Probe Kit	85070C	Hewlett Packard	US99360146	N/A	12
Signal Generator	8671B	Hewlett Packard	2823A00656	January 15, 2013	24
Amplifier	25S1G4 (25 Watt)	Amplifier Reasearch	20452	N/A	--
Power Meter	NRP	Rohde & Schwarz	101367	January 15, 2013	24
Power Meter Sensor	NRP Z22	Rohde & Schwarz	100227	January 14, 2013	12
Power Meter Sensor	NRP Z22	Rohde & Schwarz	100234	January 14, 2013	12
Directional Coupler	778D	Hewlett Packard	19171	January 14, 2013	12

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

9 Observations

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

Annex A: System performance check

Date/Time: 22.10.2013 10:05:13

SystemPerformanceCheck-D2450 body 2013-10-22

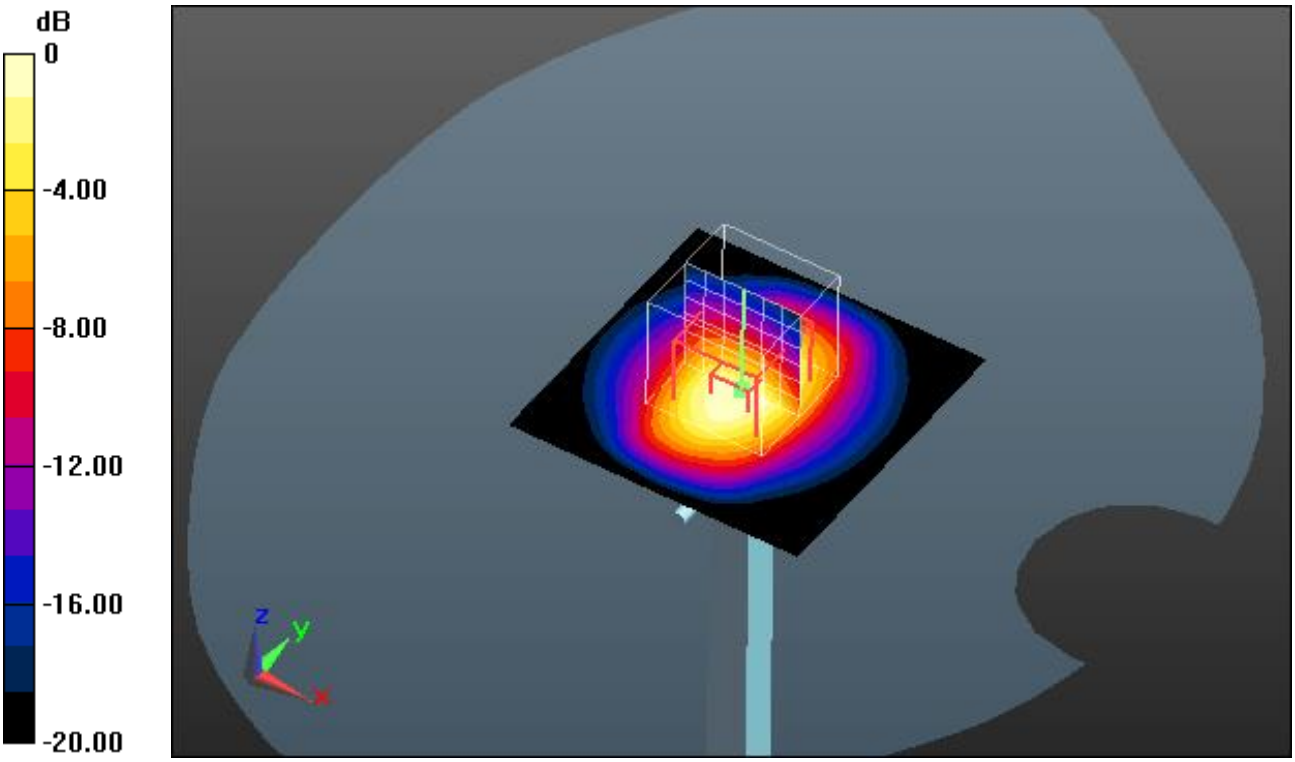
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 710
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 2450 MHz; σ = 1.973 S/m; ε_r = 51.281; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: ET3DV6 - SN1558; ConvF(3.81, 3.81, 3.81); Calibrated: 22.08.2013;
- Sensor-Surface: 4mm (Mechanical Surface Detection), z = 2.7, 32.7
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL2450/d=10mm, Pin=100 mW, dist=4.0mm/Area Scan (51x51x1):

Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 7.60 W/kg

MSL2450/d=10mm, Pin=100 mW, dist=4.0mm/Zoom Scan/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 56.505 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 13.2 W/kg
SAR(1 g) = 5.4 W/kg; SAR(10 g) = 2.45 W/kg
Maximum value of SAR (measured) = 5.95 W/kg



0 dB = 5.95 W/kg = 7.75 dBW/kg

Additional information:
ambient temperature: 22.0°C; liquid temperature: 21.6°C

Date/Time: 30.10.2013 15:48:28

SystemPerformanceCheck-D2450 head 2013-10-30

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 710

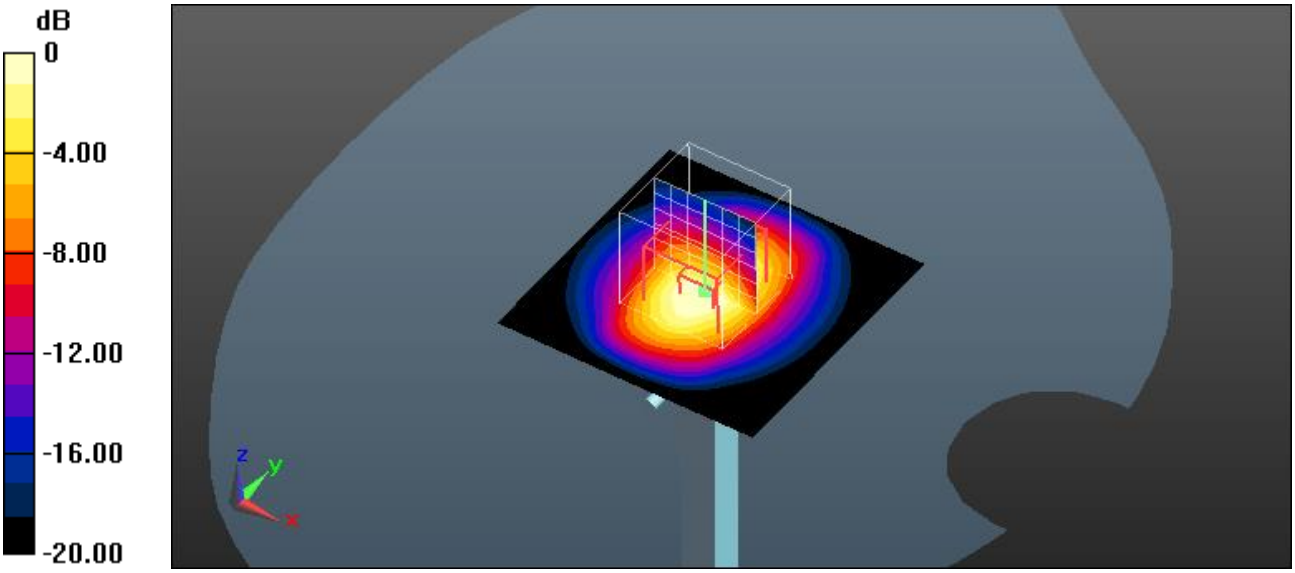
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 2450 MHz; σ = 1.973 S/m; ε_r = 51.281; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: ET3DV6 - SN1558; ConvF(3.81, 3.81, 3.81); Calibrated: 22.08.2013;
- Sensor-Surface: 4mm (Mechanical Surface Detection), z = 2.7, 32.7
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL2450/d=10mm, Pin=100 mW, dist=4.0mm/Area Scan (51x51x1):

Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 7.63 W/kg

MSL2450/d=10mm, Pin=100 mW, dist=4.0mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 56.341 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 13.2 W/kg
SAR(1 g) = 5.41 W/kg; SAR(10 g) = 2.43 W/kg
Maximum value of SAR (measured) = 6.00 W/kg



0 dB = 6.00 W/kg = 7.78 dBW/kg

Additional information:
ambient temperature: 22.2°C; liquid temperature: 21.8°C

Date/Time: 24.10.2013 09:20:04

SystemPerformanceCheck-D5GHz-body 2013-10-24

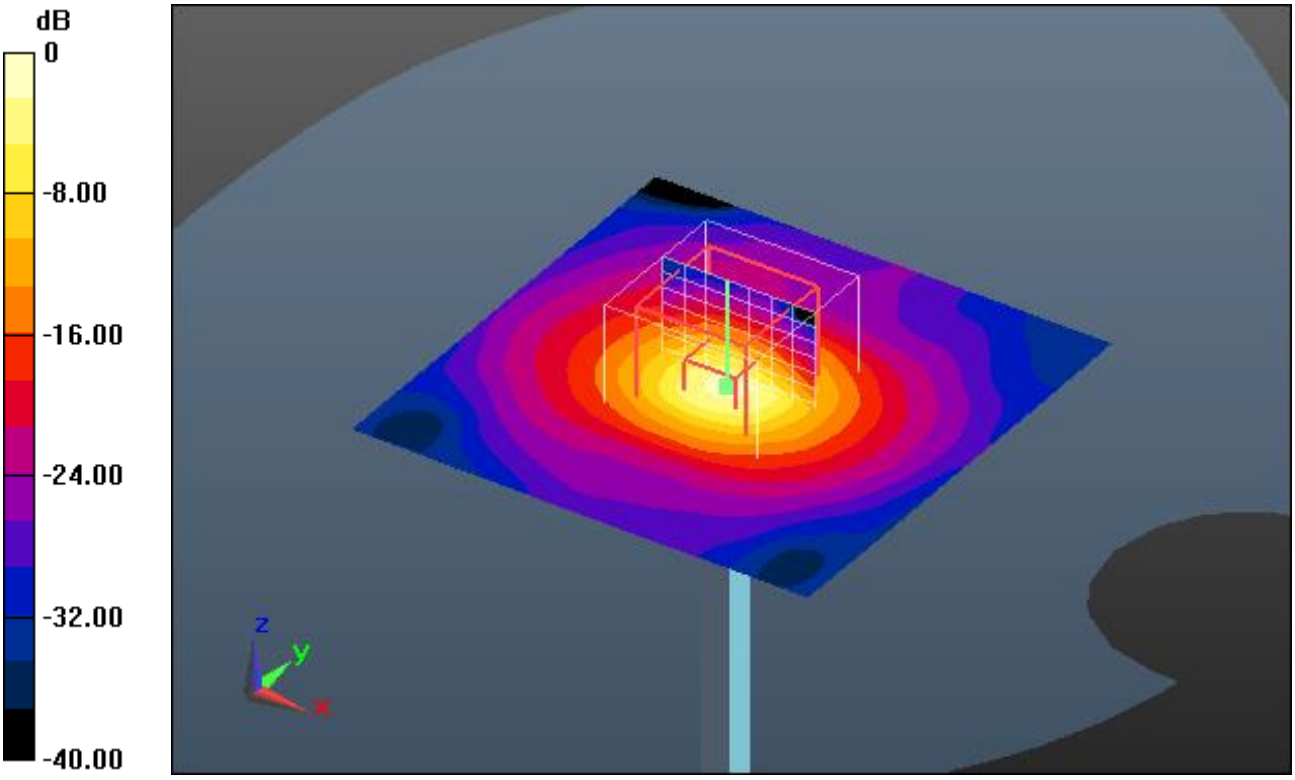
DUT: Dipole 5 GHz; Type: D5GHzV2; Serial: 1055
Communication System: UID 0, CW; Communication System Band: 5 GHz; Frequency: 5200 MHz;
Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5200 MHz; σ = 5.34 S/m; ε_r = 48.02; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: EX3DV4 - SN3944; ConvF(4.47, 4.47, 4.47); Calibrated: 02.08.2013;
- Sensor-Surface: 4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 22.0
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL/d=10mm, Pin=100mW 5.2GHz/Area Scan (91x91x1): Interpolated grid:

dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 9.87 W/kg

MSL/d=10mm, Pin=100mW 5.2GHz/Zoom Scan (8x8x8) (8x8x8)/Cube 0:

Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm
Reference Value = 41.083 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 28.8 W/kg
SAR(1 g) = 7.33 W/kg; SAR(10 g) = 2.05 W/kg
Maximum value of SAR (measured) = 14.4 W/kg



0 dB = 14.4 W/kg = 11.58 dBW/kg

Additional information:
ambient temperature: 22.0°C; liquid temperature: 21.6°C

Date/Time: 24.10.2013 10:44:23

SystemPerformanceCheck-D5GHz-body 2013-10-24

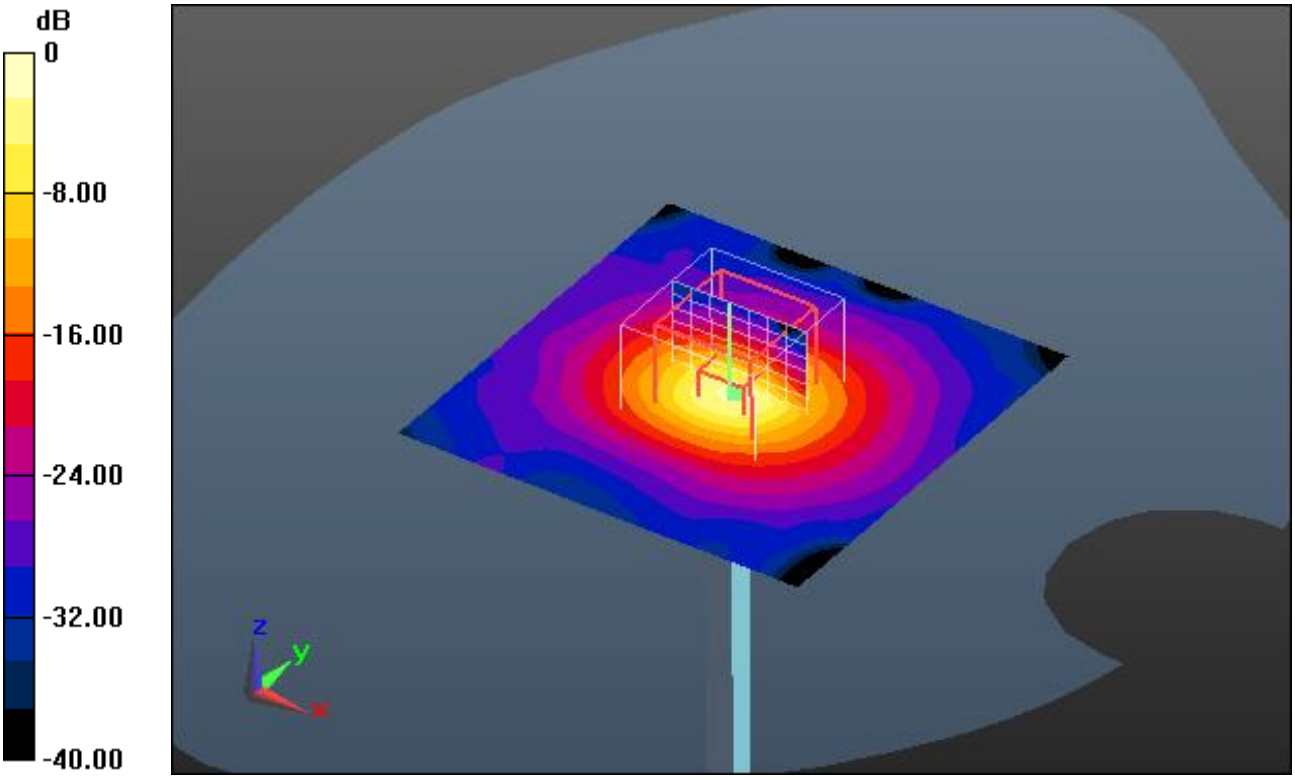
DUT: Dipole 5 GHz; Type: D5GHzV2; Serial: 1055
Communication System: UID 0, CW; Communication System Band: 5 GHz; Frequency: 5500 MHz;
Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5500 MHz; σ = 5.71 S/m; ε_r = 47.27; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: EX3DV4 - SN3944; ConvF(4.09, 4.09, 4.09); Calibrated: 02.08.2013;
- Sensor-Surface: 4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 22.0
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL/d=10mm, Pin=100mW 5.5GHz/Area Scan (91x91x1): Interpolated grid:

dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 10.1 W/kg

MSL/d=10mm, Pin=100mW 5.5GHz/Zoom Scan (8x8x8) (8x8x8)/Cube 0:

Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm
Reference Value = 40.919 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 32.8 W/kg
SAR(1 g) = 7.93 W/kg; SAR(10 g) = 2.19 W/kg
Maximum value of SAR (measured) = 16.1 W/kg



0 dB = 16.1 W/kg = 12.07 dBW/kg

Additional information:
ambient temperature: 22.0°C; liquid temperature: 21.6°C

Date/Time: 24.10.2013 11:07:06

SystemPerformanceCheck-D5GHz-body 2013-10-24

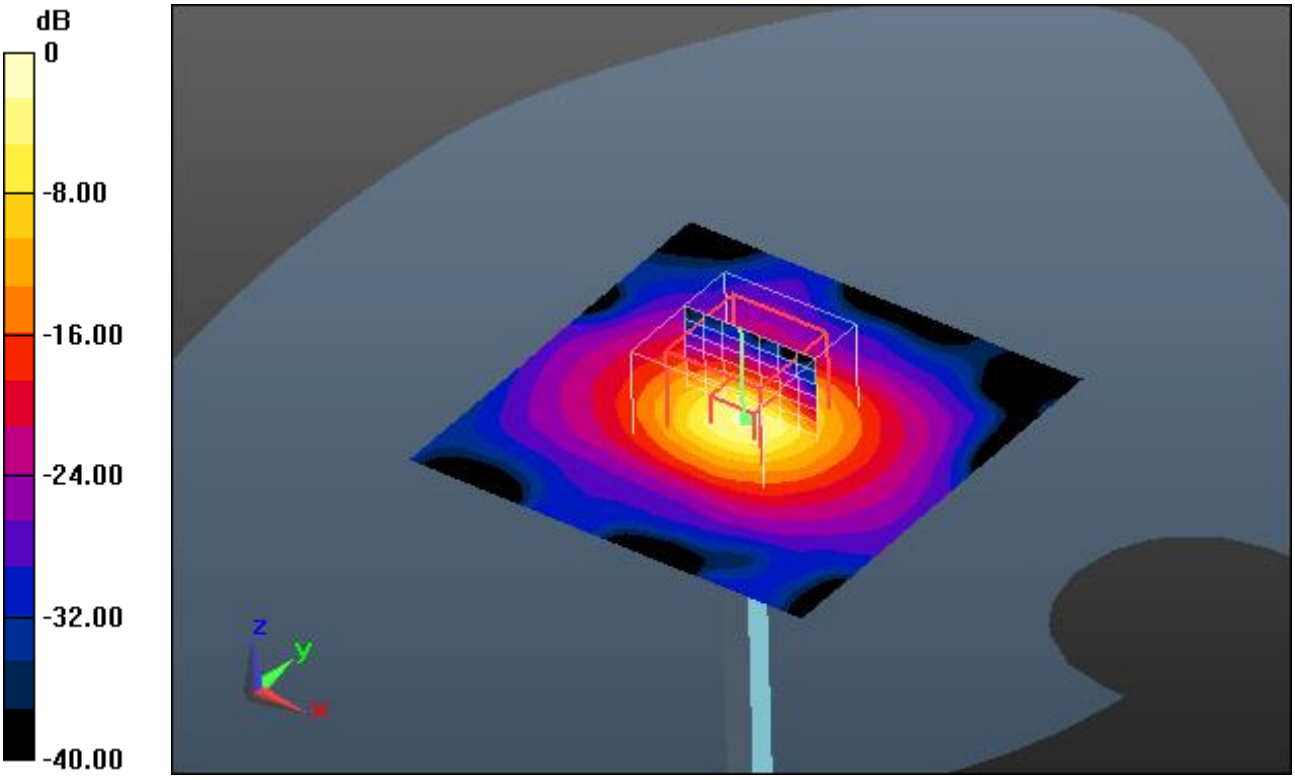
DUT: Dipole 5 GHz; Type: D5GHzV2; Serial: 1055
Communication System: UID 0, CW; Communication System Band: 5 GHz; Frequency: 5800 MHz;
Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5800 MHz; σ = 6.1 S/m; ε_r = 46.69; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: EX3DV4 - SN3944; ConvF(4.2, 4.2, 4.2); Calibrated: 02.08.2013;
- Sensor-Surface: 4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 22.0
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL/d=10mm, Pin=100mW 5.8GHz/Area Scan (91x91x1): Interpolated grid:

dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 9.41 W/kg

MSL/d=10mm, Pin=100mW 5.8GHz/Zoom Scan (8x8x8) (8x8x8)/Cube 0:

Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm
Reference Value = 38.160 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 32.9 W/kg
SAR(1 g) = 7.57 W/kg; SAR(10 g) = 2.1 W/kg
Maximum value of SAR (measured) = 15.2 W/kg



0 dB = 15.2 W/kg = 11.82 dBW/kg

Additional information:
ambient temperature: 22.0°C; liquid temperature: 21.6°C

Date/Time: 29.10.2013 7:54:42

SystemPerformanceCheck-D5GHz-body 2013-10-29

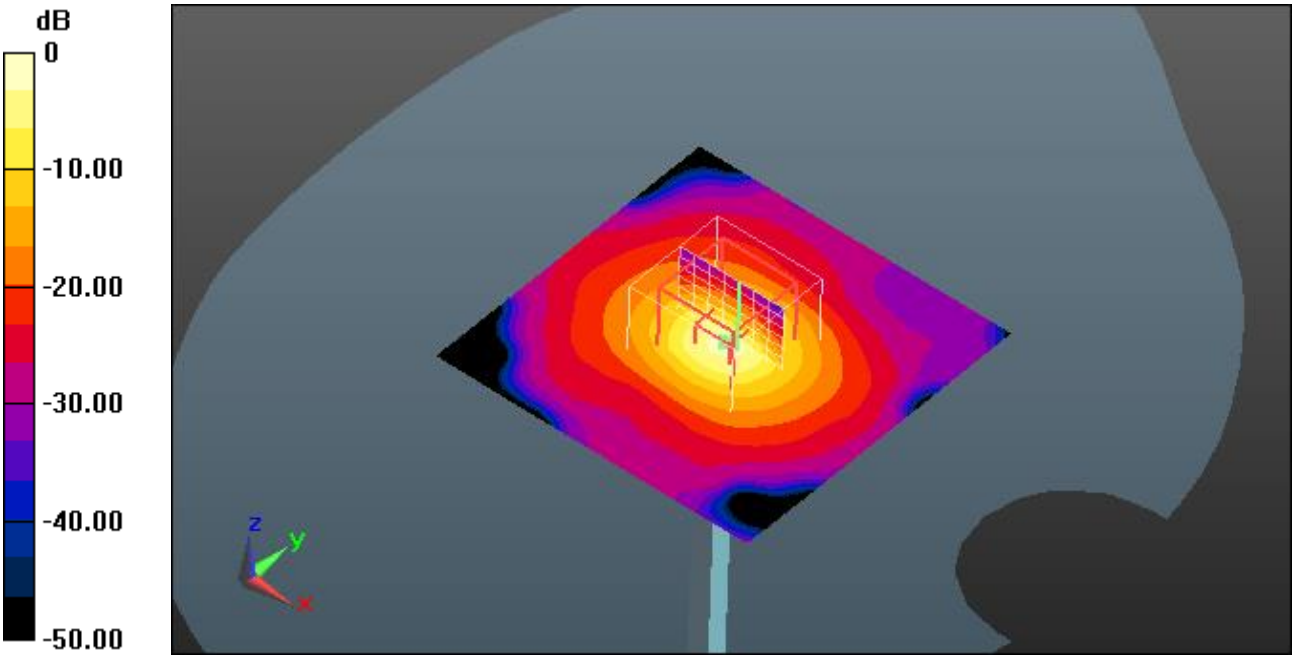
DUT: Dipole 5 GHz; Type: D5GHzV2; Serial: 1055
Communication System: UID 0, CW; Communication System Band: 5 GHz; Frequency: 5200 MHz;
Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5200 MHz; σ = 5.34 S/m; ε_r = 48.02; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: EX3DV4 - SN3944; ConvF(4.47, 4.47, 4.47); Calibrated: 02.08.2013;
- Sensor-Surface: 4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 22.0
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL/d=10mm, Pin=100mW 5.2GHz/Area Scan (91x91x1): Interpolated grid:

dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 8.83 W/kg

MSL/d=10mm, Pin=100mW 5.2GHz/Zoom Scan (8x8x8)/Cube 0: Measurement

grid: dx=4.3mm, dy=4.3mm, dz=3mm
Reference Value = 40.909 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 28.6 W/kg
SAR(1 g) = 7.27 W/kg; SAR(10 g) = 2.02 W/kg
Maximum value of SAR (measured) = 14.4 W/kg



0 dB = 14.4 W/kg = 11.58 dBW/kg

Additional information:
ambient temperature: 21.5°C; liquid temperature: 21.2°C

Date/Time: 29.10.2013 8:26:37

SystemPerformanceCheck-D5GHz-body 2013-10-29

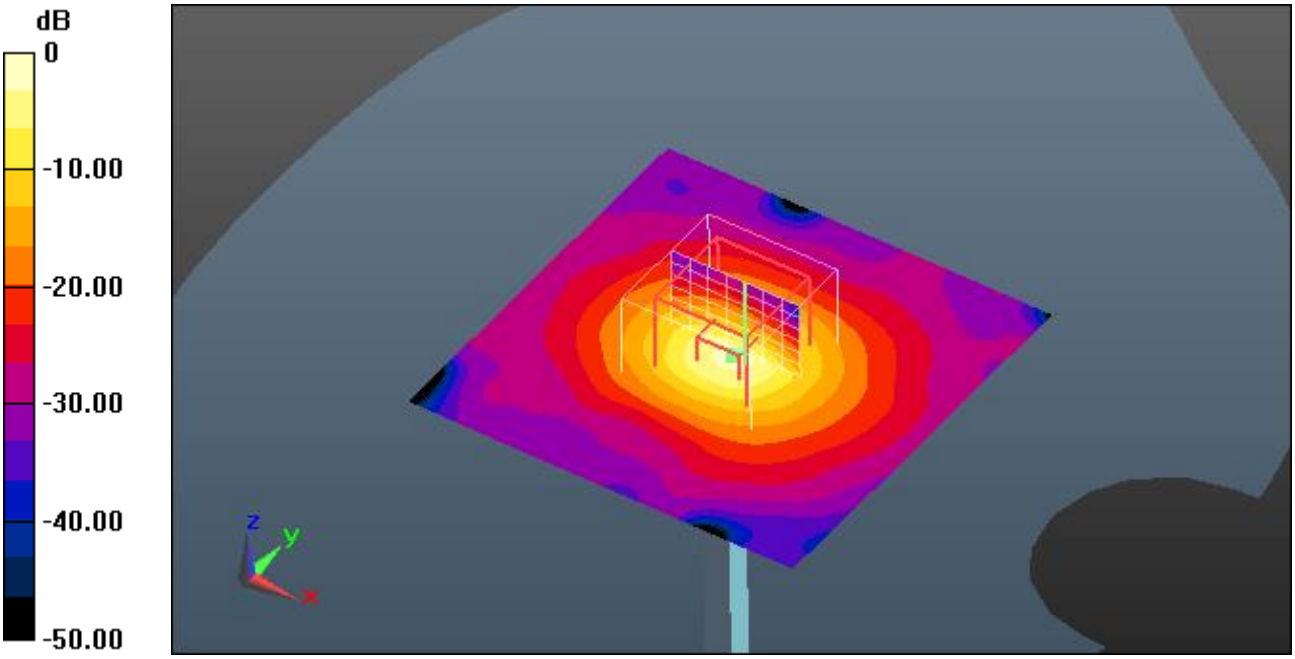
DUT: Dipole 5 GHz; Type: D5GHzV2; Serial: 1055
Communication System: UID 0, CW; Communication System Band: 5 GHz; Frequency: 5500 MHz;
Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5500 MHz; σ = 5.71 S/m; ε_r = 47.27; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: EX3DV4 - SN3944; ConvF(4.09, 4.09, 4.09); Calibrated: 02.08.2013;
- Sensor-Surface: 4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 22.0
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL/d=10mm, Pin=100mW 5.5GHz/Area Scan (91x91x1): Interpolated grid:

dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 9.40 W/kg

MSL/d=10mm, Pin=100mW 5.5GHz/Zoom Scan (8x8x8)/Cube 0: Measurement

grid: dx=4.3mm, dy=4.3mm, dz=3mm
Reference Value = 41.072 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 32.4 W/kg
SAR(1 g) = 7.94 W/kg; SAR(10 g) = 2.21 W/kg
Maximum value of SAR (measured) = 15.8 W/kg



0 dB = 15.8 W/kg = 11.99 dBW/kg

Additional information:
ambient temperature: 21.5°C; liquid temperature: 21.2°C

Date/Time: 29.10.2013 8:57:59

SystemPerformanceCheck-D5GHz-body 2013-10-29

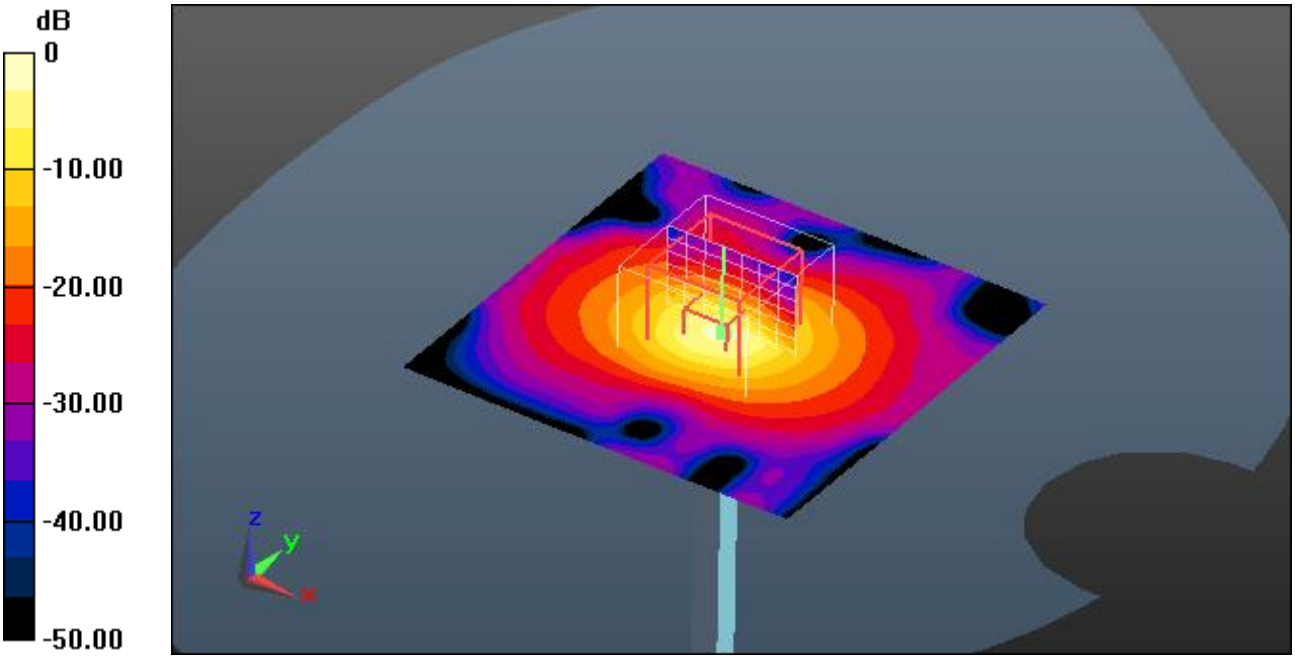
DUT: Dipole 5 GHz; Type: D5GHzV2; Serial: 1055
Communication System: UID 0, CW; Communication System Band: 5 GHz; Frequency: 5800 MHz;
Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5800 MHz; σ = 6.1 S/m; ε_r = 46.69; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: EX3DV4 - SN3944; ConvF(4.2, 4.2, 4.2); Calibrated: 02.08.2013;
- Sensor-Surface: 4mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 22.0
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL/d=10mm, Pin=100mW 5.8GHz/Area Scan (91x91x1): Interpolated grid:

dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 8.70 W/kg

MSL/d=10mm, Pin=100mW 5.8GHz/Zoom Scan (8x8x8)/Cube 0: Measurement

grid: dx=4.3mm, dy=4.3mm, dz=3mm
Reference Value = 37.175 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 32.5 W/kg
SAR(1 g) = 7.36 W/kg; SAR(10 g) = 2.03 W/kg
Maximum value of SAR (measured) = 15.3 W/kg



0 dB = 15.3 W/kg = 11.85 dBW/kg

Additional information:
ambient temperature: 21.5°C; liquid temperature: 21.2°C

Annex B: DASY5 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: WLAN 2450 MHz

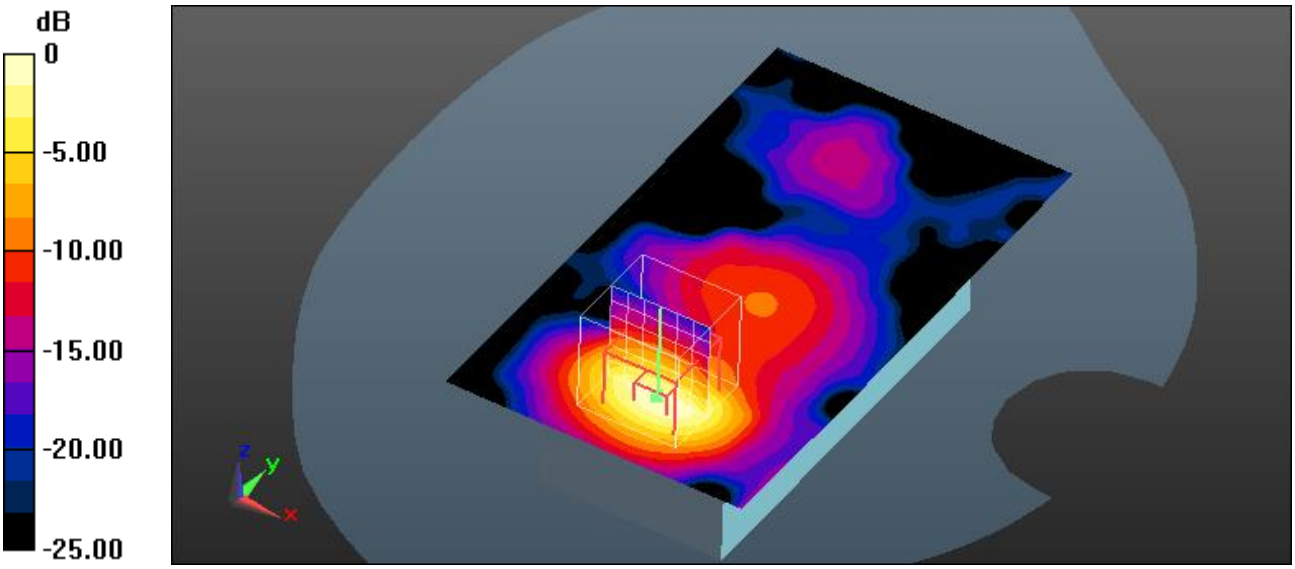
Date/Time: 30.10.2013 14:27:15

FCC_EN62209-2 WLAN2450 body worn - 10mm

DUT: Philips; Type: CL Transmitter; Serial: D932Y0201
Communication System: UID 0, WLAN 2450 (0); Communication System Band: 2.4 GHz; Frequency: 2412 MHz; Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 2412 MHz; σ = 1.933 S/m; ε_r = 51.351; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: ET3DV6 - SN1558; ConvF(3.81, 3.81, 3.81); Calibrated: 22.08.2013;
- Sensor-Surface: 4mm (Mechanical Surface Detection), z = 2.7, 32.7
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL2450/Front Low 10mm/Area Scan (91x161x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.205 W/kg

MSL2450/Front Low 10mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.709 V/m; Power Drift = 0.14 dB
Peak SAR (extrapolated) = 0.488 W/kg
SAR(1 g) = 0.193 W/kg; SAR(10 g) = 0.085 W/kg
Maximum value of SAR (measured) = 0.211 W/kg



0 dB = 0.211 W/kg = -6.76 dBW/kg

Additional information:
position or distance of DUT to SAM: 10mm
ambient temperature: 22.2°C; liquid temperature: 21.8°C

Annex B.2: WLAN 5GHz

Date/Time: 29.10.2013 10:25:06

FCC_EN62209-2 WLAN 5GHz body worn

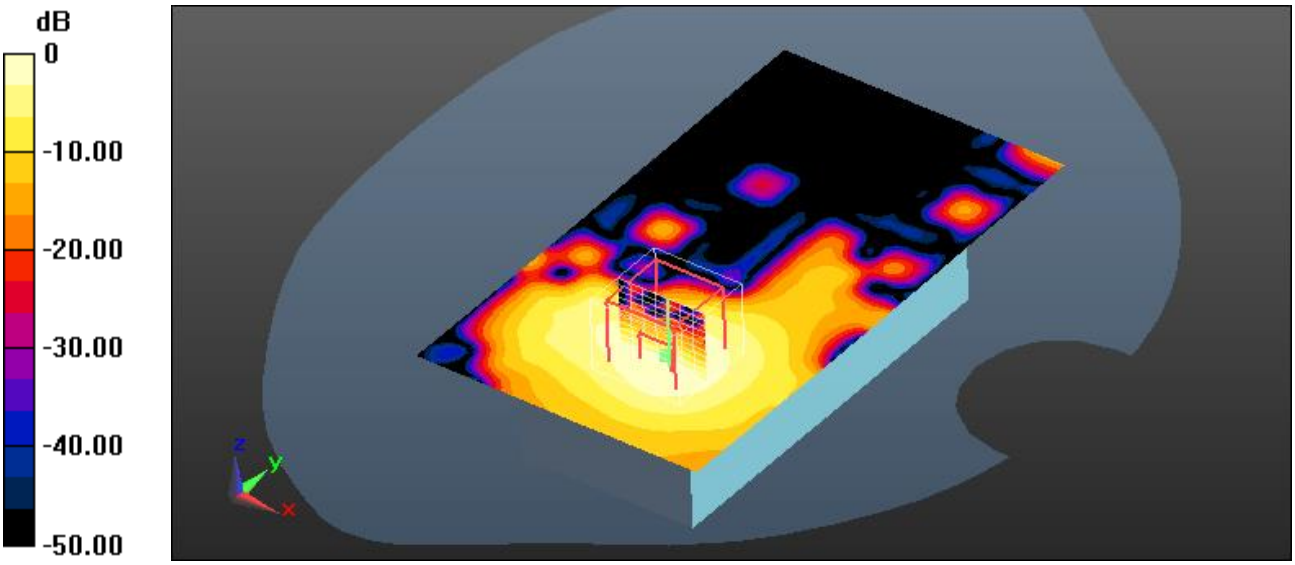
DUT: Philips; Type: CL Transmitter; Serial: D932Y0201
Communication System: UID 0, WLAN 5GHz (0); Communication System Band: 5 GHz Band; Frequency: 5180 MHz; Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5180 MHz; σ = 5.34 S/m; ε_r = 48.02; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: EX3DV4 - SN3944; ConvF(4.47, 4.47, 4.47); Calibrated: 02.08.2013;
- Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 23.0
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL-5/Front Ch36 10mm/Area Scan (91x161x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.372 W/kg

MSL-5/Front Ch36 10mm/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 8.644 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 0.713 W/kg
SAR(1 g) = 0.214 W/kg; SAR(10 g) = 0.084 W/kg
Maximum value of SAR (measured) = 0.368 W/kg



0 dB = 0.368 W/kg = -4.34 dBW/kg

Additional information:
position or distance of DUT to SAM: 10mm
ambient temperature: 21.5°C; liquid temperature: 21.2°C

Date/Time: 29.10.2013 10:59:34

FCC_EN62209-2 WLAN 5GHz body worn

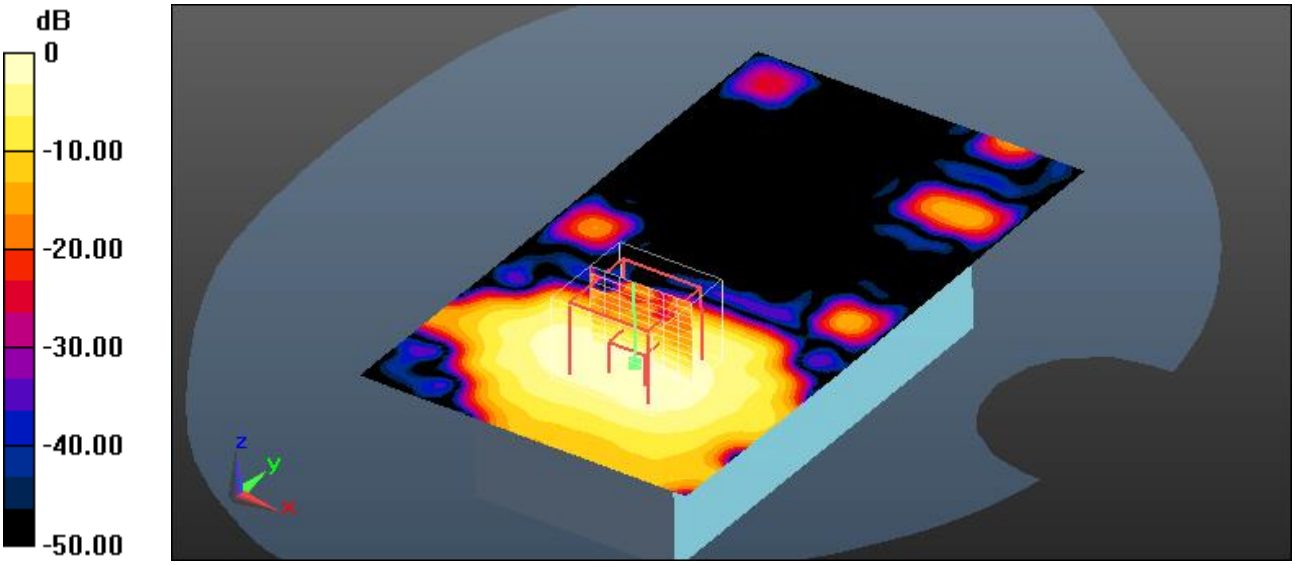
DUT: Philips; Type: CL Transmitter; Serial: D932Y0201
Communication System: UID 0, WLAN 5GHz (0); Communication System Band: 5 GHz Band; Frequency: 5300 MHz; Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5300 MHz; σ = 5.46 S/m; ε_r = 47.79; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: EX3DV4 - SN3944; ConvF(4.3, 4.3, 4.3); Calibrated: 02.08.2013;
- Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 23.0
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL-5/Front Ch60 10mm/Area Scan (91x161x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.240 W/kg

MSL-5/Front Ch60 10mm/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 7.057 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 0.474 W/kg
SAR(1 g) = 0.132 W/kg; SAR(10 g) = 0.052 W/kg
Maximum value of SAR (measured) = 0.241 W/kg



0 dB = 0.241 W/kg = -6.18 dBW/kg

Additional information:
position or distance of DUT to SAM: 10mm
ambient temperature: 21.5°C; liquid temperature: 21.2°C

Date/Time: 29.10.2013 11:34:35

FCC_EN62209-2 WLAN 5GHz body worn

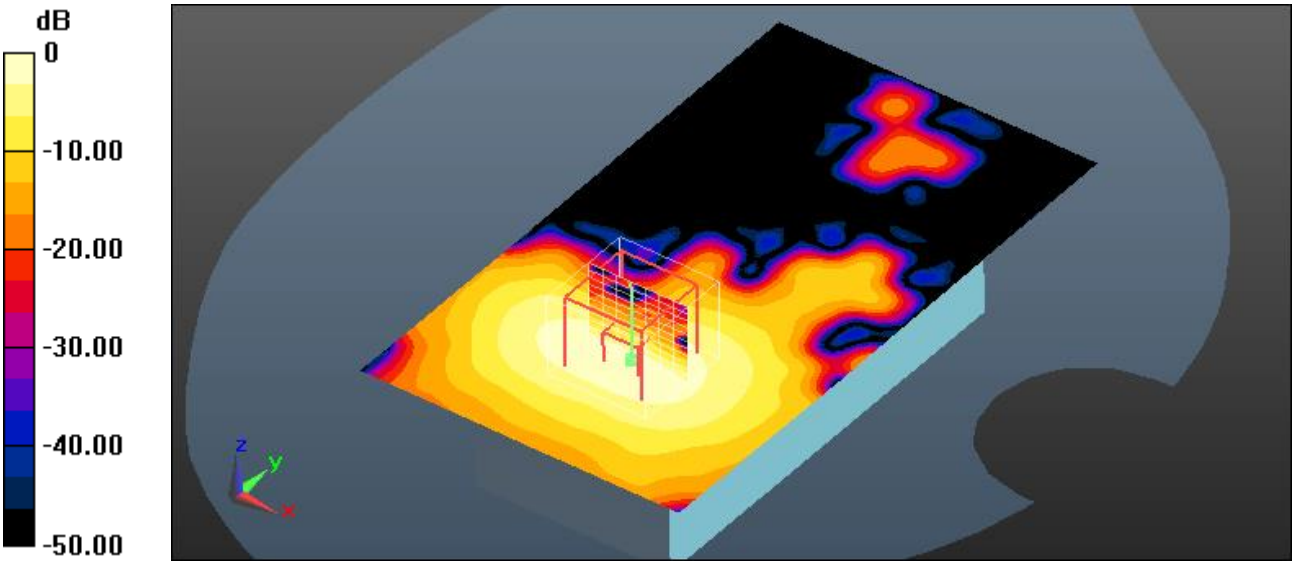
DUT: Philips; Type: CL Transmitter; Serial: D932Y0201
Communication System: UID 0, WLAN 5GHz (0); Communication System Band: 5 GHz Band; Frequency: 5560 MHz; Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5560 MHz; σ = 5.78 S/m; ε_r = 47.17; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: EX3DV4 - SN3944; ConvF(4.33, 4.33, 4.33); Calibrated: 02.08.2013;
- Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 23.0
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL-5/Front Ch112 10mm/Area Scan (91x161x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.424 W/kg

MSL-5/Front Ch112 10mm/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 8.981 V/m; Power Drift = -0.16 dB
Peak SAR (extrapolated) = 0.894 W/kg
SAR(1 g) = 0.224 W/kg; SAR(10 g) = 0.082 W/kg
Maximum value of SAR (measured) = 0.412 W/kg



0 dB = 0.412 W/kg = -3.85 dBW/kg

Additional information:
position or distance of DUT to SAM: 10mm
ambient temperature: 21.5°C; liquid temperature: 21.2°C

Date/Time: 29.10.2013 12:02:06

FCC_EN62209-2 WLAN 5GHz body worn

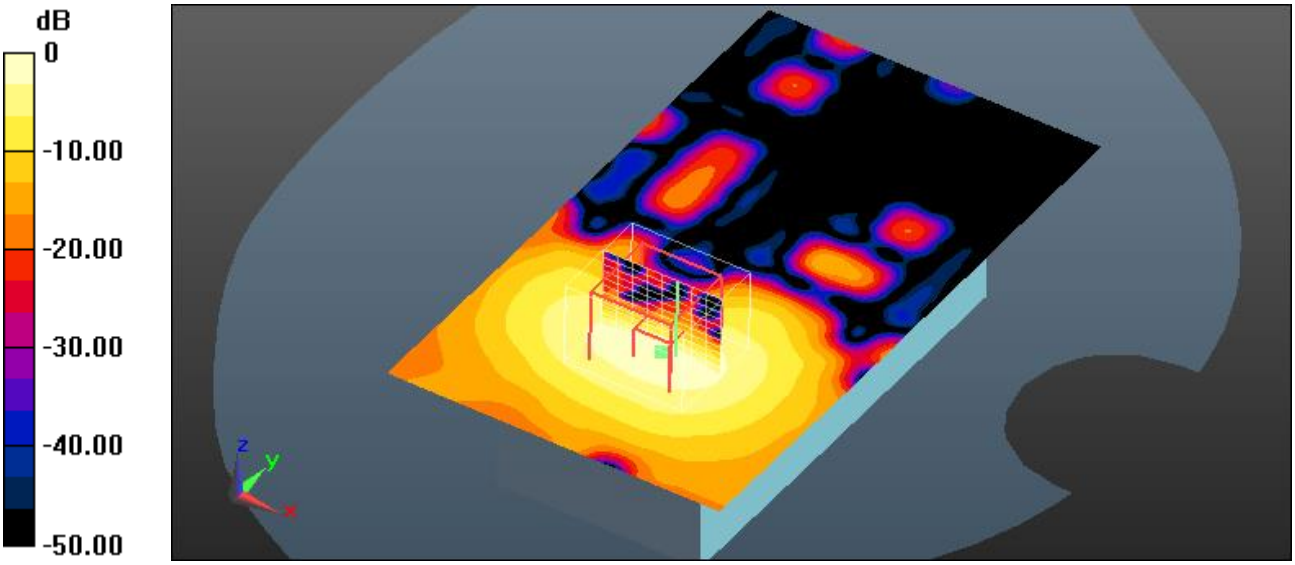
DUT: Philips; Type: CL Transmitter; Serial: D932Y0201
Communication System: UID 0, WLAN 5GHz (0); Communication System Band: 5 GHz Band; Frequency: 5805 MHz; Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 5805 MHz; σ = 6.12 S/m; ε_r = 46.68; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5
DASY5 Configuration:
- Probe: EX3DV4 - SN3944; ConvF(4.2, 4.2, 4.2); Calibrated: 02.08.2013;
- Sensor-Surface: 2mm (Mechanical Surface Detection (Locations From Previous Scan Used)), Sensor-Surface: 2mm (Mechanical Surface Detection), z = 1.0, 23.0
- Electronics: DAE3 Sn477; Calibrated: 13.05.2013
- Phantom: SAM front; Type: QD000P40CC; Serial: TP-1042
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

MSL-5/Front Ch161 10mm/Area Scan (91x161x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.585 W/kg

MSL-5/Front Ch161 10mm/Zoom Scan (9x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 10.872 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 1.24 W/kg
SAR(1 g) = 0.320 W/kg; SAR(10 g) = 0.115 W/kg
Maximum value of SAR (measured) = 0.605 W/kg



0 dB = 0.605 W/kg = -2.18 dBW/kg

Additional information:
position or distance of DUT to SAM: 10mm
ambient temperature: 21.5°C; liquid temperature: 21.2°C

Annex B.3: Liquid depth

Photo 1: Liquid depth 2450 MHz body simulating liquid

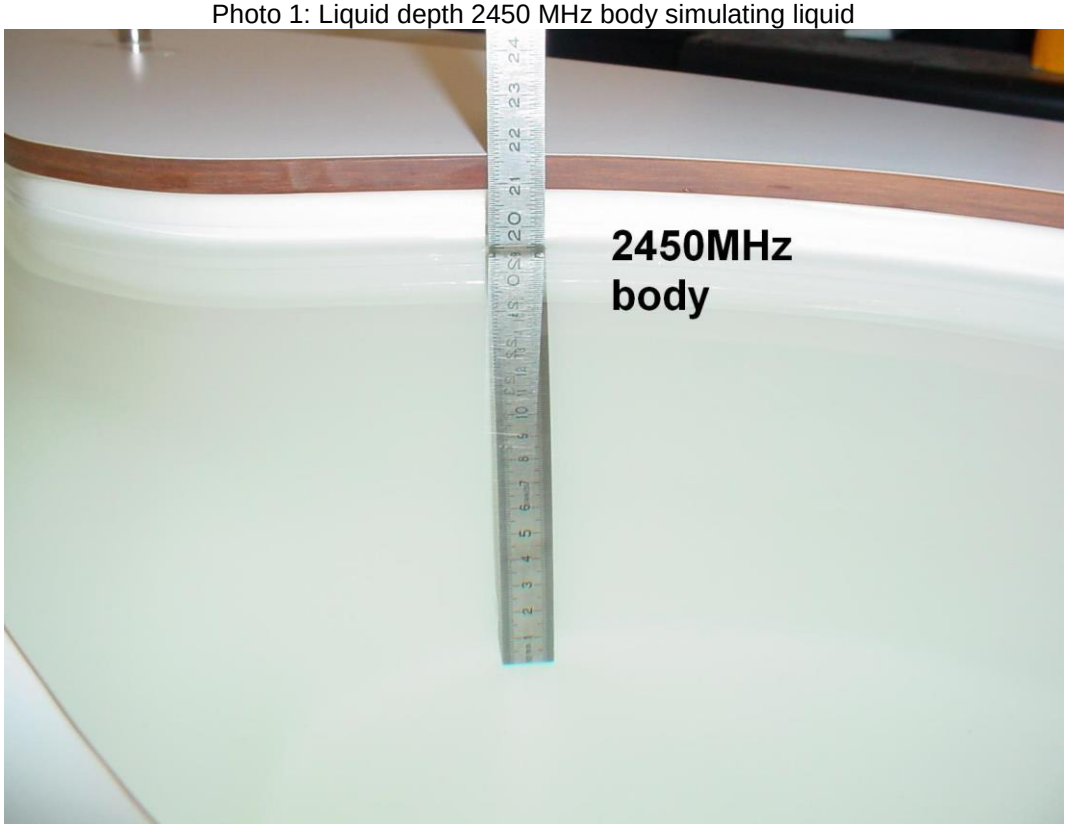


Photo 2: Liquid depth 5 GHz body simulating liquid

Annex C: Photo documentation

Photo 1: Measurement System DASY 5

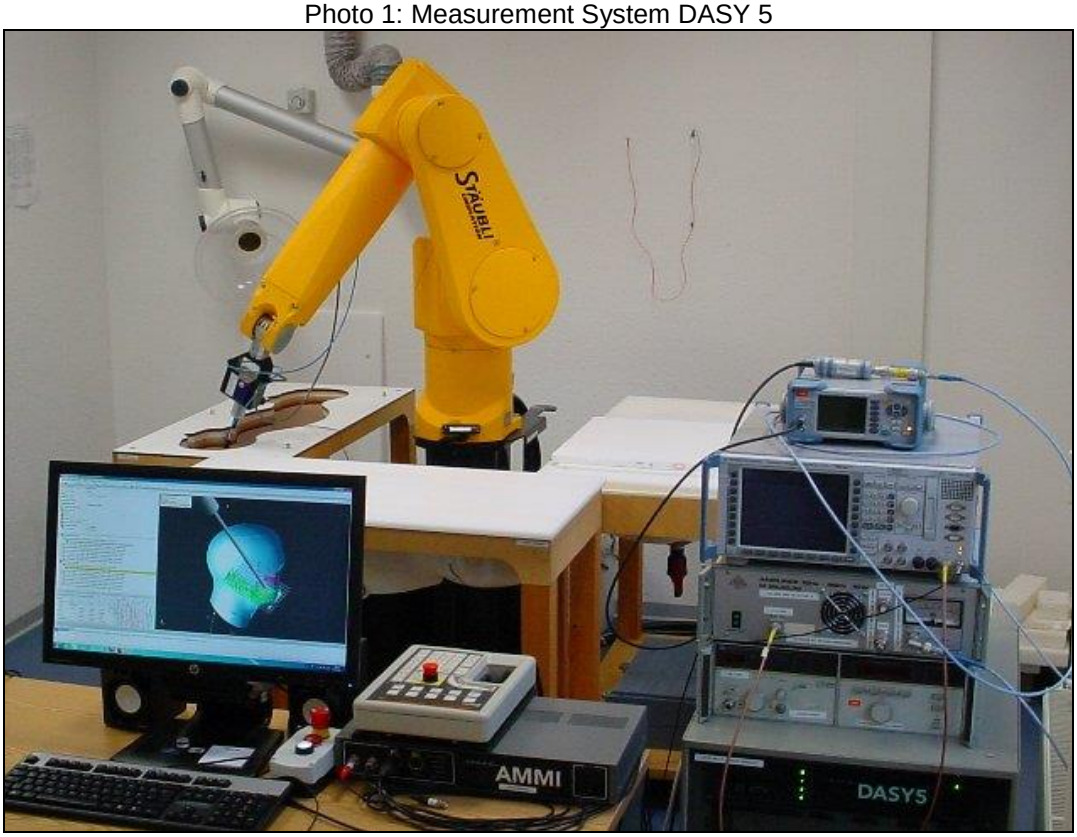


Photo 2: DUT - front view

Photo 3: DUT - side view

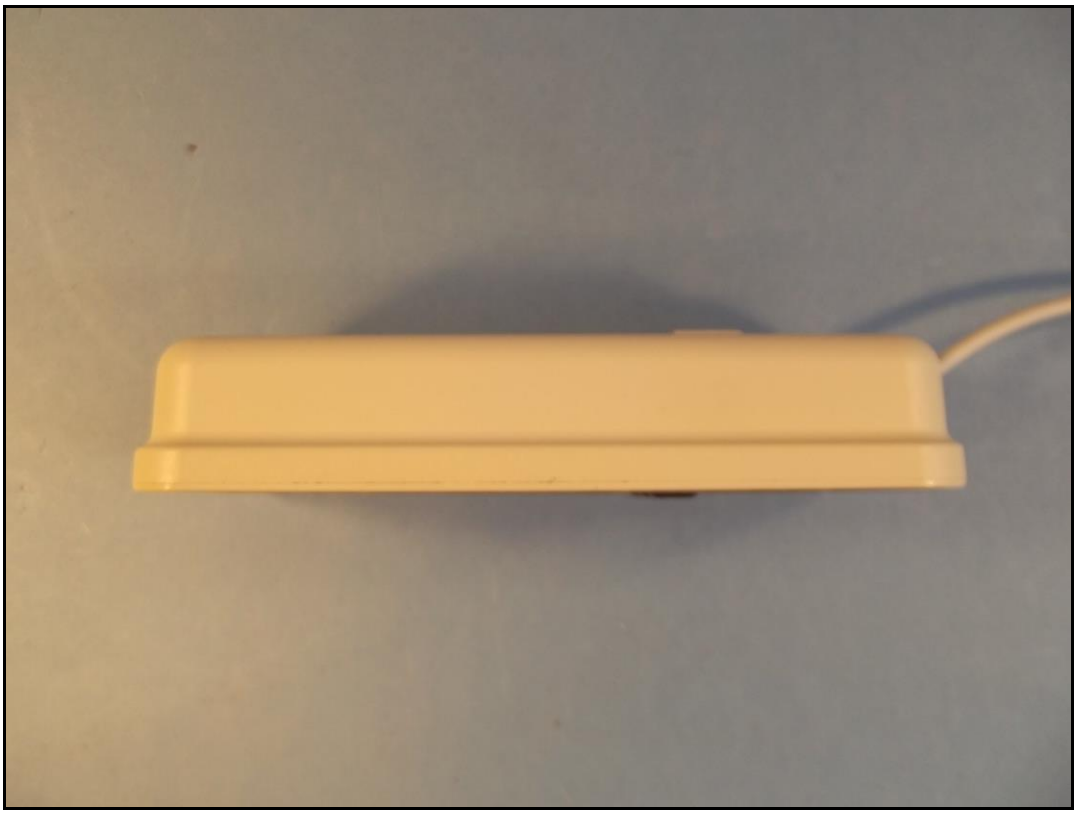


Photo 4: DUT - rear view

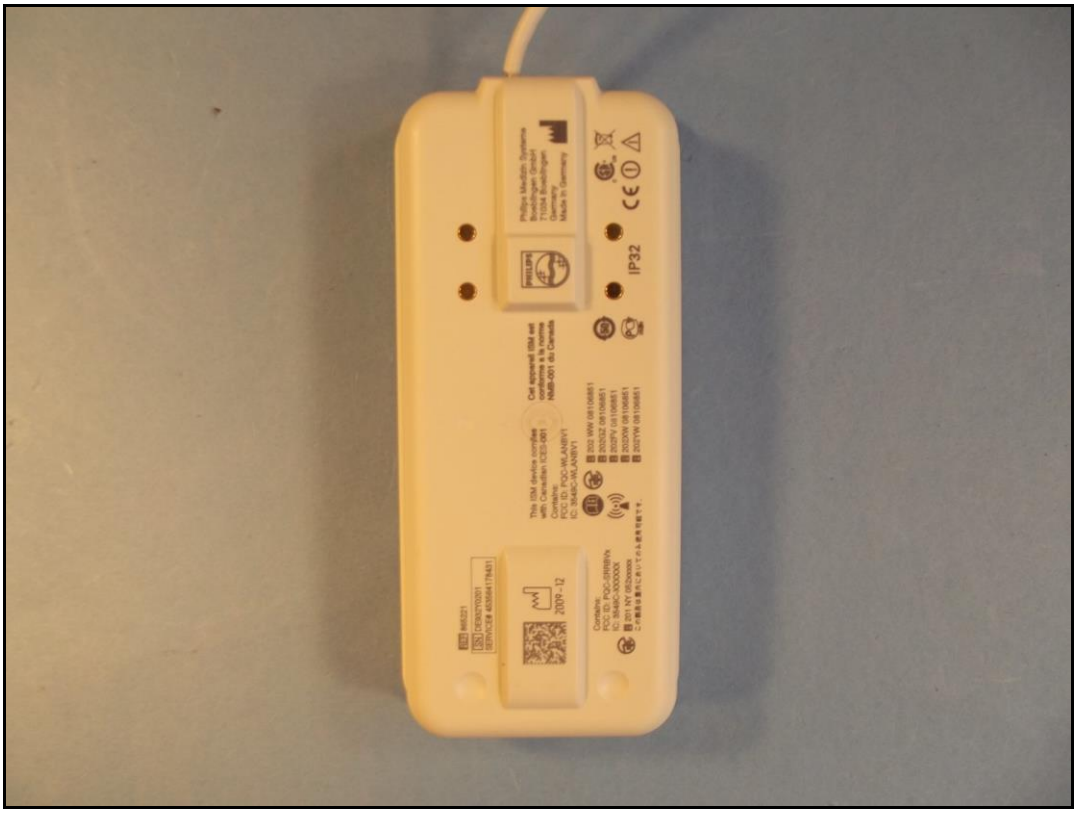


Photo 5: DUT - rear view (label)

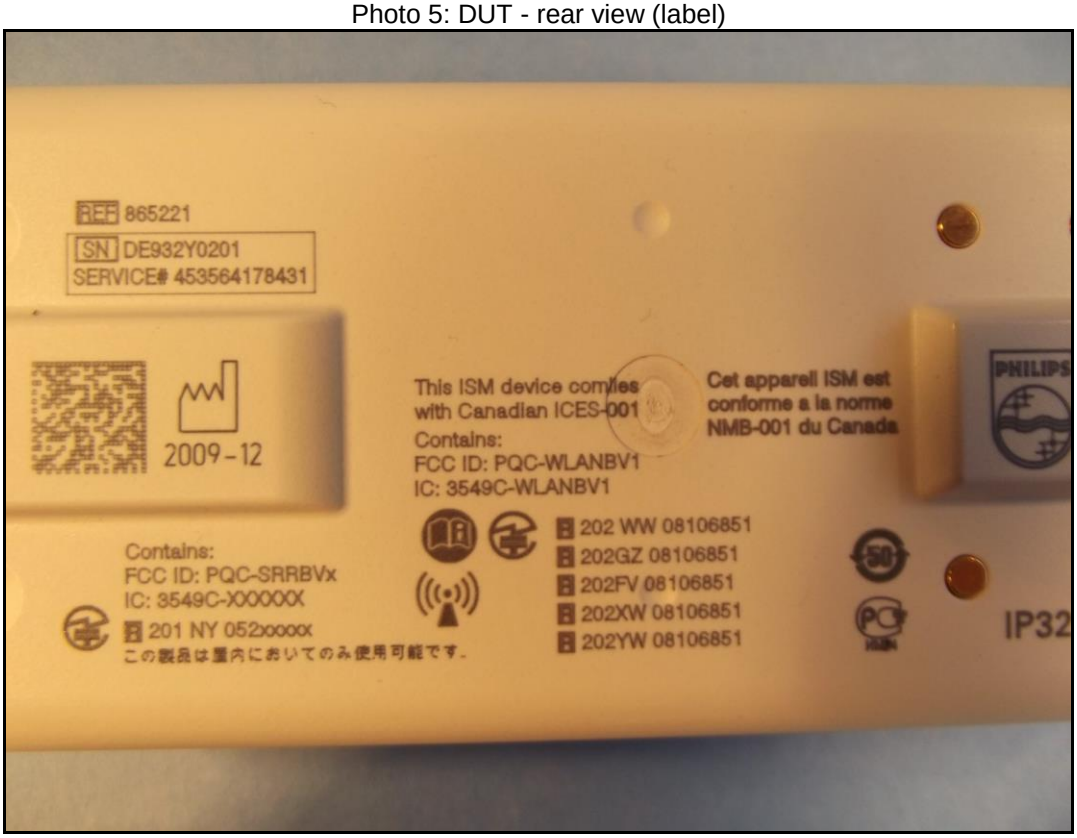


Photo 6: DUT - rear view (label)

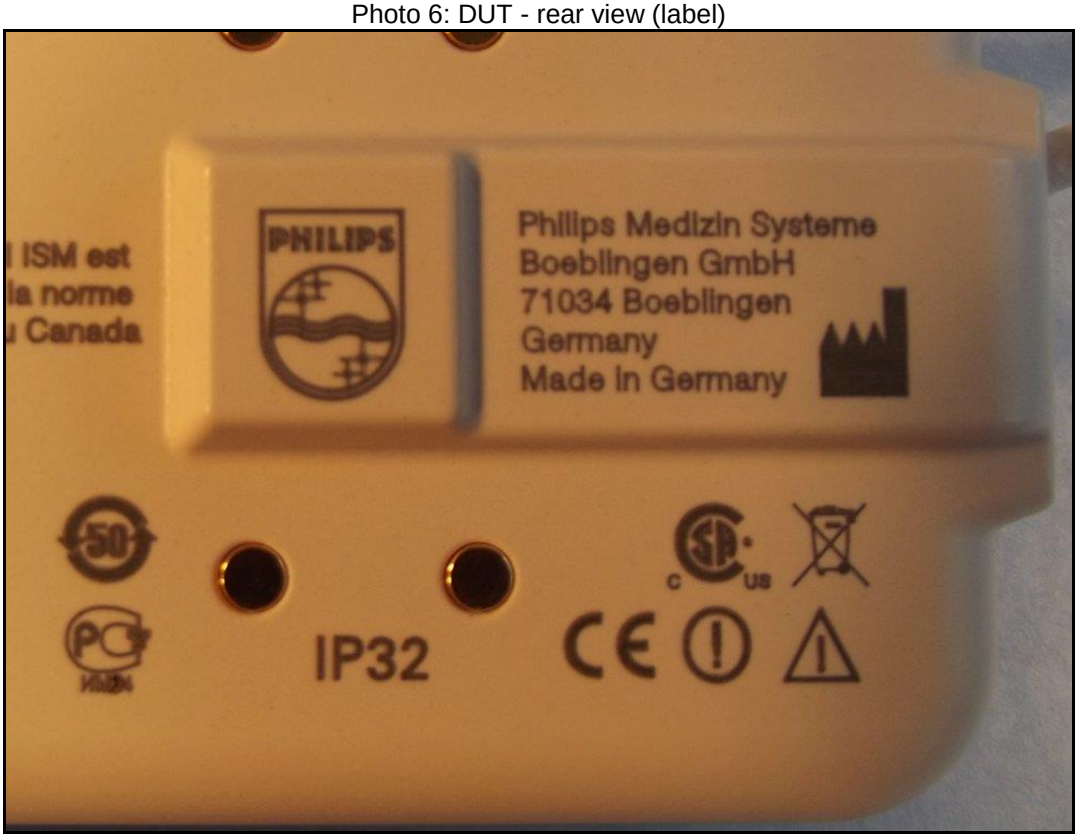


Photo 7: Test position body worn front side with 10 mm distance

Photo 8: Test position body worn left side with 0 mm distance

Photo 9: Test position body worn right side with 0 mm distance

Photo 10: Test position body worn rear side with 0 mm distance

Photo 11: Test position body worn bottom side with 0 mm distance

Annex D: Calibration parameters

Calibration parameters are described in the additional document:

Appendix to test report no. 1-2856/16-01-03
Calibration data, Phantom certificate
and detail information of the DASY5 System

Annex E: Document History

Version	Applied Changes	Date of Release
	Initial Release	2018-03-07

Annex F: Further Information

Glossary

DTS	-	Distributed Transmission System
DUT	-	Device under Test
EUT	-	Equipment under Test
FCC	-	Federal Communication Commission
FCC ID	-	Company Identifier at FCC
HW	-	Hardware
IC	-	Industry Canada
Inv. No.	-	Inventory number
N/A	-	not applicable
SAR	-	Specific Absorption Rate
S/N	-	Serial Number
SW	-	Software
UNII	-	Unlicensed National Information Infrastructure