Specific Absorption Rate Test Report

Report Number	:	**68.950.16.015.01**	Date of Issue:	**January 12, 2017**
Model	:	**MRHH600, MRHH600W**		
Product Type	:	MR HH600 GPS BT		
Applicant	:	Cobra Electronics Corporation		
Address	:	6500 West Cortland Street Chicago, IL		
Manufacture	:	XIN XING GREAT SUCCESS PLASTIC PRODUCTS LIMITED		
Address	:	Building A, District 1, B2-02, Xincheng Industrial Park, Xinxing, YunFu, Guangdong, P.R.C		
Test Result	:	■ **Positive**	☐ **Negative**	
Total pages including Appendices	:	**38**		

TÜV SÜD Certification and Testing (China) Co., Ltd. – Shenzhen Branch is a subcontractor to TÜV SÜD Product Service GmbH according to the principles outlined in ISO 17025.

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Contents

1. Report Version

Revision	Release Date	History/Memo.
1.0	January 12, 2017	Initial Release

TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch
Building 12&13, Zhiheng Wisdomland Business Park, Nantou Checkpoint Road 2, Nanshan District, Shenzhen City, 518052, P. R. China

2. General Information

2.1. Notes

TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch is a subcontractor to TÜV SÜD Product Service GmbH according to the principles outlined in ISO 17025.

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Prepared by	2017-01-12	Alan Xiong	Alan Xiong
Project Engineer	Date	Name	Signature
Approved by	2017-01-12	John Zhi	John Zhi
Section Manager	Date	Name	Signature

TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch
Building 12&13, Zhiheng Wisdomland Business Park, Nantou Checkpoint Road 2, Nanshan District, Shenzhen City, 518052, P. R. China

3. TEST STANDARDS

3.1. Test Standards

The tests were performed according to following standards:

IEEE Std C95.1, 1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 KHz to 300 GHz.
IEEE Std 1528™-2013: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.
KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04: SAR Measurement Requirements for 100 MHz to 6 GHz
KDB 865664 D02 RF Exposure Reporting v01r02: RF Exposure Compliance Reporting and Documentation Considerations
KDB 447498 D01: General RF Exposure Guidance v05r02: Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies
KDB 643646 D01: SAR Test for PTT Radios v01r03 :SAR Test Reduction Considerations for Occupational PTT Radios

3.2. Test Description

The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power

4. SUMMARY

4.1. Client Information

Applicant:	Cobra Electronics Corporation
Address:	6500 West Cortland Street Chicago, IL
Manufacturer:	XIN XING GREAT SUCCESS PLASTIC PRODUCTS LIMITED
Address:	Building A, District 1, B2-02, Xincheng Industrial Park, Xinxing, YunFu, Guangdong, P.R.C

4.2. Product Description

Name of EUT:	MR HH600 GPS BT	
Trade mark:	Cobra MARINE	
Model/Type reference:	For Radio:MRHH600, MRHH600W For Charging Cradle:CM 110-032	
Hardware version:	MRHH600, MRHH600W	
Software version:	0.27	
Power supply:	7.4Vdc 2000mAh supplied by rechargeable battery	
Battery information:	Model: FT704159P	
Adapter information:	Model: K12S120100U Input: 100-240Va.c., 50/60Hz, 0.45A Output:12Vd.c.,1.0A	
Car Charger:	Input: 12Vdc, 1.0A Output:12Vdc.,1.0A	
Marine Radio		
Operation Frequency Range:	TX:156.050MHz to 157.425MHz	
	RX:156.050MHz to 162.000MHz	
Rated Output Power:	☒ High Power: 5W (36.98dBm)	☒ Low Power 1W (30.00dBm)
Modulation Type:	Analog Voice:	PM
	Digital Data(DSC):	FSK
Channel Separation:	Analog Voice:	25kHz
	Digital Data(DSC):	25kHz
Emission Designator:	Analog Voice:	16K0G3E
	Digital Data(DSC):	16K0G2B
Maximum Transmitter Power:	Analog Voice:	5W
	Digital Data(DSC):	5W
Antenna Type:	External	
Others		
Exposure category:	Uncontrolled environment / general population	
Operating mode(s):	Bluetooth 3.0+EDR+Bluetooth Low Energy	
Test modulation:	GFSK, π/4-DQPSK, 8DPSK	
Others		

Separation Distance:	Body:	0mm
	Face:	25mm
Maximun SAR Value (1g):	Body:	**5.76 W/Kg**
	Face:	**3.51 W/Kg**

Remark 1: The above EUT's information was declared by manufacturer. Please refer to related test reports or user's manual for more detailed description.
Remark 2: As per Client Declaration, MRHH600 and MRHH600W are identical, only the cosmetics have different color, so we use MRHH600 as a representative to perform all testing.

4.3. Test frequency list

- For each operational mode of the handset, tests should be performed at the channel that is closest to the centre of each transmit frequency band.
- If the width of the transmit frequency band, (f = fhigh . flow,) exceeds 1 % of its centre frequency fc, then the channels at the lowest and highest frequencies of the transmit band should also be tested.
- if the width of the transmit band exceeds 10 % of its centre frequency, the following formula should be used to determine the number of channels, Nc, to be tested:

$$N_c = 2 * \text{roundup}\ [10^* (f_{high} - f_{low})/f_c] + 1$$

fc: is the centre frequency of the band in hertz;
fhigh: is the highest frequency in the band in hertz;
flow: is the lowest frequency in the band in hertz;
Nc: is the number of channels;
f: is the width of the transmit frequency band in hertz.

Nc=2* roundup[10*(136.025-157.425)/156.725]+1=3

ModulationType	Channel Separation	Test Channel	Test Frequency (MHz)	
			TX	RX
Analog	25KHz	CH_L	156.05	156.050
		CH_M	156.80	156.80
		CH_H	157.425	157.425
Digital	25KHz	CH_{M1}	156.525	156.525

Note: The Product channel frequency table:FCC Marine VHF Channels and Frequencies:

Channel	TX Frequency (MHz)	RX Frequency (MHz)	Channel	TX Frequency (MHz)	RX Frequency (MHz)
01A	156.050	156.050	63A	156.175	156.175
05A	156.250	156.250	65A	156.275	156.275
06	156.300	156.300	66A	156.325	156.325
07A	156.350	156.350	67	156.375	156.375
08	156.400	156.400	68	156.425	156.425
09	156.450	156.450	69	156.475	156.475
10	156.500	156.500	70	N/A	156.625
11	156.550	156.550	71	156.575	156.575
12	156.600	156.600	72	156.625	156.625
13	156.650	156.650	73	156.675	156.675
14	156.700	156.700	74	156.725	156.725
15	N/A	156.750	75	156.775	156.775
16	156.800	156.800	76	156.825	156.825
17	156.850	156.850	77	156.875	156.875
18A	156.900	156.900	78A	156.925	156.925
19A	156.950	156.950	79A	156.975	156.975
20	157.000	161.600	80A	157.025	157.025

20A	157.000	157.000	81A	157.075	157.075
21A	157.050	157.050	82A	157.125	157.125
22A	157.100	157.100	84	157.225	161.825
23A	157.150	157.150	85	157.275	161.875
24	157.200	161.800	86	157.325	161.925
25	157.250	161.850	87	157.375	157.375
26	157.300	161.900	88	157.425	157.425
27	157.350	161.950	88A	157.425	157.425
28	157.400	162.000			

Note: The Product channel frequency table:IC Marine VHF Channels and Frequencies:

Channel	TX Frequency (MHz)	RX Frequency (MHz)	Channel	TX Frequency (MHz)	RX Frequency (MHz)
01	156.050	160.650	60	156.025	160.625
02	156.100	160.700	61A	156.075	156.075
03	156.150	160.750	62A	156.125	156.125
04A	156.200	156.200	63A	156.175	156.175
05A	156.250	156.250	64	156.225	160.825
06	156.300	156.300	64A	156.225	156.225
07A	156.350	156.350	65A	156.275	156.275
08	156.400	156.400	66A	156.325	156.325
09	156.450	156.450	67	156.375	156.375
10	156.500	156.500	68	156.425	156.425
11	156.550	156.550	69	156.475	156.475
12	156.600	156.600	70	N/A	156.625
13	156.650	156.650	71	156.575	156.575
14	156.700	156.700	72	156.625	156.625
15	156.750	156.750	73	156.675	156.675
16	156.800	156.800	74	156.725	156.725
17	156.850	156.850	75	156.775	156.775
18A	156.900	156.900	76	156.825	156.825
19A	156.950	156.950	77	156.875	156.875
20	157.000	161.600	78A	156.925	156.925
20A	157.000	157.000	79A	156.975	156.975
21A	157.050	157.050	80A	157.025	157.025
21B	N/A	161.650	81A	157.075	157.075
22A	157.100	157.100	82A	157.125	157.125
23	157.150	161.750	83A	157.175	157.175
23B	N/A	161.750	83B	N/A	161.775
24	157.200	161.800	84	157.225	161.825
25	157.250	161.850	85	157.275	161.875
25B	N/A	161.850	86	157.325	161.925
26	157.300	161.900	87	157.375	157.375
27	157.350	161.950	88	157.425	157.425
28	157.400	162.000			
28B	N/A	162.000			

4.4. Short description of the Equipment under Test (EUT)

The spatial peak SAR values were assessed for UHF systems. Battery and accessories shell be specified by the manufacturer. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output.

4.5. TEST Configuration

Body-worn Configuration

The EUT is tested with the antenna,the backpack and the earphone.

The back of the EUT is towards the phantom.

The back surface of the backpack directed tightly to touch the bottom of the flat phantom

4.6. EUT operation mode

The EUT has been tested under typical operating condition and The Transmitter was operated in the normal operating mode. The TX frequency was fixed which was for the purpose of the measurements. The multiple transmission modes are assessed separately, then combined arithmetically

4.7. EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

● - supplied by the manufacturer

○ - supplied by the lab

●	/	Length (m) :	/
		Shield :	/
		Detachable :	/
○	Multimeter	Manufacturer :	FLUKE
		Model No. :	/

4.8. Modifications

No modifications were implemented to meet testing criteria.

5. TEST ENVIRONMENT

5.1. Address of the test laboratory

Test Laboratory: Shenzhen Huatongwei International Inspection Co., Ltd
Address: Keji Nan No.12 Road, Hi-tech Park, Shenzhen, China
Phone: 86-755-26715686 Fax: 86-755-26748089

5.2. Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

CNAS-Lab Code: L1225

Shenzhen Huatongwei International Inspection Co., Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC 17025: 2005 General Requirements) for the Competence of Testing and Calibration Laboratories, Date of Registration: Feb. 28, 2015. Valid time is until Feb. 27, 2018.

A2LA-Lab Cert. No. 3902.01

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing. Valid time is until Dec. 31, 2016.

FCC-Registration No.: 317478

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory has been registered and fully descri bed in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FC C is maintained in our files. Registration 317478, Renewal date Jul. 18, 2014, valid time is until Jul. 18, 2017.

IC-Registration No.: 5377A&5377B

The 3m Alternate Test Site of Shenzhen Huatongwei International Inspection Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for the performance of radiated measurements with Registration No. 5377A on Dec. 31, 2013, valid time is until Dec. 31, 2016.
Two 3m Alternate Test Site of Shenzhen Huatongwei International Inspection Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for the performance of radiated measurements with Registration No. 5377B on Dec.03, 2014, valid time is until Dec.03, 2017.

ACA

Shenzhen Huatongwei International Inspection Co., Ltd. EMC Laboratory can also perform testing for the Aust ralian C-Tick mark as a result of our A2LA accreditation.

5.3. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	18-25 ° C
Humidity:	40-65 %
Atmospheric pressure:	950-1050mbar

6. SAR Measurements System configuration

6.1. SAR Measurement Set-up

The DASY5 system for performing compliance tests consists of the following items:

A standard high precision 6-axis robot (Stäubli RX 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. The probe is equipped with an optical surface detector system.

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.

A unit to operate the optical surface detector which is connected 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 DASY5 measurement server.

The DASY5 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 2003.

DASY5 software and SEMCAD data evaluation software.

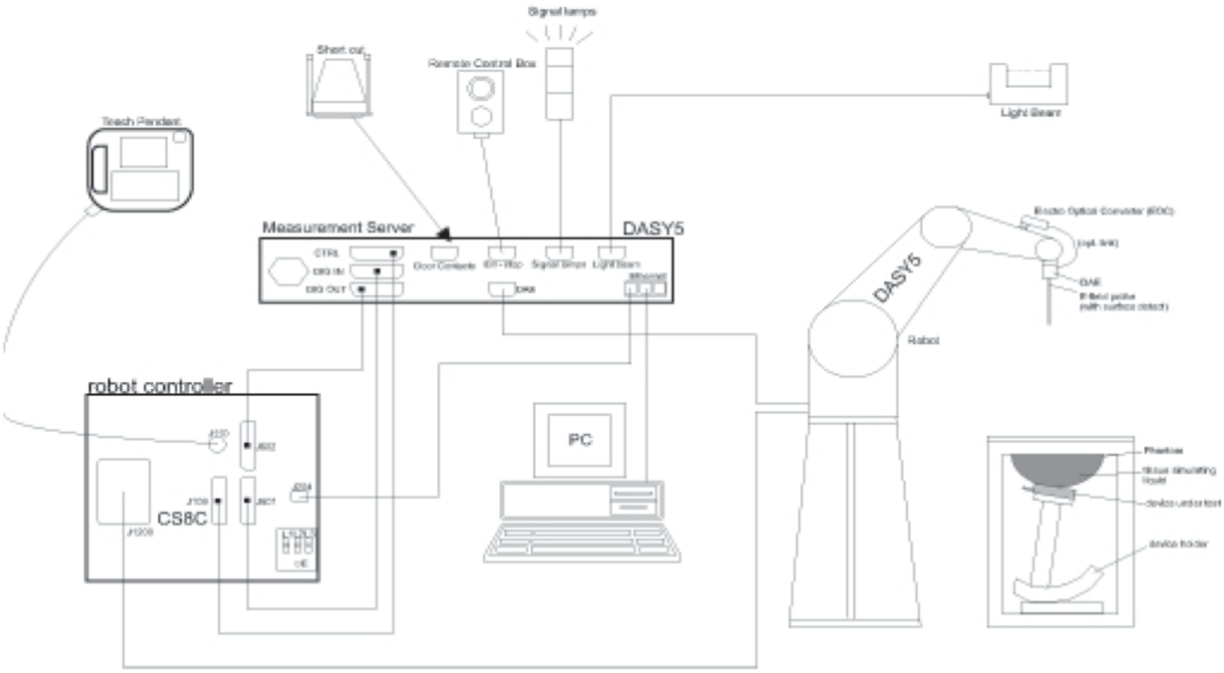
Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.

The generic twin phantom enabling the testing of left-hand and right-hand usage.

The device holder for handheld mobile phones.

Tissue simulating liquid mixed according to the given recipes.

System validation dipoles allowing to validate the proper functioning of the system.



6.2. DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe ES3DV3 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

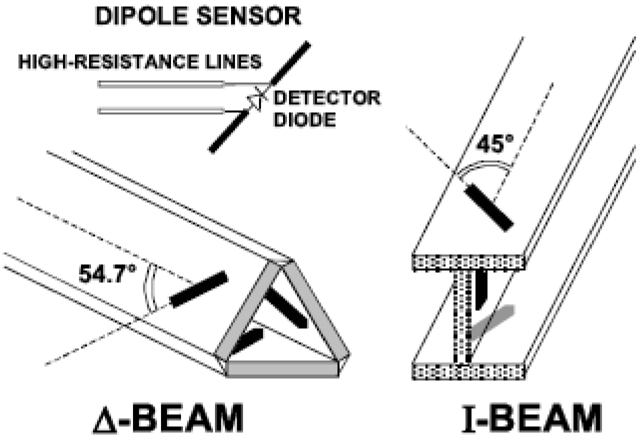
Probe Specification

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 4 GHz; Linearity: ± 0.2 dB (30 MHz to 4 GHz)
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in tissue material (rotation normal to probe axis)
Dynamic Range	5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm
Application	General dosimetry up to 4 GHz Dosimetry in strong gradient fields Compliance tests of mobile phones
Compatibility	DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI

Isotropic E-Field Probe

The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change.

The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



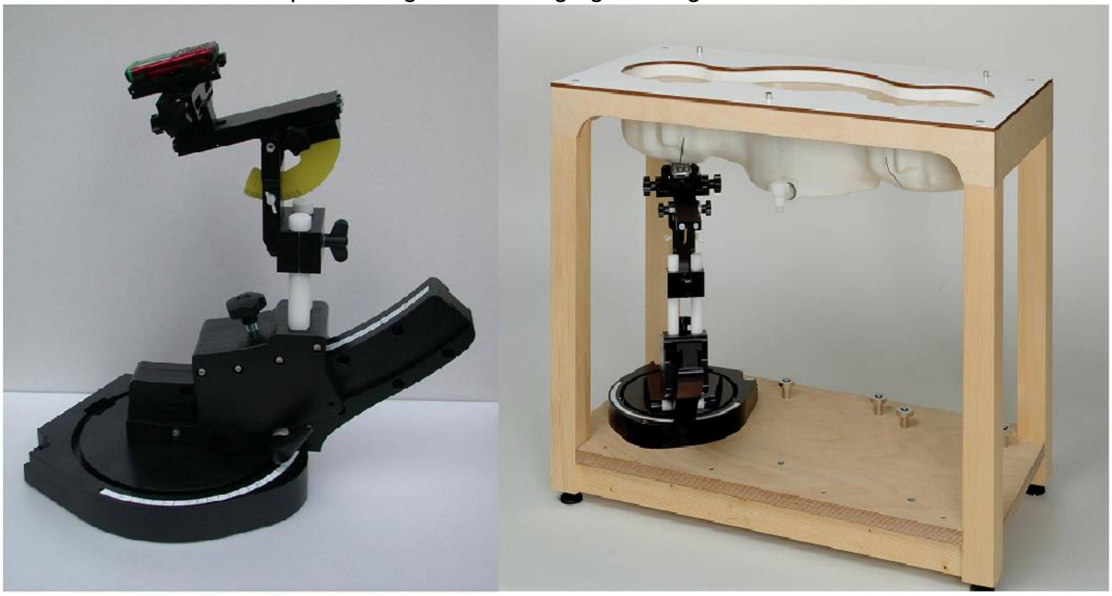
6.3. Phantoms

The phantom used for all tests i.e. for both system checks and device testing, was the twin-headed "SAM Phantom", manufactured by SPEAG. The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region, where shell thickness increases to 6mm).
System checking was performed using the flat section, whilst Head SAR tests used the left and right head profile sections. Body SAR testing also used the flat section between the head profiles.

SAM Twin Phantom

6.4. Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the DASY system.
The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.



Device holder supplied by SPEAG

6.5. Scanning Procedure

The DASY5 installation includes predefined files with recommended procedures for measurements and validation. 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 “surface check” measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ± 0.1mm). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe (It does not depend on the surface reflectivity or the probe angle to the surface within ± 30°.)

Area Scan
The Area Scan is used as a fast scan in two dimensions to find the area of high field values before running a detailed measurement around the hot spot.Before starting the area scan a grid spacing of 15 mm x 15 mm is set. During the scan the distance of the probe to the phantom remains unchanged. After finishing area scan, the field maxima within a range of 2 dB will be ascertained.

Zoom Scan
Zoom Scans are used to estimate the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default Zoom Scan is done by 7x7x7 points within a cube whose base is centered around the maxima found in the preceding area scan.

Spatial Peak Detection
The procedure for spatial peak SAR evaluation has been implemented and can determine values of masses of 1g and 10g, as well as for user-specific masses.The DASY5 system allows evaluations that combine measured data and robot positions, such as: • maximum search • extrapolation • boundary correction • peak search for averaged SAR During a maximum search, global and local maxima searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard's method. The algorithm will find the global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation. Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Zoom Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard's method for extrapolation. For a grid using 7x7x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1g and 10g cubes.

A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube 7x7x7 scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 5mm steps.

6.6. Data Storage and Evaluation

Data Storage

The DASY5 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". 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

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	Normi, ai0, ai1, ai2
	- Conversion factor	ConvFi
	- 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 DASY5 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:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

With Vi = compensated signal of channel i (i = x, y, z)
Ui = input signal of channel i (i = x, y, z)
cf = crest factor of exciting field (DASY parameter)
dcpi = diode compression point (DASY parameter)

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

$$\text{E} - \text{fieldprobes :} \qquad E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$\text{H} - \text{fieldprobes :} \qquad H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

With Vi = compensated signal of channel i (i = x, y, z)
Normi = sensor sensitivity of channel i (i = x, y, z)
[mV/(V/m)2] for E-field Probes
ConvF = sensitivity enhancement in solution
aij = sensor sensitivity factors for H-field probes
f = carrier frequency [GHz]
Ei = electric field strength of channel i in V/m

Hi = magnetic field strength of channel i in A/m

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

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

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

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

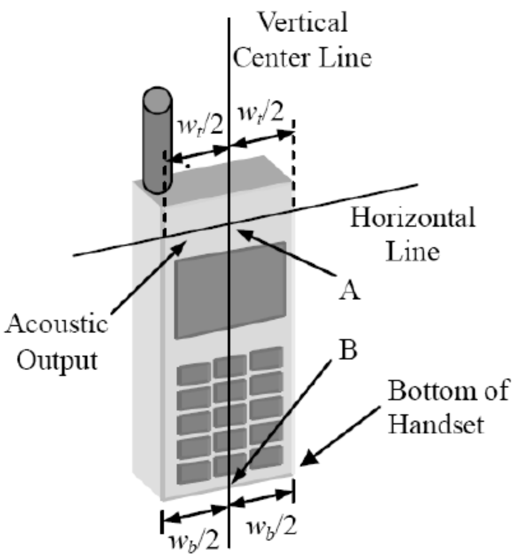
with SAR = local specific absorption rate in mW/g
Etot = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm3

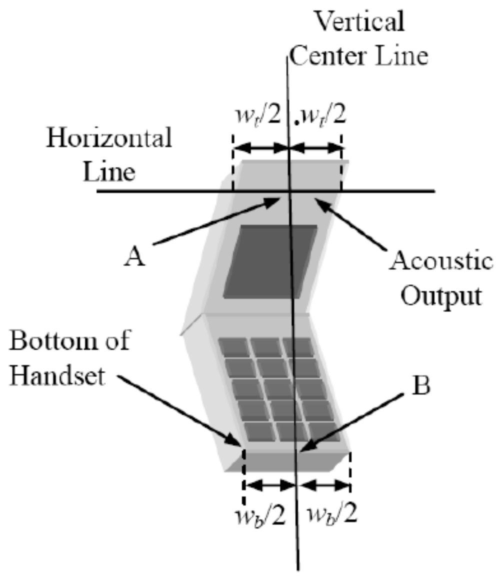
Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

6.7. Position of the wireless device in relation to the phantom

General considerations

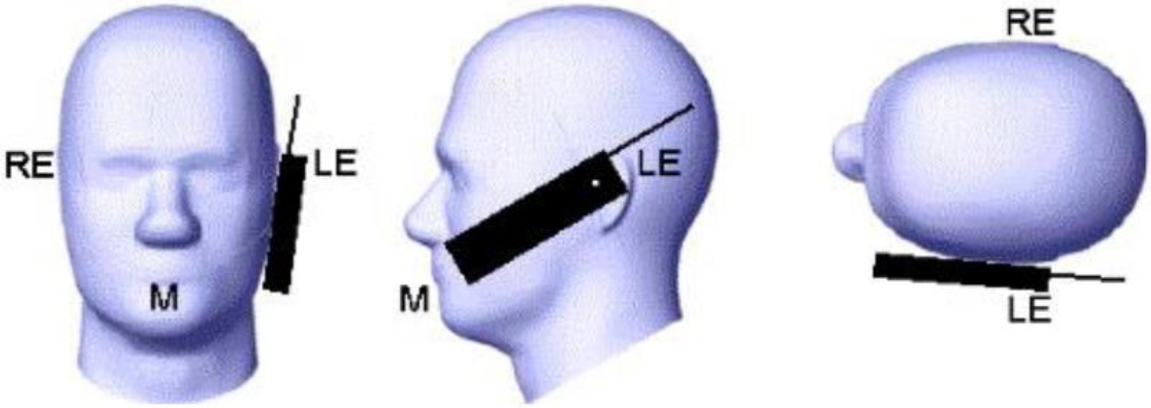
This standard specifies two handset test positions against the head phantom – the “cheek” position and the “tilt” position.



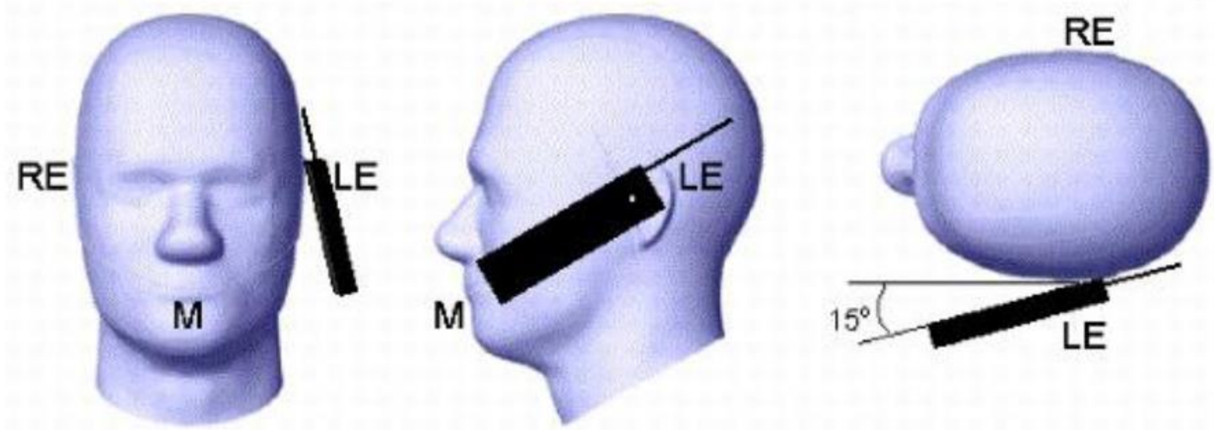


W_t Width of the handset at the level of the acoustic
W_b Width of the bottom of the handset
A Midpoint of the width w_t of the handset at the level of the acoustic output
B Midpoint of the width w_b of the bottom of the handset

Picture 1-a Typical “fixed” case handset Picture 1-b Typical “clam-shell” case handset

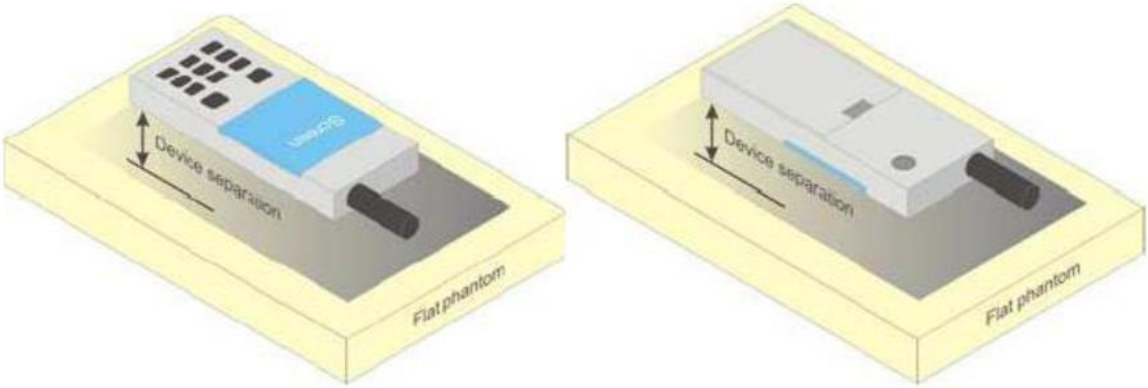


Picture 2 Cheek position of the wireless device on the left side of SAM



Picture 3 Tilt position of the wireless device on the left side of SAM

Body-worn device
A typical example of a body-worn device is a mobile phone, wireless enabled PDA or other battery operated wireless device with the ability to transmit while mounted on a person's body using a carry accessory approved by the wireless device manufacturer.



Picture 4 Test positions for body-worn devices

Devices with hinged or swivel antenna(s)
For devices that employ one or more external antennas with variable positions (e.g. antenna extended, retracted, rotated), these shall be positioned in accordance with the user instructions provided by the manufacturer. For a device with only one antenna, if no intended antenna position is specified, tests shall be performed if applicable in both the horizontal and vertical positions relative to the phantom, and with the antenna oriented away from the body of the DUT (Figure 5) and/or with the antenna extended and retracted such as to obtain the highest exposure condition. For antennas that may be rotated through one or two planes, an evaluation should be made and documented in the measurement report to the highest exposure scenario and only that position(s) need(s) to be tested. For devices with multiple detachable antennas see provisions of 6.2.2.

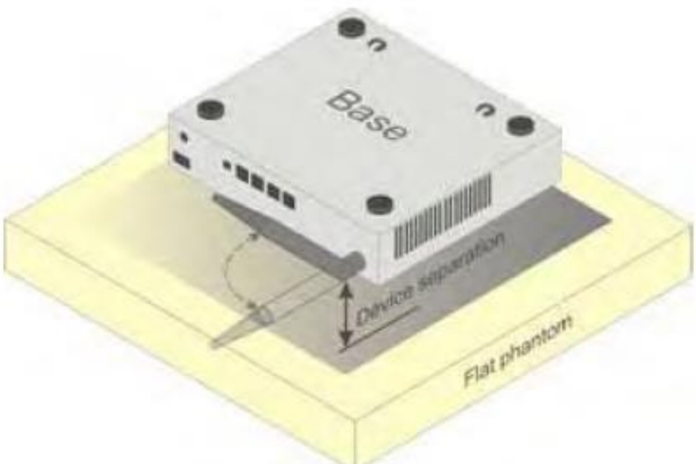


Figure 5– Device with swivel antenna (example of desktop device)

Body-supported device

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

The screen portion of the device shall be in an open position at a 90° angle as seen in Figure 6a (left side), or at an operating angle specified for intended use by the manufacturer in the operating instructions. Where a body supported device has an integral screen required for normal operation, then the screen-side will not need to be tested if the antenna(s) integrated in it ordinarily remain(s) 200 mm from the body. Where a screen mounted antenna is present, the measurement shall be performed with the screen against the flat phantom as shown in Figure 6a) (right side), if operating the screen against the body is consistent with the intended use.

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

The example in Figure 6b) shows a tablet form factor portable computer for which SAR should be separately assessed with

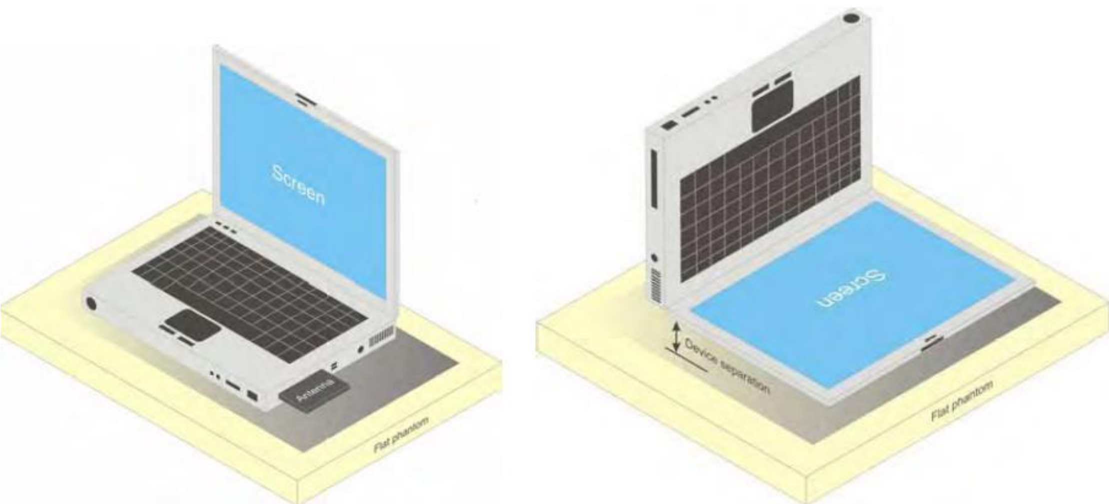
c). each surface and

d). the separation distances

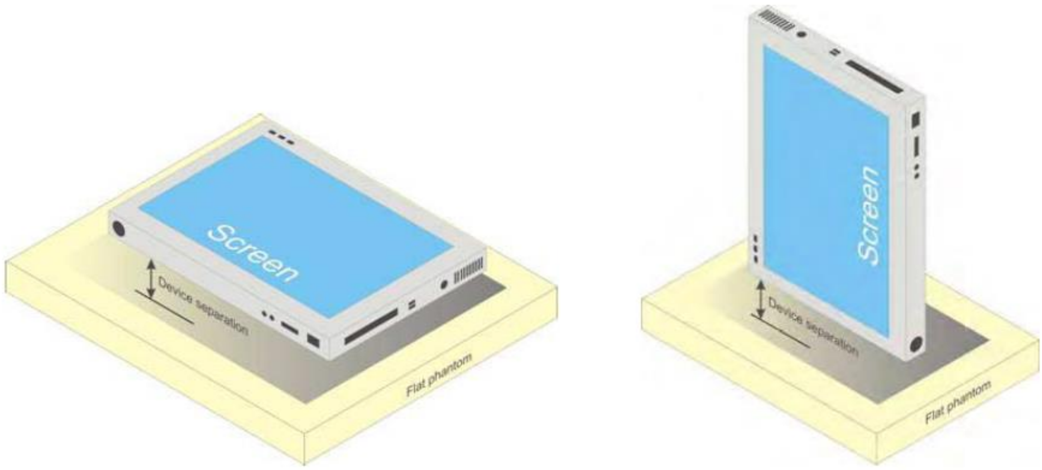
positioned against the flat phantom that correspond to the intended use as specified by the manufacturer. If the intended use is not specified in the user instructions, the device shall be tested directly against the flat phantom in all usable orientations.

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

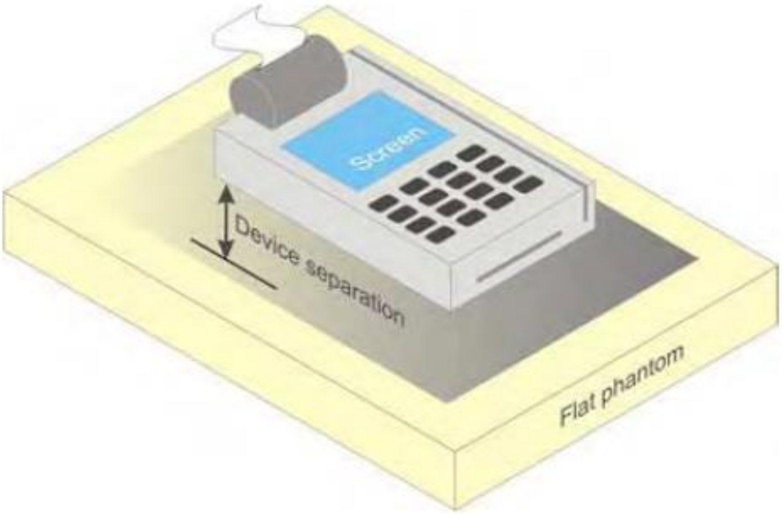
For devices that employ an external antenna with variable positions (e.g. swivel antenna), see 6.1.4.5 and Figure 5.



a) Portable computer with external antenna plug-in-radio-card (left side) or with internal antenna located in screen section (right side)



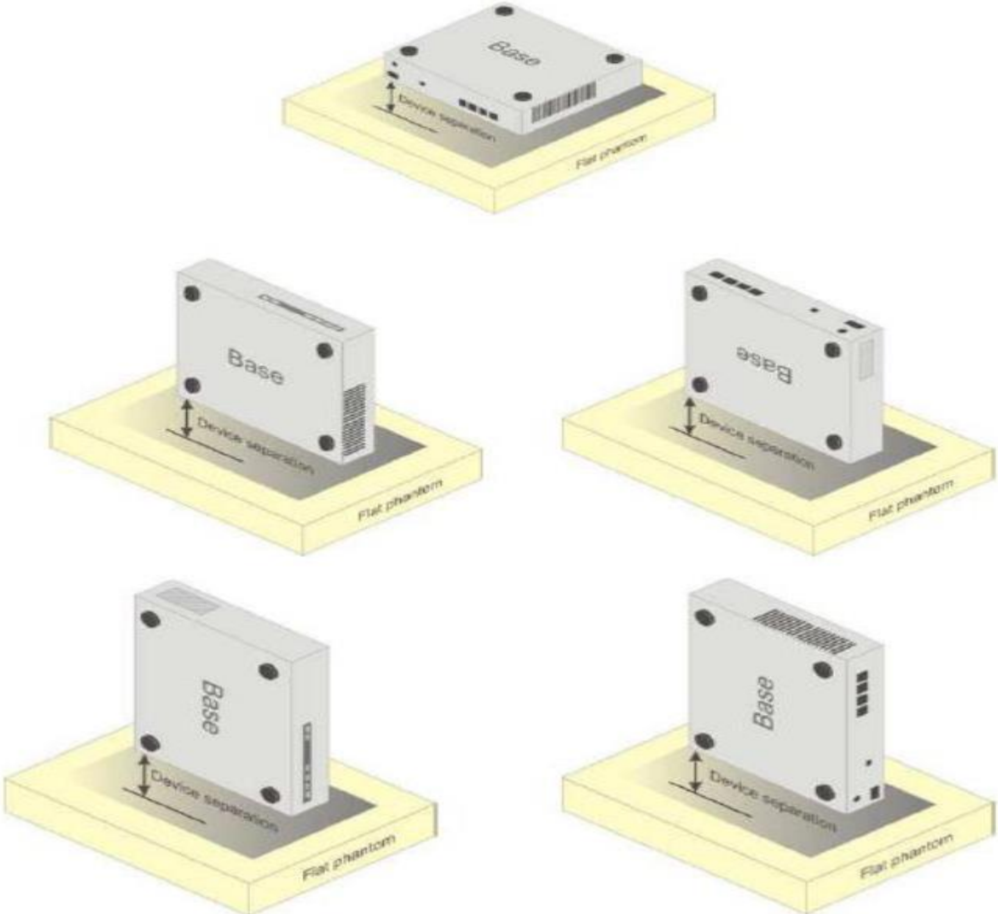
b) Tablet form factor portable computer



c) Wireless credit card transaction authorisation terminal

Figure 6 – Test positions for body supported devices

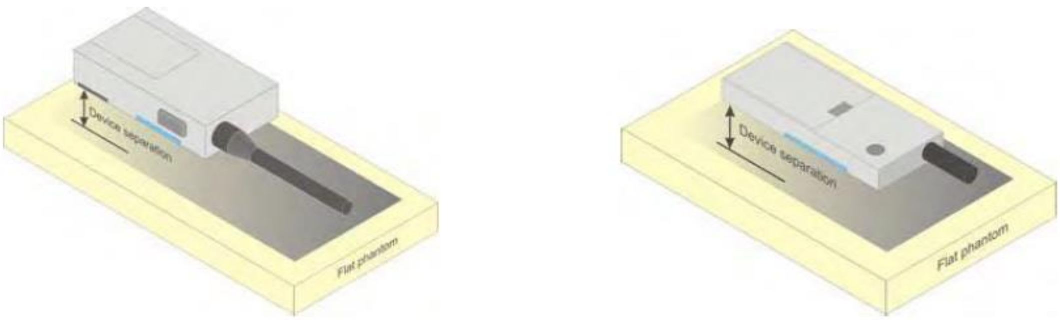
Desktop device
A typical example of a desktop device is a wireless enabled desktop computer placed on a table or desk when used.
The DUT shall be positioned at the distance and in the orientation to the phantom that corresponds to the intended use as specified by the manufacturer in the user instructions. For devices that employ an external antenna with variable positions, tests shall be performed for all antenna positions specified. Picture 14 shows positions for desktop device SAR tests. If the intended use is not specified, the device shall be tested directly against the flat phantom.



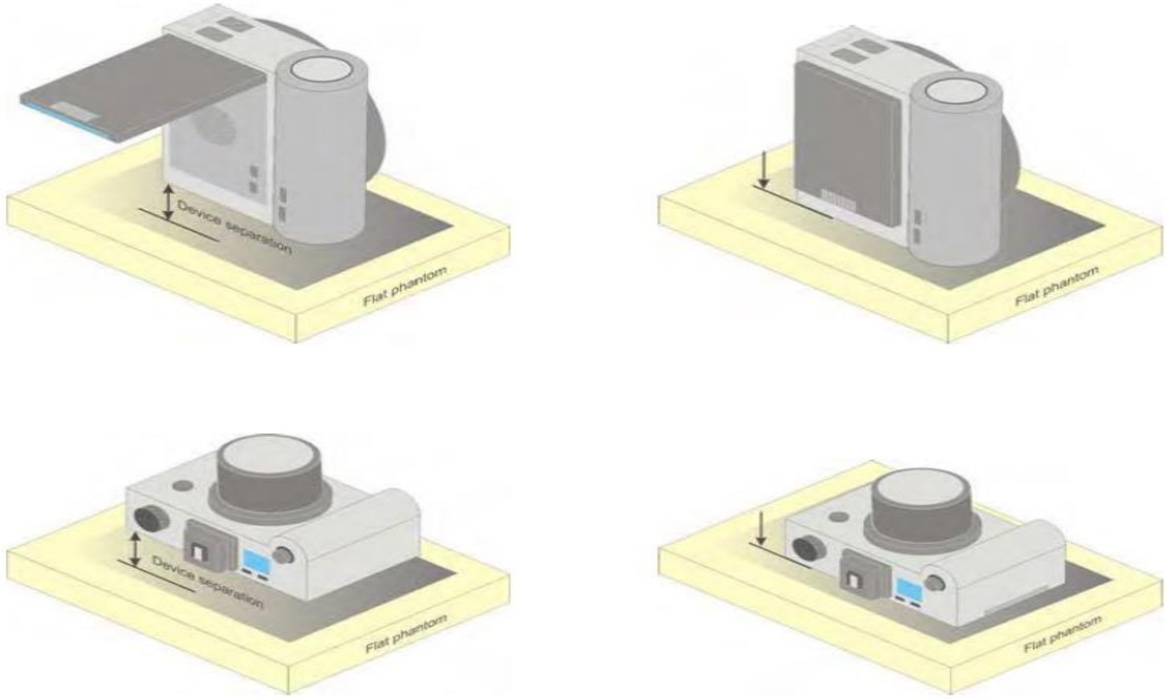
Picture 7 Test positions for desktop devices

Front-of-face device

A typical example of a front-of-face device is a two-way radio that is held at a distance from the face of the user when transmitting. In these cases the device under test shall be positioned at the distance to the phantom surface that corresponds to the intended use as specified by the manufacturer in the user instructions (Figure 8a). If the intended use is not specified, a separation distance of 25 mm between the phantom surface and the device shall be used.



a) Two-way radios



b) Still cameras and video cameras

Figure 8 – Test positions for front-of-face devices

Other devices that fall into this category include wireless-enabled still cameras and video cameras that can send data to a network or other device (Figure 8b). In the case of a device whose intended use requires a separation distance from the user (e.g., device with a viewing screen), this shall be positioned at the distance to the phantom surface that corresponds to the intended use as specified by the manufacturer in the user instructions (Figure 8b, left side). If the intended use is not specified, a separation distance of 25 mm between the phantom surface and the device shall be used.

For a device whose intended use requires the user's face to be in contact with the device (e.g., device with an optical viewfinder), this shall be placed directly against the phantom (Figure 8b, right side).

Hand-held usage of the device, not at the head or torso

Additional studies remain needed for devising a representative method for evaluating SAR in the hand of hand-held devices. Future versions of this standard are intended to contain a test method based on scientific data and rationale. Annex J presents the currently available test procedure.

Limb-worn device

A limb-worn device is a unit whose intended use includes being strapped to the arm or leg of the user while transmitting (except in idle mode). It is similar to a body-worn device. Therefore, the test positions of 6.1.4.4 also apply. The strap shall be opened so that it is divided into two parts as shown in Figure 9. The device shall be positioned directly against the phantom surface with the strap straightened as much as possible and the back of the device towards the phantom.

If the strap cannot normally be opened to allow placing in direct contact with the phantom surface, it may be necessary to break the strap of the device but ensuring to not damage the antenna.

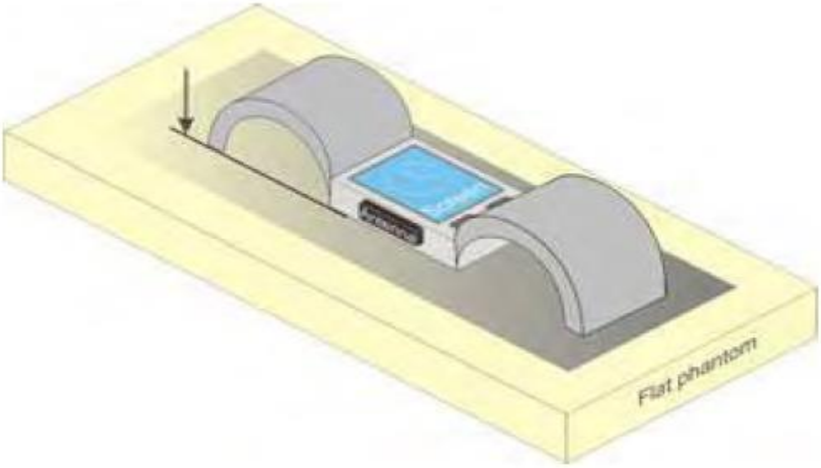


Figure 9 – Test position for limb-worn devices

Clothing-integrated device
A typical example of a clothing-integrated device is a wireless device (mobile phone) integrated into a jacket to provide voice communications through an embedded speaker and microphone. This category also includes headgear with integrated wireless devices.
All wireless or RF transmitting components shall be placed in the orientation and at the separation distance to the phantom surface that correspond to intended use of the device when it is integrated into the clothing (Figure 10).

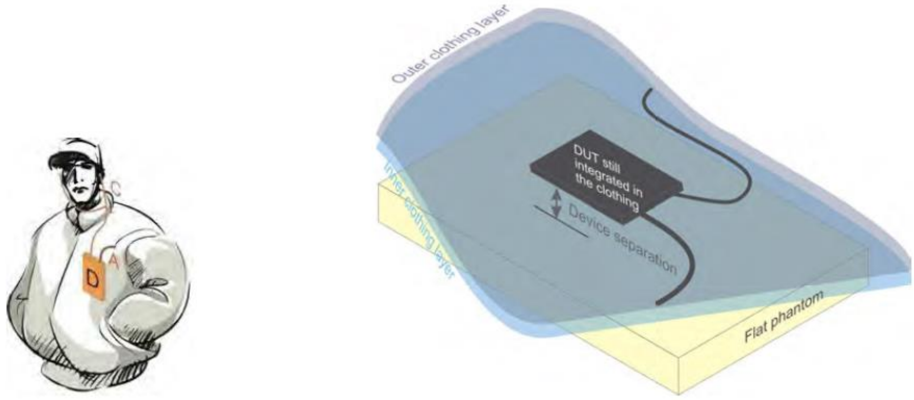


Figure 10– Test position for clothing-integrated wireless devices

7. SAR Measurement Procedure

7.1. SAR System Validation

7.1.1. Purpose

- To verify the simulating liquids are valid for testing.
- To verify the performance of testing system is valid for testing.

7.1.2. Tissue Dielectric Parameters for Head and Body Phantoms

The liquid used for the frequency range of 400-3000 MHz consisted of water, sugar, salt and Cellulose. The liquid has been previously proven to be suited for worst-case. The Table 1 and 2 shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEEE 1528 and IEC 62209.

Table 1. Composition of the Head Tissue Equivalent Matter

Ingredients (% by weight)	Frequency (MHz)				
	835	900	1800	1950	2450
Water	41.45	40.92	16.33	54.89	46.70
Sugar	56.0	56.5	/	/	/
Salt	4.45	1.48	0.41	0.18	/
Preventol	0.19	0.1	/	/	/
Cellulose	0.1	0.4	/	/	/
Clycol Monobutyl	/	/	65.3	44.93	53.3
Dielectric ParametersTarget Value	f=835MHz ε=42.5 σ=0.91	f=900MHz ε=41.5 σ=0.97	f=1800MHz ε=40.0 σ=1.40	f=1950 MHz ε=40.0 σ=1.40	f=2450 MHz ε=39.2 σ=1.80

Table 2. Targets for tissue simulating liquid

Frequency (MHz)	Liquid Type	Liquid Type (σ)	± 5% Range	Permittivity (ε)	± 5% Range
150	Head	0.76	0.72～0.80	52.30	49.69～54.92

7.1.3. Tissue Dielectric ParametersValidation Result

Frequency (MHz)	Description	Dielectric Parameters		Temp
		εr	σ(s/m)	℃
150	Recommended result ±5% window	52.30 49.69～54.92	0.76 0.72～0.80	/
	Measurement value 2016-12-18	53.25	0.77	21

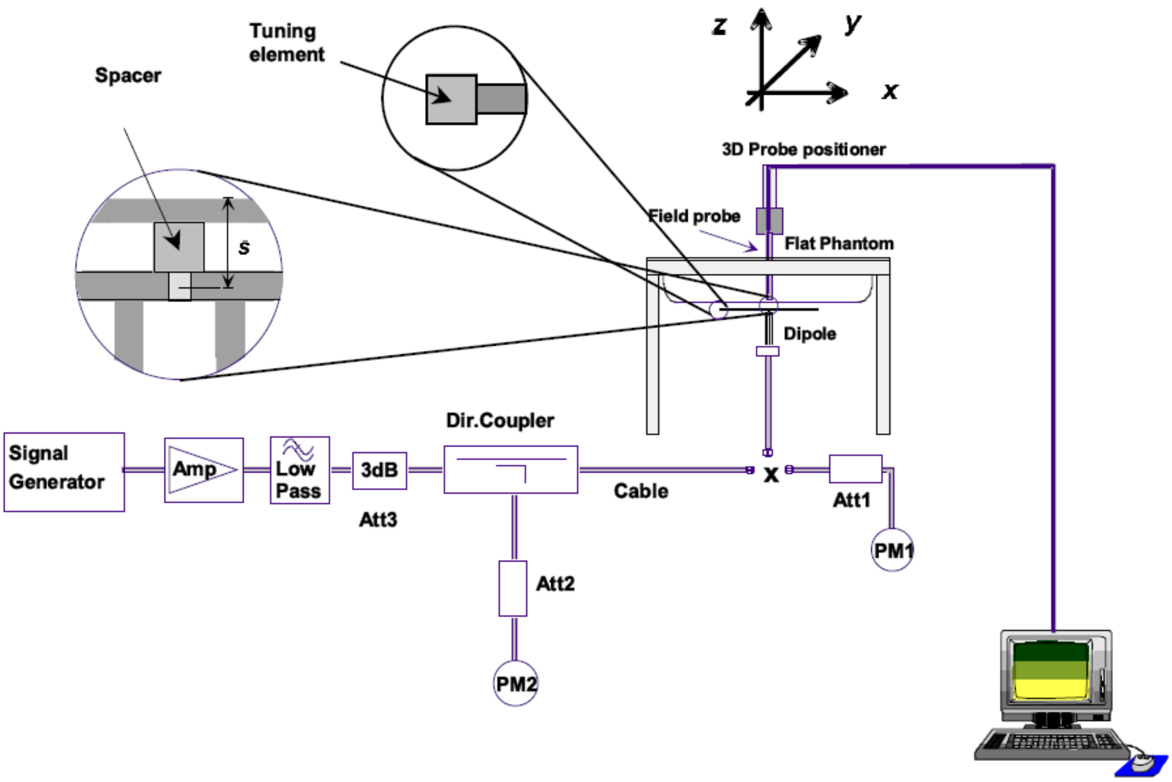
TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch
Building 12&13, Zhiheng Wisdomland Business Park, Nantou Checkpoint Road 2, Nanshan District, Shenzhen City, 518052, P. R. China

7.1.4. System Check Validation

The purpose of the system check is to verify that the system operates within its specifications at the decice test frequency.The system check is simple check of repeatability to make sure that the system works correctly at the time of the compliance test;

System check results have to be equal or near the values determined during dipole calibration with the relevant liquids and test system (±10 %).

System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.



The output power on dipole port must be calibrated to 26 dBm (398mW) before dipole is connected.

Photo of Dipole Setup

7.1.5. SAR System Validation Result

Frequency (MHz)	Description	SAR(W/kg)		Temp
		1g	10g	℃
150	Recommended result ±10% window	3.89 3.50-4.28	2.57 2.31-2.83	/
	Measurement value 2016-12-18	4.15	2.76	21

Note:
1. *the graph results see follow.*
2. *Recommended Values used derive from the calibration certificate and 250 mW is used asfeeding power to the calibrated dipole.*

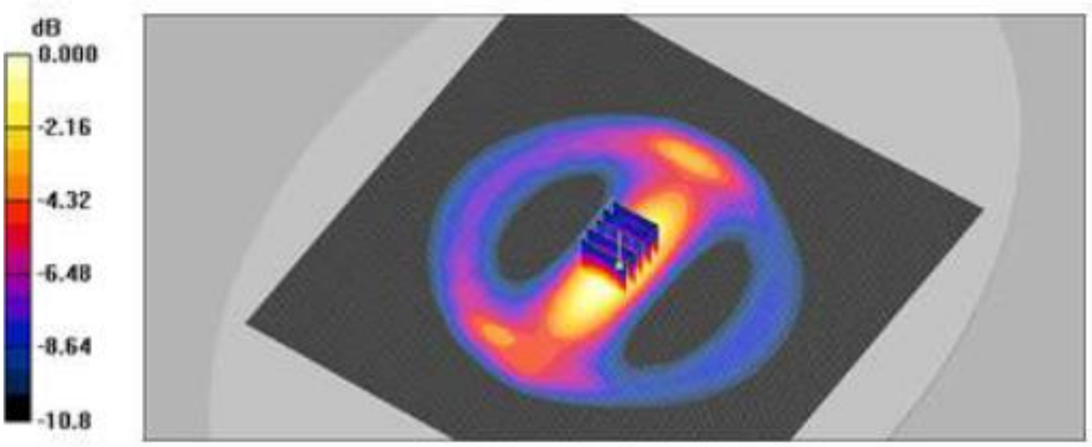
System Performance Check at 150 MHz

DUT: Dipole 150 MHz; Type: CLA150; Serial: 4007
Date: 2016-12-18
Communication System: CW; Frequency: 150 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 150 MHz; σ = 0.77 S/m; ε_r = 53.25; ρ = 1000 kg/m
Phantom section: Flat Section

DASY5 Configuration:
Probe: EX3DV4 - SN3600; ConvF(9.80, 9.80, 9.80); Calibrated: 15/04/2016;
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1315; Calibrated: 26/07/2016;
Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.5 (6469)

Area Scan (41x151x1): Measurement grid: dx=15.00 mm, dy=15.00 mm
Maximum value of SAR (measured) = 4.19 mW/g

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 25.0 V/m; Power Drift = -0.101 dB
Peak SAR (extrapolated) = 6.42 W/kg
SAR(1 g) = 4.15 mW/g; SAR(10 g) = 2.76 mW/g
Maximum value of SAR (measured) = 4.47 mW/g



System Performance Check 150MHz 1W

7.2. Measurement Procedures

7.2.1. Tests to be performed

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in EN62209-1 firure 8 for head test and EN62209-2 figure 12 for body test.

Step 1:
The tests described in EN62209-1 firure 8 shall be performed at the channel that is closest to the centre of the transmit frequency band (f_c) for:

a) all device positions (cheek and tilt, for both left and right sides of the SAM phantom, as described in Chapter 8),
b) all configurations for each device position in a), e.g., antenna extended and retracted, and
c) all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.
d) If more than three frequencies need to be tested according to EN62209-1 firure 8 (i.e., $N_c > 3$), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

Step 2:
For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in EN62209-2 figure 12 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

Step 3:
Examine all data to determine the highest value of the peak spatial-average SAR found in Steps 1 to 2.

7.2.2. Measurement procedure

(a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineeringsoftware to configure EUT WLAN continuously transmission, at maximum RF power, in the highest powerchannel.
(b) Place the EUT in the positions as demonstrates.
(c) Set scan area, grid size and other setting on the DASY software.
(d) Measure SAR results for the highest power channel on each testing position.
(e) Find out the largest SAR result on these testing positions of each band

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR valueconsists of the following steps:

(a) Power reference measurement
(b) Area scan
(c) Zoom scan
(d) Power drift measurement

7.3. SAR Limits

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average(averaged over the whole body)	0.08	0.4
Spatial Peak(averaged over any 1 g of tissue)	2.0	10
Spatial Peak(hands/wrists/ feet/ankles averaged over 10 g)	4.0	20.0

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

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

8. TEST RESULTS

8.1. Conducted Power Measurement Results

Conducted power measurement results

Mode	Channel	Frequency (MHz)	Conducted power (dBm)
Analog / 25KHz	CH_L	156.05	37.26
	CH_M	156.80	37.16
	CH_H	157.425	37.34
Digital / 25KHz	CH_{M1}	156.525	37.36

Mode	Channel	Frequency (MHz)	Conducted power (dBm)
BDR	CH_L	2402	-3.58
	CH_M	2441	-4.01
	CH_H	2480	-4.99
EDR (π /4-DQPSK)	CH_L	2402	-3.74
	CH_M	2441	-3.13
	CH_H	2480	-4.08
EDR(8DPSK)	CH_L	2402	-2.34
	CH_M	2441	-2.86
	CH_H	2480	-3.81
BLE	CH_L	2402	-1.02
	CH_M	2440	-1.21
	CH_H	2480	-1.97

Remark: the conudcted output power of Bluetooth less than 20mW.

8.1.1. Test reduction procedure

Maximum power level

The maximum power level, $P_{max,m}$, that can be transmitted by a device before the SAR averaged over a mass, m, exceeds a given limit, SAR_{lim}, can be defined. Any device transmitting at power levels below $P_{max,m}$ can then be excluded from SAR testing. The lowest possible value for $P_{max,m}$ is: $P_{max,m} = SAR_{lim}*$ m.

8.2. SAR Measurement Results

Analog mode									
Test Position	Channel separation (KHz)	Frequency		Power Drift(dB)	Turn-up Scailing Factor	Measured SAR (1g) (W/Kg)	Report SAR (1g) (W/Kg)	SAR 50% duty (W/kg)	Test Plot
		Channel	MHz						
Body	25.0	CH_L	156.05	-0.06	1.18	9.46	11.19	5.60	-
		CH_M	156.80	**-0.15**	**1.21**	**9.52**	**11.52**	**5.76**	AB1
		CH_H	157.425	-0.06	1.16	9.39	10.91	5.46	-
Face	25.0	CH_L	156.05	-0.05	1.18	5.61	6.64	3.32	-
		CH_M	156.80	**-0.12**	**1.21**	**5.79**	**7.01**	**3.51**	AF1
		CH_H	157.425	-0.05	1.16	5.54	6.43	3.22	-

Digital mode									
Test Position	Channel separation (KHz)	Frequency		Power Drift(dB)	Turn-up Scailing Factor	Measured SAR (1g) (W/Kg)	SAR(1g) (W/kg)	SAR 50% duty (W/kg)	Test Plot
		Channel	MHz						
Body	25.0	CH_{M1}	156.525	**-0.09**	**1.19**	**8.87**	**10.59**	**5.30**	DB1
Face	25.0	CH_{M1}	156.525	**0.18**	**1.19**	**4.85**	**5.79**	**2.90**	DF1

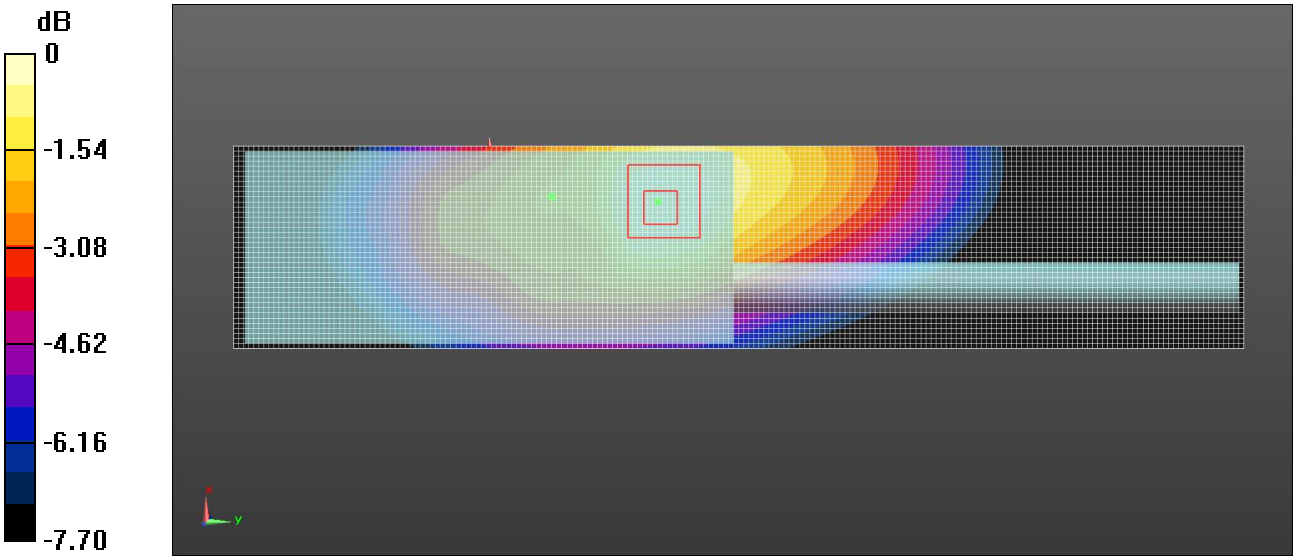
8.3. SAR Test Graph Results

Test Plot:	AB1	Test Position:	Body

Date: 2016-12-15
Communication System: Customer System; Frequency: 156.80 MHz;
Medium parameters used (interpolated): f = 156.80 MHz; σ = 0.81 S/m; εr = 61.65; ρ=1000 kg/m3

DASY5 Configuration:
- Probe: EX3DV4 - SN3600; ConvF(8.81, 8.81, 8.81); Calibrated: 15/04/2016;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1315; Calibrated: 26/07/2016
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan(41x151x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 10.19 W/kg
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 108.30 V/m; Power Drift = -0.15 dB
Peak SAR (extrapolated) = 10.36 mW/g
SAR(1 g) = 9.52 mW/g; SAR(10 g) = 7.10 mW/g
Maximum value of SAR (measured) = 10.13 W/kg



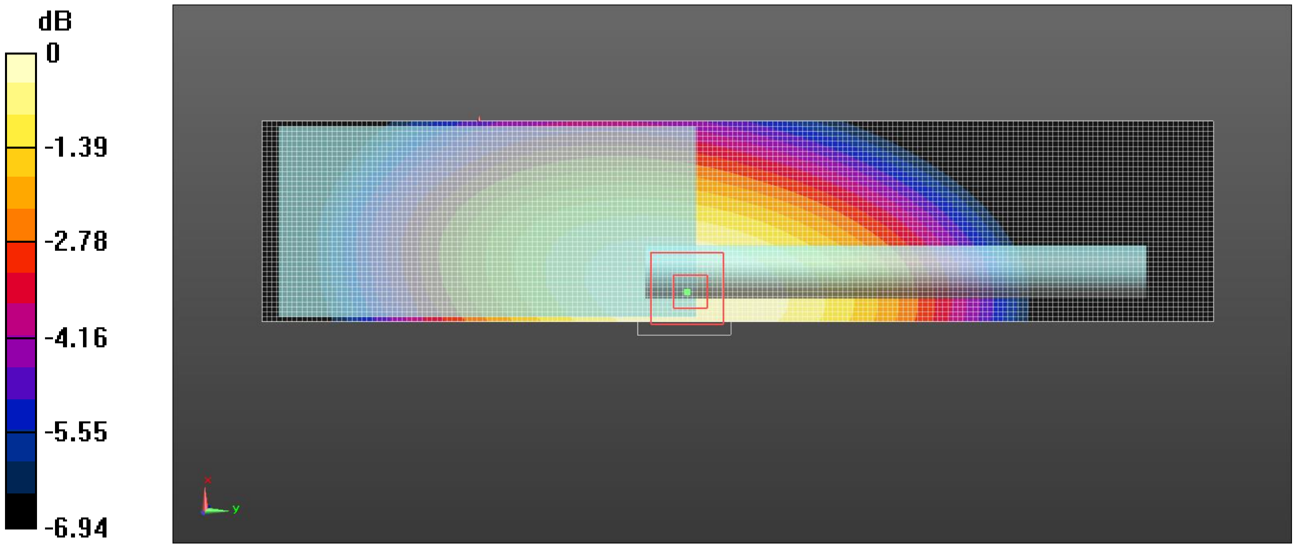
Test Plot:	AF1	Test Position:	Front of face

Date: 2016-12-15
Communication System: Customer System; Frequency: 156.80 MHz;
Medium parameters used (interpolated): f = 156.80 MHz; σ = 0.77 S/m; εr = 52.24; ρ=1000 kg/m3

DASY5 Configuration:

- Probe: EX3DV4 - SN3600; ConvF(9.80, 9.80, 9.80); Calibrated: 15/04/2016;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1315; Calibrated: 26/07/2016
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan (51x141x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 6.20 W/kg
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 49.186 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 6.56 mW/g
SAR(1 g) = 5.79 mW/g; SAR(10 g) = 3.46 mW/g
Maximum value of SAR (measured) = 6.08 W/kg



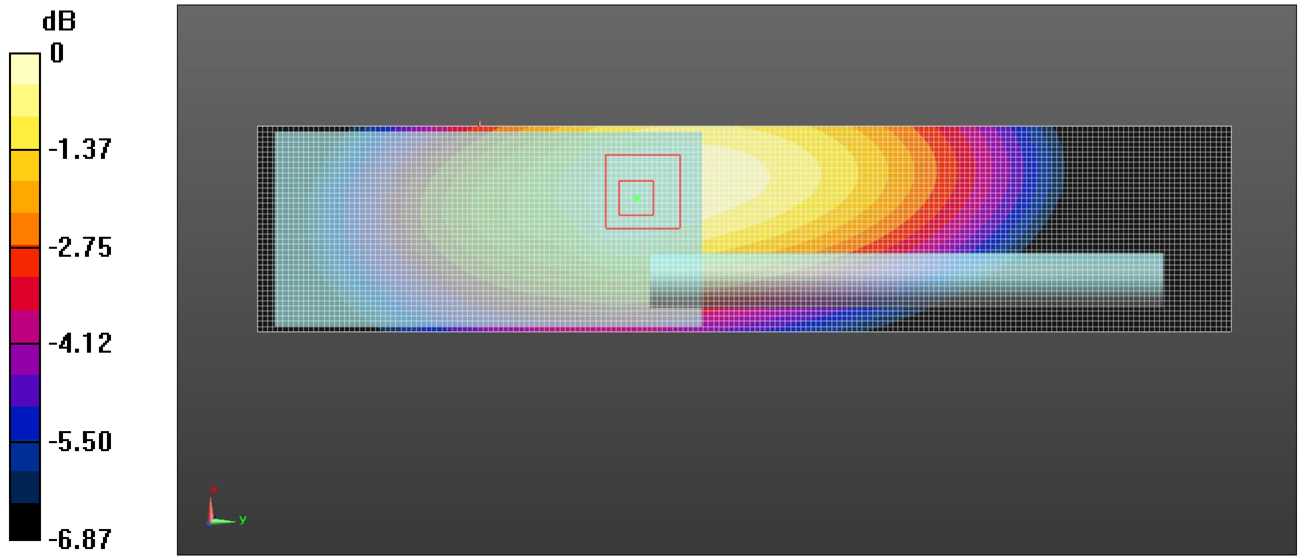
Test Plot:	DB1	Test Position:	Body

Date: 2016-12-15
Communication System: Customer System; Frequency: 156.525 MHz;
Medium parameters used (interpolated): f = 156.525 MHz; σ = 0.81 S/m; εr = 61.83; ρ=1000 kg/m3

DASY5 Configuration:

- Probe: EX3DV4 - SN3600; ConvF(8.81, 8.81, 8.81); Calibrated: 15/04/2016;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1315; Calibrated: 26/07/2016
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan(41x151x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 9.22 W/kg
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 118.286 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 10.191 mW/g
SAR(1 g) = 8.87 mW/g; SAR(10 g) = 6.32 mW/g
Maximum value of SAR (measured) = 9.19 W/kg



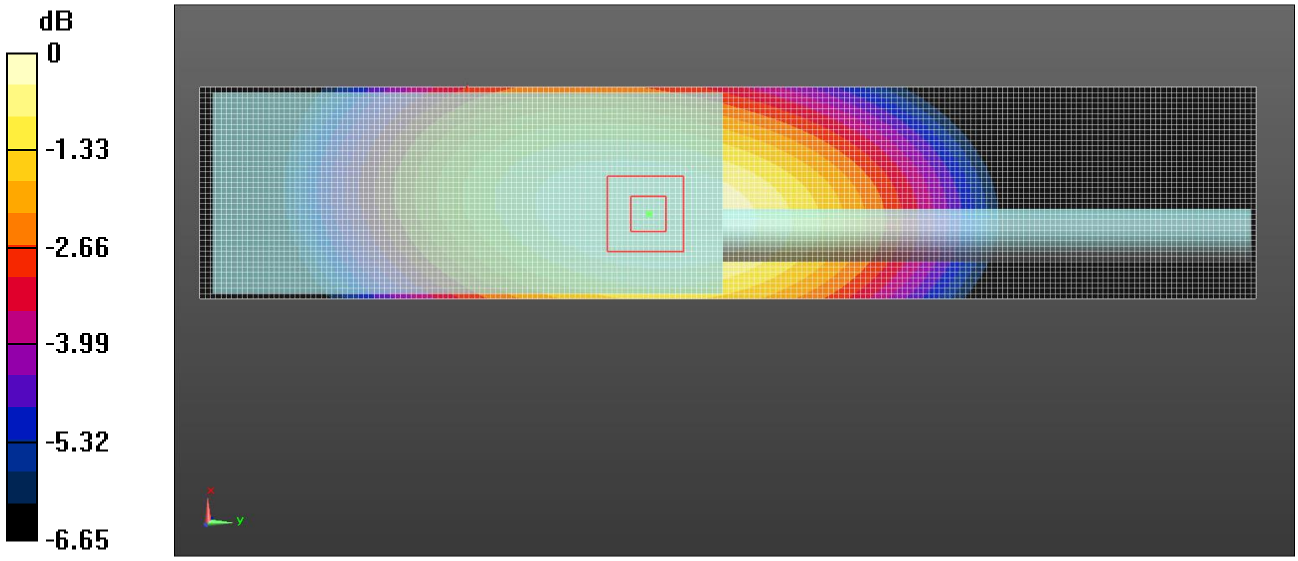
Test Plot:	DF1	Test Position:	Front of face

Date: 2016-12-15
Communication System: Customer System; Frequency: 156.525 MHz;
Medium parameters used (interpolated): f = 156.525 MHz; σ = 0.77 S/m; εr = 52.24; ρ=1000 kg/m3

DASY5 Configuration:

- Probe: EX3DV4 - SN3600; ConvF(9.80, 9.80, 9.80); Calibrated: 15/04/2016;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1315; Calibrated: 26/07/2016
- Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

Area Scan(41x151x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 5.40 W/kg
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 47.804 V/m; Power Drift = 0.18 dB
Peak SAR (extrapolated) = 5.93 mW/g
SAR(1 g) = 4.85mW/g; SAR(10 g) = 3.33 mW/g
Maximum value of SAR (measured) = 5.47 W/kg



9. Equipments Used during the Test

Test Equipment	Manufacturer	Type/Model	Serial Number	Calibration	
				Last Calibration	Calibration Interval
Data Acquisition Electronics DAEx	SPEAG	DAE4	1315	2016/07/26	1
E-field Probe	SPEAG	EX3DV4	3600	2016/04/15	1
System Validation Dipole CLA150	SPEAG	CLA150	4007	2016/01/24	1
Dielectric Probe Kit	Agilent	85070E	US44020288	/	/
Power meter	Agilent	N1914A	MY52140008	2016/05/07	1
Power sensor	Agilent	E9304A	MY54470001	2016/05/07	1
Power sensor	Agilent	E9301H	MY51491493	2016/05/07	1
Network analyzer	Agilent	8753E	US37390562	2016/10/24	1
Signal Generator	ROHDE & SCHWARZ	SMBV100A	258525	2016/10/22	1
Power Divider	ARRA	A3200-2	N/A	N/A	N/A
Dual Directional Coupler	Agilent	778D	50783	Note	
Attenuator 1	PE	PE7005-10	N/A	Note	
Attenuator 2	PE	PE7005-10	N/A	Note	
Attenuator 3	PE	PE7005-3	N/A	Note	
Power Amplifier	AR	5S1G4M2	0328798	Note	

10. Measurement Uncertainty

Measurement Uncertainty										
No.	Error Description	Type	Uncertainty Value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement System										
1	Probe calibration	B	6.0%	N	1	1	1	6.0%	6.0%	∞
2	Axial isotropy	B	4.70%	R	$\sqrt{3}$	0.7	0.7	1.90%	1.90%	∞
3	Hemispherical isotropy	B	9.60%	R	$\sqrt{3}$	0.7	0.7	3.90%	3.90%	∞
4	Boundary Effects	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
5	Probe Linearity	B	4.70%	R	$\sqrt{3}$	1	1	2.70%	2.70%	∞
6	Detection limit	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
7	RF ambient conditions-noise	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
8	RF ambient conditions-reflection	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
9	Response time	B	0.80%	R	$\sqrt{3}$	1	1	0.50%	0.50%	∞
10	Integration time	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
11	RF ambient	B	3.00%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
12	Probe positioned mech. restrictions	B	0.40%	R	$\sqrt{3}$	1	1	0.20%	0.20%	∞
13	Probe positioning with respect to phantom shell	B	2.90%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
14	Max.SAR evalation	B	3.90%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
Test Sample Related										
15	Test sample positioning	A	1.86%	N	1	1	1	1.86%	1.86%	∞
16	Device holder uncertainty	A	1.70%	N	1	1	1	1.70%	1.70%	∞
17	Drift of output power	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
Phantom and Set-up										
18	Phantom uncertainty	B	4.00%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
19	Liquid conductivity (target)	B	5.00%	R	$\sqrt{3}$	0.64	0.43	1.80%	1.20%	∞
20	Liquid conductivity (meas.)	A	0.50%	N	1	0.64	0.43	0.32%	0.26%	∞
21	Liquid permittivity (target)	B	5.00%	R	$\sqrt{3}$	0.64	0.43	1.80%	1.20%	∞
22	Liquid cpermittivity (meas.)	A	0.16%	N	1	0.64	0.43	0.10%	0.07%	∞
Combined standard uncertainty		$u_c = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$		/	/	/	/	9.79%	9.67%	∞
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$		R	K=2	/	/	19.57%	19.34%	∞

THE END