FCC

SAR

TEST REPORT

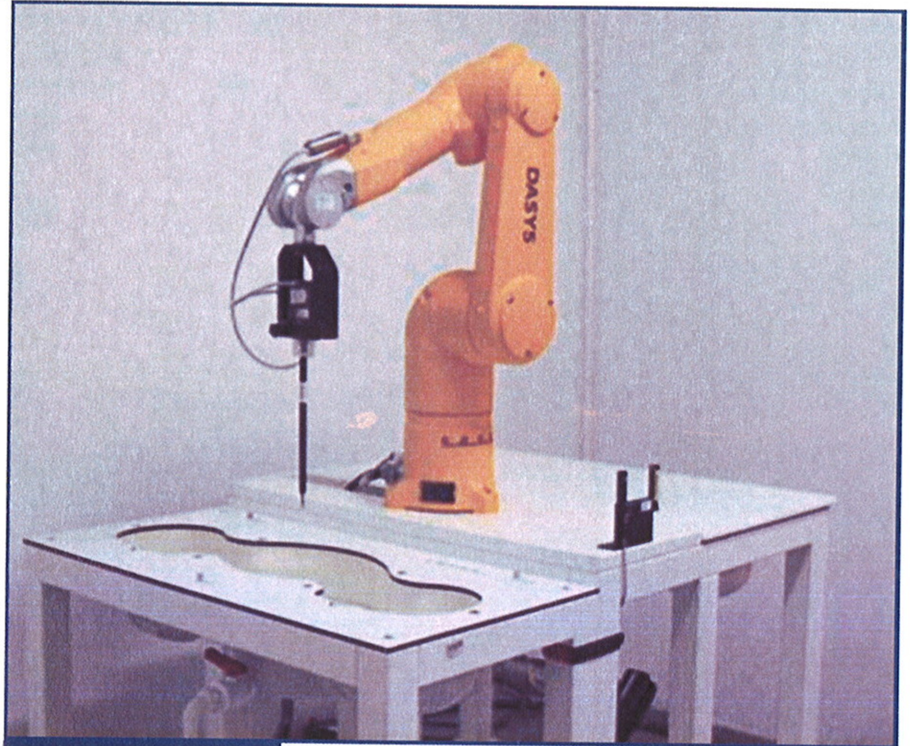
ISSUED BY
Shenzhen BALUN Technology Co., Ltd.

FOR

Panda Wireless® 300Mbps Wireless N USB Adapter

ISSUED TO
Panda Wireless, Inc.

15559 Union Ave, Suite 300, Los Gatos, CA 95032



Report No:	BL-SZ1560094-701
EUT Type:	Panda Wireless® 300Mbps Wireless N USB Adapter
Model Name:	PAU05
Brand Name:	N/A
FCC ID:	2ADUTLGPAU05
Test Standard:	FCC 47 CFR Part 2.1093 ANSI C95.1: 1992 IEEE 1528: 2013
Maximum SAR:	Body (1 g): 0.200 W/kg
Test Conclusion:	Pass
Test Date:	Jun. 25, 2015
Date of Issue:	Jul. 10, 2015

Prepared by: Wen Lin
Wen Lin
(Reporting Specialist)
Date Jul. 10, 2015

Approved by: Wei Yanquan
Wei Yanquan
(Chief Engineer)
Date Jul. 10, 2015

BALUN CERTIFICATION CONSULTING SERVICE

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Revision History

Version	Issue Date	Revisions
Rev. 01	Jul. 10, 2015	Initial Issue Add Tune-up power tolerance in chapter 8; Add Measurement uncertainly evaluation for system check in chapter 3.4 Add Dielectric Probe Calibration Report in ANNEX F

TABLE OF CONTENTS

1 GENERAL INFORMATION

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co.,Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province,P. R. China
Phone Number	+86 755 66850100
Fax Number	+86 755 6182 4271

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co.,Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province,P. R. China
Accreditation Certificate	The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1. The laboratory has been listed by US Federal Communications Commission to perform electromagnetic emission measurements. The recognition numbers of test site are 832625. The laboratory has met the requirements of the IAS Accreditation Criteria for Testing Laboratories (AC89), has demonstrated compliance with ISO/IEC Standard 17025:2005. The accreditation certificate number is TL-588. The laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6791.
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

1.3 Test Environment Condition

Ambient Temperature	21 to 23℃
Ambient Relative Humidity	40 to 50%
Ambient Pressure	100 to 102KPa

1.4 Announce

(1) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.

(2) The test report is invalid if there is any evidence and/or falsification.

(3) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.

(4) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.

(5) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

2 PRODUCT INFORMATION

2.1 Applicant

Applicant	Panda Wireless, Inc.
Address	15559 Union Ave, Suite 300, Los Gatos, CA 95032.

2.2 Manufacturer

Manufacturer	Panda Wireless, Inc.
Address	15559 Union Ave, Suite 300, Los Gatos, CA 95032.

2.3 General Description for Equipment under Test (EUT)

EUT Type	Panda Wireless® 300Mbps Wireless N USB Adapter
EUT Model Name	PAU05
Hardware Version	N/A
Software Version	N/A
Dimensions	44 × 20 × 6mm
Weight	4.9 g
Network and Wireless connectivity	WLAN

2.4 Technical Information

The requirement for the following technical information of the EUT was tested in this report:

Operating Mode	2.4G WLAN	
Frequency Range	802.11b/g/ n(HT20/HT40)	2412~2462 MHz
Antenna Type	WLAN: PCB Antenna	
Environment	Uncontrolled	
EUT Stage	Portable Device	

3 SUMMARY OF TEST RESULT

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 2	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
2	ANSI/IEEE Std. C95.1-1992	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
3	IEEE Std. 1528-2013	Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
4	FCC KDB 447498 D01 v05r02	Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies
5	FCC KDB 447498 D02 v02	SAR Measurement Procedures for USB Dongle Transmitters
6	FCC KDB 248227 D01 v02r01	SAR GUIDANCE FOR IEEE 802.11 (Wi-Fi) TRANSMITTERS
7	FCC KDB 865664 D01 v01r03	SAR Measurement 100 MHz to 6 GHz
8	FCC KDB 865664 D02 v01r01	RF Exposure Reporting

3.2 Device Categoryand SAR Limit

This device belongs to portable device category because its radiating structure is allowed to be used within 20 centimeters of the body of the user.

Limit for General Population/Uncontrolled exposure should be applied for this device, it is 1.6 W/kg as averaged over any 1 gram of tissue.

Table of Exposure Limits:

Body Position	SAR Value (W/Kg)	
	General Population/ Uncontrolled Exposure	Occupational/ ControlledExposure
Whole-Body SAR (averaged over the entire body)	0.08	0.4
Partial-Body SAR (averaged over any 1 gram of tissue)	1.60	8.0
SAR for hands, wrists, feet and ankles (averaged over any 1 grams of tissue)	4.0	20.0

NOTE:

General Population/Uncontrolled Exposure: Locationswhere there is the exposure of individuals who have no knowledge or control of their exposure. General population/uncontrolled exposure limits are applicable to situations in which thegeneral public may be exposed or in which persons who are exposed as a consequence of theiremployment may not be made fully aware of the potential for exposure or cannot exercise control overtheir exposure. Members of the general public would come under this category when exposure is notemployment-related; for example, in the case of a wireless transmitter that exposes persons in itsvicinity.

Occupational/ControlledExposure: Locations where there is exposure that may be incurred by persons who are aware of the potential for exposure,In general, occupational/controlled exposure limits are applicable to situations in which personsare exposed as a consequence of their employment, who have been made fully aware of the potentialfor exposure and can exercise control over their exposure. This exposure category is also applicablewhen the exposure is of a transient nature due to incidental passage through a location where theexposure levels may be higher than the general population/uncontrolled limits, but the exposed person isfully aware of the potential for exposure and can exercise control over his or her exposure by leaving thearea or by some other appropriate means.

3.3 Test Result Summary

3.3.1 Highest SAR (1 g Value)

Position	Band	Maximum Measured SAR (W/kg)	Maximum Report SAR (W/kg)	Limit (W/kg)	Verdict
Body	WLAN 802.11b	0.193	0.198	1.6	Pass
	WLAN 802.11g	0.089	0.092	1.6	Pass

3.4 Test Uncertainty

3.4.1 Measurement uncertainly evaluation for SAR test

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in IEEE 1528: 2013.This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

System Measurement Uncertainty (frequency range from 300 MHz to 3 GHz)

Uncertainty Component	Tol (+- %)	Prob. Dist.	Div.	Ci (1g)	Ci (10g)	1g Ui (+-%)	10g Ui (+-%)	Vi
Measurement System								
Probe calibration	6.0	N	1	1	1	6.00	6.00	∞
Axial Isotropy	4.7	R	$\sqrt{3}$	0.7	0.7	1.90	1.90	∞
Hemispherical Isotropy	9.6	R	$\sqrt{3}$	0.7	0.7	3.90	3.90	∞
Boundary effect	1.0	R	$\sqrt{3}$	1	1	0.60	0.60	∞
Linearity	4.7	R	$\sqrt{3}$	1	1	2.70	2.70	∞
System detection limits	1.0	R	$\sqrt{3}$	1	1	0.60	0.60	∞
Readout Electronics	0.3	N	1	1	1	0.30	0.30	∞
Reponse Time	0.8	R	$\sqrt{3}$	1	1	0.50	0.50	∞
Integration Time	2.6	R	$\sqrt{3}$	1	1	1.50	1.50	∞
RF ambient Conditions - Noise	3.0	R	$\sqrt{3}$	1	1	1.70	1.70	∞
RF ambient Conditions - Reflections	3.0	R	$\sqrt{3}$	1	1	1.70	1.70	∞
Probe positioner Mechanical Tolerance	0.4	R	$\sqrt{3}$	1	1	0.20	0.20	∞
Probe positioning with respect to Phantom Shell	2.9	R	$\sqrt{3}$	1	1	1.70	1.70	∞
Extrapolation, interpolation and integration Algoritms for Max. SAR Evaluation	2.0	R	$\sqrt{3}$	1	1	1.20	1.20	∞
Test sample Related								
Test sample positioning	2.9	N	1	1	1	2.90	2.90	N-1
Device Holder Uncertainty	3.6	N	1	1	1	3.60	3.60	N-1
Output power Variation - SAR drift measurement	5.0	R	$\sqrt{3}$	1	1	2.90	2.90	∞
SAR scaling	0.0	R	$\sqrt{3}$	1	1	0.00	0.00	∞
Phantom and Tissue Parameters								
Phantom Uncertainty (Shape and thickness tolerances)	4.0	R	$\sqrt{3}$	1	1	3.50	3.50	∞
SAR correction	1.9	R	$\sqrt{3}$	1	0.84	1.10	0.90	∞
Liquid conductivity - measurement uncertainty	2.5	N	$\sqrt{3}$	0.78	0.71	1.10	1.00	∞
Liquid permittivity - measurement uncertainty	2.5	N	$\sqrt{3}$	0.26	0.26	0.30	0.40	∞
Liquid conductivity - temperature uncertainty	3.4	N	$\sqrt{3}$	0.78	0.71	1.50	1.40	∞
Liquid permittivity - temperature uncertainty	0.4	N	$\sqrt{3}$	0.26	0.26	0.10	0.10	∞
Combined Standard Uncertainty		RSS				13.1	13.0	
Expanded Uncertainty (95% Confidence interval)		K=2				26.1	26.1	

3.4.2 Measurement uncertainly evaluation for system check

System Measurement Uncertainty (frequency range from 3 GHz to 6 GHz)

Uncertainty Component	Tol (+- %)	Prob. Dist.	Div.	Ci (1g)	Ci (10g)	1g Ui (+-%)	10g Ui (+-%)	Vi
Measurement System								
Probe calibration	6.55	N	1	1	1	6.55	6.55	∞
Axial Isotropy	4.7	R	$\sqrt{3}$	0.7	0.7	1.90	1.90	∞
Hemispherical Isotropy	9.6	R	$\sqrt{3}$	0.7	0.7	3.90	3.90	∞
Boundary effect	2.0	R	$\sqrt{3}$	1	1	1.20	1.20	∞
Linearity	4.7	R	$\sqrt{3}$	1	1	2.70	2.70	∞
System detection limits	1.0	R	$\sqrt{3}$	1	1	0.60	0.60	∞
Readout Electronics	0.3	N	1	1	1	0.30	0.30	∞
Reponse Time	0.8	R	$\sqrt{3}$	1	1	0.50	0.50	∞
Integration Time	2.6	R	$\sqrt{3}$	1	1	1.50	1.50	∞
RF ambient Conditions - Noise	3.0	R	$\sqrt{3}$	1	1	1.70	1.70	∞
RF ambient Conditions - Reflections	3.0	R	$\sqrt{3}$	1	1	1.70	1.70	∞
Probe positioner Mechanical Tolerance	0.8	R	$\sqrt{3}$	1	1	0.50	0.50	∞
Probe positioning with respect to Phantom Shell	6.7	R	$\sqrt{3}$	1	1	3.90	3.90	∞
Extrapolation, interpolation and integration Algoritms for Max. SAR Evaluation	4.0	R	$\sqrt{3}$	1	1	2.30	2.30	∞
Test sample Related								
Test sample positioning	2.9	N	1	1	1	2.90	2.90	N-1
Device Holder Uncertainty	3.6	N	1	1	1	3.60	3.60	N-1
Output power Variation - SAR drift measurement	5.0	R	$\sqrt{3}$	1	1	2.90	2.90	∞
SAR scaling	0.0	R	$\sqrt{3}$	1	1	0.00	0.00	∞
Phantom and Tissue Parameters								
Phantom Uncertainty (Shape and thickness tolerances)	6.6	R	$\sqrt{3}$	1	1	3.80	3.80	∞
SAR correction	1.9	R	$\sqrt{3}$	1	0.84	1.10	0.90	∞
Liquid conductivity - measurement uncertainty	2.5	N	$\sqrt{3}$	0.78	0.71	1.10	1.00	∞
Liquid permittivity - measurement uncertainty	2.5	N	$\sqrt{3}$	0.26	0.26	0.30	0.40	∞
Liquid conductivity - temperature uncertainty	3.4	N	$\sqrt{3}$	0.78	0.71	1.50	1.40	∞
Liquid permittivity - temperature uncertainty	0.4	N	$\sqrt{3}$	0.26	0.26	0.10	0.10	∞
Combined Standard Uncertainty		RSS				14.0	14.0	
Expanded Uncertainty (95% Confidence interval)		K=2				28.1	28.0	

4 MEASUREMENT SYSTEM

4.1 Specific Absorption Rate (SAR) Definition

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and generalpopulation/uncontrolled, based on a person's awarenessand ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$\mathbf{SAR} = \frac{d}{\mathbf{dt}}\left(\frac{d\mathbf{W}}{\mathbf{dm}}\right) = \frac{d}{\mathbf{dt}}\left(\frac{d\mathbf{W}}{\rho\mathbf{dv}}\right)$$

SAR is expressed in units of Watts per kilogram (W/kg) SAR measurement can be related to the electrical field in the tissue by

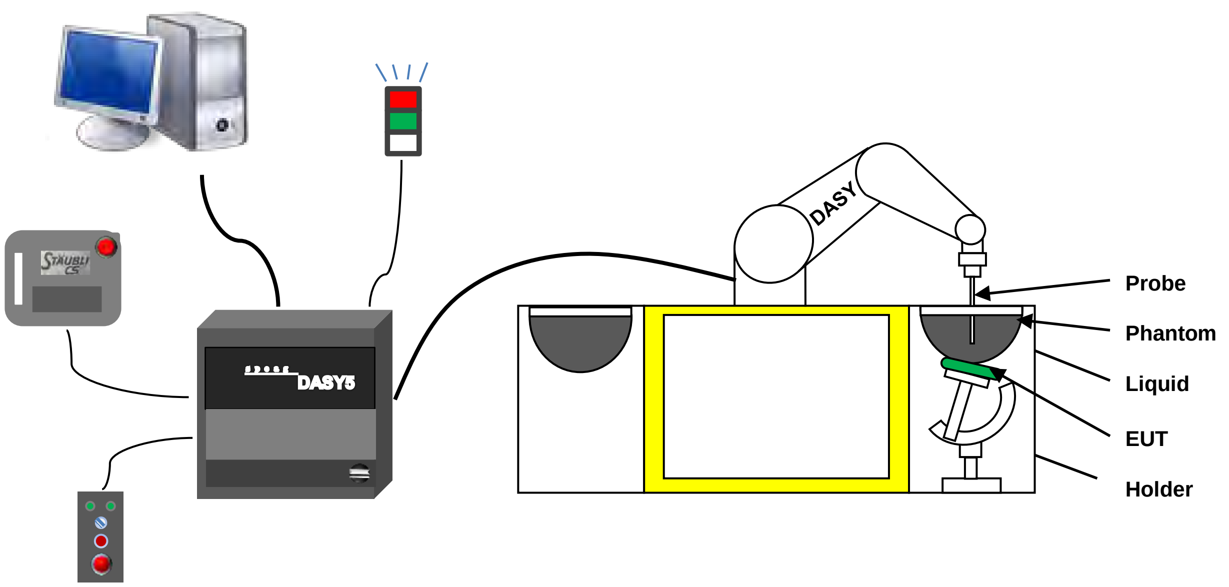
$$\mathbf{SAR} = \frac{\sigma \mathbf{E}^2}{\rho}$$

Where: ζ is the conductivity of the tissue,

ρis the mass density of the tissue and E is the RMS electrical field strength.

4.2 DASY SAR System

4.2.1 DASY SAR System Diagram



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

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. 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.
3. 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.
4. A unit to operate the optical surface detector which is connected to the EOC.
5. 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.
6. The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation.
7. DASY5 software and SEMCAD data evaluation software.
8. Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling the testing of left-hand and right-hand usage.
10. The device holder for handheld mobile phones.
11. Tissue simulating liquid mixed according to the given recipes.
12. System validation dipoles allowing to validate the proper functioning of the system.

4.2.2 Robot

The Dasy SAR system uses the high precision robots.Symmetrical design with triangular coreBuilt-in optical fiber for surface detection system For the 6-axis controller system, Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents) The robot series have many features that are important for our application:

- High precision
  (repeatability ±0.02 mm)
- High reliability
  (industrial design)
- Low maintenance costs
  (virtually maintenancefree due to direct drive gears; no belt drives)
- Jerk-free straight movements
  (brushless synchron motors; no stepper motors)
- Low ELF interference
  (motor control _elds shielded via the closed metallic constructionshields)

4.2.3 E-FieldProbe

The probe is specially designed and calibrated for use in liquids with high permittivities for the measurements the Specific Dosimetric E-Field Probe EX3DV4-SN:7340 with following specifications is used.

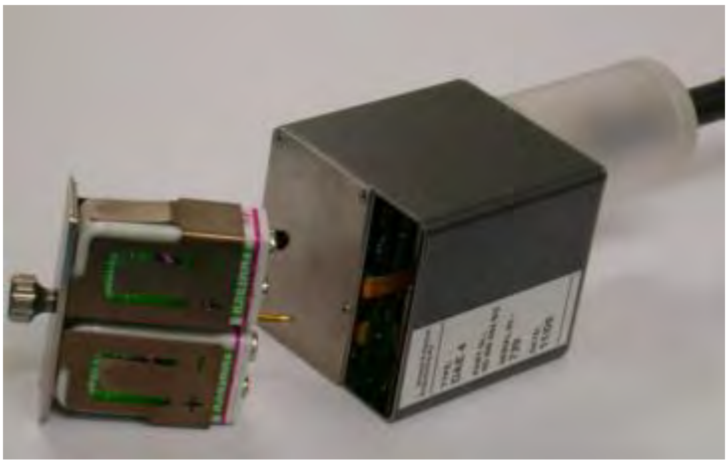
Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection systemBuilt-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycolether)
Calibration	ISO/IEC 17025 calibration service available
Frequency	10 MHz to 6 GHz; Linearity: ± 0.2 dB (30 MHz to 4 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
Dimensions	Overall length: 337 mm (Tip: 9 mm) Tip diameter: 2.5 mm (Body: 10 mm) Distance from probe tip to dipole centers: 1.0 mm
Application	General dosimetry up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms (EX3DV4)

E-Field Probe Calibration Process

Probe calibration is realized, in compliance with CENELEC EN 62209-1/-2 and IEEE 1528 std, withCALISAR, Antennessa proprietary calibration system. The calibration is performed with the EN 62209-1/2 annexe technique using reference guide at the five frequencies.

4.2.4 Data Acquisition Electronics

The data acquisition electronics (DAE) consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converte and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.



- Input Impedance: 200MOhm
- The Inputs: Symmetrical and Floating
- Commom Mode Rejection: Above 80dB

4.2.5 Phantoms

For the measurements the Specific Anthropomorphic Mannequin (SAM) defined by the IEEE SCC-34/SC2 group is used. The phantom is a polyurethane shell integrated in a wooden table. The thickness of the phantom amounts to 2mm +/- 0.2mm. It enables the dosimetric evaluation of left and right phone usage and includes an additional flat phantom part for the simplified performance check. The phantom set-up includes a cover, which prevents the evaporation of the liquid.

- Left hand
- Right hand
- Flat phantom

Photo of Phantom SN1857

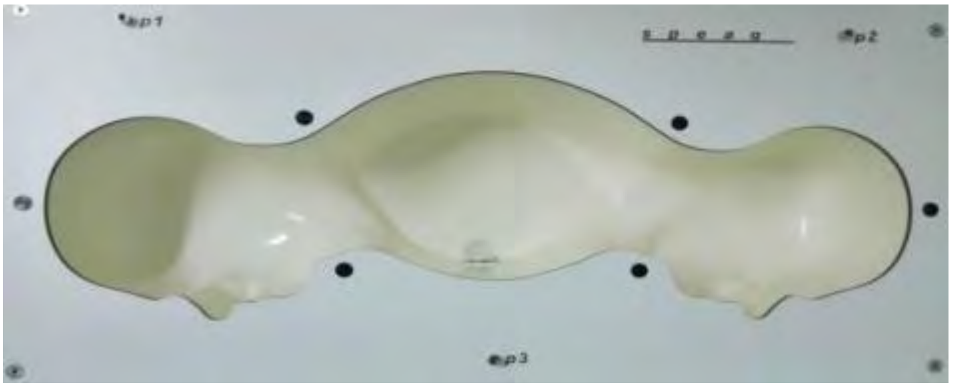
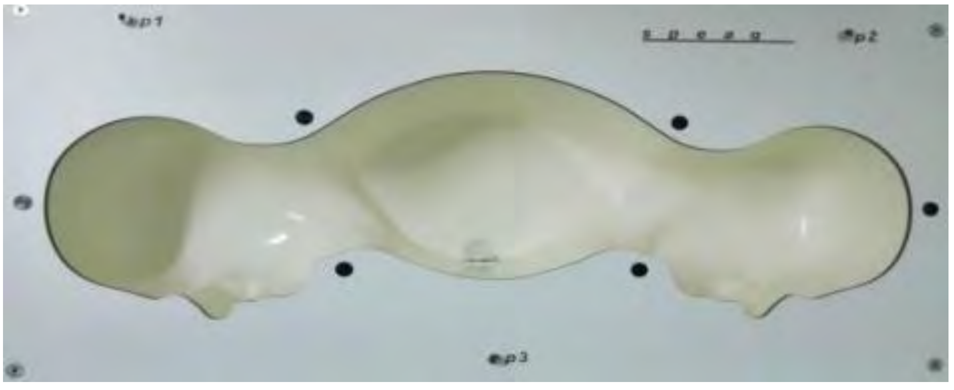


Photo of Phantom SN1859



Serial Number	Material	Length	Height
SN 1857 SAM1	Vinylester, glass fiber reinforced	1000	500
SN 1859 SAM2	Vinylester, glass fiber reinforced	1000	500

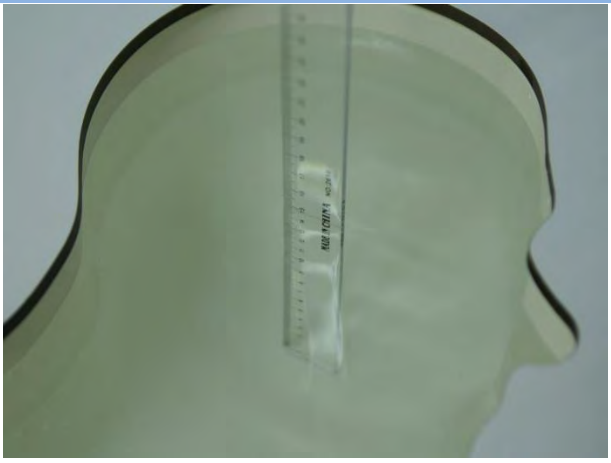
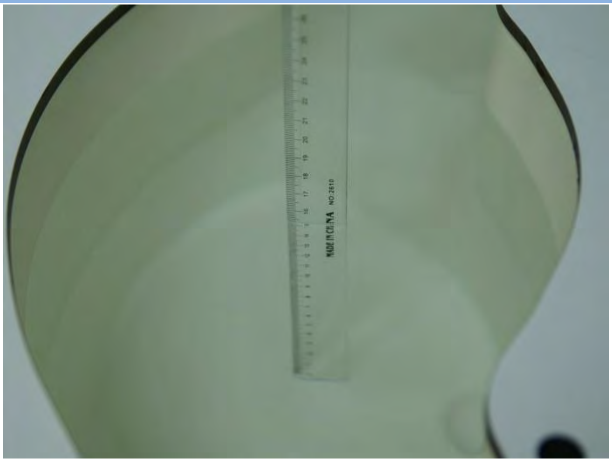
4.2.6 Device Holder

The DASY5 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.

The positioning system allows obtaining cheek and tilting position with a very good accuracy. Incompliance with CENELEC, the tilt angle uncertainty is lower than 1°.

4.2.7 Simulating Liquid

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5%.

Head Liquid Depth	Body Liquid Depth
	

The following table gives the recipes for tissue simulating liquid.

Frequency (MHz)	Water %	Sugar %	Cellulose %	Salt %	Preventol %	DGBE %	Conductivity σ	Permittivity ε
Head								
750	41.1	57.0	0.2	1.4	0.2	0	0.89	41.9
835	40.3	57.9	0.2	1.4	0.2	0	0.90	41.5
900	40.3	57.9	0.2	1.4	0.2	0	0.97	41.5
1800, 1900, 2000	55.2	0	0	0.3	0	44.5	1.4	40.0
2450	55.0	0	0	0.1	0	44.9	1.80	39.2
2600	54.9	0	0	0.1	0	45.0	1.96	39.0
Body								
750	51.7	47.2	0	0.9	0.1	0	0.96	55.5
835	50.8	48.2	0	0.9	0.1	0	0.97	55.2
900	50.8	48.2	0	0.9	0.1	0	1.05	55.0
1800, 1900, 2000	70.2	0	0	0.4	0	29.4	1.52	53.3
2450	68.6	0	0	0.1	0	31.3	1.95	52.7
2600	68.2	0	0	0.1	0	31.7	2.16	52.5

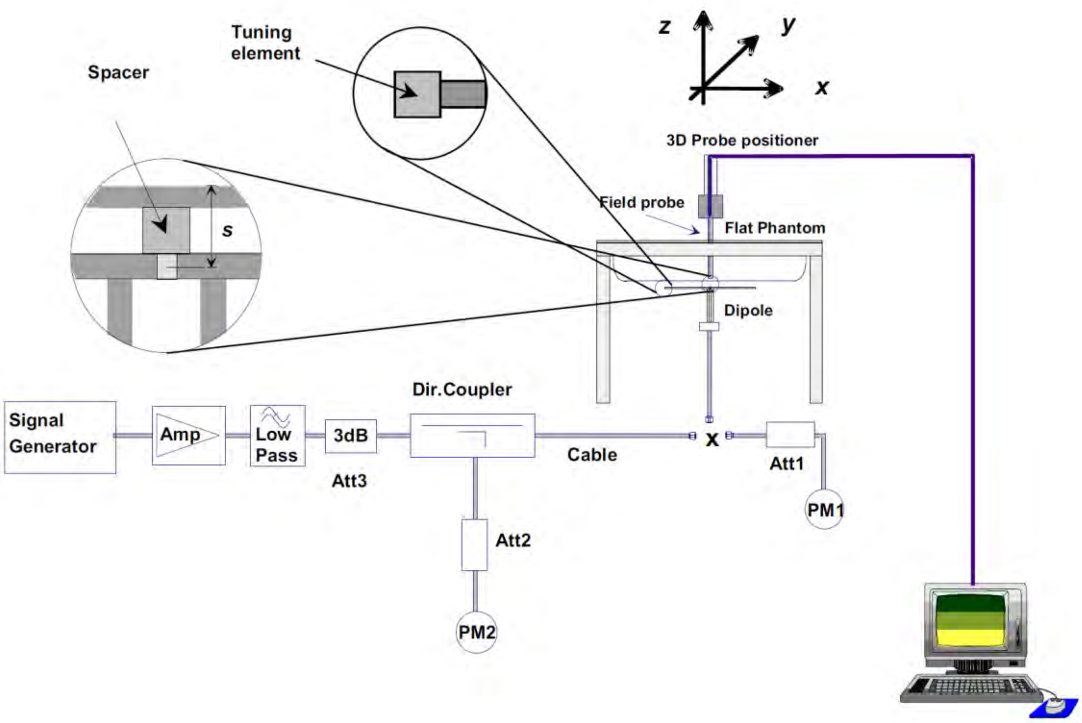
5 SYSTEM VERIFICATION

5.1 Purpose of System Check

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source.This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

5.2 System Check Setup

In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



6 TEST POSITION CONFIGURATIONS

According to KDB 648474 D04 Handset v01r02, handsets are tested for SAR compliance in head, body-worn accessory and other use configurations described in the following subsections.

6.1 Head Exposure Conditions

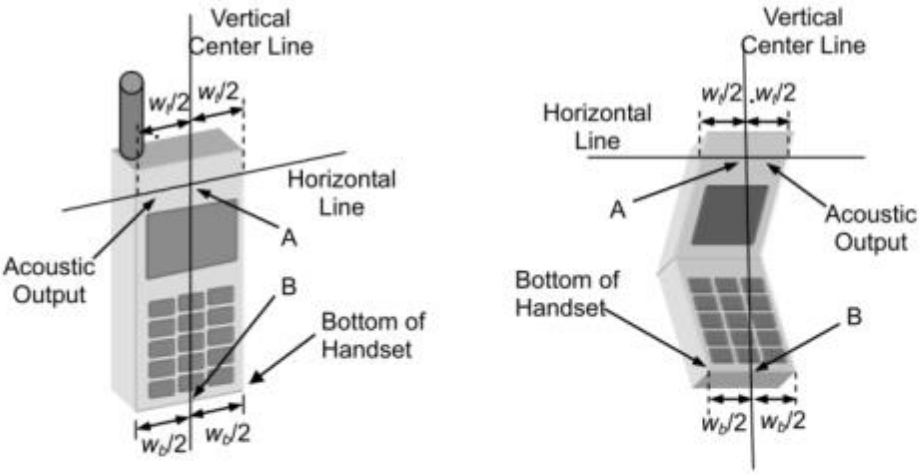
Head exposure is limited to next to the ear voice mode operations. Head SAR compliance is tested according to the test positions defined in IEEE Std 1528-2013 using the SAM phantom illustrated as below.

6.1.1 Two Imaginary Lines on the Handset

(a) The vertical centerline passes through two points on the front side of the handset - the midpoint of the width w t of the handset at the level of the acoustic output, and the midpoint of the width w b of the bottom of the handset.

(b) The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output. The horizontal line is also tangential to the face of the handset at point A.

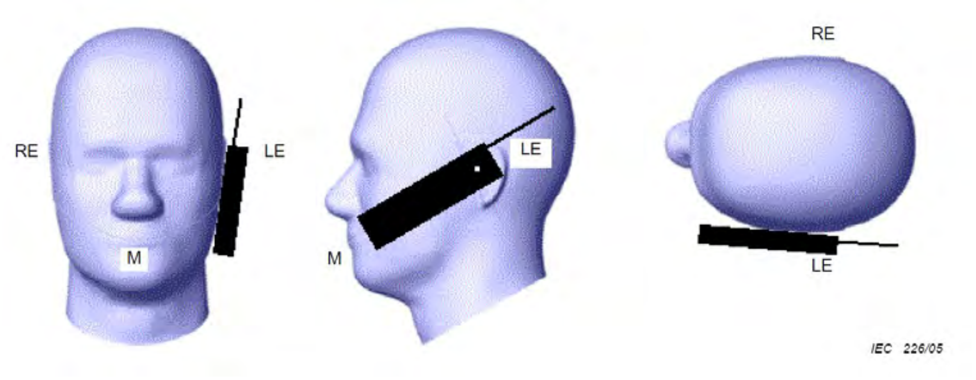
(c) The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output; however, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset, especially for clamshell handsets, handsets with flip covers, and other irregularly shaped handsets.



6.1.2 Cheek Position

(a) To position the device with the vertical center line of the body of the device and the horizontal line crossing the center piece in a plane parallel to the sagittal plane of the phantom. While maintaining the device in this plane, align the vertical center line with the reference plane containing the three ear and mouth reference point (M: Mouth, RE: Right Ear, and LE: Left Ear) and align the center of the ear piece with the line RE-LE.

(b) To move the device towards the phantom with the ear piece aligned with the line LE-RE until the phone touched the ear. While maintaining the device in the reference plane and maintaining the phone contact with the ear, move the bottom of the phone until any point on the front side is in contact with the cheek of the phantom or until contact with the ear is lost.



6.1.3 Tilted Position

(a) To position the device in the “cheek” position described above.

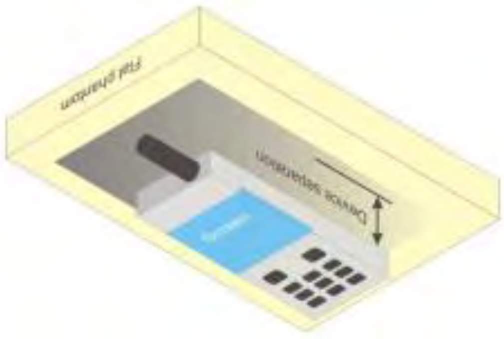
(b) While maintaining the device the reference plane described above and pivoting against the ear, moves it outward away from the mouth by an angle of 15 degrees or until contact with the ear is lost.

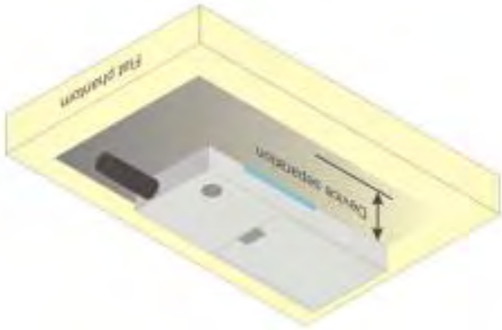
6.2 Body-worn Position Conditions

Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in KDB 447498 are used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode. When the reported SAR for a body-wornaccessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

Body-worn accessories that do not contain metallic or conductive components may be tested according to worst-case exposure configurations, typically according to the smallest test separation distance required for the group of body-worn accessories with similar operating and exposure characteristics. All body-worn accessories containing metallic components are tested in conjunction with the host device.

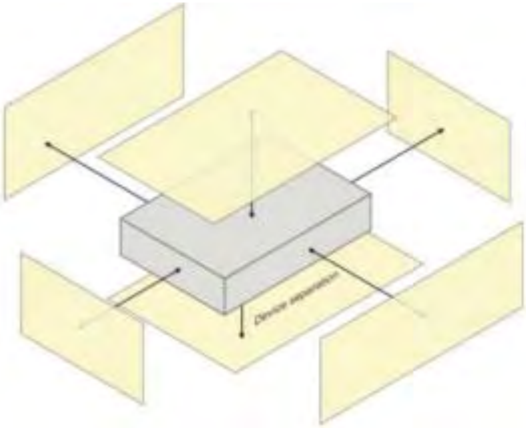
Body-worn accessory SAR compliance is based on a single minimum test separation distance for all wireless and operating modes applicable to each body-worn accessory used by the host, and according to the relevant voice and/or data mode transmissions and operations. If a body-worn accessory supports voice only operations in its normal and expected use conditions, testing of data mode for body-worn compliance is not required. A conservative minimum test separation distance for supporting off-the-shelf body-worn accessories that may be acquired by users of consumer handsets is used to test for body-worn accessory SAR compliance. This distance is determined by the handset manufacturer, according to the requirements of Supplement C 01-01. Devices that are designed to operate on the body of users using lanyards and straps, or without requiring additional body-worn accessories, will be tested using a conservative minimum test separation distance <= 5 mm to support compliance.



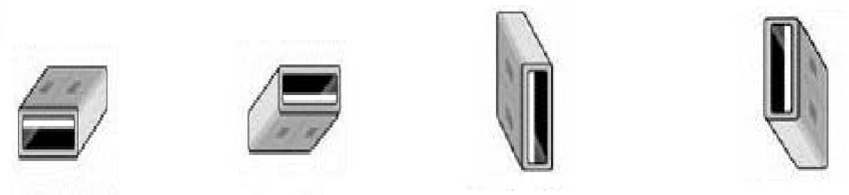


6.3 Hotspot Mode Exposure Position Conditions

For handsets that support hotspot mode operations, with wireless router capabilities and various web browsing functions, the relevant hand and body exposure conditions are tested according to the hotspot SAR procedures in KDB 941225. A test separation distance of 10 mm is required between the phantom and all surfaces and edges with a transmitting antenna located within 25 mm from that surface or edge. When the form factor of a handset is smaller than 9 cm x 5 cm, a test separation distance of 5 mm (instead of 10 mm) is required for testing hotspot mode. When the separation distance required for body-worn accessory testing is larger than or equal to that tested for hotspot mode, in the same wireless mode and for the same surface of the phone, the hotspot mode SAR data may be used to support body-worn accessory SAR compliance for that particular configuration (surface).



6.4 USB Connector Orientations Implemented on Laptop Computers



Horizontal-Up Horizontal-Down Vertical-Front Vertical-Back

Note: These are USB connector orientations on laptop computers; USB dongles have the reverse configuration for plugging into the corresponding laptop computers.

6.5 Simple Dongle Test Procedures

Test all USB orientations [see figure below: (A) Horizontal-Up, (B) Horizontal-Down, (C) Vertical-Front, and (D) Vertical-Back] with a device-to-phantom separation distance of 5 mm or less, according to KDB 447498 requirements. These test orientations are intended for the exposure conditions found in typical laptop/notebook/netbook or tablet computers with either horizontal or vertical USB connector configurations at various locations in the keyboard section of the computer. Current generation portable host computers should be used to establish the required SAR measurement separation distance. The same test separation distance must be used to test all frequency bands and modes in each USB orientation. The typical Horizontal-Up USB connection (A), found in the majority of host computers, must be tested using an appropriate host computer. A host computer with either Vertical-Front (C) or Vertical-Back (D) USB connection should be used to test one of the vertical USB orientations. If a suitable host computer is not available for testing the Horizontal-Down (B) or the remaining Vertical USB orientation, a high quality USB cable, 12 inches or less, may be used for testing these other orientations. It must be documented that the USB cable does not influence the radiating characteristics and output power of the transmitter.

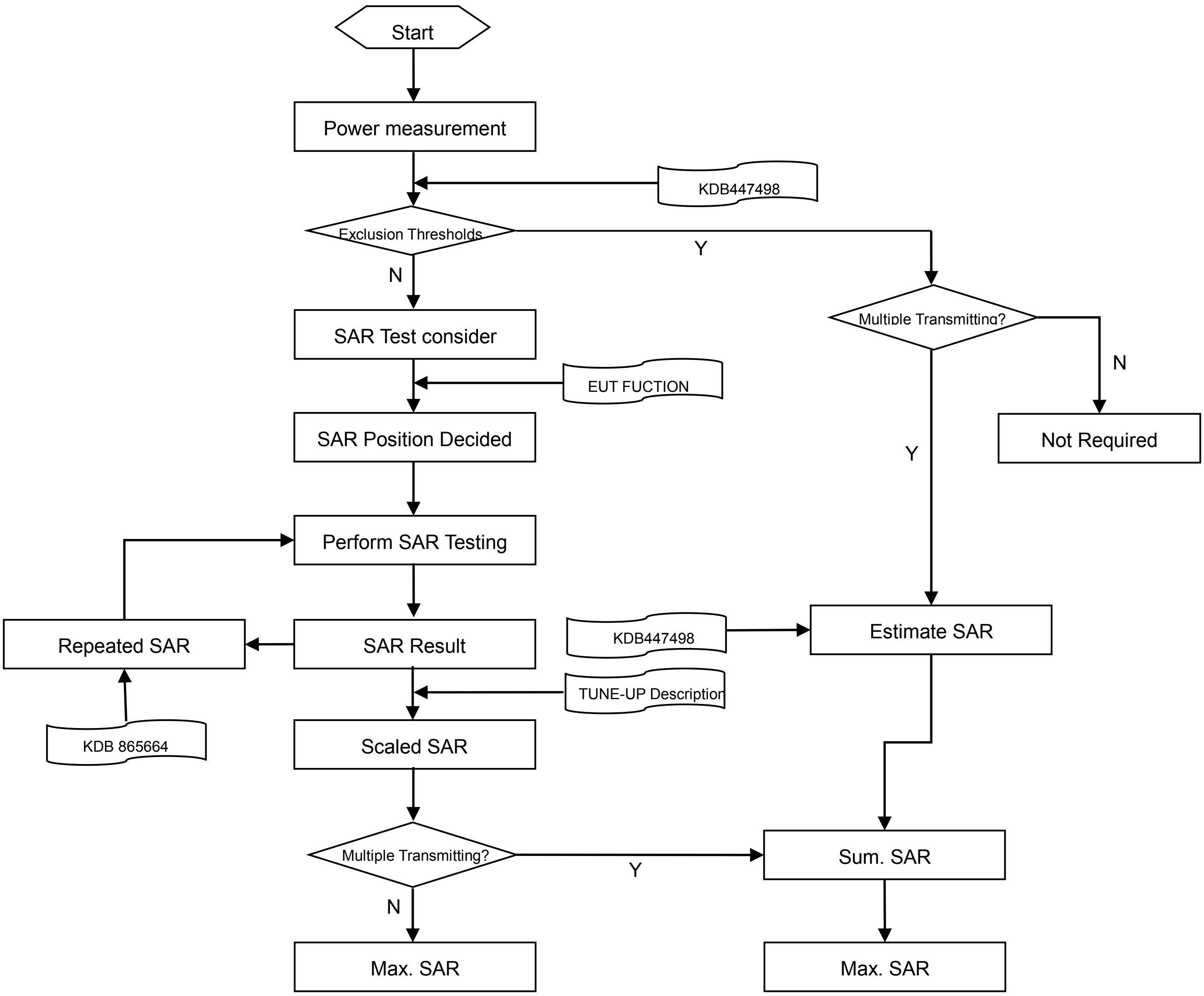
6.6 Dongles with Swivel or Rotating Connectors

A swivel or rotating USB connector may enable the dongle to connect in different orientations to host computers. When the antenna is built-in within the housing of a dongle, a swivel or rotating connector may allow the antenna to assume different positions. The combination of these possible configurations must be considered to determine the SAR test requirements. When the antenna is located near the tip of a dongle, it may operate at closer proximity to users in certain connector orientations where dongle tip testing may be required.

The 5 mm test separation distance used for testing simple dongles has been established based on the overall host platform (laptop/notebook/netbook) and device variations, and varying user operating configurations and exposure conditions expected for a peripheral device. The same test distance should generally apply to dongles with swivel or rotating connectors. The procedures described for simple dongles should be used to position the four surfaces of the dongle at 5 mm from the phantom to evaluate SAR. At least one of the horizontal and one of the vertical positions should be tested using an applicable host computer. If the antenna is within 1 cm from the tip of the dongle (the end without the USB connector), the tip of the dongle should also be tested at 5 mm perpendicular to the phantom. For antennas located within 2.5 cm from the USB connector and if the dongle can be positioned at 45º to 90º from the horizontal position [(A) or (B)], testing in one or more of these configurations may need to be considered. A KDB inquiry should be submitted to determine the applicable test configurations.

7 MEASUREMENT PROCEDURE

7.1 Measurement Process Diagram



7.2 SAR Scan General Requirement

Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1 g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2013.

<table>
<tr><th colspan="3"></th><th>≤3GHz</th><th>>3GHz</th></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5±1 mm</td><td>½·δ·ln(2)±0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30°±1°</td><td>20°±1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx Area , Δy Area</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3–4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx Zoom , Δy Zoom</td><td>≤ 2 GHz: ≤ 8 mm
2 –3 GHz: ≤ 5 mm*</td><td>3–4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="7">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2" rowspan="3">uniform grid: Δz Zoom (n)</td><td rowspan="3">≤ 5 mm</td><td>3–4 GHz: ≤ 4 mm</td></tr>
<tr><td>4–5 GHz: ≤ 3 mm</td></tr>
<tr><td>5–6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="4">graded grid</td><td rowspan="3">Δz Zoom (1): between 1st two points closest to phantom surface</td><td rowspan="3">≤ 4 mm</td><td>3–4 GHz: ≤ 3 mm</td></tr>
<tr><td>4–5 GHz: ≤ 2.5 mm</td></tr>
<tr><td>5–6 GHz: ≤ 2 mm</td></tr>
<tr><td>Δz Zoom (n>1): between subsequent points</td><td colspan="2">≤ 1.5·Δz Zoom (n-1)</td></tr>
<tr><td rowspan="3">Minimum zoom scan volume</td><td colspan="2" rowspan="3">x, y, z</td><td rowspan="3">≥30 mm</td><td>3–4 GHz: ≥ 28 mm</td></tr>
<tr><td>4–5 GHz: ≥ 25 mm</td></tr>
<tr><td>5–6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">Note:
1. δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
2. * When zoom scan is required and the reported SAR from the area scan based 1 g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

7.3 Measurement Procedure

The following steps are used for each test position

a. Establish a call with the maximum output power with a base station simulator. The connection between the mobile and the base station simulator is established via air interface

b. Measurement of the local E-field value at a fixed location. This value serves as a reference value for calculating a possible power drift.

c. Measurement of the SAR distribution with a grid of 8 to 16mm * 8 to16 mm and a constant distance to the inner surface of the phantom. Since the sensors cannot directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With these values the area of the maximum SAR is calculated by an interpolation scheme.

d. Around this point, a cube of 30 * 30 * 30 mm or 32 * 32 *32 mm is assessed by measuring 5 or 8 * 5 or 8*4 or 5 mm. With these data, the peak spatial-average SAR value can be calculated.

7.4 Area & Zoom Scan Procedure

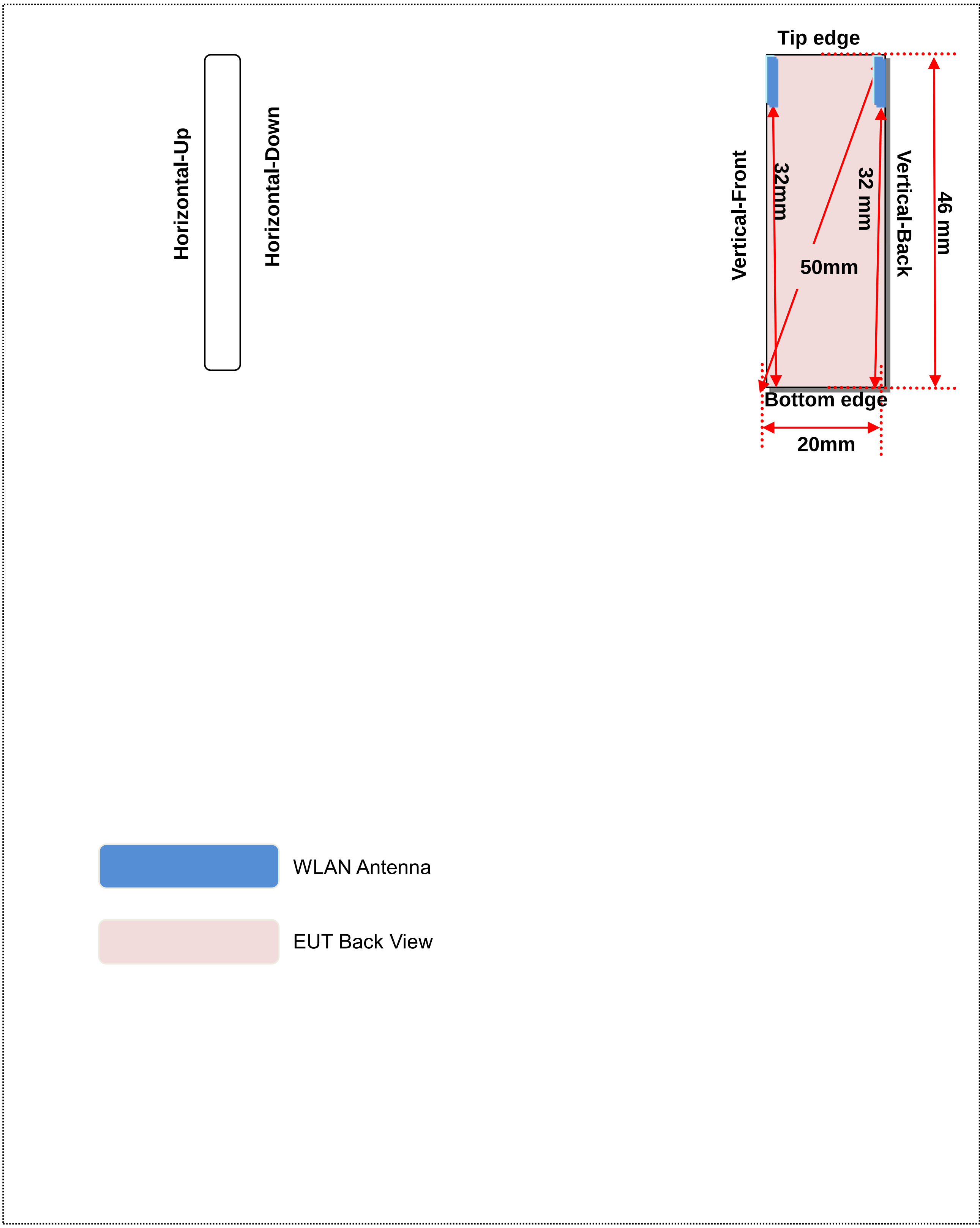
First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. Area scan and zoom scan resolution setting follows KDB 865664 D01v01r03 quoted below.

When the 1 g SAR of the highest peak is within 2 dB of the SAR limit, additional zoom scans are required for otherpeaks within 2 dB of the highest peak that have not been included in any zoom scan to ensure there is no increase in SAR.

8 CONDUCTED RF OUPUT POWER

WLAN 2.4G						
Mode	802.11b			802.11g		
Channel	1	6	11	1	6	11
Frequency (MHz)	2412	2437	2462	2412	2437	2462
Peak Power (dBm)	19.53	**19.55**	18.92	16.01	16.34	**16.46**
Average Power (dBm)	16.45	**16.69**	16.66	15.31	15.65	**15.75**
Tune-up power tolerance (dBm):	18.70~19.70			15.80~16.60		
Mode	802.11n(HT-20)			802.11n(HT-40)		
Channel	1	6	11	3	6	9
Frequency (MHz)	2412	2437	2462	2422	2437	2452
Peak Power (dBm)	14.08	**14.90**	14.89	**15.00**	14.64	14.29
Average Power (dBm)	13.52	**13.95**	13.45	**14.41**	13.67	13.22
Tune-up power tolerance (dBm):	14..00~15.00			14.25~15.15		

9 EUT ANTENNA LOCATION SKETCH



9.1 SAR Test Exclusion Consider Table

According with FCC KDB 447498 D01v05r02, Appendix A, <SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm> Table, this Device SAR test configurations consider as following :

Band	Mode	Max. Peak Power		Test Position Configurations					
		dBm	mW	Head	Horizontal-Up/ Horizontal-Down	Vertical-front	Vertical-Back	Tip Edge	Bottom Edge
WLAN 2.4 G	Distance to User			<5mm	<5mm	<5mm	<5mm	<5mm	32mm
	802.11b	19.55	90.16	No	Yes	Yes	Yes	Yes	No
	802.11g	16.46	44.26	No	Yes	Yes	Yes	Yes	No
	802.11n(HT20)	14.90	30.90	No	No	No	No	No	No
	802.11n(HT40)	15.00	31.62	No	No	No	No	No	No

10 TEST RESULT

10.1Body SAR (5mm separation)

Band	Mode	Position	Ch.	Freq. (MHz)	Power Drift	Meas. SAR (W/Kg)	Meas. Power (dBm)	Max. tune-up Power(dBm)	Scaling Factor	Scaled SAR(W/Kg)	Meas. No.
802.11b	DATA	Horizontal-Down	6	2437	-3.67	**0.193**	19.55	19.70	1.035	**0.200**	1#
		Horizontal-Up	6	2437	0.12	0.116	19.55	19.70	1.035	0.120	2#
		Vertical-Front	6	2437	-0.12	0.091	19.55	19.70	1.035	0.094	3#
		Vertical-Back	6	2437	0.42	0.044	19.55	19.70	1.035	0.046	4#
		Tip edge	6	2437	-1.40	0.091	19.55	19.70	1.035	0.094	5#
802.11g	DATA	Horizontal-Down	11	2462	-1.78	0.089	16.46	16.60	1.033	0.073	6#
		Horizontal-Up	11	2462	-0.56	0.071	16.46	16.60	1.033	0.092	7#
		Vertical-Front	11	2462	1.25	0.030	16.46	16.60	1.033	0.031	8#
		Vertical-Back	11	2462	-0.36	0.019	16.46	16.60	1.033	0.020	9#
		Tip edge	11	2462	-0.67	0.051	16.46	16.60	1.033	0.053	10#

10.2 SAR Measurement Variability

According to KDB 865664 D01 v01r03, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 1.10, the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR repeated measurement procedure:

1. When the highest measured SAR is < 0.80 W/kg, repeated measurement is not required.
2. When the highest measured SAR is >= 0.80 W/kg, repeat that measurement once.
3. If the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20, or when the original or repeated measurement is >= 1.45 W/kg, perform a second repeated measurement.
4. If the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20, and the original, first or second repeated measurement is >= 1.5 W/kg, perform a third repeated measurement.

SAR Repeated Measurement

The highest measured SAR is 0.193 W/kg, which is less than 0.80 W/kg, repeated measurement is not required.

11 TEST EQUIPMENTS LIST

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
PC	Dell	N/A	N/A	N/A	N/A
2450MHz Validation Dipole	Speag	D2450V2	SN: 952	2014/11/27	2015/11/26
E-Field Probe	Speag	EX3DV4	SN: 7340	2014/12/02	2015/12/01
Phantom1	Speag	SAM	SN: 1859	N/A	N/A
Phantom2	Speag	SAM	SN: 1857	N/A	N/A
Data acquisition electronics	Speag	DAE4	SN: 1454	2014/12/01	2015/11/30
Signal Generator	R&S	SMF100A	1167.0000k02/104260	2015/07/07	2016/07/06
Power Meter	Agilent	5738A	11290	2014/10/18	2015/10/17
Power Sensor	R&S	NRP-Z21	103971	2014/11/03	2015/11/02
Power Amplifier	SATIMO	6552B	22374	2014/05/17	2015/08/15
Dielectric Probe Kit	SATIMO	SCLMP	SN 25/13 OCPG56	2014/08/17	2015/08/16
Notebook	Lenovo	4291-YIQ	N/A	N/A	N/A
Network Analyzer	Agilent	5071C	EMY46103472	2014/11/03	2015/11/02
Attenuator	COM-MW	ZA-S1-31	1305003187	N/A	N/A
Directional coupler	AA-MCS	AAMCS-UDC	000272	N/A	N/A

12 REFERENCES

1 FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”

2 ANSI/IEEE Std. C95.1-1992, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, September 1992

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

4 FCC KDB 248227 D01 v02, “SAR Guidance for IEEE 802.11 (Wi-Fi) Transmitters”, March 2015

5 FCC KDB 447498 D01 v05r02, “Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies”, May 2013

6 FCC KDB 447498 D02 v02, “SAR Measurement Procedures for USB Dongle Transmitters”

7 FCC KDB 648474 D04 v01r02, “SAR Evaluation Considerations for Wireless Handsets”, May 2013

8 FCC KDB 941225 D01 v03, “3G SAR MEAUREMENT PROCEDURES”, October 2014

9 FCC KDB 616217 D04 v01r01, “SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers”, May 2013

10 FCC KDB 865664 D01 v01r03, "SAR Measurement Requirements for 100 MHz to 6 GHz", May 2013.

11 FCC KDB 865664 D02 v01r01, “RF Exposure Compliance Reporting and Documentation Considerations”, May 2013

12 SATIMO COMOSAR_V4

13 SATIMO OPENSAR_V4

ANNEX A SIMULATING LIQUID VERIFICATIONRESULT

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an SATIMO SCLMP Dielectric Probe Kit and a Network Analyzer.

Date	Liquid Type	Fre. (MHz)	Temp. (℃)	Meas. Conductivity (ζ)	Meas. Permittivity (ε)	Target Conductivity (ζ)	Target Permittivity (ε)	Conductivity Tolerance (%)	Permittivity Tolerance (%)
2015.06.25	Body	2450	21.4	2.02	50.72	1.95	52.70	3.59	-3.75
Note: The tolerances limit of Conductivity and Permittivity is ± 5%.									

ANNEX B SYSTEM CHECK RESULT

Comparing to the original SAR value provided by SPEAG, the validation data should be within itsspecification of 10 %(for 1 g).

Date	Liquid Type	Freq. (MHz)	Power (mW)	Measured SAR (W/kg)	Normalized SAR (W/kg)	DipoleSAR (W/kg)	Tolerance (%)	Targeted SAR(W/kg)	Tolerance (%)
2015.06.25	Body	2450	100	4.900	49.00	50.60	-3.16	52.40	-3.44
Note: The tolerance limit of System validation ±10%.									

System Performance Check Data (2450MHz Body)

2450-BODY-2015-6-25

Communication System Band: CD2450 (2450.0 MHz); Frequency: 2450 MHz;

Medium parameters used: f = 2450 MHz; ζ = 2.02 S/m; ε_r = 50.719; ρ = 1000 kg/m^3 ; ConvF(7.55, 7.55, 7.55)

Phantom section: Flat Section

Configuration/CW 2450 100mW BODY/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 52.83 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 10.6 W/kg

SAR(1 g) = 4.96 W/kg; SAR(10 g) = 2.24 W/kg

Maximum value of SAR (measured) = 5.65 W/kg

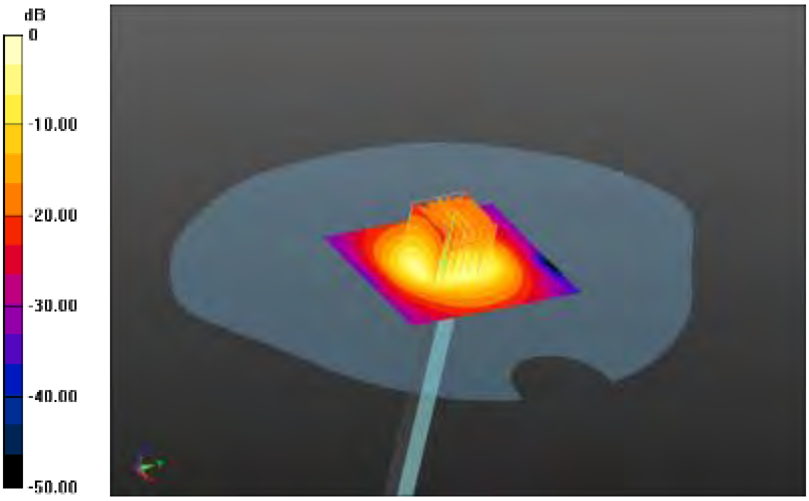
Configuration/CW 2450 100mW BODY/Area Scan (81x101x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm

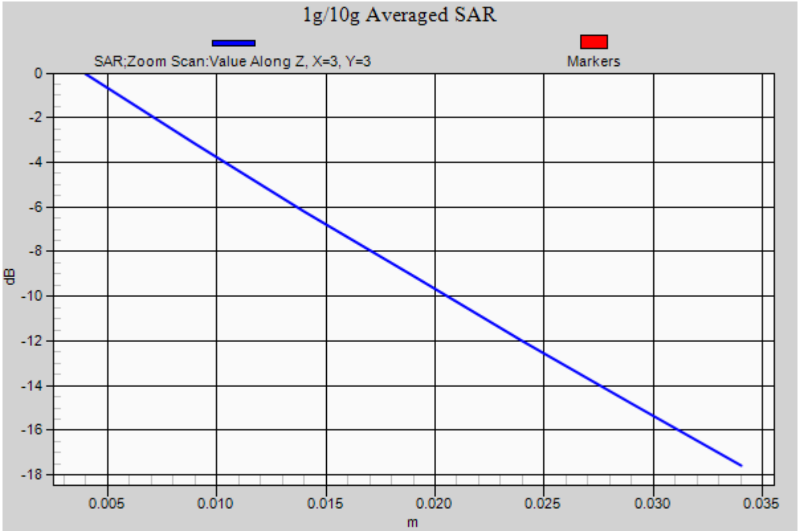
Reference Value = 52.83 V/m; Power Drift = -0.01 dB

Fast SAR: SAR(1 g) = 4.9 W/kg; SAR(10 g) = 2.26 W/kg

Maximum value of SAR (interpolated) = 5.76 W/kg



0 dB = 5.76 W/kg = 7.60 dBW/kg



ANNEX C TEST DATA

MEAS.1 Body Plane with Horizontal-Down on Middle Channel in IEEE 802.11b mode

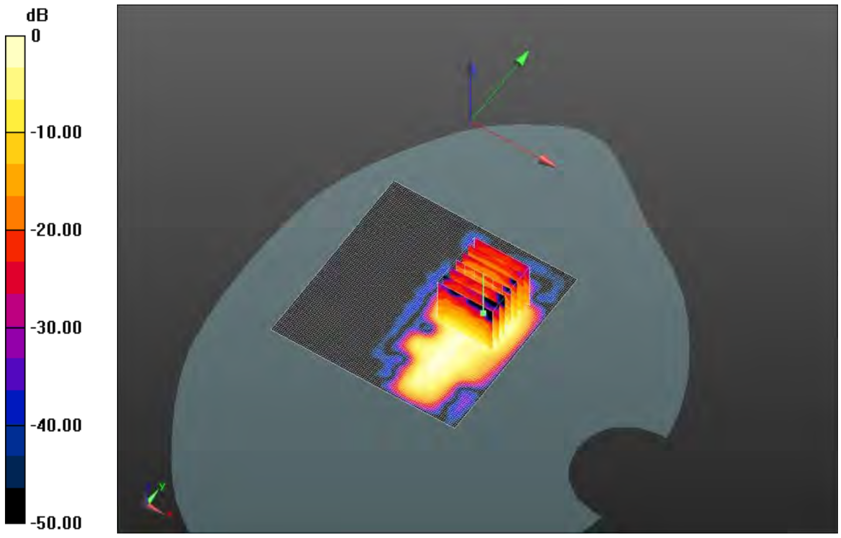
Date/Time: 6/25/2015 9:08:58 AM
Communication System Band: WLAN(b); Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f =2437 MHz; ζ = 2.02 S/m; ε_r = 50.719; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature:22.3 Liquid Temperature:21.4

DASY5 Configuration:

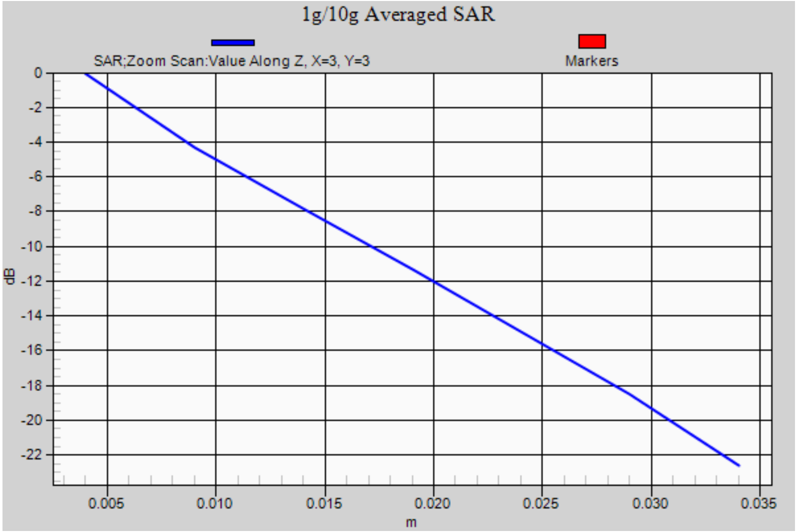
- Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55); Calibrated: 12/2/2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 12/1/2014
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/WLAN Horizontal-Down /Area Scan (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 9.602 V/m; Power Drift = -3.67 dB
Fast SAR: SAR(1 g) = 0.264 W/kg; SAR(10 g) = 0.111 W/kg
Maximum value of SAR (interpolated) = 0.328 W/kg

Configuration/WLAN Horizontal-Down/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.602 V/m; Power Drift = -3.67 dB
Peak SAR (extrapolated) = 0.551 W/kg
SAR(1 g) = 0.193 W/kg; SAR(10 g) = 0.071 W/kg
Maximum value of SAR (measured) = 0.239 W/kg



0 dB = 0.239 W/kg = -6.22 dBW/kg


1g/10g Averaged SAR
SAR;Zoom Scan:Value Along Z, X=3, Y=3
Markers
dB
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

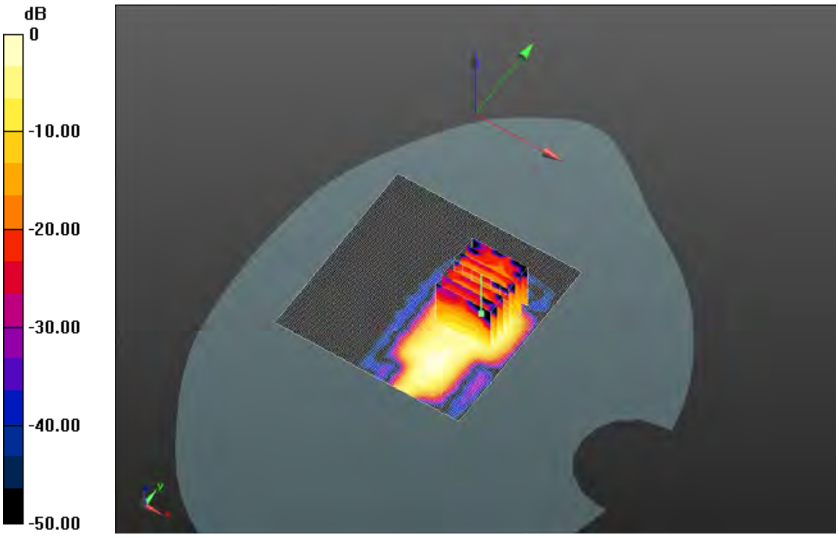
MEAS.2 Body Plane with Body Plane with Horizontal-Up on Middle Channel in IEEE 802.11b mode

Date/Time: 6/25/2015 9:28:58 AM
Communication System Band: WLAN(b); Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2437 MHz; ζ = 2.02 S/m; εr = 50.719; ρ = 1000 kg/m3
Phantom section: Flat Section
Ambient Temperature:22.3 Liquid Temperature:21.4

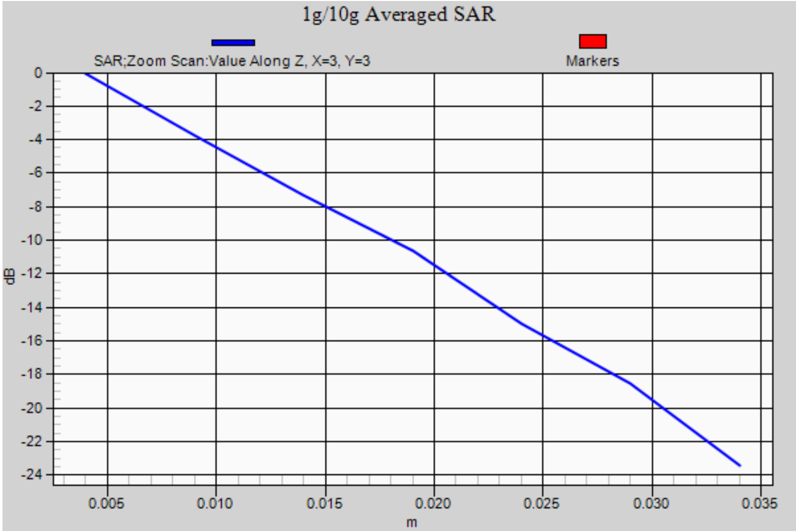
DASY5 Configuration:
Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55); Calibrated: 12/2/2014;
Sensor-Surface: 4mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1454; Calibrated: 12/1/2014
Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/ WLAN Horizontal-Up Area Scan (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 5.685 V/m; Power Drift = 0.12 dB
Fast SAR: SAR(1 g) = 0.138 W/kg; SAR(10 g) = 0.058 W/kg
Maximum value of SAR (interpolated) = 0.183 W/kg

Configuration/ WLAN Horizontal-Up /Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.685 V/m; Power Drift = 0.12 dB
Peak SAR (extrapolated) = 0.260 W/kg
SAR(1 g) = 0.116 W/kg; SAR(10 g) = 0.043 W/kg
Maximum value of SAR (measured) = 0.144 W/kg



0 dB = 0.239 W/kg = -6.22 dBW/kg


1g/10g Averaged SAR
SAR;Zoom Scan:Value Along Z, X=3, Y=3
Markers
dB
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

MEAS.3 Body Plane with Body Plane with Vertical-Front on Middle Channel in IEEE 802.11b mode

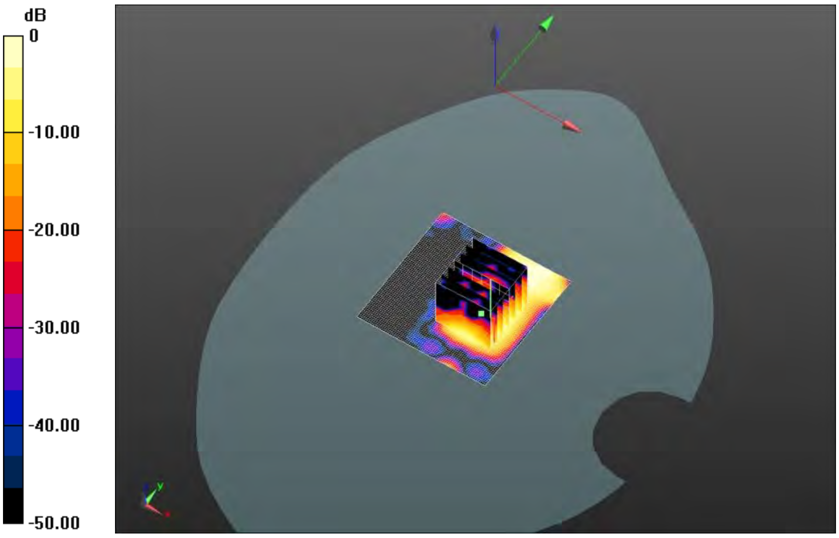
Date/Time: 6/25/2015 9:45:30 AM
Communication System Band: WLAN(b); Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2437 MHz; ζ = 2.02 S/m; εr = 50.719; ρ = 1000 kg/m3
Phantom section: Flat Section
Ambient Temperature:22.3 Liquid Temperature:21.4

DASY5 Configuration:

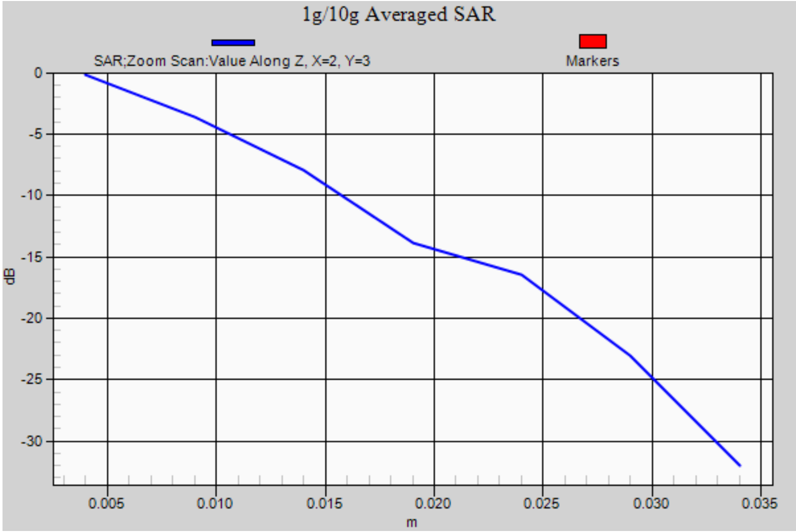
- Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55); Calibrated: 12/2/2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 12/1/2014
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/WLAN Vertical-Front /Area Scan (71x71x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 5.131 V/m; Power Drift = -0.12 dB
Fast SAR: SAR(1 g) = 0.111 W/kg; SAR(10 g) = 0.046 W/kg
Maximum value of SAR (interpolated) = 0.145 W/kg

Configuration/WLAN Vertical-Front /Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.131 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 0.340 W/kg
SAR(1 g) = 0.091 W/kg; SAR(10 g) = 0.033 W/kg
Maximum value of SAR (measured) = 0.0991 W/kg



0 dB = 0.0991 W/kg = -10.04 dBW/kg


1g/10g Averaged SAR
SAR;Zoom Scan:Value Along Z, X=2, Y=3
Markers
0
-5
-10
-15
-20
-25
-30
dB
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

MEAS.3 Body Plane with Body Plane with Vertical-Back on Middle Channel in IEEE 802.11b mode

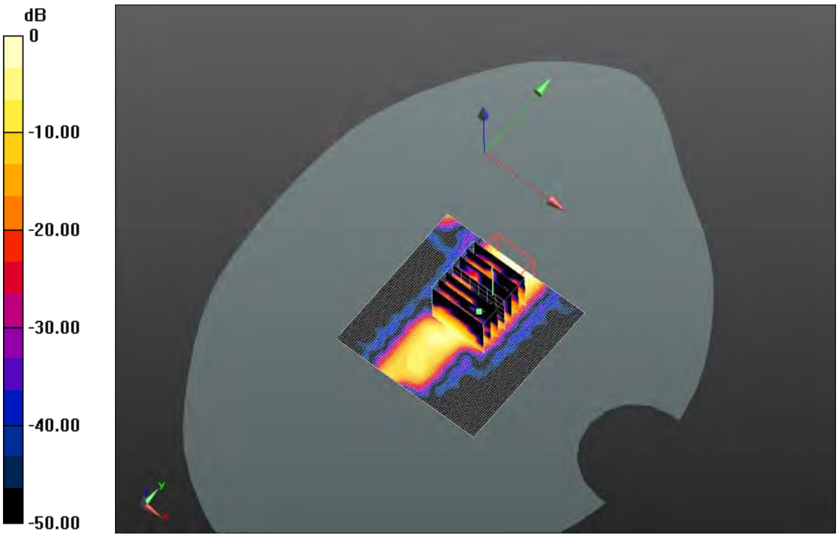
Date/Time: 6/25/2015 10:05:30 AM
Communication System Band: WLAN(b); Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2437 MHz; ζ = 2.02 S/m; ε_r = 50.719; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature:22.3 Liquid Temperature:21.4

DASY5 Configuration:

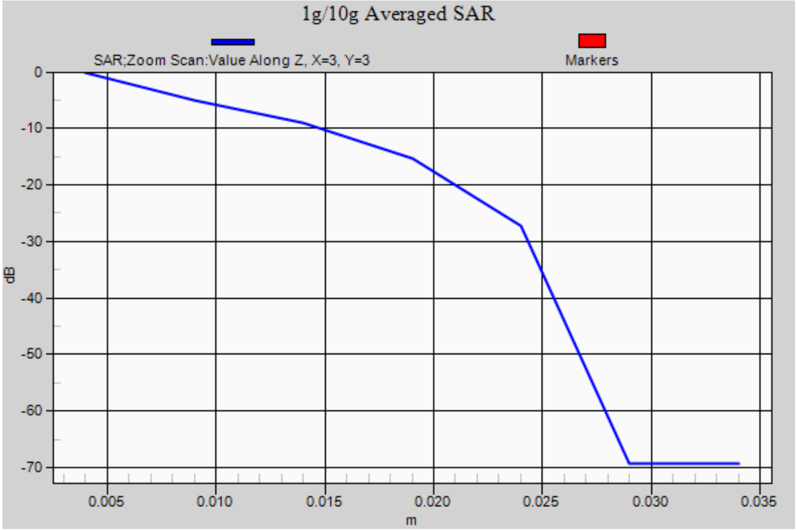
- Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55); Calibrated: 12/2/2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 12/1/2014
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/WLAN Vertical-Back /Area Scan (81x81x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 4.279 V/m; Power Drift = 0.42 dB
Fast SAR: SAR(1 g) = 0.041 W/kg; SAR(10 g) = 0.018 W/kg
Maximum value of SAR (interpolated) = 0.0550 W/kg

Configuration/WLAN Vertical-Back /Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 4.279 V/m; Power Drift = 0.42 dB
Peak SAR (extrapolated) = 0.0950 W/kg
SAR(1 g) = 0.044 W/kg; SAR(10 g) = 0.016 W/kg
Maximum value of SAR (measured) = 0.0511 W/kg



0 dB = 0.0511 W/kg = -12.92 dBW/kg


1g/10g Averaged SAR
SAR;Zoom Scan:Value Along Z, X=3, Y=3
Markers
0
-10
-20
-30
-40
-50
-60
-70
dB
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

MEAS.5 Body Plane with Body Plane with Tip edge on Middle Channel in IEEE 802.11b mode

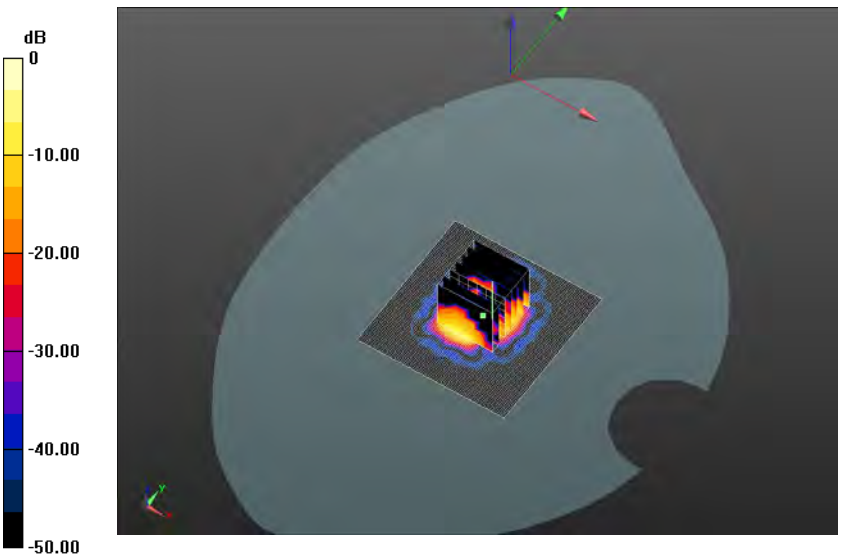
Date/Time: 6/25/2015 10:30:40 AM
Communication System Band: WLAN(b); Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2437 MHz; ζ = 2.02 S/m; ε_r = 50.719; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature:22.3 Liquid Temperature:21.4

DASY5 Configuration:

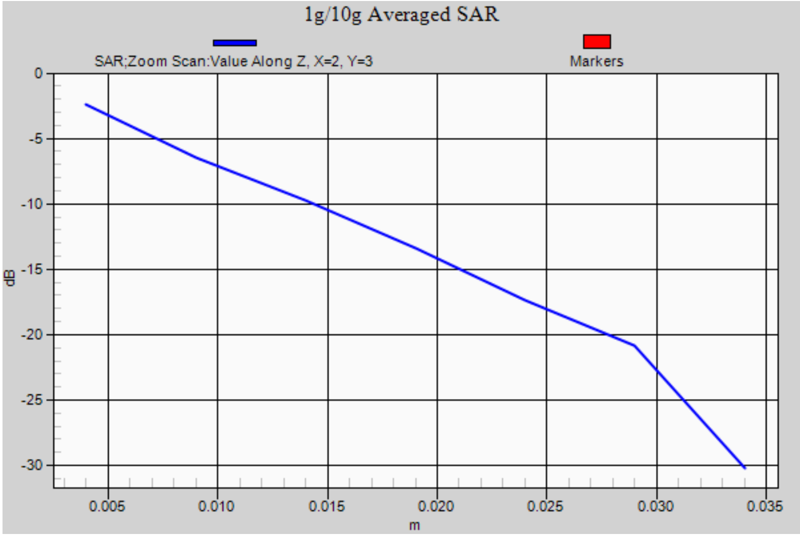
- Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55); Calibrated: 12/2/2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 12/1/2014
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/WLAN Tip edge /Area Scan (81x81x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 9.047 V/m; Power Drift = -1.40 dB
Fast SAR: SAR(1 g) = 0.111 W/kg; SAR(10 g) = 0.035 W/kg
Maximum value of SAR (interpolated) = 0.146 W/kg

Configuration/ WLAN Tip edge /Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.047 V/m; Power Drift = -1.40 dB
Peak SAR (extrapolated) = 0.223 W/kg
SAR(1 g) = 0.091 W/kg; SAR(10 g) = 0.026 W/kg
Maximum value of SAR (measured) = 0.116 W/kg



0 dB = 0.116 W/kg = -9.36 dBW/kg


1g/10g Averaged SAR
SAR;Zoom Scan:Value Along Z, X=2, Y=3
Markers
0
-5
-10
-15
-20
-25
-30
dB
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

MEAS.6 Body Plane with Horizontal-Down on High Channel in IEEE 802.11g mode

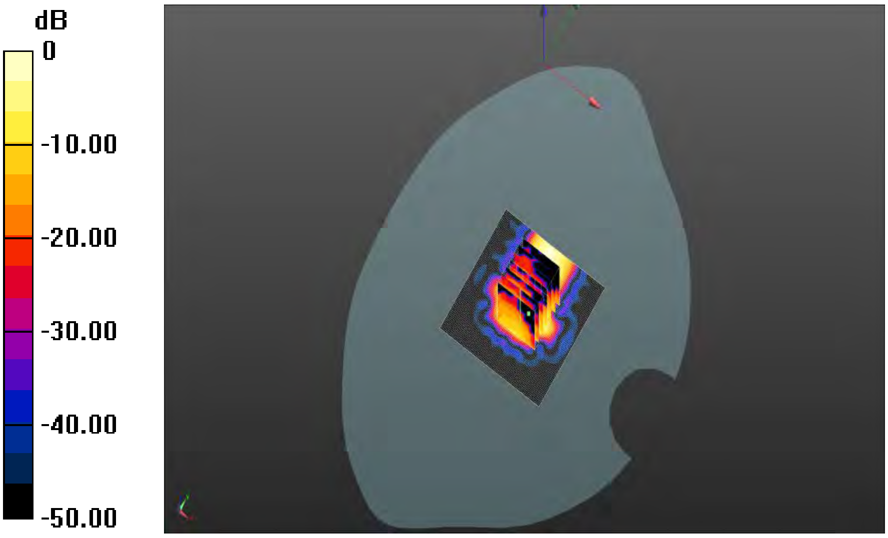
Date/Time: 6/25/2015 1:45:36 PM
Communication System Band: WLAN(g); Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2462 MHz; ζ = 2.048 S/m; ε_r = 50.622; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature:22.3 Liquid Temperature:21.4

DASY5 Configuration:

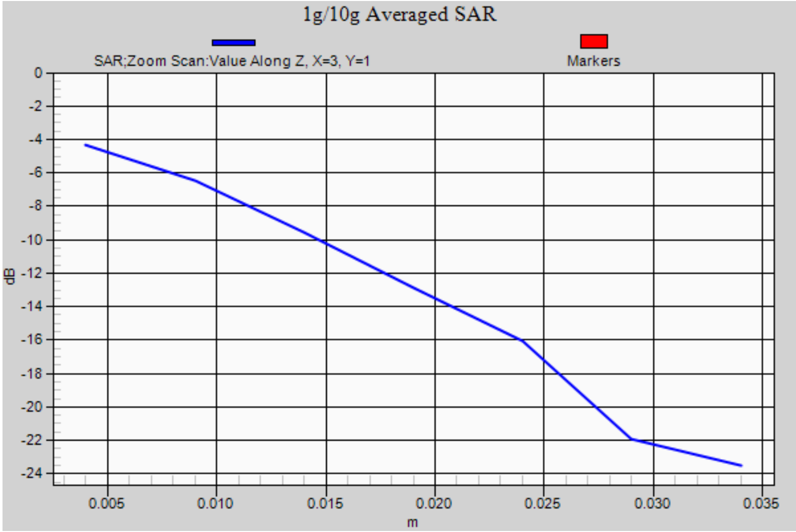
- Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55); Calibrated: 12/2/2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 12/1/2014
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/WLAN Horizontal-Down /Area Scan (81x81x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 7.775 V/m; Power Drift = -0.56 dB
Fast SAR: SAR(1 g) = 0.110 W/kg; SAR(10 g) = 0.045 W/kg
Maximum value of SAR (interpolated) = 0.135 W/kg

Configuration/WLAN Horizontal-Down /Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 7.775 V/m; Power Drift = -0.56 dB
Peak SAR (extrapolated) = 0.197 W/kg
SAR(1 g) = 0.089 W/kg; SAR(10 g) = 0.032 W/kg
Maximum value of SAR (measured) = 0.108 W/kg



0 dB = 0.108 W/kg = -9.67 dBW/kg


1g/10g Averaged SAR
SAR;Zoom Scan:Value Along Z, X=3, Y=1
Markers
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
dB
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

MEAS.7 Body Plane with Body Plane with Horizontal-Up on High Channel in IEEE 802.11g mode

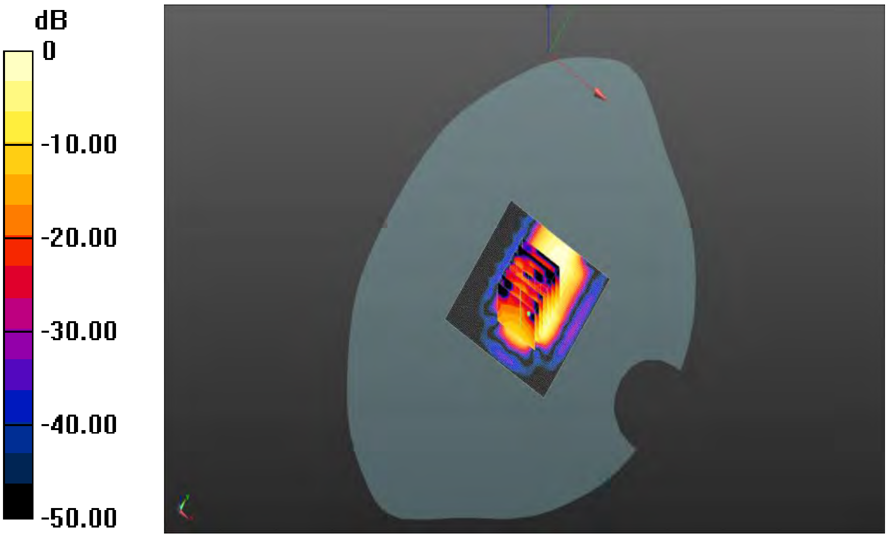
Date/Time: 6/25/2015 2:01:21 PM
Communication System Band: WLAN(g); Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2462 MHz; ζ = 2.048 S/m; ε_r = 50.622; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature:22.3 Liquid Temperature:21.4

DASY5 Configuration:

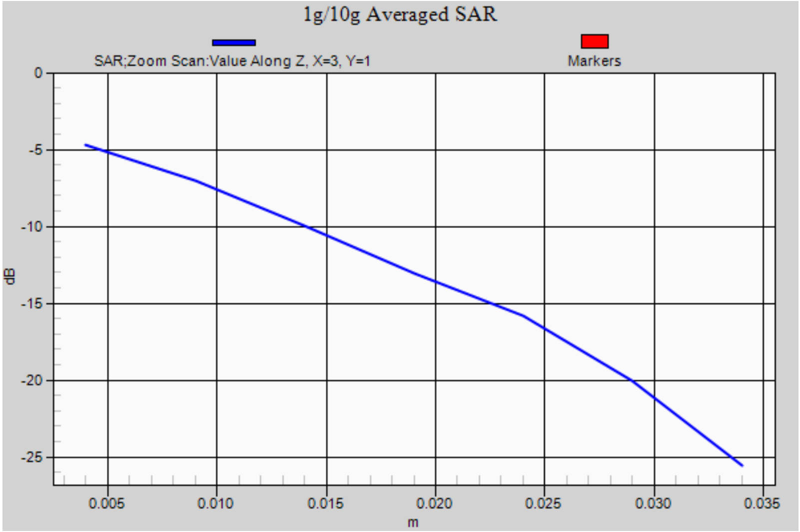
- Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55); Calibrated: 12/2/2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 12/1/2014
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/WLAN Horizontal-Up /Area Scan (81x81x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 7.007 V/m; Power Drift = -1.78 dB
Fast SAR: SAR(1 g) = 0.105 W/kg; SAR(10 g) = 0.044 W/kg
Maximum value of SAR (interpolated) = 0.144 W/kg

Configuration/WLAN Horizontal-Up /Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 7.007 V/m; Power Drift = -1.78 dB
Peak SAR (extrapolated) = 0.216 W/kg
SAR(1 g) = 0.071 W/kg; SAR(10 g) = 0.026 W/kg
Maximum value of SAR (measured) = 0.0932 W/kg



0 dB = 0.0932 W/kg = -10.31 dBW/kg


1g/10g Averaged SAR
SAR;Zoom Scan:Value Along Z, X=3, Y=1
Markers
dB
0
-5
-10
-15
-20
-25
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

MEAS.8 Body Plane with Body Plane with Vertical-Front on High Channel in IEEE 802.11g mode

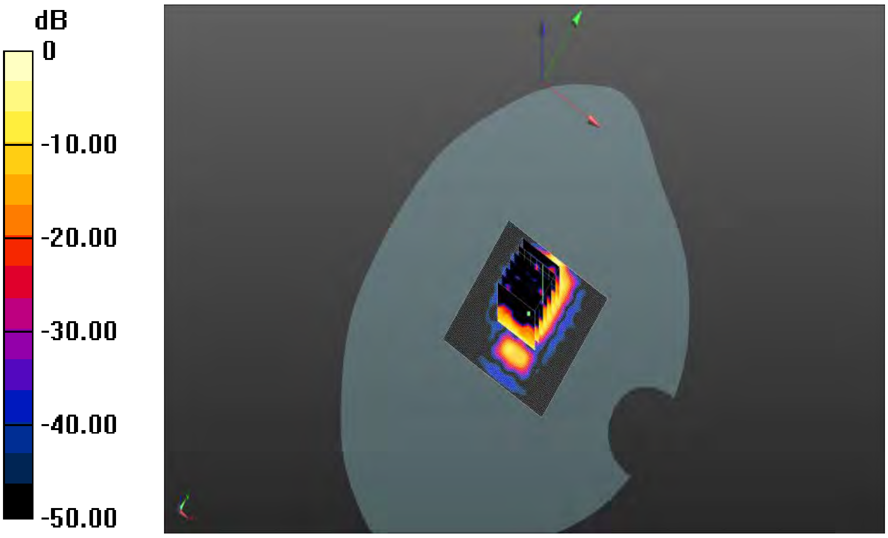
Date/Time: 6/25/2015 2:27:38 PM
Communication System Band: WLAN(g); Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2462 MHz; ζ = 2.048 S/m; ε_r = 50.622; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature:22.3 Liquid Temperature:21.4

DASY5 Configuration:

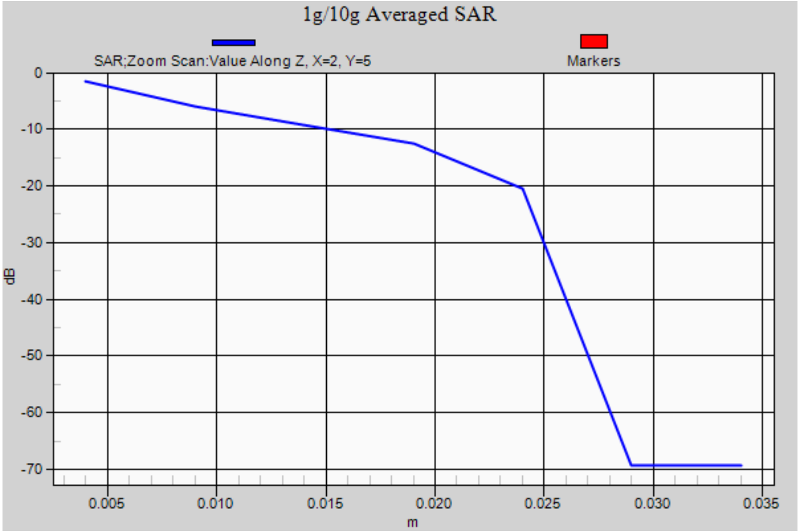
- Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55); Calibrated: 12/2/2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 12/1/2014
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/WLAN Vertical-Front /Area Scan (81x81x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 2.890 V/m; Power Drift = 1.25 dB
Fast SAR: SAR(1 g) = 0.033 W/kg; SAR(10 g) = 0.015 W/kg
Maximum value of SAR (interpolated) = 0.0425 W/kg

Configuration/WLAN Vertical-Front /Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.890 V/m; Power Drift = 1.25 dB
Peak SAR (extrapolated) = 0.0650 W/kg
SAR(1 g) = 0.030 W/kg; SAR(10 g) = 0.011 W/kg
Maximum value of SAR (measured) = 0.0378 W/kg



0 dB = 0.0378 W/kg = -14.23 dBW/kg


1g/10g Averaged SAR
SAR;Zoom Scan:Value Along Z, X=2, Y=5
Markers
0
-10
-20
-30
-40
-50
-60
-70
dB
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

MEAS.9 Body Plane with Body Plane with Vertical-Back on High Channel in IEEE 802.11g mode

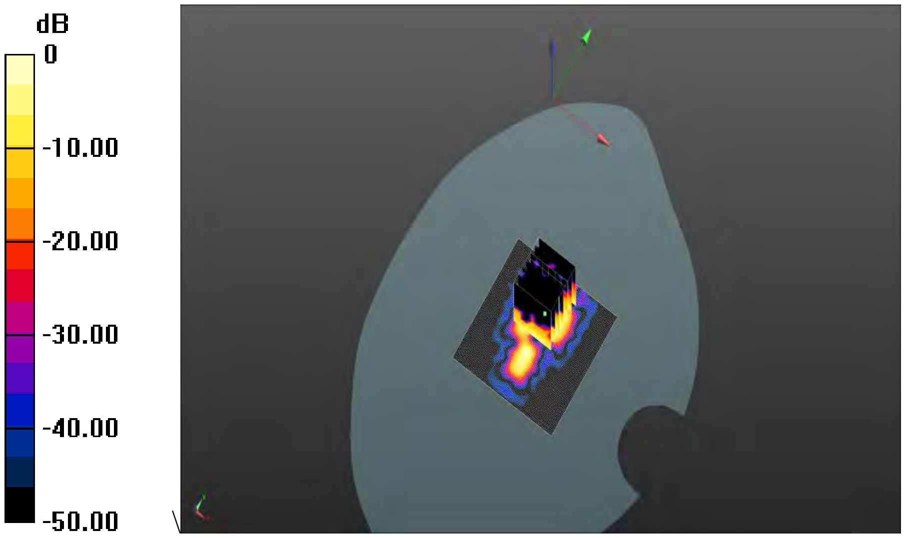
Date/Time: 6/25/2015 3:01:31 PM
Communication System Band: WLAN(g); Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2462 MHz; σ = 2.048 S/m; ε_r = 50.622; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature:22.3 Liquid Temperature:21.4

DASY5 Configuration:

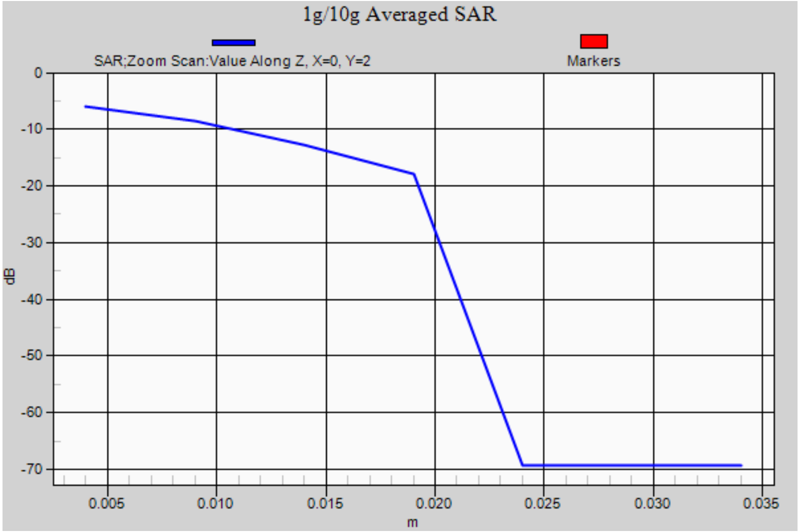
- Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55); Calibrated: 12/2/2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 12/1/2014
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/WLAN Vertical-Front /Area Scan (81x81x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 2.709 V/m; Power Drift = -0.36 dB
Fast SAR: SAR(1 g) = 0.032 W/kg; SAR(10 g) = 0.011 W/kg
Maximum value of SAR (interpolated) = 0.0418 W/kg

Configuration/WLAN Vertical-Front /Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.709 V/m; Power Drift = -0.36 dB
Peak SAR (extrapolated) = 0.0380 W/kg
SAR(1 g) = 0.019 W/kg; SAR(10 g) = 0.00696 W/kg
Maximum value of SAR (measured) = 0.0240 W/kg



0 dB = 0.0240 W/kg = -16.20 dBW/kg


1g/10g Averaged SAR
SAR;Zoom Scan:Value Along Z, X=0, Y=2
Markers
0
-10
-20
-30
-40
-50
-60
-70
dB
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

MEAS.10 Body Plane with Body Plane with Tip edge on High Channel in IEEE 802.11g mode

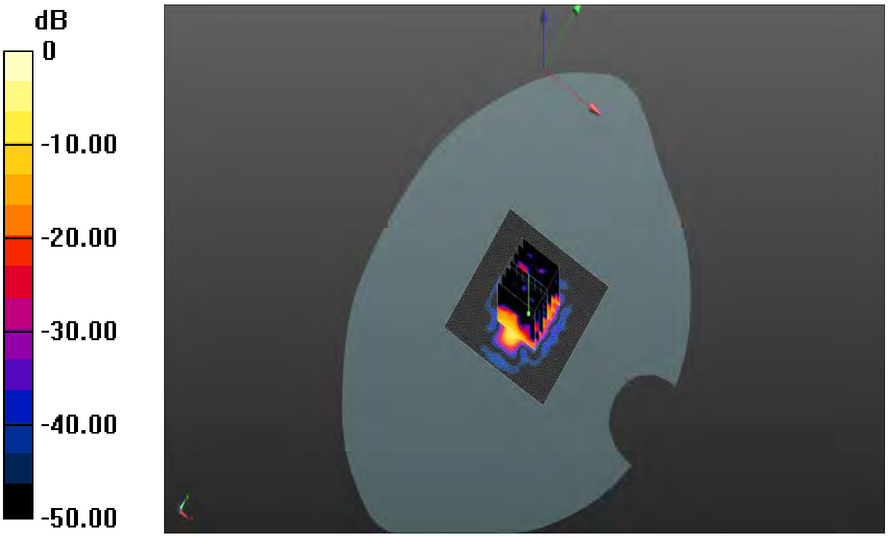
Date/Time: 6/25/2015 3:45:47 PM
Communication System Band: WLAN(g); Frequency: 2462 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2462 MHz; ζ = 2.048 S/m; ε_r = 50.622; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature:22.3 Liquid Temperature:21.4

DASY5 Configuration:

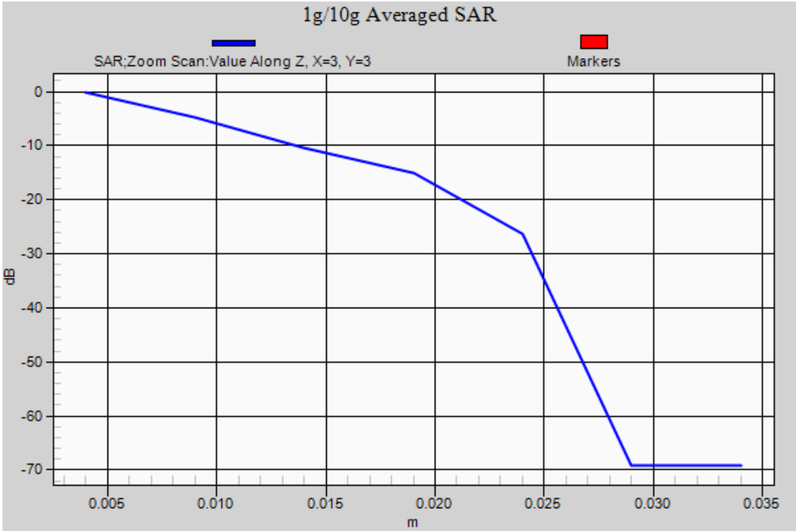
- Probe: EX3DV4 - SN7340; ConvF(7.55, 7.55, 7.55); Calibrated: 12/2/2014;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 12/1/2014
- Phantom: SAM (30deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CD; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Configuration/WLAN Tip edge /Area Scan (81x81x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Reference Value = 6.070 V/m; Power Drift = -0.67 dB
Fast SAR: SAR(1 g) = 0.061 W/kg; SAR(10 g) = 0.017 W/kg
Maximum value of SAR (interpolated) = 0.0856 W/kg

Configuration/WLAN Tip edge /Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 6.070 V/m; Power Drift = -0.67 dB
Peak SAR (extrapolated) = 0.131 W/kg
SAR(1 g) = 0.051 W/kg; SAR(10 g) = 0.014 W/kg
Maximum value of SAR (measured) = 0.0659 W/kg

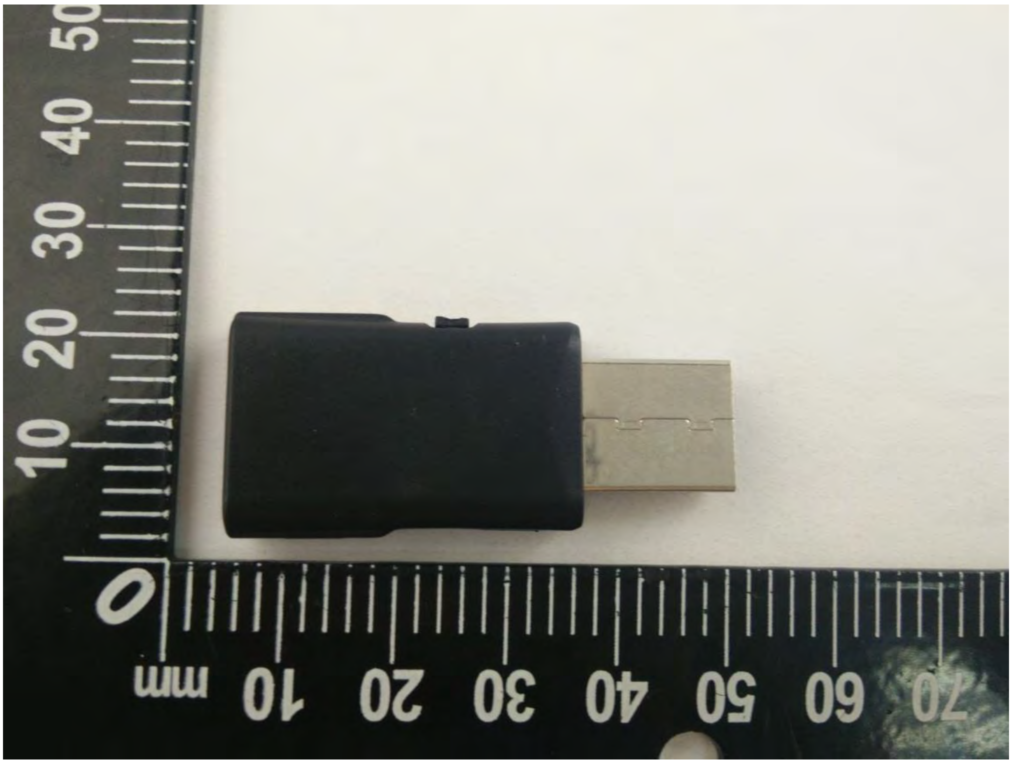


0 dB = 0.0659 W/kg = -11.81 dBW/kg

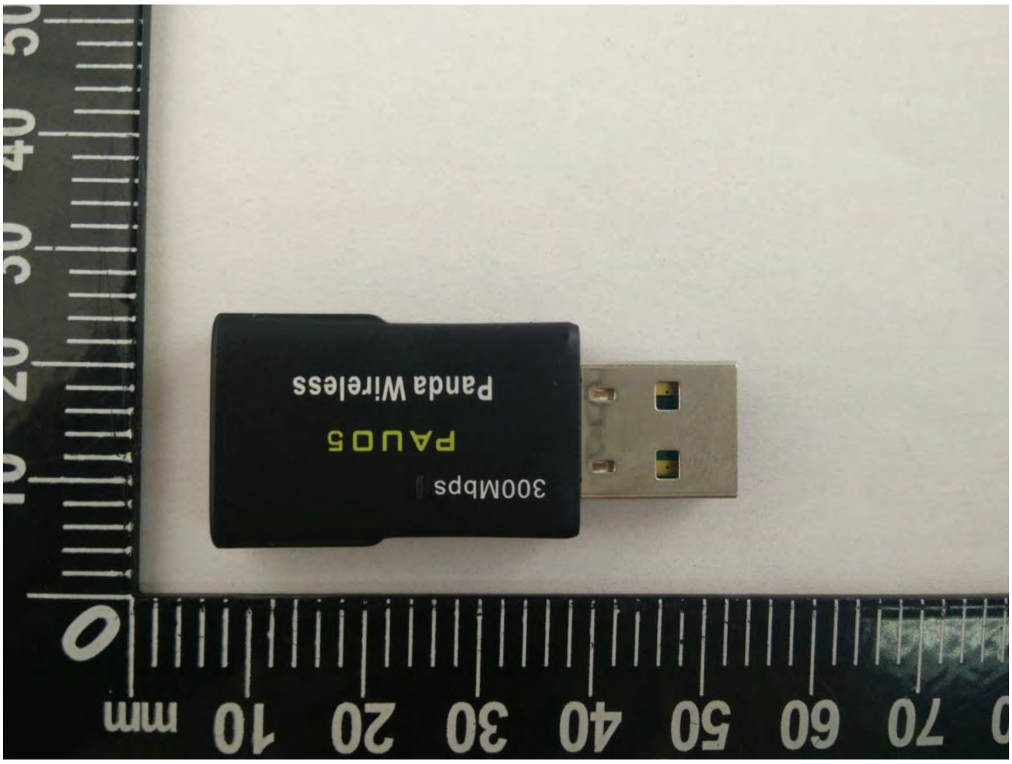

1g/10g Averaged SAR
SAR;Zoom Scan:Value Along Z, X=3, Y=3
Markers
0
-10
-20
-30
-40
-50
-60
-70
dB
0.005
0.010
0.015
0.020
0.025
0.030
0.035
m

ANNEX D EUT PHOTO

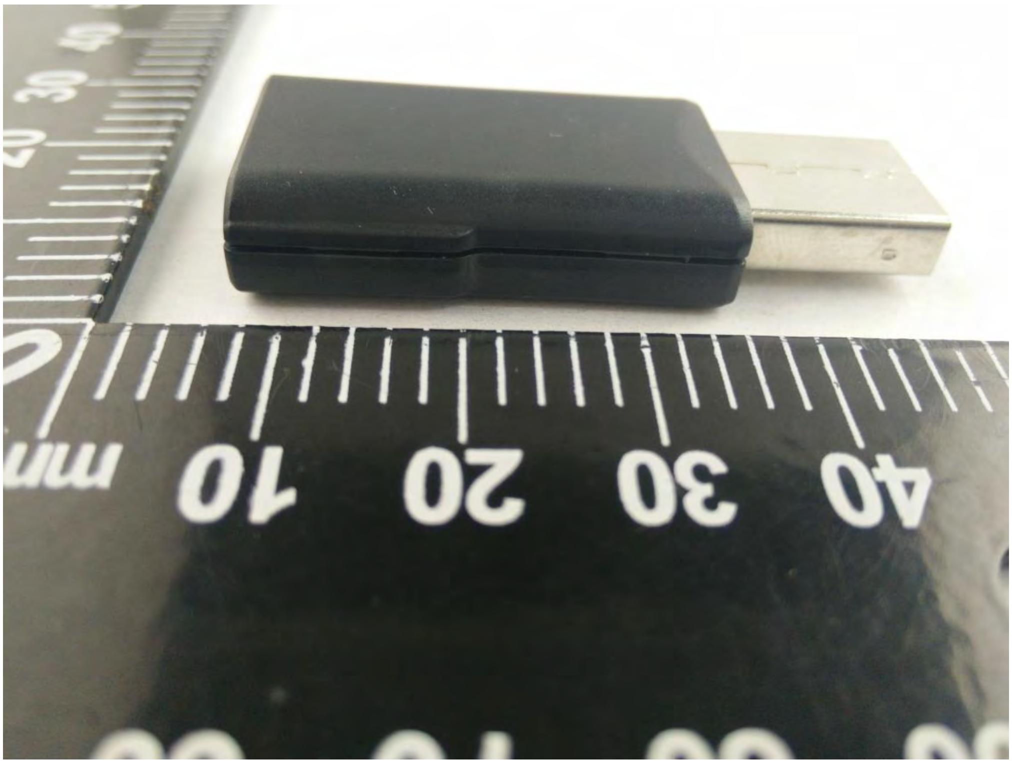
THE Horizontal-Down OF EUT



THE Horizontal-Up OF EUT

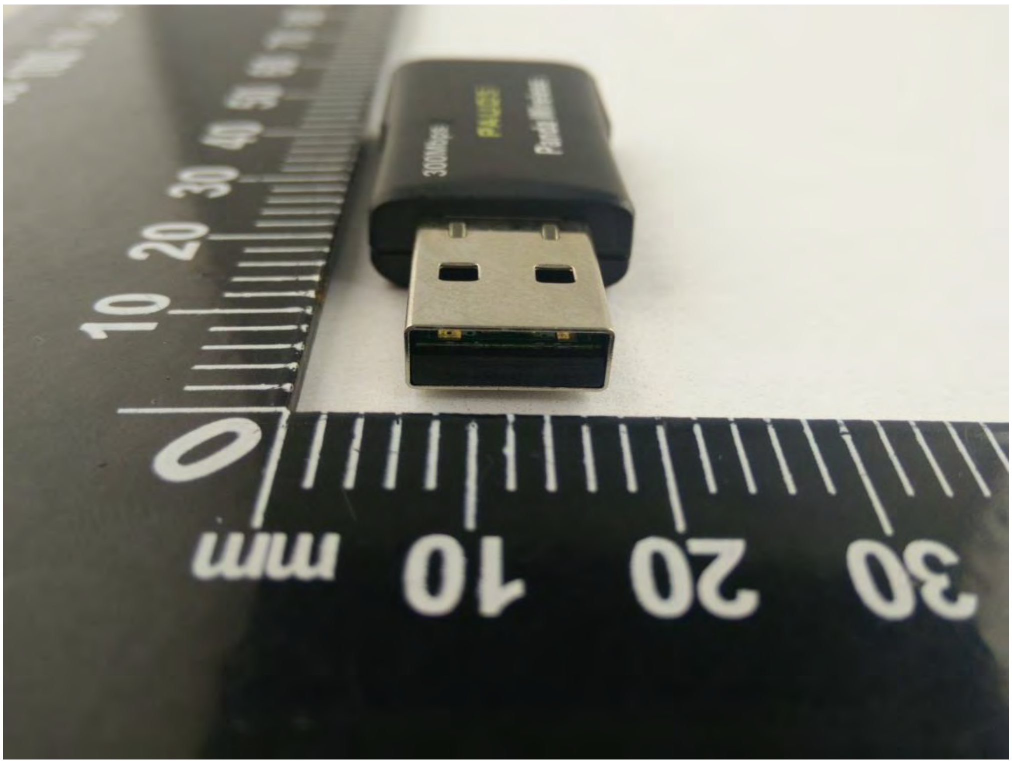


THE Vertical-Front OF EUT

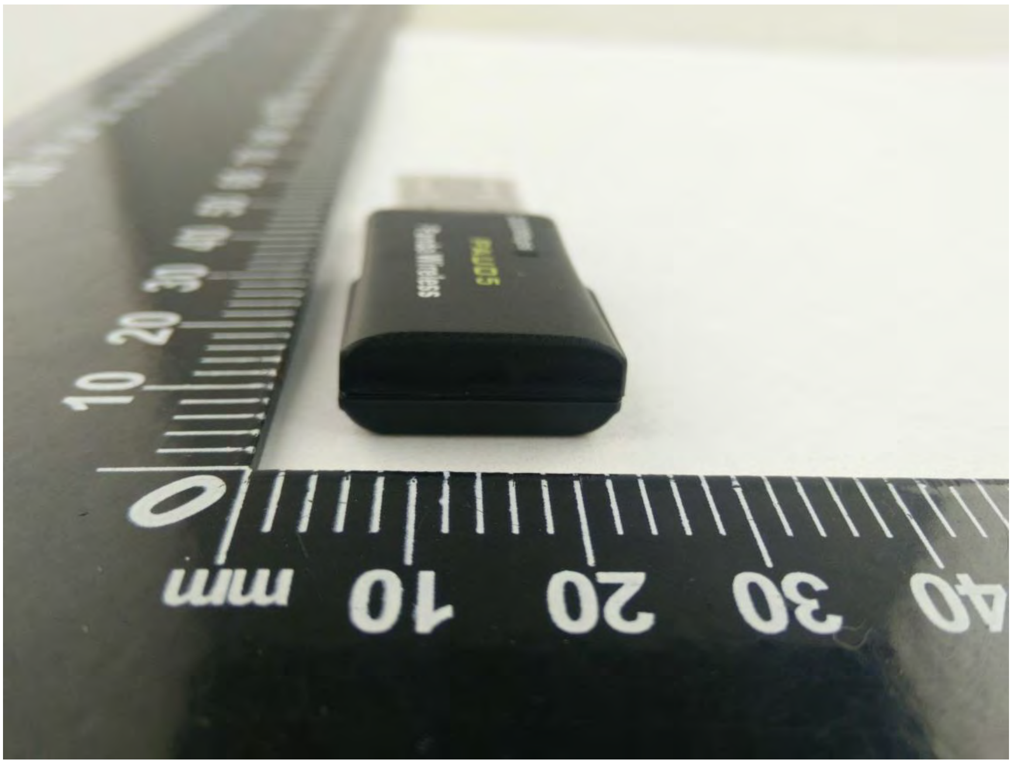


THE Vertical-Back OF EUT

THE Bottom Edge OF EUT

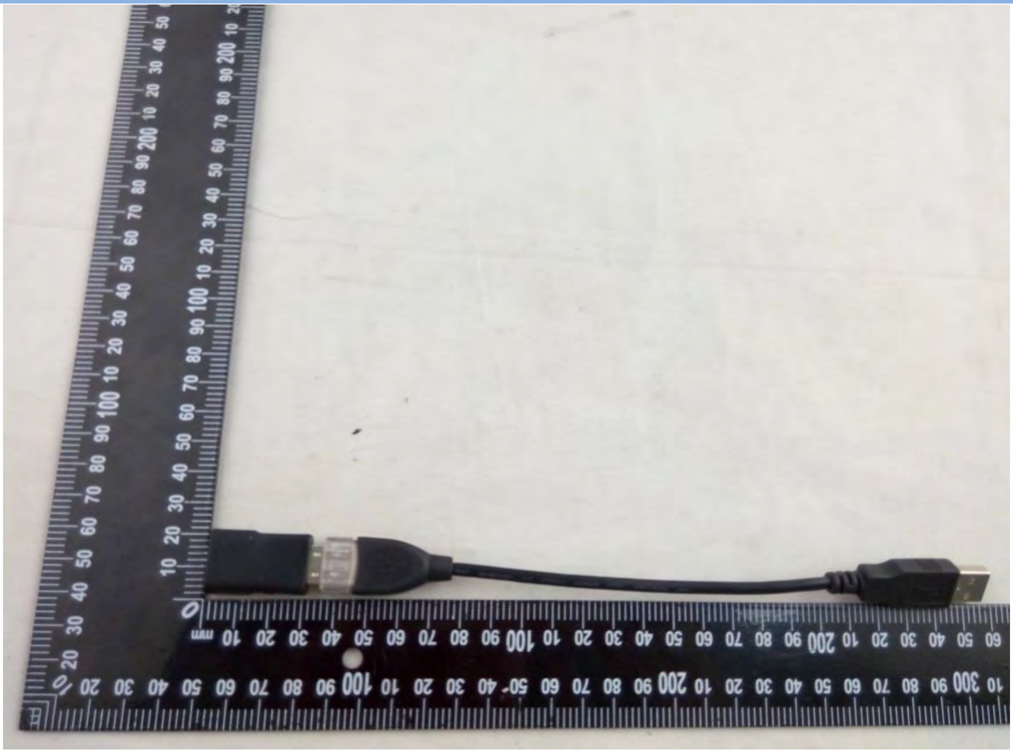


THE Tip Edge OF EUT



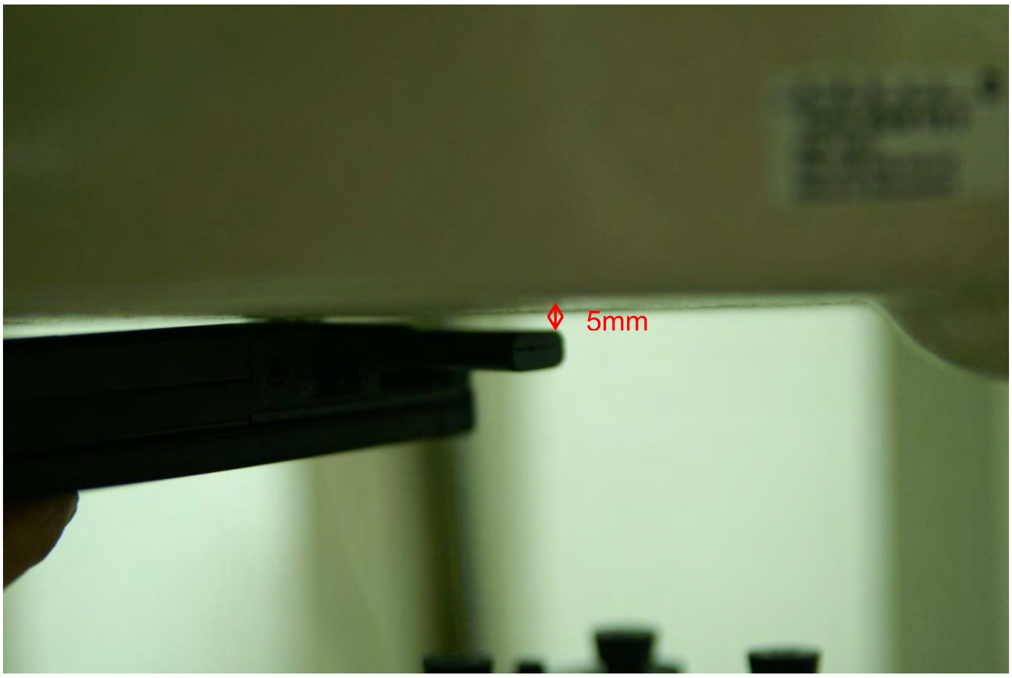
THE USB CABLE

THE COVER

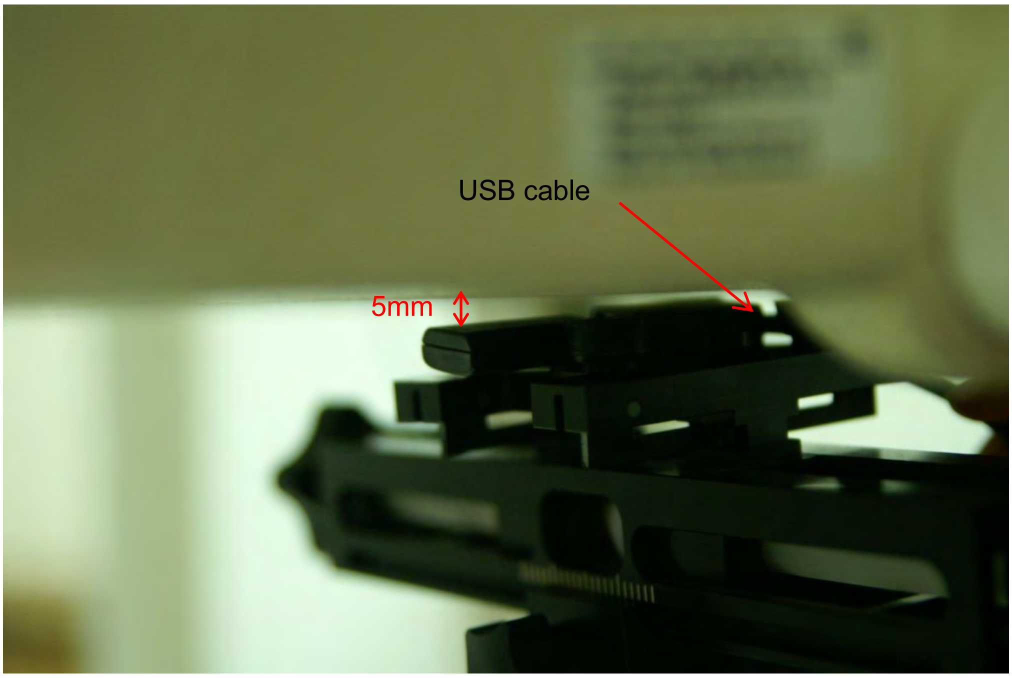


ANNEX E TEST SETUP PHOTO

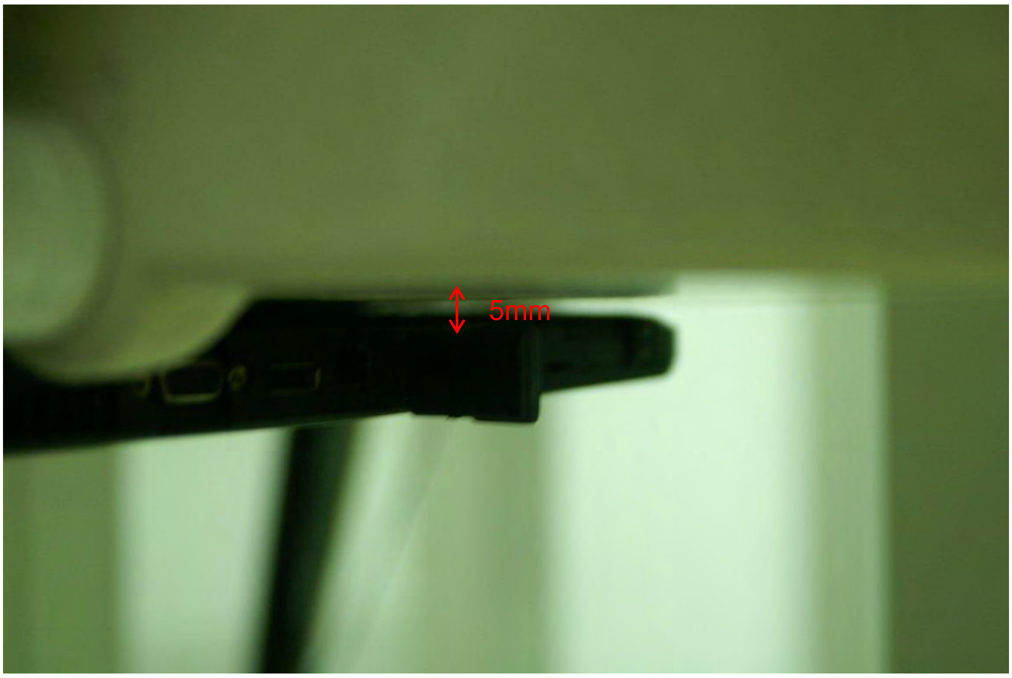
Horizontal-Up(5mm separation)



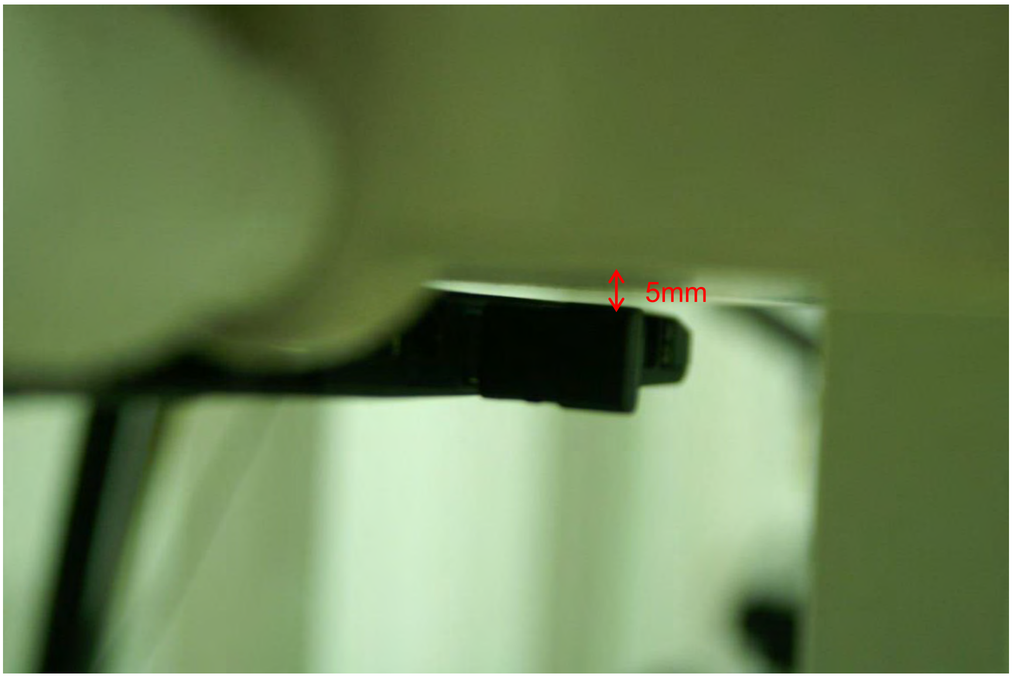
Horizontal-Down(5mm separation)



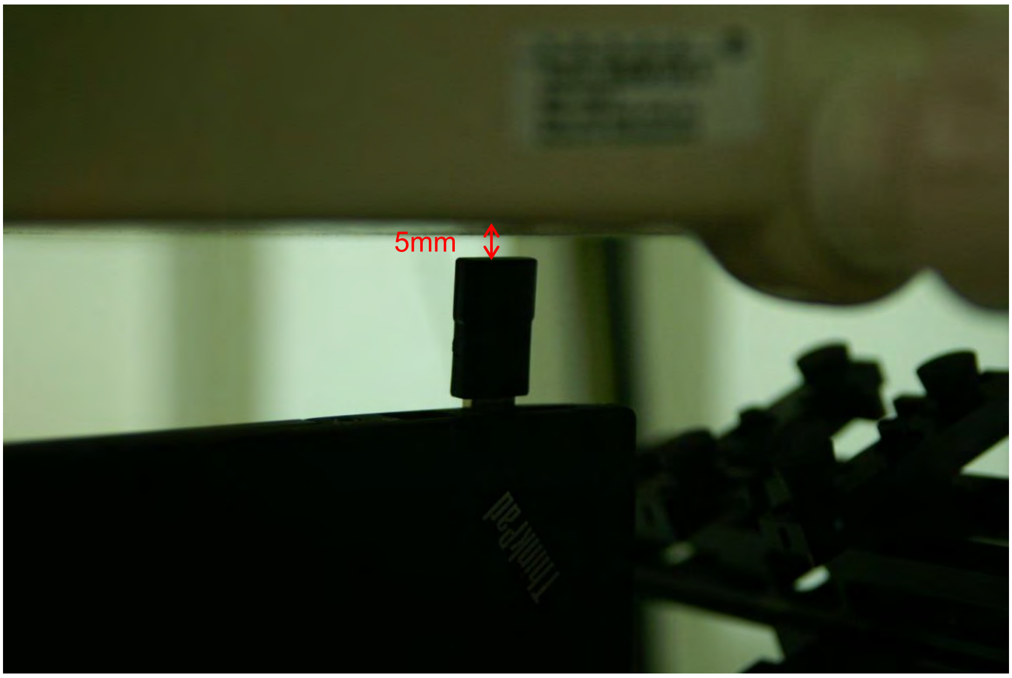
Vertical-Front (5mm separation)



Vertical-Back (5mm separation)



Tip Edge (5mm separation)



ANNEX F CALIBRATION REPORT

F.1 E-Field Probe

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Dgiele (Vitec)**

Certificate No: **EX3-7340_Dec14**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:7340
Calibration procedure(s)	QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	December 2, 2014

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: December 2, 2014

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: EX3-7340_Dec14 Page 1 of 11

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
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S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Probe EX3DV4

SN:7340

Manufactured: July 23, 2014
Calibrated: December 2, 2014

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7340

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.53	0.49	0.46	± 10.1 %
DCP (mV)[B]	100.7	91.3	102.1	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	166.9	±3.3 %
		Y	0.0	0.0	1.0		162.2	
		Z	0.0	0.0	1.0		149.8	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of NormX,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7340

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
835	41.5	0.90	9.91	9.91	9.91	0.52	0.80	± 12.0 %
1750	40.1	1.37	9.13	9.13	9.13	0.55	0.75	± 12.0 %
1900	40.0	1.40	8.77	8.77	8.77	0.46	0.78	± 12.0 %
2450	39.2	1.80	7.83	7.83	7.83	0.41	0.86	± 12.0 %
2600	39.0	1.96	7.64	7.64	7.64	0.41	0.87	± 12.0 %
5200	36.0	4.66	5.28	5.28	5.28	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.75	4.75	4.75	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.72	4.72	4.72	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7340

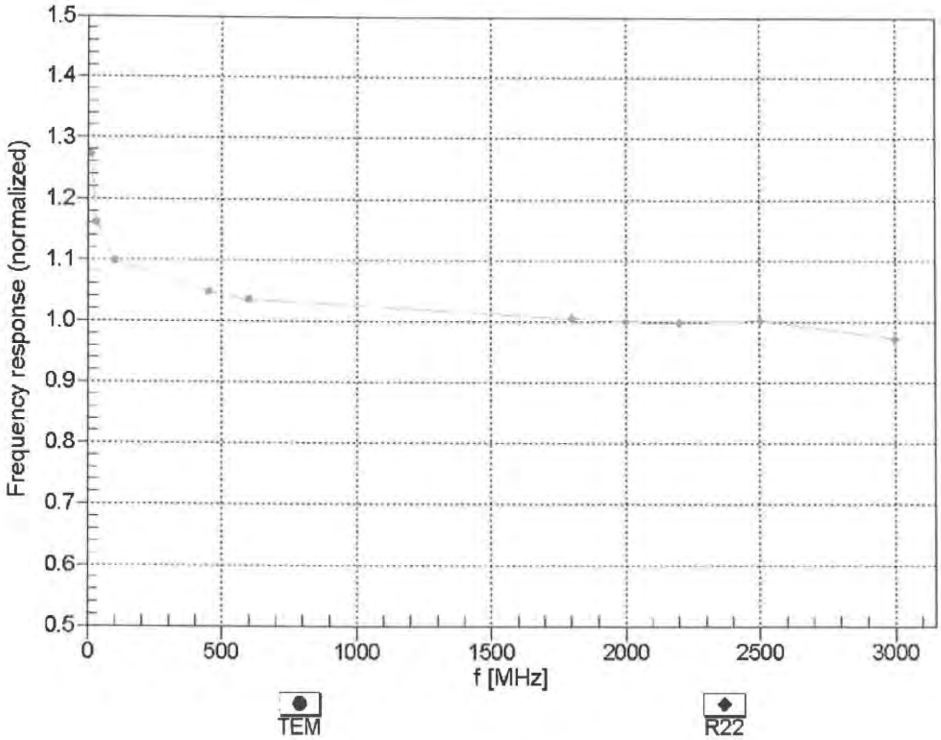
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
835	55.2	0.97	9.97	9.97	9.97	0.69	0.68	± 12.0 %
1750	53.4	1.49	8.53	8.53	8.53	0.41	0.93	± 12.0 %
1900	53.3	1.52	8.18	8.18	8.18	0.80	0.58	± 12.0 %
2450	52.7	1.95	7.55	7.55	7.55	0.80	0.50	± 12.0 %
2600	52.5	2.16	7.11	7.11	7.11	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.62	4.62	4.62	0.45	1.90	± 13.1 %
5600	48.5	5.77	4.10	4.10	4.10	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.31	4.31	4.31	0.50	1.90	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide: R22)



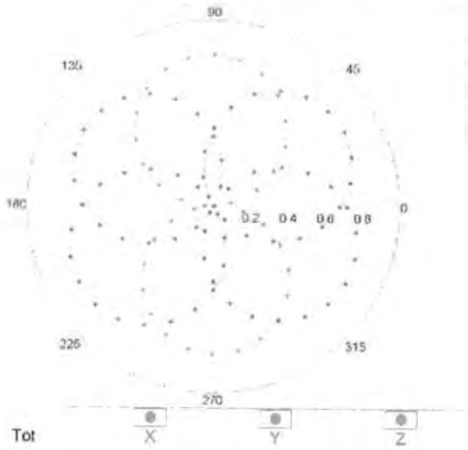
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

EX3DV4– SN:7340

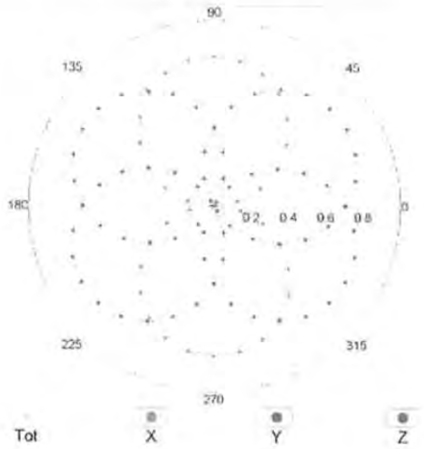
December 2, 2014

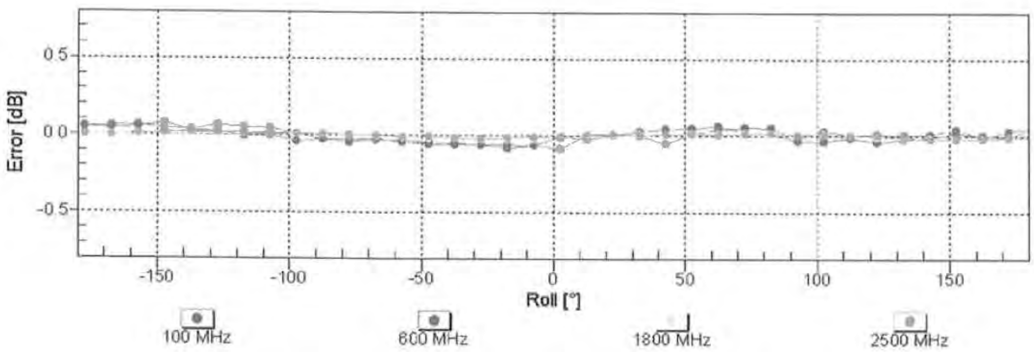
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

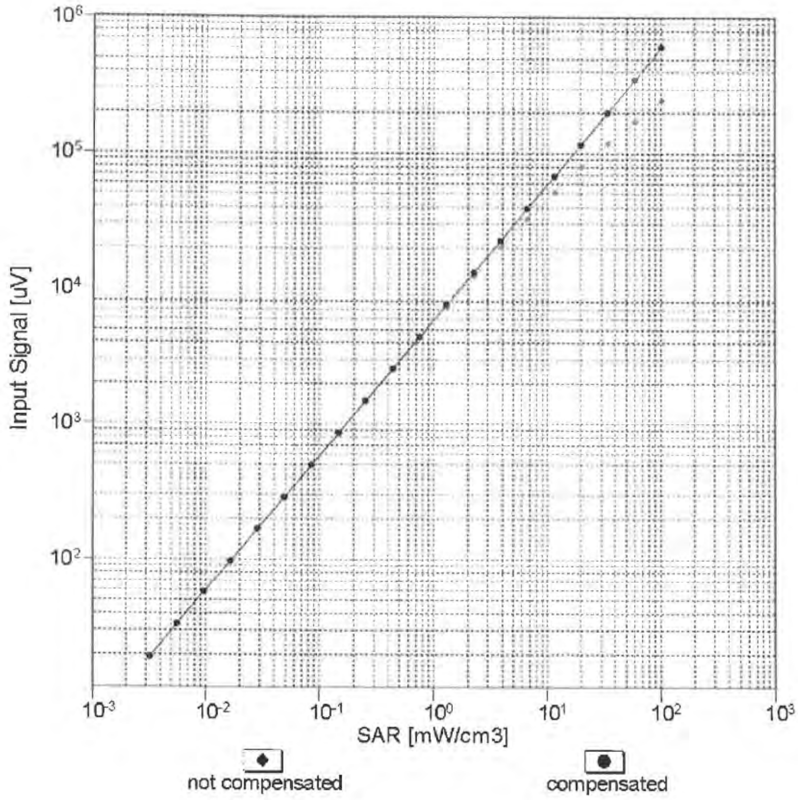


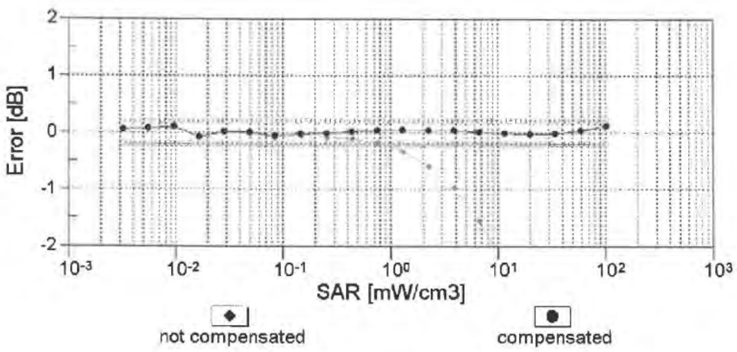


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR$_{head}$)

(TEM cell , f_{eval}= 1900 MHz)



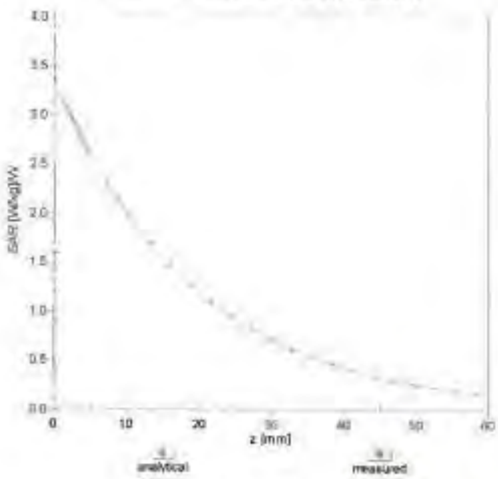


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

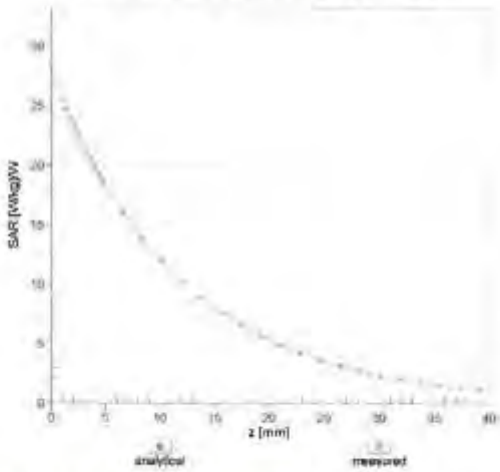
EX3DV4– SN:7340 December 2, 2014

Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

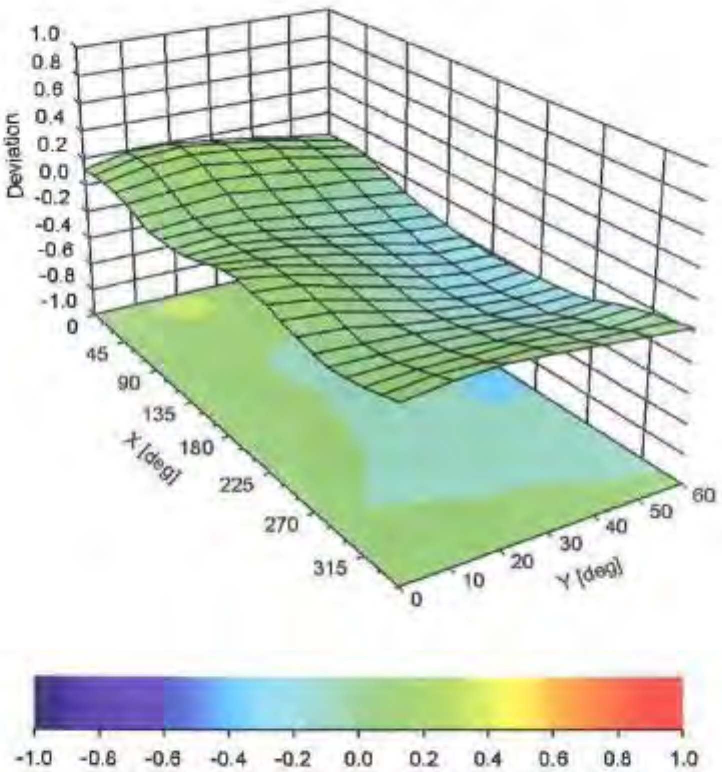


f = 1900 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7340

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-47.4
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

F.2 Dielectric Probe

SATIMO
The microwave vision company

Dielectric Probe Calibration Report

Ref : ACR.219.12.13.SATU.A

SHENZHEN BALUN TECHNOLOGY CO., LTD.
ROOM 601, EAST TOWER, NANSHAN SOFTWARE PARK,
10128 SHENNAN ROAD, SHENZHEN, 518084, CHINA
SATIMO LIMESAR DIELECTRIC PROBE
FREQUENCY: 0.3-6 GHZ
SERIAL NO.: SN 25/13 OCPG56

Calibrated at SATIMO US
2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED
Calibration CERT #2246.02

17/08/2014

Summary:

This document presents the method and results from an accredited Dielectric Probe calibration performed in SATIMO USA using the LIMESAR test bench. All calibration results are traceable to national metrology institutions.

SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.219.12.13.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	8/17/2014	
Checked by :	Jérôme LUC	Product Manager	8/17/2014	
Approved by :	Kim RUTKOWSKI	Quality Manager	8/17/2014	

	Customer Name
Distribution :	Shenzhen BALUN Technology Co., Ltd.

Issue	*Date*	*Modifications*
A	8/17/2014	Initial release

Page: 2/7

TABLE OF CONTENTS

1 INTRODUCTION

This document contains a summary of the suggested methods and requirements set forth by the IEEE 1528 and CEI/IEC 62209 standards for liquid permittivity measurements and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test	
Device Type	LIMESAR DIELECTRIC PROBE
Manufacturer	Satimo
Model	SCLMP
Serial Number	SN 25/13 OCPG56
Product Condition (new / used)	New

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

Satimo's Dielectric Probes are built in accordance to the IEEE 1528 and CEI/IEC 62209 standards. The product is designed for use with the LIMESAR test bench only.

Figure 1 – *Satimo LIMESAR Dielectric Probe*

4 MEASUREMENT METHOD

The IEEE 1528-2003, OET 65 Bulletin C and CEI/IEC 62209-1 & 2 standards outline techniques for dielectric property measurements. The LIMESAR test bench employs one of the methods outlined in the standards, using a contact probe or open-ended coaxial transmission-line probe and vector network analyzer. The standards recommend the measurement of two reference materials that have well established and stable dielectric properties to validate the system, one for the calibration and one for checking the calibration. The LIMESAR test bench uses De-ionized water as the reference for the calibration and either DMS or Methanol as the reference for checking the calibration. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 LIQUID PERMITTIVITY MEASUREMENTS

The permittivity of a liquid with well established dielectric properties was measured and the measurement results compared to the values provided in the fore mentioned standards.

5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

5.1 DIELECTRIC PERMITTIVITY MEASUREMENT

The following uncertainties apply to the Dielectric Permittivity measurement:

Uncertainty analysis of Permittivity Measurement					
ERROR SOURCES	Uncertainty value (+/-%)	Probability Distribution	Divisor	ci	Standard Uncertainty (+/-%)
Repeatability (n repeats, mid-band)	4.00%	N	1	1	4.000%
Deviation from reference liquid	5.00%	R	√3	1	2.887%
Network analyser-drift, linearity	2.00%	R	√3	1	1.155%
Test-port cable variations	0.00%	U	√2	1	0.000%
Combined standard uncertainty					5.066%
Expanded uncertainty (confidence level of 95%, k = 2)					10.0%

Uncertainty analysis of Conductivity Measurement					
ERROR SOURCES	Uncertainty value (+/-%)	Probability Distribution	Divisor	ci	Standard Uncertainty (+/-%)
Repeatability (n repeats, mid-band)	3.50%	N	1	1	3.500%
Deviation from reference liquid	3.00%	R	√3	1	1.732%
Network analyser-drift, linearity	2.00%	R	√3	1	1.155%
Test-port cable variations	0.00%	U	√2	1	0.000%
Combined standard uncertainty					4.072%
Expanded uncertainty (confidence level of 95%, k = 2)					8.1%

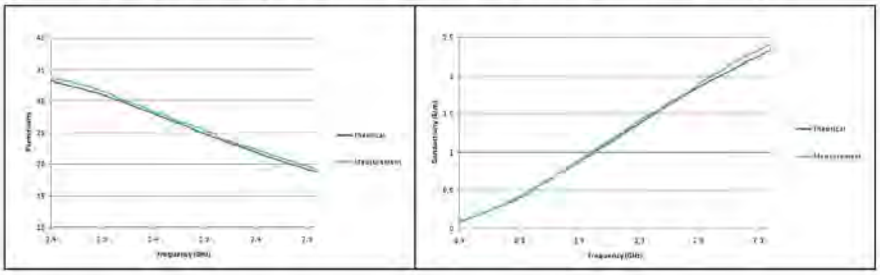
6 CALIBRATION MEASUREMENT RESULTS

Measurement Condition

Software	LIMESAR
Liquid Temperature	21°C
Lab Temperature	21°C
Lab Humidity	44%

6.1 LIQUID PERMITTIVITY MEASUREMENT

A liquid of known characteristics (methanol at 20°C) is measured with the probe and the results (complex permittivity ε'+jε'') are compared with the well-known theoretical values for this liquid.



7 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
LIMESAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2012	02/2015
Methanol CAS 67-56-1	Alpha Aesar	Lot D13W011	Validated. No cal required.	Validated. No cal required.
Temperature and Humidity Sensor	Control Company	11-661-9	3/2013	3/2015

F.3 Data Acquisition Electronics

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **Dgieie (Vitec)**

Certificate No: **DAE4-1454_Dec14**

CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BM - SN: 1454

Calibration procedure(s): QA CAL-06.v28
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: December 01, 2014

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	03-Oct-14 (No:15573)	Oct-15
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-14 (in house check)	In house check: Jan-15
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-14 (in house check)	In house check: Jan-15

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	i.V.

Issued: December 1, 2014

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: SCS 108

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.......+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.134 ± 0.02% (k=2)	403.641 ± 0.02% (k=2)	403.713 ± 0.02% (k=2)
Low Range	4.01178 ± 1.50% (k=2)	3.98989 ± 1.50% (k=2)	3.99971 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	316.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200031.80	-0.26	-0.00
Channel X	+ Input	20001.23	-2.68	-0.01
Channel X	- Input	-20003.35	1.70	-0.01
Channel Y	+ Input	200039.44	7.23	0.00
Channel Y	+ Input	20000.28	-3.57	-0.02
Channel Y	- Input	-20006.44	-1.22	0.01
Channel Z	+ Input	200040.26	7.92	0.00
Channel Z	+ Input	20000.97	-2.84	-0.01
Channel Z	- Input	-20007.52	-2.33	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2000.65	0.03	0.00
Channel X	+ Input	200.83	0.05	0.02
Channel X	- Input	-198.91	0.45	-0.23
Channel Y	+ Input	2000.46	-0.10	-0.01
Channel Y	+ Input	199.94	-0.66	-0.33
Channel Y	- Input	-199.92	-0.45	0.23
Channel Z	+ Input	2000.59	0.10	0.01
Channel Z	+ Input	199.12	-1.46	-0.73
Channel Z	- Input	-200.88	-1.43	0.72

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	-14.55	-16.51
	- 200	17.71	16.60
Channel Y	200	-22.05	-22.66
	- 200	22.22	21.96
Channel Z	200	-12.87	-12.55
	- 200	10.00	9.91

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-2.55	-2.28
Channel Y	200	4.25	-	-1.65
Channel Z	200	9.93	2.36	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	16115	16385
Channel Y	16297	16505
Channel Z	16059	16142

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	-0.24	-1.34	0.92	0.37
Channel Y	-0.07	-1.28	0.82	0.40
Channel Z	-1.81	-2.74	-0.39	0.48

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	–0.01	-8	-9

F.4 2450MHz Dipole

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

ilac-MRA

SWISS CALIBRATION

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client Dgieie (Vitec)

Certificate No: D2450V2-952_Nov14

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 952
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	November 27, 2014

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 20 dB Attenuator	SN: 5058 (20k)	03-Apr-14 (No. 217-01918)	Apr-15
Type-N mismatch combination	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Reference Probe ES3DV3	SN: 3205	30-Dec-13 (No. ES3-3205_Dec13)	Dec-14
DAE4	SN: 601	18-Aug-14 (No. DAE4-601_Aug14)	Aug-15

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-13)	In house check: Oct-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	[signature]

Issued: November 28, 2014

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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Calibration Laboratory of
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Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
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Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

d) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.0 ± 6 %	1.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.3 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.5 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.9 ± 6 %	2.03 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**50.6 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.02 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.7 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.4 Ω + 3.0 jΩ
Return Loss	- 27.2 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.7 Ω + 5.1 jΩ
Return Loss	- 25.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.161 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	August 05, 2014

DASY5 Validation Report for Head TSL

Date: 27.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

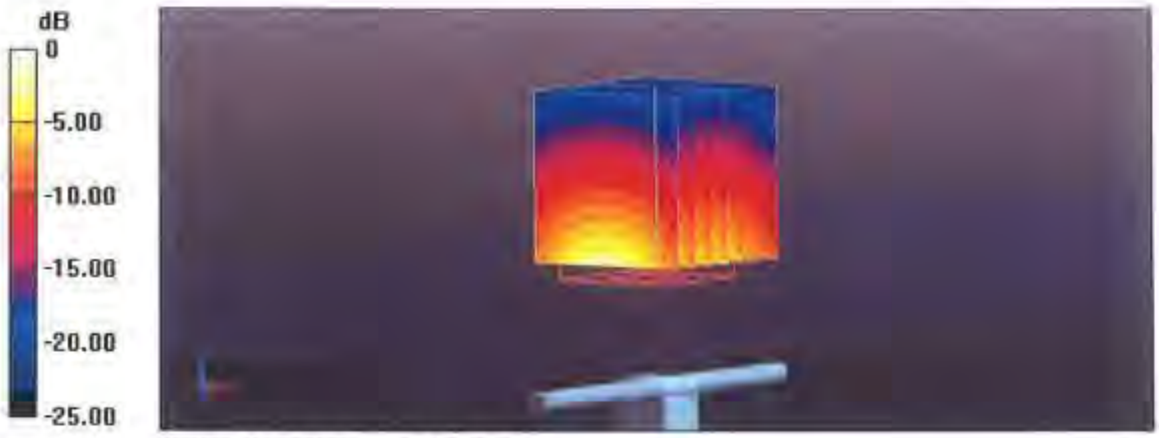
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 952

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.86 S/m; ε_r = 39; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

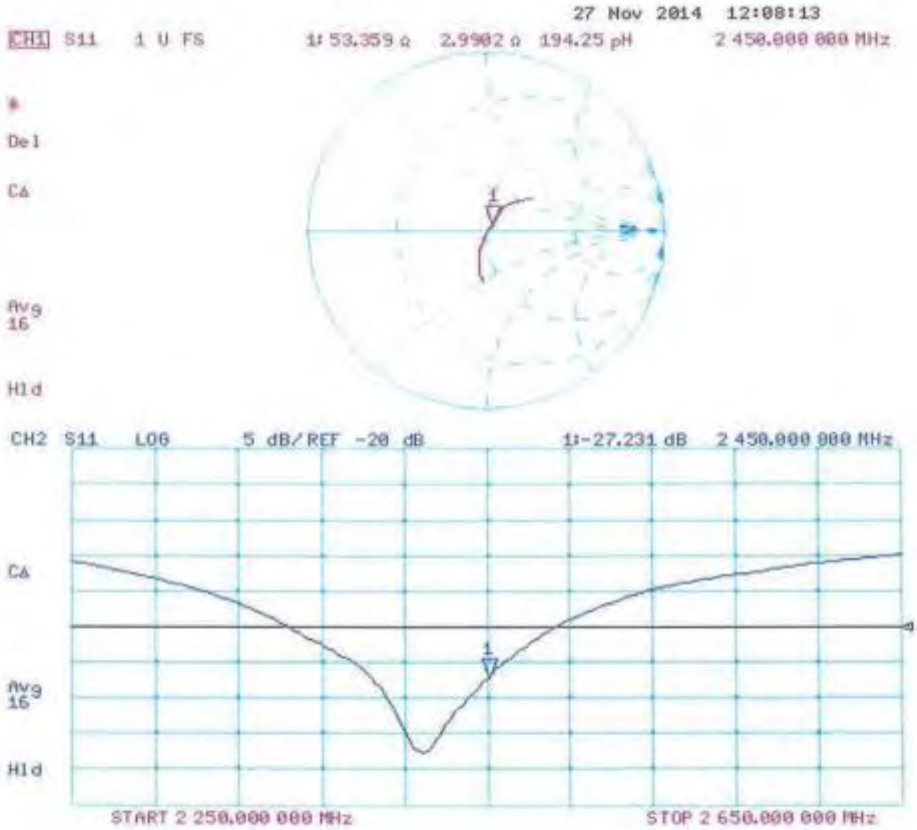
- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 100.8 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 27.5 W/kg
SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.17 W/kg
Maximum value of SAR (measured) = 17.5 W/kg



0 dB = 17.5 W/kg = 12.43 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 27.11.2014

Test Laboratory: SPEAG, Zurich, Switzerland

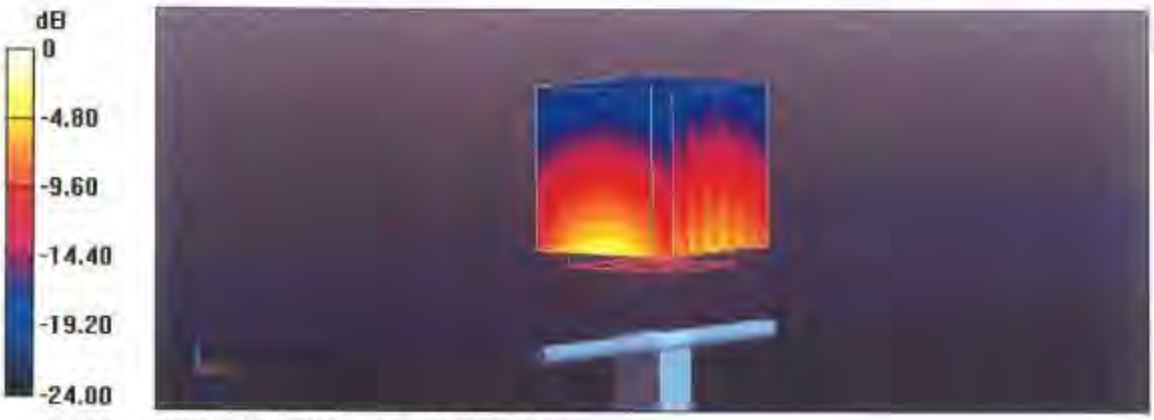
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 952

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma = 2.03$ S/m; $\varepsilon_r = 50.9$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

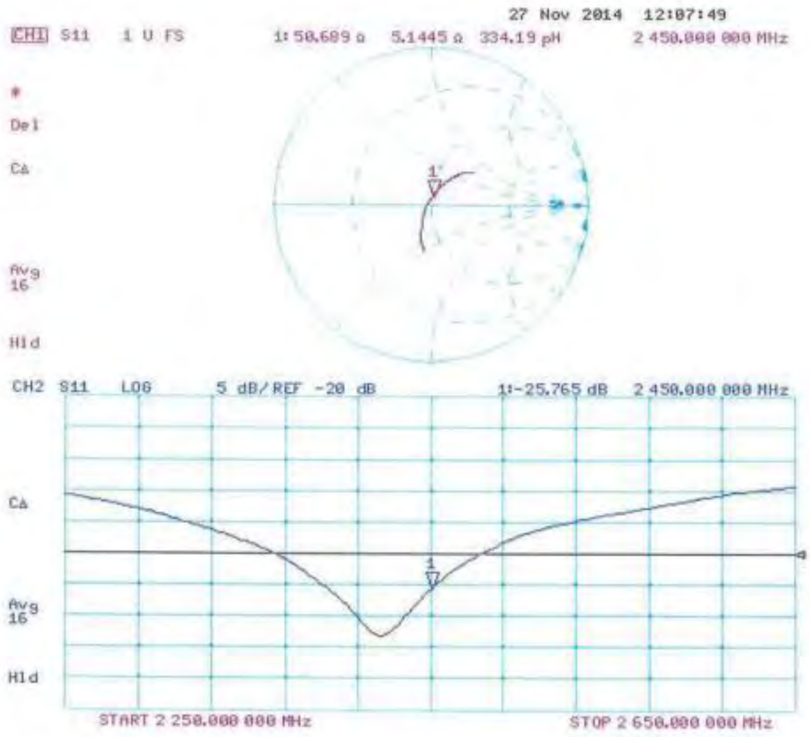
- Probe: ES3DV3 - SN3205; ConvF(4.35, 4.35, 4.35); Calibrated: 30.12.2013;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 18.08.2014
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.25 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 27.2 W/kg
SAR(1 g) = 13 W/kg; SAR(10 g) = 6.02 W/kg
Maximum value of SAR (measured) = 17.3 W/kg



0 dB = 17.3 W/kg = 12.38 dBW/kg

Impedance Measurement Plot for Body TSL



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--END OF REPORT--