SAR Test Report

Model: BCM943228HMB

IC CERTIFICATION #:	4324A-BRCM1058
FCC ID:	QDS-BRCM1058
APPLICANT:	Broadcom Corporation 190 Mathilda Ave Sunnyvale, CA 94089
TEST SITE(S):	NTS Silicon Valley 41039 Boyce Road. Fremont, CA. 94538-2435
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REVISION HISTORY

Rev#	Date	Comments	Modified By
1	May 6, 2013	First Release	
2	May 9, 2013	Added scaled-up SAR results for 5 GHz bands	Deniz Demirci

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1. Introduction

This measurement report shows compliance of the Broadcom Corporation Model BCM943228HMB FCC ID: QDS- BRCM1058 with FCC Part 2, 1093, ET Docket 93-62 Rules for mobile and portable devices and IC Certificate: 4324A- BRCM1058 with RSS102 & Safety Code 6. The FCC have adopted the guidelines for evaluating the environmental effects of radio frequency radiation in ET Docket 93-62 on August 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC regulated portable devices. [1], [6]

The purpose of this report is to show compliance of this wireless module to be used in multiple host platforms with antenna-to-user separation distance of 5 mm or greater per FCC KDB 616217 D04 SAR for laptop and tablets v01 and FCC KDB 447498 D01 General RF Exposure Guidance v05

Per FCC KDB 447498 D01 v05; When the highest *reported* 1-g SAR is > 0.4 W/kg and ≤ 0.8 W/kg, modules and peripheral transmitters may be approved to operate in multiple host platforms. To qualify for multiple host platforms, the modular transmitter may be approved under one FCC ID, either in the initial filing or through Class II permissive changes. All subsequent Class II permissive changes must be within the scope of the defined host platform configurations and exposure conditions in the initial equipment approval.

Per FCC KDB 616217 D04; The *modular approach* is applied to this module in order to use it in qualified laptop and tablet hosts. When the test separation distances and test setups for the laptop and tablet host platforms are satisfied by the antenna and host configurations and the highest *reported* SAR for a host platform is ≤ 0.8 W/kg, testing in representative hosts is optional for the *modular approach.*

The test results recorded herein are based on a single type test of Broadcom Corporation model BCM943228HMB with ACON APP8P-700045 antenna and therefore apply only to the tested sample.

The test procedures, as described in ANSI C95.1 – 1999 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [2], ANSI C95.3 – 2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields [3], FCC OET Bulletin 65 Supp. C – 2001 [4], IEEE Std.1528 – 2003 Recommended Practice [5], and Industry Canada Safety Code 6 Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz were employed.

SAR definition

Specific Absorption Rate is defined as 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).

$$SAR = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho dV}\right)$$

SAR is expressed in units of watts per kilogram (W/kg). *SAR* can be related to the electric field at a point by

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

where:

σ = conductivity of the tissue (S/m)
ρ = mass density of the tissue (kg/m^3)
E = rms electric field strength (V/m)

2. SAR measurement setup

Robotic system

These measurements are performed using the DASY52 automated dosimetric assessment system. The DASY52 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, Intel Core2 computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the body equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Fig. 2.1).

System hardware

A cell controller system contains the power supply, robot controller teach pendant (Joystick), and a remote control used to drive the robot motors. The PC consists of the HP Intel Core2 computer with Windows XP system and SAR Measurement Software DASY52, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

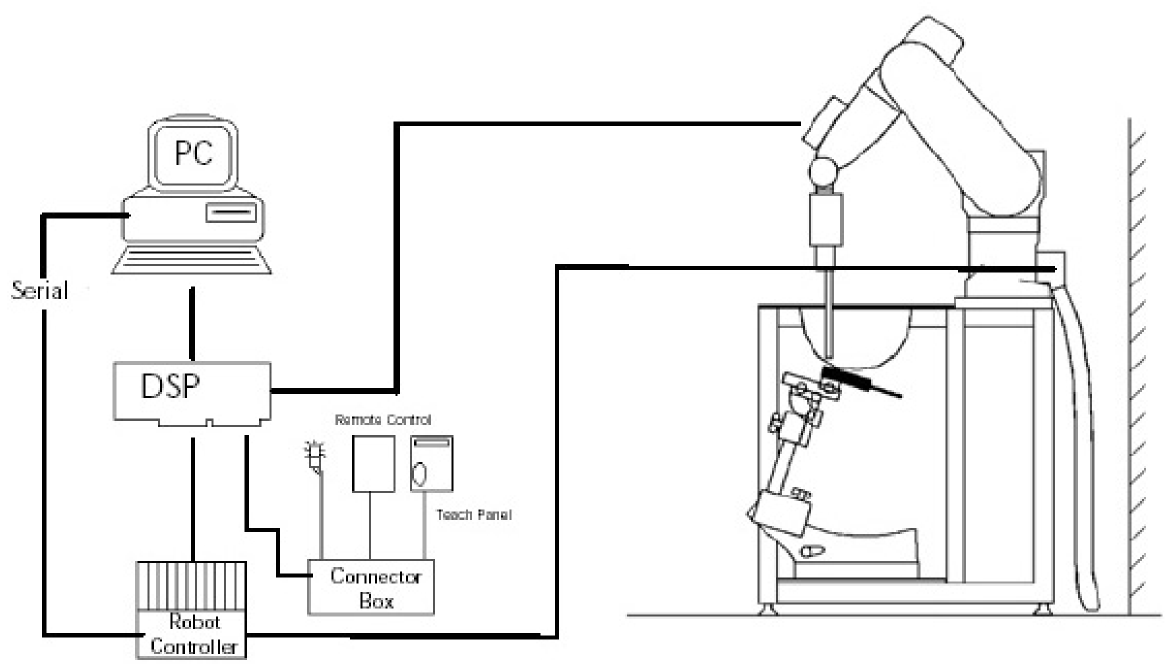


Figure 2.1 SAR measurement system setup

System electronics

The DAE4 consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in.

Probe measurement system

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration (see Fig. 2.2) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi fiber line ending at the front of the probe tip. (see Fig. 2.3) It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY52 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.

DAE system

Probe specifications

Calibration: In air from 10 MHz to 6.0 GHz
In brain and muscle simulating tissue at Frequencies of 450 MHz, 835 MHz, 1750 MHz, 1900 MHz, 2450 MHz, 2600 MHz, 3500 MHz, 5200 MHz, 5300 MHz, 5600 MHz, 5800 MHz

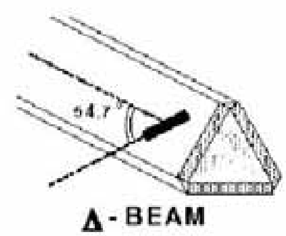


Figure 2.2 Triangular Probe Configurations

Frequency: 10 MHz to 6 GHz

Linearity: ±0.2dB (30 MHz to 6 GHz)

Dynamic: 10 mW/kg to 100 W/kg

Range: Linearity: ±0.2dB

Dimensions: Overall length: 330 mm

Figure 2.3 Probe Thick-Film Technique

Tip length: 20 mm

Body diameter: 12 mm

Tip diameter: 2.5 mm

Distance from probe tip to sensor center: 1 mm

Application: SAR Dosimetry Testing
Compliance tests of wireless device

Probe calibration process

Dosimetric assessment procedure

Each probe is calibrated according to a dosimetric assessment procedure described in with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in and found to be better than +/-0.25dB. The sensitivity parameters (Norm X, Norm Y, Norm Z), the diode compression parameter (DCP) and the conversion factor (Conv F) of the probe is tested.

Free space assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a waveguide above 1GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/cm^2.

Temperature assessment *

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium, correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor based temperature probe is used in conjunction with the E-field probe

$$SAR = C\frac{\Delta T}{\Delta t}$$

where:

Δt = exposure time (30 seconds),

C = heat capacity of tissue (brain or muscle),

ΔT = temperature increase due to RF exposure.

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

where:

σ = simulated tissue conductivity,

ρ = Tissue density (1.25 g/cm^3 for brain tissue)

SAR is proportional to $\Delta T / \Delta t$, the initial rate of tissue heating, before thermal diffusion takes place. Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E- field;

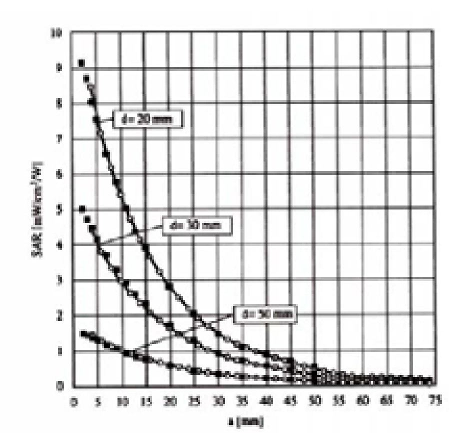


Figure 2.4 E-Field and Temperature Measurements at 900MHz

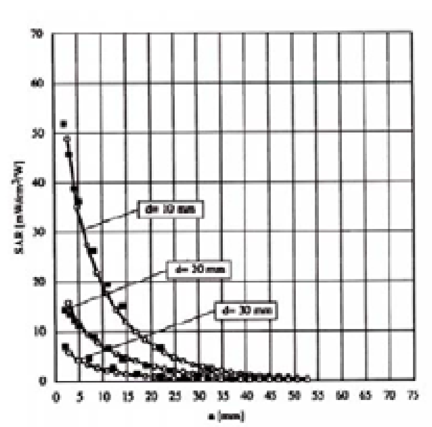


Figure 2.5 E-Field and Temperature Measurements at 1800MHz

Data extrapolation

The DASY52 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given like below;

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

with V_i = compensated signal of channel i (i=x,y,z)
U_i = input signal of channel i (i=x,y,z)
cf = crest factor of exciting field (DASY parameter)
dcp_i = diode compression point (DASY parameter)

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

E-field probes:

$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

with V_i = compensated signal of channel i (i = x,y,z)
$Norm_i$ = sensor sensitivity of channel i (i = x,y,z) $\mu V/(V/m)^2$ for E-field probes
ConvF = sensitivity of enhancement in solution
E_i = electric field strength of channel i in V/m

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

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

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

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with SAR = local specific absorption rate in W/g
E_{tot} = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm^3

The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{3770}$$

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

SAM phantom

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. (see Fig. 2.6)

Phantom: SAM Twin Phantom (V4.0)
Shell material: Vivac Composite
Thickness: 2.0 ± 0.2 mm

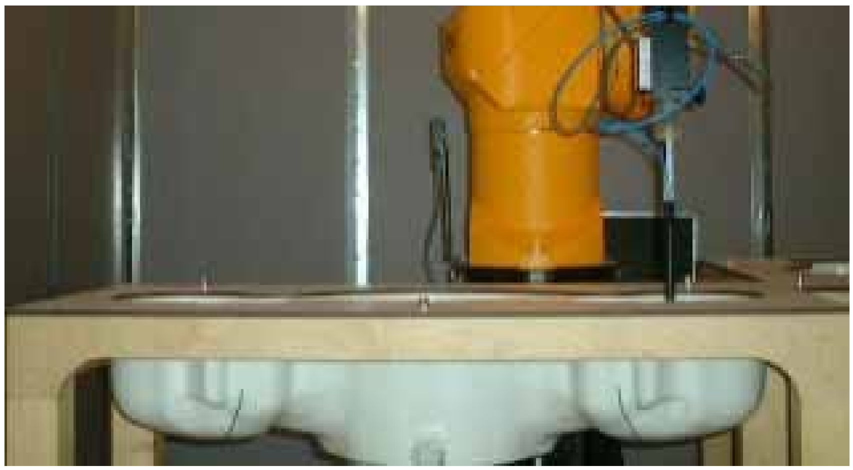


Figure 2.6 SAM twin phantom

Device holder for transmitters

In combination with the SAM Twin Phantom V4.0 the Mounting Device (see Fig. 2.7), enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening. The devices can be easily, accurately, and repeat ably be positioned according to the FCC, CENELEC, IEC and IEEE specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

Figure 2.7 Mounting device

Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produce infinite number of configurations. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

3. Probe and dipole calibration

See Appendix D and E.

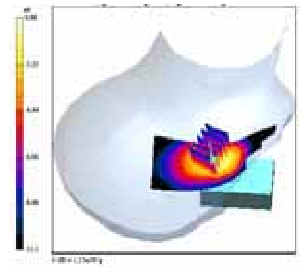
4. Simulating tissue specifications

The head and body simulating mixtures consist of the material based on the table listed below.
The mixture is calibrated to obtain proper permittivity and conductivity of the desired tissue. Body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations

Table 4.1 Typical composition of ingredients for tissue

Ingredients		**Body simulating tissue**			
		2450 MHz	**5200 MHz**	**5500 MHz**	**5800 MHz**
Mixing Percentage					
Water		73.20	Proprietary mixture	Proprietary mixture	Proprietary mixture
Sugar		0.00			
Salt		0.00			
HEC		0.00			
Bactericide		0.00			
DGBE		26.70			
Dielectric Constant	Target	52.70	49.0	48.6	48.20
Conductivity (S/m)	Target	1.95	5.30	5.65	6.00

5. SAR measurement procedure


Sample SAR Area Scan

The evaluation was performed using the following procedure:

1. The SAR measurement was taken at a selected spatial reference point to monitor power variations during testing. This fixed location point was measured and used as a reference value.
2. The SAR distribution at the exposed side of the head was measured at a distance of 3.9mm from the Inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 15 mm
3. Based on the area scan data, the area of the maximum absorption was determined by sp line interpolation. Around this point, a volume of 32 mm x32 mm x 30 mm (fine resolution volume scan, zoom scan) was assessed by measuring 5 x 5 x 7 points. On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see Sample SAR Area Scan):
   a. The data at the surface was extrapolated, since the center of the dipoles is 2.5 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.
   b. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were computed using the 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional sp lines with the "Not a knot" condition (in x, y, and z directions). The volume was integrated with the trapezoidal algorithm. One thousand points (10 x 10x 10) were interpolated to calculate the average.
   c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 1, was re-measured. If the value changed by more than 5%, the evaluation is repeated.

Specific anthropomorphic mannequin (SAM) specifications

The phantom for handset SAR assessment testing is a low-loss dielectric shell, with shape and dimensions derived from the anthropometric data of the 90th percentile adult male head dimensions as tabulated by the US Army. The SAM Twin Phantom shell is bisected along the mid-sagittal plane into right and left halves (see Fig. 5.1). The perimeter side walls of each phantom halves are extended to allow filling with liquid to a depth that is sufficient to minimized reflections from the upper surface. The liquid depth is maintained at a minimum depth of 15cm to minimize reflections from the upper surface.

Figure 5.1 Sam twin phantom

6. Definition of reference points

EAR reference point

Figure 6.1 shows the front, back and side views of the SAM Twin Phantom. The point“M” is the reference point for the center of the mouth, “LE” is the left ear reference point(ERP), and “RE” is the right ERP. The ERPs are 15mm posterior to the entrance to the Ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 6.5. The plane Passing, through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck- Front) is perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting Line (see Figure 6.2). Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning.

Figure 6.1 Front, back and side view of SAM twin phantom

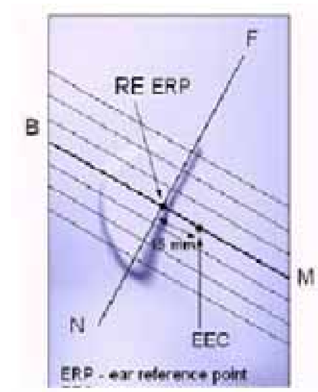


Figure 6.2 Close-up side view of ERPs

Handset reference points

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed in a normal operating position with the “test device reference point” located along the “vertical centerline” on the front of the device aligned to the “ear reference point” (See Fig. 6.3). The “test device reference point” was than located at the same level as the center of the ear reference point. The test device was positioned so that the “vertical centerline” was bisecting the front surface of the handset at it’s top and bottom edges, positioning the “ear reference point” on the outer surface of the both the left and right head phantoms on the ear reference point.

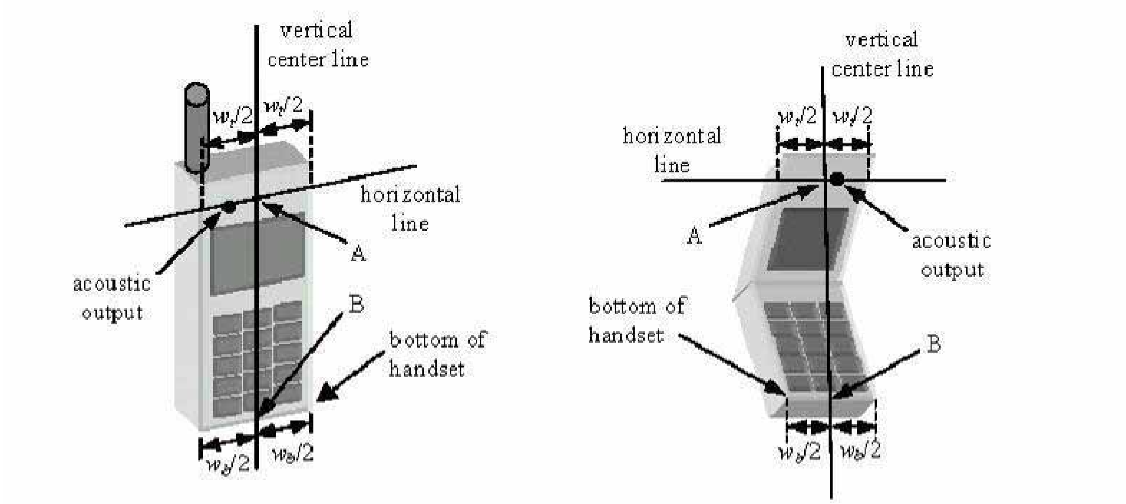


Figure 6.3 Handset vertical center & horizontal line reference points

Test configuration positions

Positioning for cheek/touch

1. The test device was positioned with the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 6.4), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom.

Figure 6.4 Front, side and top view of cheek/touch position

2. The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the ear.
3. While maintaining the handset in this plane, the handset was rotated around the LE-RE line until the vertical centerline was in the plane normal to MB-NF including the line MB (reference plane).
4. The phone was hen rotated around the vertical centerline until the phone (horizontal line) was symmetrical was respect to the line NF.
5. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, the handset was rotated about the line NF until any point on the handset made contact with a phantom point below the ear (cheek). (See Figure 6.5)

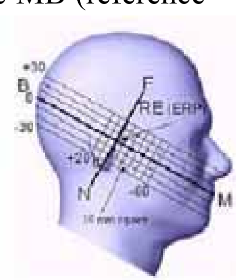


Figure 6.5 Side view w/ relevant markings

Positioning for ear / 15 ° tilt

With the test device aligned in the "Cheek/Touch Position":

1. While maintaining the orientation of the phone, the phone was retracted parallel to the reference plane far enough to enable a rotation of the phone by 15 degrees.
2. The phone was then rotated around the horizontal line by 15 degrees.
3. While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the phone touches the head. (In this position, point A was located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna, the angle of the phone would then be reduced. The tilted position was obtained when any part of the phone was in contact of the ear as well as a second part of the phone was in contact with the head (see Figure 6.6)

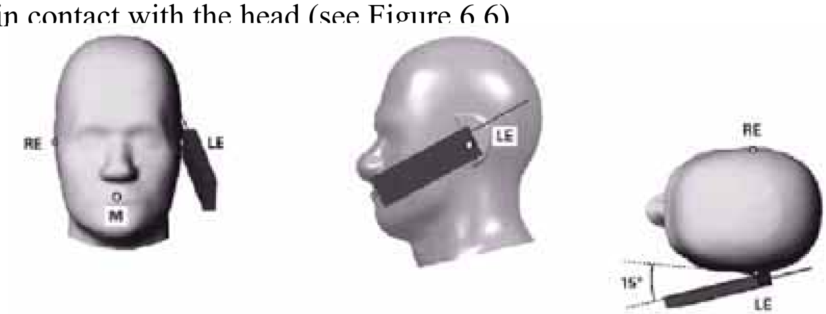


Figure 6.6 Front, side and top view of ear/15^{o} tilt position

Body holster /belt clip configurations

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration (see Figure 6.7). A device with a headset output is tested with a headset connected to the device. Body dielectric parameters are used.

Figure 6.7 Body belt clip & holster configurations

Accessories for Body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are supplied with the device, the device is tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component (i.e. the same metallic belt-clip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.

Body-worn accessories may not always be supplied or available as options for some Devices intended to be authorized for body-worn use. In this case, a test configuration where a separation distances between the back of the device and the flat phantom is used. All test position spacing is documented.

Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom. For devices that are carried next to the body such as a shoulder, waist or chest-worn transmitters, SAR compliance is tested with the accessories, including headsets and microphones, attached to the device and positioned against a flat phantom in a normal use configuration.

In all cases SAR measurements are performed to investigate the worst-case positioning. Worst-case positioning is then documented and used to perform Body SAR testing.

In order for users to be aware of the body-worn operating requirements for meeting RF exposure compliance, operating instructions and cautions statements are included in the user's manual.

7. ANSI/IEEE C95.1 – 1992 RF exposure limits

Uncontrolled environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

Controlled environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Table 7.1 Human exposure limits

	Uncontrolled environment general population (W/kg) or (mW/g)	**Controlled environment professional population (W/kg) or (mW/g)**
Spatial Peal SAR[1] Head	1.60	8.00
Spatial Peal SAR[2] Whole Body	0.08	0.40
Spatial Peal SAR[3] Hands, Feet, Ankles, Wrist	4.00	20.00

[1] The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
[2] The Spatial Average value of the SAR averaged over the whole body.
[3] The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

8. Measurement uncertainty

Source of Uncertainty	Tolerance Value	Probability Distribution	Divisor	c_i[1] (1-g)	c_i[1] (10-g)	Standard Uncertainty (1-g) %	Standard Uncertainty (10-g) %	v_i
Measurement System								
Probe Calibration	5.5	normal	1	1	1	5.5	5.5	∞
Axial Isotropy	4.7	rectangular	√3	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy	9.6	rectangular	√3	0.7	0.7	3.9	3.9	∞
Boundary Effect	1	rectangular	√3	1	1	0.6	0.6	∞
Linearity	4.7	rectangular	√3	1	1	2.7	2.7	∞
Detection Limit	1	rectangular	√3	1	1	0.6	0.6	∞
Readout Electronics	0.3	normal	1	1	1	0.3	0.3	∞
Response Time	0.8	rectangular	√3	1	1	0.5	0.5	∞
Integration Time	2.6	rectangular	√3	1	1	1.5	1.5	∞
RF Ambient Condition	3	rectangular	√3	1	1	1.7	1.7	∞
Probe Positioner Mech. Restriction	0.4	rectangular	√3	1	1	0.2	0.2	∞
Probe Positioning with respect to Phantom Shell	2.9	rectangular	√3	1	1	1.7	1.7	∞
Extrapolation and Integration	1	rectangular	√3	1	1	0.6	0.6	∞
Test Sample Positioning	2.9	normal	1	1	1	2.9	2.9	145
Device Holder Uncertainty	3.6	normal	1	1	1	3.6	3.6	5
Drift of Output Power	5	rectangular	√3	1	1	2.9	2.9	∞
Phantom and Setup								
Phantom Uncertainty(shape & thickness tolerance)	4	rectangular	√3	1	1	2.3	2.3	∞
Liquid Conductivity(target)	5	rectangular	√3	0.64	0.43	1.8	1.2	∞
Liquid Conductivity(meas.)	2.5	normal	1	0.64	0.43	1.6	1.1	5
Liquid Permittivity(target)	5	rectangular	√3	0.6	0.49	1.7	1.4	∞
Liquid Permittivity(meas.)	2.5	normal	1	0.6	0.49	1.5	1.2	5
Combined Uncertainty		RSS				10.7	10.5	387
Combined Uncertainty (coverage factor=2)		Normal(k=2)				21.4	21.0	

9. System validation

Tissue Verification

Prior to assessment, the system is verified to the ±5% of the specifications at the test frequency by using the speag DAK (Dielectric Assessment Kit) measurement kit

Table 9.1 Measured tissue parameters

Frequency (MHz)	Tissue type	Tissue temp. (˚C)	Measured dielec. cons. (ε)	Measured conductivity (σ)	Target value	Deviation (%)	Date
2452	Body	23.0	52.45		52.70	0.5	4/19/13
				1.99	1.95	1.8	
2452	Body	23.0	52.74		52.70	0.1	4/22/13
				2.02	1.95	3.7	
5200	Body	23.0	48.43		49.03	1.2	4/24/13
				5.30	5.35	1.1	
5500	Body	23.0	48.04		48.62	1.3	4/24/13
				5.64	5.68	1.3	
5800	Body	23.0	47.69		48.20	1.1	4/24/13
				5.99	6.00	0.2	
5200	Body	23.0	48.10		49.03	1.9	4/29/13
				5.35	5.35	0.0	
5500	Body	23.0	47.55		48.62	2.2	4/29/13
				5.73	5.68	1.8	
5800	Body	23.0	47.13		48.20	2.2	4/29/13
				6.17	6.00	2.8	
5200	Body	23.0	48.76		49.03	0.6	5/1/13
				5.35	5.35	0.0	
5500	Body	23.0	48.17		48.62	0.9	5/1/13
				5.70	5.68	0.3	
5800	Body	23.0	47.77		48.20	0.8	5/1/13
				6.16	6.00	2.7	

Tissue depth (>15 cm)

Test system verification

Prior to assessment, the system is verified to the ±10% of the specifications at the test frequency by using the system kit.

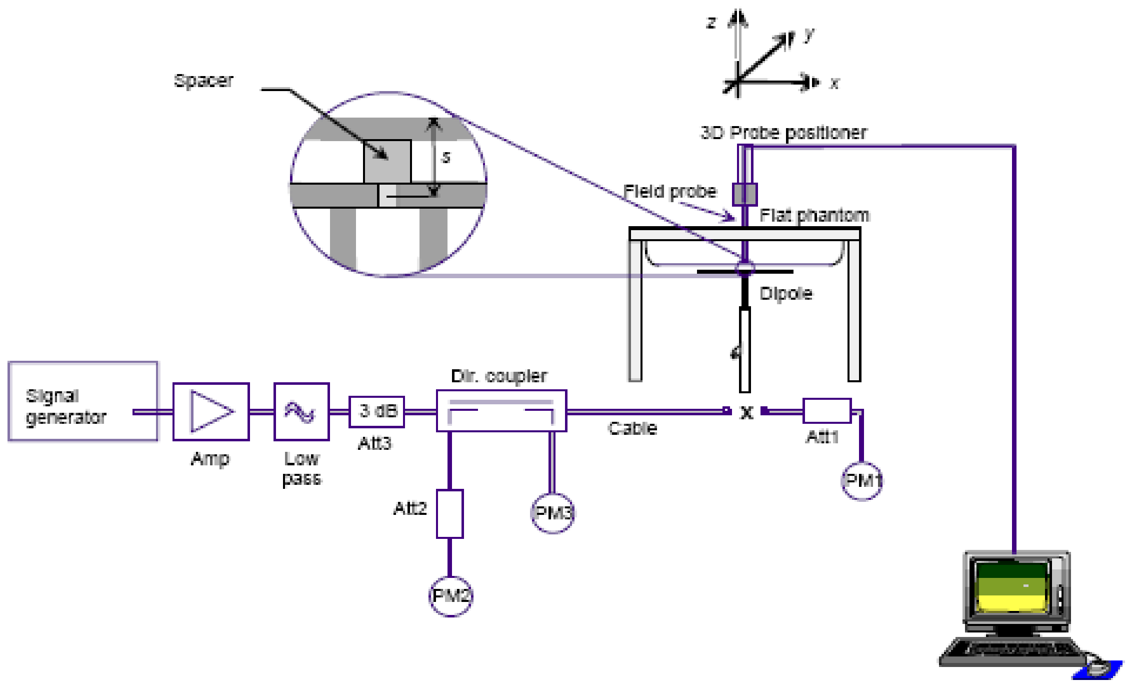
Table 9.2 System dipole validation target & measured

Test Frequency	Targeted SAR_{1g} (W/kg)	Measured SAR_{1g} (W/kg)	Tissue Used for Verification	Deviation (%)	Verification Date
2450 MHz	12.8	12.7	Body	0.8	4/19/13
2450 MHz	12.8	13.0	Body	1.6	4/22/13
5200 MHz	7.21	6.66	Body	7.6	4/24/13
5500 MHz	7.95	8.61	Body	8.3	4/24/13
5800 MHz	7.33	7.12	Body	2.9	4/24/13
5200 MHz	7.21	7.05	Body	2.2	4/29/13
5500 MHz	7.95	7.58	Body	4.7	4/29/13
5800 MHz	7.33	7.44	Body	1.5	4/29/13
5200 MHz	7.21	7.06	Body	2.1	5/1/13
5500 MHz	7.95	7.75	Body	2.5	5/1/13
5800 MHz	7.33	7.00	Body	4.1	5/1/13

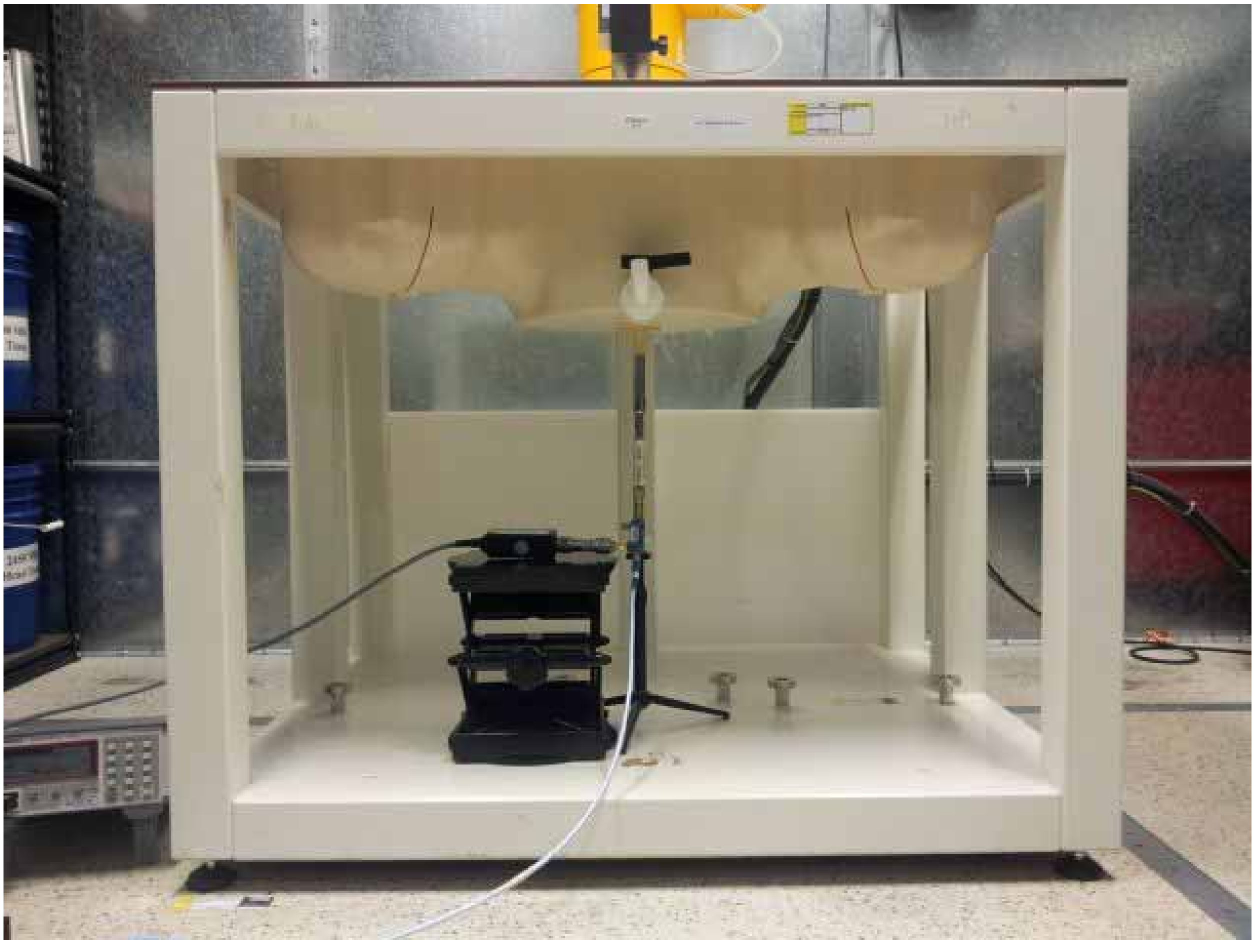
See Appendix A for detailed results and plots.

Figure 9.1 Dipole validation test setup

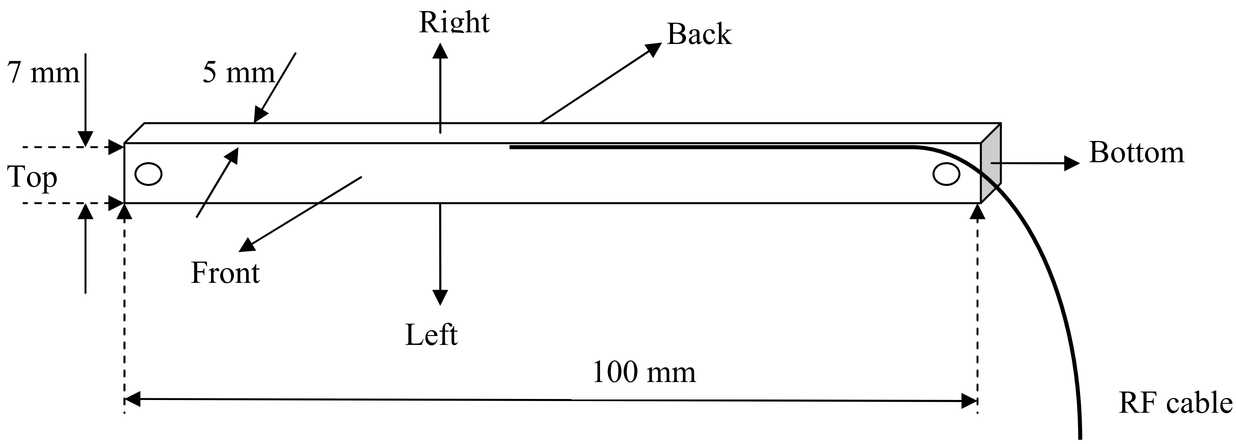
Note: KDB 450824 was applied for probe calibration frequencies greater than or equal to 50 MHz of the DUT frequencies.



Dipole validation photo



EUT SAR location diagram (Antenna)



10. SAR test data summary (5180 - 5825 MHz Body 802.11a/n)

Gap (mm)	Position	Frequency		Data rate (Mbps)	Antenna	Meas. Plot page #	End power (dBm)	SAR (W/kg)
		MHz	Channel					
5	Left	5180	36	6	Main	56	13.9	0.567
5	Right	5180	36	6	Main	57	13.9	0.185
5	Front	5180	36	6	Main	58	13.9	0.300
5	Back	5180	36	6	Main	59	13.9	0.327
5	Top	5180	36	6	Main	60	13.9	0.017
5	Bottom	5180	36	6	Main	61	13.9	0.039
5	Left	5240	48	6	Main	62	13.7	0.570
5	Left	5260	52	6	Main	63	13.6	0.652
5	Right	5260	52	6	Main	64	13.6	0.229
5	Front	5260	52	6	Main	65	13.6	0.280
5	Back	5260	52	6	Main	66	13.6	0.405
5	Left	5320	64	6	Main	67	14.3	0.395
5	Left	5500	100	6	Main	68	13.8	0.182
5	Left	5580	116	6	Main	69	14.0	0.464
5	Right	5580	116	6	Main	70	14.0	0.232
5	Front	5580	116	6	Main	71	14.0	0.430
5	Back	5580	116	6	Main	72	14.0	0.431
5	Left	5700	140	6	Main	73	13.9	0.202
5	Left	5745	149	6	Main	74	18.4	**0.727**
5	Right	5745	149	6	Main	75	18.4	0.484
5	Front	5745	149	6	Main	76	18.4	0.600
5	Back	5745	149	6	Main	77	18.4	0.613
5	Left	5825	165	6	Main	78	18.1	0.340
5	Right	5825	165	6	Main	79	18.1	0.361
5	Front	5825	165	6	Main	80	18.1	0.412
5	Back	5825	165	6	Main	81	18.1	0.370
					Maximum body SAR = 0.727 W/kg (mW/g) averaged over 1 gram			

Scaled-up SAR levels to manufacturing tolerances (5180 - 5825 MHz Body 802.11a/n)

Gap (mm)	Frequency (MHz)	Channel	End power (dBm)	Target (dBm)	Delta (dB)	Multiplier	Measured SAR (W/kg)	Scaled-up SAR (W/kg)
5	5180	36	13.6	13.0	-0.6	1.000	0.567	0.567
5	5240	48	14.0	13.5	-0.5	1.000	0.570	0.570
5	5260	52	13.6	14.0	0.4	1.096	0.652	0.715
5	5320	64	14.3	14.0	-0.3	1.000	0.395	0.395
5	5500	100	13.8	14.0	0.2	1.047	0.182	0.191
5	5580	116	14.0	14.0	0.0	1.000	0.464	0.464
5	5700	140	13.9	14.0	0.1	1.023	0.213	0.218
5	5745	149	18.4	17.0	-1.4	1.000	0.727	**0.727**
5	5825	165	18.1	17.0	0.0	1.000	0.412	0.412

Scaled-up maximum body SAR = 0.727 W/kg (mW/g)
averaged over 1 gram

1. Power Measured ☒Conducted ☐ERP ☐EIRP
2. Phantom Configuration ☐Left Head ☒Uni-phantom ☐Right Head
   SAR Configuration ☐Head ☒Body
3. Test Signal Call Mode ☒Test Code ☐Base Station Simulator
4. Test Configuration ☐With Belt Clip ☐Without Belt Clip ☒N/A
5. Tissue Depth is at least 15.0 cm

Note 1: SAR Tested on the Highest output power channel. When the measured channel is 3 dB or more below the limit the remaining channels are not required to be tested per KDB 447498 section 1) e). SAR is not required for 802.11g/HT20/HT40 channels when the maximum average output power is less than ¼ dB higher than that measured in the 802.11b. The testing was conducted on all sides of the antenna. All testing was conducted per KDB 447498, 248227, 616217 and OET Bulletin 65. See the photo in Appendix C and diagram on page 14 for a pictorial of the setup and labeling of the test locations.

Note 2: All measurements were performed with 5 mm gap (Antenna to Flat phantom measurement distance)

Note 3: Number of test channels and SAR test reductions determined based on 447498 D01 v05
Note 4: Main and Aux. chains have identical power outputs, hence SAR evaluation of Main antenna output is sufficient to represent Aux. antenna output compliance.

Note 5: Measured 1-g SAR values of top and bottom positions of the antenna at channel 36 are less than 0.05 W/kg. These measurements are closer to system noise and different channel frequencies will not create any significant change of SAR values in that positions. Hence these positions are not measured for other channels in 5 GHz band
Note 6: Target level is the highest power level in manufacturers tune up procedure, including tolerances, declared by applicant.

11. SAR test data summary (2450 MHz Body 802.11b)

Gap (mm)	Position	Frequency		Data rate (Mbps)	Antenna	Meas. Plot page #	End power (dBm)	SAR (W/kg)
		MHz	Channel					
5	Left	2437	6	1	Main	82	17.5	0.337
5	Right	2437	6	1	Main	83	17.5	0.579
5	Front	2437	6	1	Main	84	17.5	**0.726**
5	Back	2437	6	1	Main	85	17.5	0.514
5	Top	2437	6	1	Main	86	17.5	0.015
5	Bottom	2437	6	1	Main	87	17.5	0.041
					Maximum body SAR = 0.726 W/kg (mW/g) averaged over 1 gram			

1. Power Measured ☒Conducted ☐ERP ☐EIRP
2. SAR Measurement
   Phantom Configuration ☐Left Head ☒Uni-phantom ☐Right Head
3. SAR Configuration ☐Head ☒Body
   Test Signal Call Mode ☒Test Code ☐Base Station Simulator
4. Test Configuration ☐With Belt Clip ☐Without Belt Clip ☒N/A
5. Tissue Depth is at least 15.0 cm

Note 1: SAR Tested on the Highest output power channel. When the measured channel is 3 dB or more below the limit the remaining channels are not required to be tested per KDB 447498 section 1) e). SAR is not required for 802.11g/HT20/HT40 channels when the maximum average output power is less than ¼ dB higher than that measured in the 802.11b. The testing was conducted on all sides of the antenna. All testing was conducted per KDB 447498, 248227, 616217 and OET Bulletin 65. See the photo in Appendix C and diagram on page 14 for a pictorial of the setup and labeling of the test locations.

Note 2: All measurements were performed with 5 mm gap (Antenna to Flat phantom measurement distance)

Note 3: Number of test channels and SAR test reductions determined based on 447498 D01 v05 October 24 2012

Note 4: Main and Aux. chains have identical power outputs, hence SAR evaluation of Main antenna output is sufficient to represent Aux. antenna output compliance.

Note 6: For 2.4 GHz, measured end power values exceeds the maximum output levels of the production units (including tolerances) declared by the applicant. Scaling measured SAR results are not required

See Appendix B for SAR Test Data Plots.

See Appendix C for SAR Test Setup Photos.

Procedures used to establish test signal

The device was placed into simulated transmit mode using the manufacturer's test codes See data pages for actual procedure used in measurement.

Device test condition

The EUT is a 802.11abgn 2x2 / 802.11ac WLAN + Bluetooth module with external antennas (ACON APP8P-700045). Module dimensions are approximately 30 mm x 30 mm x 5 mm, antenna dimensions are approximately 100 mm x 7 mm x 5 mm. The antenna RF cable is approximately 600 mm long

The EUT was configured via a notebook to transmit at maximum power with desired channel and modes. The module and notebook were positioned with a distance longer than 30 cm from the transmit antenna. The antenna was positioned with all six sides, with 5 mm gap under the phantom.

In order to verify that the device was tested at full power, conducted output power measurements were performed before and after each SAR measurement to confirm the output power unless otherwise noted. If a conducted power deviation of more than 5% occurred, the test was repeated. The power drift of each test is measured at the start of the test and again at the end of the test. The drift percentage is calculated by the formula ((end/start)-1)*100 and rounded to three decimal places. The drift percentage is calculated into the resultant SAR value on the data sheet for each test.

Simultaneous transmission capabilities

The module has a build in Bluetooth transmitter and it is not able to transmit with WIFI simultaneously.

Per KDB Publication 447498 and 616217, Bluetooth SAR was not required since the maximum conducted power of Bluetooth Tx is 1 mW.

Main and Aux. chains have identical power outputs. In normal operation, antennas will be separated each other, hence SAR evaluation of Main antenna output is considered sufficient to show Aux. antenna output compliance.

12. Test equipment list

Manufacturer	Description	Model	Asset #	Cal Due
SAR				
Speag	SAR Probe	EX3DV4	3833	11-Mar-14
Schmid & Partner Engineering AG	Data acquisition Electronics	DAE 4	2661	05-Mar-14
Speag	Phantom	SM 000 T02 EA	2667	N/A
NTS	Body Equivalent Matter	N/A	N/A	N/A
SAR verification				
Speag	DAK 3.5mm Probe	SM DAK 040	2660	13-Jun-13
Speag	SAR Dipole	D2450V2	2654	07-Feb-14
Speag	SAR Dipole	D5GHzV2	2658	01-Feb-14
Agilent	PSG Vector Signal Generator	E8267C	2200	21-Dec-13
SM Electronics	Directional coupler	MC2045	N/A	N/A
Macom	Attenuator (3 dB)	2082-61	N/A	N/A
Mini Circuits	RF Amplifier	ZVE-8G+	N/A	N/A
Rohde & Schwarz	Power Sensor 100 uW - 2 Watts (w/ 20 dB pad, SN B844664/018)	NRV-Z53	1555	26-Feb-14
Rohde & Schwarz	Power Meter	NRVS	1290	18-Dec-13
EUT power				
Agilent	USB Power Sensor	U2001A	2442	17-Dec-13

13. Conclusion

The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the FCC. These measurements are taken to simulate the RF effects exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters subject to the test. The test results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body is a very complex phenomena that depends on the mass, shape, and size of the body; the orientation of the body with respect to the field vectors; and, the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because innumerable factors may interact to determine the specific biological outcome of an exposure to electromagnetic fields, any protection guide shall consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.

14. References

[1] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radio Frequency Radiation, August 1996

[2] ANSI/IEEE C95.1 – 1992, American National Standard Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 300kHz to 100GHz, New York: IEEE, 1992.

[3] ANSI/IEEE C95.3 – 1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave, New York: IEEE, 1992.

[4] Federal Communications Commission, OET Bulletin 65 (Edition 97-01), Supplement C (Edition 01-01), Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, June 2001.

[5] IEEE Standard 1528 – 2003, IEEE Recommended Practice for Determining the Peak-Spatial Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, October 2003.

[6] Industry Canada, RSS – 102e, Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), March 2010.

[7] Health Canada, Safety Code 6, Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3kHz to 300 GHz, 2009.

[8] KDB 450824 D02 Dipole Requirements for SAR System Validation and Verification

[9] KDB 447498 D01 General RF Exposure Guidance v05. Section 5.2.2.2 When the highest reported 1-g SAR is > 0.4 W/kg and ≤ 0.8 W/kg, modules and peripheral transmitters may be approved to operate in multiple host platforms

[10] KDB 248227 SAR Measurement Procedures for 802.11 a/b/g Transmitters

[11] KDB 616217 D01 SAR Evaluation Considerations for Laptop Computers with Antennas Built-in on Display Screens

[12] KDB 616217 D02 Review and Approval Policies for SAR Evaluation of Laptop Computers with Antennas Built-in on Display Screens

[13] KDB 616217 D03 SAR Evaluation considerations for Laptop/Notebook/Netbook and Tablet Computers

Appendix A – Tissue and system validation data and plots

Name : Body 23 deg.C, 2013/04/19, 12:13:24
Date : Body 23 deg.C, 2013/04/19, 12:13:24
Temperature(C) : 23
Probe : DAK_35
Network Analyzer : HP8753X
Notes : 2.4 GHz Body tissue validation May 19, 2013
Measured data

f(MHz)	eps.R	eps.I	sigma(S/m)	loss tangent	refl.R	refl.I
2402	52.64	14.38	1.92	0.27	0.17	-0.74
2407	52.63	14.39	1.93	0.27	0.17	-0.74
2412	52.61	14.39	1.93	0.27	0.17	-0.74
2417	52.58	14.45	1.94	0.27	0.17	-0.74
2422	52.59	14.46	1.95	0.27	0.17	-0.74
2427	52.49	14.46	1.95	0.28	0.17	-0.73
2432	52.51	14.47	1.96	0.28	0.16	-0.73
2437	52.52	14.53	1.97	0.28	0.16	-0.73
2442	52.52	14.51	1.97	0.28	0.16	-0.73
2447	52.47	14.54	1.98	0.28	0.16	-0.73
2452	52.45	14.57	1.99	0.28	0.16	-0.73
2457	52.43	14.54	1.99	0.28	0.16	-0.73
2462	52.48	14.63	2.00	0.28	0.15	-0.73
2467	52.35	14.62	2.01	0.28	0.15	-0.73
2472	52.42	14.62	2.01	0.28	0.15	-0.73

Name : Body 23 deg.C, 2013/04/22, 11:43:51
Date : Body 23 deg.C, 2013/04/22, 11:43:51
Temperature(C) : 23
Probe : DAK_35
Network Analyzer : HP8753X
Notes : 2GHZ body 4-22-2013
Measured data

f(MHz)	eps.R	eps.I	sigma(S/m)	loss tangent	refl.R	refl.I
2407	52.90	14.66	1.96	0.28	0.17	-0.73
2412	52.88	14.69	1.97	0.28	0.16	-0.73
2417	52.88	14.69	1.98	0.28	0.16	-0.73
2422	52.85	14.75	1.99	0.28	0.16	-0.73
2427	52.83	14.73	1.99	0.28	0.16	-0.73
2432	52.78	14.74	1.99	0.28	0.16	-0.73
2437	52.82	14.82	2.01	0.28	0.16	-0.73
2442	52.78	14.81	2.01	0.28	0.16	-0.73
2447	52.77	14.80	2.02	0.28	0.15	-0.73
2452	52.74	14.84	2.02	0.28	0.15	-0.73
2457	52.71	14.88	2.03	0.28	0.15	-0.73
2462	52.76	14.91	2.04	0.28	0.15	-0.73
2467	52.67	14.93	2.05	0.28	0.15	-0.73
2472	52.66	14.93	2.05	0.28	0.15	-0.73

Target data : Body 23 deg.C

f(MHz)	eps.R	eps.I	sigma(S/m)	loss tangent	refl.R	refl.I
2407	52.76	14.15	1.89	0.27	0.17	-0.74
2412	52.75	14.17	1.90	0.27	0.17	-0.74
2417	52.74	14.18	1.91	0.27	0.17	-0.74
2422	52.74	14.20	1.91	0.27	0.17	-0.74
2427	52.73	14.22	1.92	0.27	0.16	-0.74
2432	52.72	14.24	1.93	0.27	0.16	-0.74
2437	52.72	14.26	1.93	0.27	0.16	-0.74
2442	52.71	14.28	1.94	0.27	0.16	-0.74
2447	52.70	14.30	1.95	0.27	0.16	-0.74
2452	52.70	14.31	1.95	0.27	0.16	-0.74
2457	52.69	14.33	1.96	0.27	0.15	-0.74
2462	52.68	14.35	1.97	0.27	0.15	-0.74
2467	52.68	14.37	1.97	0.27	0.15	-0.74
2472	52.67	14.39	1.98	0.27	0.15	-0.74

Name : Body 23.5 deg.C, 2013/04/24, 08:25:06
Date : Body 23.5 deg.C, 2013/04/24, 08:25:06
Temperature(C) : 23.5
Probe : DAK_35
Network Analyzer : HP8753X
Notes : 5 GHz body tissue validation April 24, 2013
Measured data

f(MHz)	eps.R	eps.I	sigma(S/m)	loss tangent	refl.R	refl.I
5160	48.54	18.26	5.24	0.38	-0.36	-0.56
5180	48.43	18.28	5.27	0.38	-0.36	-0.56
5200	48.43	18.31	5.30	0.38	-0.36	-0.55
5220	48.37	18.24	5.30	0.38	-0.37	-0.55
5240	48.41	18.22	5.31	0.38	-0.37	-0.55
5260	48.35	18.27	5.35	0.38	-0.37	-0.55
5280	48.31	18.23	5.35	0.38	-0.37	-0.55
5300	48.32	18.33	5.41	0.38	-0.37	-0.55
5320	48.38	18.34	5.43	0.38	-0.38	-0.55
5340	48.24	18.34	5.45	0.38	-0.38	-0.54
5360	48.23	18.31	5.46	0.38	-0.38	-0.54
5380	48.13	18.36	5.49	0.38	-0.38	-0.54
5400	48.14	18.32	5.50	0.38	-0.38	-0.54
5420	48.07	18.34	5.53	0.38	-0.38	-0.54
5440	48.08	18.37	5.56	0.38	-0.39	-0.54
5460	48.13	18.36	5.58	0.38	-0.39	-0.54
5480	48.05	18.35	5.59	0.38	-0.39	-0.54
5500	48.04	18.42	5.64	0.38	-0.39	-0.53
5520	47.98	18.38	5.64	0.38	-0.39	-0.53
5540	47.96	18.40	5.67	0.38	-0.40	-0.53
5560	47.93	18.38	5.69	0.38	-0.40	-0.53
5580	47.89	18.48	5.74	0.39	-0.40	-0.53
5660	47.80	18.51	5.83	0.39	-0.41	-0.52
5680	47.77	18.51	5.85	0.39	-0.41	-0.52
5700	47.80	18.51	5.87	0.39	-0.41	-0.52
5720	47.72	18.60	5.92	0.39	-0.41	-0.52
5740	47.80	18.53	5.92	0.39	-0.41	-0.52
5760	47.69	18.58	5.95	0.39	-0.41	-0.51
5780	47.69	18.54	5.96	0.39	-0.42	-0.51
5800	47.69	18.56	5.99	0.39	-0.42	-0.51
5820	47.67	18.60	6.02	0.39	-0.42	-0.51

Name : Body 23 deg.C, 2013/04/29, 08:55:19
Date : Body 23 deg.C, 2013/04/29, 08:55:19
Temperature(C) : 23
Probe : DAK_35
Network Analyzer : HP8753X
Notes : 5 GHz body tissue validation April 29 2013
Measured data

f(MHz)	eps.R	eps.I	sigma(S/m)	loss tangent	refl.R	refl.I
5160	48.09	18.47	5.30	0.38	-0.35	-0.56
5180	48.10	18.49	5.33	0.38	-0.36	-0.55
5200	48.10	18.51	5.35	0.38	-0.36	-0.55
5220	48.04	18.54	5.38	0.39	-0.36	-0.55
5240	47.99	18.52	5.40	0.39	-0.36	-0.55
5260	47.92	18.55	5.43	0.39	-0.36	-0.55
5280	47.94	18.64	5.48	0.39	-0.37	-0.55
5300	47.89	18.60	5.48	0.39	-0.37	-0.54
5320	47.88	18.58	5.50	0.39	-0.37	-0.54
5340	47.81	18.62	5.53	0.39	-0.37	-0.54
5360	47.82	18.65	5.56	0.39	-0.37	-0.54
5380	47.75	18.66	5.58	0.39	-0.38	-0.54
5400	47.77	18.64	5.60	0.39	-0.38	-0.54
5420	47.70	18.66	5.63	0.39	-0.38	-0.54
5440	47.70	18.70	5.66	0.39	-0.38	-0.53
5460	47.60	18.72	5.69	0.39	-0.38	-0.53
5480	47.61	18.69	5.70	0.39	-0.39	-0.53
5500	47.55	18.72	5.73	0.39	-0.39	-0.53
5520	47.50	18.76	5.76	0.40	-0.39	-0.53
5540	47.54	18.85	5.81	0.40	-0.39	-0.53
5560	47.44	18.79	5.81	0.40	-0.39	-0.53
5580	47.38	18.88	5.86	0.40	-0.39	-0.52
5660	47.32	18.84	5.93	0.40	-0.40	-0.52
5680	47.28	18.92	5.98	0.40	-0.40	-0.52
5700	47.27	18.97	6.01	0.40	-0.40	-0.51
5720	47.33	18.93	6.02	0.40	-0.41	-0.51
5740	47.22	19.00	6.07	0.40	-0.41	-0.51
5760	47.13	18.99	6.08	0.40	-0.41	-0.51
5780	47.10	19.04	6.12	0.40	-0.41	-0.51
5800	47.13	19.12	6.17	0.41	-0.41	-0.51
5820	47.09	19.05	6.17	0.40	-0.41	-0.51

Name : Body 23 deg.C, 2013/05/01, 08:07:23
Date : Body 23 deg.C, 2013/05/01, 08:07:23
Temperature(C) : 23
Probe : DAK_35
Network Analyzer : HP8753X
Notes : 5 GHz Body tissue verification May 1 2013
Measured data

f(MHz)	eps.R	eps.I	sigma(S/m)	loss tangent	refl.R	refl.I
5160	48.79	18.46	5.30	0.38	-0.36	-0.56
5180	48.77	18.49	5.33	0.38	-0.37	-0.55
5200	48.76	18.48	5.35	0.38	-0.37	-0.55
5220	48.67	18.41	5.35	0.38	-0.37	-0.55
5240	48.60	18.52	5.40	0.38	-0.37	-0.55
5260	48.60	18.53	5.42	0.38	-0.37	-0.55
5280	48.60	18.53	5.44	0.38	-0.38	-0.55
5300	48.56	18.63	5.49	0.38	-0.38	-0.54
5320	48.50	18.61	5.51	0.38	-0.38	-0.54
5340	48.51	18.61	5.53	0.38	-0.38	-0.54
5360	48.43	18.58	5.54	0.38	-0.38	-0.54
5380	48.37	18.57	5.56	0.38	-0.38	-0.54
5400	48.37	18.65	5.60	0.39	-0.39	-0.54
5420	48.34	18.76	5.66	0.39	-0.39	-0.53
5440	48.34	18.68	5.65	0.39	-0.39	-0.53
5460	48.32	18.69	5.68	0.39	-0.39	-0.53
5480	48.25	18.72	5.71	0.39	-0.39	-0.53
5500	48.17	18.63	5.70	0.39	-0.39	-0.53
5520	48.11	18.76	5.76	0.39	-0.40	-0.53
5540	48.14	18.77	5.78	0.39	-0.40	-0.53
5560	48.13	18.80	5.82	0.39	-0.40	-0.52
5580	48.10	18.78	5.83	0.39	-0.40	-0.52
5660	47.96	18.90	5.95	0.39	-0.41	-0.52
5680	47.97	18.98	6.00	0.40	-0.41	-0.51
5700	47.93	18.91	6.00	0.39	-0.41	-0.51
5720	47.93	18.98	6.04	0.40	-0.41	-0.51
5740	47.82	18.98	6.06	0.40	-0.41	-0.51
5760	47.77	19.07	6.11	0.40	-0.41	-0.51
5780	47.72	19.07	6.13	0.40	-0.42	-0.51
5800	47.77	19.10	6.16	0.40	-0.42	-0.50
5820	47.76	19.08	6.18	0.40	-0.42	-0.50

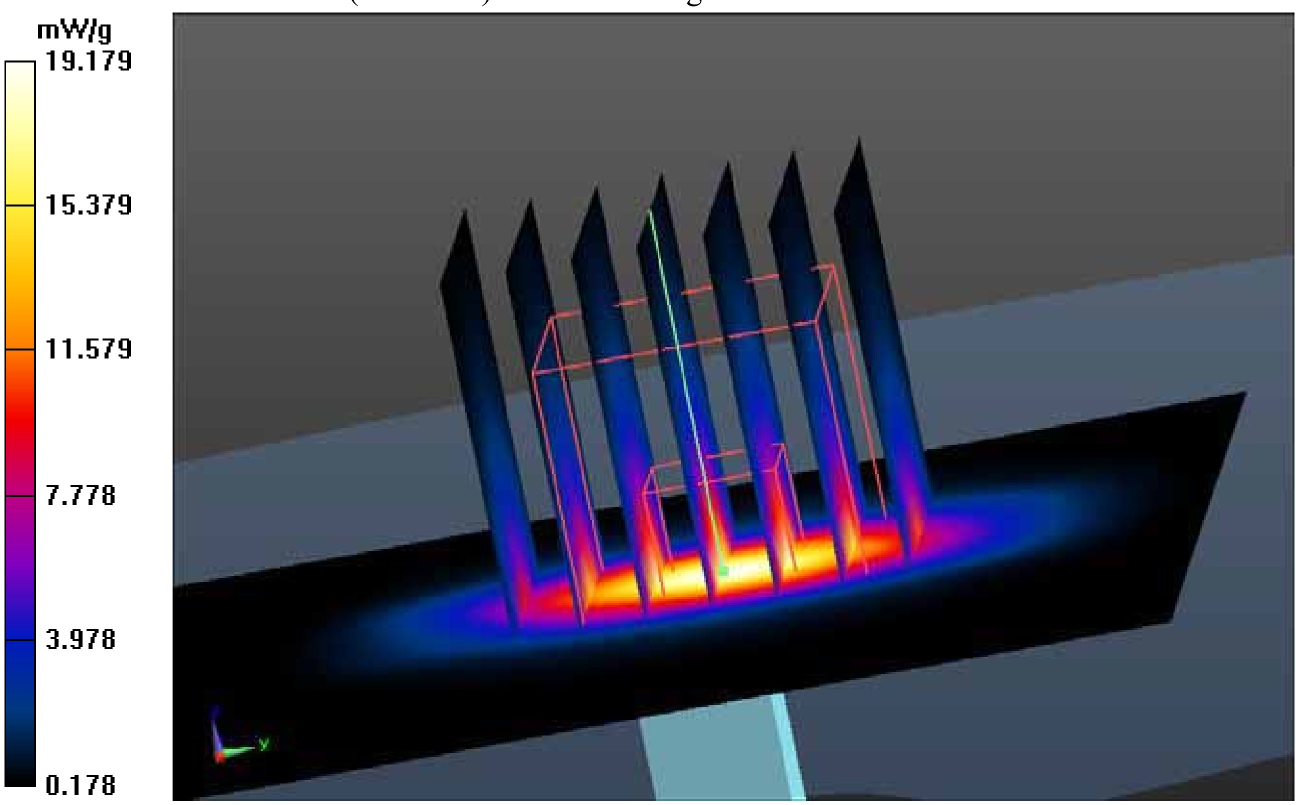
Target data : Body 23 deg.C

f(MHz)	eps.R	eps.I	sigma(S/m)	loss tangent	refl.R	refl.I
5160	49.09	18.50	5.31	0.38	-0.37	-0.55
5180	49.06	18.50	5.33	0.38	-0.37	-0.55
5200	49.03	18.51	5.35	0.38	-0.37	-0.55
5220	49.01	18.51	5.38	0.38	-0.37	-0.55
5240	48.98	18.52	5.40	0.38	-0.38	-0.55
5260	48.95	18.52	5.42	0.38	-0.38	-0.55
5280	48.92	18.53	5.44	0.38	-0.38	-0.55
5300	48.90	18.53	5.46	0.38	-0.38	-0.54
5320	48.87	18.54	5.49	0.38	-0.38	-0.54
5340	48.84	18.54	5.51	0.38	-0.39	-0.54
5360	48.81	18.55	5.53	0.38	-0.39	-0.54
5380	48.79	18.55	5.55	0.38	-0.39	-0.54
5400	48.76	18.55	5.57	0.38	-0.39	-0.54
5420	48.73	18.56	5.60	0.38	-0.39	-0.54
5440	48.70	18.56	5.62	0.38	-0.39	-0.53
5460	48.67	18.56	5.64	0.38	-0.40	-0.53
5480	48.65	18.57	5.66	0.38	-0.40	-0.53
5500	48.62	18.57	5.68	0.38	-0.40	-0.53
5520	48.59	18.57	5.70	0.38	-0.40	-0.53
5540	48.56	18.58	5.73	0.38	-0.40	-0.53
5560	48.54	18.58	5.75	0.38	-0.40	-0.53
5580	48.51	18.58	5.77	0.38	-0.41	-0.52
5600	48.48	18.58	5.79	0.38	-0.41	-0.52
5620	48.45	18.58	5.81	0.38	-0.41	-0.52
5640	48.42	18.59	5.83	0.38	-0.41	-0.52
5660	48.40	18.59	5.85	0.38	-0.41	-0.52
5680	48.37	18.59	5.87	0.38	-0.41	-0.52
5700	48.34	18.59	5.90	0.38	-0.42	-0.52
5720	48.31	18.59	5.92	0.38	-0.42	-0.52
5740	48.28	18.59	5.94	0.39	-0.42	-0.51
5760	48.26	18.59	5.96	0.39	-0.42	-0.51
5780	48.23	18.59	5.98	0.39	-0.42	-0.51
5800	48.20	18.60	6.00	0.39	-0.42	-0.51

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:881
Procedure Name: 2450 MHz Body Validation
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2450 MHz; $\sigma = 1.984$ mho/m; $\varepsilon_r = 52.457$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Test Date: 4/19/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(6.69, 6.69, 6.69); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

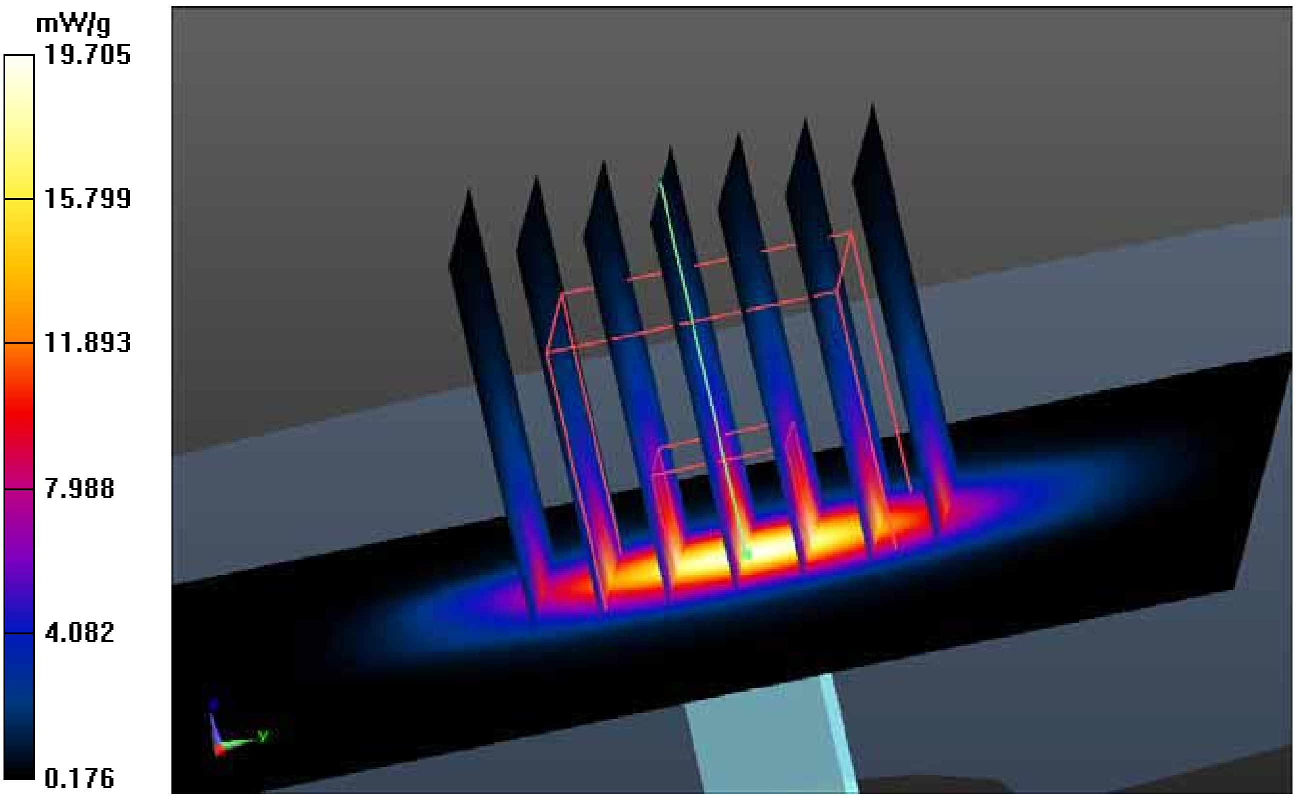
2450 MHz Body Validation/2450 MHz Body Validation/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 19.128 mW/g
2450 MHz Body Validation/2450 MHz Body Validation/Zoom Scan (7x7x8)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=4mm
Reference Value = 80.060 V/m; Power Drift = 0.12 dB
Peak SAR (extrapolated) = 25.9900
SAR(1 g) = 12.7 mW/g; SAR(10 g) = 5.92 mW/g
Maximum value of SAR (measured) = 19.179 mW/g



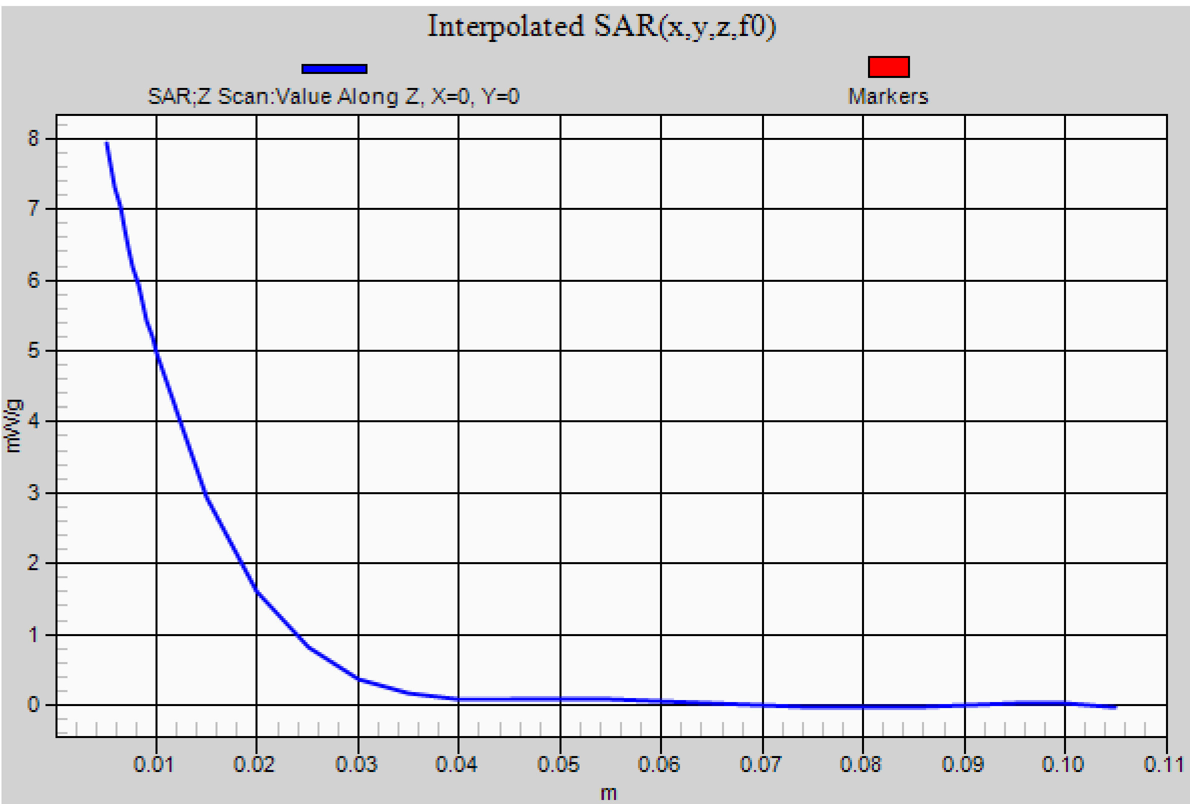
DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:881
Procedure Name: 2450 MHz Body Validation
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2450 MHz; σ = 2.021 mho/m; ε_r = 52.755; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/22/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(6.69, 6.69, 6.69); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

2450 MHz Body Validation/2450 MHz Body Validation/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 19.734 mW/g
2450 MHz Body Validation/2450 MHz Body Validation/Zoom Scan (7x7x8)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=4mm
Reference Value = 81.226 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 26.5820
SAR(1 g) = 13 mW/g; SAR(10 g) = 6.01 mW/g
Maximum value of SAR (measured) = 19.705 mW/g



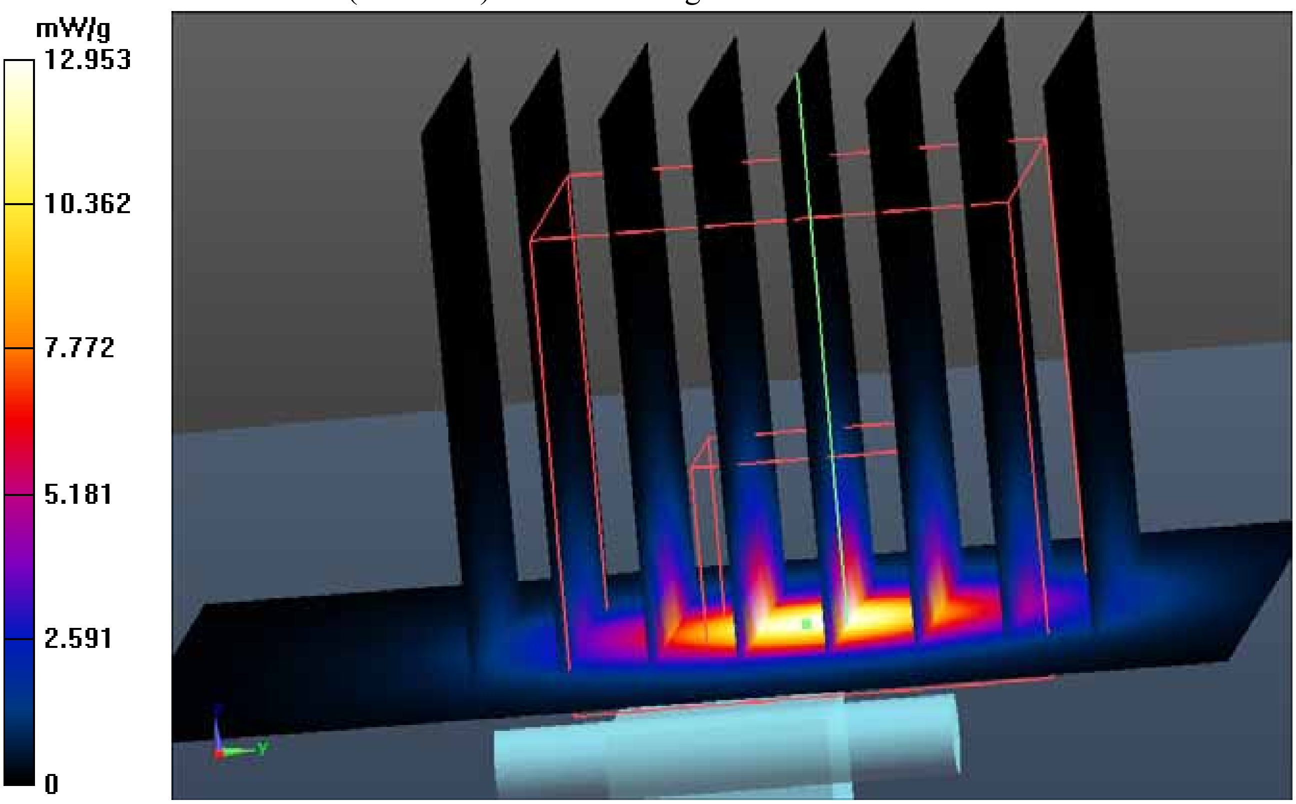
DUT: Dipole 2450 MHz D2450V2; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: MSL2450; Medium parameters used (interpolated): f = 2450 MHz; σ = 2.021 mho/m; ε_r = 52.755; ρ = 1000 kg/m^3
Phantom section: Flat Section
Date: 4/22/2013
Probe: EX3DV4 - SN3833; ConvF(6.69, 6.69, 6.69); Calibrated: 3/11/2013
Sensor-Surface: 0mm (Fix Surface)
Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
Phantom: SAM 1; Type: SAM Twin Phantom
Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)
2450 MHz Body Validation/2450 MHz Body Validation/Z Scan (1x1x31): Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (interpolated) = 7.948 mW/g



DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119
Procedure Name: 5200 MHz Body Validation
Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; σ = 5.298 mho/m; ε_r = 48.433; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/24/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.25, 4.25, 4.25); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

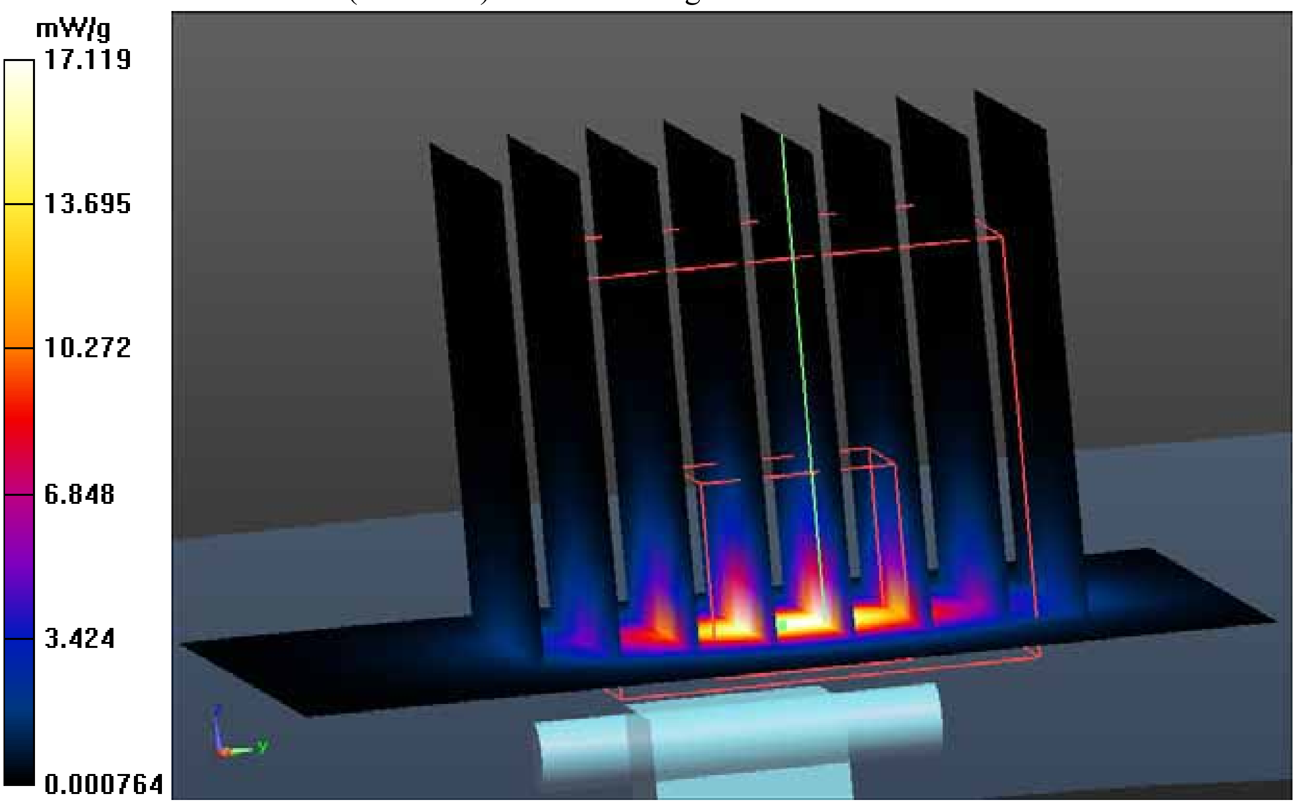
5200 MHz Body Validation/5200 MHz Body Validation/Area Scan (51x51x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 12.893 mW/g
5200 MHz Body Validation/5200 MHz Body Validation/Zoom Scan (8x8x11)/Cube 0:
Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 33.374 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 28.8480
SAR(1 g) = 6.66 mW/g; SAR(10 g) = 1.9 mW/g
Maximum value of SAR (measured) = 12.953 mW/g



DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119
Procedure Name: 5500 MHz Body Validation
Communication System: CW; Frequency: 5500 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5500 MHz; σ = 5.636 mho/m; ε_r = 48.038; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/24/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.57, 3.57, 3.57); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

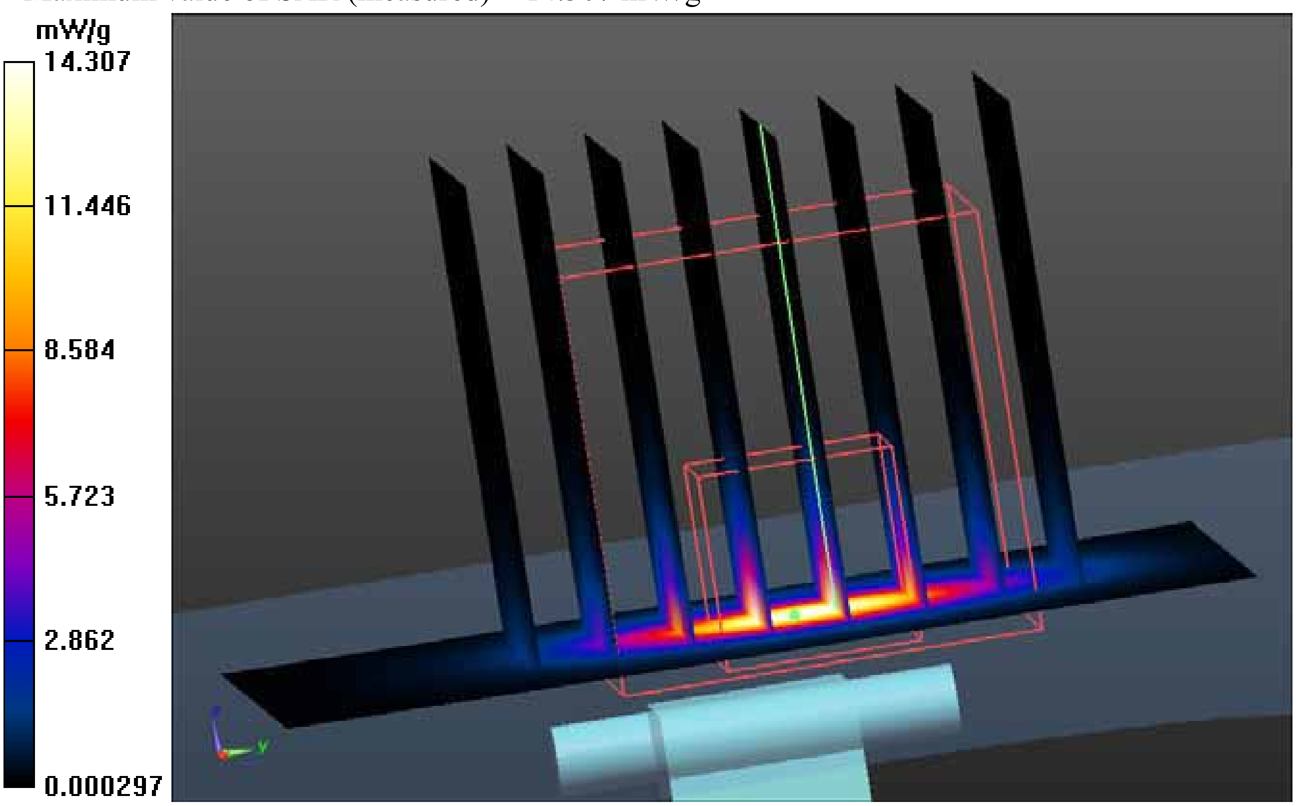
5500 MHz Body Validation/5500 MHz Body Validation/Area Scan (51x51x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 17.524 mW/g
5500 MHz Body Validation/5500 MHz Body Validation/Zoom Scan (8x8x11)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 37.781 V/m; Power Drift = 0.16 dB
Peak SAR (extrapolated) = 37.8160
SAR(1 g) = 8.61 mW/g; SAR(10 g) = 2.42 mW/g
Maximum value of SAR (measured) = 17.119 mW/g



DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119
Procedure Name: 5800 MHz Body Validation
Communication System: CW; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5800 MHz; σ = 5.99 mho/m; ε_r = 47.689; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/24/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

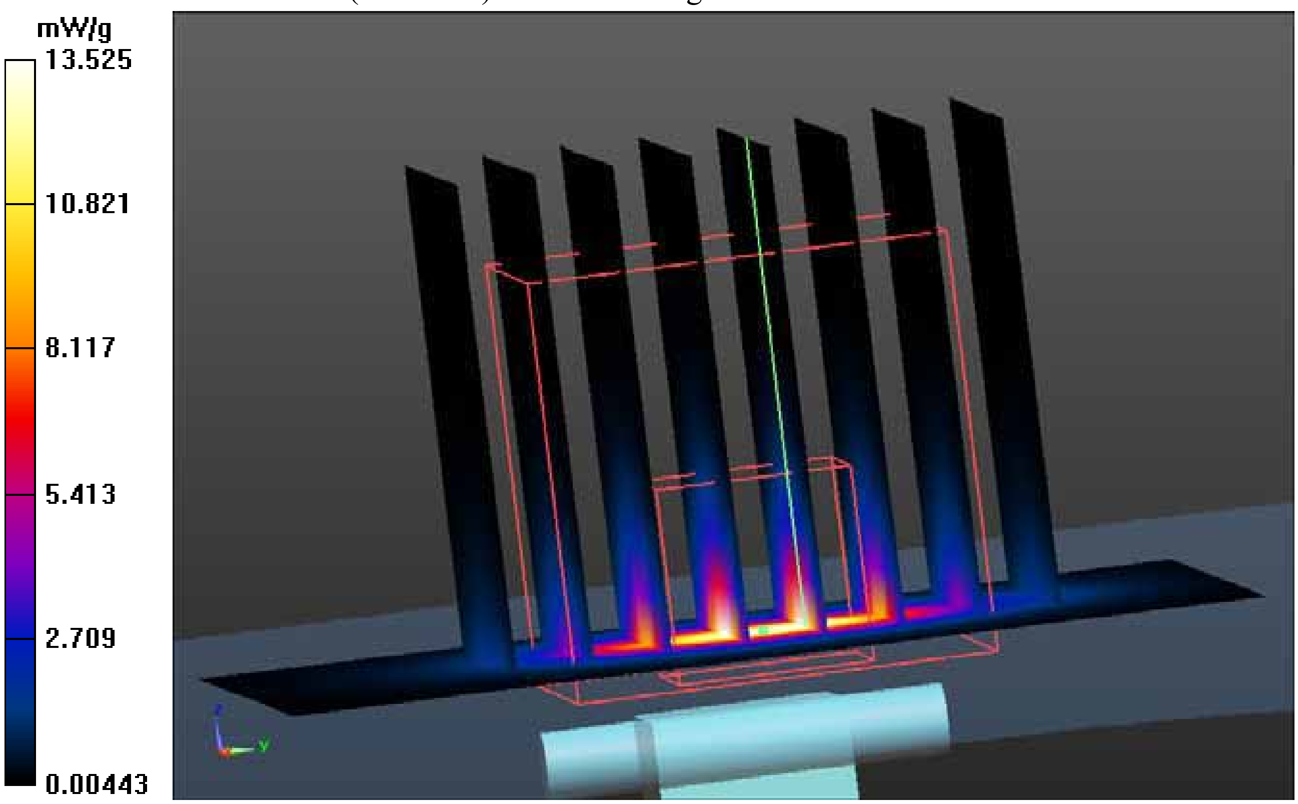
5800 MHz Body Validation/5800 MHz Body Validation/Area Scan (51x51x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 14.794 mW/g
5800 MHz Body Validation/5800 MHz Body Validation/Zoom Scan (8x8x11)/Cube 0:
Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 33.309 V/m; Power Drift = 0.13 dB
Peak SAR (extrapolated) = 31.2190
SAR(1 g) = 7.12 mW/g; SAR(10 g) = 2.01 mW/g
Maximum value of SAR (measured) = 14.307 mW/g



DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119
Procedure Name: 5200 MHz Body Validation
Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; σ = 5.355 mho/m; ε_r = 48.103; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/29/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.25, 4.25, 4.25); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

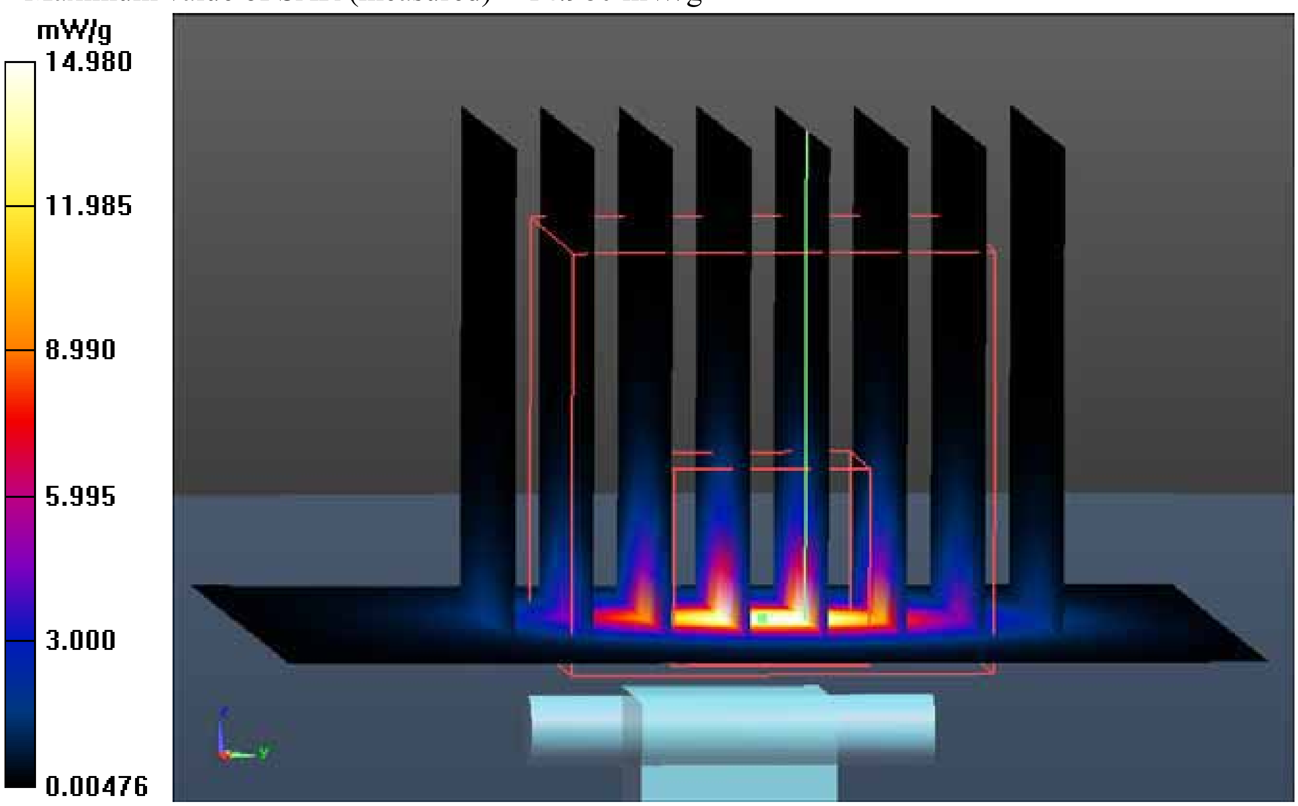
5200 MHz Body Validation/5200 MHz Body Validation/Area Scan (51x51x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 14.242 mW/g
5200 MHz Body Validation/5200 MHz Body Validation/Zoom Scan (8x8x11)/Cube 0:
Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 34.404 V/m; Power Drift = 0.24 dB
Peak SAR (extrapolated) = 29.8120
SAR(1 g) = 7.05 mW/g; SAR(10 g) = 2 mW/g
Maximum value of SAR (measured) = 13.525 mW/g



DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119
Procedure Name: 5500 MHz Body Validation
Communication System: CW; Frequency: 5500 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5500 MHz; σ = 5.728 mho/m; ε_r = 47.547; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/29/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.57, 3.57, 3.57); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

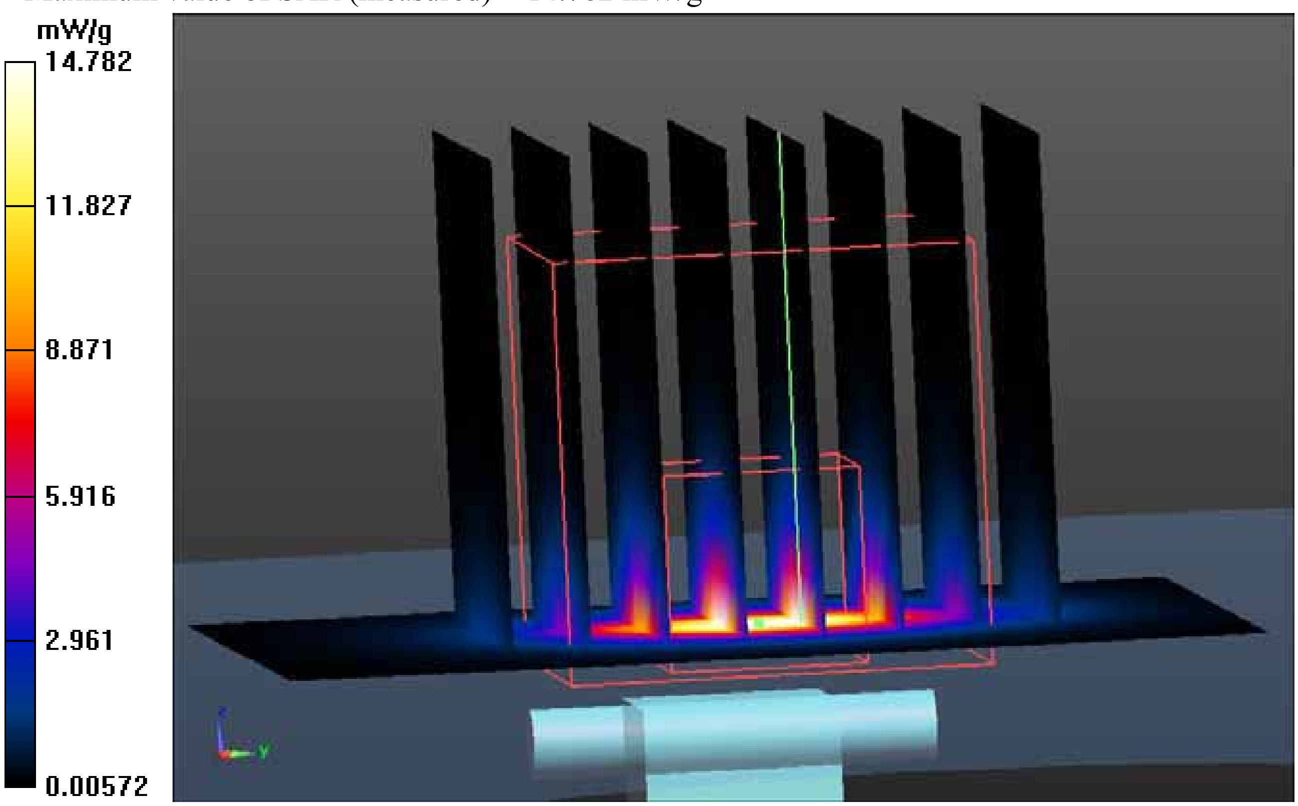
5500 MHz Body Validation/5500 MHz Body Validation/Area Scan (51x51x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 15.952 mW/g
5500 MHz Body Validation/5500 MHz Body Validation/Zoom Scan (8x8x11)/Cube 0:
Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 34.625 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 32.5030
SAR(1 g) = 7.58 mW/g; SAR(10 g) = 2.12 mW/g
Maximum value of SAR (measured) = 14.980 mW/g



DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119
Procedure Name: 5800 MHz Body Validation
Communication System: CW; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5800 MHz; σ = 6.168 mho/m; ε_r = 47.128; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/29/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

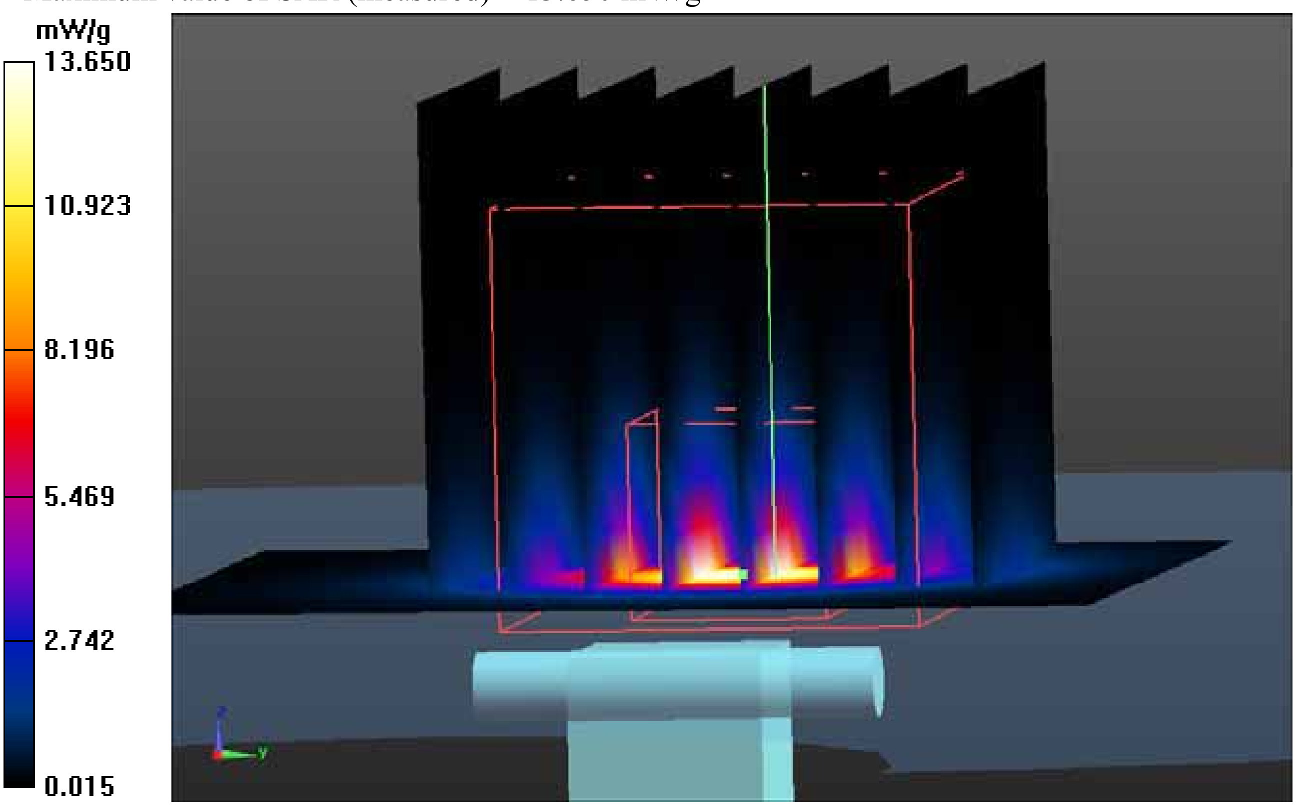
5800 MHz Body Validation/5800 MHz Body Validation/Area Scan (51x51x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 15.847 mW/g
5800 MHz Body Validation/5800 MHz Body Validation/Zoom Scan (8x8x11)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 33.218 V/m; Power Drift = 0.12 dB
Peak SAR (extrapolated) = 31.6300
SAR(1 g) = 7.44 mW/g; SAR(10 g) = 2.09 mW/g
Maximum value of SAR (measured) = 14.782 mW/g



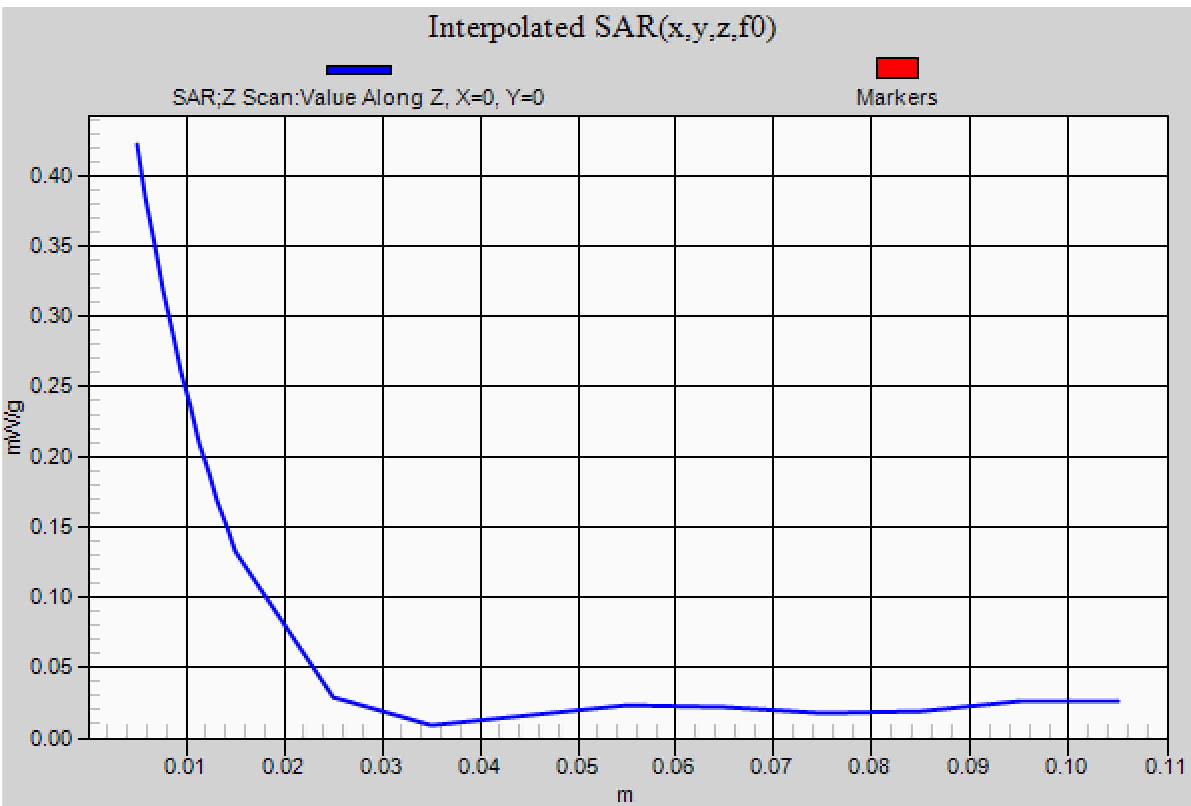
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119
Procedure Name: 5200 MHz Body Validation
Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5200 MHz; σ = 5.347 mho/m; ε_r = 48.761; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.25, 4.25, 4.25); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

5200 MHz Body Validation/5200 MHz Body Validation/Area Scan (51x51x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 14.029 mW/g
5200 MHz Body Validation/5200 MHz Body Validation/Zoom Scan (8x8x11)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 35.617 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 29.9560
SAR(1 g) = 7.06 mW/g; SAR(10 g) = 2.01 mW/g
Maximum value of SAR (measured) = 13.650 mW/g



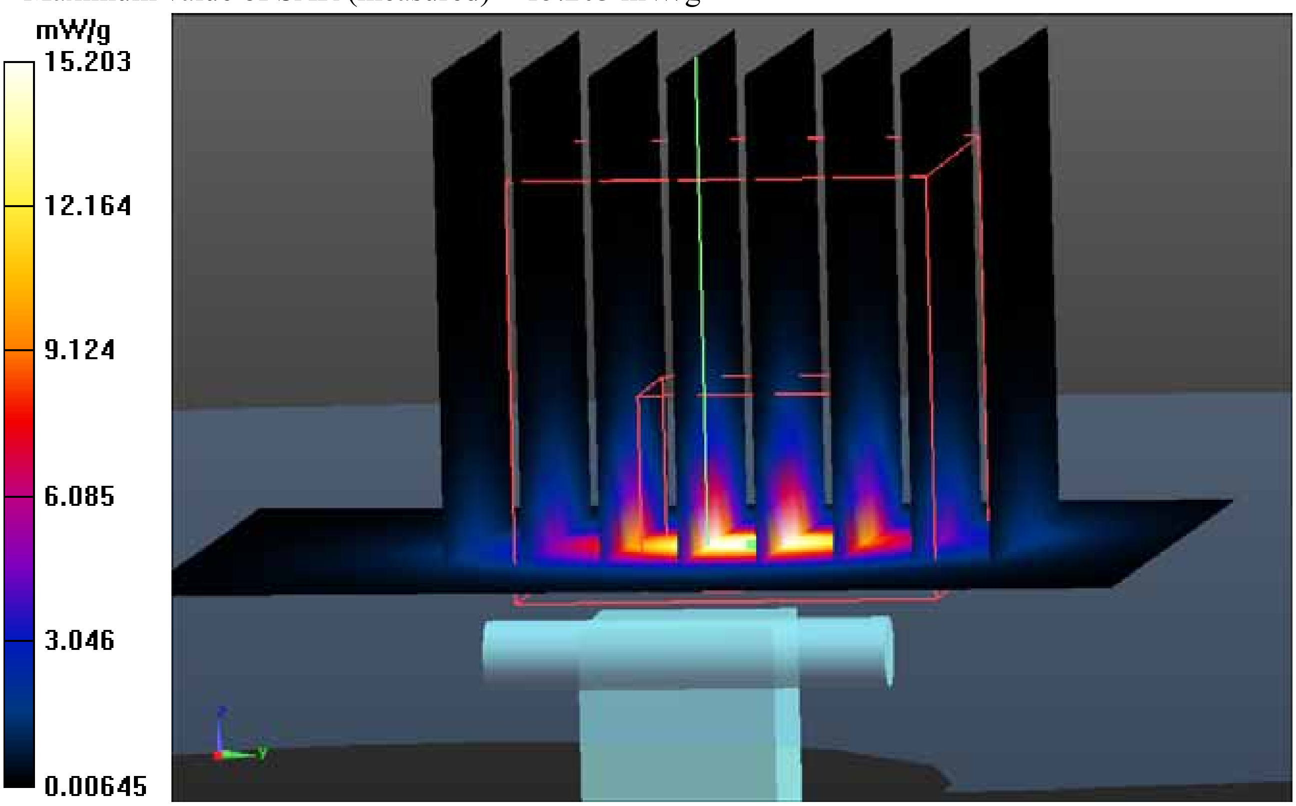
DUT: Dipole D5GHzV2; Frequency: 5200 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz; Medium parameters used: f = 5200 MHz; σ = 5.347 mho/m; ε_r = 48.761; ρ = 1000 kg/m^3
Phantom section: Flat Section
Date: 5/1/2013
Probe: EX3DV4 - SN3833; ConvF(4.25, 4.25, 4.25); Calibrated: 3/11/2013
Sensor-Surface: 0mm (Fix Surface)
Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
Phantom: SAM 1; Type: SAM Twin Phantom
Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)
5200 MHz Body Validation/5200 MHz Body Validation/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=10mm
Maximum value of SAR (interpolated) = 0.422 mW/g



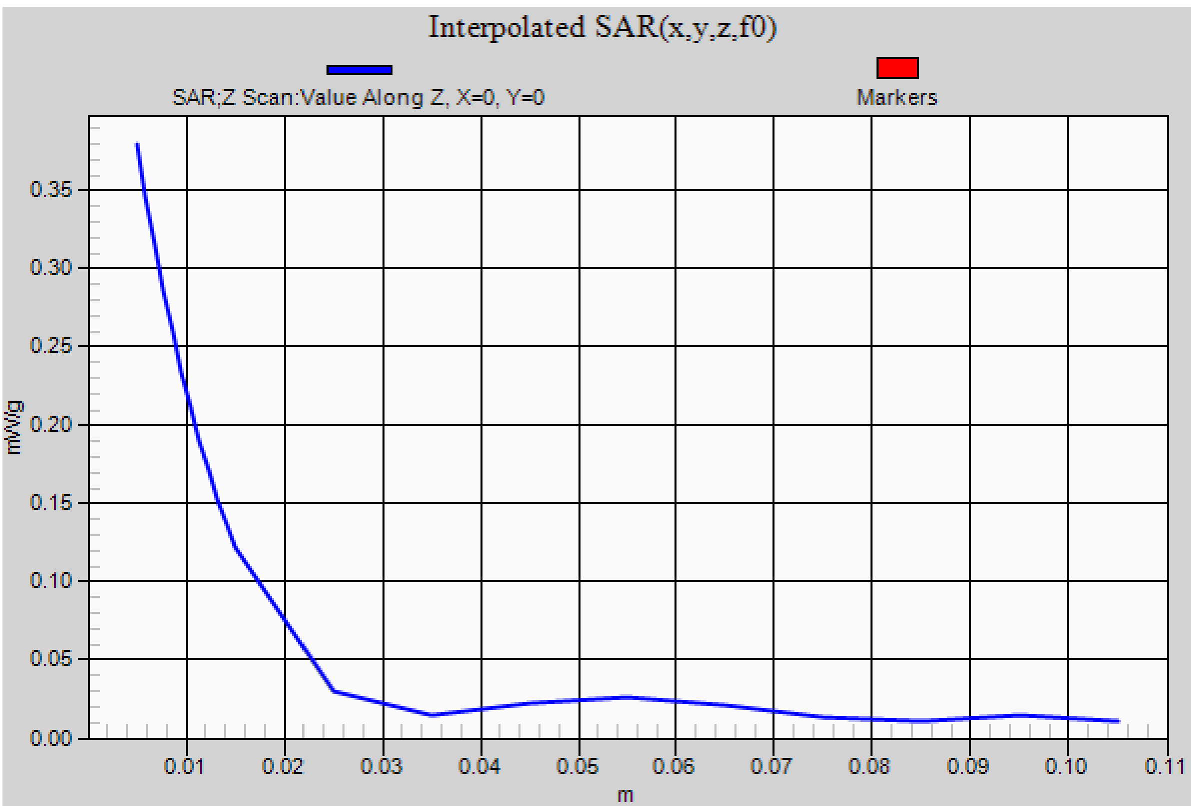
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119
Procedure Name: 5500 MHz Body Validation
Communication System: CW; Frequency: 5500 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5500 MHz; σ = 5.701 mho/m; ε_r = 48.167; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.57, 3.57, 3.57); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

5500 MHz Body Validation/5500 MHz Body Validation/Area Scan (51x51x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 15.901 mW/g
5500 MHz Body Validation/5500 MHz Body Validation/Zoom Scan (8x8x11)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 35.795 V/m; Power Drift = 0.16 dB
Peak SAR (extrapolated) = 33.2170
SAR(1 g) = 7.75 mW/g; SAR(10 g) = 2.17 mW/g
Maximum value of SAR (measured) = 15.203 mW/g



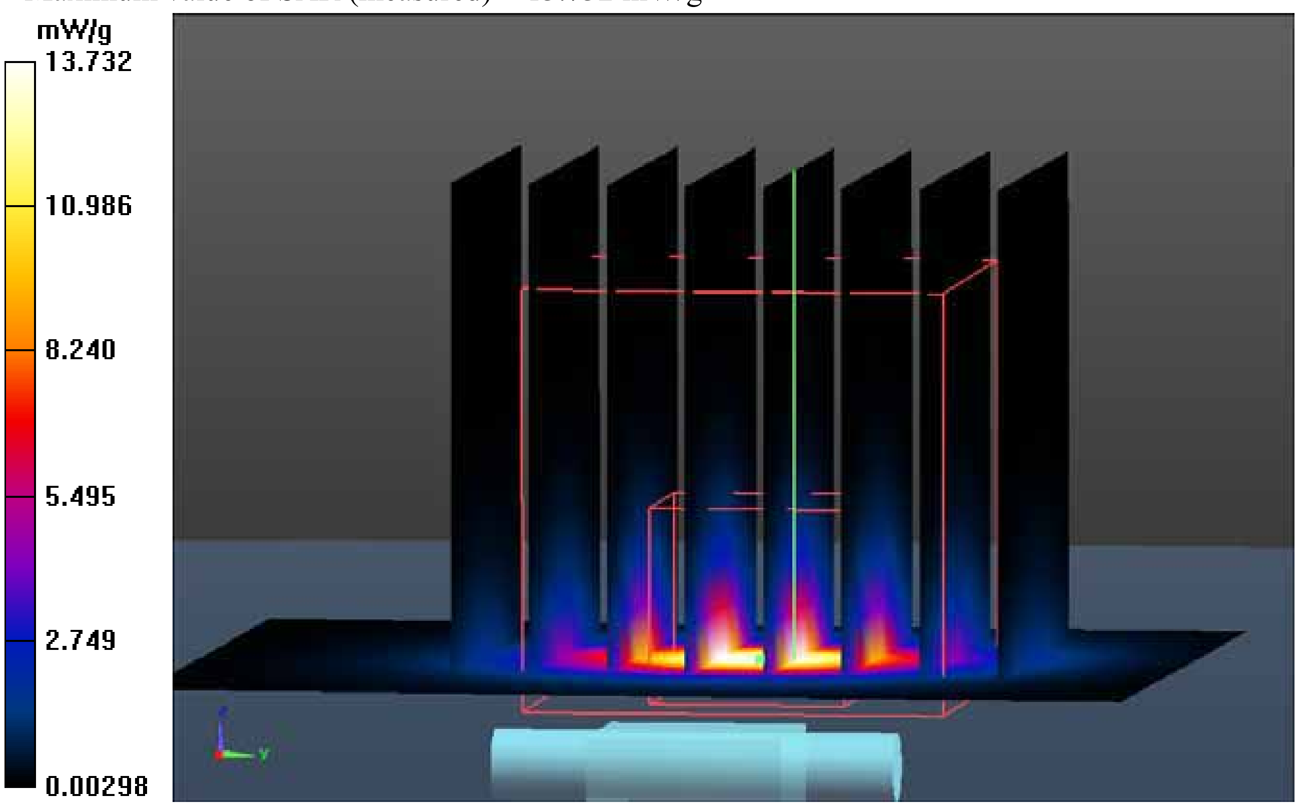
DUT: Dipole D5GHzV2; Frequency: 5500 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz; Medium parameters used: f = 5500 MHz; σ = 5.701 mho/m; ε_r = 48.167; ρ = 1000 kg/m^3
Phantom section: Flat Section
Date: 5/1/2013
Probe: EX3DV4 - SN3833; ConvF(3.57, 3.57, 3.57); Calibrated: 3/11/2013
Sensor-Surface: 0mm (Fix Surface)
Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
Phantom: SAM 1; Type: SAM Twin Phantom
Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)
5500 MHz Body Validation/5500 MHz Body Validation/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=10mm
Maximum value of SAR (interpolated) = 0.380 mW/g



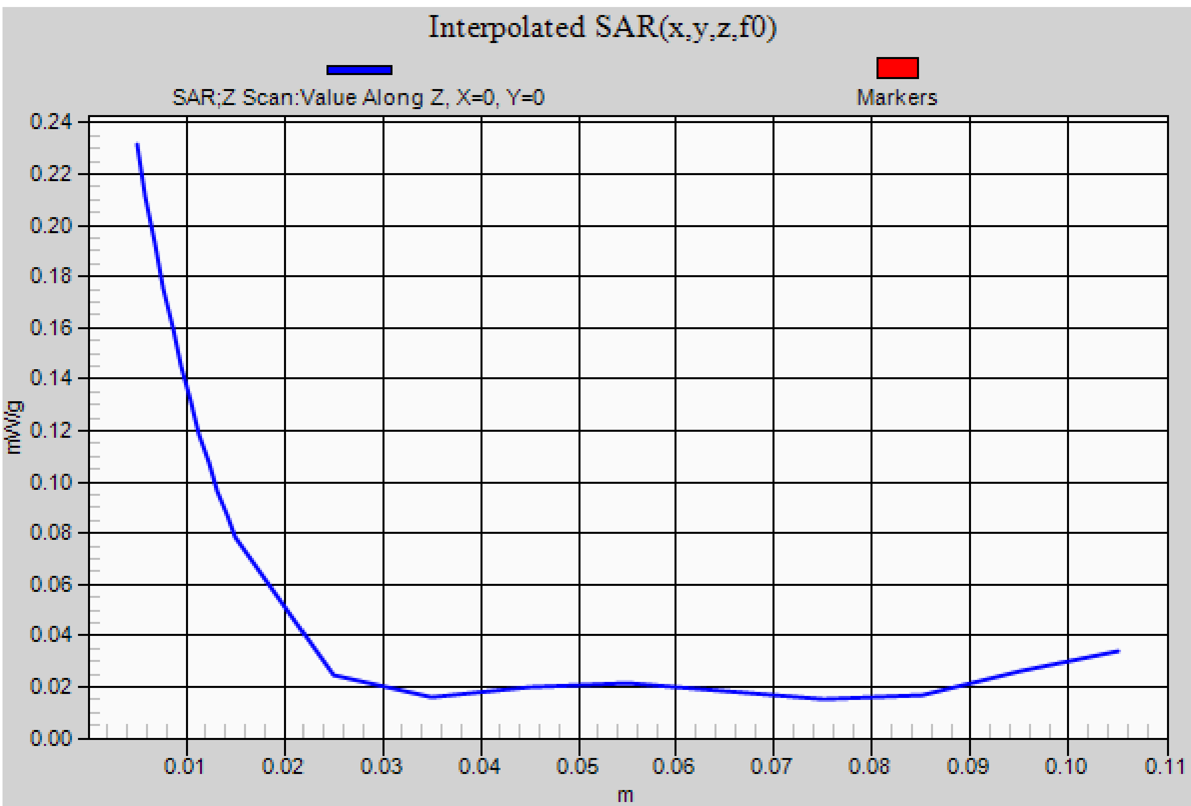
DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119
Procedure Name: 5800 MHz Body Validation
Communication System: CW; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5800 MHz; σ = 6.163 mho/m; ε_r = 47.773; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

5800 MHz Body Validation/5800 MHz Body Validation/Area Scan (51x51x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 14.817 mW/g
5800 MHz Body Validation/5800 MHz Body Validation/Zoom Scan (8x8x11)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2.5mm
Reference Value = 34.434 V/m; Power Drift = -0.13 dB
Peak SAR (extrapolated) = 29.8340
SAR(1 g) = 7 mW/g; SAR(10 g) = 1.97 mW/g
Maximum value of SAR (measured) = 13.732 mW/g



DUT: Dipole D5GHzV2; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium: MSL 3-6 GHz; Medium parameters used: f = 5800 MHz; σ = 6.163 mho/m; ε_r = 47.773; ρ = 1000 kg/m^3
Phantom section: Flat Section
Date: 5/1/2013
Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
Sensor-Surface: 0mm (Fix Surface)
Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
Phantom: SAM 1; Type: SAM Twin Phantom
Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)
5800 MHz Body Validation/5800 MHz Body Validation/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=10mm
Maximum value of SAR (interpolated) = 0.231 mW/g

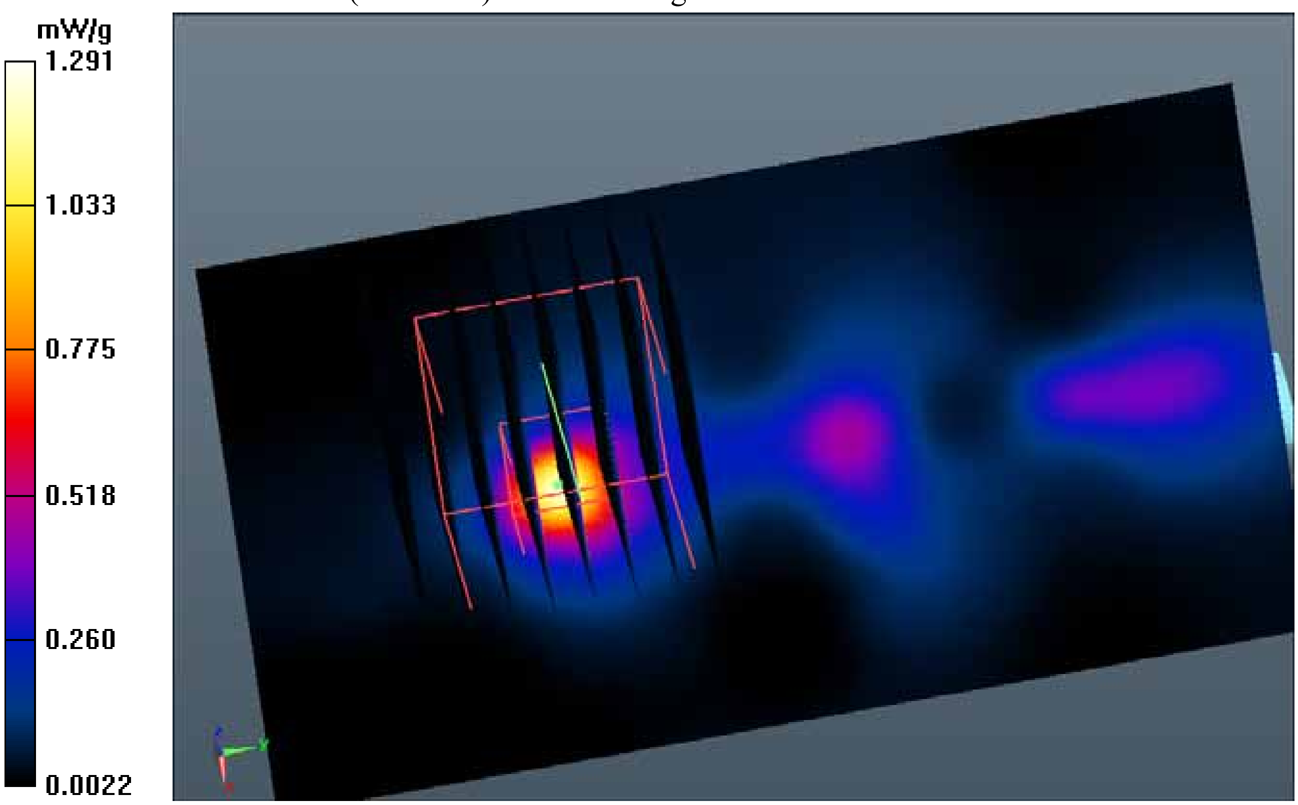


Appendix B – SAR test data plots

DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Left
Communication System: 802.11a - 6 Mbps; Frequency: 5180 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5180 MHz; $\sigma = 5.327$ mho/m; $\varepsilon_r = 48.095$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Test Date: 4/29/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.25, 4.25, 4.25); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

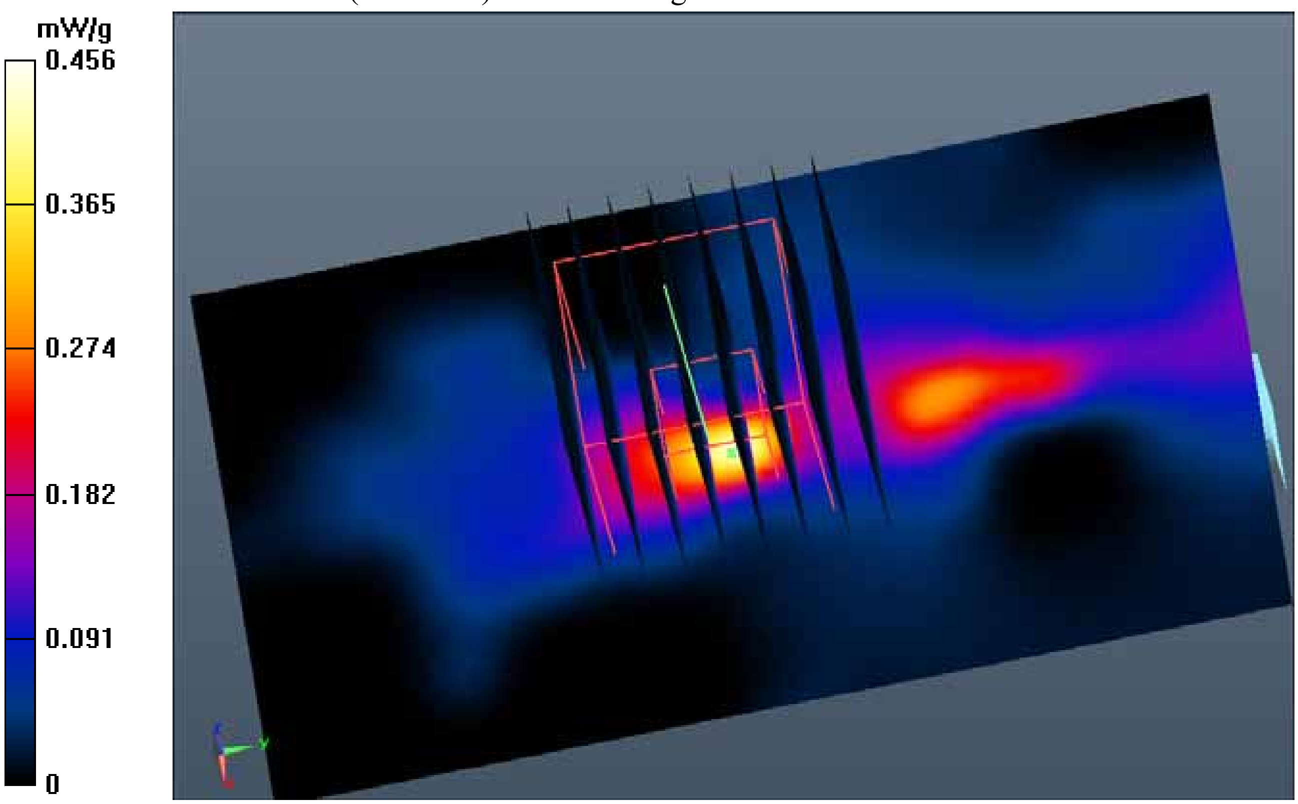
BCM943228HMB/5 mm Left/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.240 mW/g
BCM943228HMB/5 mm Left/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.444 V/m; Power Drift = -0.14 dB
Peak SAR (extrapolated) = 3.0820
SAR(1 g) = 0.567 mW/g; SAR(10 g) = 0.125 mW/g
Maximum value of SAR (measured) = 1.291 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Right
Communication System: 802.11a - 6 Mbps; Frequency: 5180 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5180 MHz; σ = 5.268 mho/m; ε_r = 48.426; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/24/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.25, 4.25, 4.25); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

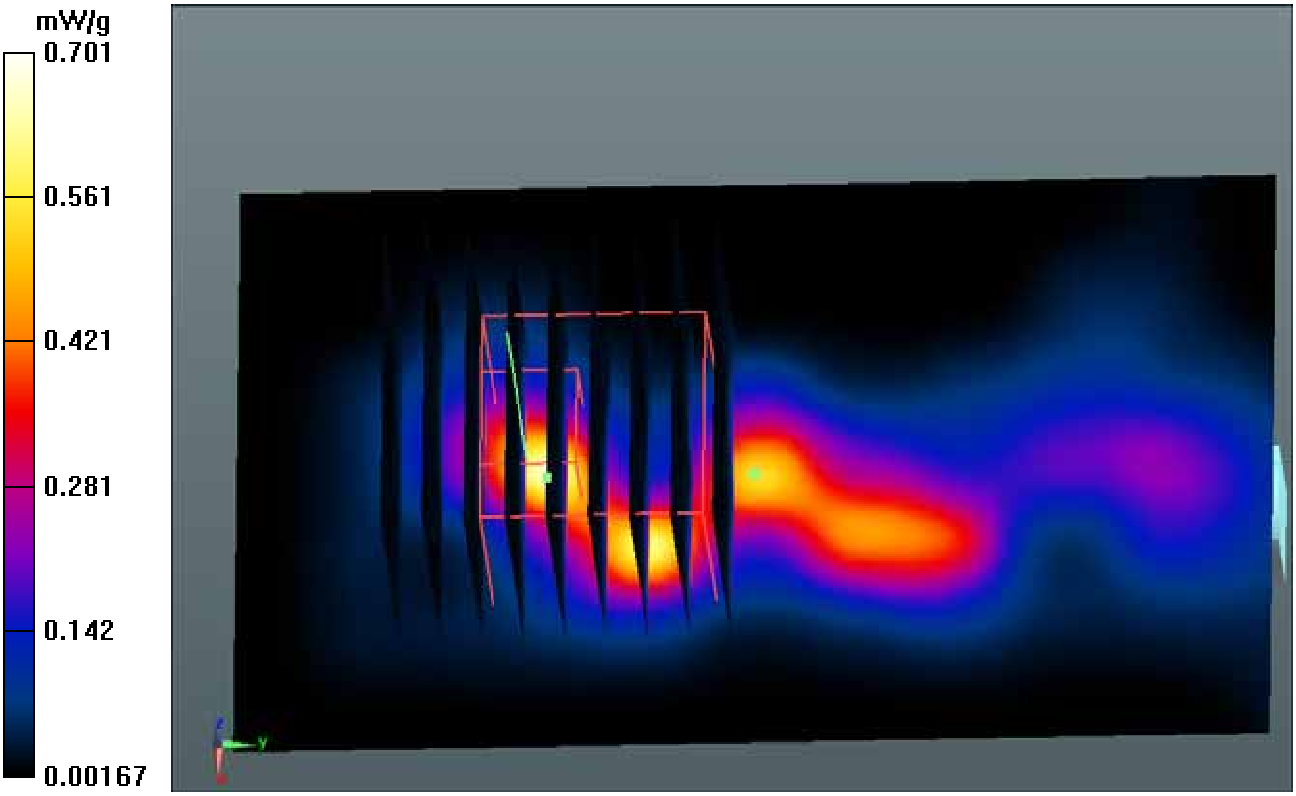
BCM943228HMB/5 mm Right/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.427 mW/g
BCM943228HMB/5 mm Right/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 6.419 V/m; Power Drift = 0.22 dB
Peak SAR (extrapolated) = 0.8330
SAR(1 g) = 0.185 mW/g; SAR(10 g) = 0.048 mW/g
Maximum value of SAR (measured) = 0.456 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Front
Communication System: 802.11a - 6 Mbps; Frequency: 5180 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5180 MHz; σ = 5.268 mho/m; ε_r = 48.426; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/24/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.25, 4.25, 4.25); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

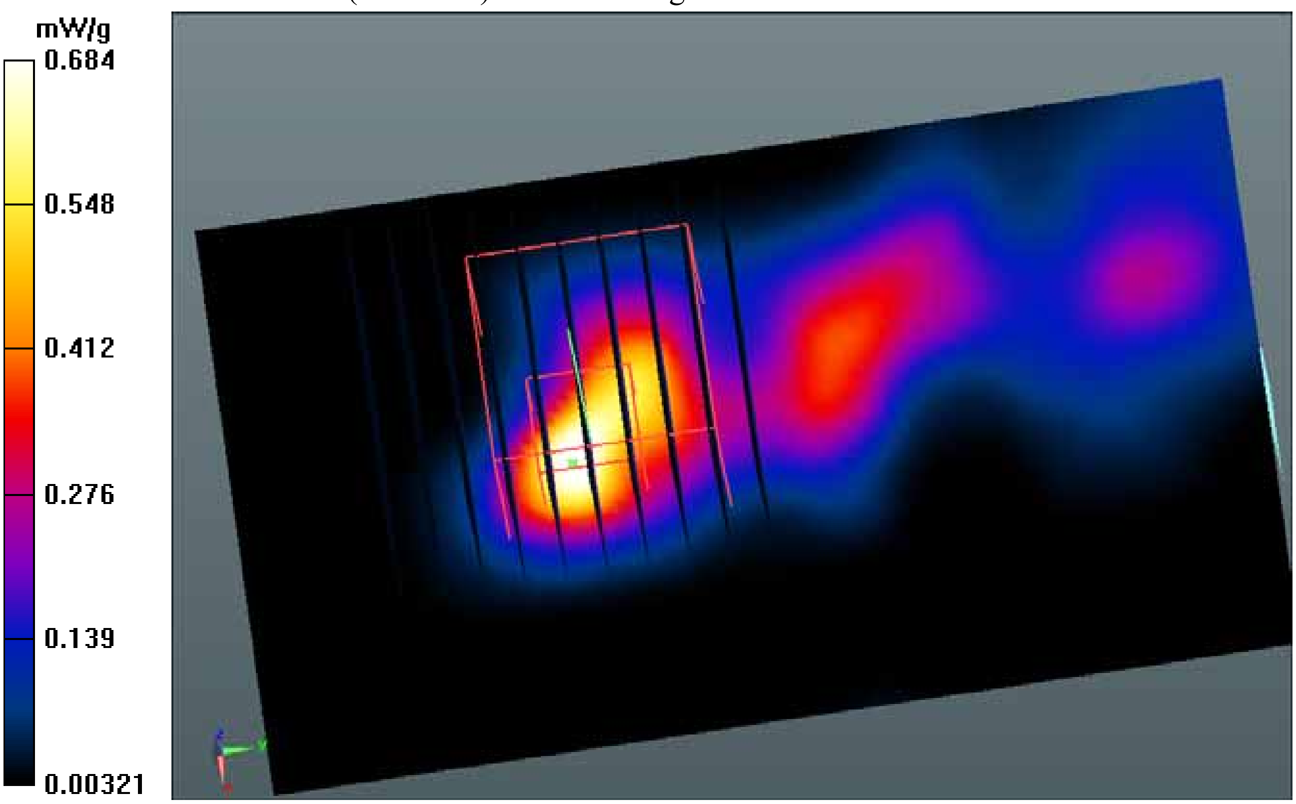
BCM943228HMB/5 mm Front/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.665 mW/g
BCM943228HMB/5 mm Front/Zoom Scan (9x9x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 7.393 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 1.7320
SAR(1 g) = 0.300 mW/g; SAR(10 g) = 0.090 mW/g
Maximum value of SAR (measured) = 0.701 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Back
Communication System: 802.11a - 6 Mbps; Frequency: 5180 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5180 MHz; σ = 5.327 mho/m; ε_r = 48.766; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.25, 4.25, 4.25); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

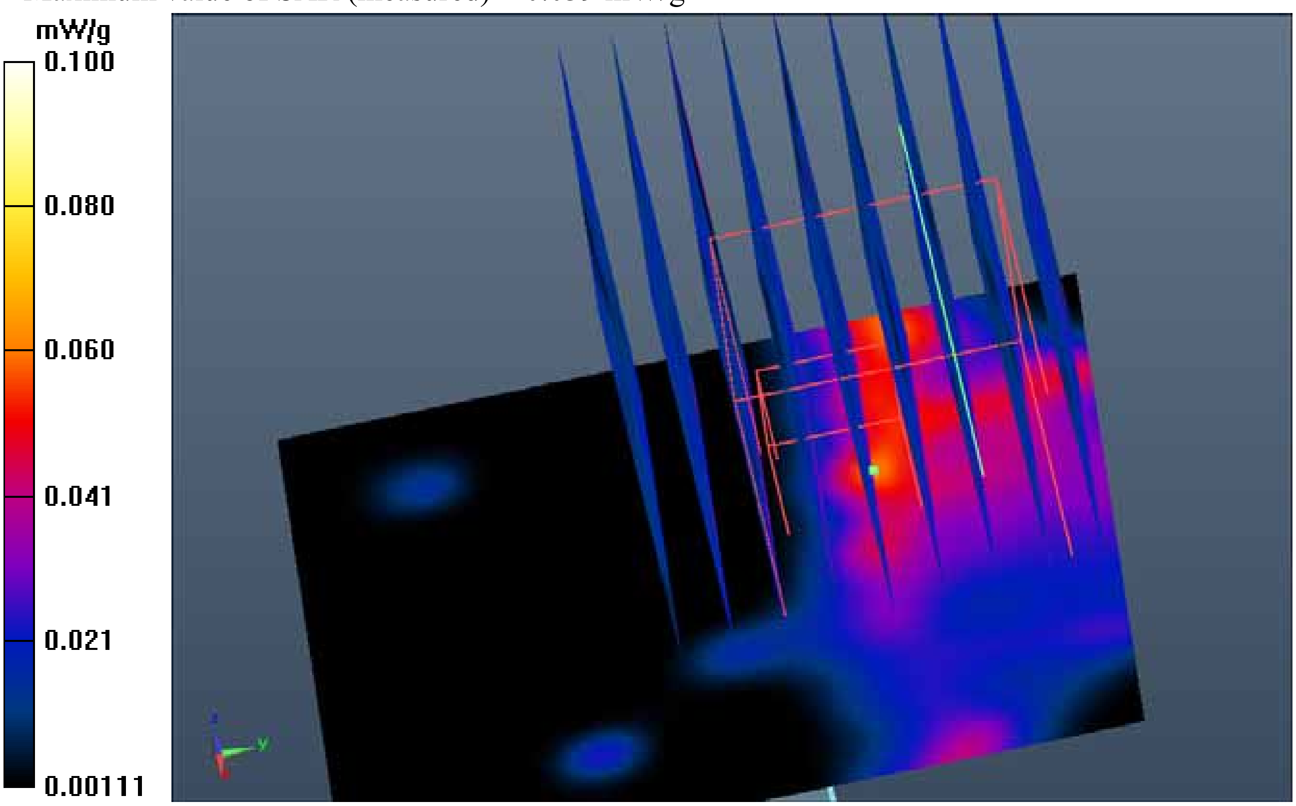
BCM943228HMB/5 mm Back/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.780 mW/g
BCM943228HMB/5 mm Back/Zoom Scan (9x10x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.055 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 1.2800
SAR(1 g) = 0.327 mW/g; SAR(10 g) = 0.095 mW/g
Maximum value of SAR (measured) = 0.684 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Top
Communication System: 802.11a - 6 Mbps; Frequency: 5180 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5180 MHz; σ = 5.327 mho/m; ε_r = 48.766; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.25, 4.25, 4.25); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

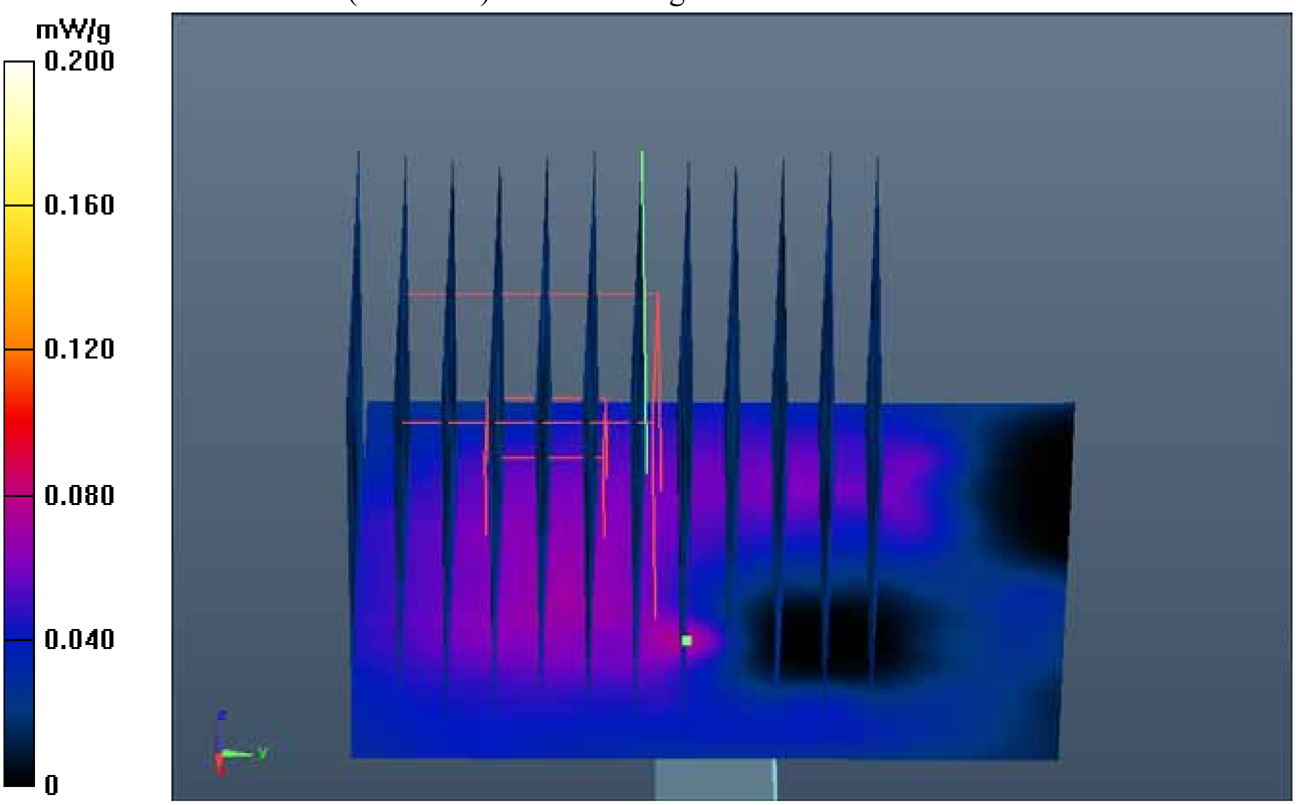
BCM943228HMB/5 mm Top/Area Scan (61x61x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.061 mW/g
BCM943228HMB/5 mm Top/Zoom Scan (10x9x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 1.771 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 0.1220
SAR(1 g) = 0.017 mW/g; SAR(10 g) = 0.00739 mW/g
Maximum value of SAR (measured) = 0.039 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Bottom
Communication System: 802.11a - 6 Mbps; Frequency: 5180 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5180 MHz; σ = 5.327 mho/m; ε_r = 48.766; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.25, 4.25, 4.25); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

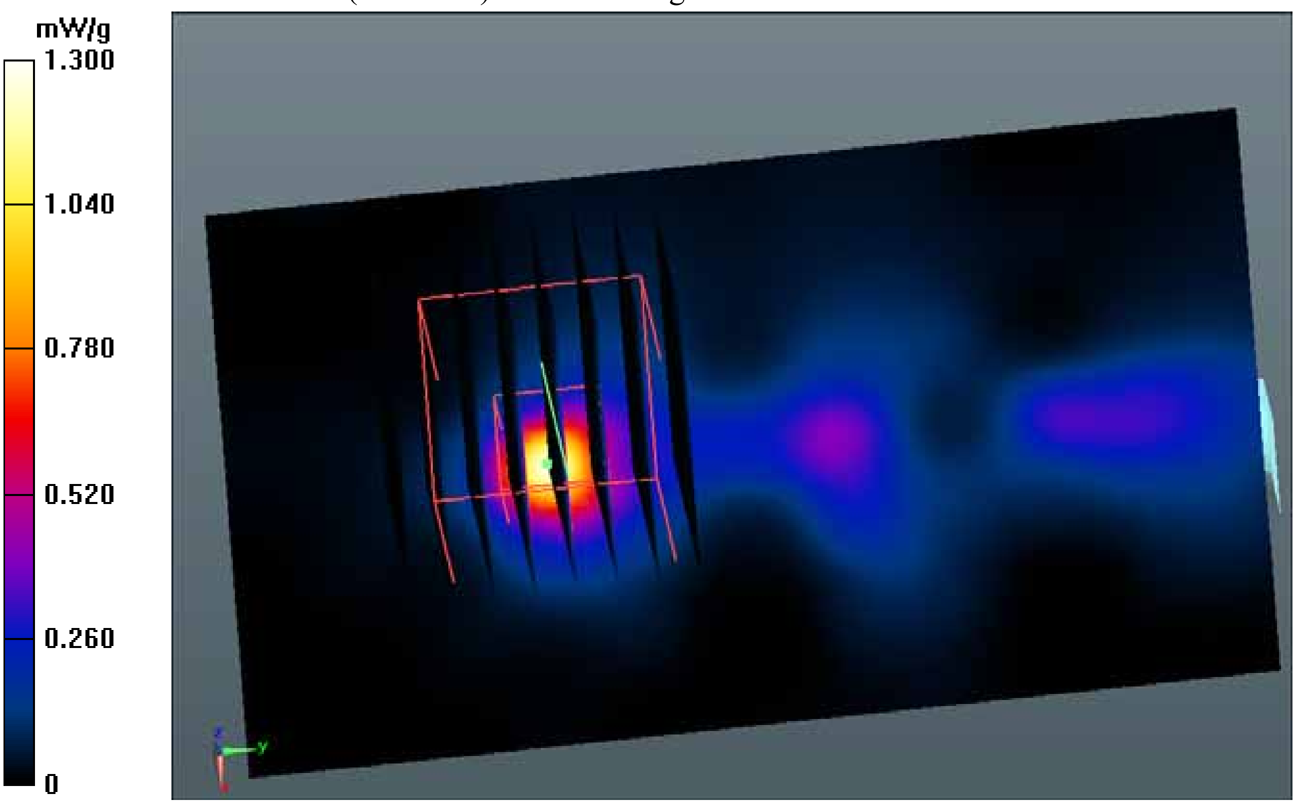
BCM943228HMB/5 mm Bottom/Area Scan (61x61x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.076 mW/g
BCM943228HMB/5 mm Bottom/Zoom Scan (12x12x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 2.387 V/m; Power Drift = -0.90 dB
Peak SAR (extrapolated) = 0.1460
SAR(1 g) = 0.039 mW/g; SAR(10 g) = 0.016 mW/g
Maximum value of SAR (measured) = 0.071 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Left
Communication System: 802.11a - 6 Mbps; Frequency: 5240 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5240 MHz; σ = 5.399 mho/m; ε_r = 48.604; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.25, 4.25, 4.25); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

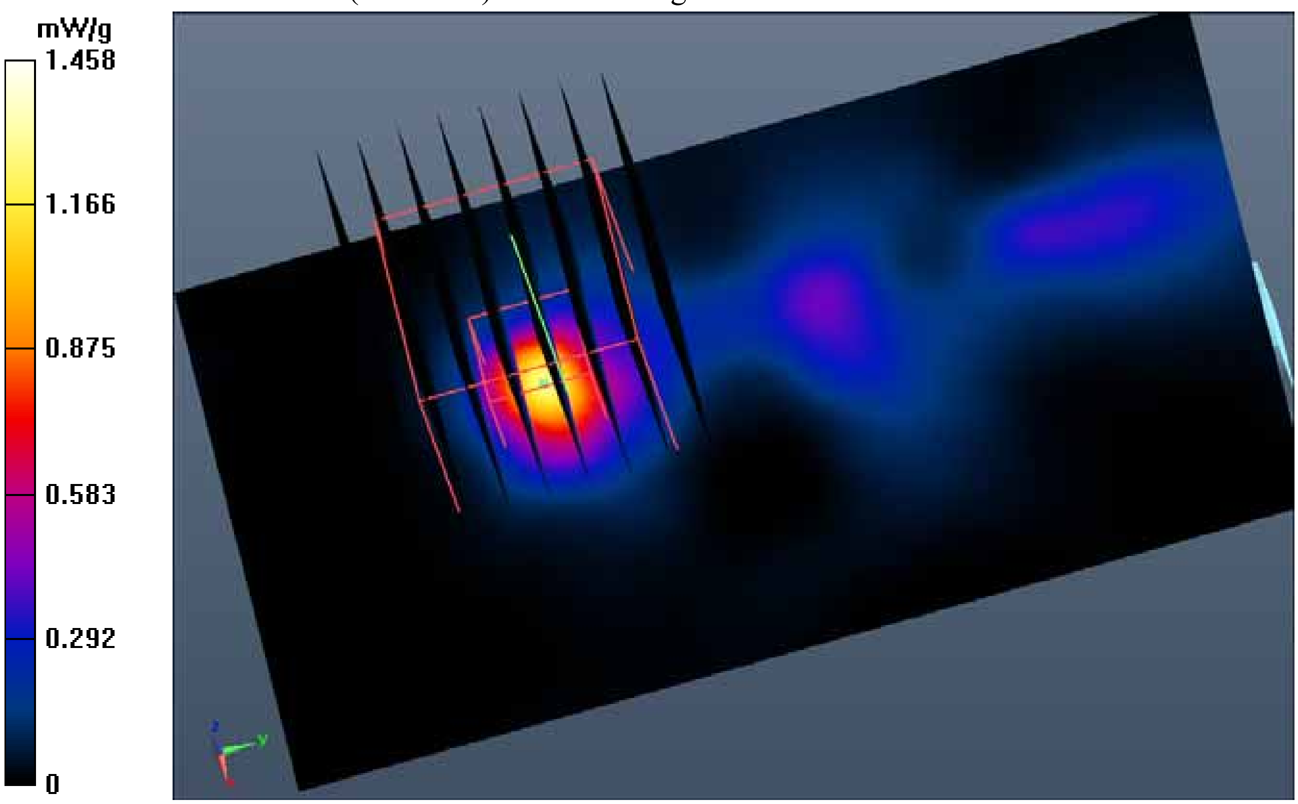
BCM943228HMB/5 mm Left/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.275 mW/g
BCM943228HMB/5 mm Left/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 4.741 V/m; Power Drift = 0.72 dB
Peak SAR (extrapolated) = 3.1550
SAR(1 g) = 0.570 mW/g; SAR(10 g) = 0.124 mW/g
Maximum value of SAR (measured) = 1.300 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Left
Communication System: 802.11a - 6 Mbps; Frequency: 5260 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5260 MHz; σ = 5.347 mho/m; ε_r = 48.352; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/24/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.06, 4.06, 4.06); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

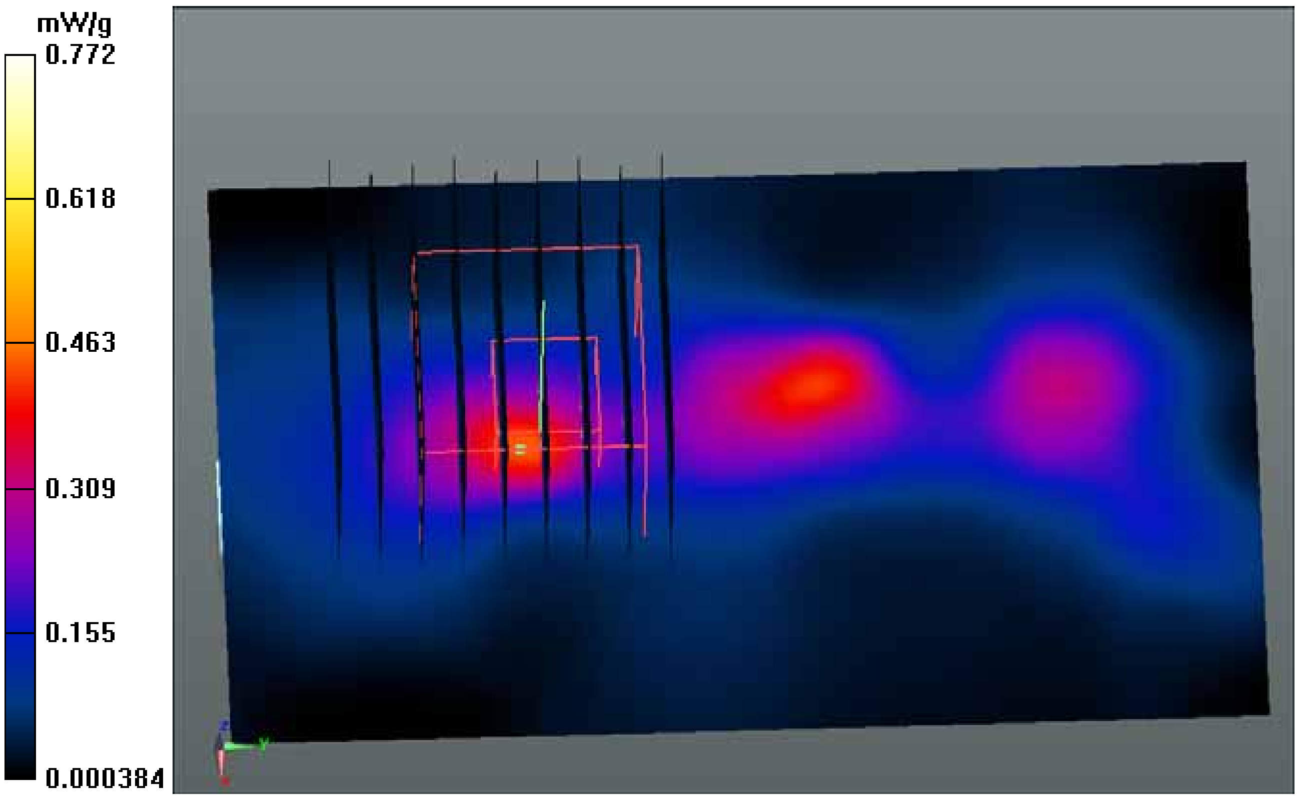
BCM943228HMB/5 mm Left/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.292 mW/g
BCM943228HMB/5 mm Left/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.464 V/m; Power Drift = 0.62 dB
Peak SAR (extrapolated) = 3.5490
SAR(1 g) = 0.652 mW/g; SAR(10 g) = 0.138 mW/g
Maximum value of SAR (measured) = 1.458 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Right
Communication System: 802.11a - 6 Mbps; Frequency: 5260 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5260 MHz; σ = 5.421 mho/m; ε_r = 48.597; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.06, 4.06, 4.06); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

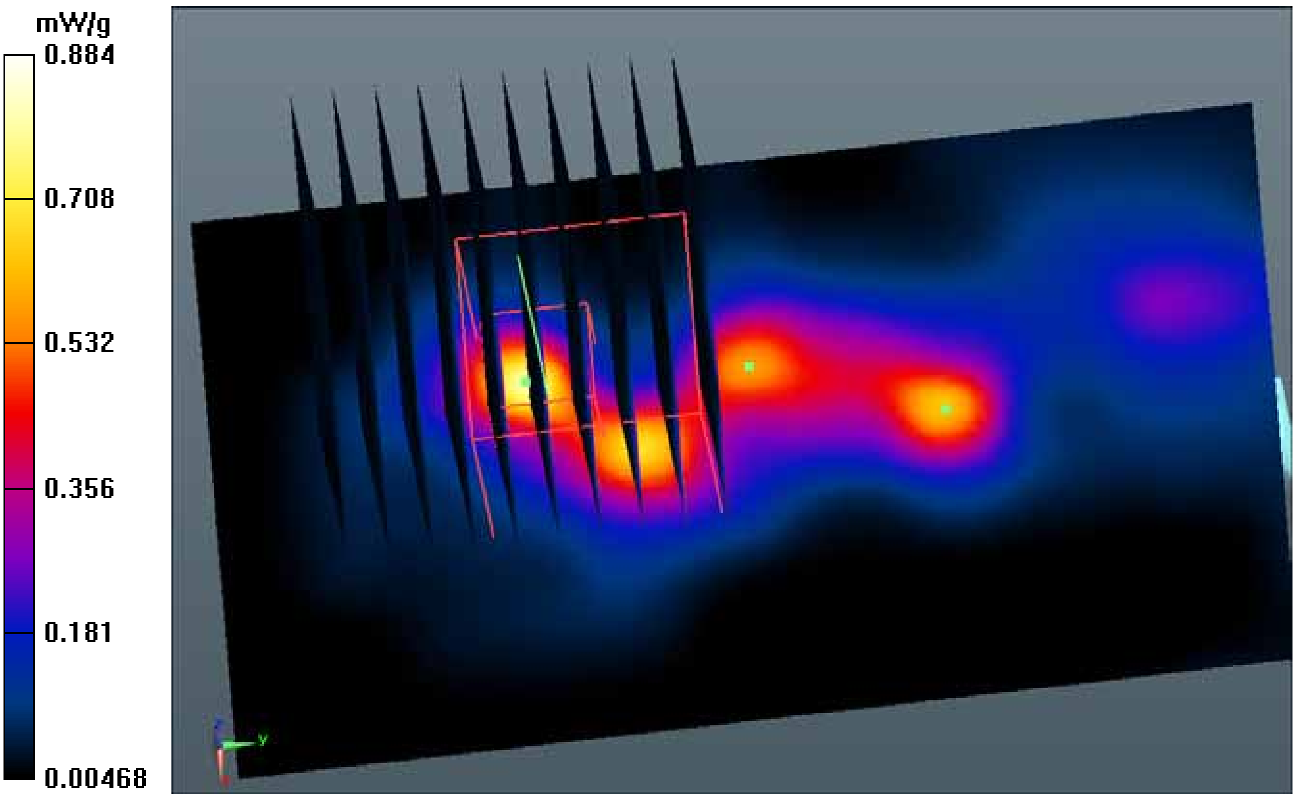
BCM943228HMB/5 mm Right/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.446 mW/g
BCM943228HMB/5 mm Right/Zoom Scan (9x9x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.451 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 2.0460
SAR(1 g) = 0.229 mW/g; SAR(10 g) = 0.083 mW/g
Maximum value of SAR (measured) = 0.772 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Front
Communication System: 802.11a - 6 Mbps; Frequency: 5260 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5260 MHz; σ = 5.421 mho/m; ε_r = 48.597; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.06, 4.06, 4.06); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

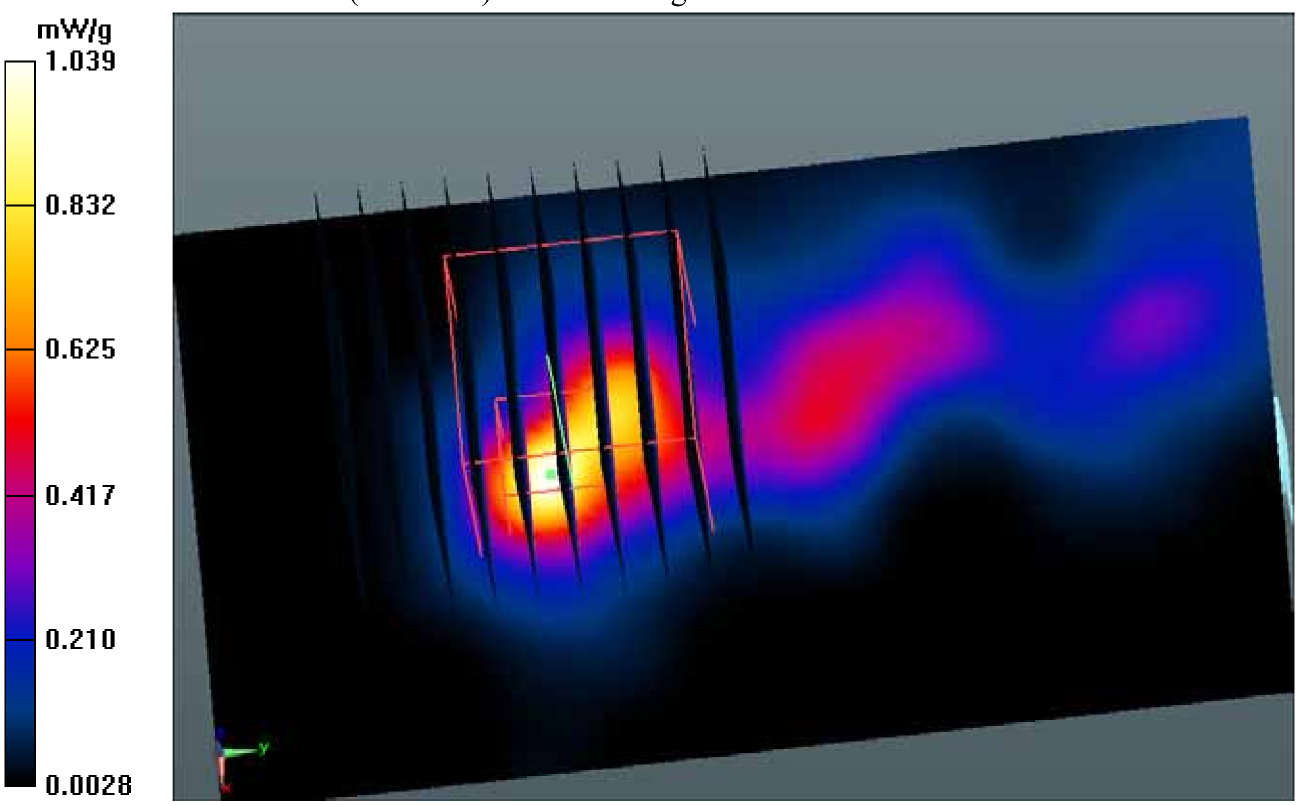
BCM943228HMB/5 mm Front/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.814 mW/g
BCM943228HMB/5 mm Front/Zoom Scan (10x10x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.125 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 1.6400
SAR(1 g) = 0.280 mW/g; SAR(10 g) = 0.115 mW/g
Maximum value of SAR (measured) = 0.884 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Back
Communication System: 802.11a - 6 Mbps; Frequency: 5260 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5260 MHz; σ = 5.421 mho/m; ε_r = 48.597; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.06, 4.06, 4.06); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

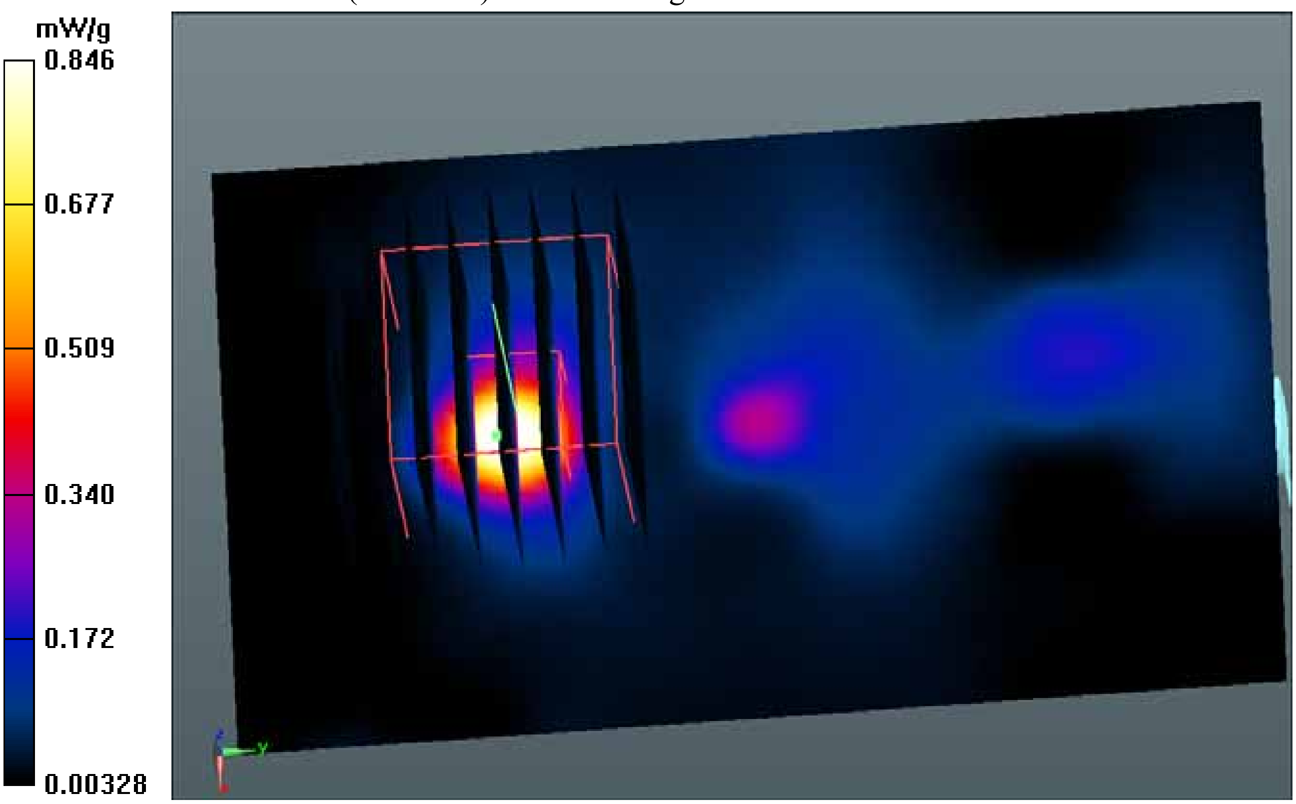
BCM943228HMB/5 mm Back/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.072 mW/g
BCM943228HMB/5 mm Back/Zoom Scan (9x10x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.748 V/m; Power Drift = 0.44 dB
Peak SAR (extrapolated) = 2.4940
SAR(1 g) = 0.405 mW/g; SAR(10 g) = 0.145 mW/g
Maximum value of SAR (measured) = 1.039 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Left
Communication System: 802.11a - 6 Mbps; Frequency: 5320 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5320 MHz; $\sigma = 5.498$ mho/m; $\varepsilon_r = 47.876$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Test Date: 4/29/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(4.06, 4.06, 4.06); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

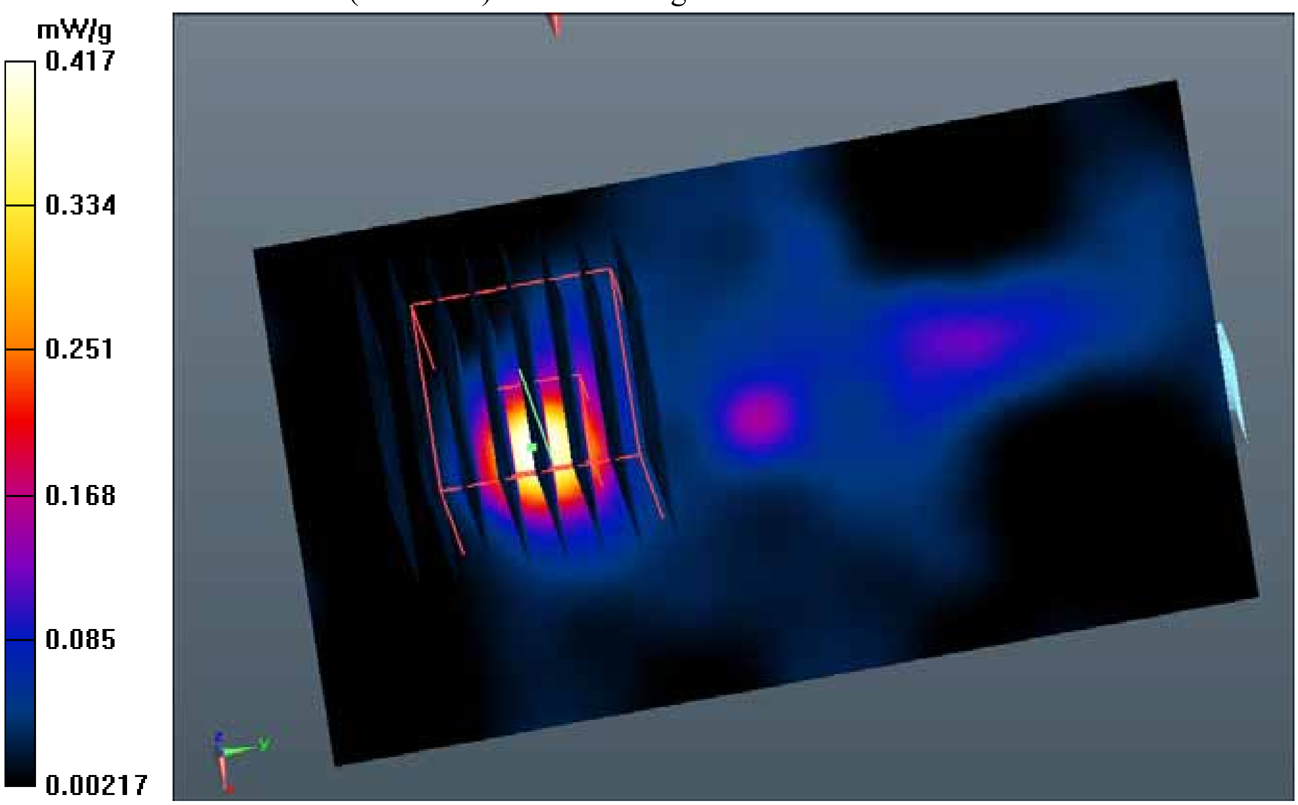
BCM943228HMB/5 mm Left/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.965 mW/g
BCM943228HMB/5 mm Left/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.633 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 2.1900
SAR(1 g) = 0.395 mW/g; SAR(10 g) = 0.089 mW/g
Maximum value of SAR (measured) = 0.846 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Left
Communication System: 802.11a - 6 Mbps; Frequency: 5500 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5500 MHz; σ = 5.728 mho/m; ε_r = 47.547; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/29/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.57, 3.57, 3.57); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

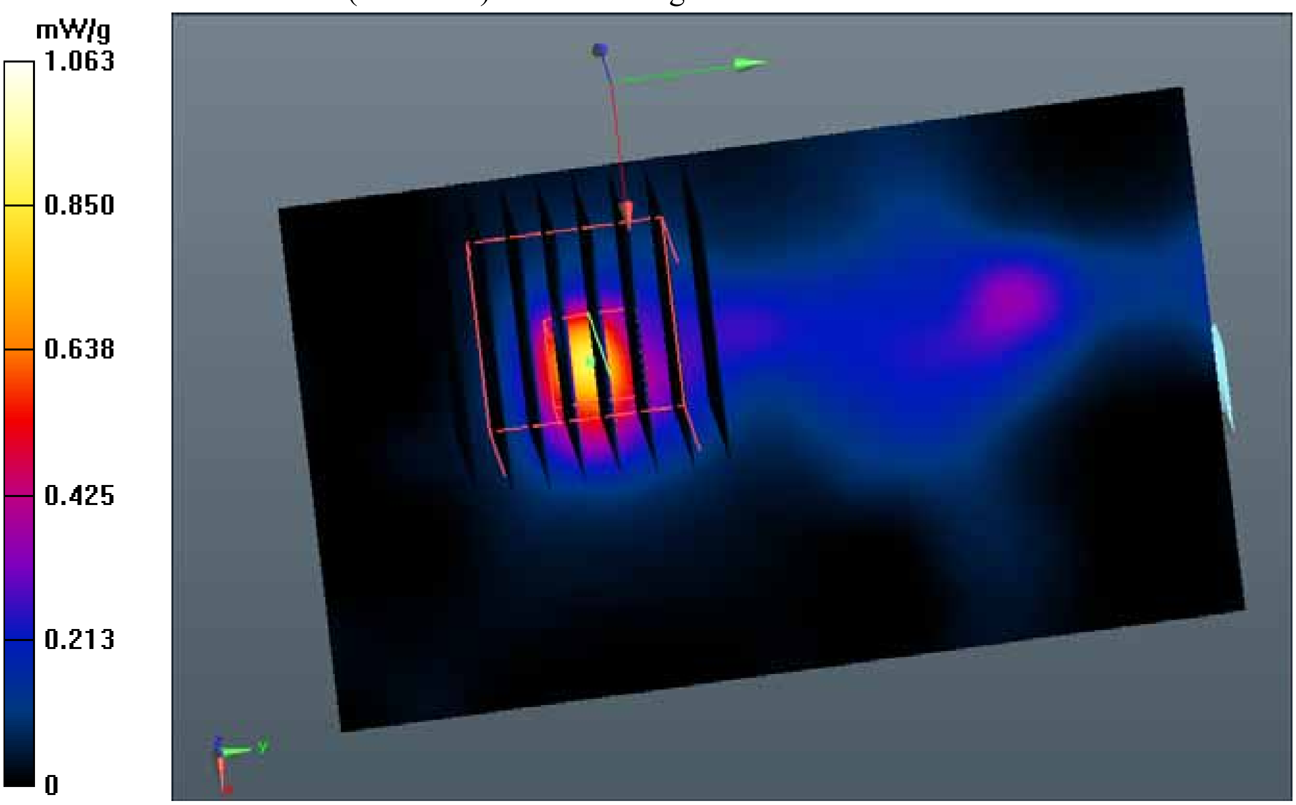
BCM943228HMB/5 mm Left/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.451 mW/g
BCM943228HMB/5 mm Left/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 3.730 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 0.7600
SAR(1 g) = 0.182 mW/g; SAR(10 g) = 0.045 mW/g
Maximum value of SAR (measured) = 0.417 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Left
Communication System: 802.11a - 6 Mbps; Frequency: 5580 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5580 MHz; σ = 5.738 mho/m; ε_r = 47.886; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/24/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.57, 3.57, 3.57); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

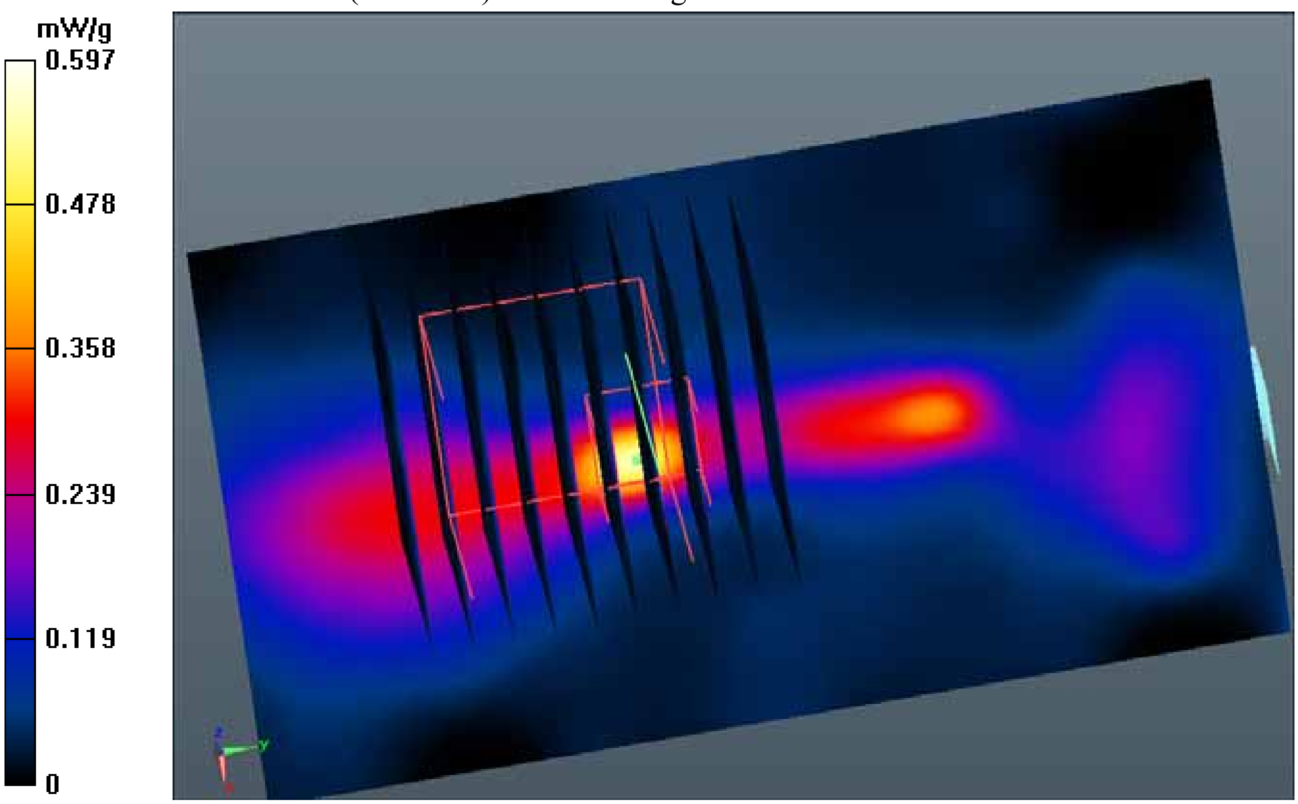
BCM943228HMB/5 mm Left/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.888 mW/g
BCM943228HMB/5 mm Left/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 3.196 V/m; Power Drift = 1.37 dB
Peak SAR (extrapolated) = 4.5620
SAR(1 g) = 0.464 mW/g; SAR(10 g) = 0.068 mW/g
Maximum value of SAR (measured) = 1.063 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Right
Communication System: 802.11a - 6 Mbps; Frequency: 5580 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5580 MHz; σ = 5.831 mho/m; ε_r = 48.097; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.57, 3.57, 3.57); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

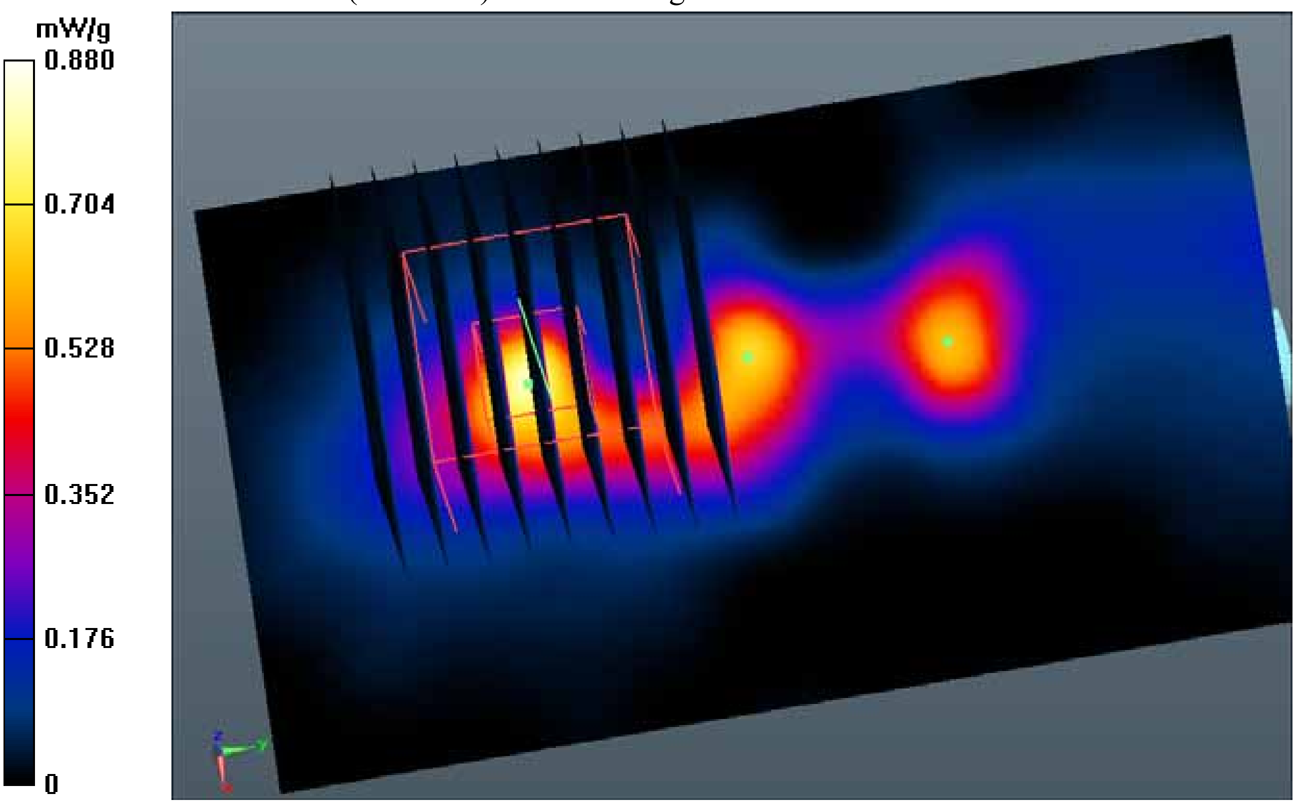
BCM943228HMB/5 mm Right/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.557 mW/g
BCM943228HMB/5 mm Right/Zoom Scan (9x10x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 4.460 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 1.0880
SAR(1 g) = 0.232 mW/g; SAR(10 g) = 0.061 mW/g
Maximum value of SAR (measured) = 0.597 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Front
Communication System: 802.11a - 6 Mbps; Frequency: 5580 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5580 MHz; σ = 5.831 mho/m; ε_r = 48.097; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.57, 3.57, 3.57); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

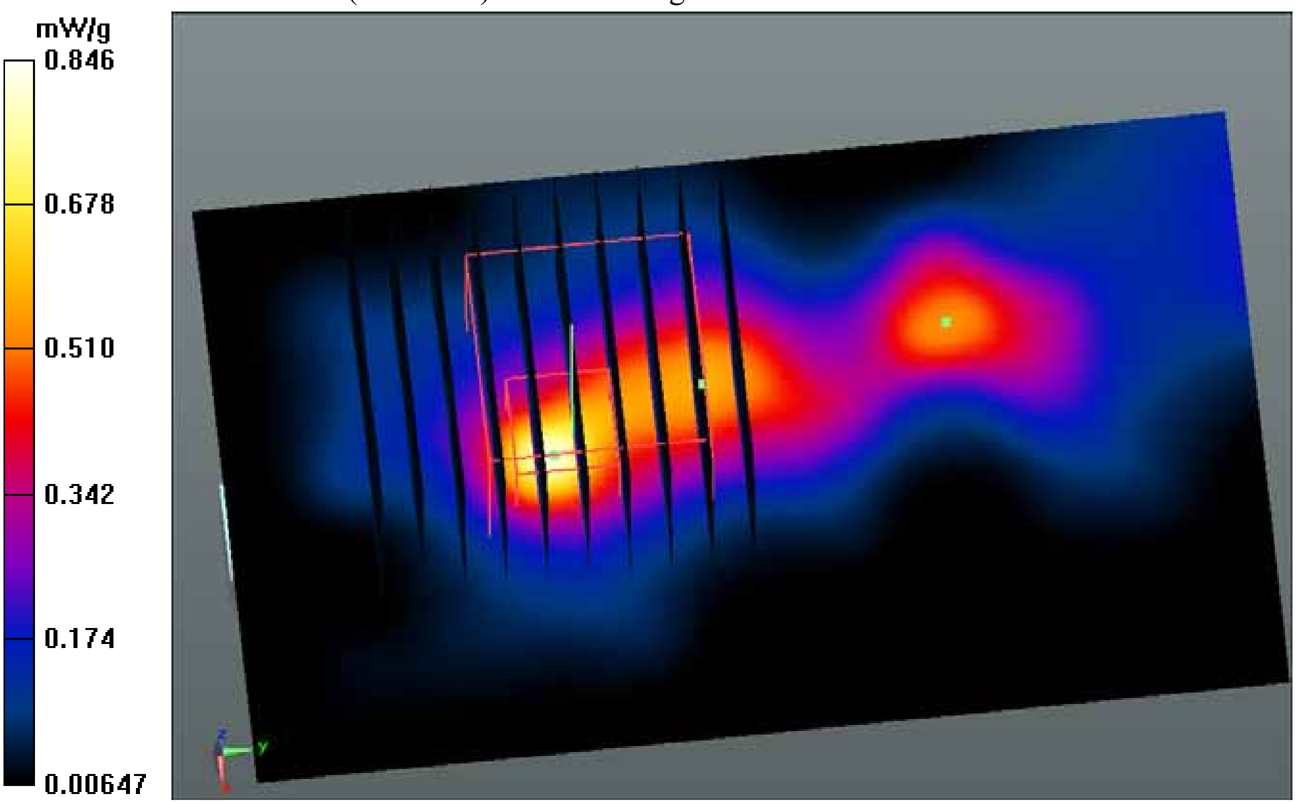
BCM943228HMB/5 mm Front/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.827 mW/g
BCM943228HMB/5 mm Front/Zoom Scan (9x9x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 6.746 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 2.9580
SAR(1 g) = 0.430 mW/g; SAR(10 g) = 0.120 mW/g
Maximum value of SAR (measured) = 0.880 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Back
Communication System: 802.11a - 6 Mbps; Frequency: 5580 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5580 MHz; σ = 5.831 mho/m; ε_r = 48.097; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.57, 3.57, 3.57); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

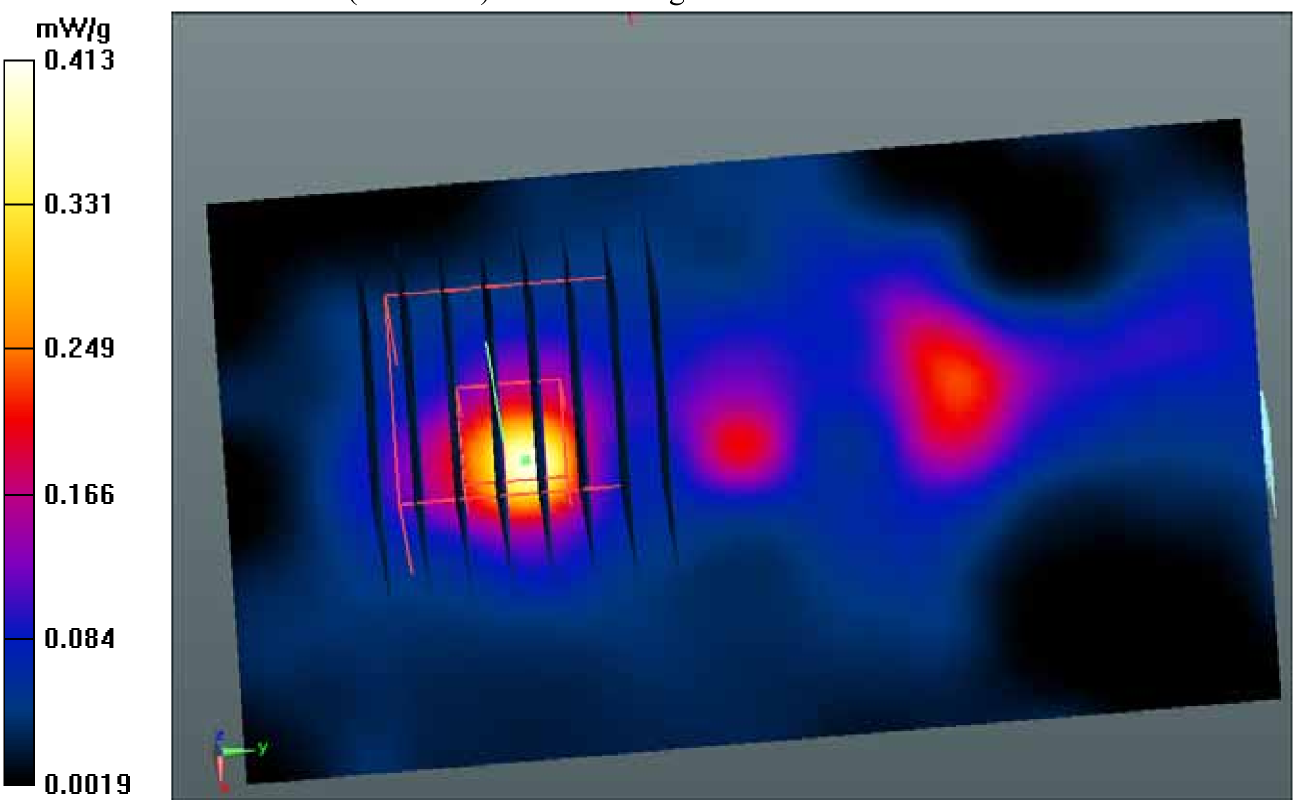
BCM943228HMB/5 mm Back/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.823 mW/g
BCM943228HMB/5 mm Back/Zoom Scan (9x10x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.528 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 2.0790
SAR(1 g) = 0.431 mW/g; SAR(10 g) = 0.123 mW/g
Maximum value of SAR (measured) = 0.846 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Left
Communication System: 802.11a - 6 Mbps; Frequency: 5700 MHz; Duty Cycle: 1:1
Medium parameters used: f = 5700 MHz; σ = 6.014 mho/m; ε_r = 47.271; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/29/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.57, 3.57, 3.57); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

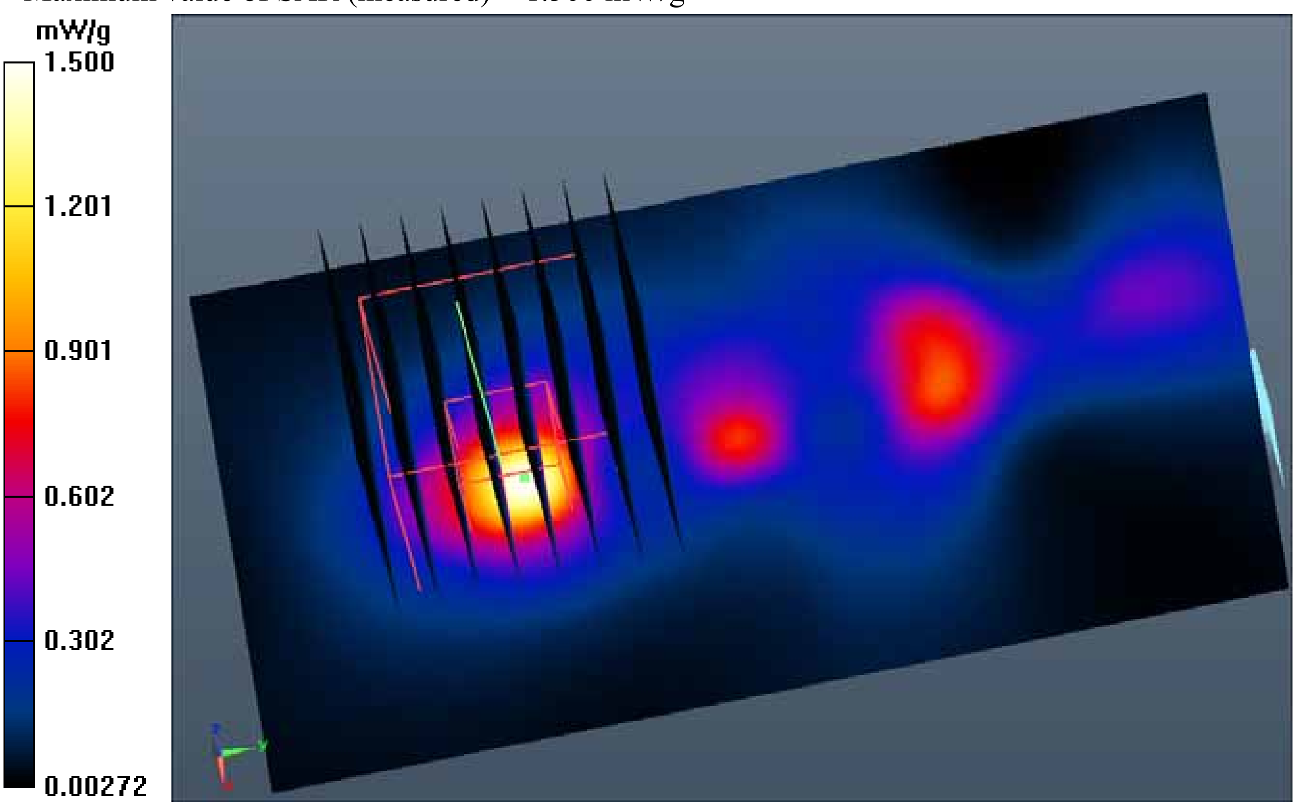
BCM943228HMB/5 mm Left/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.406 mW/g
BCM943228HMB/5 mm Left/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 4.230 V/m; Power Drift = 0.54 dB
Peak SAR (extrapolated) = 1.0630
SAR(1 g) = 0.202 mW/g; SAR(10 g) = 0.053 mW/g
Maximum value of SAR (measured) = 0.413 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Left
Communication System: 802.11a - 6 Mbps; Frequency: 5745 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 5745 MHz; σ = 6.07 mho/m; ε_r = 47.197; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/29/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

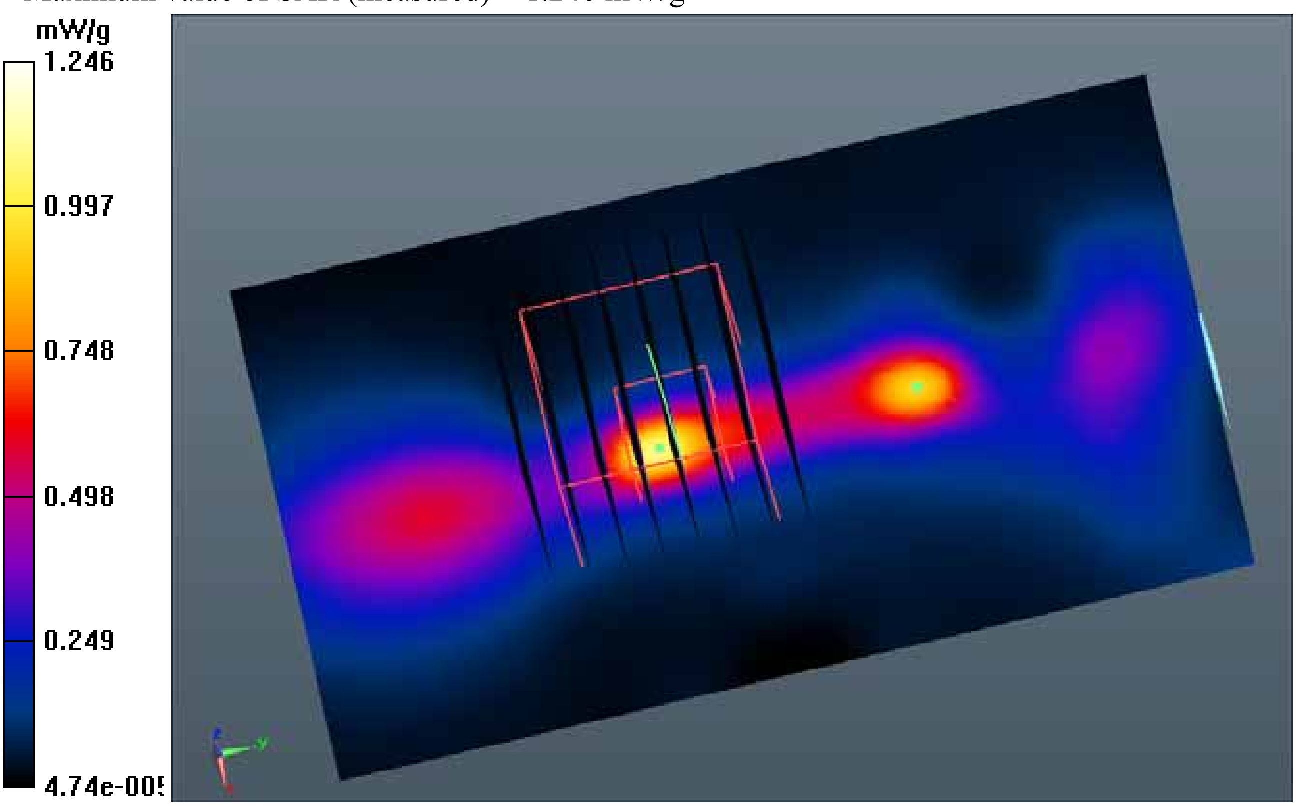
BCM943228HMB/5 mm Left/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.534 mW/g
BCM943228HMB/5 mm Left/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 8.163 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 3.5870
SAR(1 g) = 0.727 mW/g; SAR(10 g) = 0.190 mW/g
Maximum value of SAR (measured) = 1.500 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Right
Communication System: 802.11a - 6 Mbps; Frequency: 5745 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 5745 MHz; σ = 6.073 mho/m; ε_r = 47.804; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

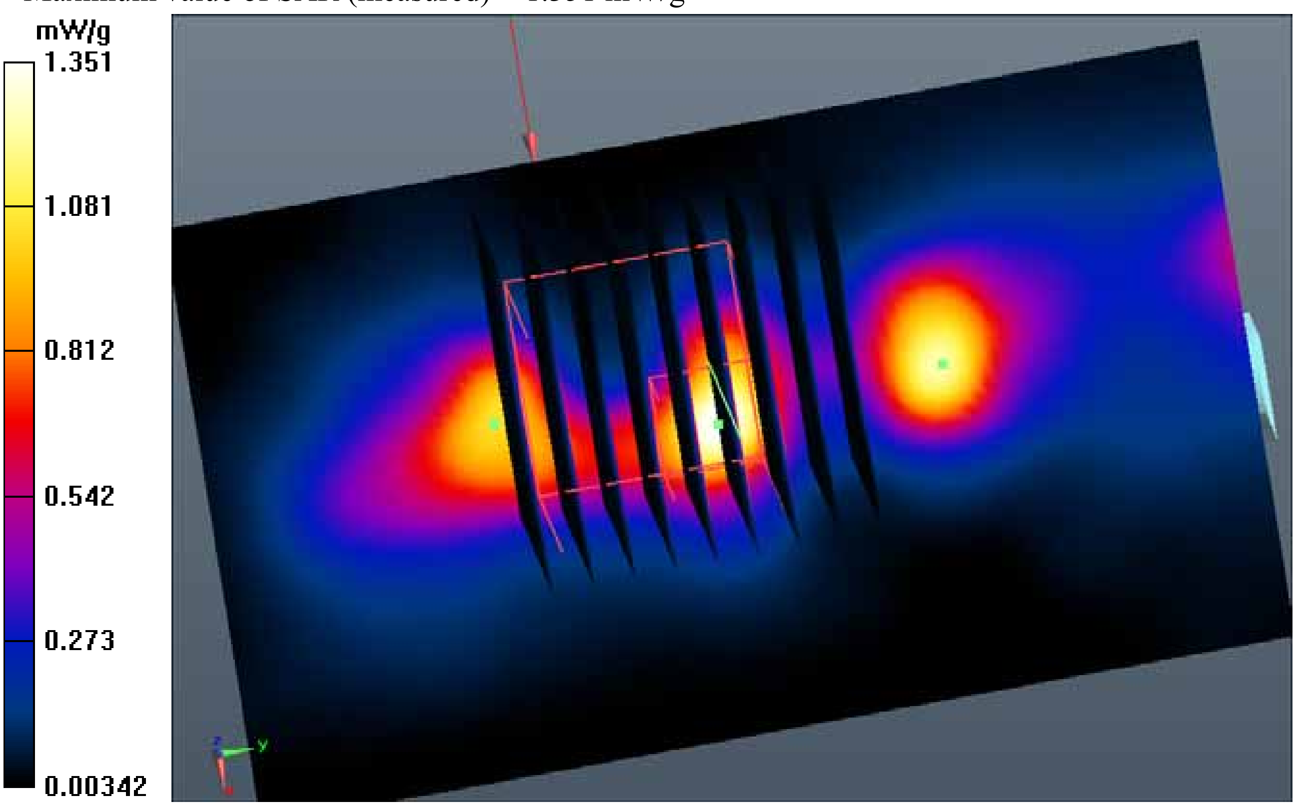
BCM943228HMB/5 mm Right/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.101 mW/g
BCM943228HMB/5 mm Right/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 7.918 V/m; Power Drift = -0.61 dB
Peak SAR (extrapolated) = 2.2570
SAR(1 g) = 0.484 mW/g; SAR(10 g) = 0.107 mW/g
Maximum value of SAR (measured) = 1.246 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Front
Communication System: 802.11a - 6 Mbps; Frequency: 5745 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 5745 MHz; σ = 6.073 mho/m; ε_r = 47.804; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

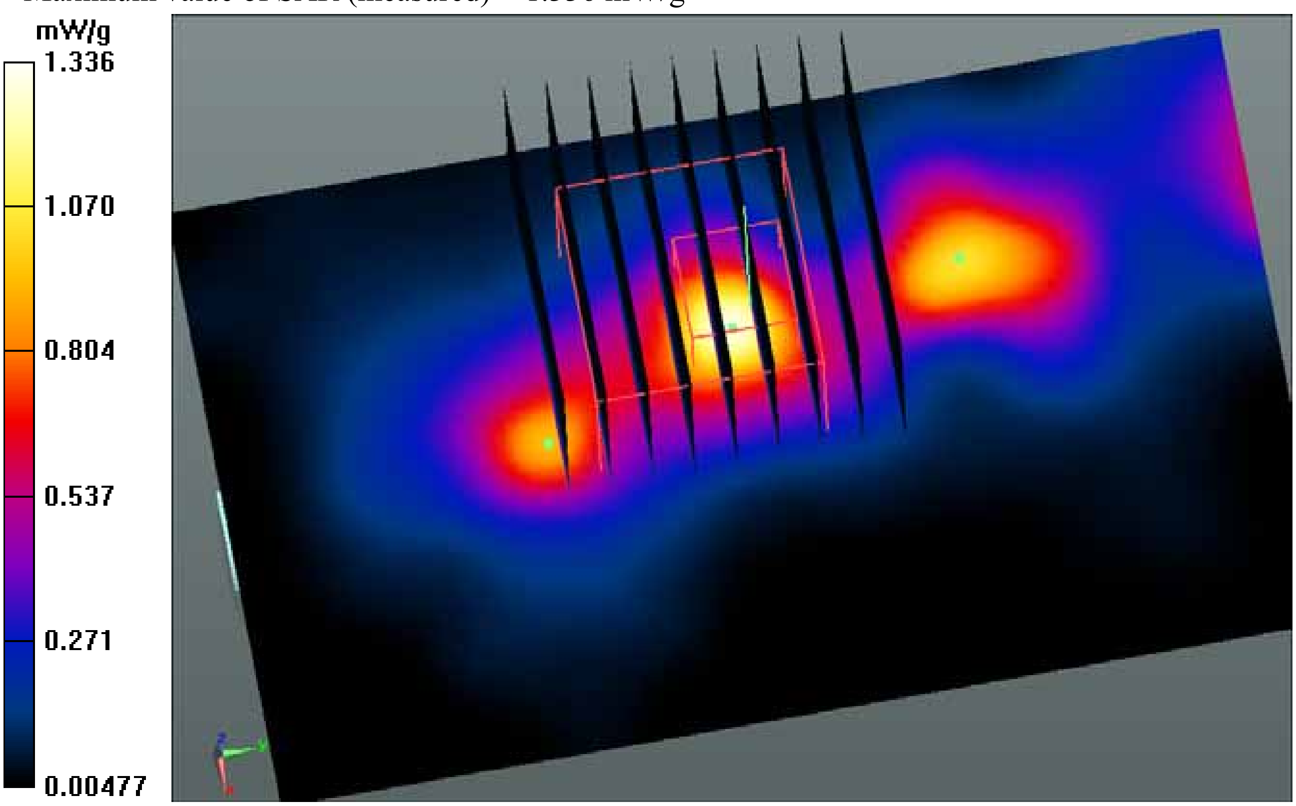
BCM943228HMB/5 mm Front/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.422 mW/g
BCM943228HMB/5 mm Front/Zoom Scan (9x9x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 11.298 V/m; Power Drift = -0.16 dB
Peak SAR (extrapolated) = 3.0810
SAR(1 g) = 0.600 mW/g; SAR(10 g) = 0.175 mW/g
Maximum value of SAR (measured) = 1.351 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Back
Communication System: 802.11a - 6 Mbps; Frequency: 5745 MHz; Duty Cycle: 1:1
Medium parameters used (interpolated): f = 5745 MHz; σ = 6.073 mho/m; ε_r = 47.804; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

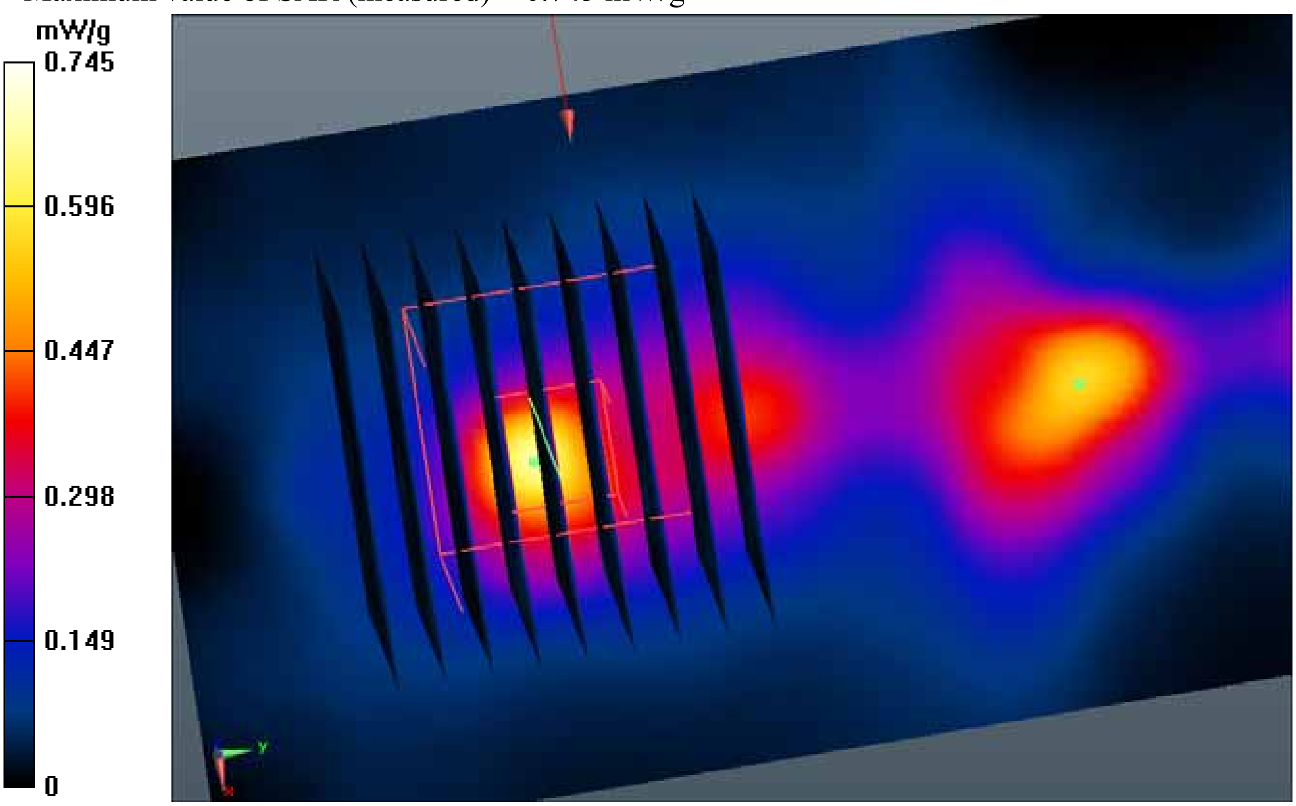
BCM943228HMB/5 mm Back/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.315 mW/g
BCM943228HMB/5 mm Back/Zoom Scan (9x9x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 6.496 V/m; Power Drift = -0.22 dB
Peak SAR (extrapolated) = 2.7290
SAR(1 g) = 0.613 mW/g; SAR(10 g) = 0.181 mW/g
Maximum value of SAR (measured) = 1.336 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Left
Communication System: 802.11a - 6 Mbps; Frequency: 5825 MHz; Duty Cycle: 1:1
Medium parameters used (extrapolated): f = 5825 MHz; σ = 6.183 mho/m; ε_r = 47.768; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

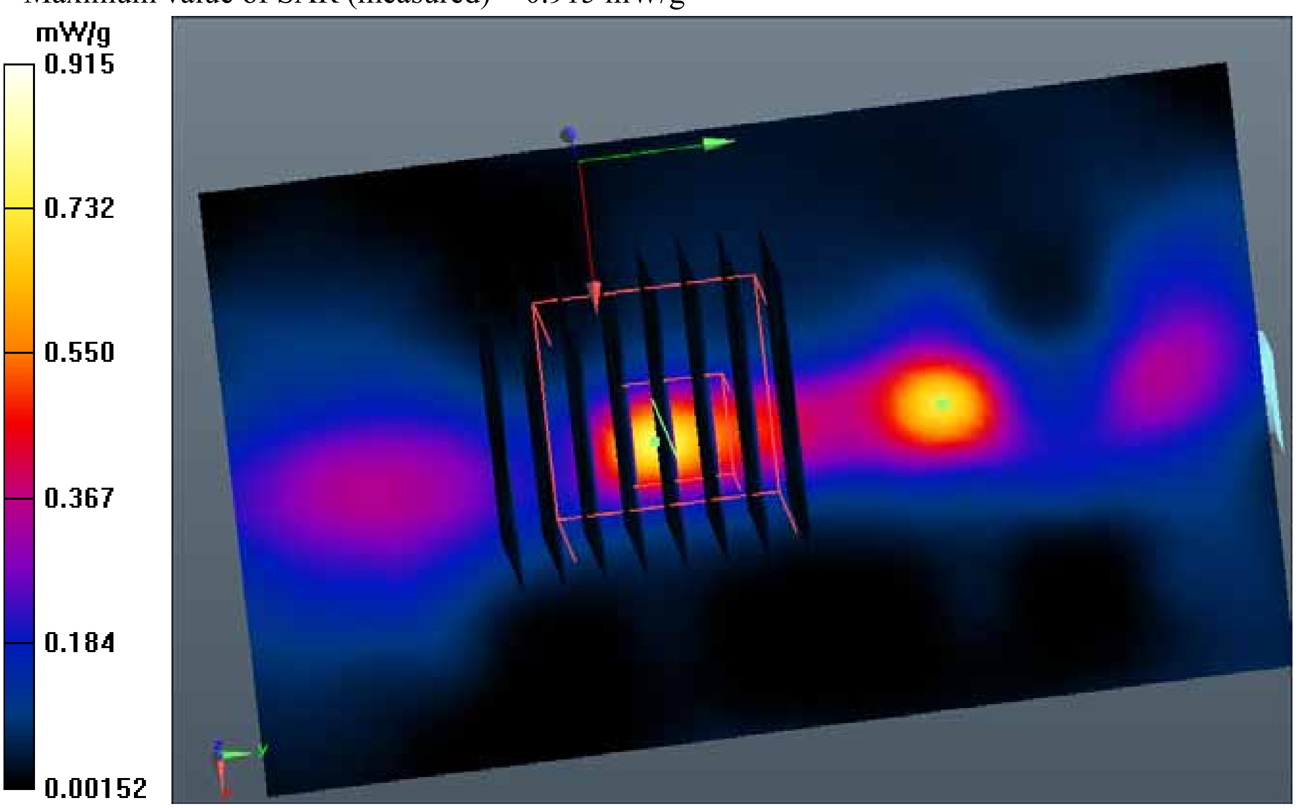
BCM943228HMB/5 mm Left/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.675 mW/g
BCM943228HMB/5 mm Left/Zoom Scan (9x9x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 5.885 V/m; Power Drift = -0.18 dB
Peak SAR (extrapolated) = 1.7070
SAR(1 g) = 0.340 mW/g; SAR(10 g) = 0.093 mW/g
Maximum value of SAR (measured) = 0.745 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Right
Communication System: 802.11a - 6 Mbps; Frequency: 5825 MHz; Duty Cycle: 1:1
Medium parameters used (extrapolated): f = 5825 MHz; σ = 6.183 mho/m; ε_r = 47.768; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

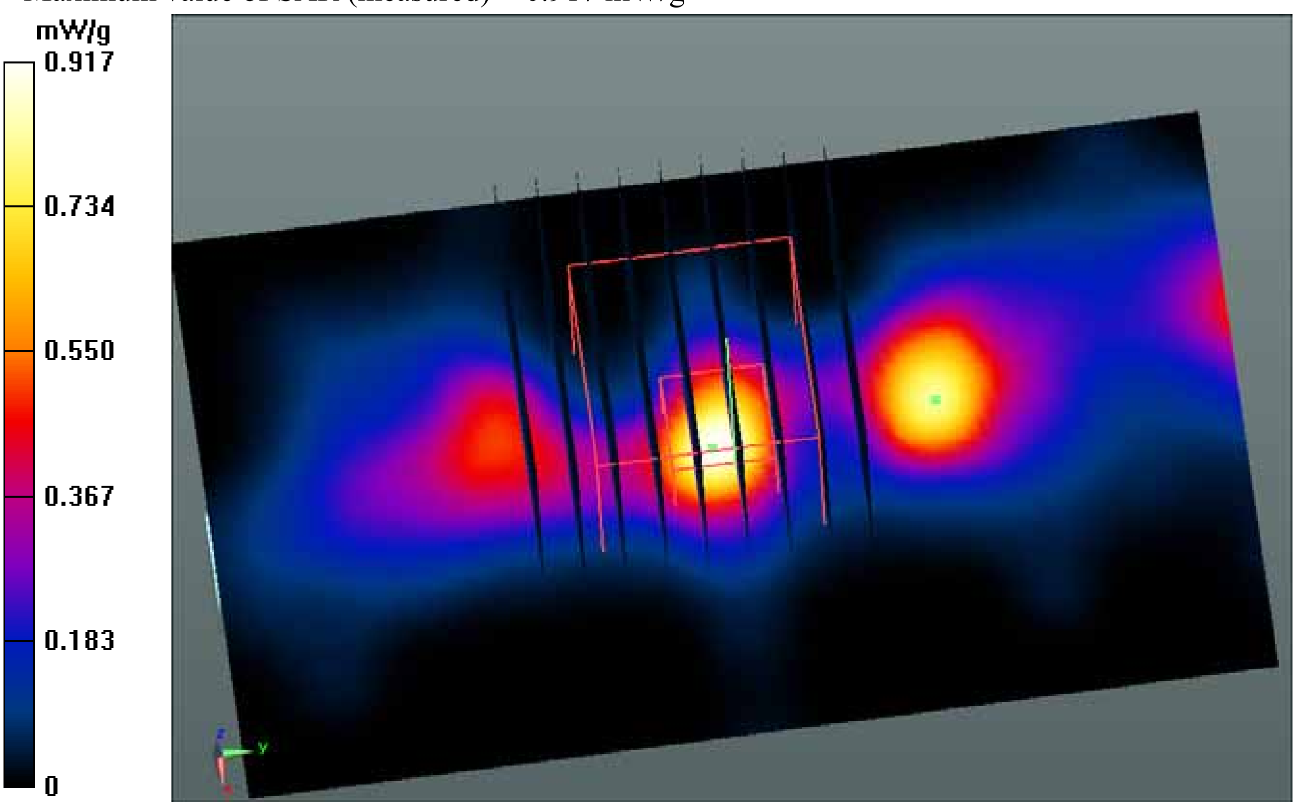
BCM943228HMB/5 mm Right/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.774 mW/g
BCM943228HMB/5 mm Right/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 6.463 V/m; Power Drift = 0.33 dB
Peak SAR (extrapolated) = 1.7090
SAR(1 g) = 0.361 mW/g; SAR(10 g) = 0.079 mW/g
Maximum value of SAR (measured) = 0.915 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Front
Communication System: 802.11a - 6 Mbps; Frequency: 5825 MHz; Duty Cycle: 1:1
Medium parameters used (extrapolated): f = 5825 MHz; σ = 6.183 mho/m; ε_r = 47.768; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

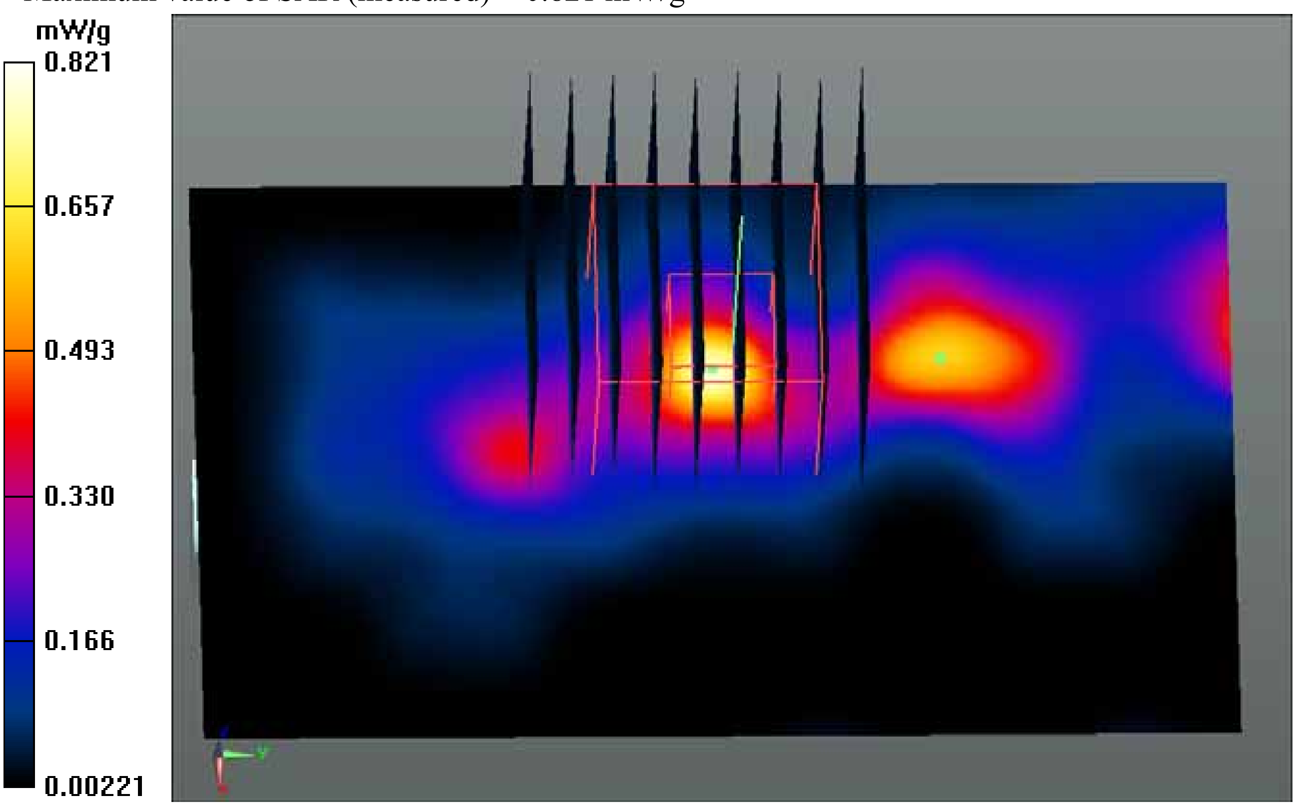
BCM943228HMB/5 mm Front/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.939 mW/g
BCM943228HMB/5 mm Front/Zoom Scan (9x9x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 9.167 V/m; Power Drift = -0.07 dB
Peak SAR (extrapolated) = 2.2040
SAR(1 g) = 0.412 mW/g; SAR(10 g) = 0.105 mW/g
Maximum value of SAR (measured) = 0.917 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Back
Communication System: 802.11a - 6 Mbps; Frequency: 5825 MHz; Duty Cycle: 1:1
Medium parameters used (extrapolated): f = 5825 MHz; σ = 6.183 mho/m; ε_r = 47.768; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 5/1/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(3.64, 3.64, 3.64); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

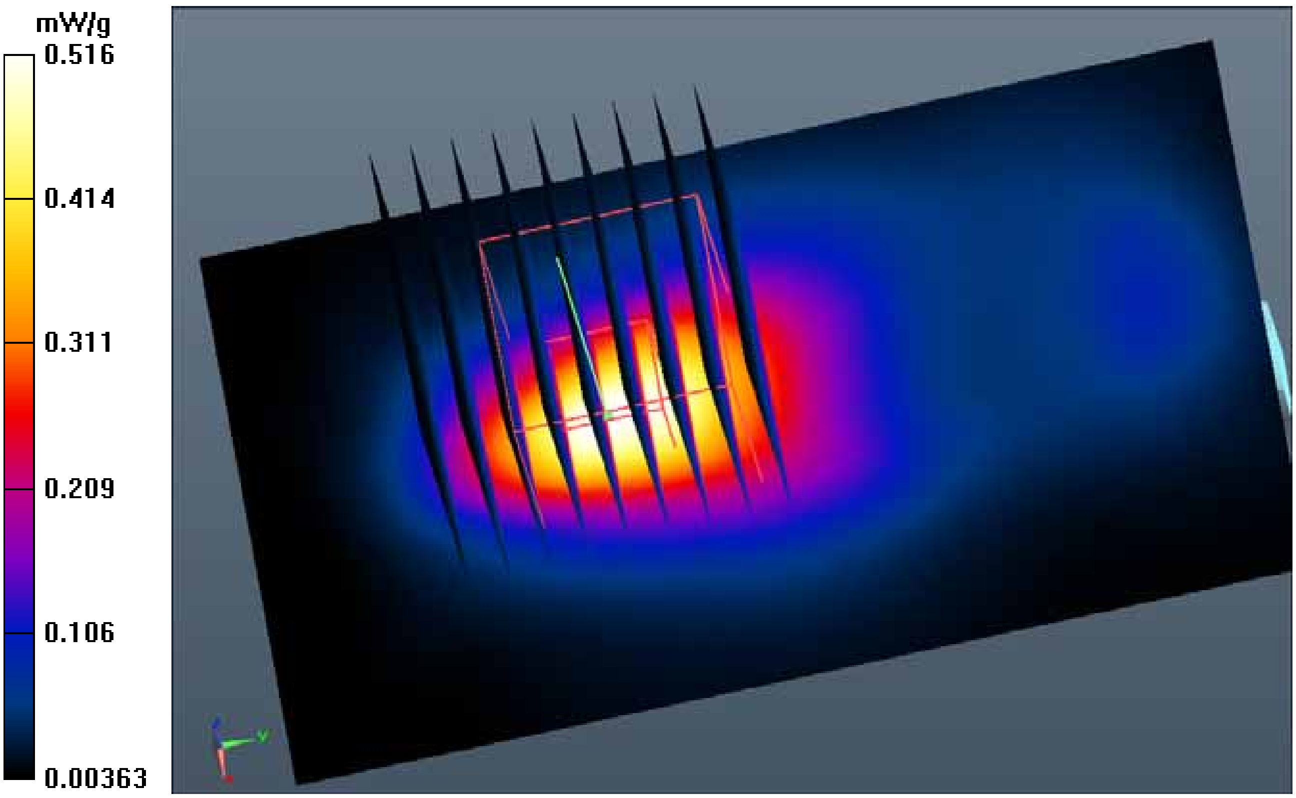
BCM943228HMB/5 mm Back/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.789 mW/g
BCM943228HMB/5 mm Back/Zoom Scan (9x9x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 4.464 V/m; Power Drift = -0.30 dB
Peak SAR (extrapolated) = 1.7930
SAR(1 g) = 0.370 mW/g; SAR(10 g) = 0.099 mW/g
Maximum value of SAR (measured) = 0.821 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Left
Communication System: 802.11b - 1 Mbps; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2437 MHz; σ = 2.009 mho/m; ε_r = 52.818; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/22/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(6.69, 6.69, 6.69); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

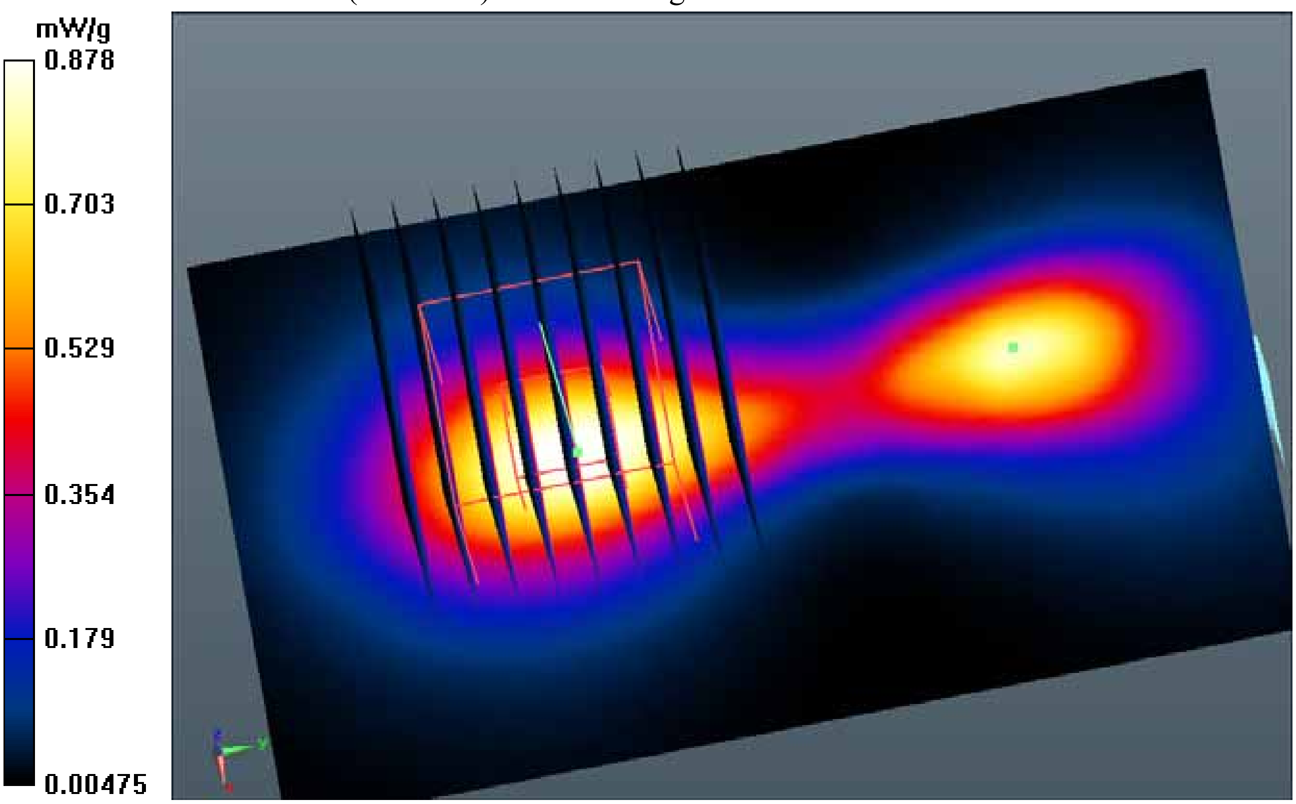
BCM943228HMB/5 mm Left/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.534 mW/g
BCM943228HMB/5 mm Left/Zoom Scan (9x9x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 10.570 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 0.7140
SAR(1 g) = 0.337 mW/g; SAR(10 g) = 0.156 mW/g
Maximum value of SAR (measured) = 0.516 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Right
Communication System: 802.11b - 1 Mbps; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2437 MHz; σ = 2.009 mho/m; ε_r = 52.818; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/22/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(6.69, 6.69, 6.69); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

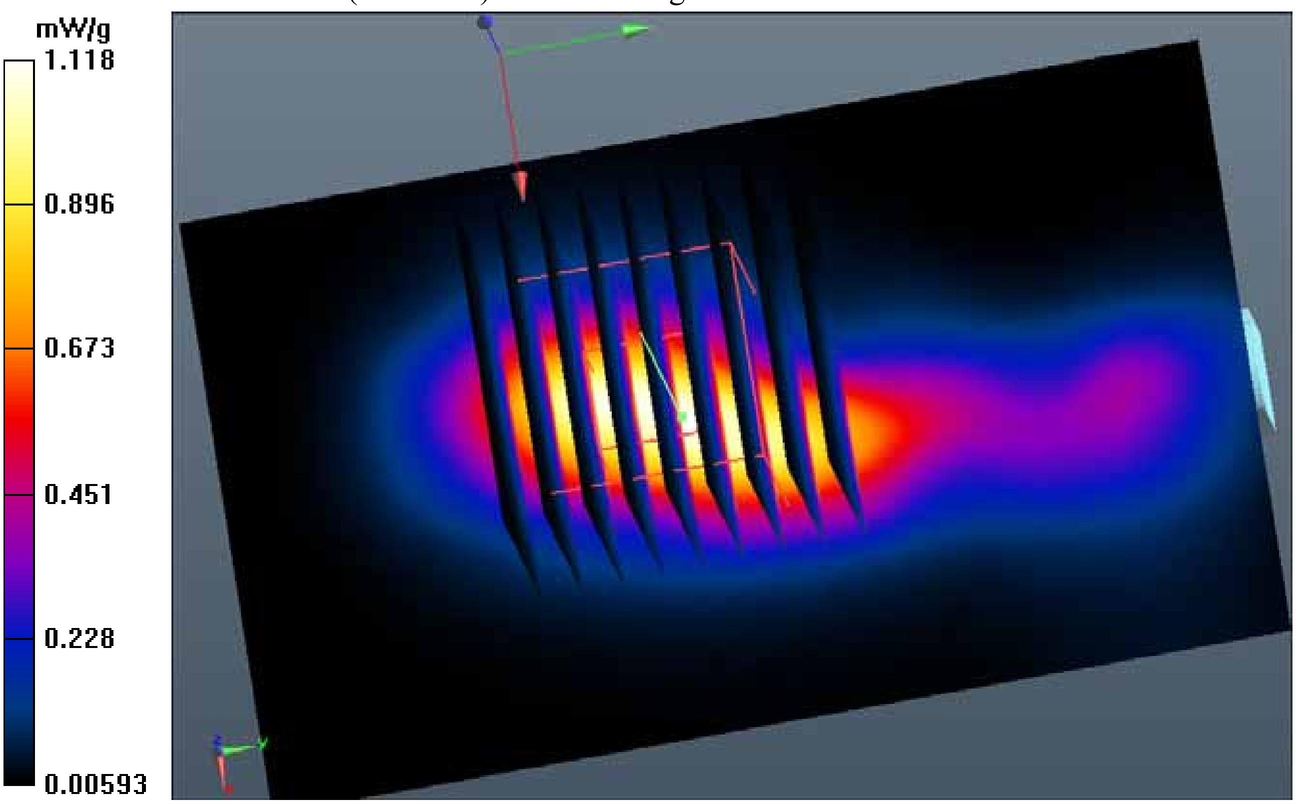
BCM943228HMB/5 mm Right/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.939 mW/g
BCM943228HMB/5 mm Right/Zoom Scan (9x9x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 13.128 V/m; Power Drift = 0.58 dB
Peak SAR (extrapolated) = 1.2360
SAR(1 g) = 0.579 mW/g; SAR(10 g) = 0.273 mW/g
Maximum value of SAR (measured) = 0.878 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Back
Communication System: 802.11b - 1 Mbps; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2437 MHz; σ = 1.969 mho/m; ε_r = 52.519; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/19/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(6.69, 6.69, 6.69); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

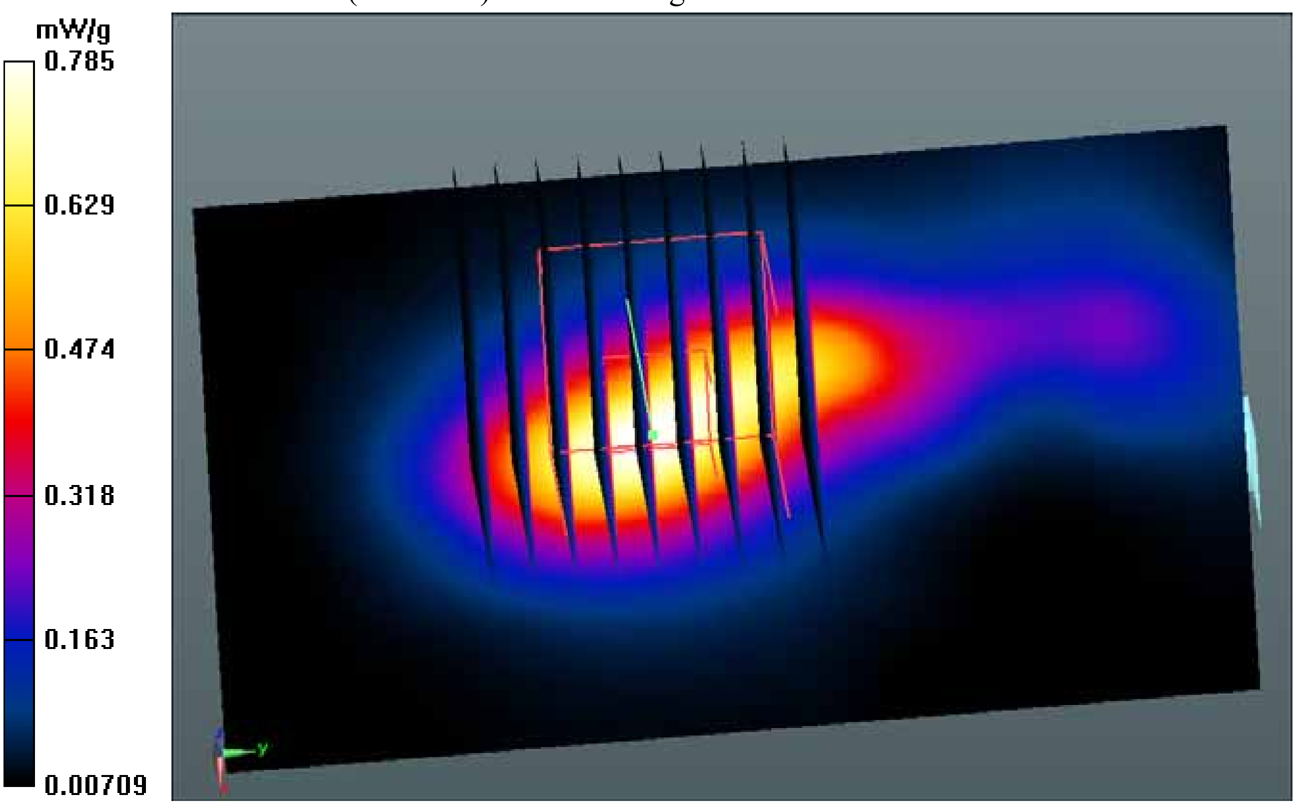
BCM943228HMB/5 mm Back/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.123 mW/g
BCM943228HMB/5 mm Back/Zoom Scan (9x9x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 20.520 V/m; Power Drift = -0.14 dB
Peak SAR (extrapolated) = 1.5050
SAR(1 g) = 0.726 mW/g; SAR(10 g) = 0.333 mW/g
Maximum value of SAR (measured) = 1.118 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Back
Communication System: 802.11b - 1 Mbps; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2437 MHz; σ = 2.009 mho/m; ε_r = 52.818; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/22/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(6.69, 6.69, 6.69); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

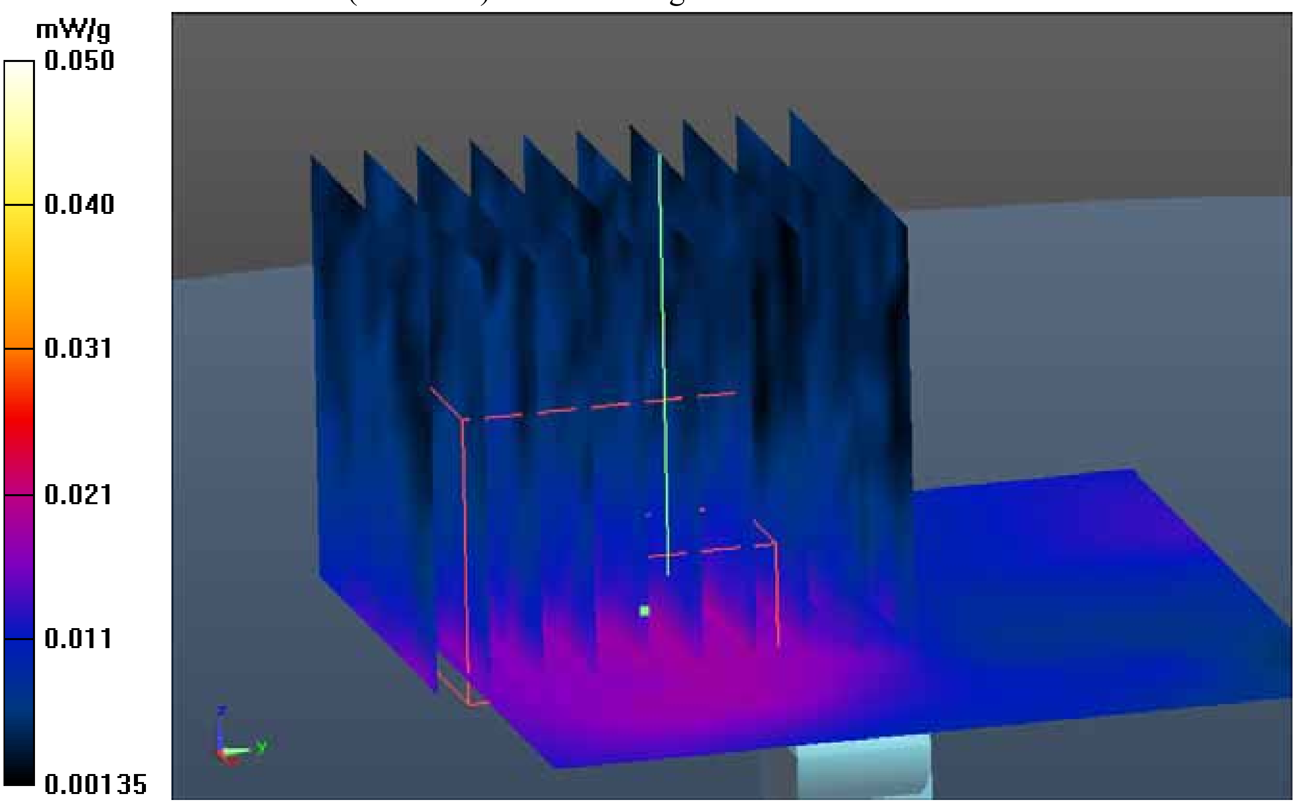
BCM943228HMB/5 mm Back/Area Scan (61x101x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.818 mW/g
BCM943228HMB/5 mm Back/Zoom Scan (9x9x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 15.495 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 1.0520
SAR(1 g) = 0.514 mW/g; SAR(10 g) = 0.247 mW/g
Maximum value of SAR (measured) = 0.785 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Top
Communication System: 802.11b - 1 Mbps; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2437 MHz; σ = 2.009 mho/m; ε_r = 52.818; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/22/2013
DASY5 Configuration:

- Probe: EX3DV4 - SN3833; ConvF(6.69, 6.69, 6.69); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

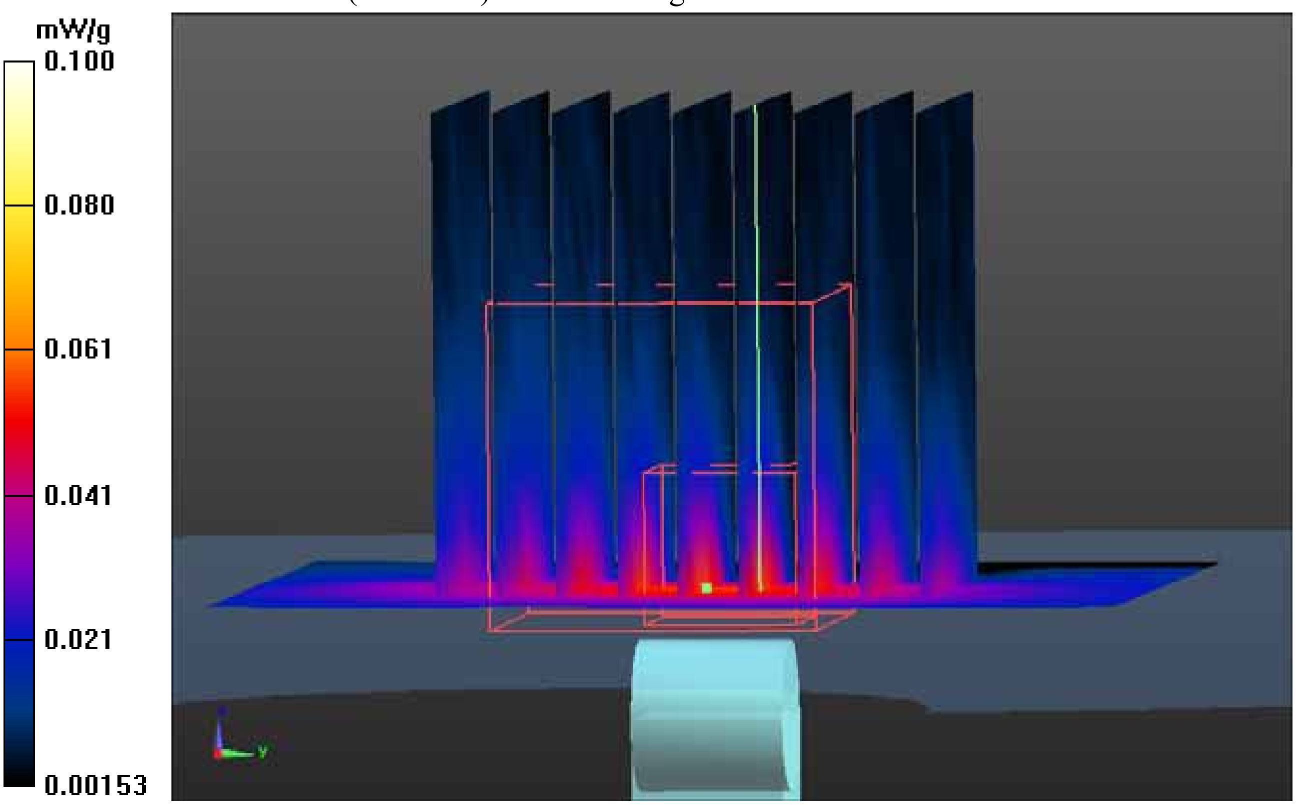
BCM943228HMB/5 mm Top/Area Scan (61x61x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.019 mW/g
BCM943228HMB/5 mm Top/Zoom Scan (9x10x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 2.205 V/m; Power Drift = 1.27 dB
Peak SAR (extrapolated) = 0.0330
SAR(1 g) = 0.015 mW/g; SAR(10 g) = 0.00891 mW/g
Maximum value of SAR (measured) = 0.021 mW/g



DUT: BCM943228HMB; Type: 802.11a/b/g/n WLAN + Bluetooth PCI-E Mini Card; Serial: 68A3C4DCADDB
Procedure Name: 5 mm Bottom
Communication System: 802.11b - 1 Mbps; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium parameters used: f = 2437 MHz; σ = 2.009 mho/m; ε_r = 52.818; ρ = 1000 kg/m^3
Phantom section: Flat Section
Test Date: 4/22/2013
DASY5 Configuration:

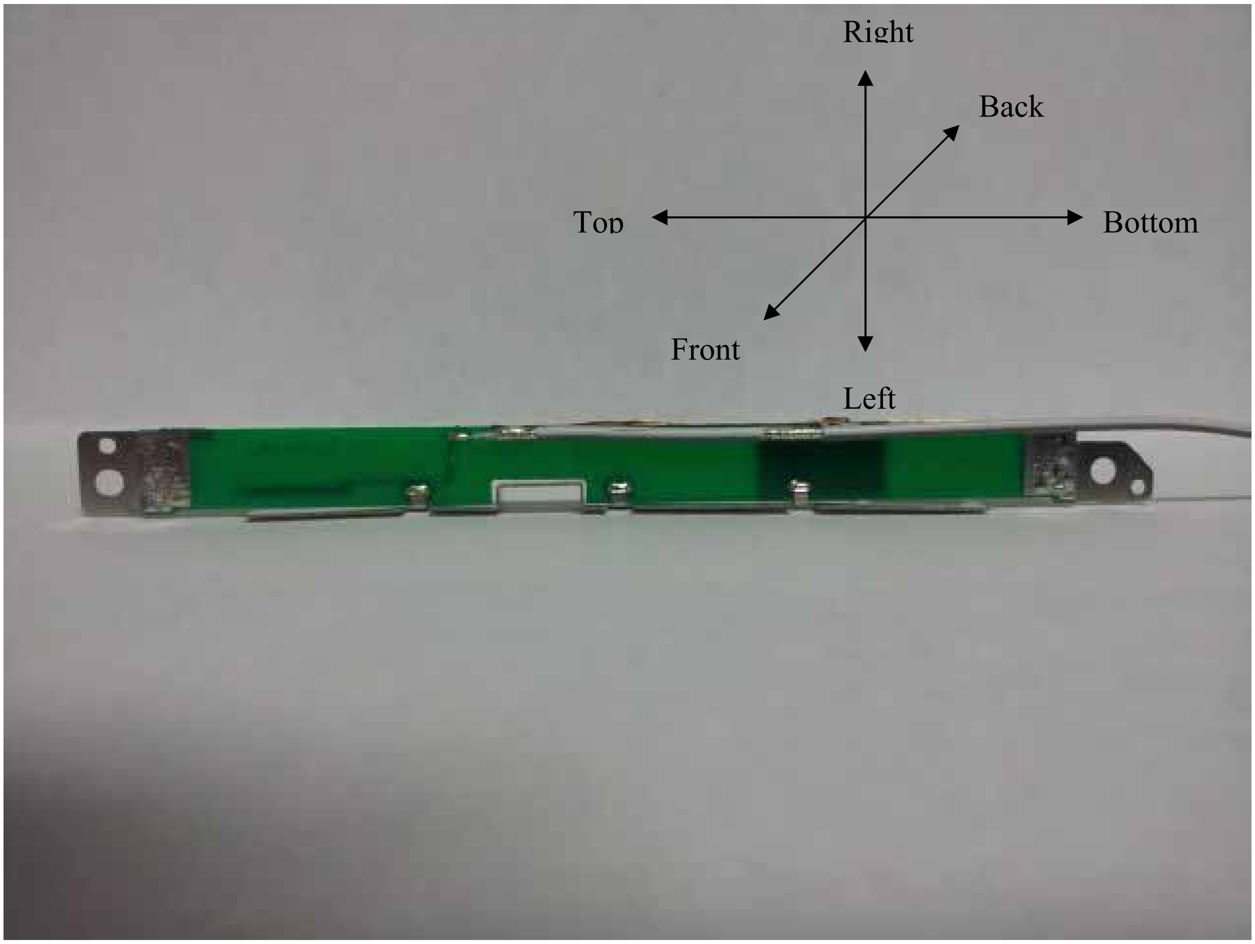
- Probe: EX3DV4 - SN3833; ConvF(6.69, 6.69, 6.69); Calibrated: 3/11/2013
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1321; Calibrated: 3/5/2013
- Phantom: SAM 1; Type: SAM Twin Phantom
- Measurement SW: DASY52, Version 52.8 (0); SEMCAD X Version 14.6.4 (4989)

BCM943228HMB/5 mm Bottom/Area Scan (61x61x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.057 mW/g
BCM943228HMB/5 mm Bottom/Zoom Scan (9x9x9)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 4.061 V/m; Power Drift = 0.30 dB
Peak SAR (extrapolated) = 0.0720
SAR(1 g) = 0.041 mW/g; SAR(10 g) = 0.023 mW/g
Maximum value of SAR (measured) = 0.058 mW/g

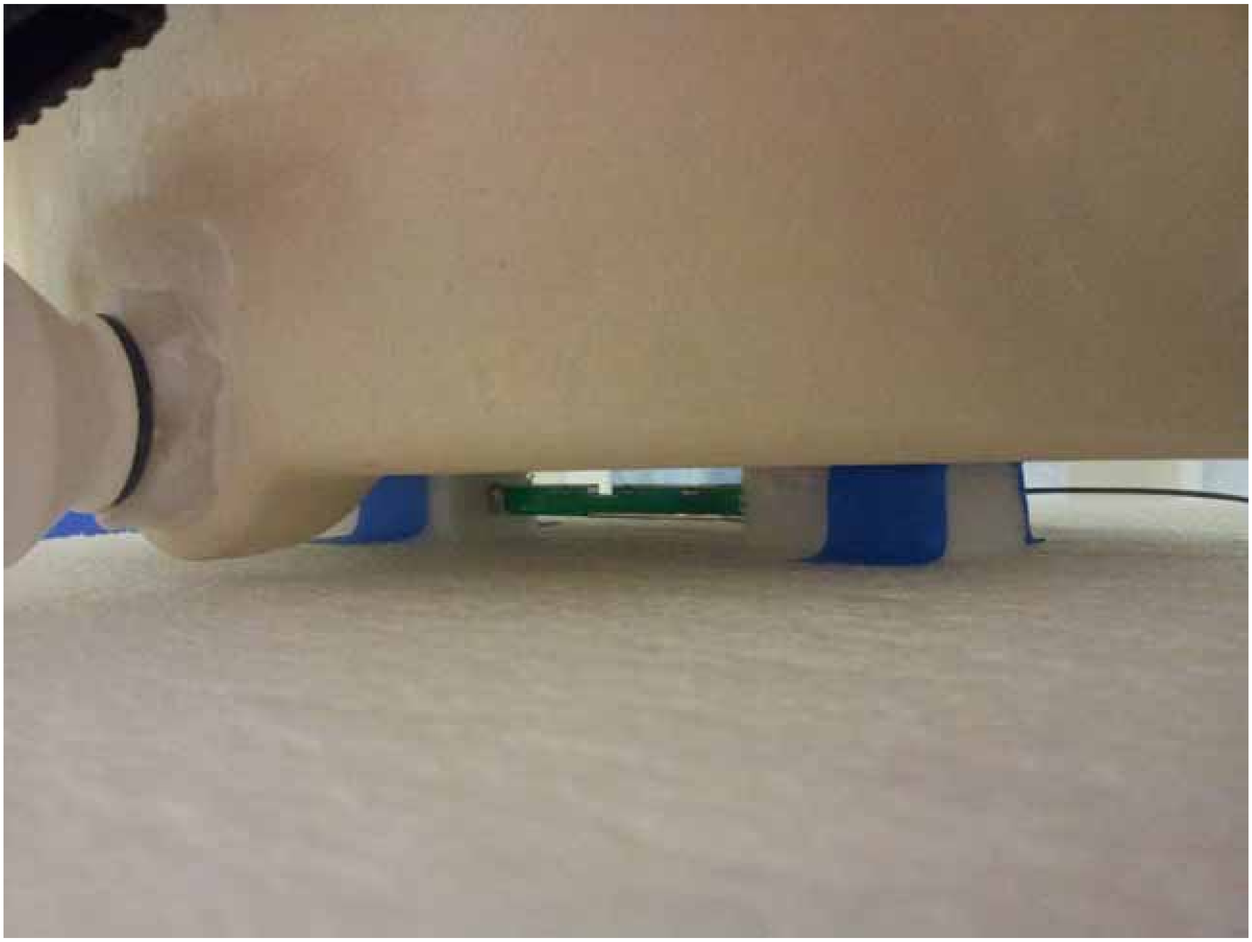


Appendix C – SAR Test Setup Photos

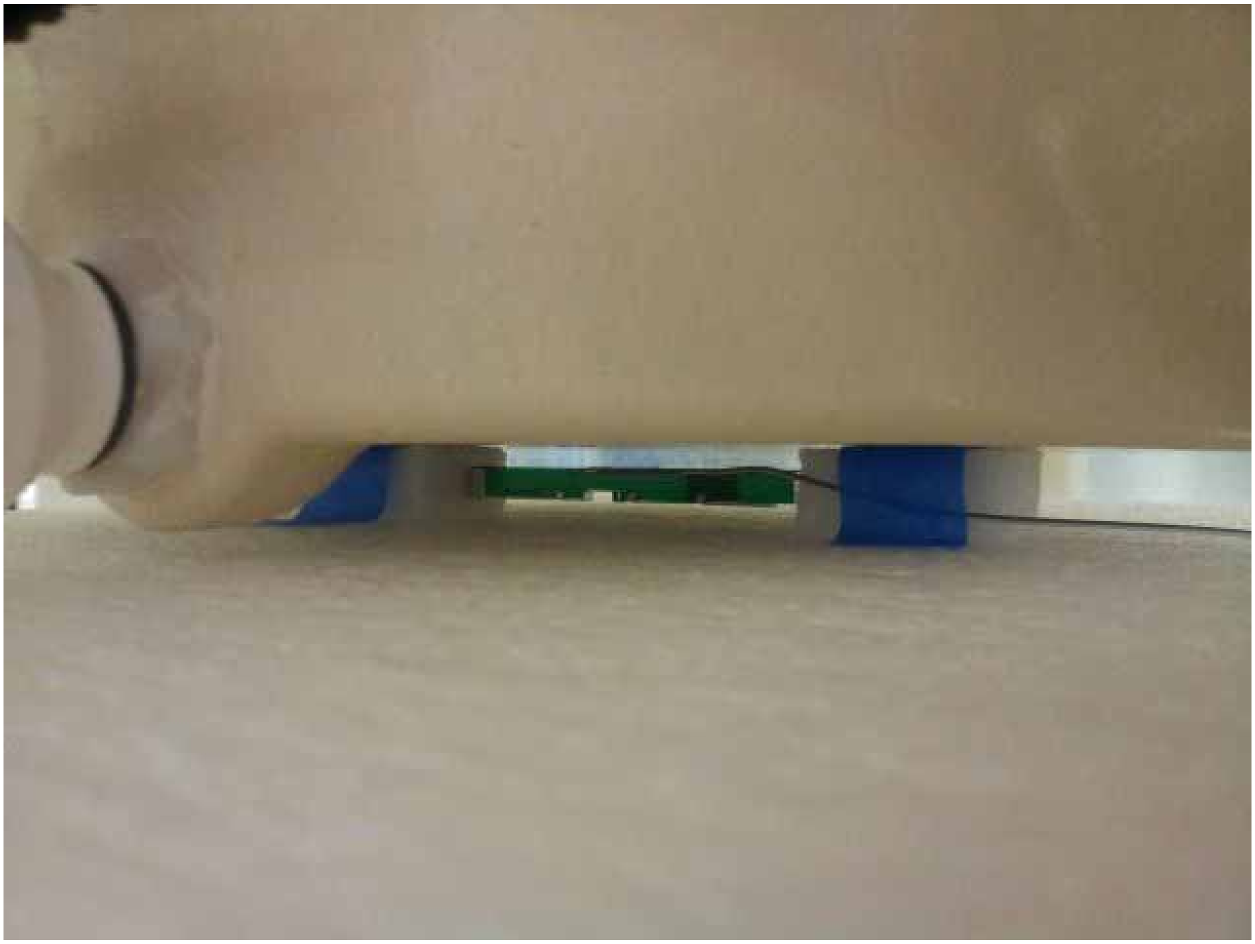
Picture 1: ACON APP8P-700045 antenna



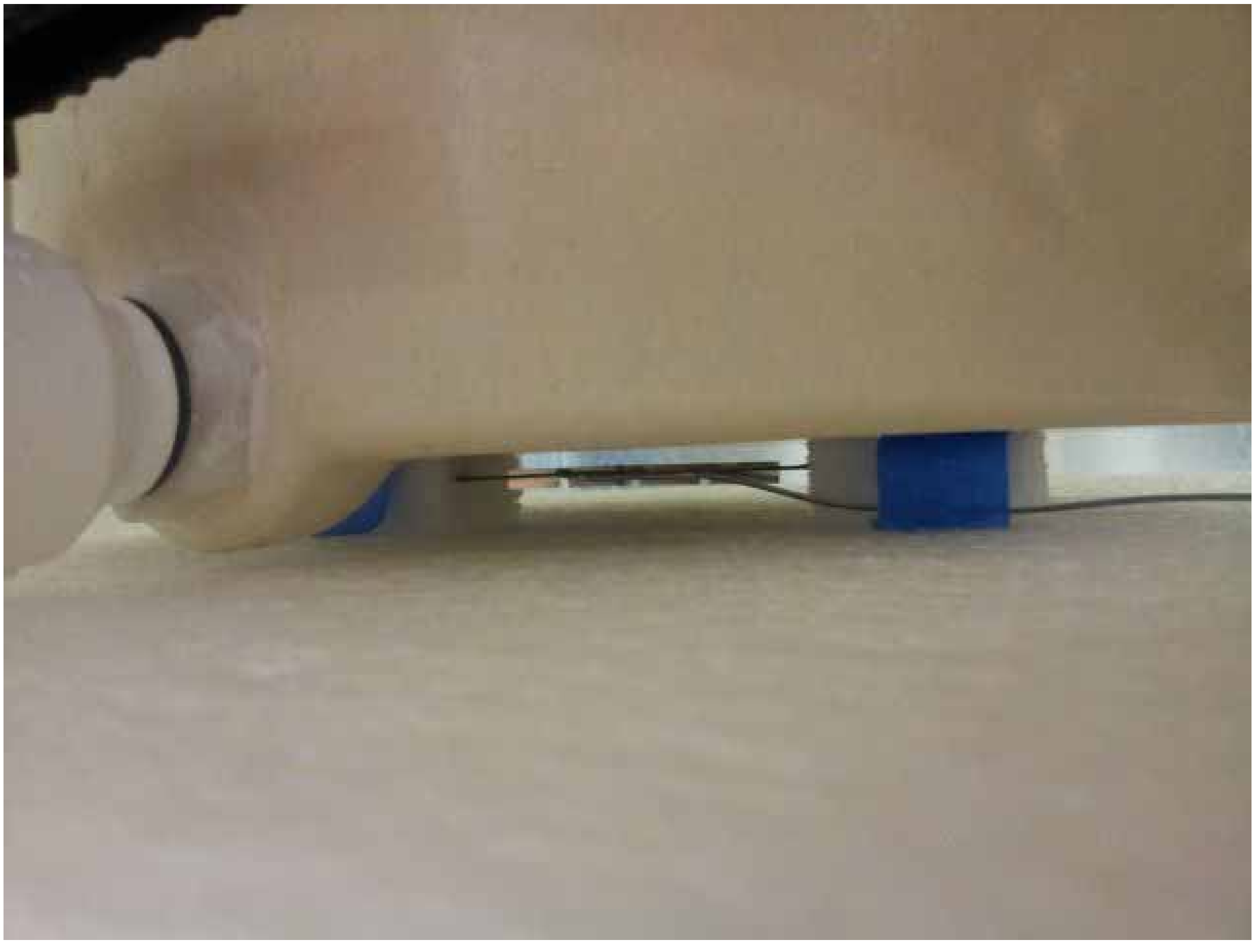
Picture 2: ACON APP8P-700045 antenna, Orientation= Left



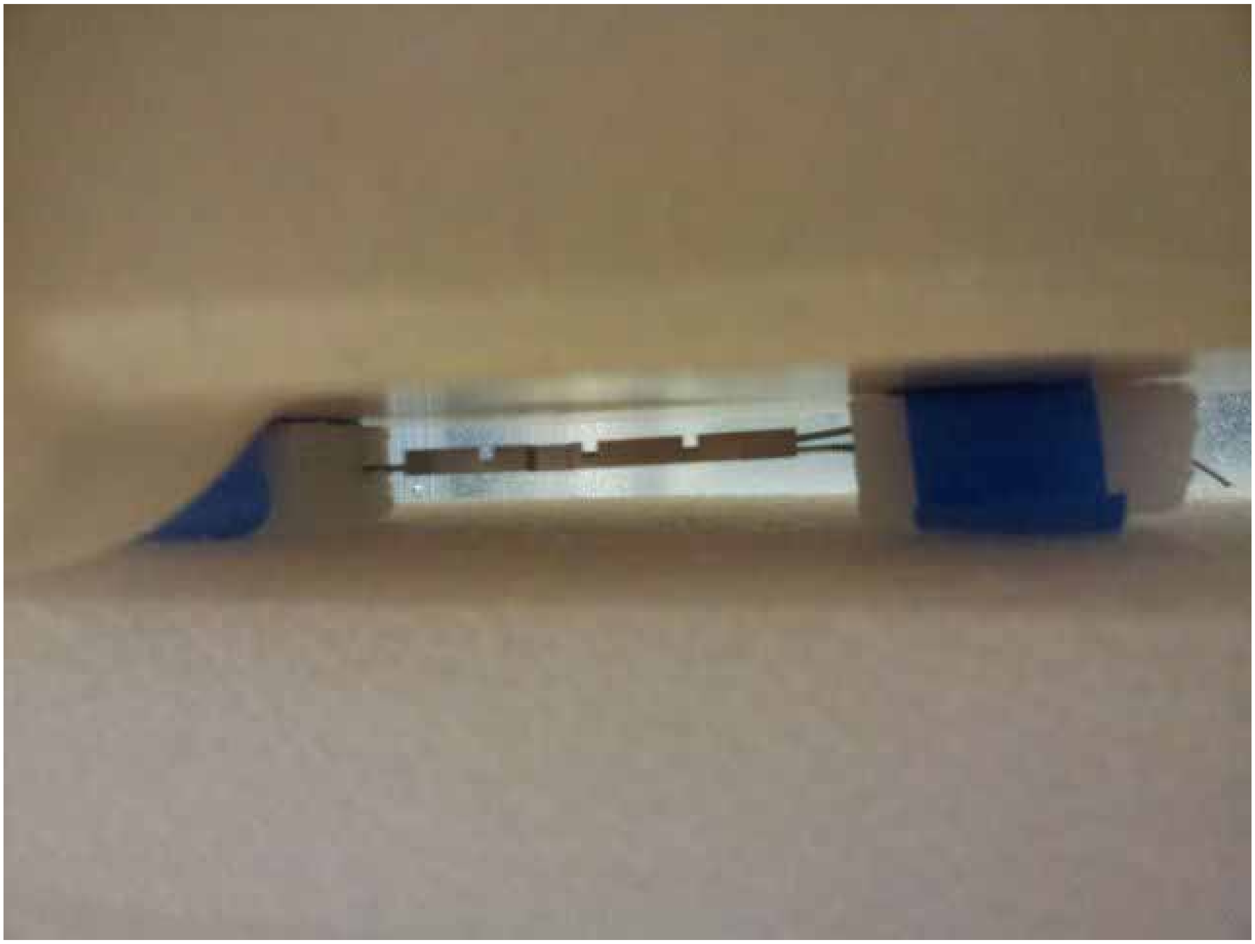
Picture 3: ACON APP8P-700045 antenna, Orientation = Right



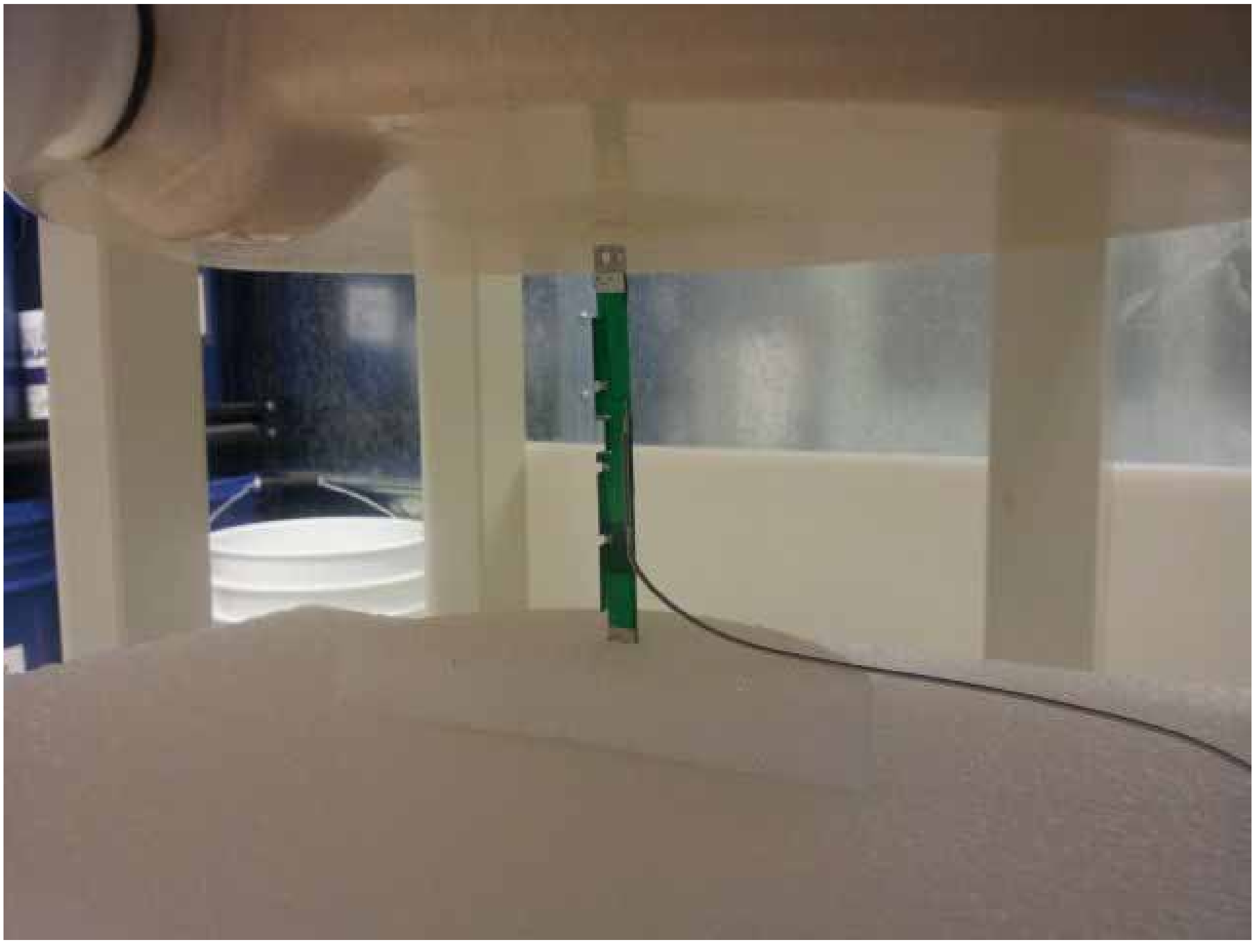
Picture 4: ACON APP8P-700045 antenna, Orientation = Front



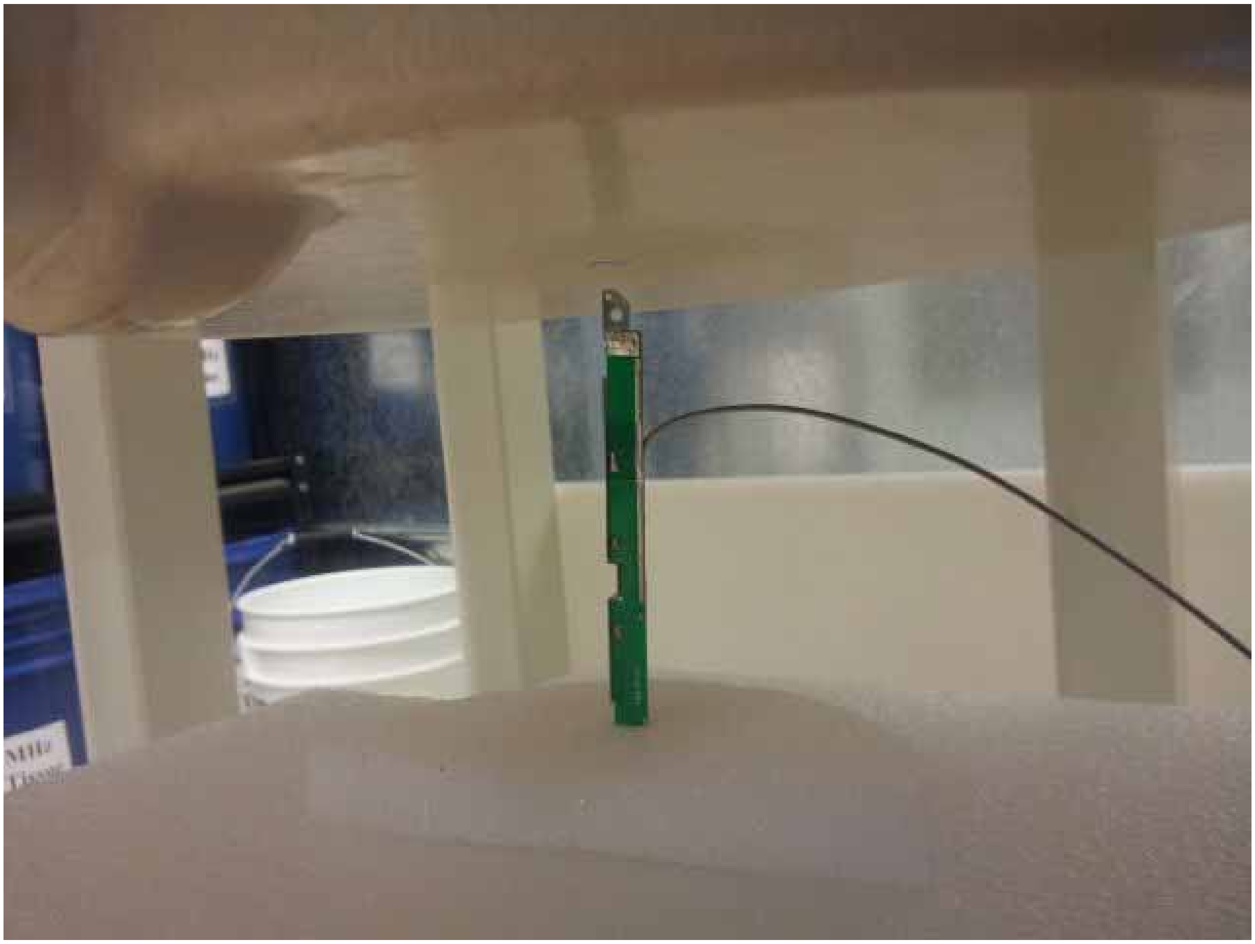
Picture 5: ACON APP8P-700045 antenna, Orientation = Back



Picture 6: ACON APP8P-700045 antenna, Orientation = Top



Picture 7: ACON APP8P-700045 antenna, Orientation = Bottom



Picture 8: EUT setup

Appendix D – Probe Calibration Data Sheets

2650

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
Servizio svizzero di taratura
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 **NTS**

Certificate No: **EX3-3833_Mar13**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3833

Calibration procedure(s): QA CAL-01.v8, QA CAL-14.v3, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes

Calibration date: March 11, 2013

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	29-Mar-12 (No. 217-01508)	Apr-13
Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01531)	Apr-13
Reference 20 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-01529)	Apr-13
Reference 30 dB Attenuator	SN: S5129 (30b)	27-Mar-12 (No. 217-01532)	Apr-13
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 12, 2013

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

Certificate No: EX3-3833_Mar13 Page 1 of 11

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

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

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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.

Probe EX3DV4

SN:3833

Manufactured: November 7, 2011
Calibrated: March 11, 2013

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3833

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m)²)[A]	0.47	0.49	0.35	± 10.1 %
DCP (mV)[B]	101.1	101.3	101.2	

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	154.8	±3.5 %
		Y	0.0	0.0	1.0		154.2	
		Z	0.0	0.0	1.0		133.1	

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:3833

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	Depth (mm)	Unct. (k=2)
750	41.9	0.89	9.31	9.31	9.31	0.28	1.05	± 12.0 %
835	41.5	0.90	8.91	8.91	8.91	0.37	0.89	± 12.0 %
900	41.5	0.97	8.77	8.77	8.77	0.27	1.00	± 12.0 %
1750	40.1	1.37	7.47	7.47	7.47	0.48	0.72	± 12.0 %
1900	40.0	1.40	7.22	7.22	7.22	0.37	0.82	± 12.0 %
2450	39.2	1.80	6.71	6.71	6.71	0.39	0.76	± 12.0 %
5200	36.0	4.66	4.78	4.78	4.78	0.30	1.80	± 13.1 %
5300	35.9	4.76	4.55	4.55	4.55	0.30	1.80	± 13.1 %
5600	35.5	5.07	4.01	4.01	4.01	0.40	1.80	± 13.1 %
5800	35.3	5.27	3.90	3.90	3.90	0.50	1.80	± 13.1 %

[C] Frequency validity 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.
[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.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3833

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	Depth (mm)	Unct. (k=2)
750	55.5	0.96	9.00	9.00	9.00	0.37	0.90	± 12.0 %
835	55.2	0.97	8.93	8.93	8.93	0.35	1.00	± 12.0 %
900	55.0	1.05	8.75	8.75	8.75	0.80	0.60	± 12.0 %
1750	53.4	1.49	7.21	7.21	7.21	0.75	0.63	± 12.0 %
1900	53.3	1.52	6.97	6.97	6.97	0.31	0.99	± 12.0 %
2450	52.7	1.95	6.69	6.69	6.69	0.80	0.57	± 12.0 %
5200	49.0	5.30	4.25	4.25	4.25	0.30	1.90	± 13.1 %
5300	48.9	5.42	4.06	4.06	4.06	0.30	1.90	± 13.1 %
5600	48.5	5.77	3.57	3.57	3.57	0.40	1.90	± 13.1 %
5800	48.2	6.00	3.64	3.64	3.64	0.50	1.90	± 13.1 %

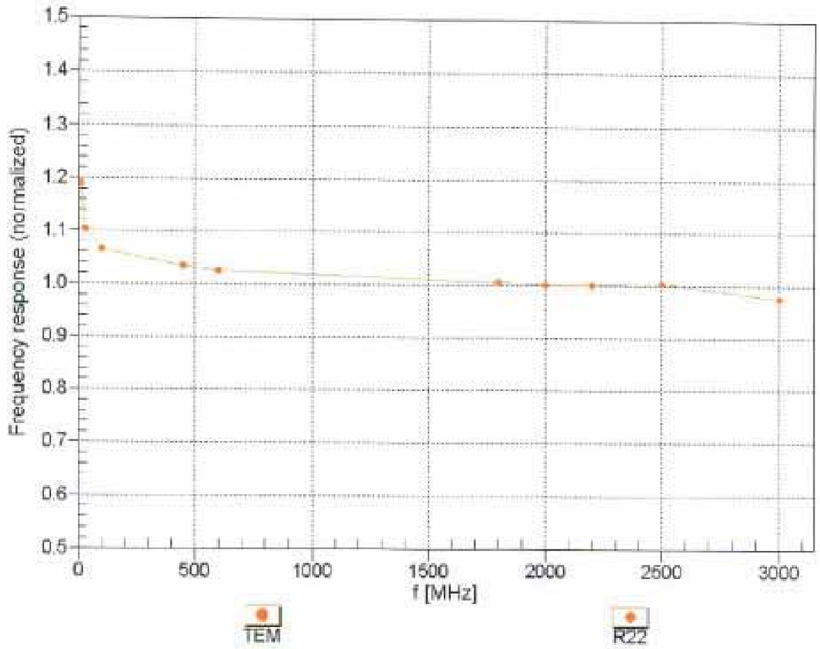
[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of 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.

EX3DV4– SN:3833

March 11, 2013

Frequency Response of E-Field

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

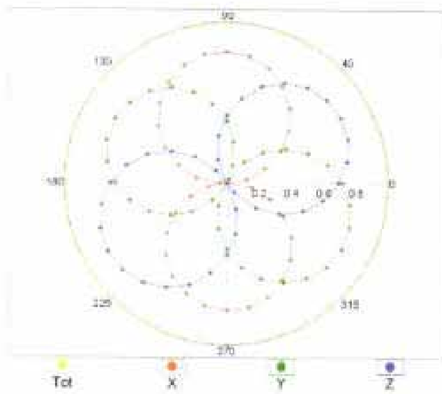


Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

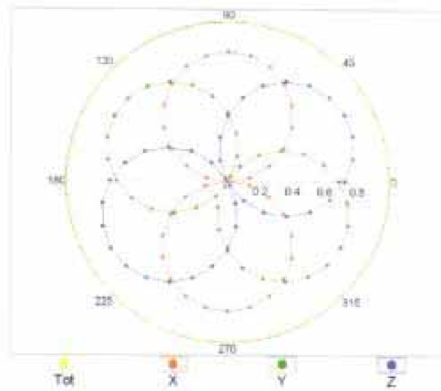
Certificate No: EX3-3833_Mar13 Page 7 of 11

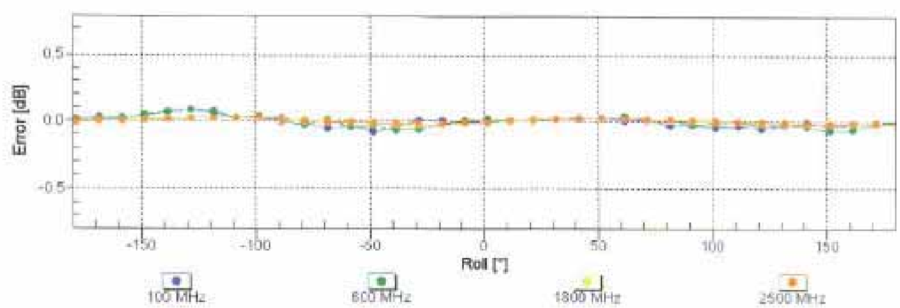
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22

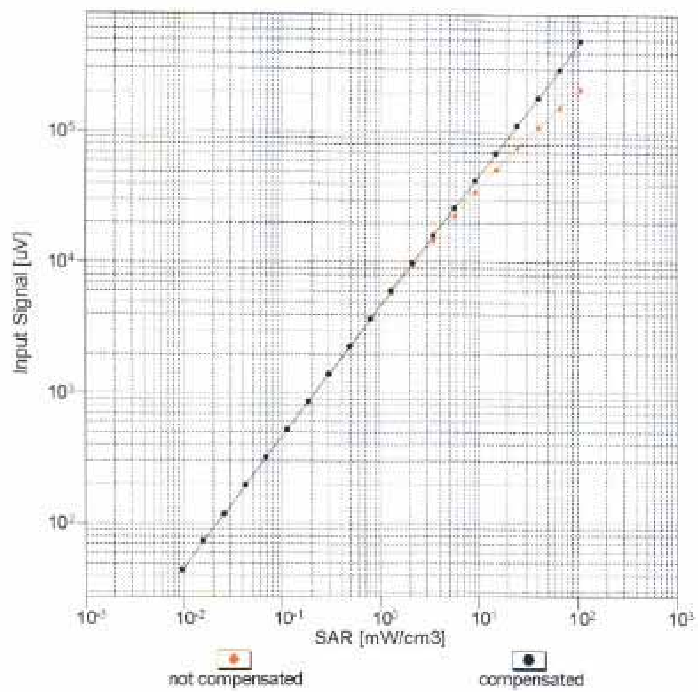


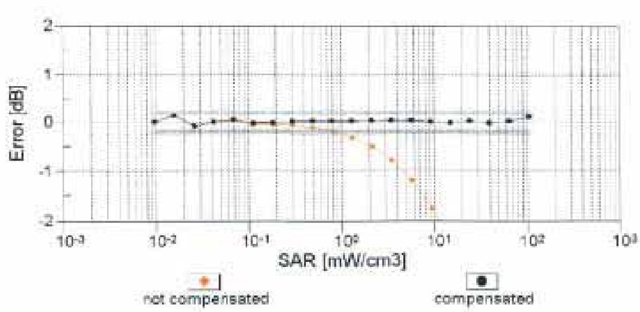


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

(TEM cell , f = 900 MHz)



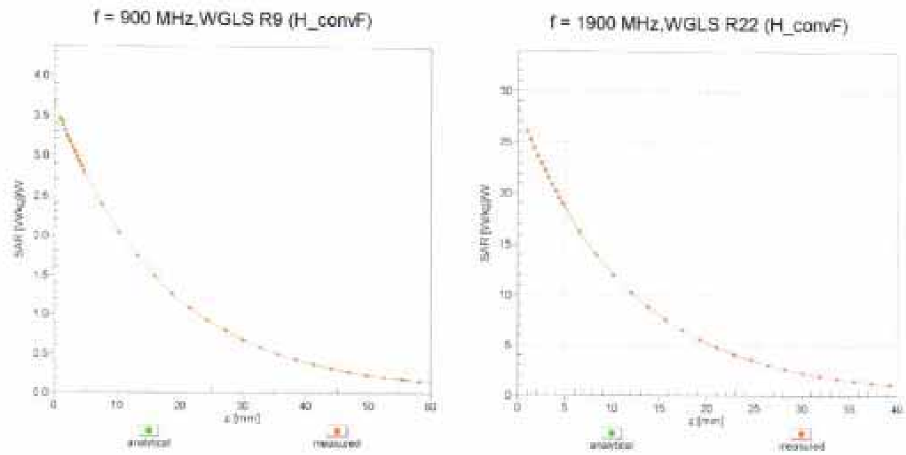


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

EX3DV4– SN:3833

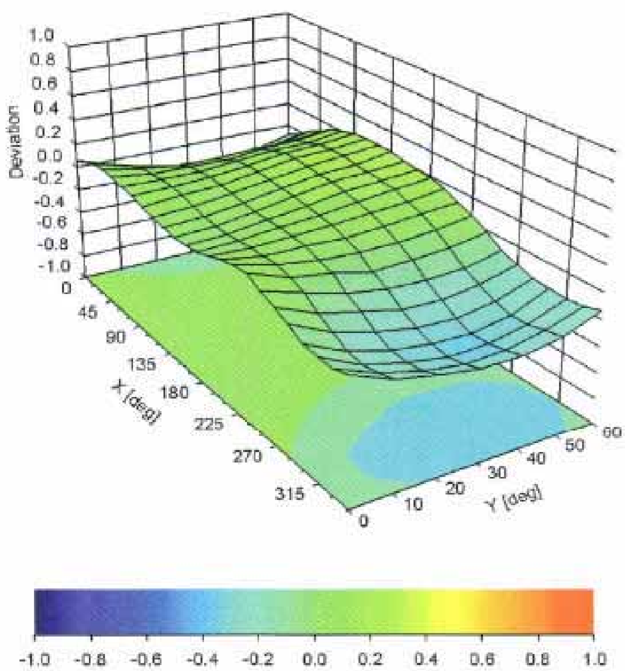
March 11, 2013

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

Certificate No: EX3-3833_Mar13 Page 10 of 11

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3833

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	11.5
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	2 mm

Appendix E – Dipole Calibration Data Sheets

#2654

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Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: **SCS 108**

Client **NTS**

Certificate No: **D2450V2-881_Feb12**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN: 881
Calibration procedure(s)	QA CAL-05.v8 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	February 07, 2012

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	05-Oct-11 (No. 217-01451)	Oct-12
Power sensor HP 8481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5086 (20g)	29-Mar-11 (No. 217-01368)	Apr-12
Type-N mismatch combination	SN: 5047.2 / 06327	29-Mar-11 (No. 217-01371)	Apr-12
Reference Probe ES3DV3	SN: 3205	30-Dec-11 (No. ES3-3205_Dec11)	Dec-12
DAE4	SN: 601	04-Jul-11 (No. DAE4-601_Jul11)	Jul-12
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	Israe El-Naouq
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 7, 2012

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Zeughausstrasse 43, 8004 Zurich, Switzerland

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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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

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.

Measurement Conditions

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

DASY Version	DASY5	V52.8.0
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	38.9 ± 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	13.5 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**53.1 mW /g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.23 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**24.7 mW /g ± 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	52.3 ± 6 %	2.02 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	12.8 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**50.3 mW / g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.93 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**23.5 mW / g ± 16.5 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.6 Ω + 3.1 jΩ
Return Loss	- 26.7 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.7 Ω + 4.6 jΩ
Return Loss	- 26.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.154 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 18, 2010

DASY5 Validation Report for Head TSL

Date: 07.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

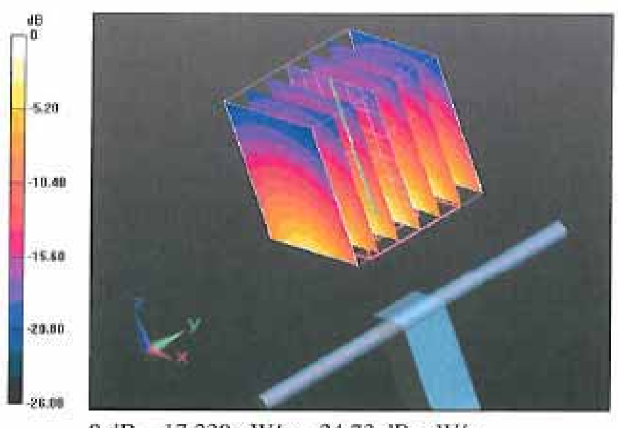
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 881

Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.86 mho/m; ε_r = 38.9; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

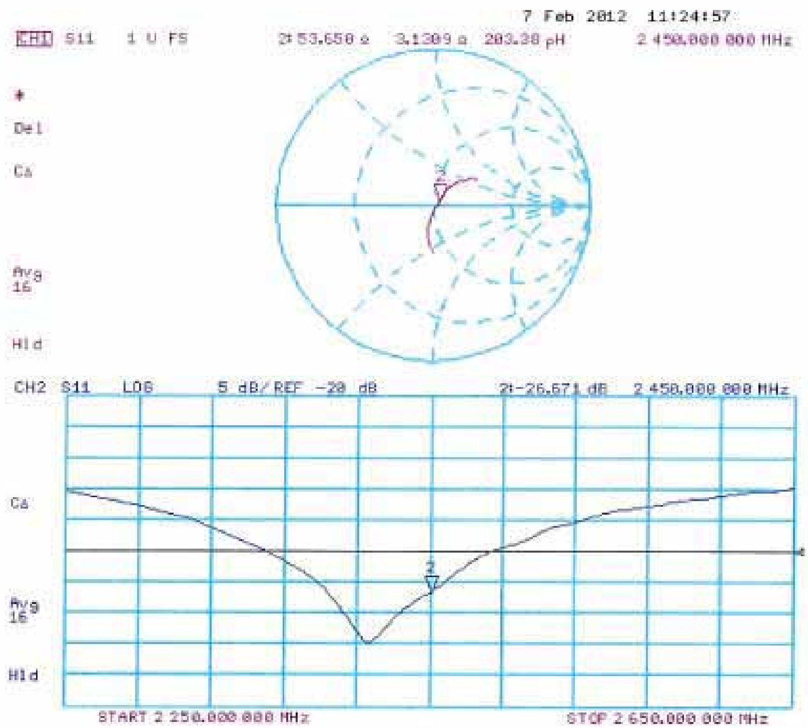
- Probe: ES3DV3 - SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

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 = 100.0 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 28.2110
SAR(1 g) = 13.5 mW/g; SAR(10 g) = 6.23 mW/g
Maximum value of SAR (measured) = 17.226 mW/g



0 dB = 17.230mW/g = 24.73 dB mW/g

Impedance Measurement Plot for Head TSL



Certificate No: D2450V2-881_Feb12 Page 6 of 8

DASY5 Validation Report for Body TSL

Date: 07.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 881

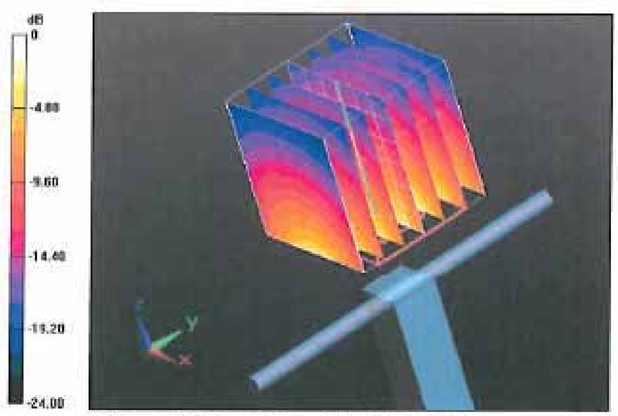
Communication System: CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.02 mho/m; ε_r = 52.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

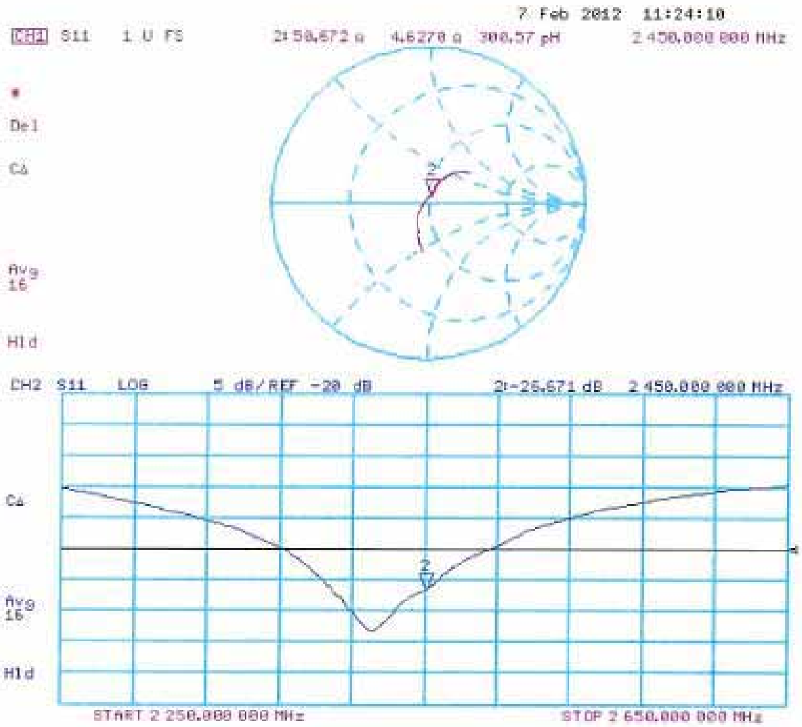
Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 94.726 V/m; Power Drift = 0.00039 dB
Peak SAR (extrapolated) = 26.1450
SAR(1 g) = 12.8 mW/g; SAR(10 g) = 5.93 mW/g
Maximum value of SAR (measured) = 16.781 mW/g



0 dB = 16.780mW/g = 24.50 dB mW/g

Impedance Measurement Plot for Body TSL



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Accreditation No.: **SCS 108**

Client **NTS**

Certificate No: **D5GHzV2-1119_Feb12**

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN: 1119
Calibration procedure(s)	QA CAL-22.v1 Calibration procedure for dipole validation kits between 3-6 GHz
Calibration date:	February 01, 2012

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	05-Oct-11 (No. 217-01451)	Oct-12
Power sensor HP 8481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5086 (20g)	29-Mar-11 (No. 217-01368)	Apr-12
Type-N mismatch combination	SN: 5047.2 / 06327	29-Mar-11 (No. 217-01371)	Apr-12
Reference Probe EX3DV4	SN: 3503	30-Dec-11 (No. EX3-3503_Dec11)	Dec-12
DAE4	SN: 601	04-Jul-11 (No. DAE4-601_Jul11)	Jul-12

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: February 2, 2012

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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 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
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) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

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.

Measurement Conditions

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

DASY Version	DASY5	V52.8.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5500 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	36.3 ± 6 %	4.60 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.05 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**80.6 mW /g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**23.0 mW /g ± 16.5 % (k=2)**

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.8 ± 6 %	4.90 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.46 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**84.6 mW / g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**24.0 mW / g ± 16.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.3 ± 6 %	5.22 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.93 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**79.3 mW / g ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.26 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	**22.6 mW / g ± 16.5 % (k=2)**

Body TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	49.2 ± 6 %	5.46 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.21 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**72.2 mW / g ± 18.1 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.02 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**20.3 mW / g ± 17.6 % (k=2)**

Body TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.65 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.7 ± 6 %	5.86 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.95 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**79.7 mW / g ± 18.1 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.21 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**22.1 mW / g ± 17.6 % (k=2)**

Body TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	48.2 ± 6 %	6.28 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	100 mW input power	7.33 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**73.4 mW / g ± 18.1 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.03 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	**20.3 mW / g ± 17.6 % (k=2)**

Appendix

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	52.2 Ω - 7.5 jΩ
Return Loss	- 22.4 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	54.8 Ω - 3.3 jΩ
Return Loss	- 25.1 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	57.0 Ω - 2.8 jΩ
Return Loss	- 23.1 dB

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	52.3 Ω - 4.4 jΩ
Return Loss	- 26.0 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	55.9 Ω - 0.7 jΩ
Return Loss	- 25.4 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	58.2 Ω - 0.5 jΩ
Return Loss	- 22.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.207 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	September 08, 2011

DASY5 Validation Report for Head TSL

Date: 01.02.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1119

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.6 mho/m; ε_r = 36.3; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 4.9 mho/m; ε_r = 35.8; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 5.22 mho/m; ε_r = 35.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

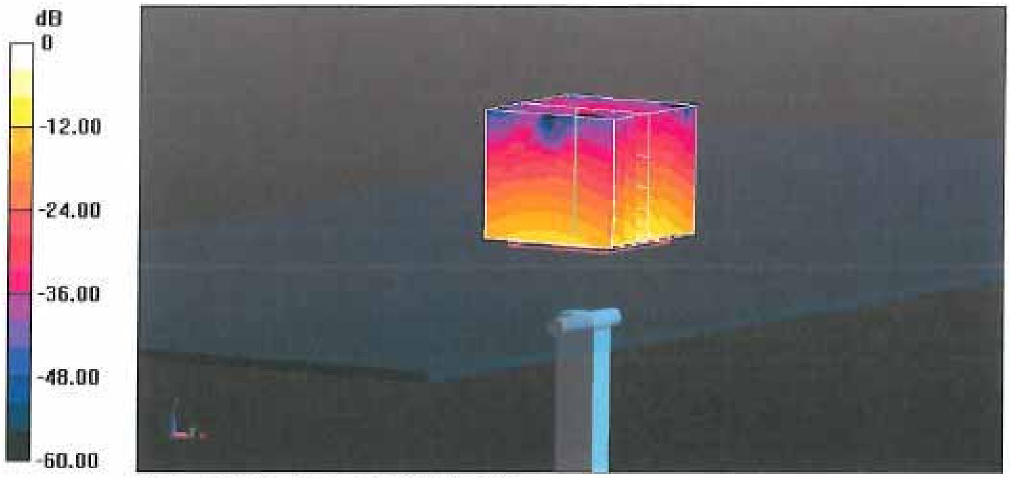
DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.41, 5.41, 5.41), ConvF(4.91, 4.91, 4.91), ConvF(4.81, 4.81, 4.81); Calibrated: 30.12.2011
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.696 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 30.1420
SAR(1 g) = 8.05 mW/g; SAR(10 g) = 2.3 mW/g
Maximum value of SAR (measured) = 18.341 mW/g

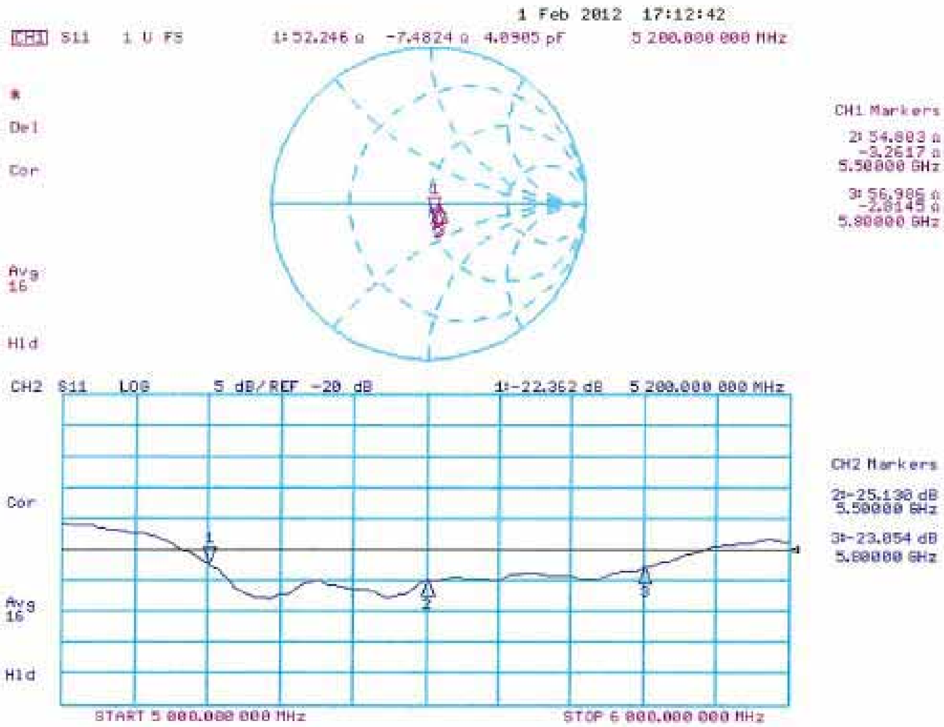
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 65.190 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 33.7070
SAR(1 g) = 8.46 mW/g; SAR(10 g) = 2.4 mW/g
Maximum value of SAR (measured) = 19.665 mW/g

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 61.520 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 33.0670
SAR(1 g) = 7.93 mW/g; SAR(10 g) = 2.26 mW/g
Maximum value of SAR (measured) = 18.794 mW/g



0 dB = 18.790mW/g = 25.48 dB mW/g

Impedance Measurement Plot for Head TSL



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DASY5 Validation Report for Body TSL

Date: 31.01.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1119

Communication System: CW; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 5.46 mho/m; ε_r = 49.2; ρ = 1000 kg/m^3 , Medium parameters used: f = 5500 MHz; σ = 5.86 mho/m; ε_r = 48.7; ρ = 1000 kg/m^3 , Medium parameters used: f = 5800 MHz; σ = 6.28 mho/m; ε_r = 48.2; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

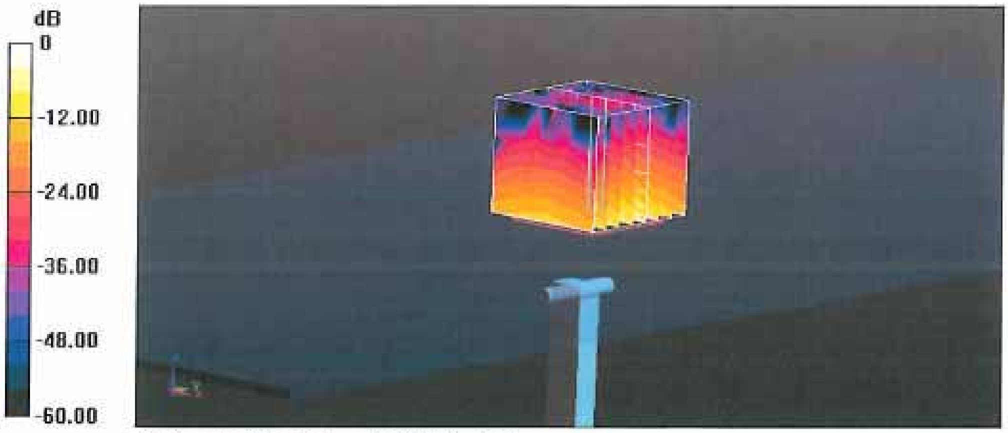
DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.91, 4.91, 4.91), ConvF(4.43, 4.43, 4.43), ConvF(4.38, 4.38, 4.38); Calibrated: 30.12.2011
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 57.414 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 28.2590
SAR(1 g) = 7.21 mW/g; SAR(10 g) = 2.02 mW/g
Maximum value of SAR (measured) = 16.585 mW/g

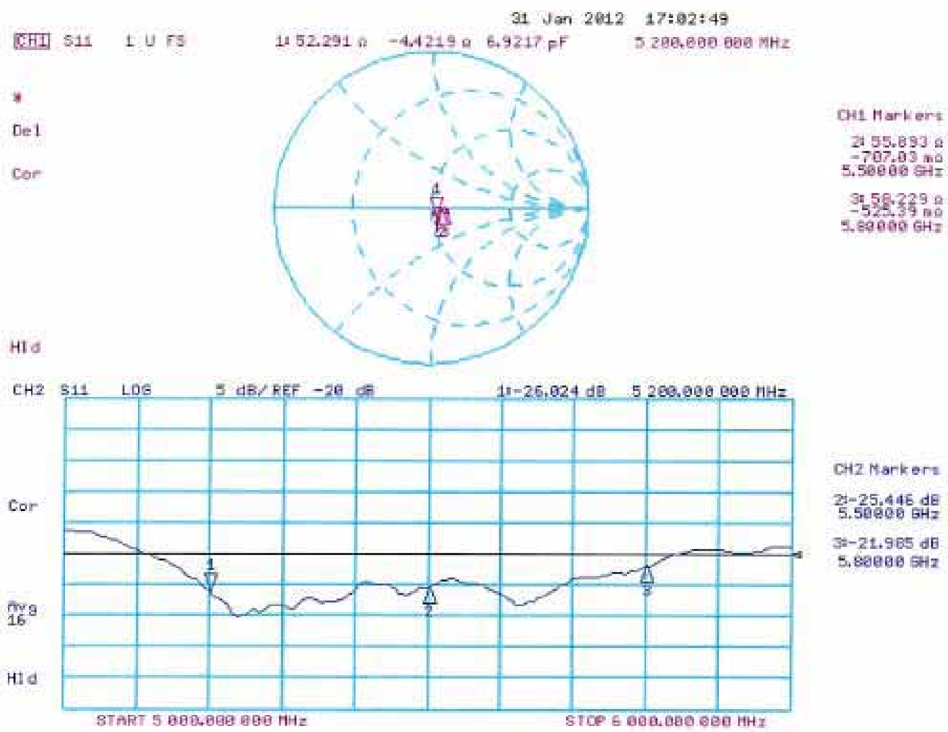
Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 58.115 V/m; Power Drift = -0.0036 dB
Peak SAR (extrapolated) = 34.0110
SAR(1 g) = 7.95 mW/g; SAR(10 g) = 2.21 mW/g
Maximum value of SAR (measured) = 18.670 mW/g

Dipole Calibration for Body Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 54.109 V/m; Power Drift = -0.0044 dB
Peak SAR (extrapolated) = 33.9510
SAR(1 g) = 7.33 mW/g; SAR(10 g) = 2.03 mW/g
Maximum value of SAR (measured) = 17.843 mW/g



0 dB = 17.840mW/g = 25.03 dB mW/g

Impedance Measurement Plot for Body TSL



End of test report