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SAR COMPLIANCE EVALUATION REPORT FCC CFR §2.1093 / INDUSTRY CANADA RSS-102

Applicant Name:
Panasonic Corporation of North America
One Panasonic Way, 4B-8
Secaucus, NJ 07094
United States

Date of Testing:
04/12/10 - 04/15/10
Test Site/Location:
PCTEST Lab, Columbia, MD, USA
Test Report Serial No.:
0Y1003170442.ACJ

FCC ID: ACJ9TGCF-F91

IC CERTIFICATION No.: 216-CFF91

APPLICANT: PANASONIC CORPORATION OF NORTH AMERICA

EUT Type: Laptop PC with WLAN, Bluetooth and WWAN
Application Type: Certification
FCC Rule Part(s): CFR §2.1093; FCC/OET Bulletin 65 Supplement C [June 2001]
IC Specification(s): RSS-102, Issue 4, Health Canada Safety Code 6
FCC Classification: Unlicensed National Information Infrastructure (UNII)/ PCS Licensed Transmitter (PCB) / Digital Transmission system (DTS)/FCC Part 15 Frequency Hopping Spread Spectrum Transceiver (DSS)
IC Radio Equipment Type: Cellular communications Apparatus
FCC Model(s): CF-F9mk1
IC Model(s): CF-F91
Tx Frequencies Evaluated: 2412-2462 MHz(WLAN 802.11b/g/n)
5180-5240 MHz / 5260-5320 MHz / 5500-5700 MHz(WLAN 802.11a/n)
2402-2480 MHz (Bluetooth)
Conducted Power: 13.61 dBm 802.11b/14.47 dBm 802.11g/14.72 dBm 802.11n 2.4GHz
14.46 dBm 802.11a 5.2 GHz / 13.85 dBm 802.11n 5.2 GHz
14.44 dBm 802.11a 5.3 GHz / 13.72 dBm 802.11n 5.3 GHz
14.96 dBm 802.11a 5.5 GHz / 13.94 dBm 802.11n 5.5 GHz
14.35 dBm 802.11a 5.8 GHz / 14.23 dBm 802.11n 5.8 GHz
13.67 dBm Bluetooth
Max. SAR Measurement: 0.01 W/kg 802.11a 2.4 GHz Body SAR
0.02 W/kg 802.11a 5.2 GHz / 0.01 W/kg 802.11a 5.3 GHz Body SAR
0.02 W/kg 802.11a 5.5 GHz / 0.01 W/kg 802.11a 5.8 GHz Body SAR
0.01 W/kg Bluetooth SAR
DUT Serial No.: Pre-Production [S/N: 0AKSA00515]

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE C95.1-1992 and has been tested in accordance with the measurement procedures specified in FCC/OET Bulletin 65 Supplement C (2001), IEEE 1528-2003 and in applicable Industry Canada Radio Standards Specifications (RSS); for North American frequency bands only.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them. Test results reported herein relate only to the item(s) tested.

PCTEST certifies that no party to this application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 862.


Randy Ortanez
President



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1 INTRODUCTION

The FCC and Industry Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices.[1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz[2] and Health Canada RF Exposure Guidelines Safety Code 6 [26]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [3] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields,” Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

1.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Fig. 1-1).

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

Figure 1-1
SAR Mathematical Equation

SAR is expressed in units of Watts per Kilogram (W/kg).

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

where:

- σ = conductivity of the tissue-simulating material (S/m)
- ρ = mass density of the tissue-simulating material (kg/m³)
- E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.[6]

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2 TEST SITE LOCATION

2.1 INTRODUCTION

The map at the right shows the location of the PCTEST LABORATORY in Columbia, Maryland. It is in proximity to the FCC Laboratory, the Baltimore-Washington International (BWI) airport, the city of Baltimore and Washington, DC (See Figure 2).

These measurement tests were conducted at the PCTEST Engineering Laboratory, Inc. facility in New Concept Business Park, Guilford Industrial Park, Columbia, Maryland. The site address is 6660-B Dobbin Road, Columbia, MD 21045. The test site is one of the highest points in the Columbia area with an elevation of 390 feet above mean sea level. The site coordinates are 39° 11'15" N latitude and 76° 49' 38" W longitude. The facility is 1.5 miles north of the FCC laboratory, and the ambient signal and ambient signal strength are approximately equal to those of the FCC laboratory. There are no FM or TV transmitters within 15 miles of the site. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4 on January 27, 2006 and Industry Canada. PCTEST facility is an IC registered (2341A-1) test laboratory with the site description filed to Industry Canada in accordance with Radio Standards Specifications (RSS).

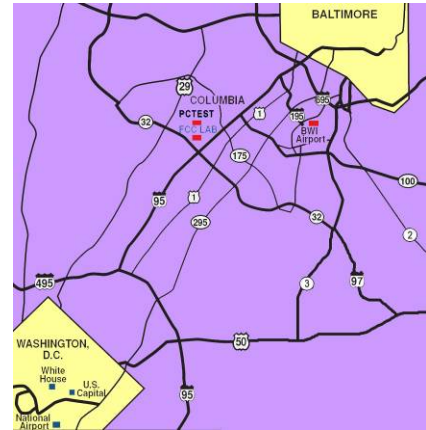
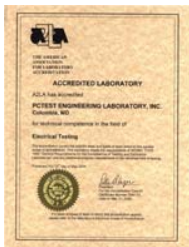


Figure 2-1
Map of the Greater Baltimore and Metropolitan Washington, D.C. area

2.2 Test Facility / Accreditations:

Measurements were performed at an independent accredited PCTEST Engineering Lab located in Columbia, MD 21045, U.S.A.



- PCTEST Lab is accredited to ISO 17025-2005 by the American Association for Laboratory Accreditation (A2LA) in Specific Absorption Rate (SAR) testing, Hearing-Aid Compatibility (HAC), CTIA Test Plans, and wireless testing for FCC and Industry Canada Rules.
- PCTEST Lab is accredited to ISO 17025 by U.S. National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP Lab code: 100431-0) in EMC, FCC and Telecommunications.
- PCTEST facility is an FCC registered (PCTEST Reg. No. 90864) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules and Industry Canada (IC-2451).
- PCTEST Lab is a recognized U.S. Conformity Assessment Body (CAB) in EMC and R&TTE (n.b. 0982) under the U.S.-EU Mutual Recognition Agreement (MRA).
- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC Guide 65 by the American National Standards Institute (ANSI) in all scopes of FCC Rules and all Industry Canada Standards (RSS).
- PCTEST facility is an IC registered (IC-2451) test laboratory with the site description on file at Industry Canada.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for AMPS and CDMA, and EvDO mobile phones.
- PCTEST is a CTIA Authorized Test Laboratory (CATL) for Over-the-Air (OTA) Antenna Performance testing for AMPS, CDMA, GSM, GPRS, EGPRS, UMTS (W-CDMA), CDMA 1xEVDO Data, CDMA 1xEVDO Data

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3 SAR MEASUREMENT SETUP

3.1 Robotic System

Measurements are performed using the DASY4 automated dosimetric assessment system. The DASY4 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, Pentium 4 computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the brain 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 Figure 3-1).

3.2 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 Gateway Pentium 4 2.53 GHz computer with Windows XP system and SAR Measurement Software DASY4, 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.

3.3 System Electronics

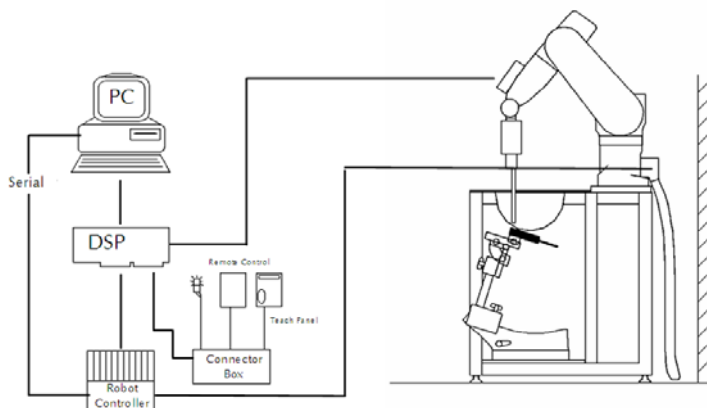


Figure 3-1
SAR Measurement System Setup

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 [7].

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3.4 Automated Test System Specifications

Positioner

Robot: Stäubli Unimation Corp. Robot RX60L
Repeatability: 0.02 mm
No. of Axes: 6

Data Acquisition Electronic System (DAE)

Cell Controller

Processor: Pentium 4
Clock Speed: 2.53 GHz
Operating System: Windows XP Professional

Data Converter

Features: Signal Amplifier, multiplexer, A/D converter & control logic
Software: DASY4, SEMCAD software
Connecting Lines: Optical Downlink for data and status info
Optical upload for commands and clock

PC Interface Card

Function: 166MHz low power Pentium MMX 32MB chipdisk
Link to DAE
16-bit A/D converter for surface detection system
Two Serial & Ethernet link to robotics
Direct emergency stop output for robot

Phantom

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



Figure 3-2
DASY4 SAR Measurement System

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4.1 Probe Measurement System



Figure 4-1
SAR System

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration [7] (see Figure 4-3) 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. 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 DASY4 software reads the reflection during a software approach

and looks for the maximum using a 2nd order fitting (see Figure 5-1). The approach is stopped at reaching the maximum.

4.2 Probe Specifications

Model:	ES3DV3, EX3DV4
Frequency Range:	10 MHz – 6.0 GHz (EX3DV4) 10 MHz – 4 GHz (ES3DV3)
Calibration:	In brain and muscle simulating tissue at Frequencies from 835 up to 5800MHz
Linearity:	± 0.2 dB (30 MHz to 6 GHz) for EX3DV4 ± 0.2 dB (30 MHz to 4 GHz) for ES3DV3
Dynamic Range:	10 mW/kg – 100 W/kg
Probe Length:	330 mm
Probe Tip Length:	20 mm
Body Diameter:	12 mm
Tip Diameter:	2.5 mm (3.9mm for ES3DV3)
Tip-Center:	1 mm (2.0 mm for ES3DV3)
Application:	SAR Dosimetry Testing Compliance tests of mobile phones Dosimetry in strong gradient fields



Figure 4-2
Near-Field Probe



Figure 4-3
Triangular Probe Configuration

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5 PROBE CALIBRATION PROCESS

5.1 Dosimetric Assessment Procedure

Each E-Probe/Probe amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm²) using an RF Signal generator, TEM cell, and RF Power Meter.

5.2 Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/cm².

5.3 Temperature Assessment

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The E-field in the medium correlates with the temperature rise in the 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/cm³ 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;

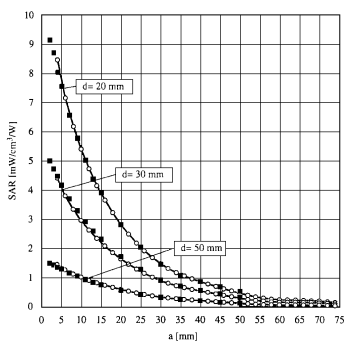


Figure 5-1 E-Field and Temperature measurements at 900MHz [7]

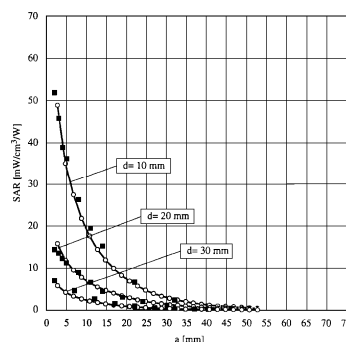


Figure 5-2 E-Field and temperature measurements at 1.9GHz [7]

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6 PHANTOM AND EQUIVALENT TISSUES

6.1 SAM Phantoms



Figure 6-1
SAM Phantoms

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 [11][12]. 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. 5.1)

6.2 Brain & Muscle Simulating Mixture Characterization

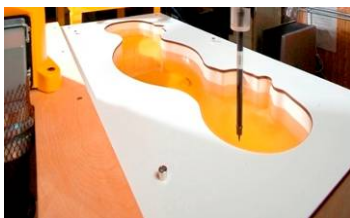


Figure 6-2
Head Simulated

The brain and muscle mixtures consist of a viscous gel using hydroxethylcellulose (HEC) gelling agent and saline solution (see Table 6-1). Preservation with a bactericide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 have been incorporated in the following table. Other head and body tissue parameters that have not been specified in IEEE-1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations. The mixture characterizations used for the brain and muscle tissue simulating liquids are according to the data by C. Gabriel and G. Hartsgrrove [13]. (See Table 6-1)

Table 6-1
Composition of the Brain & Muscle Tissue Equivalent Matter

Frequency (MHz)	300	450	835	900				1450	1800				1900		1950	2000	2100			2450	3000
Recipe #	1	1	3	1	1	2	3	1	1	2	2	3	1	2	4	1	1	2	2	3	2
Ingredient: (% by weight)																					
1,2-Propanediol							64.81														
Bactericide	0.19	0.19	0.50	0.10	0.10		0.50					0.50								0.50	
Diacetin			48.90				49.20					49.43								49.75	
DGSE								45.41	47.00	13.84	44.92		44.94	13.84	45.00	50.00	50.00	7.99	7.99		7.99
HEC	0.98	0.98		1.00	1.00																
NaCl	5.95	3.95	1.70	1.45	1.48	0.79	1.10	0.67	0.36	0.35	0.18	0.64	0.18	0.35				0.16	0.16		0.16
Sucrose	55.32	56.32		57.00	56.50																
Triton X-100										30.45				30.45				19.97	19.97		19.97
Water	37.56	38.56	48.90	40.45	40.92	34.40	49.20	53.80	52.64	55.36	54.90	49.43	54.90	55.36	55.00	50.00	50.00	71.88	71.88	49.75	71.88
Measured dielectric parameters																					
ϵ'_p	46.00	43.4	44.3	41.6	41.2	41.8	42.7	40.9	39.3	41	40.4	39.2	39.9	41	40.1	37	36.8	41.1	40.3	39.2	37.9
σ (S/m)	0.86	0.85	0.9	0.9	0.98	0.97	0.99	1.21	1.39	1.38	1.4	1.4	1.42	1.38	1.41	1.4	1.51	1.55	1.88	1.82	2.46
Temp. (°C)	22	22	20	22	22	22	20	22	22	21	22	20	21	21	20	22	22	20	20	20	20
Target dielectric parameters: (Table 2)																					
ϵ'_p	45.30	43.50	41.5	41.50				40.5	40.0								39.80			39.2	38.3
σ (S/m)	0.87	0.87	0.9	0.97				1.2	1.4								1.49			1.8	2.4
NOTE—Multiple columns for any single frequency are optional recipes. Recipe #, reference: 1 (Kashi et al. [B85]), 2 (Vignosa [B143]), 3 (Peyman and Gabriel [B119]), 4 (Polaronga et al. [B50]).																					

NOTE—Multiple columns for any single frequency are optional recipes. Recipe #, reference: 1 (Kanda et al. [B85]), 2 (Vigneron [B145]), 3 (Vigneron and Gabriel [B119]), 4 (Fitzpatrick et al. [B50]).

*The formulas containing Triton X-100 and corresponding measured parameters are under review and verification.

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7.1 Measurement Procedure

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 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 3.0mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 15mm x 15mm.
3. Based on the area scan data, the area of the maximum absorption was determined by spline interpolation. Around this point, a volume of 32mm x 32mm x 30mm (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 Figure 7-1):
 - a. The data at the surface was extrapolated, since the center of the dipoles is 2.7mm 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 [15]. 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 splines with the "Not a knot" condition (in x, y, and z directions) [15][16]. The volume was integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 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.

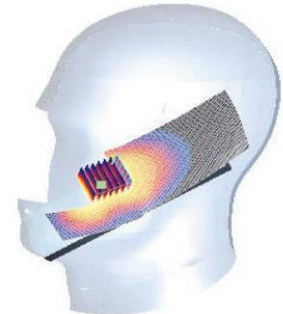


Figure 7-1
Sample SAR Area Scan

7.2 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 Figure 7-2). The perimeter sidewalls 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 7-2
SAM Twin Phantom Shell

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8.1 SAR Testing with IEEE 802.11 a/b/g Transmitters

Normal network operating configurations are not suitable for measuring the SAR of 802.11 a/b/g transmitters. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable.

8.1.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.



8.1.2 Frequency Channel Configurations²²

802.11 a/b/g and 4.9 GHz operating modes are tested independently according to the service requirements in each frequency band. 802.11 b/g modes are tested on channels 1, 6 and 11. 802.11a is tested for UNII operations on channels 36 and 48 in the 5.15-5.25 GHz band; channels 52 and 64 in the 5.25-5.35 GHz band; channels 104, 116, 124 and 136 in the 5.470-5.725 GHz band; and channels 149 and 161 in the 5.8 GHz band. When 5.8 GHz §15.247 is also available, channels 149, 157 and 165 should be tested instead of the UNII channels. 4.9 GHz is tested on channels 1, 10 and 5 or 6, whichever has the higher output power, for 5 MHz channels; channels 11, 15 and 19 for 10 MHz channels; and channels 21 and 25 for 20 MHz channels. These are referred to as the "default test channels". 802.11g mode was evaluated only if the output power was 0.25 dB higher than the 802.11b mode.

Table 8-1
802.11 Test Channels per FCC Requirements

Mode	GHz	Channel	Turbo Channel	"Default Test Channels"		UNII	
				§15.247	802.11g		
802.11 b/g	2.412	1		✓	✓		
	2.437	6		✓	✓		
	2.462	11		✓	✓		
802.11a	5.18	36				✓	
	5.20	40	42 (5.21 GHz)				*
	5.22	44					*
	5.24	48				✓	
	5.26	52	50 (5.25 GHz)			✓	
	5.28	56					*
	5.30	60	58 (5.29 GHz)				*
	5.32	64				✓	
	5.500	100					*
	5.520	104				✓	
	5.540	108					*
	5.560	112					*
	5.580	116				✓	
	5.600	120					*
	5.620	124				✓	
	5.640	128					*
	5.660	132					*
	5.680	136				✓	
	5.700	140					*
	5.745	149		✓		✓	
UNII or §15.247	5.765	153	152 (5.76 GHz)		*		*
	5.785	157		✓			*
	5.805	161	160 (5.80 GHz)		*	✓	
	§15.247	5.825	165	✓			

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9.1 SAR for Notebooks and Lap-touching Devices

Lap-touching devices that have transmitting antennas located less than 20 cm from the lap of the user require routine SAR evaluation. Such devices are considered portable and are capable of being held to the body. Devices are to be setup touching the phantom and are configured with maximum output power during SAR assessment for a worst-case SAR evaluation.



Figure 9-1
Notebook Setup for SAR

9.2 Positioning for Convertible and Slate Tablet Computers



Figure 9-2
Tablet Computer Form Factors

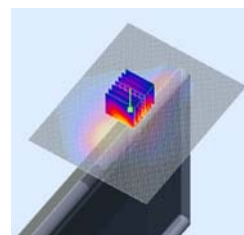
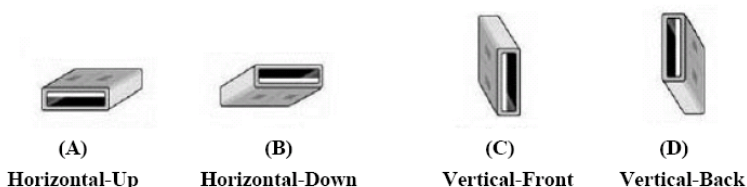


Figure 9-3
Tablet PC Body SAR

KDB 447498. Tablet (notepad) computers are tested in a lap-held position with the bottom of the computer in direct contact against a flat phantom for all user-enabled portrait and landscape positions.

9.3 SAR test procedure for USB Dongles



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

Figure 9-4
USB Dongle Test Configurations

KDB 447498. USB orientations (see Figure 9-4) with a device to phantom separation distance of 5 mm or less, according to KDB 447498 requirements. Current generation laptop computers should be used to ensure proper measurement distances. The same test separation distance should be used for all frequency bands and modes in each USB orientation. The typical Horizontal-Up USB connection (A), found in the majority of laptop computers, must be tested using an appropriate laptop computer. A laptop with either Vertical-Front (C) or Vertical-Back (D) USB connection should be used to test one of the vertical USB orientations. If laptop computers are not available for testing the Horizontal-Down (B) or the remaining Vertical USB orientation, a short and high quality USB cable (12 inches or less) may be used for testing these other orientations. It should be ensured that the USB cable does not affect device radiating characteristics and output power of the dongle.

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10 FCC AND HEALTH CANADA SAFETY CODE 6 RF EXPOSURE LIMITS

10.1 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.

10.2 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 10-1
SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6 (2.2.1 & 2.2.6)

HUMAN EXPOSURE LIMITS		
	UNCONTROLLED ENVIRONMENT <i>General Population</i> (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT <i>Occupational</i> (W/kg) or (mW/g)
SPATIAL PEAK SAR Brain	1.6	8.0
SPATIAL AVERAGE SAR Whole Body	0.08	0.4
SPATIAL PEAK SAR Hands, Feet, Ankles, Wrists	4.0	20

- 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.

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11 MEASUREMENT UNCERTAINTIES

a	b	c	d	e= f(d,k)	f	g	h = c x f/e	i = c x g/e	k
Uncertainty Component	IEEE 1528 Sec.	Tol. (± %)	Prob. Dist.	Div.	c_1 1gm	c_1 10 gms	1gm u_1 (± %)	10gms u_1 (± %)	v_1
Measurement System									
Probe Calibration	E2.1	6.6	N	1	1.0	1.0	6.6	6.6	∞
Axial Isotropy	E2.2	0.25	N	1	0.7	0.7	0.2	0.2	∞
Hemishperical Isotropy	E2.2	1.3	N	1	1.0	1.0	1.3	1.3	∞
Boundary Effect	E2.3	0.4	N	1	1.0	1.0	0.4	0.4	∞
Linearity	E2.4	0.3	N	1	1.0	1.0	0.3	0.3	∞
System Detection Limits	E2.5	5.1	N	1	1.0	1.0	5.1	5.1	∞
Readout Electronics	E2.6	1.0	N	1	1.0	1.0	1.0	1.0	∞
Response Time	E2.7	0.8	R	1.73	1.0	1.0	0.5	0.5	∞
Integration Time	E2.8	2.6	R	1.73	1.0	1.0	1.5	1.5	∞
RF Ambient Conditions	E6.1	3.0	R	1.73	1.0	1.0	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E6.2	0.4	R	1.73	1.0	1.0	0.2	0.2	∞
Probe Positioning w/ respect to Phantom	E6.3	2.9	R	1.73	1.0	1.0	1.7	1.7	∞
Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation	E5	1.0	R	1.73	1.0	1.0	0.6	0.6	∞
Test Sample Related									
Test Sample Positioning	E4.2	6.0	N	1	1.0	1.0	6.0	6.0	287
Device Holder Uncertainty	E4.1	3.32	R	1.73	1.0	1.0	1.9	1.9	∞
Output Power Variation - SAR drift measurement	6.6.2	5.0	R	1.73	1.0	1.0	2.9	2.9	∞
Phantom & Tissue Parameters									
Phantom Uncertainty (Shape & Thickness tolerances)	E3.1	4.0	R	1.73	1.0	1.0	2.3	2.3	∞
Liquid Conductivity - deviation from target values	E3.2	5.0	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Conductivity - measurement uncertainty	E3.3	3.8	N	1	0.64	0.43	2.4	1.6	6
Liquid Permittivity - deviation from target values	E3.2	5.0	R	1.73	0.60	0.49	1.7	1.4	∞
Liquid Permittivity - measurement uncertainty	E3.3	4.5	N	1	0.60	0.49	2.7	2.2	6
Combined Standard Uncertainty (k=1)							RSS	12.4	12.0
Expanded Uncertainty (95% CONFIDENCE LEVEL)							k=2	24.7	24.0
									299

The above measurement uncertainties are according to IEEE Std. 1528-2003

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12 SYSTEM VERIFICATION

12.1 Tissue Verification

Table 12-1
Measured Tissue Properties

Calibrated Date:	Tissue Type	Measured Frequency (MHz)	Measured Conductivity, σ (S/m)	Measured Dielectric Constant, ϵ	TARGET Conductivity, σ (S/m)	TARGET Dielectric Constant, ϵ	% dev σ	% dev ϵ
04/13/2010	2450M	2401	1.857	50.80	1.95	52.70	-4.77%	-3.61%
		2450	1.923	50.58	1.95	52.70	-1.38%	-4.02%
		2499	1.996	50.40	1.95	52.70	2.36%	-4.36%
04/12/2010	5200-5800M	5170	5.127	47.38	5.26	49.15	-2.60%	-3.60%
		5210	5.157	47.34	5.31	48.95	-2.92%	-3.29%
		5250	5.192	47.27	5.36	48.75	-3.13%	-3.04%
		5270	5.282	47.19	5.38	48.65	-1.89%	-3.00%
		5310	5.291	47.15	5.43	48.45	-2.60%	-2.68%
		5350	5.327	47.09	5.48	48.25	-2.79%	-2.40%
		5470	5.513	46.82	5.61	48.63	-1.80%	-3.72%
		5510	5.549	46.73	5.66	48.59	-2.00%	-3.83%
		5550	5.588	46.74	5.71	48.55	-2.14%	-3.73%
		5570	5.644	46.66	5.73	48.53	-1.57%	-3.85%
		5610	5.578	46.57	5.78	48.49	-3.53%	-3.96%
		5650	5.724	46.53	5.83	48.45	-1.82%	-3.96%
		5670	5.787	46.46	5.85	48.40	-1.14%	-4.00%
		5710	5.820	46.39	5.90	48.34	-1.39%	-4.02%
		5750	5.861	46.34	5.95	48.28	-1.50%	-4.01%
		5770	5.924	46.28	5.97	48.25	-0.84%	-4.07%
		5810	5.958	46.22	6.01	48.20	-0.87%	-4.11%
		5850	5.998	46.13	6.07	48.13	-1.19%	-4.15%

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

The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies (per IEEE 1528 6.6.1.2).

12.2 Measurement Procedure for Tissue verification

- 1) The network analyzer and probe system was configured and calibrated.
- 2) The probe was immersed in the sample which was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
- 3) The complex admittance with respect to the probe aperture was measured
- 4) The complex relative permittivity, for example from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\epsilon_r\epsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos\phi' \frac{\exp[-j\omega r(\mu_0\epsilon_r'\epsilon_0)^{1/2}]}{r} d\phi' d\rho' d\rho$$

where Y is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho'\cos\phi'$, ω is the angular frequency, and $j = \sqrt{-1}$.

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12.3 Test System Verification

Prior to assessment, the system is verified to $\pm 10\%$ of the manufacturer SAR result on the reference dipole at the time of calibration, by using the below system validation kit(s).

Table 12-2
System Verification Results
System Verification
TARGET & MEASURED

Date:	Amb. Temp (°C)	Liquid Temp (°C)	Input Power (W)	Tissue Frequency (MHz)	Dipole SN	Tissue Type	Targeted SAR _{1g} (W/kg)	Measured SAR _{1g} (W/kg)	Deviation (%)
04/12/2010	23.9	23	0.025	2450	719	Muscle	1.29	1.29	0.39
04/14/2010	23.6	23.1	0.025	5200	1057	Muscle	1.98	1.88	-4.93
04/15/2010	23.8	23.2	0.025	5500	1057	Muscle	2.04	1.95	-5.39
04/15/2010	23.4	22.1	0.025	5800	1057	Muscle	1.79	1.7	-5.03

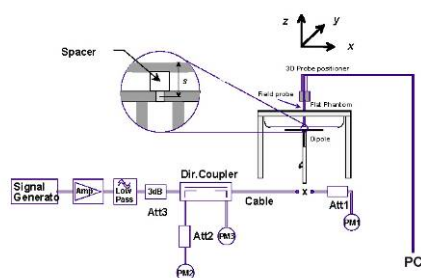


Figure 12-1
System Verification Setup Diagram



Figure 12-2
System Verification Setup Photo

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12.4 RF Conducted Powers

12.4.1 Main Antenna

Mode	Freq [MHz]	Channel	Tx Chain	Conducted Power [dBm]			
				Data Rate [Mbps]			
				1	2	5.5	11
802.11b	2412	1	A	13.44	13.48	13.44	13.45
802.11b	2437	6	A	13.51	13.57	13.61	13.51
802.11b	2462	11	A	13.30	13.39	13.44	13.42

Mode	Freq [MHz]	Channel	Tx Chain	Conducted Power [dBm]							
				Data Rate [Mbps]							
				6	9	12	18	24	36	48	54
802.11g	2412	1	A	12.61	12.59	12.60	12.61	12.57	12.44	12.55	11.90
802.11g	2437	6	A	14.20	14.39	14.47	14.15	14.25	13.13	13.19	11.23
802.11g	2462	11	A	14.41	14.08	14.45	13.08	14.35	14.33	12.72	10.42

Mode	Freq [MHz]	Channel	Tx Chain	Conducted Power [dBm]							
				Data Rate [Mbps]							
				13.5	27	40	54	81	108	122	135
802.11n	2422	3	A	7.31	7.42	5.93	6.90	6.93	7.03	6.71	6.86
802.11n	2437	6	A	14.40	14.02	14.72	14.25	14.16	12.95	11.23	9.56
802.11n	2452	9	A	8.16	7.81	7.52	8.08	8.08	8.16	8.00	7.81

Mode	Freq [MHz]	Channel	Tx Chain	Conducted Power [dBm]							
				Data Rate [Mbps]							
				6	9	12	18	24	36	48	54
802.11a	5180	36	A	12.51	12.36	12.32	12.38	12.26	12.20	12.22	10.95
802.11a	5200	40	A	14.14	14.08	14.00	14.05	13.95	13.89	12.90	11.13
802.11a	5220	44	A	14.14	14.22	14.42	14.45	14.36	14.34	13.58	11.40
802.11a	5240	48	A	14.42	14.46	14.01	14.42	13.89	13.85	13.20	11.03
802.11a	5260	52	A	14.02	14.12	13.97	14.08	13.88	13.88	13.00	11.30
802.11a	5280	56	A	14.31	14.25	13.92	14.12	13.96	13.76	12.80	11.18
802.11a	5300	60	A	14.44	14.23	14.22	14.27	14.19	14.18	13.38	11.61
802.11a	5320	64	A	13.99	14.15	14.00	14.19	13.79	13.70	12.86	11.22
802.11a	5500	100	A	13.28	13.50	13.40	13.42	13.20	13.10	12.45	10.98
802.11a	5520	104	A	14.02	13.97	13.99	14.12	14.01	14.06	13.30	11.60
802.11a	5540	108	A	14.20	14.05	13.98	14.38	14.29	13.90	13.53	11.63
802.11a	5560	112	A	14.30	14.29	14.25	14.33	14.20	14.24	13.45	11.65
802.11a	5580	116	A	14.48	14.51	14.48	14.58	14.18	14.50	13.29	11.60
802.11a	5600	120	A	13.79	13.66	13.65	13.71	13.56	13.45	12.62	10.81
802.11a	5620	124	A	14.54	14.51	14.46	14.55	14.42	14.45	13.62	11.36
802.11a	5640	128	A	14.96	14.54	14.57	14.70	14.52	14.55	13.84	11.64
802.11a	5660	132	A	14.85	14.80	14.77	14.83	14.73	14.73	13.92	11.40
802.11a	5680	136	A	14.95	14.92	14.91	14.73	14.60	13.98	13.39	11.22
802.11a	5700	140	A	13.77	13.68	13.65	13.71	13.51	13.47	12.71	10.83
802.11a	5745	149	A	14.12	14.01	14.00	14.04	13.85	13.82	12.98	10.81
802.11a	5765	153	A	13.96	14.04	14.03	14.21	13.89	14.24	13.30	11.10
802.11a	5785	157	A	14.08	14.35	13.89	13.92	13.74	13.70	13.17	11.43
802.11a	5805	161	A	13.97	13.95	13.95	14.07	13.91	13.95	13.30	10.84
802.11a	5825	165	A	13.99	13.88	13.98	14.19	14.04	14.02	13.55	11.05

Mode	Freq [MHz]	Channel	Tx Chain	Conducted Power [dBm]							
				Data Rate [Mbps]							
				13.5	27	40	54	81	108	122	135
802.11n	5190	38	A	9.62	9.63	9.41	9.37	9.25	9.18	9.25	9.15
802.11n	5230	46	A	13.85	13.75	13.71	13.47	13.40	12.90	11.20	9.82
802.11n	5270	54	A	13.51	13.72	13.63	13.22	13.20	12.91	11.14	9.62
802.11n	5310	62	A	11.02	11.02	10.98	10.62	10.73	10.67	10.63	9.67
802.11n	5510	102	A	13.02	13.00	13.17	12.71	12.61	12.18	10.50	9.35
802.11n	5550	110	A	13.90	13.89	13.87	13.37	13.47	13.03	12.06	9.94
802.11n	5590	118	A	13.36	13.34	13.20	13.08	12.99	12.43	10.80	9.38
802.11n	5630	126	A	13.75	13.90	13.94	13.79	13.87	13.45	11.35	7.04
802.11n	5670	134	A	13.22	13.21	13.07	12.94	12.87	12.27	10.60	5.90
802.11n	5755	151	A	14.23	14.15	14.19	14.09	14.15	13.71	11.51	7.34
802.11n	5795	159	A	14.22	13.89	13.89	13.15	13.92	13.50	11.56	7.56

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12.4.2 Auxiliary Antenna

Mode	Freq [MHz]	Channel	Tx Chain	Conducted Power [dBm]			
				Data Rate [Mbps]			
				1	2	5.5	11
802.11b	2412	1	B	13.54	13.00	13.50	13.05
802.11b	2437	6	B	13.54	13.52	13.55	13.25
802.11b	2462	11	B	12.84	13.25	13.23	13.10

Mode	Freq [MHz]	Channel	Tx Chain	Conducted Power [dBm]							
				Data Rate [Mbps]							
				6	9	12	18	24	36	48	54
802.11g	2412	1	B	11.91	11.78	11.77	11.78	11.68	11.00	11.54	10.30
802.11g	2437	6	B	14.22	14.16	14.03	14.01	13.84	13.80	12.50	10.70
802.11g	2462	11	B	12.56	12.50	12.45	12.44	12.28	12.20	12.22	11.15

Mode	Freq [MHz]	Channel	Tx Chain	Conducted Power [dBm]							
				Data Rate [Mbps]							
				13.5	27	40	54	81	108	122	135
802.11n	2422	3	B	7.42	7.43	7.77	7.15	7.08	7.00	7.01	6.90
802.11n	2437	6	B	14.05	14.00	13.93	13.68	13.61	12.20	10.49	8.80
802.11n	2452	9	B	7.73	7.78	8.14	7.50	7.40	7.84	7.38	7.31

Mode	Freq [MHz]	Channel	Tx Chain	Conducted Power [dBm]							
				Data Rate [Mbps]							
				6	9	12	18	24	36	48	54
802.11a	5180	36	B	12.28	12.20	12.11	12.12	12.20	11.94	11.96	9.80
802.11a	5200	40	B	12.98	12.92	12.80	12.84	12.72	12.62	11.85	10.03
802.11a	5220	44	B	13.34	13.34	13.73	13.76	13.86	13.80	12.94	11.15
802.11a	5240	48	B	12.65	13.11	13.04	13.05	12.92	12.83	11.63	10.23
802.11a	5260	52	B	12.84	13.24	12.80	12.83	12.70	12.66	11.85	10.04
802.11a	5280	56	B	13.11	13.10	13.10	13.14	12.97	12.91	11.71	10.23
802.11a	5300	60	B	13.18	13.30	13.39	13.19	13.24	13.24	12.33	10.60
802.11a	5320	64	B	13.22	13.18	12.94	12.92	12.73	13.02	11.78	9.95
802.11a	5500	100	B	13.10	13.32	13.24	13.31	12.81	12.80	12.30	10.64
802.11a	5520	104	B	13.51	13.42	13.70	13.02	13.12	13.16	12.22	10.68
802.11a	5540	108	B	13.27	13.26	14.05	12.84	12.90	12.97	12.04	10.37
802.11a	5560	112	B	13.11	13.50	13.89	13.20	12.86	12.89	11.75	10.51
802.11a	5580	116	B	13.45	13.39	13.39	12.71	12.80	13.05	11.81	10.09
802.11a	5600	120	B	12.74	12.67	12.62	12.72	12.56	12.54	11.74	9.49
802.11a	5620	124	B	12.82	13.07	13.34	13.86	12.28	12.33	11.27	9.16
802.11a	5640	128	B	13.07	12.91	13.34	12.40	12.22	12.48	11.63	9.31
802.11a	5660	132	B	12.71	12.88	13.06	12.53	12.52	12.54	11.61	9.27
802.11a	5680	136	B	12.75	12.66	12.93	12.30	12.97	12.41	11.64	9.30
802.11a	5700	140	B	12.47	12.43	12.06	12.12	12.00	11.93	11.10	9.28
802.11a	5745	149	B	11.82	12.04	12.00	12.03	11.84	11.76	10.85	8.50
802.11a	5765	153	B	12.40	12.57	12.62	12.61	12.51	12.47	11.88	9.47
802.11a	5785	157	B	12.31	12.35	12.10	12.20	12.03	11.95	11.10	8.78
802.11a	5805	161	B	12.44	12.51	12.57	12.29	12.36	12.38	11.79	9.45
802.11a	5825	165	B	12.92	12.80	12.40	12.62	12.10	12.10	11.25	8.85

Mode	Freq [MHz]	Channel	Tx Chain	Conducted Power [dBm]							
				Data Rate [Mbps]							
				13.5	27	40	54	81	108	122	135
802.11n	5190	38	B	9.06	9.01	8.97	8.81	8.67	8.73	8.68	8.63
802.11n	5230	46	B	12.82	12.41	12.72	12.40	12.08	11.56	9.81	7.97
802.11n	5270	54	B	12.22	12.60	12.52	12.32	12.22	11.76	10.01	8.25
802.11n	5310	62	B	10.03	10.01	9.96	9.78	9.71	9.69	9.73	8.35
802.11n	5510	102	B	11.47	11.43	11.36	11.16	11.10	10.63	10.27	8.48
802.11n	5550	110	B	11.21	11.09	11.42	11.05	11.40	11.04	9.14	7.68
802.11n	5590	118	B	12.59	12.57	12.45	11.93	11.81	11.43	10.00	8.25
802.11n	5630	126	B	10.72	10.89	10.80	10.44	10.56	10.47	8.17	6.72
802.11n	5670	134	B	11.80	11.79	11.69	11.47	11.42	11.24	9.17	5.06
802.11n	5755	151	B	11.35	11.66	11.54	11.35	11.30	10.72	8.60	5.60
802.11n	5795	159	B	12.00	11.90	11.76	11.56	11.40	11.00	8.81	6.01

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12.4.3 Bluetooth Conducted Powers

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Conducted Power [DH5 Packet Type]	
			[dBm]	[mW]
2402	1.0	0	12.81	19.099
2441	1.0	39	13.67	23.281
2480	1.0	78	13.67	23.281

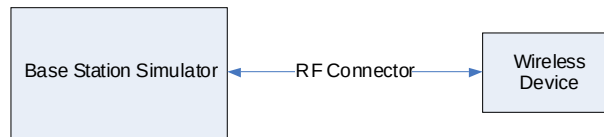


Figure 12-3
Power Measurement Setup

13 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

13.1 Maximum Conducted Power

Maximum Conducted Power						
Transmitter	Frequency Band	Highest Frequency	Conducted Power		60/f (GHz)	>60/f
	MHz	MHz	dBm	mW	mW	
GSM GPRS850	836.6	848.80	31.51	1,415.79	70.69	yes
GSM GPRS1900	1880	1,908.75	29.24	839.46	31.43	yes
GSM EDGE850	836.6	848.80	27.17	521.19	70.69	yes
GSM EDGE1900	1880	1,908.75	25.77	377.57	31.43	yes
WCDMA850-HSPA	836.6	848.80	24.49	281.19	70.69	yes
WCDMA1900-HSPA	1880	1,908.75	23.86	243.22	31.43	yes
Cell CDMA	836.6	848.80	24.88	307.61	70.69	yes
PCS CDMA	1880	1,908.75	25.21	331.89	31.43	yes
EVDO Rev.0	836.6	848.80	25.07	321.37	70.69	yes
EVDO Rev.0	1880	1,908.75	25.13	325.84	31.43	yes
EVDO Rev.A	836.6	848.80	24.32	270.40	70.69	yes
EVDO Rev.A	1880	1,908.75	24.60	288.40	31.43	yes
Bluetooth	2441	2,480.00	13.67	23.28	24.19	no
802.11b	2437	2,462.00	13.61	22.96	24.37	no
802.11g	2437	2,462.00	14.47	27.99	24.37	yes
802.11a	5200	5,240.00	14.46	27.93	11.45	yes
802.11a	5300	5,320.00	14.44	27.80	11.28	yes
802.11a	5500	5,600.00	14.96	31.33	10.71	yes
802.11a	5785	5,825.00	14.35	27.23	10.30	yes
802.11n	2437	2,462.00	14.72	29.65	24.37	yes
802.11n	5200	5,240.00	13.85	24.27	11.45	yes
802.11n	5300	5,320.00	13.72	23.55	11.28	yes
802.11n	5500	5,600.00	13.94	24.77	10.71	yes
802.11n	5785	5,825.00	14.23	26.49	10.30	yes

13.2 Distance- Antenna to Antenna

Distance - Antenne to Antenna				
Antenna	WWAN	WLAN Main	WLAN Aux	BT
WWAN	N/A	260 mm	320 mm	320 mm
WLAN Main	260 mm	N/A	300 mm	300 mm
WLAN Aux.	320 mm	300 mm	N/A	8 mm
BT	320 mm	300 mm	8 mm	N/A

13.3 Distance- Antenna to Body

Distance - Antenna to Body				
Position	Antenna			
	WWAN	WLAN Main	WLAN Aux.	BT
Laptop	220 mm	30 mm	30 mm	30 mm

The WWAN Antenna was located more than 200 mm from the body so it was not tested for SAR.

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14 SAR DATA SUMMARY

14.1 2.4 GHz SAR Results

MEASUREMENT RESULTS										
FREQUENCY		Modulation	Conducted Power [dBm]		Test Position	Antenna	Spacing (cm)	Data Rate (Mbps)	SAR	Remarks
MHz	Ch.		Start	End		A-Main / B-Aux			(W/kg)	
2437	6	DSSS	13.61	13.34	Laptop	A	0.00	5.5	0.00287	802.11b
2437	6	DSSS	13.54	13.40	Laptop	B	0.00	1	0.00098	802.11b
2437	6	OFDM	14.47	14.09	Laptop	A	0.00	12	0.00623	802.11g
2437	6	OFDM	14.22	14.37	Laptop	B	0.00	6	0.00389	802.11g
2437	6	OFDM	14.72	13.86	Laptop	A	0.00	40	0.00116	802.11n
2437	6	OFDM	14.05	13.88	Laptop	B	0.00	13.5	0.00305	802.11n
ANSI / IEEE C95.1 1992 - SAFETY LIMIT					Body					
Spatial Peak					1.6 W/kg (mW/g)					
Uncontrolled Exposure/General					averaged over 1 gram					

Notes:

1. The test data reported are the worst-case SAR value with the position set in a typical configuration. Test procedures used were according to FCC/OET Bulletin 65, Supplement C [June 2001], IEEE1528-2003 and RSS-102.
2. All modes of operation were investigated, and worst-case results are reported.
3. Tissue parameters and temperatures are listed on the SAR plots.
4. Batteries are fully charged for all readings.
5. Liquid tissue depth was at least 15.0 cm.
6. WLAN antennas are located on the right and left sides of the keypad.
7. WLAN transmission was verified using a spectrum analyzer.

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14.2 5.2 – 5.8 GHz SAR Results

MEASUREMENT RESULTS										
FREQUENCY		Modulation	Conducted Power [dBm]		Test Position	Antenna	Spacing (cm)	Data Rate (Mbps)	SAR	Remarks
MHz	Ch.		Start	End		A-Main / B-Aux			(W/kg)	
5240	48	OFDM	14.46	13.9902	Laptop	A	0	9	0.00495	802.11a
5220	44	OFDM	13.86	13.71	Laptop	B	0	24	0.0242	802.11a
5300	60	OFDM	14.44	13.25	Laptop	A	0	6	0.0112	802.11a
5300	60	OFDM	13.39	13.3761	Laptop	B	0	12	0.00484	802.11a
5640	128	OFDM	14.96	13.907	Laptop	A	0	6	0.00415	802.11a
5540	108	OFDM	14.05	13.888	Laptop	B	0	12	0.0163	802.11a
5785	157	OFDM	14.35	12.778	Laptop	A	0	9	0.00474	802.11a
5825	165	OFDM	12.92	13.1	Laptop	B	0	6	0.00618	802.11a
ANSI / IEEE C95.1 1992 - SAFETY LIMIT					Body					
Spatial Peak					1.6 W/kg (mW/g)					
Uncontrolled Exposure/General Population					averaged over 1 gram					

Notes:

1. The test data reported are the worst-case SAR value with the position set in a typical configuration. Test procedures used were according to FCC/OET Bulletin 65, Supplement C [June 2001], IEEE1528-2003 and RSS-102.
2. All modes of operation were investigated, and worst-case results are reported.
3. Tissue parameters and temperatures are listed on the SAR plots.
4. Batteries are fully charged for all readings.
5. Liquid tissue depth was at least 15.0 cm.
6. WLAN antennas are located on the right and left sides of the keypad.
7. WLAN transmission was verified using a spectrum analyzer.

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14.3 Bluetooth SAR Results

MEASUREMENT RESULTS									
FREQUENCY		Modulation	Service	Conducted Power [dBm]		Test Position	Spacing (cm)	Data Rate (Mbps)	SAR
MHz	Ch.			Start	End				(W/kg)
2441	39	Bluetooth	FHSS	13.67	13.83	Laptop	0.0 cm	1	0.007
ANSI / IEEE C95.1 1992 - SAFETY LIMIT						Body			
Spatial Peak						1.6 W/kg (mW/g)			
Uncontrolled Exposure/General Population						averaged over 1 gram			

Notes:

1. The test data reported are the worst-case SAR value with the position set in a typical configuration. Test procedures used were according to FCC/OET Bulletin 65, Supplement C [June 2001], IEEE1528-2003 and RSS-102.
2. All modes of operation were investigated, and worst-case results are reported.
3. Tissue parameters and temperatures are listed on the SAR plots.
4. Batteries are fully charged for all readings.
5. Liquid tissue depth was at least 15.0 cm.
6. Bluetooth transmission was verified using a spectrum analyzer.

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15 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	8648D	(9kHz-4GHz) Signal Generator	9/19/2009	Biennial	9/19/2011	3613A00315
Agilent	8753E	(30kHz-6GHz) Network Analyzer	3/31/2010	Annual	3/31/2011	JP38020182
Agilent	E5515C	Wireless Communications Test Set	9/10/2009	Annual	9/10/2010	GB46110872
Agilent	E5515C	Wireless Communications Test Set	9/11/2009	Annual	9/11/2010	GB46310798
Agilent	E5515C	Wireless Communications Test Set	8/25/2009	Annual	8/25/2010	GB41450275
Agilent	E8257D	(250kHz-20GHz) Signal Generator	3/30/2010	Biennial	3/30/2012	MY45470194
Gigatronics	80701A	(0.05-18GHz) Power Sensor	9/9/2009	Annual	9/9/2010	1833460
Gigatronics	8651A	Universal Power Meter	9/9/2009	Annual	9/9/2010	8650319
Index SAR	IXTL-010	Dielectric Measurement Kit	N/A		N/A	N/A
Index SAR	IXTL-030	30MM TEM line for 6 GHz	N/A		N/A	N/A
Rohde & Schwarz	CMU200	Base Station Simulator	9/11/2009	Annual	9/11/2010	836371/0079
Rohde & Schwarz	CMU200	Base Station Simulator	4/6/2009	Annual	4/6/2010	833855/0010
Rohde & Schwarz	CMU200	Base Station Simulator	9/4/2009	Annual	9/4/2010	109892
Rohde & Schwarz	NRVD	Dual Channel Power Meter	8/20/2008	Biennial	8/20/2010	101695
Rohde & Schwarz	NRV-Z32	Peak Power Sensor (100uW-2W)	12/5/2008	Biennial	12/5/2010	100155
Rohde & Schwarz	NRV-Z33	Peak Power Sensor (1mW-20W)	12/5/2008	Biennial	12/5/2010	100004
SPEAG	D1450V2	1450 MHz SAR Dipole	5/20/2009	Biennial	5/20/2011	1025
SPEAG	D1765V2	1765 MHz SAR Dipole	5/19/2009	Biennial	5/19/2011	1008
SPEAG	D1900V2	1900 MHz SAR Dipole	1/20/2009	Biennial	1/20/2011	502
SPEAG	D1900V2	1900 MHz SAR Dipole	8/18/2009	Biennial	8/18/2011	5d080
SPEAG	D2300V2	2300 MHz SAR Dipole	3/6/2008	Biennial	3/6/2010	1008
SPEAG	D2450V2	2450 MHz SAR Dipole	8/27/2009	Biennial	8/27/2011	719
SPEAG	D2450V2	2450 MHz SAR Dipole	1/8/2009	Biennial	1/8/2011	797
SPEAG	D2600V2	2600 MHz SAR Dipole	8/12/2009	Biennial	8/12/2011	1004
SPEAG	D5GHzV2	5 GHz SAR Dipole	8/19/2009	Biennial	8/19/2011	1007
SPEAG	D5GHzV2	5 GHz SAR Dipole	1/15/2009	Biennial	1/15/2011	1057
SPEAG	D835V2	835 MHz SAR Dipole	1/19/2009	Biennial	1/19/2011	4d047
SPEAG	D835V2	835 MHz SAR Dipole	8/24/2009	Biennial	8/24/2011	4d026
SPEAG	DAE3	Dasy Data Acquisition Electronics	9/17/2009	Annual	9/17/2010	455
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/22/2010	Annual	3/22/2011	704
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/22/2010	Annual	1/22/2011	649
SPEAG	ES3DV2	SAR Probe	9/18/2009	Annual	9/18/2010	3022
SPEAG	EX3DV4	SAR Probe	1/26/2010	Annual	1/26/2011	3550
SPEAG	DAE4	Dasy Data Acquisition Electronics	7/21/2009	Annual	7/21/2010	859
SPEAG	D750V3	750 MHz Dipole	2/19/2009	Biennial	2/19/2011	1003
Speag	ES3DV3	SAR Probe	3/16/2010	Annual	3/16/2011	3213
Rohde & Schwarz	SMI03B	Signal Generator	5/21/2009	Annual	5/21/2010	832810/021
Speag	D1640V2	1640 MHz Dipole	8/21/2008	Biennial	8/21/2010	321
Rohde & Schwarz	CMW500	LTE Base Station Simulator	8/25/2009	Annual	8/25/2010	100976
Anritsu	MA2481A	Power Sensor	12/2/2009	Annual	12/2/2010	5318
Anritsu	MA2481A	Power Sensor	12/3/2009	Annual	12/3/2010	5442
Anritsu	ML2438A	Power Meter	12/3/2009	Annual	12/3/2010	1190013
Anritsu	ML2438A	Power Meter	12/3/2009	Annual	12/3/2010	98150041
Agilent	8648D	Signal Generator	4/1/2010	Annual	4/1/2011	3629U00687
Anritsu	ML2438A	Power Meter	12/3/2009	Annual	12/3/2010	1070030
Anritsu	MA2481A	Power Sensor	12/2/2009	Annual	12/2/2010	5821
Anritsu	MA2481A	Power Sensor	12/3/2009	Annual	12/3/2010	8013
Anritsu	MA2481A	Power Sensor	12/3/2009	Annual	12/3/2010	2400
Apriel	ALS-PR-DIEL	Dielectric Probe Kit	N/A		N/A	260-00959

Notes:

The E-field probe was calibrated by SPEAG, by the waveguide technique procedure. Dipole Validation measurement is performed by PCTEST prior to SAR evaluation. The brain simulating material is calibrated by PCTEST using the dielectric probe system and network analyzer to determine the conductivity and permittivity (dielectric constant) of the brain-equivalent material.

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16 CONCLUSION

16.1 Measurement Conclusion

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

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend 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 various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [3]

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Filename: 0Y1003170442.ACJ	Test Dates: 04/12/10 - 04/15/10	EUT Type: Laptop PC with WLAN, Bluetooth and WWAN	Page 26 of 29

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Filename: 0Y1003170442.ACJ	Test Dates: 04/12/10 - 04/15/10	EUT Type: Laptop PC with WLAN, Bluetooth and WWAN	Page 27 of 29

APPENDIX A: SAR TEST DATA

PCTEST ENGINEERING LABORATORY, INC.

**DUT: CF-F9; Type: Laptop PC with WLAN, Bluetooth, and WWAN;
Serial: 0AKSA00515**

Communication System: IEEE 802.11b; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium: 2450 Muscle Medium parameters used (interpolated):
 $f = 2437 \text{ MHz}$; $\sigma = 1.91 \text{ mho/m}$; $r = 50.4$; $\epsilon_r = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 0.0 cm

Test Date: 04-12-2010; Ambient Temp: 23.9°C; Tissue Temp: 23.0°C

Probe: EX3DV4 - SN3550; ConvF(6.4, 6.4, 6.4); Calibrated: 1/26/2010

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 1/22/2010

Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Mode: WLAN 802.11b, Lap position, Mid.ch, 5.5 Mbps, Tx Chain A

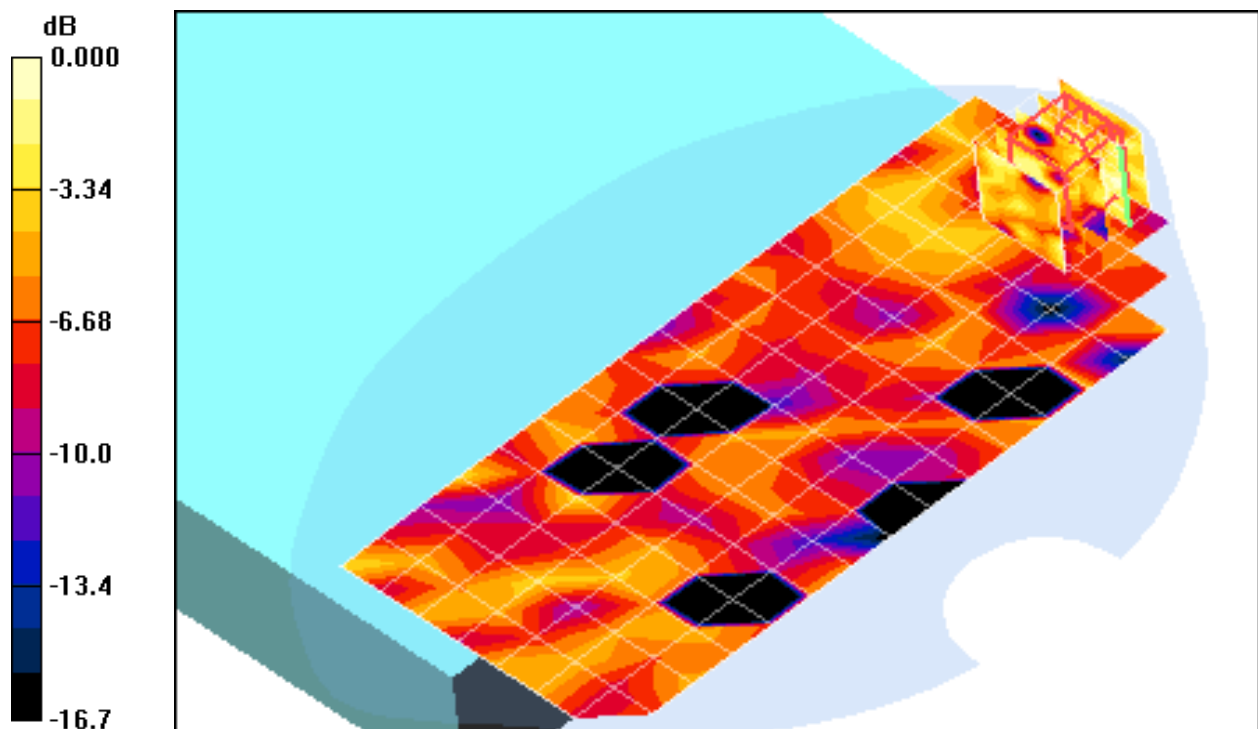
Area Scan (8x17x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 0.807 V/m

Peak SAR (extrapolated) = 0.011 W/kg

SAR(1 g) = 0.00287 mW/g; SAR(10 g) = 0.000736 mW/g



0 dB = 0.012mW/g

PCTEST ENGINEERING LABORATORY, INC.

**DUT: CF-F9; Type: Laptop PC with WLAN, Bluetooth, and WWAN;
Serial: 0AKSA00515**

Communication System: IEEE 802.11g; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium: 2450 Muscle Medium parameters used (interpolated):
 $f = 2437 \text{ MHz}$; $\sigma = 1.91 \text{ mho/m}$; $\epsilon_r = 50.4$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 04-12-2010; Ambient Temp: 23.9°C; Tissue Temp: 23.0°C

Probe: EX3DV4 - SN3550; ConvF(6.4, 6.4, 6.4); Calibrated: 1/26/2010
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 1/22/2010
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114
Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Mode: WLAN 802.11g, Lap position, Mid.ch, 12 Mbps, Tx Chain A

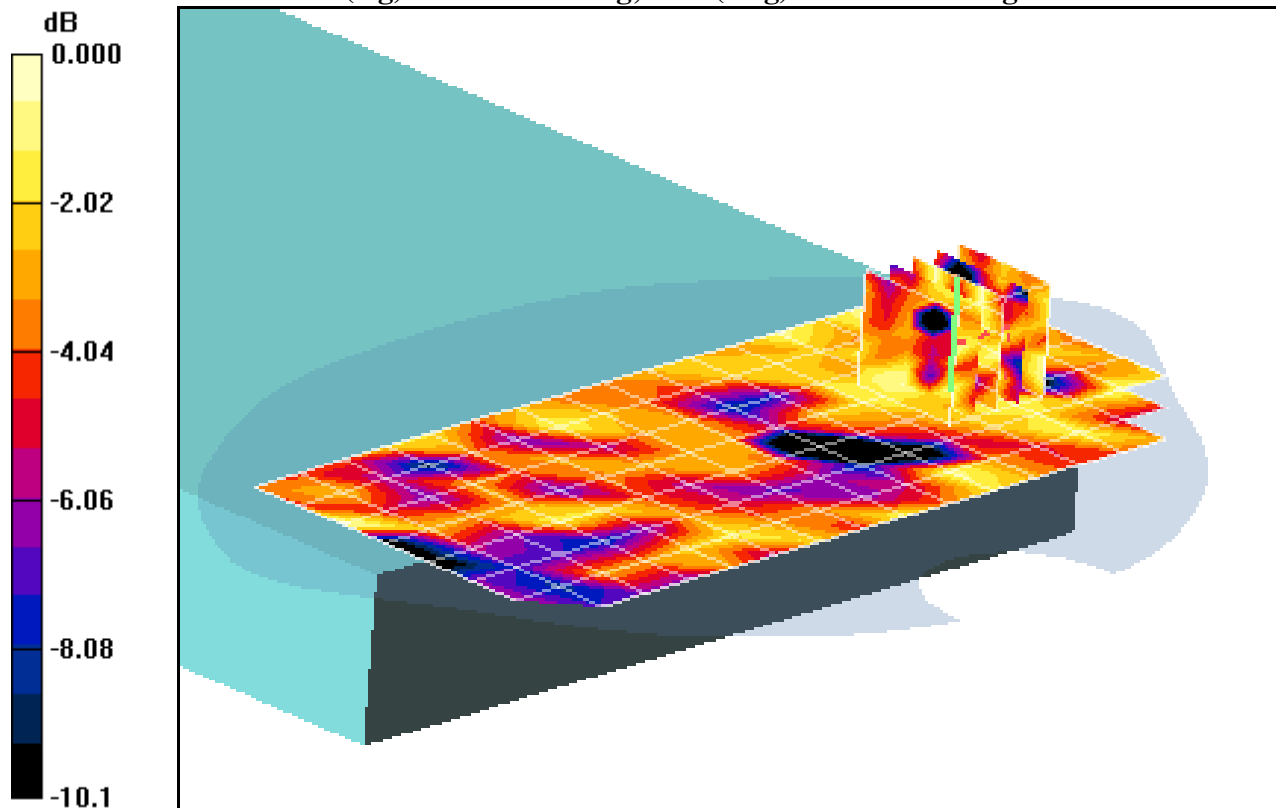
Area Scan (8x17x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 1.44 V/m

Peak SAR (extrapolated) = 0.011 W/kg

SAR(1 g) = 0.00623 mW/g; SAR(10 g) = 0.00372 mW/g



0 dB = 0.008mW/g

PCTEST ENGINEERING LABORATORY, INC.

**DUT: CF-F9; Type: Laptop PC with WLAN, Bluetooth, and WWAN;
Serial: 0AKSA00515**

Communication System: IEEE 802.11n; Frequency: 2437 MHz; Duty Cycle: 1:1
Medium: 2450 Muscle Medium parameters used (interpolated):
 $f = 2437 \text{ MHz}$; $\sigma = 1.91 \text{ mho/m}$; $\epsilon_r = 50.4$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 04-12-2010; Ambient Temp: 23.9°C; Tissue Temp: 23.0°C

Probe: EX3DV4 - SN3550; ConvF(6.4, 6.4, 6.4); Calibrated: 1/26/2010
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 1/22/2010
Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114
Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Mode: WLAN 802.11n, Lap position, Mid.ch, MCS/HT0, Tx Chain B

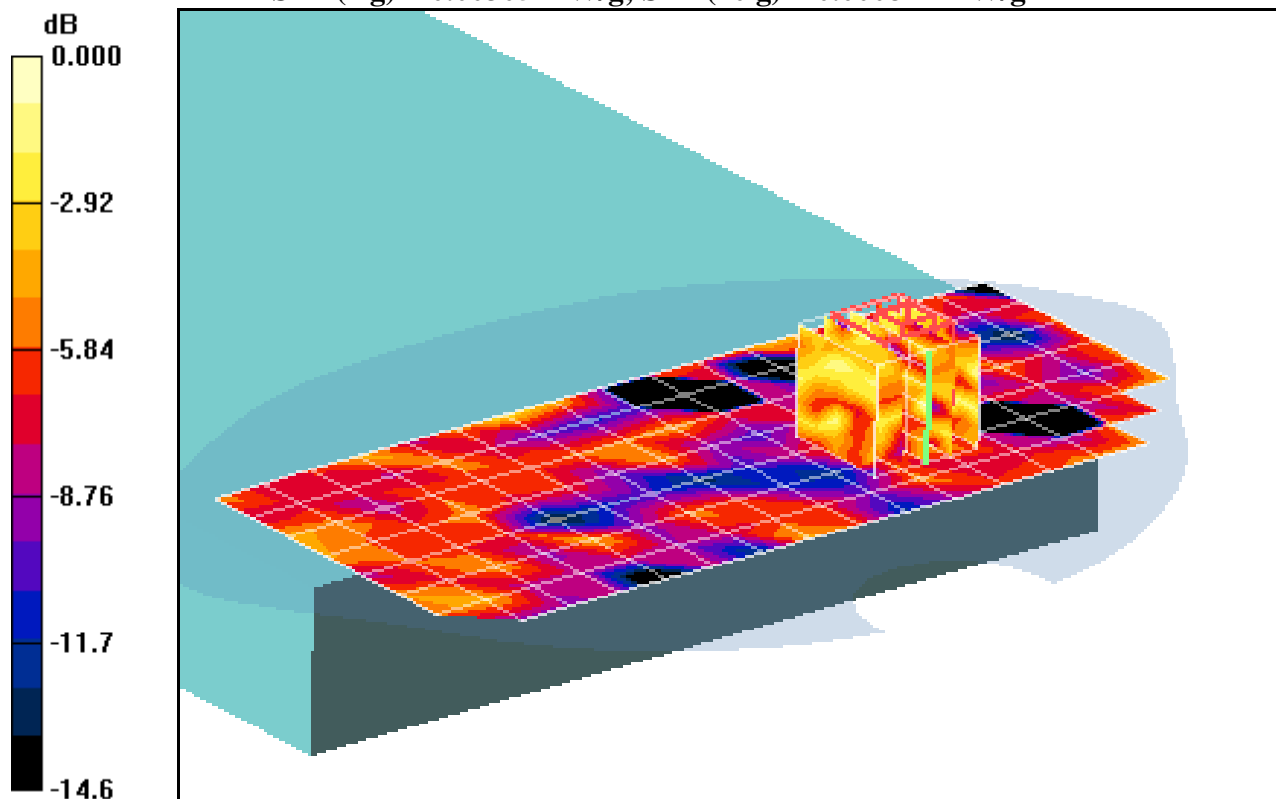
Area Scan (8x17x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 0.932 V/m

Peak SAR (extrapolated) = 0.011 W/kg

SAR(1 g) = 0.00305 mW/g; SAR(10 g) = 0.000872 mW/g



0 dB = 0.012mW/g

PCTEST ENGINEERING LABORATORY, INC.

DUT: SAR Dipole 2450 MHz; Type: D2450V2; Serial: 719

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: 2450 Muscle Medium parameters used:

$f = 2450 \text{ MHz}$; $\sigma = 1.92 \text{ mho/m}$; $\epsilon_r = 50.6$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-12-2010; Ambient Temp: 23.9°C; Tissue Temp: 23.0°C

Probe: EX3DV4 - SN3550; ConvF(6.4, 6.4, 6.4); Calibrated: 1/26/2010

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 1/22/2010

Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

2450MHz System Verification

Area Scan (5x7x1): Measurement grid: dx=15mm, dy=15mm

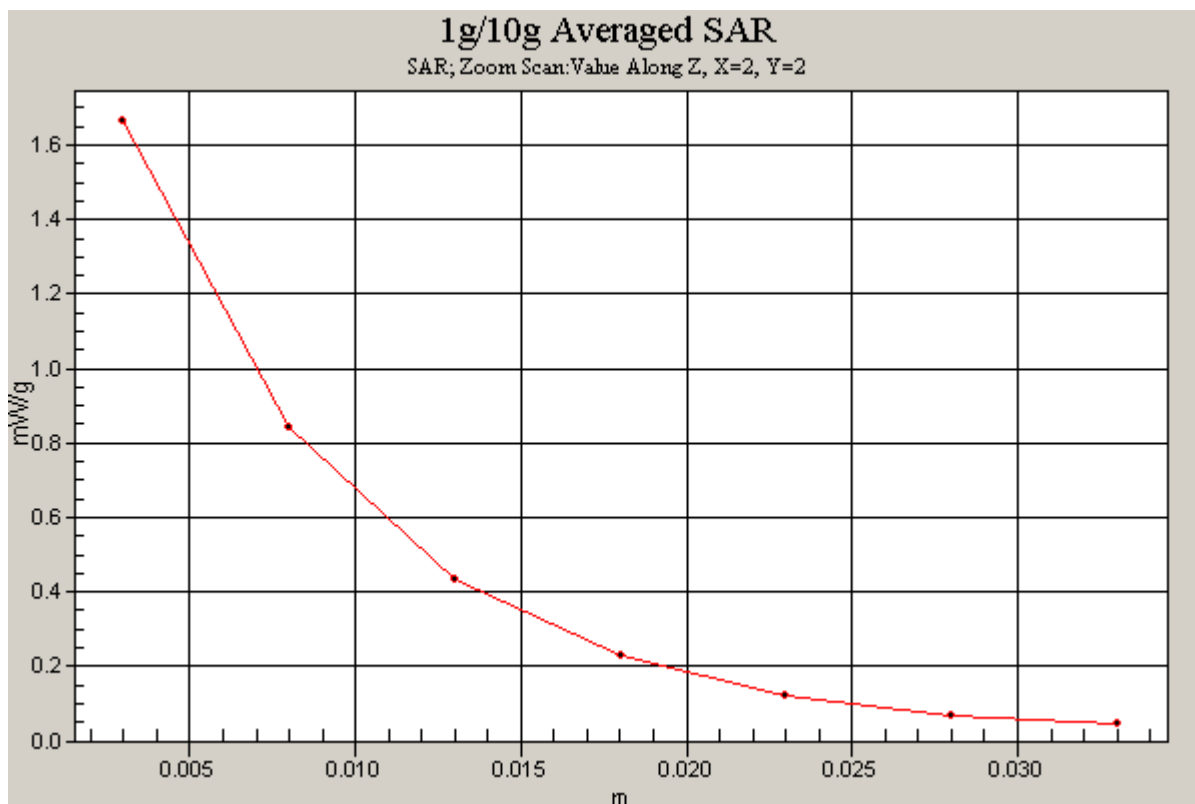
Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Input Power = 14 dBm (25mW)

SAR(1 g) = 1.29 mW/g; SAR(10 g) = 0.594 mW/g

Maximum value of SAR (measured) = 1.67 mW/g

Deviation = 0.39%



PCTEST ENGINEERING LABORATORY, INC.

DUT: CF-F9; Type: Laptop PC with WLAN, Bluetooth, and WWAN
Serial: 0AKSA00515

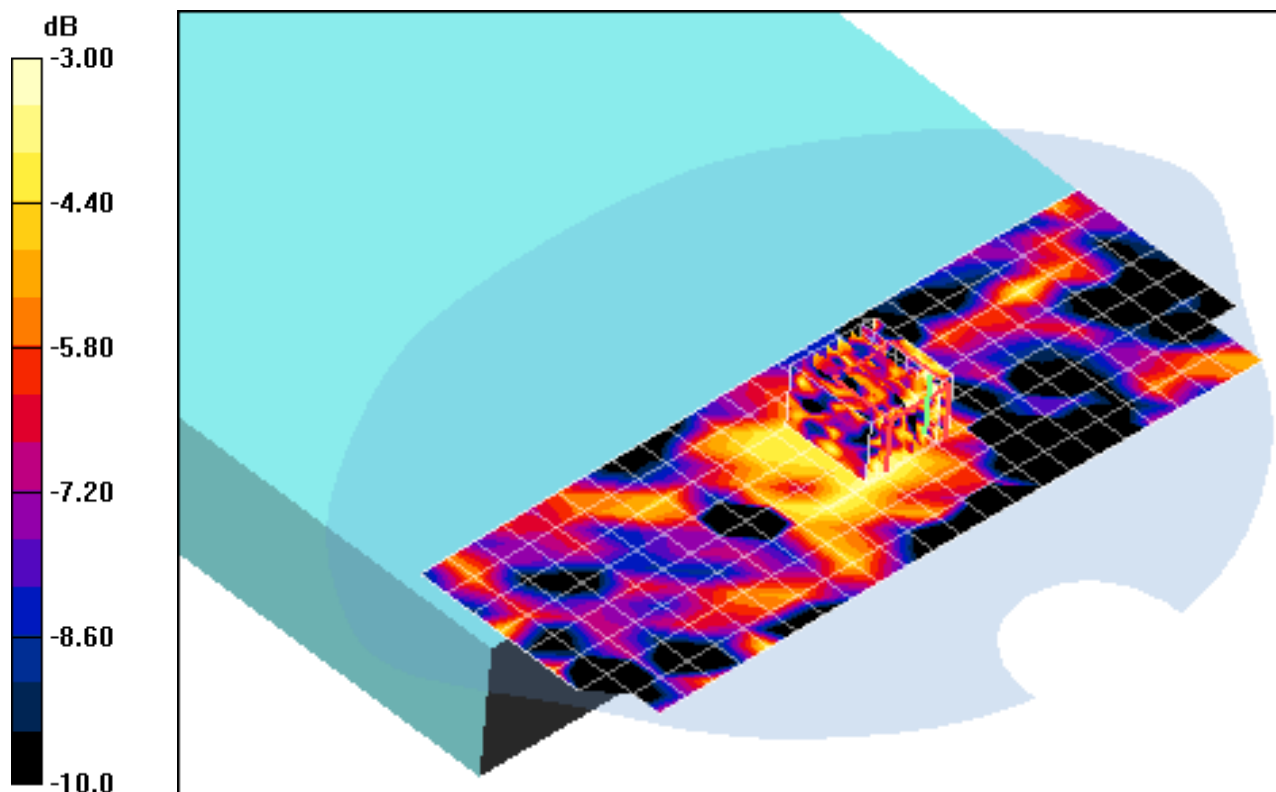
Communication System: IEEE 802.11a 5.2GHz Band; Frequency: 5220 MHz; Duty Cycle: 1:1
Medium: 5.2-5.8 GHz Muscle; Medium parameters used (interpolated):
 $f = 5220 \text{ MHz}$; $\sigma = 5.17 \text{ mho/m}$; $\epsilon_r = 47.3$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 04-14-2010; Ambient Temp: 24.6°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN3550; ConvF(3.73, 3.73, 3.73); Calibrated: 1/26/2010
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 1/22/2010
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Mode: WLAN 802.11a, Lap position, Ch.44, 24 Mbps, Tx Chain B

Area Scan (9x25x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$
Zoom Scan (8x8x8) Cube 0: Measurement grid: $dx=4.3\text{mm}$, $dy=4.3\text{mm}$, $dz=3\text{mm}$
Reference Value = 2.62 V/m
Peak SAR (extrapolated) = 0.224 W/kg
SAR(1 g) = 0.0243 mW/g; SAR(10 g) = 0.00728 mW/g



0 dB = 0.085mW/g

PCTEST ENGINEERING LABORATORY, INC.

**DUT: CF-F9; Type: Laptop PC with WLAN, Bluetooth, and WWAN
Serial: 0AKSA00515**

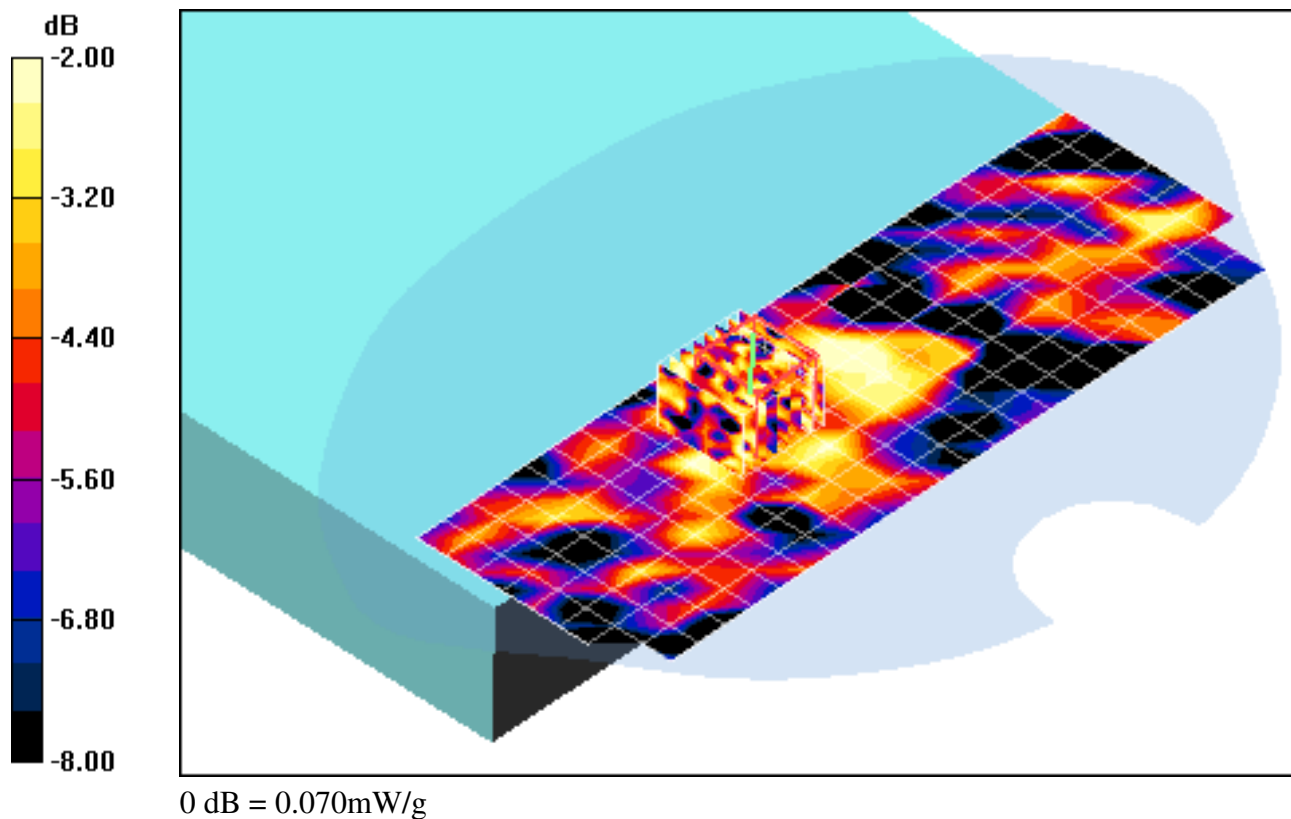
Communication System: IEEE 802.11a 5.3GHz Band; Frequency: 5300 MHz; Duty Cycle: 1:1
Medium: 5.2-5.8 GHz Muscle; Medium parameters used (interpolated):
 $f = 5300 \text{ MHz}$; $\sigma = 5.29 \text{ mho/m}$; $\epsilon_r = 47.2$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 04-14-2010; Ambient Temp: 24.6°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN3550; ConvF(3.52, 3.52, 3.52); Calibrated: 1/26/2010
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 1/22/2010
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Mode: WLAN 802.11a, Lap position, Ch.60, 6 Mbps, Tx Chain A

Area Scan (9x25x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$
Zoom Scan (8x8x8) Cube 0: Measurement grid: $dx=4.3\text{mm}$, $dy=4.3\text{mm}$, $dz=3\text{mm}$
Reference Value = 1.89 V/m
Peak SAR (extrapolated) = 0.081 W/kg
SAR(1 g) = 0.0112 mW/g; SAR(10 g) = 0.00438 mW/g



PCTEST ENGINEERING LABORATORY, INC.

DUT: CF-F9; Type: Laptop PC with WLAN, Bluetooth, and WWAN
Serial: 0AKSA00515

Communication System: IEEE 802.11a 5.5GHz Band; Frequency: 5540 MHz; Duty Cycle: 1:1
Medium: 5.2-5.8 GHz Muscle; Medium parameters used (interpolated):
 $f = 5540 \text{ MHz}$; $\sigma = 5.58 \text{ mho/m}$; $\epsilon_r = 46.7$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 04-14-2010; Ambient Temp: 23.8°C; Tissue Temp: 23.2°C

Probe: EX3DV4 - SN3550; ConvF(3.25, 3.25, 3.25); Calibrated: 1/26/2010
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 1/22/2010
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357
Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Mode: WLAN 802.11a, Lap position, Ch.108, 12 Mbps, Tx Chain B

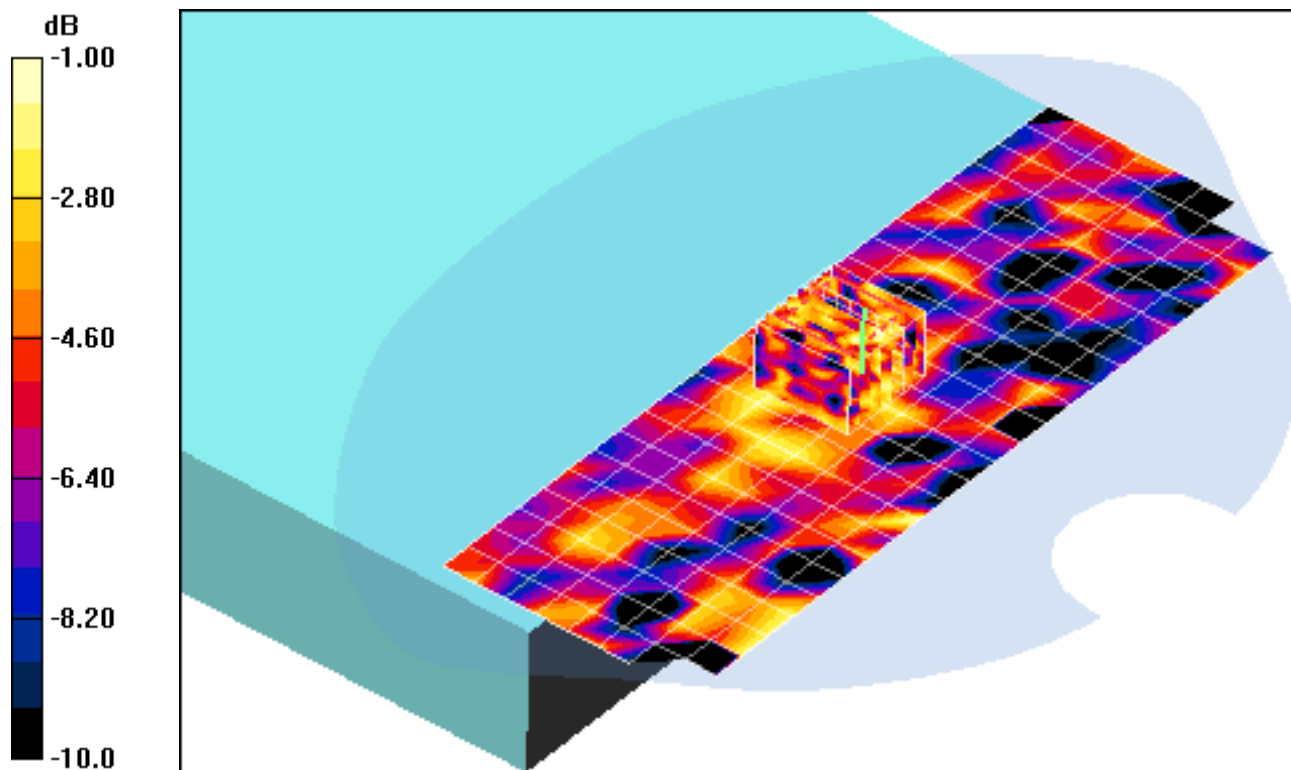
Area Scan (9x25x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

Zoom Scan (8x8x8) Cube 0: Measurement grid: $dx=4.3\text{mm}$, $dy=4.3\text{mm}$, $dz=3\text{mm}$

Reference Value = 2.55 V/m

Peak SAR (extrapolated) = 0.097 W/kg

SAR(1 g) = 0.0163 mW/g; SAR(10 g) = 0.00566 mW/g



0 dB = 0.064mW/g

PCTEST ENGINEERING LABORATORY, INC.

**DUT: CF-F9; Type: Laptop PC with WLAN, Bluetooth, and WWAN
Serial: 0AKSA00515**

Communication System: IEEE 802.11a 5.8GHz Band; Frequency: 5825 MHz; Duty Cycle: 1:1
Medium: 5.2-5.8 GHz Muscle; Medium parameters used (interpolated):
 $f = 5825 \text{ MHz}$; $\sigma = 5.97 \text{ mho/m}$; $\epsilon_r = 46.2$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: Flat Section; Space: 0.0 cm

Test Date: 04-14-2010; Ambient Temp: 23.6°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN3550; ConvF(3.3, 3.3, 3.3); Calibrated: 1/26/2010
Sensor-Surface: 3mm (Mechanical Surface Detection)
Electronics: DAE4 Sn649; Calibrated: 1/22/2010
Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Mode: WLAN 802.11a, Lap position, Ch.165, 6 Mbps, Tx Chain B

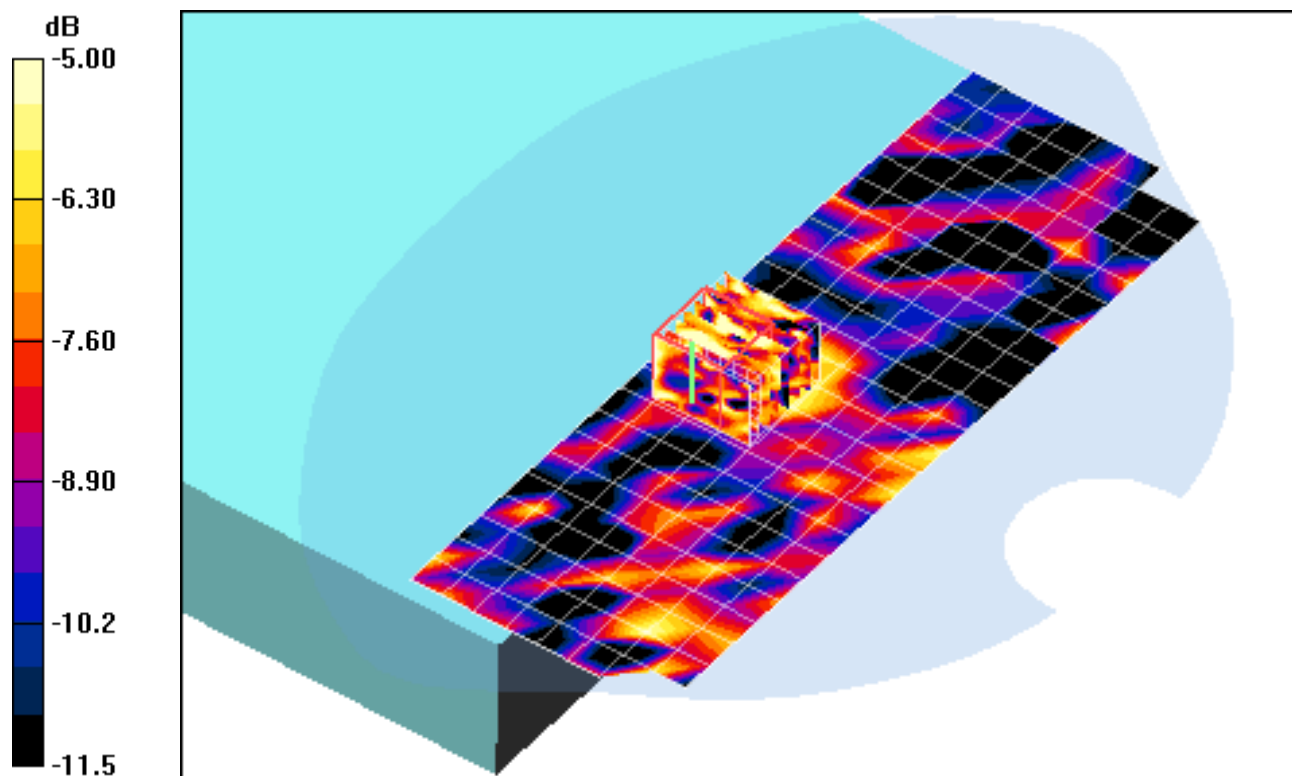
Area Scan (9x25x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

Zoom Scan (8x8x8) Cube 0: Measurement grid: $dx=4.3\text{mm}$, $dy=4.3\text{mm}$, $dz=3\text{mm}$

Reference Value = 1.38 V/m

Peak SAR (extrapolated) = 0.140 W/kg

SAR(1 g) = 0.00618 mW/g; SAR(10 g) = 0.0011 mW/g



0 dB = 0.140mW/g

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 5500 MHz; Type: D5GHzV2; Serial: 1057

Communication System: CW; Frequency: 5500 MHz; Duty Cycle: 1:1

Medium: 5500 Muscle Medium parameters used (interpolated):

$f = 5500 \text{ MHz}$; $\sigma = 5.54 \text{ mho/m}$; $\epsilon_r = 46.8$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-14-2010; Ambient Temp: 23.8°C; Tissue Temp: 23.2°C

Probe: EX3DV4 - SN3550; ConvF(3.25, 3.25, 3.25); Calibrated: 1/26/2010

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 1/22/2010

Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5500MHz System Verification

Area Scan (7x9x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

Zoom Scan (8x8x8)/Cube 0: Measurement grid: $dx=4.3\text{mm}$, $dy=4.3\text{mm}$, $dz=3\text{mm}$

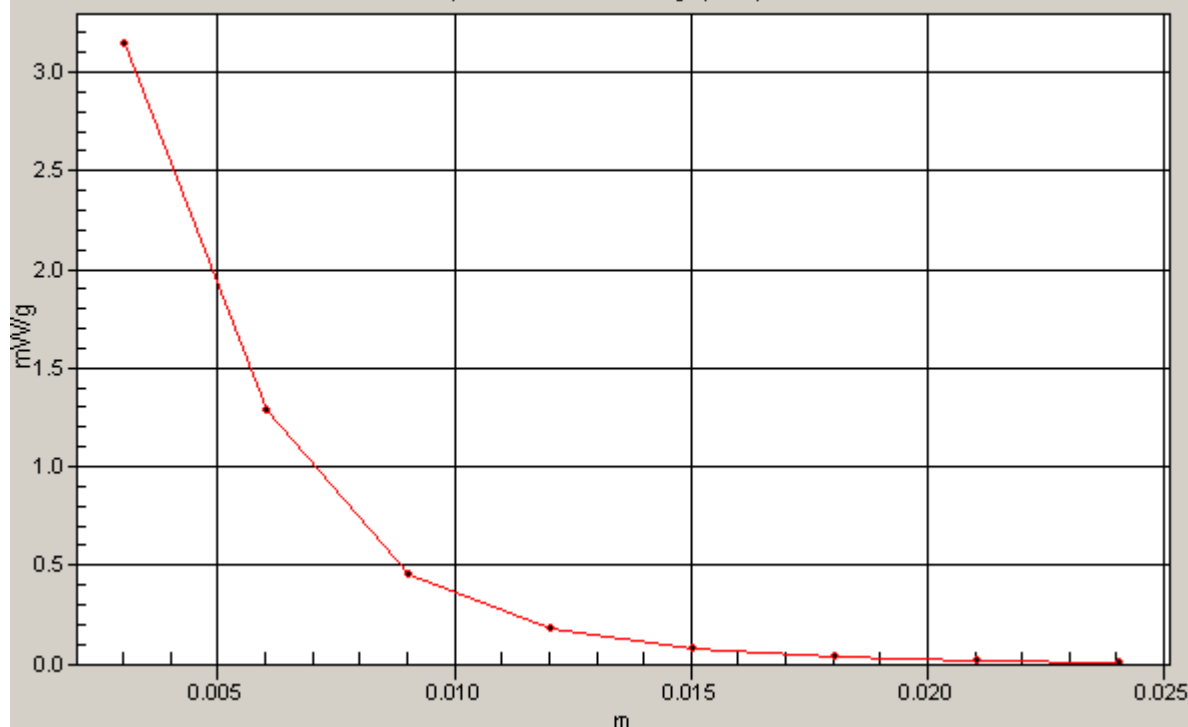
Input Power = 14 dBm (25 mW)

SAR(1 g) = 1.95 mW/g; SAR(10 g) = 0.521 mW/g

Deviation = -4.41%

1g/10g Averaged SAR

SAR; Zoom Scan: Value Along Z, X=4, Y=3



PCTEST ENGINEERING LABORATORY, INC.

**DUT: CF-F9; Type: Laptop/Tablet PC with WLAN, Bluetooth, and WWAN;
Serial: 0AKSA00515**

Communication System: Bluetooth; Frequency: 2441 MHz; Duty Cycle: 1:1

Medium: 2450 Muscle Medium parameters used (interpolated):

$f = 2441 \text{ MHz}$; $\sigma = 1.91 \text{ mho/m}$; $\epsilon_r = 50.5$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 0.0cm

Test Date: 04-12-2010; Ambient Temp: 23.9°C; Tissue Temp: 23.0°C

Probe: EX3DV4 - SN3550; ConvF(6.4, 6.4, 6.4); Calibrated: 1/26/2010

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 1/22/2010

Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Mode: Bluetooth, Lap position, Mid.ch, Tx

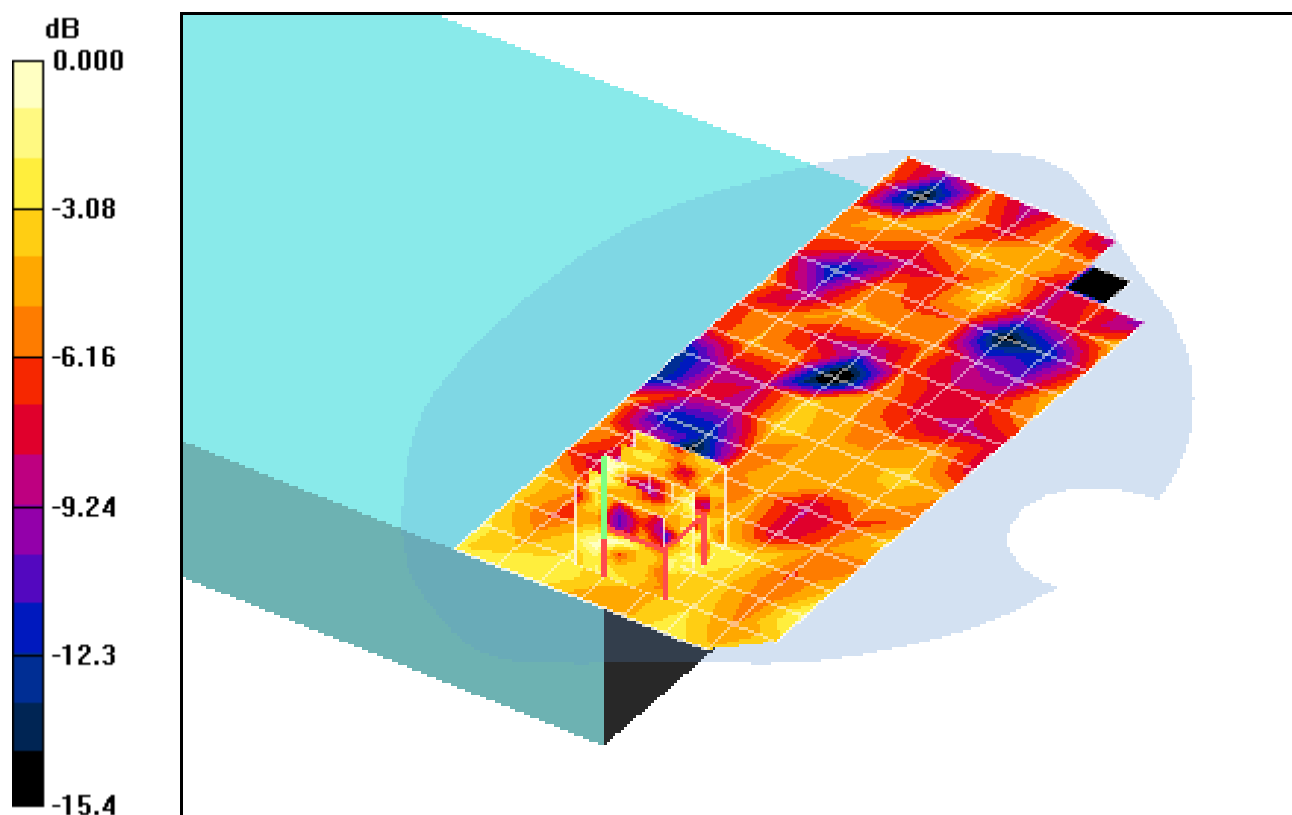
Area Scan (8x17x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 1.40 V/m

Peak SAR (extrapolated) = 0.022 W/kg

SAR(1 g) = 0.00711 mW/g; SAR(10 g) = 0.00271 mW/g



0 dB = 0.013mW/g

APPENDIX B: DIPOLE VALIDATION

PCTEST ENGINEERING LABORATORY, INC.

DUT: SAR Dipole 2450 MHz; Type: D2450V2; Serial: 719

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: 2450 Muscle Medium parameters used:

$f = 2450 \text{ MHz}$; $\sigma = 1.92 \text{ mho/m}$; $\epsilon_r = 50.6$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-12-2010; Ambient Temp: 23.9°C; Tissue Temp: 23.0°C

Probe: EX3DV4 - SN3550; ConvF(6.4, 6.4, 6.4); Calibrated: 1/26/2010

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 1/22/2010

Phantom: SAM Main; Type: SAM 4.0; Serial: TP-1114

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

2450MHz System Verification

Area Scan (5x7x1): Measurement grid: $dx=15\text{mm}$, $dy=15\text{mm}$

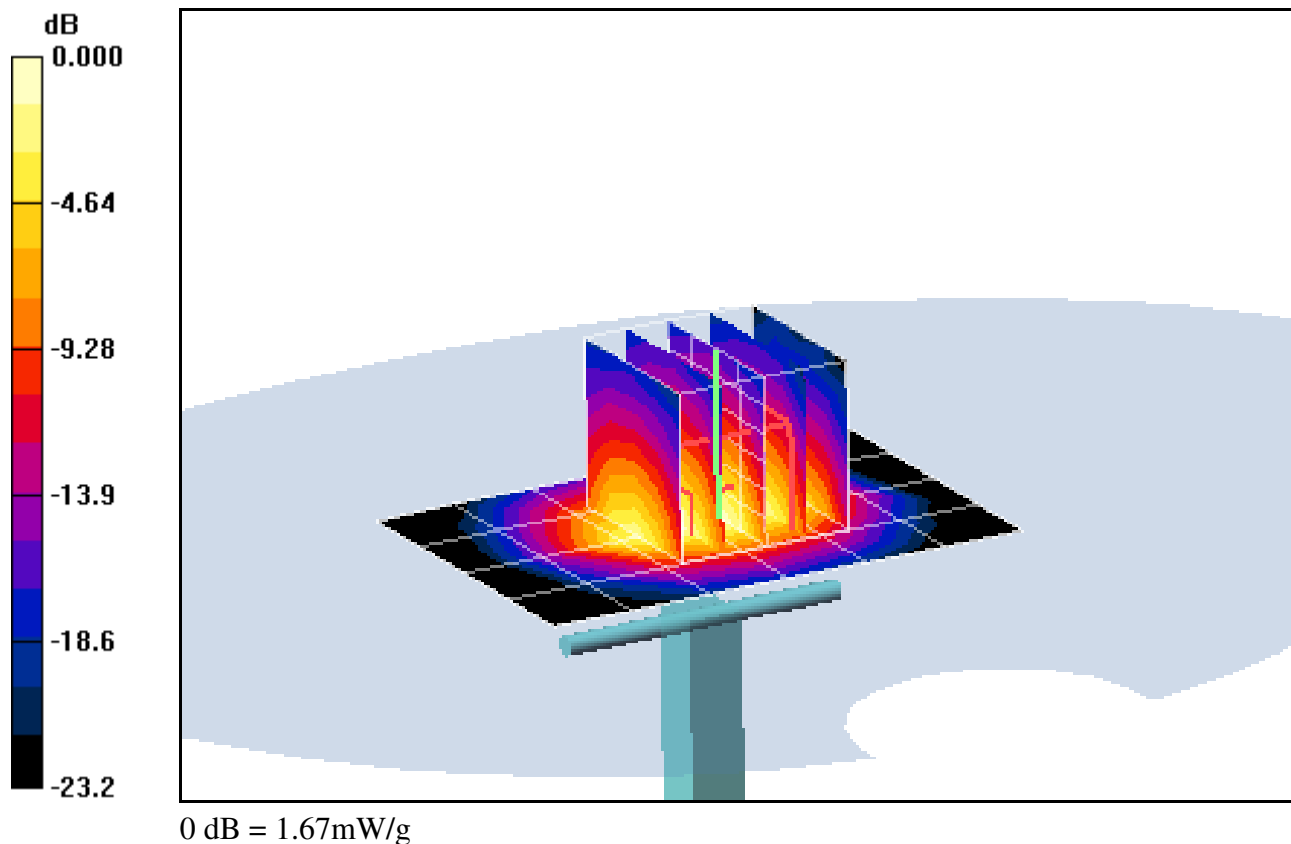
Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Input Power = 14 dBm (25mW)

SAR(1 g) = 1.29 mW/g; SAR(10 g) = 0.594 mW/g

Maximum value of SAR (measured) = 1.67 mW/g

Deviation = 0.39%



PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 5200 MHz; Type: D5GHzV2; Serial: 1057

Communication System: CW; Frequency: 5200 MHz; Duty Cycle: 1:1

Medium: 5200 Muscle Medium parameters used (interpolated):

$f = 5200 \text{ MHz}$; $\sigma = 5.15 \text{ mho/m}$; $\epsilon_r = 47.4$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-14-2010; Ambient Temp: 23.6°C; Tissue Temp: 23.1°C

Probe: EX3DV4 - SN3550; ConvF(3.73, 3.73, 3.73); Calibrated: 1/26/2010

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 1/22/2010

Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5200MHz System Verification

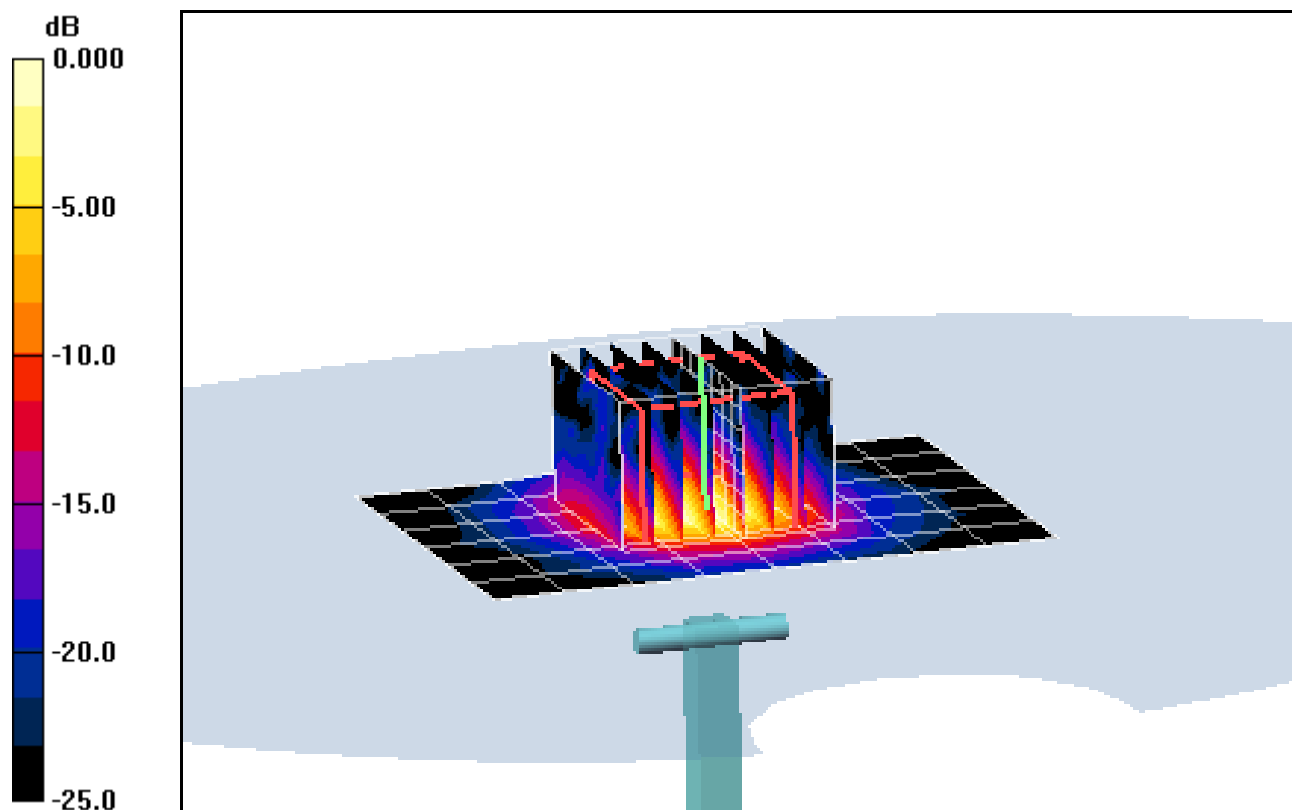
Area Scan (7x9x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

Zoom Scan (8x8x8)/Cube 0: Measurement grid: $dx=4.3\text{mm}$, $dy=4.3\text{mm}$, $dz=3\text{mm}$

Input Power = 14 dBm (25 mW)

SAR(1 g) = 1.88 mW/g; SAR(10 g) = 0.500 mW/g

Deviation = -4.93 %



0 dB = 2.75mW/g

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 5500 MHz; Type: D5GHzV2; Serial: 1057

Communication System: CW; Frequency: 5500 MHz; Duty Cycle: 1:1

Medium: 5500 Muscle Medium parameters used (interpolated):

$f = 5500 \text{ MHz}$; $\sigma = 5.54 \text{ mho/m}$; $\epsilon_r = 46.8$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-14-2010; Ambient Temp: 23.8°C; Tissue Temp: 23.2°C

Probe: EX3DV4 - SN3550; ConvF(3.25, 3.25, 3.25); Calibrated: 1/26/2010

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 1/22/2010

Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5500MHz System Verification

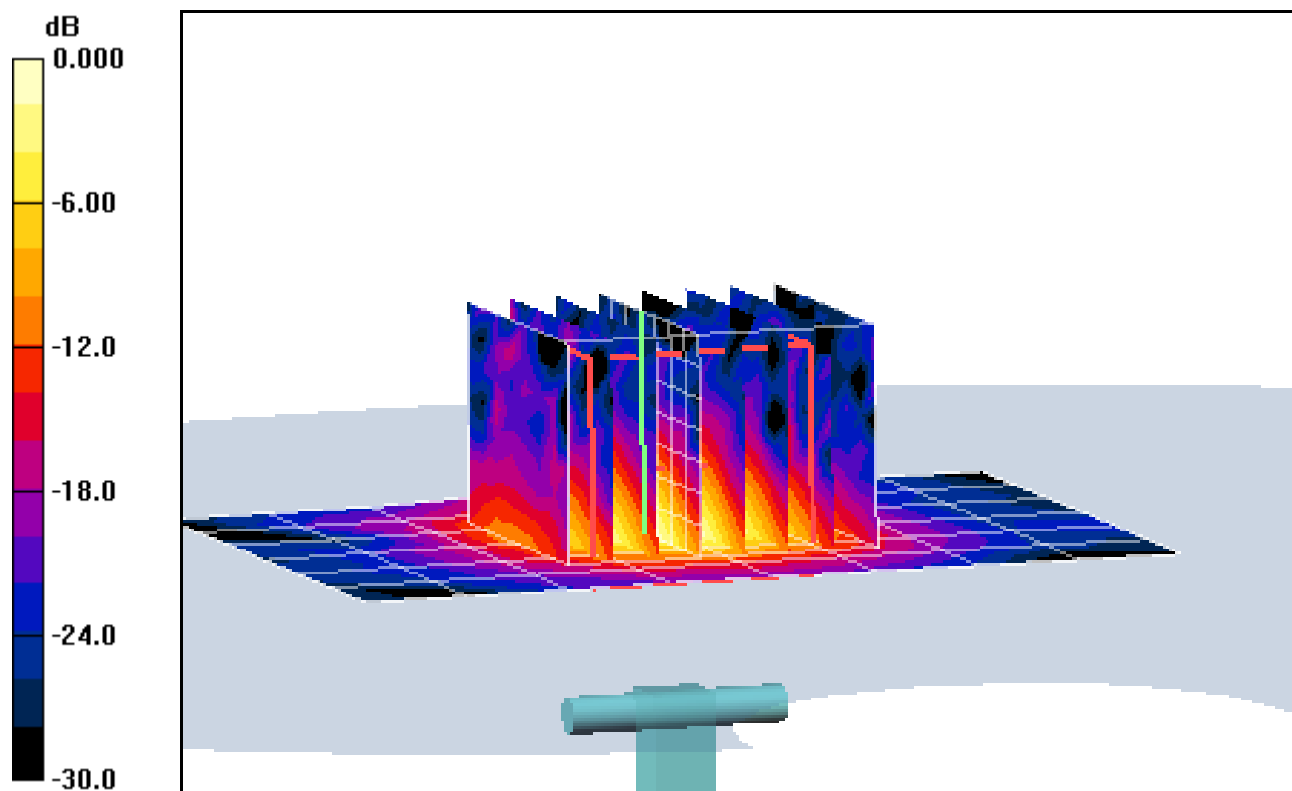
Area Scan (7x9x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

Zoom Scan (8x8x8)/Cube 0: Measurement grid: $dx=4.3\text{mm}$, $dy=4.3\text{mm}$, $dz=3\text{mm}$

Input Power = 14 dBm (25 mW)

SAR(1 g) = 1.95 mW/g; SAR(10 g) = 0.521 mW/g

Deviation = -4.41 %



0 dB = 3.14mW/g

PCTEST ENGINEERING LABORATORY, INC.

DUT: Dipole 5800 MHz; Type: D5GHzV2; Serial: 1057

Communication System: CW; Frequency: 5800 MHz; Duty Cycle: 1:1
Medium: 5.2-5.8 GHz Muscle Medium parameters used (interpolated):

$f = 5800 \text{ MHz}$; $\sigma = 5.95 \text{ mho/m}$; $\epsilon_r = 46.2$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section; Space: 1.0 cm

Test Date: 04-14-2010; Ambient Temp: 23.4°C; Tissue Temp: 22.1°C

Probe: EX3DV4 - SN3550; ConvF(3.3, 3.3, 3.3); Calibrated: 1/26/2010

Sensor-Surface: 3mm (Mechanical Surface Detection)

Electronics: DAE4 Sn649; Calibrated: 1/22/2010

Phantom: SAM Sub; Type: SAM 4.0; Serial: TP-1357

Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

5800MHz System Verification

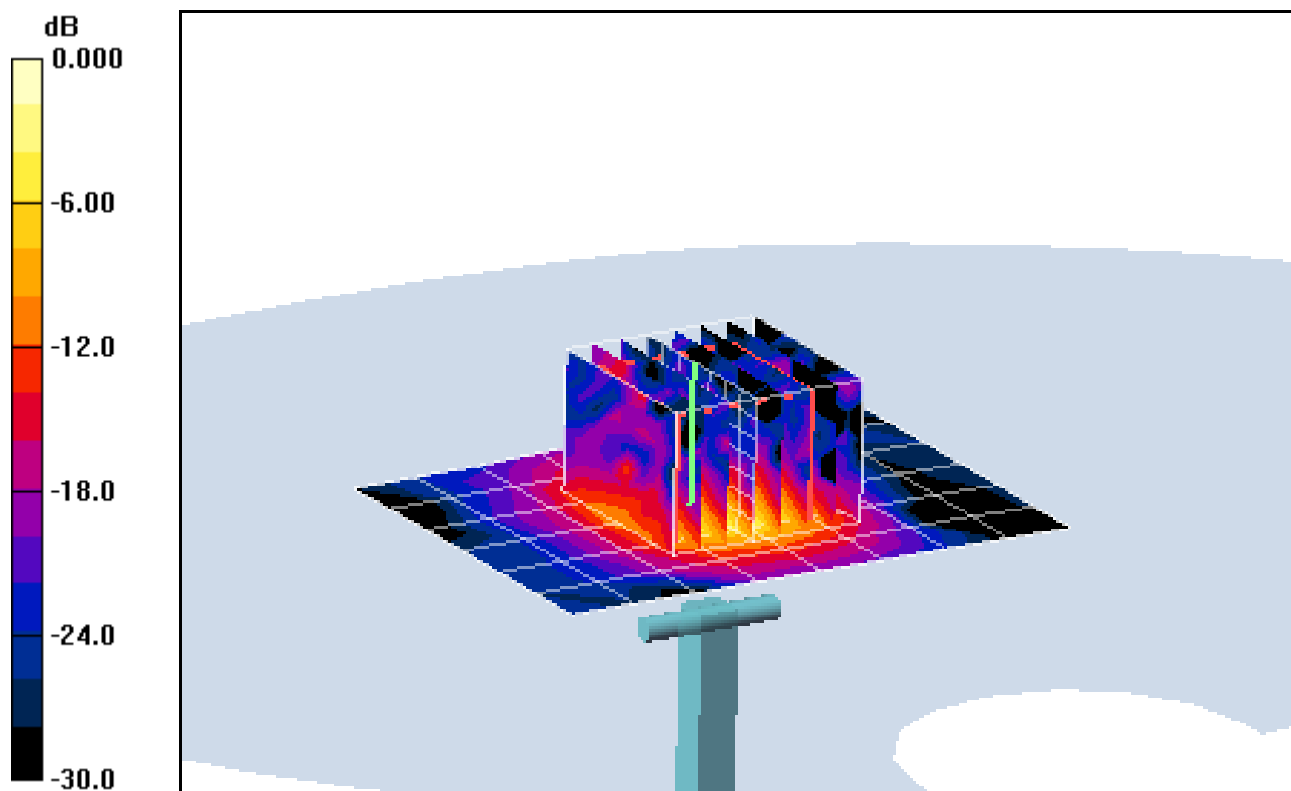
Area Scan (7x9x1): Measurement grid: $dx=10\text{mm}$, $dy=10\text{mm}$

Zoom Scan (8x8x8)/Cube 0: Measurement grid: $dx=4.3\text{mm}$, $dy=4.3\text{mm}$, $dz=3\text{mm}$

Input Power = 14 dBm (25 mW)

SAR(1 g) = 1.7 mW/g; SAR(10 g) = 0.457 mW/g

Deviation = -5.03 %



0 dB = 2.75mW/g

APPENDIX C: PROBE CALIBRATION



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **EX3-3550_Jan10**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3550**

Calibration procedure(s) **QA CAL-01.v6, QA CAL-14.v3, QA CAL-23.v3 and QA CAL-25.v2
Calibration procedure for dosimetric E-field probes**

Calibration date: **January 26, 2010**

✓
1/26/10

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	1-Apr-09 (No. 217-01030)	Apr-10
Power sensor E4412A	MY41495277	1-Apr-09 (No. 217-01030)	Apr-10
Power sensor E4412A	MY41498087	1-Apr-09 (No. 217-01030)	Apr-10
Reference 3 dB Attenuator	SN: S5054 (3c)	31-Mar-09 (No. 217-01026)	Mar-10
Reference 20 dB Attenuator	SN: S5086 (20b)	31-Mar-09 (No. 217-01028)	Mar-10
Reference 30 dB Attenuator	SN: S5129 (30b)	31-Mar-09 (No. 217-01027)	Mar-10
Reference Probe ES3DV2	SN: 3013	30-Dec-09 (No. ES3-3013_Dec09)	Dec-10
DAE4	SN: 660	29-Sep-09 (No. DAE4-660_Sep09)	Sep-10

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-09)	In house check: Oct10

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Technical Manager	
Approved by:	Fin Bornholt	R&D Director	

Issued: January 26, 2010

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



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
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C	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., $\vartheta = 0$ is normal to probe axis

Calibration is Performed According to the Following Standards:

- 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
- 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:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not effect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,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.
- DCP_{x,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.
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}**: A, B, C 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 $f \leq 800$ 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 NORM_{x,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:3550

Manufactured:	May 19, 2004
Last calibrated:	January 21, 2009
Recalibrated:	January 26, 2010

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: EX3DV4 SN:3550**Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.48	0.47	0.48	± 10.1%
DCP (mV) ^B	92.9	88.4	91.4	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dBuV	C	VR mV	Unc ^E (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	300	± 1.5%
			Y	0.00	0.00	1.00	300	
			Z	0.00	0.00	1.00	300	

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 E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the maximum deviation from linear response applying recatangular distribution and is expressed for the square of the field value.

DASY - Parameters of Probe: EX3DV4 SN:3550

Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz]	Validity [MHz] ^c	Permittivity	Conductivity	ConvF X	ConvF Y	ConvF Z	Alpha	Depth Unc (k=2)
835	± 50 / ± 100	41.5 ± 5%	0.90 ± 5%	8.28	8.28	8.28	0.45	0.70 ± 11.0%
1750	± 50 / ± 100	40.1 ± 5%	1.37 ± 5%	7.03	7.03	7.03	0.39	0.75 ± 11.0%
1900	± 50 / ± 100	40.0 ± 5%	1.40 ± 5%	6.81	6.81	6.81	0.32	0.81 ± 11.0%
2450	± 50 / ± 100	39.2 ± 5%	1.80 ± 5%	6.21	6.21	6.21	0.22	1.07 ± 11.0%

^c The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

DASY - Parameters of Probe: EX3DV4 SN:3550

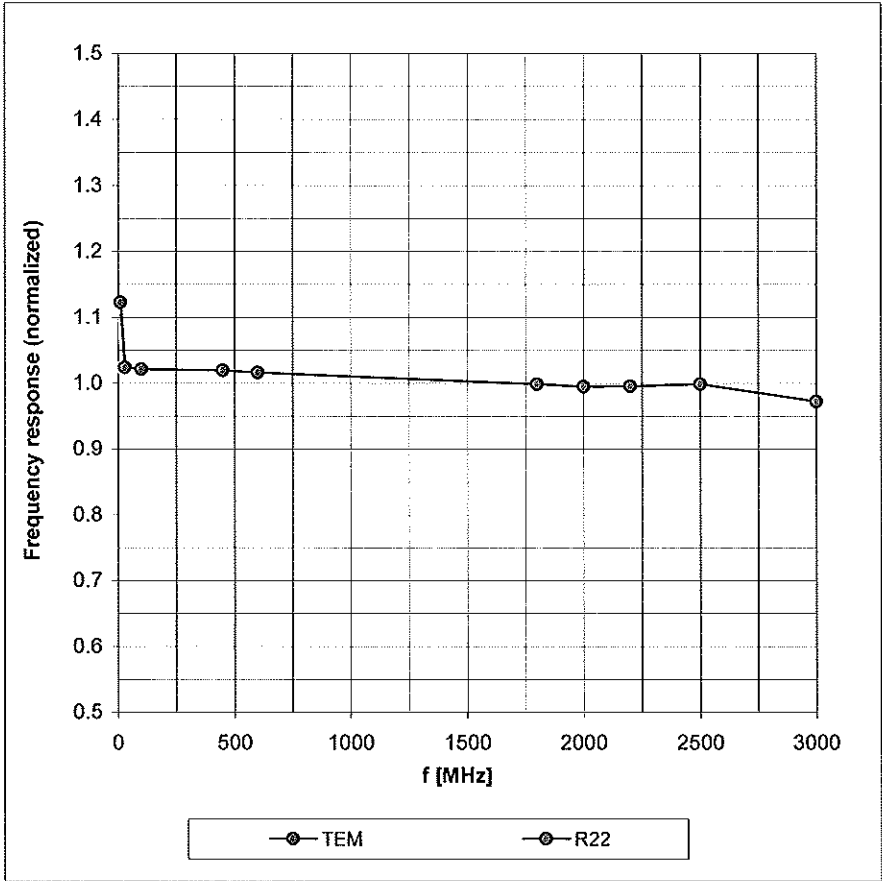
Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz]	Validity [MHz] ^c	Permittivity	Conductivity	ConvF X	ConvF Y	ConvF Z	Alpha	Depth Unc (k=2)
835	± 50 / ± 100	55.2 ± 5%	0.97 ± 5%	8.30	8.30	8.30	0.47	0.76 ± 11.0%
1750	± 50 / ± 100	53.4 ± 5%	1.49 ± 5%	6.90	6.90	6.90	0.49	0.69 ± 11.0%
1900	± 50 / ± 100	53.3 ± 5%	1.52 ± 5%	6.63	6.63	6.63	0.76	0.54 ± 11.0%
2450	± 50 / ± 100	52.7 ± 5%	1.95 ± 5%	6.40	6.40	6.40	0.22	1.09 ± 11.0%
2600	± 50 / ± 100	52.5 ± 5%	2.16 ± 5%	6.26	6.26	6.26	0.19	1.42 ± 11.0%
4950	± 50 / ± 100	49.4 ± 5%	5.01 ± 5%	3.64	3.64	3.64	0.50	1.75 ± 13.1%
5200	± 50 / ± 100	49.0 ± 5%	5.30 ± 5%	3.73	3.73	3.73	0.50	1.75 ± 13.1%
5300	± 50 / ± 100	48.5 ± 5%	5.42 ± 5%	3.52	3.52	3.52	0.52	1.75 ± 13.1%
5500	± 50 / ± 100	48.6 ± 5%	5.65 ± 5%	3.26	3.26	3.26	0.55	1.80 ± 13.1%
5600	± 50 / ± 100	48.5 ± 5%	5.77 ± 5%	3.16	3.16	3.16	0.65	1.80 ± 13.1%
5800	± 50 / ± 100	48.2 ± 5%	6.00 ± 5%	3.30	3.30	3.30	0.60	1.75 ± 13.1%

^c The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

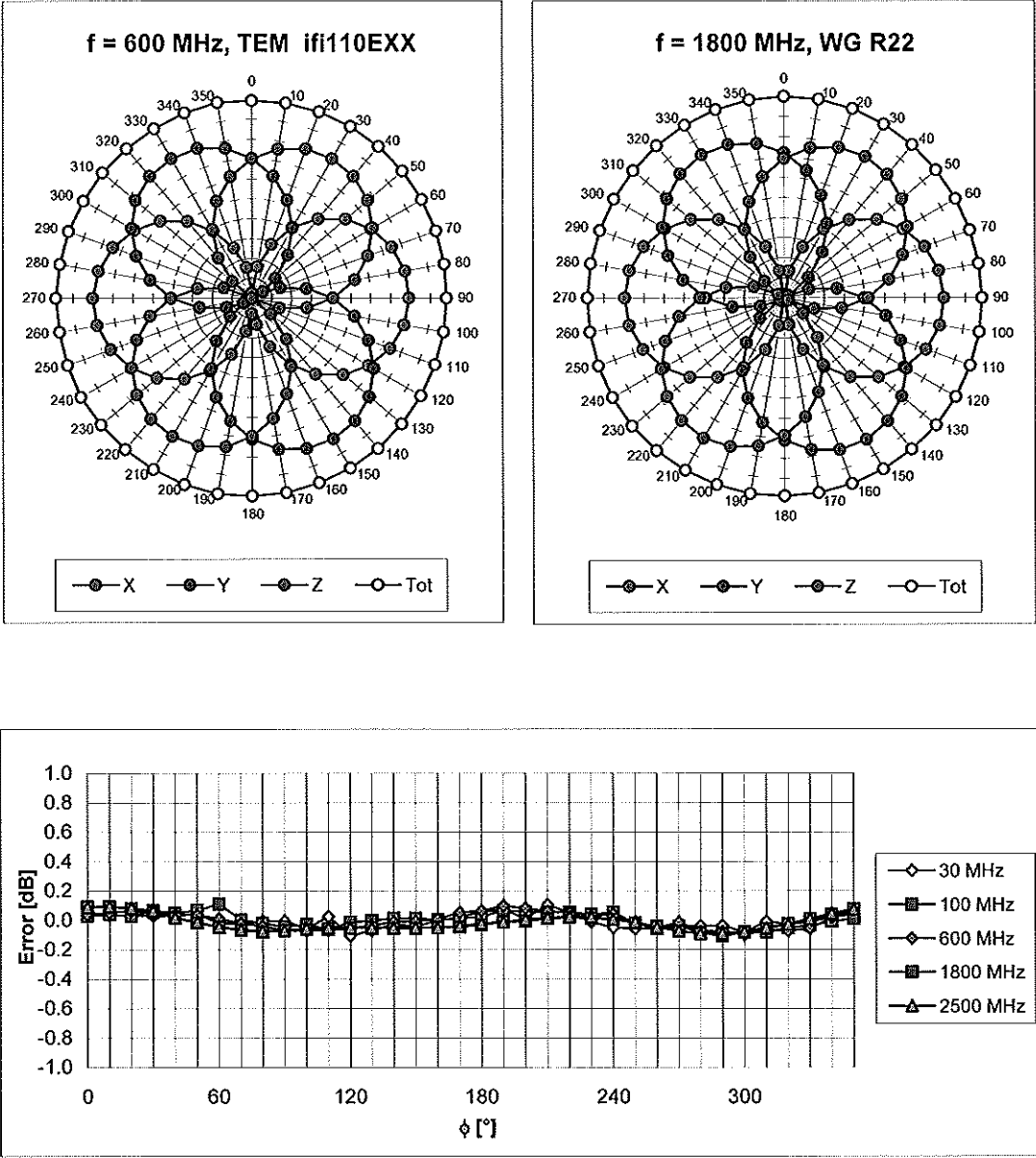
Frequency Response of E-Field

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



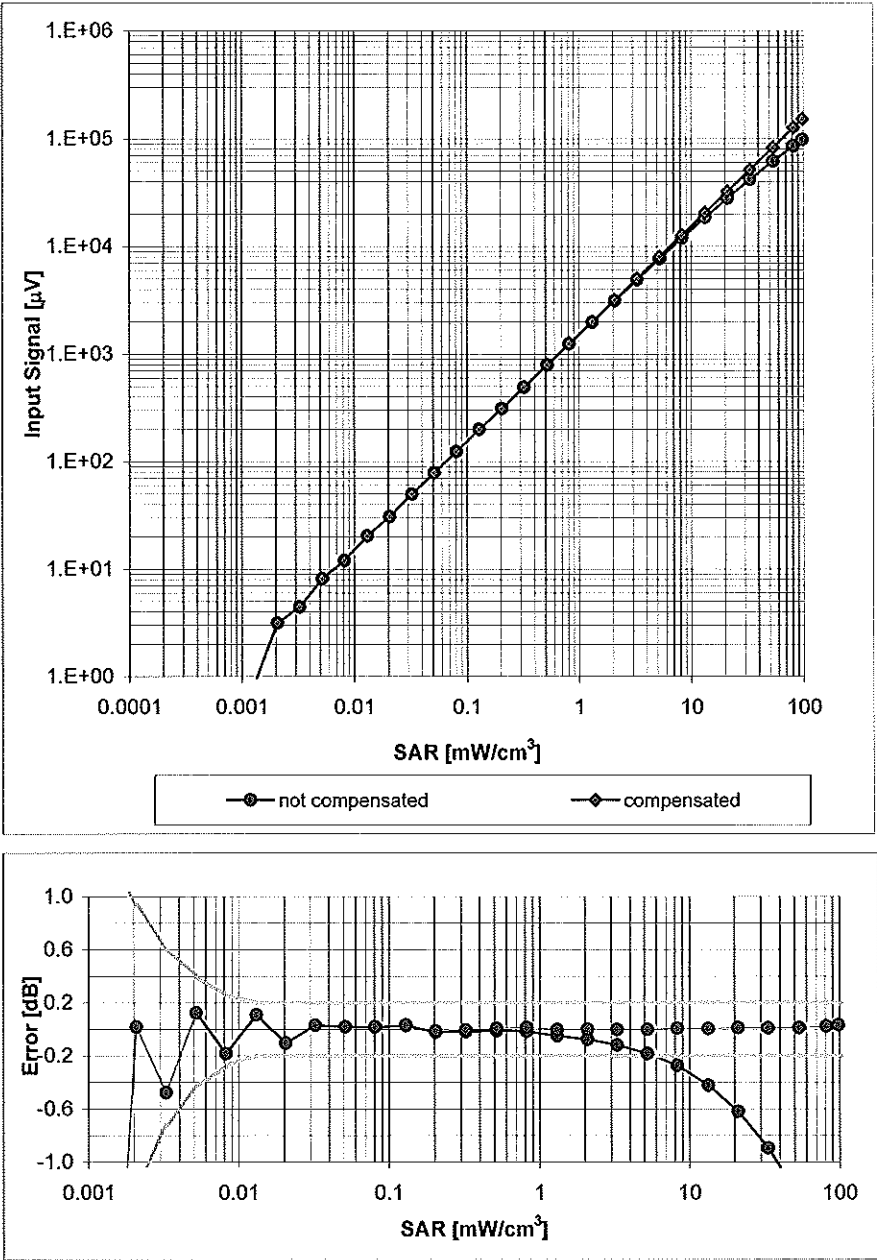
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

Receiving Pattern (ϕ), $\vartheta = 0^\circ$



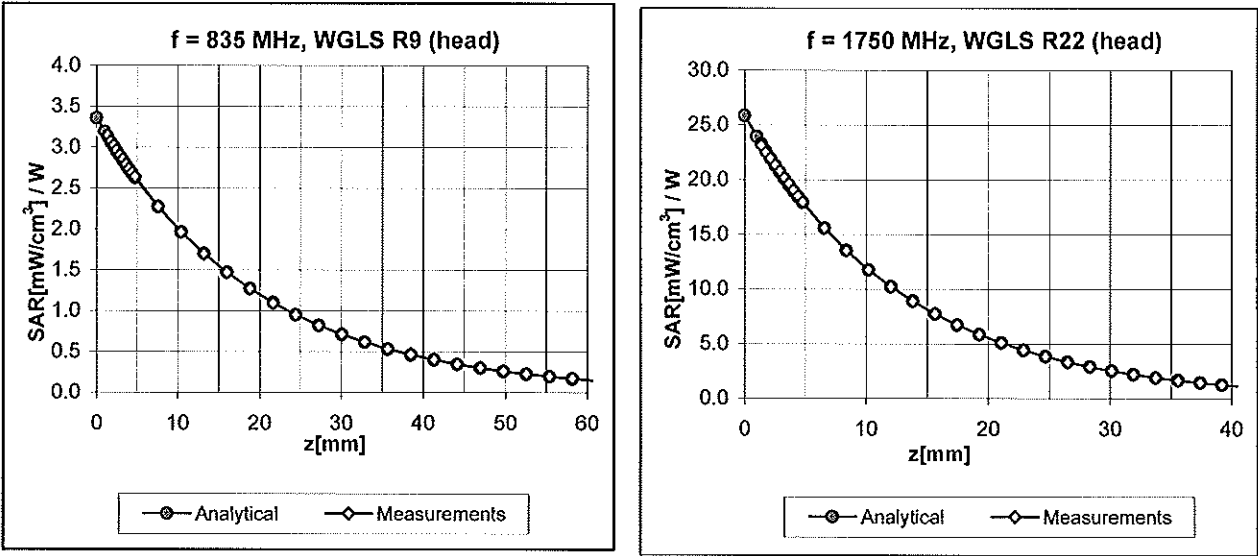
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range f(SAR_{head})
(Waveguide R22, f = 1800 MHz)



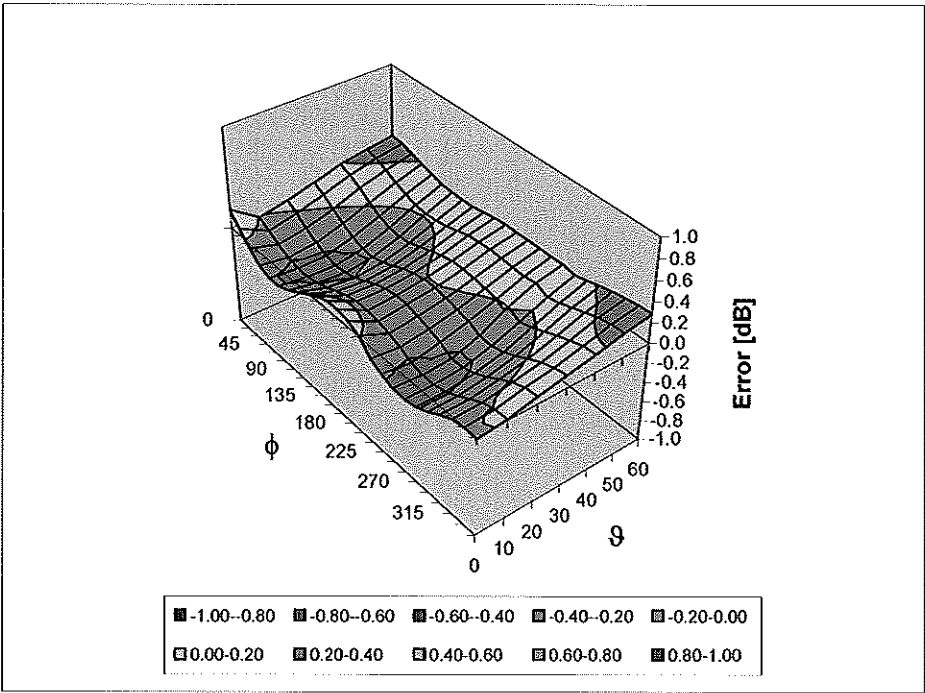
Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in HSL

Error (ϕ, θ), f = 900 MHz



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

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	Not applicable
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



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Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D2450V2-719_Aug09**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN: 719**

Calibration procedure(s) **QA CAL-05.v7**
Calibration procedure for dipole validation kits

Calibration date: **August 27, 2009**

Condition of the calibrated item **In Tolerance**

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 $(22 \pm 3)^\circ\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	08-Oct-08 (No. 217-00898)	Oct-09
Power sensor HP 8481A	US37292783	08-Oct-08 (No. 217-00898)	Oct-09
Reference 20 dB Attenuator	SN: 5086 (20g)	31-Mar-09 (No. 217-01025)	Mar-10
Type-N mismatch combination	SN: 5047.2 / 06327	31-Mar-09 (No. 217-01029)	Mar-10
Reference Probe ES3DV3	SN: 3205	26-Jun-09 (No. ES3-3205_Jun09)	Jun-10
DAE4	SN: 601	07-Mar-09 (No. DAE4-601_Mar09)	Mar-10

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-07)	In house check: Oct-09
RF generator R&S SMT-06	100005	4-Aug-99 (in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-08)	In house check: Oct-09

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

Issued: August 27, 2009

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



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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:

- 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
- 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
- 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:

- 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	V5.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 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 $\pm$ 0.2) °C	40.1 $\pm$ 6 %	1.80 mho/m $\pm$ 6 %
Head TSL temperature during test	(22.3 $\pm$ 0.2) °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm ³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.3 mW / g
SAR normalized	normalized to 1W	53.2 mW / g
SAR for nominal Head TSL parameters ¹	normalized to 1W	53.5 mW / g $\pm$ 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 normalized	normalized to 1W	24.9 mW / g
SAR for nominal Head TSL parameters ¹	normalized to 1W	25.0 mW / g $\pm$ 16.5 % (k=2)

¹ Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

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	53.2 ± 6 %	2.01 mho/m ± 6 %
Body TSL temperature during test	(22.5 ± 0.2) °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 mW / g
SAR normalized	normalized to 1W	52.0 mW / g
SAR for nominal Body TSL parameters ²	normalized to 1W	51.4 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.00 mW / g
SAR normalized	normalized to 1W	24.0 mW / g
SAR for nominal Body TSL parameters ²	normalized to 1W	23.9 mW /g ± 16.5 % (k=2)

² Correction to nominal TSL parameters according to d), chapter "SAR Sensitivities"

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$53.4 \Omega + 1.8 j\Omega$
Return Loss	- 28.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$48.2 \Omega + 3.9 j\Omega$
Return Loss	- 27.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.150 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.

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 10, 2002

DASY5 Validation Report for Head TSL

Date/Time: 27.08.2009 11:14:47

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN719

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: HSL U11 BB

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.8$ mho/m; $\epsilon_r = 40.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.53, 4.53, 4.53); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 07.03.2009
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.4 Build 45

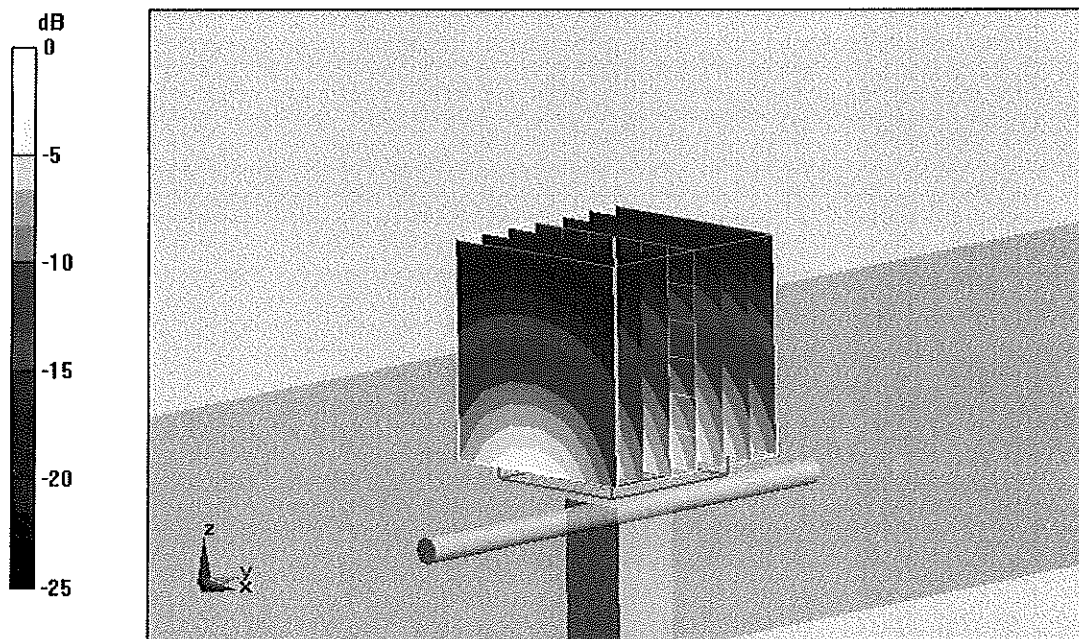
Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 101.4 V/m; Power Drift = 0.025 dB

Peak SAR (extrapolated) = 27 W/kg

SAR(1 g) = 13.3 mW/g; SAR(10 g) = 6.23 mW/g

Maximum value of SAR (measured) = 17.2 mW/g

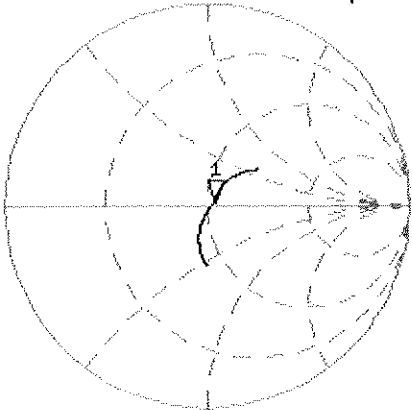


0 dB = 17.2mW/g

Impedance Measurement Plot for Head TSL

27 Aug 2009 09:14:09
[CH1] S11 1 U FS 1: 53.385 Ω 1.7910 Ω 116.35 pF 2 450.000 000 MHz

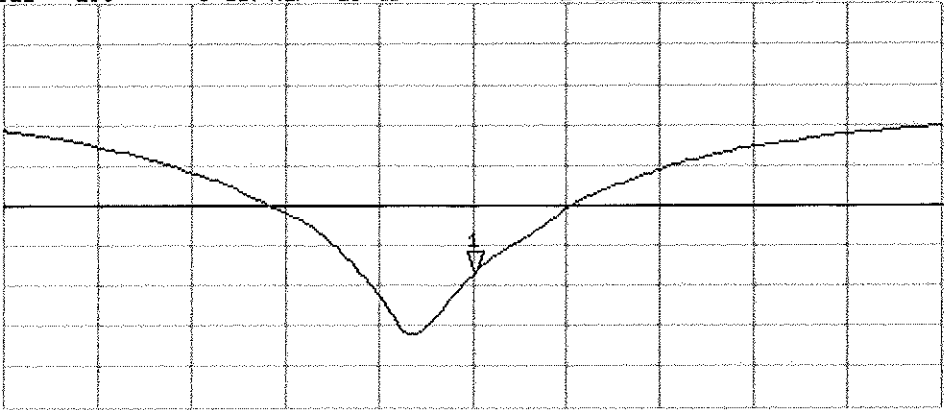
*
De1
Cor



↑

CH2 S11 LOG 5 dB/REF -20 dB 1:-28.624 dB 2 450.000 000 MHz

Cor



↑

START 2 250.000 000 MHz

STOP 2 650.000 000 MHz

DASY5 Validation Report for Body TSL

Date/Time: 17.08.2009 15:35:28

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:719

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: MSL U10 BB

Medium parameters used: $f = 2450$ MHz; $\sigma = 2.01$ mho/m; $\epsilon_r = 53.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC)

DASY5 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.31, 4.31, 4.31); Calibrated: 26.06.2009
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 07.03.2009
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.4 Build 45

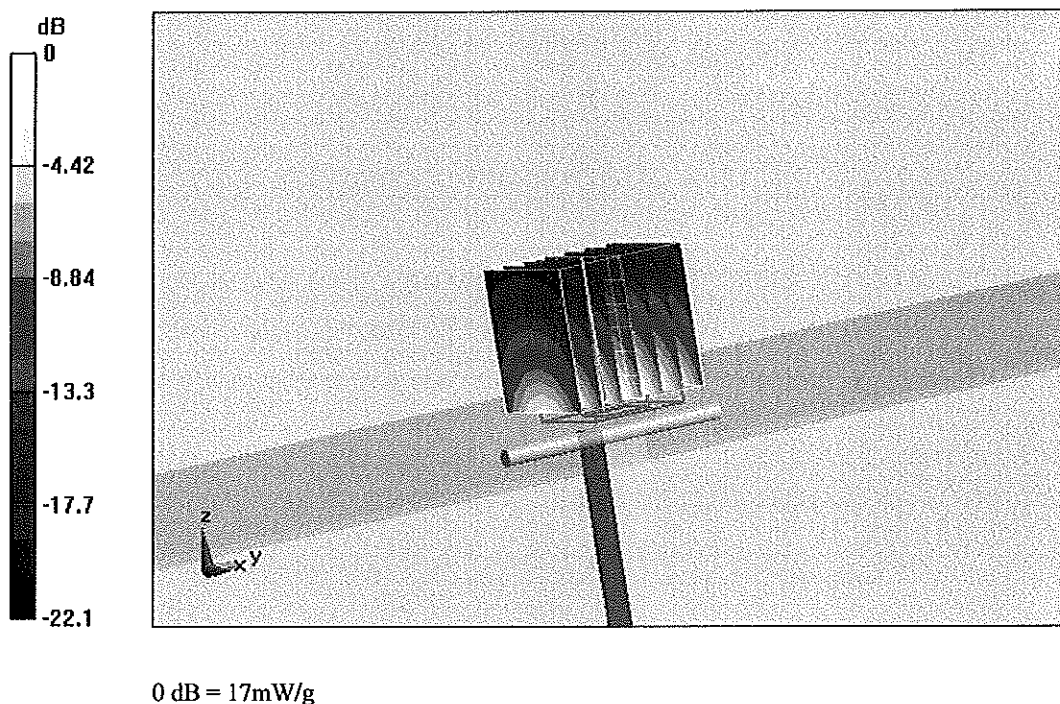
Pin = 250 mW; d = 10 mm/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.8 V/m; Power Drift = -0.00649 dB

Peak SAR (extrapolated) = 27.2 W/kg

SAR(1 g) = 13 mW/g; SAR(10 g) = 6 mW/g

Maximum value of SAR (measured) = 17 mW/g



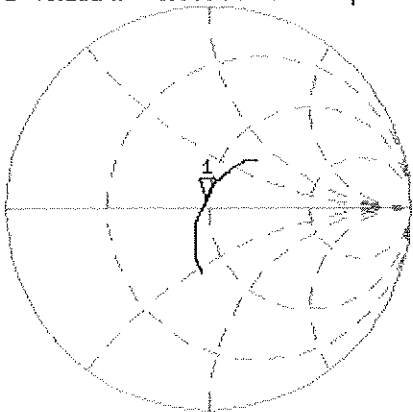
Impedance Measurement Plot for Body TSL

17 Aug 2009 15:56:32
[CH1] S11 1 U FS 1: 48.221 Ω 3.9004 Ω 253.37 pF 2 450.000 000 MHz

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De1
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↑

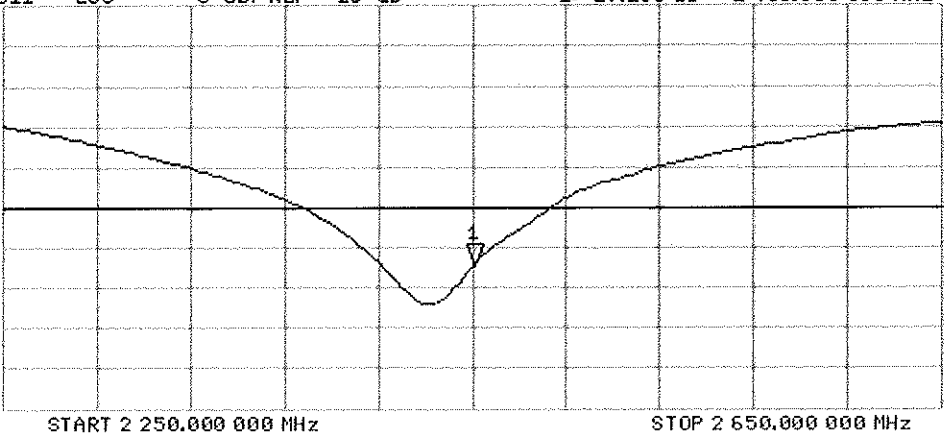


CH2 S11 LOG 5 dB/REF -20 dB 1:-27.205 dB 2 450.000 000 MHz

Cor

Avg
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↑





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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **PC Test**

Certificate No: **D5GHzV2-1057_Jan09**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN: 1057**

Calibration procedure(s) **QA CAL-22.v1
 Calibration procedure for dipole validation kits between 3-6 GHz**

Calibration date: **January 15, 2009**

Condition of the calibrated item **In Tolerance**

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	08-Oct-08 (No. 217-00898)	Oct-09
Power sensor HP 8481A	US37292783	08-Oct-08 (No. 217-00898)	Oct-09
Reference 20 dB Attenuator	SN: 5086 (20g)	01-Jul-08 (No. 217-00864)	Jul-09
Type-N mismatch combination	SN: 5047.2 / 06327	01-Jul-08 (No. 217-00867)	Jul-09
Reference Probe EX3DV4	SN: 3503	8-Mar-08 (No. EX3-3503_Mar08)	Mar-09
DAE4	SN: 601	14-Mar-08 (No. DAE4-601_Mar08)	Mar-09
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-07)	In house check: Oct-09
RF generator R&S SMT-06	100005	4-Aug-99 (in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-08)	In house check: Oct-09

Calibrated by: **Jeton Kastrati** **Laboratory Technician**

Approved by: **Katja Pokovic** **Technical Manager**

Issued: January 16, 2009

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



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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) IEC Std 62209 Part 2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", Draft Version 0.9, December 2004
- b) 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:

- c) 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	V5.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Area Scan resolution	dx, dy = 10 mm	
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 2.5 mm	
Frequency	5200 MHz $\pm$ 1 MHz 5500 MHz $\pm$ 1 MHz 5800 MHz $\pm$ 1 MHz	

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 $\pm$ 0.2) °C	47.4 $\pm$ 6 %	5.34 mho/m $\pm$ 6 %
Body TSL temperature during test	(21.6 $\pm$ 0.2) °C	----	----

SAR result with Body TSL at 5200 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	condition	
SAR measured	100 mW input power	7.96 mW / g
SAR normalized	normalized to 1W	79.6 mW / g
SAR for nominal Body TSL parameters ¹	normalized to 1W	79.1 mW / g $\pm$ 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.22 mW / g
SAR normalized	normalized to 1W	22.2 mW / g
SAR for nominal Body TSL parameters ¹	normalized to 1W	22.1 mW / g $\pm$ 19.5 % (k=2)

¹ Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities"

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	46.7 ± 6 %	5.70 mho/m ± 6 %
Body TSL temperature during test	(21.6 ± 0.2) °C	----	----

SAR result with Body TSL at 5500 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	condition	
SAR measured	100 mW input power	8.23 mW / g
SAR normalized	normalized to 1W	82.3 mW / g
SAR for nominal Body TSL parameters ²	normalized to 1W	81.6 mW / g ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	2.27 mW / g
SAR normalized	normalized to 1W	22.7 mW / g
SAR for nominal Body TSL parameters ²	normalized to 1W	22.5 mW / g ± 19.5 % (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	46.1 ± 6 %	6.03 mho/m ± 6 %
Body TSL temperature during test	(21.6 ± 0.2) °C	----	----

SAR result with Body TSL at 5800 MHz

SAR averaged over 1 cm³ (1 g) of Body TSL	condition	
SAR measured	100 mW input power	7.22 mW / g
SAR normalized	normalized to 1W	72.2 mW / g
SAR for nominal Body TSL parameters ²	normalized to 1W	71.6 mW / g ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	100 mW input power	1.99 mW / g
SAR normalized	normalized to 1W	19.9 mW / g
SAR for nominal Body TSL parameters ²	normalized to 1W	19.7 mW / g ± 19.5 % (k=2)

² Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities"

Appendix

Antenna Parameters with Body TSL at 5200 MHz

Impedance, transformed to feed point	50.8 Ω - 5.2 j Ω
Return Loss	-25.6 dB

Antenna Parameters with Body TSL at 5500 MHz

Impedance, transformed to feed point	51.5 Ω - 2.8 j Ω
Return Loss	-30.2 dB

Antenna Parameters with Body TSL at 5800 MHz

Impedance, transformed to feed point	53.5 Ω - 1.4 j Ω
Return Loss	-28.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.202 ns
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After long term use with 40 W 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.

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	November 27, 2006

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN:1057

Communication System: CW-5GHz; Frequency: 5200 MHzFrequency: 5500 MHzFrequency: 5800 MHz;
Duty Cycle: 1:1

Medium: MSL 5800 MHz

Medium parameters used: $f = 5200$ MHz; $\sigma = 5.37$ mho/m; $\epsilon_r = 47.4$; $\rho = 1000$ kg/m³ Medium parameters used: $f = 5500$ MHz; $\sigma = 5.73$ mho/m; $\epsilon_r = 46.6$; $\rho = 1000$ kg/m³ Medium parameters used: $f = 5800$ MHz; $\sigma = 6.06$ mho/m; $\epsilon_r = 46.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC)

DASY5 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.95, 4.95, 4.95)ConvF(4.61, 4.61, 4.61)ConvF(4.74, 4.74, 4.74); Calibrated: 08.03.2008
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 14.03.2008
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- Measurement SW: DASY5, V5.0 Build 120; SEMCAD X Version 13.4 Build 45

d=10mm, Pin=100mW, f=5200 MHz/Area Scan (61x61x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 16.4 mW/g

d=10mm, Pin=100mW, f=5200 MHz/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:

Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 60.1 V/m; Power Drift = -0.034 dB

Peak SAR (extrapolated) = 30.1 W/kg

SAR(1 g) = 7.96 mW/g; SAR(10 g) = 2.22 mW/g

Maximum value of SAR (measured) = 16.5 mW/g

d=10mm, Pin=100mW, f=5500 MHz/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:

Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 59.3 V/m; Power Drift = 0.012 dB

Peak SAR (extrapolated) = 33.9 W/kg

SAR(1 g) = 8.23 mW/g; SAR(10 g) = 2.27 mW/g

Maximum value of SAR (measured) = 17.6 mW/g

d=10mm, Pin=100mW, f=5800 MHz/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:

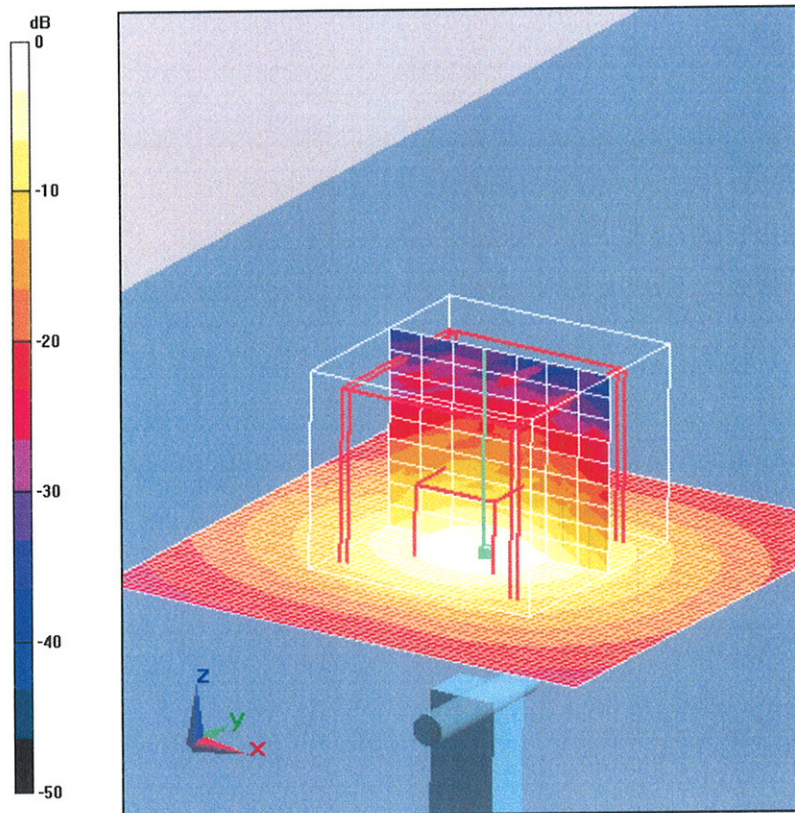
Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 54.6 V/m; Power Drift = 0.014 dB

Peak SAR (extrapolated) = 31.2 W/kg

SAR(1 g) = 7.22 mW/g; SAR(10 g) = 1.99 mW/g

Maximum value of SAR (measured) = 15.6 mW/g



0 dB = 15.6mW/g

Impedance Measurement Plot for Body TSL

14 Jan 2009 14:37:11

[CH1] S11 1 U FS

1: 50.777 Ω -5.2422 Ω 5.8385 pF

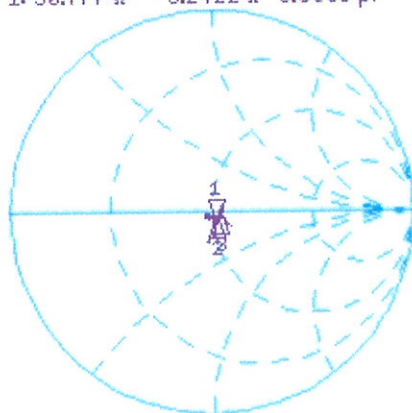
5 200.000 000 MHz

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CH1 Markers

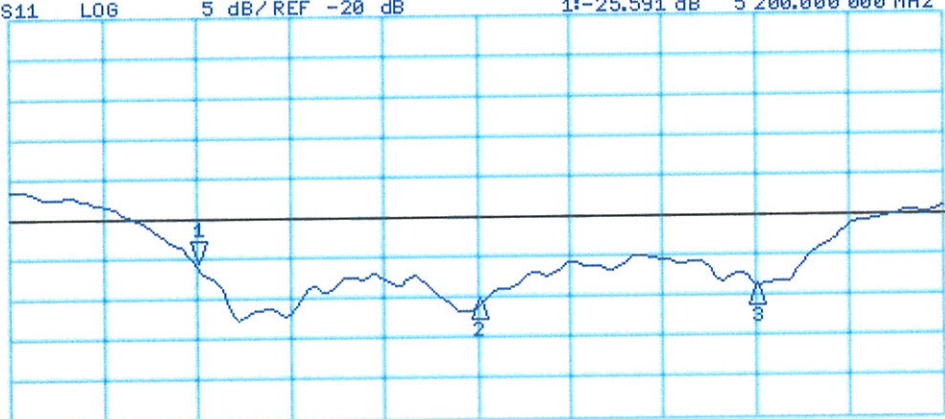
2: 51.465 Ω
-2.7676 Ω
5.50000 GHz

3: 53.498 Ω
-1.4004 Ω
5.80000 GHz

CH2 S11 LOG 5 dB/REF -20 dB 1:-25.591 dB 5 200.000 000 MHz

Cor

Avg
16



CH2 Markers

2:-30.210 dB
5.50000 GHz

3:-28.778 dB
5.80000 GHz

START 5 000.000 000 MHz

STOP 6 000.000 000 MHz