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Dosimetric Assessment
Test Report

For the

Versatek Wireless Datalogger VWD-1

Tested and Evaluated In Accordance With
FCC OET 65 Supplement C: 01-01

Prepared for

Tekscan, Inc.
307 West First Street
Boston, MA 02127

Engineering Statement: The measurements shown in this report were made in accordance with the procedures specified in Supplement C to OET Bulletin 65 of the Federal Communications Commission (FCC) Guidelines [FCC 2001] for uncontrolled exposure. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment evaluated is capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE Std. C95.1-1992.

SAR Evaluation

Applicant Name and Address: **Tekscan, Inc.**
307 West First Street
Boston, MA 02127

Test Location: **MET Laboratories, Inc.**
3162 Belick Street
Santa Clara, CA 95054
USA

EUT:	Versatek Wireless Datalogger VWD-1	
Date of Receipt:	September 8, 2010	
Device Category:	Portable	
RF exposure environment:	Uncontrolled Exposure / General Population	
RF exposure category:	Portable	
Production/prototype:	Prototype	
Antenna:	Internal	
Modulations Tested:	DTS	
Duty Cycle:	100%	
TX Range:	2400–2483.5 MHz 802.11b	2400–2483.5 MHz 802.11g
Max SAR Measured:	**SAR 1g (mW/g)**	
Body:	1.080	0.394

Shawn McMillen
SAR Compliance Manager

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1 INTRODUCTION

The intent of this measurement report is to demonstrate that the Tekscan Versatek Wireless Datalogger VWD-1 described within this report complies with the Specific Absorption Rate (SAR) RF exposure requirements specified in ANSI/IEEE Std. C95.1-1992 and FCC 47 CFR §2.1093 for the Occupational/ Controlled Exposure environment when used with a holster for body worn configuration. The test procedures described in FCC OET Bulletin 65, Supplement C, Edition 01-01 were employed.

A description of the device under test, device operating configuration and test conditions, measurement and site description, methodology and procedures used in the evaluation, equipment used, detailed summary of the test results and the various provisions of the rules are included in this dosimetric assessment test report.

2 SAR DEFINITION

Specific Absorption Rate (SAR) 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).

$$SAR = \sigma E^2 / \rho$$

where:

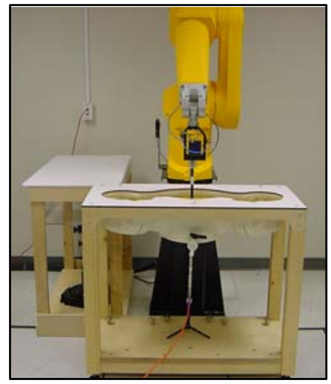
σ - conductivity of the tissue - simulant material (S/m)
ρ - mass density of the tissue - simulant material (kg/m3)
E - Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relations 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.

3 DESCRIPTION OF TEST PLATFORMS

Applicant:	Tekscan, Inc.
Description of EUT:	The VWD is an electronic tactile pressure measurement system. The VWD collects and bundles the data from the Cuff units and then can transfer the data to a PC by three methods: through a tethered USB2.0 cable, removable on board microSD card, or wirelessly via IEEE 802.11 b/g with a 3rd party internal WiFi component.
Model Number:	VWD-1
Serial Number:	Prototype D14/C14
Battery Type(s) Tested:	7.4V 2400mAh Lithium-Ion Battery
Antenna Type(s) Tested:	Internal
Body Worn Accessories:	Holster
Tested Modes and Bands of Operation:	802.11b/g
Maximum Duty Cycle Tested:	100%
Tested Frequency:	2412, 2437, 2462 MHz
Application Type:	Certification
Exposure Category:	Uncontrolled Exposure / General Population
FCC Rule Part(s):	FCC 47 CFR §2.1093,
Standards:	IEEE Std. 1528-2003, FCC OET Bulletin 65, Supplement C, Edition 01-01
IC Standard:	RSS-102 – Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands); Issue 4, March 2010

SAR MEASUREMENT SYSTEM



MET Laboratories, Inc SAR measurement facility utilizes the DASY4 Professional Dosimetric Assessment System (DASY™) manufactured by Schmid & Partner Engineering AG (SPEAG™) of Zurich, Switzerland for performing SAR compliance tests. The DASY4 measurement system is comprised of the measurement server, robot controller, computer, near-field probe, probe alignment sensor, specific anthropomorphic mannequin (SAM) phantom, and various planar phantoms for brain and/or body SAR evaluations. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF). The Cell controller system contain the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The Staubli robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit 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 DASY4 measurement server. The DAE4 utilizes 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 DASY4 measurement server 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. The sensor systems are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.

4 MEASUREMENT SUMMARY

BODY SAR MEASUREMENT RESULTS (2450 MHz) Band									
Freq (MHz)	Chan	Mode Test ed	Data Rate	Battery Type	Body-Worn Accessories	Antenna Position	EUT Test Position	Phantom Section	Measured SAR 1g (W/kg)
2412	Low	b mode	1 Mbps	Standard	None	Internal	Touch	Body	0.574
2437	Mid	b mode	1 Mbps	Standard	None	Internal	Touch	Body	0.800
2462	High	b mode	1 Mbps	Standard	None	Internal	Touch	Body	1.080
2437	Low	g mode	6 Mbps	Standard	None	Internal	Touch	Body	0.394
ANSI/IEEE C95.1 1992 – SAFETY LIMITBODY: 1.6 W/kg (averaged over 1 gram) Spatial Peak – Uncontrolled Exposure / General Population									

Measured Mixture Type	2450 MHz Body		Date Tested	August 23rd, 2010
Dielectric Constant εr	IEEE Target	Measured	Duty Cycle	100%
	52.7	51.696	Ambient Temperature (C)	23.0
Conductivity σ (mho/m)	IEEE Target	Measured	Fluid Temperature (C)	22.3
	1.95	1.9679	Fluid Depth	≥15cm

DETAILS OF SAR EVALUATION

The Tekscan Versatek Wireless Datalogger VWD-1 was determined to be compliant for localized Specific Absorption Rate based on the test provisions and conditions described below. Detailed test setup photographs are shown in the Appendix.

1. The EUT was tested for body worn configuration.

2. There was no method of measuring the conducted power of the EUT. It was confirmed by the client that the device was operating at or slightly above that of the EMC tested version.

3. The EUT was placed into a test mode using Tekscan's SARconfig software.

4. The SAR evaluations were performed with a fully charged battery.

5. The dielectric parameters of the simulated body fluid were measured prior to the evaluation using an 85070D Dielectric Probe Kit and an 8722D Network Analyzer.

6. The fluid and air temperature was measured prior to and after each SAR evaluation to ensure the temperature remained within ±2 deg C of the temperature of the fluid when the dielectric properties were measured.

7. During the SAR evaluations if a distribution produced several hotspots over the course of the area scan, each hotspot was evaluated separately.

5 EVALUATION PROCEDURES

The evaluation was performed in the applicable area of the phantom depending on the type of device being tested.

(i) For devices held to the ear during normal operation, both the left and right ear positions were evaluated using the SAM phantom.
(ii) For body-worn and face-held devices a planar phantom was used.

The SAR was determined by a pre-defined procedure within the DASY4 software. Upon completion of a reference check, the exposed region of the phantom was scanned near the inner surface with a grid spacing of 15mm x 15mm.

An area scan was determined as follows:

Based on the defined area scan grid, a more detailed grid is created to increase the points by a factor of 10. The interpolation function then evaluates all field values between corresponding measurement points.

A linear search is applied to find all the candidate maxima. Subsequently, all maxima are removed that are >2 dB from the global maximum. The remaining maxima are then used to position the cube scans.

A 1g and 10g spatial peak SAR was determined as follows:

For frequencies ≤4.5GHz a 32mm x 32mm x 34mm (7x7x7 data points) zoom scan was assessed at the position where the greatest V/m was detected. For frequencies ≥4.5GHz a 28mm x 28mm x 24mm (7x7x9 data points) zoom scan was assessed at the position where the greatest V/m was detected. The data at the surface was extrapolated since the distance from the probes sensors to the surface is 3.9cm. A least squares fourth-order polynomial was used to generate points between the probe detector and the inner surface of the phantom.

Interpolated data is used to calculate the average SAR over 1g and 10g cubes by spatially discretizing the entire measured cube. The volume used to determine the averaged SAR is a 1mm grid (42875 interpolated points).

Z-Scan was determined as follows:

The Z-scan measures points along a vertical straight line. The line runs along a line normal to the inner surface of the phantom surface.

6 DATA EVALUATION PROCEDURES

The DASY4 post processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe Parameters:	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion Factor	$ConvF_i$
	- Dipole Compression Point	dcp_i
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used. The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC - transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

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

with V_i = Compensated signal of channel i (i = x, y, z)
U_i = Input signal of channel i (i = x, y, z)
cf = Crest factor of exciting field (DASY parameter)
dcp_i = Diode compression point (DASY parameter)

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

$$\text{E}-\text{fieldprobes}: \qquad E_i = \sqrt{\frac{V_1}{Norm_i \cdot ConvF}}$$

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

with V_i = Compensated signal of channel i (i = x, y, z)
$Norm_i$ = Sensor sensitivity of channel i (i = x, y, z)
$\mu V/(V/m)^2$ for E-field probes
$ConvF$ = Sensitivity enhancement in solution
a_{ij} = Sensor sensitivity factors for H-field probes
f = Carrier frequency (GHz)
E_i = Electric field strength of channel i in V/m
H_i = Magnetic field strength of channel i in A/m

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

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

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

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

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

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

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

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

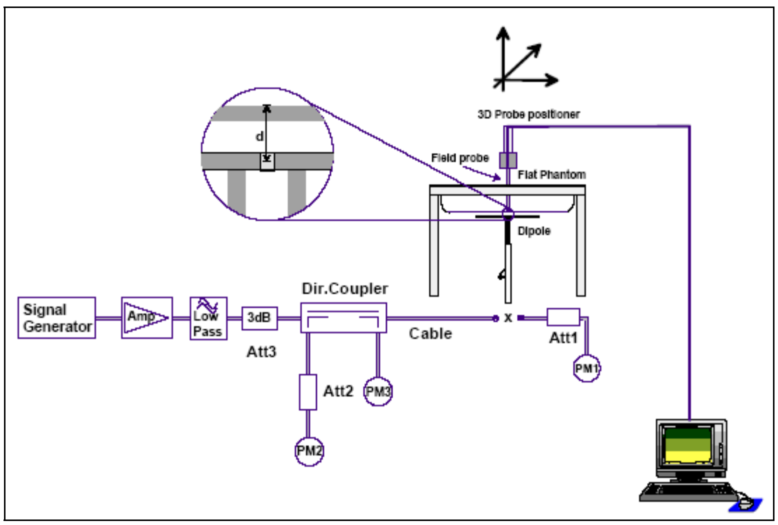
with P_{pwe} = Equivalent power density of a plane wave in mW/cm2
E_{tot} = total electric field strength in V/m
H_{tot} = total magnetic field strength in A/m

7 SYSTEM PERFORMANCE CHECK

Prior to the SAR evaluation a system check was performed in the planar section of the SAM phantom with an 835MHz and a 1900 MHz dipole. The dielectric parameters of the simulated body fluids were measured prior to the system performance check using an 85070D Dielectric Probe Kit and an 8722D Network Analyzer. A forward power of 250mW was applied to the dipole and the system was verified to a tolerance of ±5%.

Test Date	Fluid Type (MHz)	SAR 1g (W/kg)		Permittivity Constant εr		Conductivity σ (mho/m)		Ambient Temp. (C)	Fluid Temp. (C)	Fluid Depth (cm)
		Calibrated Target	Measured	IEEE Target	Measured	IEEE Target	Measured			
08/23/10	2450 Body	55.6±5%	54.0	52.7 ±5%	51.696	1.95±10%	1.9679	22.0	22.0	≥15

Note: The ambient and fluid temperatures were measured prior to the fluid parameter check and the system performance check. The temperatures listed in the table above were consistent for all measurement periods.



8 SIMULATED EQUIVALENT TISSUES

Simulated Tissue Mixture		
Ingredient	**2450MHz Head**	**2450MHz Body**
Water	55.0%	68.64%
DGMBE	45.0%	31.37%

9 SAR SAFETY LIMITS

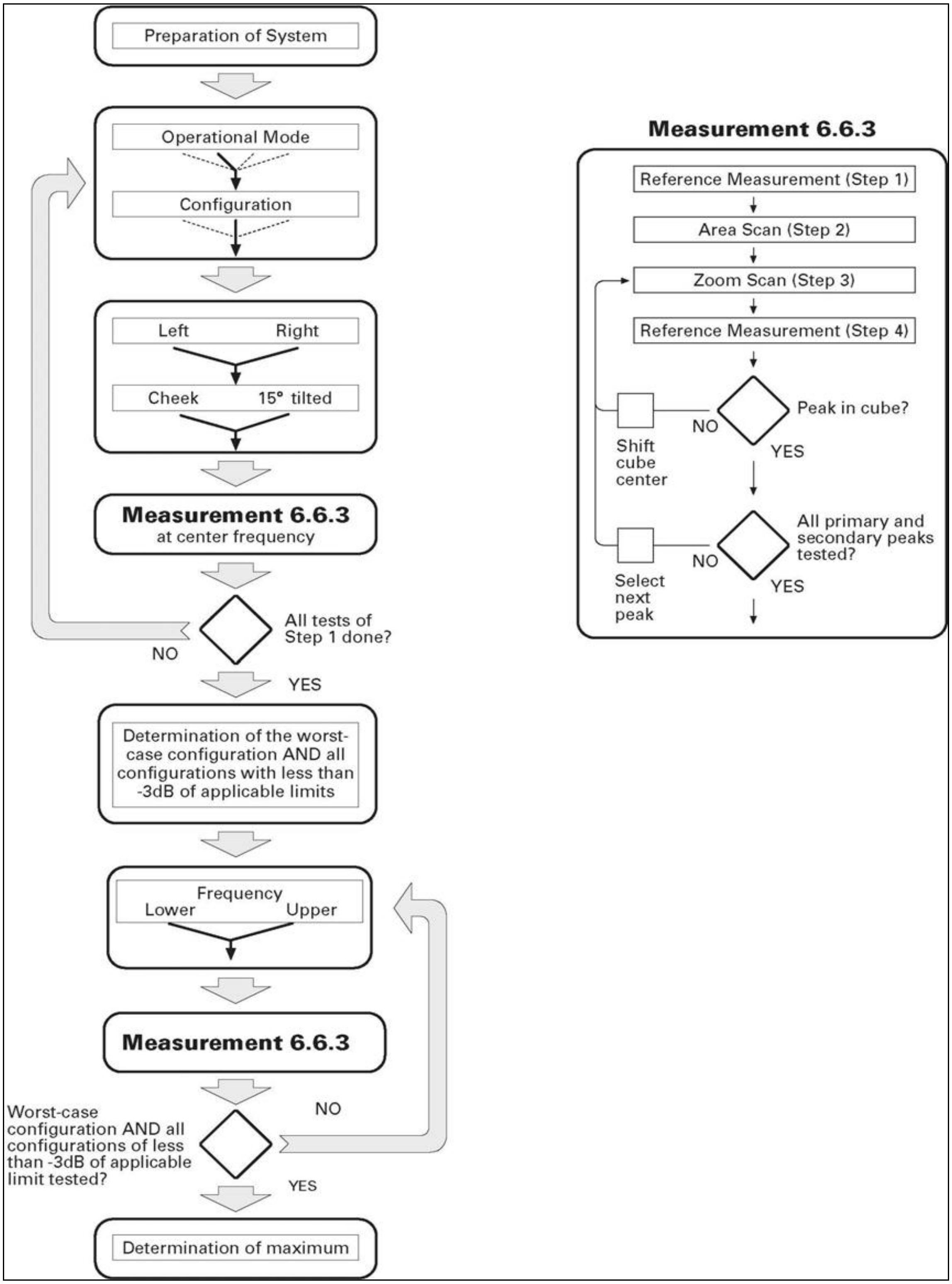
EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	**(Occupational / Controlled Exposure Environment)**
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 1g of tissue)	1.60	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10g)	4.0	20.0

Notes:

1. Uncontrolled exposure environments are locations where there is potential exposure of individuals who have no knowledge or control of their potential exposure.

2. Controlled exposure environments are locations where there is potential exposure of individuals who have knowledge of their potential exposure and can exercise control over their exposure.

10 FLOW CHART OF THE RECOMMENDED PRACTICES AND PROCEDURES



11 DEFINITION OF REFERENCE POINTS

11.1. EAR REFERENCE POINT

Figure 12.1 shows the front, back and side views of the SAM Twin Phantom. The point M is the reference point for the center of the mouth, LE is the left ear reference point (ERP), and RE is the right ERP. The ERPs are 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 12.2. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) is perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting. Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning.

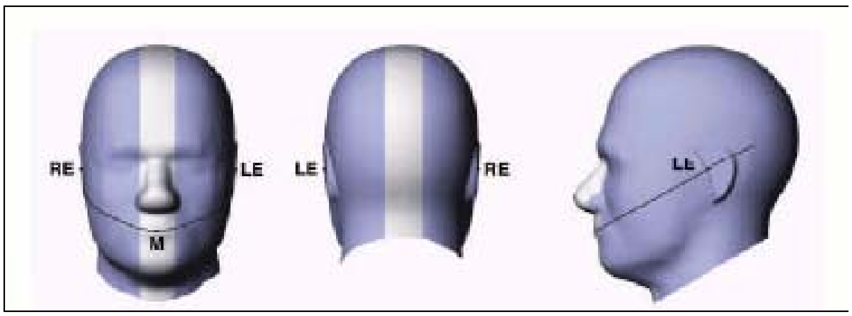


Figure 12.1
Front, back and side view of SAM Twin Phantom

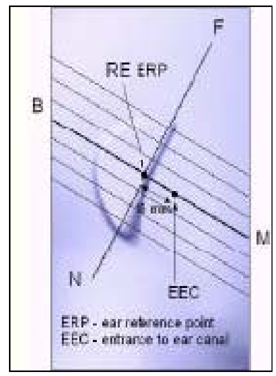


Figure 12.2
Side view of ERPs

11.2. HANDSET REFERENCE POINTS

Two imaginary lines on the handset were established: the vertical centerline and the horizontal line. The test device was placed in a normal operating position with the test device reference point located along the vertical centerline on the front of the device aligned to the ear reference point (See Fig. 12.3). The test device reference point was than located at the same level as the center of the ear reference point. The test device was positioned so that the vertical centerline was bisecting the front surface of the handset at it s top and bottom edges, positioning the ear reference point on the outer surface of the both the left and right head phantoms on the ear reference point.

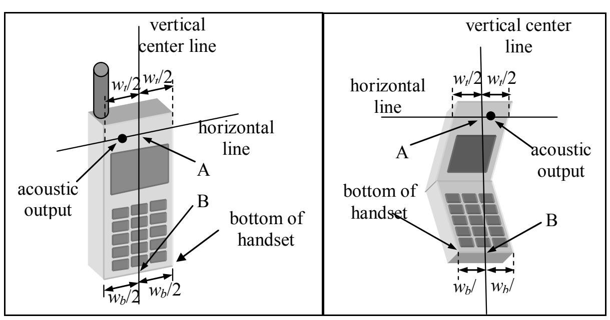


Figure 12.3
Handset Vertical Center & Horizontal Line Reference Points

11.3. POSITIONING FOR CHEEK/TOUCH

1. The test device was positioned with the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 12.4), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom.

2. The handset was translated towards the phantom along the line passing through RE & LE until the handset touches the ear.

3. While maintaining the handset in this plane, the handset was rotated around the LE-RE line until the vertical centerline was in the plane normal to MB-NF including the line MB (reference plane).

4. The phone was hen rotated around the vertical centerline until the phone (horizontal line) was symmetrical was respect to the line NF.

5. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, the handset was rotated about the line NF until any point on the handset made contact with a phantom point below the ear (cheek). See Figure 12.5)

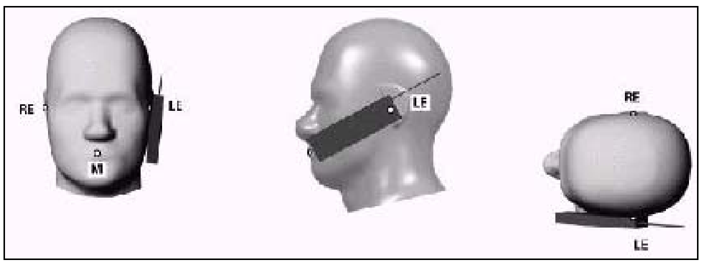


Figure 12.4
Front, Side and Top View of Cheek/Touch Position

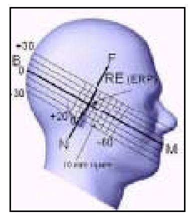


Figure 12.5
Side view with relevant markings

11.4. POSITIONING FOR EAR/15 DEGREE TILE

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

1. While maintaining the orientation of the phone, the phone was retracted parallel to the reference plane far enough to enable a rotation of the phone by 15 degree.

2. The phone was then rotated around the horizontal line by 15 degree.

3. While maintaining the orientation of the phone, the phone was moved parallel to the reference plane until any part of the phone touches the head. (In this position, point A was located on the line RE-LE). The tilted position is obtained when the contact is on the pinna. If the contact was at any location other than the pinna, the angle of the phone would then be reduced. The tilted position was obtained when any part of the phone was in contact of the ear as well as a second part of the phone was in contact with the head (see Figure 12.6).

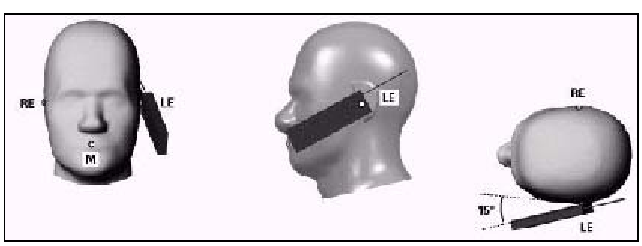


Figure 12.6
Front, Side and Top View of Ear/15 Tilt Position

12 ROBOT SYSTEM SPECIFICATIONS

12.1. SPECIFICATION

Positioner:

Robot:	Staubli Unimation Corp. Robot Model: RX90
Repeatability:	0.02 mm
No. of axis:	6

12.2. DATA ACQUISITION ELECTRONIC (DAE) SYSTEM:

Cell Controller

Processor:	Compaq Evo Clock Speed:2.4 GHz Operating System: Windows XP Professional

Data Converter

Features:	Signal Amplifier, multiplexer, A/D converter, and control logic
Software:	DASY4 software
Connecting Lines:	Optical downlink for data and status info. Optical uplink for commands and clock

Dasy4 Measurement Server

Function:	Real-time data evaluation for field measurements and surface detection
Hardware:	PC/104 166MHz Pentium CPU; 32 MB chipdisk; 64 MB RAM
Connections:	COM1, COM2, DAE, Robot, Ethernet, Service Interface

E-Field Probe

Model:	ET3DV6
Serial No.:	1793
Construction:	Triangular core fiber optic detection system
Frequency:	10 MHz to 6 GHz
Linearity:	± 0.2 dB (30 MHz to 3 GHz)

EX-Probe

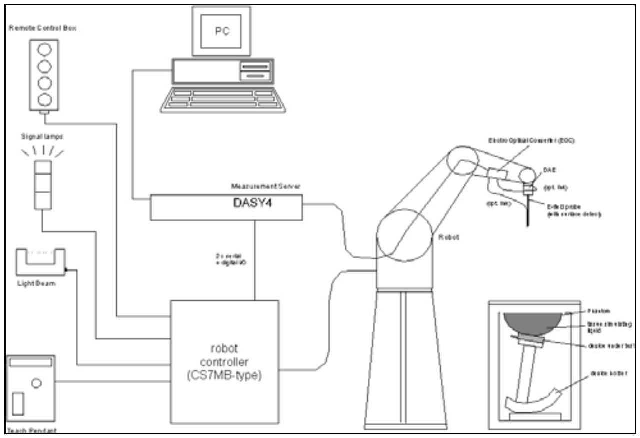
Model:	EX3DV4
Serial No.	3722
Construction:	Triangular core
Frequency:	10 MHz to > 6 GHz
Linearity:	± 0.2 dB (30 MHz to 6 GHz)

12.3. PHANTOM(S):

Validation & Evaluation Phantom

Type:	SAM V4.0C
Shell Material:	Fiberglass
Thickness:	2.0 ±0.1 mm
Volume:	Approx. 20 liters

13 SAR MEASUREMENT SYSTEM



Measurement System Diagram

13.1. RX90BL ROBOT

The Stäubli RX90BL Robot is a standard high precision 6-axis robot with an arm extension for accommodating the data acquisition electronics (DAE).

13.2. ROBOT CONTROLLER

The CS7MB Robot Controller system drives the robot motors. The system consists of a power supply, robot controller, and remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.

13.3. LIGHT BEAM SWITCH

The Light Beam Switch (Probe alignment tool) allows automatic ”tooling” of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured as well as the probe length and the horizontal probe offset. The software then corrects all movements, so that the robot coordinates are valid for the probe tip. The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.

13.4. DATA ACQUISITION ELECTRONICS

The Data Acquisition Electronics consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain switching multiplexer, a fast 16-bit A/D converter and a command decoder and control logic unit. Some of the task the DAE performs is signal amplification, signal multiplexing, A/D conversion, and offset measurements. The DAE also contains the mechanical probe-mounting device, which contains two different sensor systems for frontal and sideways probe contacts used for probe collision detection and mechanical surface detection for controlling the distance between the probe and the inner surface of the phantom shell. Transmission from the DAE to the measurement server, via the EOC, is through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

13.5. ELECTRO-OPTICAL CONVERTER (EOC)

The Electro-Optical Converter performs the conversion between the optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC connects to, and transfers data to, the DASY4 measurement server. The EOC also contains the fiber optical surface detection system for controlling the distance between the probe and the inner surface of the phantom shell.

13.6. MEASUREMENT SERVER

The Measurement Server performs time critical tasks such as signal filtering, all real-time data evaluation for field measurements and surface detection, controls robot movements, and handles safety operation. The PC-operating system cannot interfere with these time critical processes. A watchdog supervises all connections, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements.

13.7. DOSIMETRIC PROBE

Dosimetric Probe is a symmetrical design with triangular core that incorporates three 3 mm long dipoles arranged so that the overall response is close to isotropic. The probe sensors are covered by an outer protective shell, which is resistant to organic solvents i.e. glycol. The probe is equipped with an optical multi-fiber line, ending at the front of the probe tip, for optical surface detection. This line connects to the EOC box on the robot arm and provides automatic detection of the phantom surface. The optical surface detection works in transparent liquids and on diffuse reflecting surfaces with a repeatability of better than ±0.1mm.

13.8. SAM PHANTOM

The SAM (Specific Anthropomorphic Mannequin) twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm) integrated into a wooden table. The shape of the shell corresponds to the phantom defined by SCC34-SC2. It enables the dosimetric evaluation of left hand, right hand phone usage as well as body mounted usage at the flat phantom region. The flat section is also used for system validation and the length and width of the flat section are at least 0.75 λO and 0.6 λO respectively at frequencies of 824 MHz and above (λO = wavelength in air).

Reference markings on the phantom top allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. A white cover is provided to cover the phantom during off-periods preventing water evaporation and changes in the liquid parameters. Free space scans of devices on the cover are possible. The phantom is filled with a tissue simulating liquid to a depth of at least 15 cm at each ear reference point. The bottom plate of the wooden table contains three pair of bolts for locking the device holder.

13.9. PLANAR PHANTOM

The planar phantom is constructed of Plexiglas material with a 2.0 mm shell thickness for face-held and body-worn SAR evaluations of handheld radio transceivers. The planar phantom is mounted on the wooden table of the DASY4 system.

13.10. VALIDATION PLANAR PHANTOM

The validation planar phantom is constructed of Plexiglas material with a 6.0 mm shell thickness for system validations at 450MHz and below. The validation planar phantom is mounted on the wooden table of the DASY4 system.

13.11. DEVICE HOLDER

The device holder is designed to cope with the different measurement positions in the three sections of the SAM phantom given in the standard. It has two scales, one for device rotation (with respect to the body axis) and one for device inclination (with respect to the line between the ear openings). The rotation center for both scales is the ear opening, thus the device needs no repositioning when changing the angles. The plane between the ear openings and the mouth tip has a rotation angle of 65°.

The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

The dielectric properties of the liquid conform to all the tabulated values [2-5]. Liquids are prepared according to Annex A and dielectric properties are measured according to Annex B.

13.12. SYSTEM VALIDATION KITS

Power Capability: > 100 W (f < 1GHz); > 40 W (f > 1GHz)

Construction: Symmetrical dipole with l/4 balun Enables measurement of feed point impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

Frequency: 300, 450, 835, 1900, 2450 MHz

Return loss: >20 dB at specified validation position

Dimensions:
300 MHz Dipole: Length: 396mm; Overall Height: 430 mm; Diameter: 6 mm
450 MHz Dipole: Length: 270 mm; Overall Height: 347 mm; Diameter: 6 mm
835 MHz Dipole: Length: 161 mm; Overall Height: 270 mm; Diameter: 3.6 mm
1900 MHz Dipole: Length: 68 mm; Overall Height: 219 mm; Diameter: 3.6 mm
2450 MHz Dipole: Length: 51.5 mm; Overall Height: 300 mm; Diameter: 3.6 mm

TEST EQUIPMENT LIST

Test Equipment	Serial Number	Calibration Date
DASY4 System Robot EX3DV4 DAE3 2450MHz Dipole 5500MHz Dipole SAM Phantom V4.0C EUT Planar Phantom Validation Phantom	FO3/SX19A1/A/01 3722 584 1S2452 1S2571 N/A N/A N/A	N/A May 2010 April 2010 May 2010 June 2010 N/A N/A N/A
85070D Dielectric Probe Kt	N/A	N/A
83650B Signal Generator	3844A00910	August 2009
HP E4418B Power Meter	GB40205140	October 2009
Agilent E4407B	MY41441050	July 2010
HP 8482A Power Sensor	2607A11286	May 2010
HP 8722D Vector Network Analyzer	3S36140188	July 2010
HP EPM-442A Power Meter	GB37480766	June 2010
Mini-Circuits Power Amplifier	D111903#8	N/A
Mini-Circuits Power Amplifier	N902400810	N/A

MEASUREMENT UNCERTAINTIES

UNCERTAINTY ASSESSMENT FOR EUT

Error Description	Tol. ±%	Prob. Dist.	Div.	c_i 1g	c_i 10g	Std Unc ±% (1g)	Std Unc ±% (10g)	v_i or v_{eff}
Measurement System								
Probe calibration	4.8	N	1	1	1	4.8	4.8	∞
Axial isotropy of the probe	4.7	R	√3	0.7	0.7	1.9	1.9	∞
Spherical isotropy of the probe	9.6	R	√3	0.7	0.7	3.9	3.9	∞
Boundary effects	1.0	R	√3	1	1	4.8	4.8	∞
Probe linearity	4.7	R	√3	1	1	2.7	2.7	∞
Detection limit	1.0	R	√3	1	1	0.6	0.6	∞
Readout electronics	1.0	N	1	1	1	1.0	1.0	∞
Response time	0.8	R	√3	1	1	0.5	0.5	∞
Integration time	2.6	R	√3	1	1	0.8	0.8	∞
RF ambient conditions	3.0	R	√3	1	1	0.43	0.43	∞
Mech. constraints of robot	0.4	R	√3	1	1	0.2	0.2	∞
Probe positioning	2.9	R	√3	1	1	1.7	1.7	∞
Extrapolation & integration	1.0	R	√3	1	1	2.3	2.3	∞
Test Sample Related								
Device positioning	2.9	N	1	1	1	2.23	2.23	145
Device holder uncertainty	3.6	N	1	1	1	5.0	5.0	5
Power drift	5.0	R	√3			2.9	2.9	∞
Phantom and Setup								
Phantom uncertainty	4.0	R	√3	1	1	2.3	2.3	∞
Liquid conductivity (target)	5.0	R	√3	0.64	0.43	1.8	1.2	∞
Liquid conductivity (measured)	2.5	N	1	0.64	0.43	1.6	1.1	∞
Liquid permittivity (target)	5.0	R	√3	0.6	0.5	1.7	1.4	∞
Liquid permittivity (measured)	2.5	N	1	0.6	0.5	1.5	1.2	∞
Combined Standard Uncertainty (k=1)		RSS				10.3	10.0	
Expanded Uncertainty (k=2) 95% Confidence Level						20.6	20.1	

Table 1. Worst-case uncertainty for DASY4 assessed according to IEEE P1528.

The budget is valid for the frequency range 300MHz to 6GHz and represents a worst-case analysis.

UNCERTAINTY ASSESSMENT FOR SYSTEM VALIDATION

Error Description	Uncertainty Value ±%	Probability Distribution	Divisor	c_i 1g	Standard Uncertainty ±% (1g)	v_i or v_{eff}
Measurement System						
Probe calibration	± 4.8	Normal	1	1	± 4.8	∞
Axial isotropy of the probe	± 4.7	Rectangular	√3	(1-cp)1/2	± 2.7	∞
Spherical isotropy of the probe	± 9.6	Rectangular	√3	(cp)1/2	± 3.8	∞
Boundary effects	± 1.0	Rectangular	√3	1	± 0.0	∞
Probe linearity	± 4.7	Rectangular	√3	1	± 3.2	∞
Detection limit	± 1.0	Rectangular	√3	1	± 0.6	∞
Readout electronics	± 1.0	Normal	1	1	± 1.0	∞
Response time	± 0.8	Rectangular	√3	1	± 0.5	∞
Integration time	± 1.3	Rectangular	√3	1	± 0.8	∞
RF ambient conditions	± 3.0	Rectangular	√3	1	± 1.7	∞
Mech. constraints of robot	± 0.4	Rectangular	√3	1	± 0.2	∞
Probe positioning	± 1.4	Rectangular	√3	1	± 1.7	∞
Extrapolation & integration	± 4.0	Rectangular	√3	1	± 2.3	∞
Dipole						
Dipole Axis to liquid distance	± 2.0	Normal	1	1	± 1.2	11
Input Power	± 5.0	Normal	1	1	± 2.7	7
Phantom and Setup						
Phantom uncertainty	± 4.0	Rectangular	√3	1	± 2.3	∞
Liquid conductivity (target)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Liquid conductivity (measured)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Liquid permittivity (target)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Liquid permittivity (measured)	± 5.0	Rectangular	√3	0.6	± 1.7	∞
Combined Standard Uncertainty					± 9.8	
Coverage Factor for 95%		Kp=2				
Expanded Uncertainty (k=2)					± 19.7	

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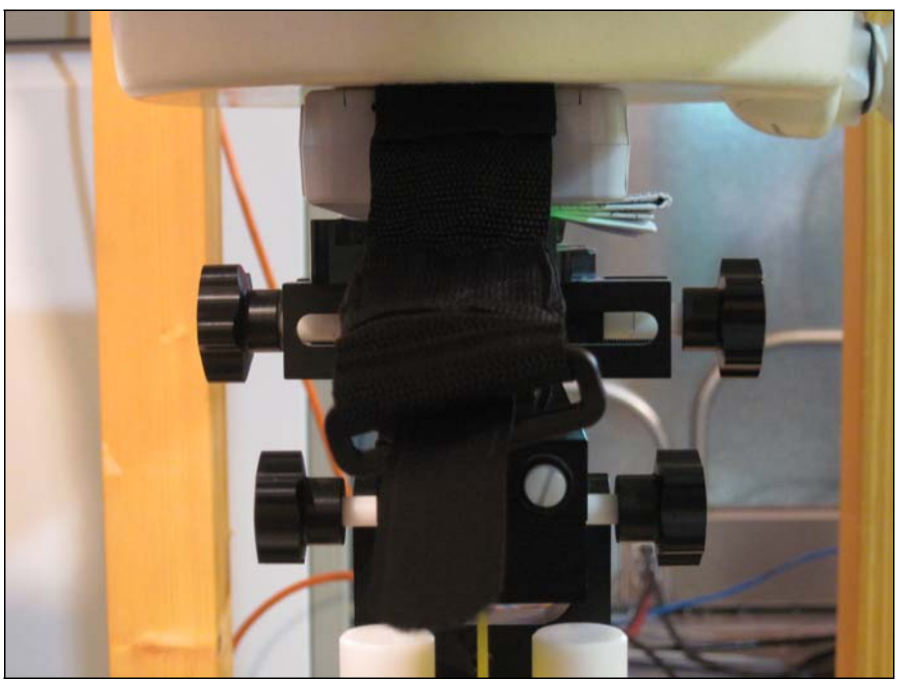
TEST SETUP

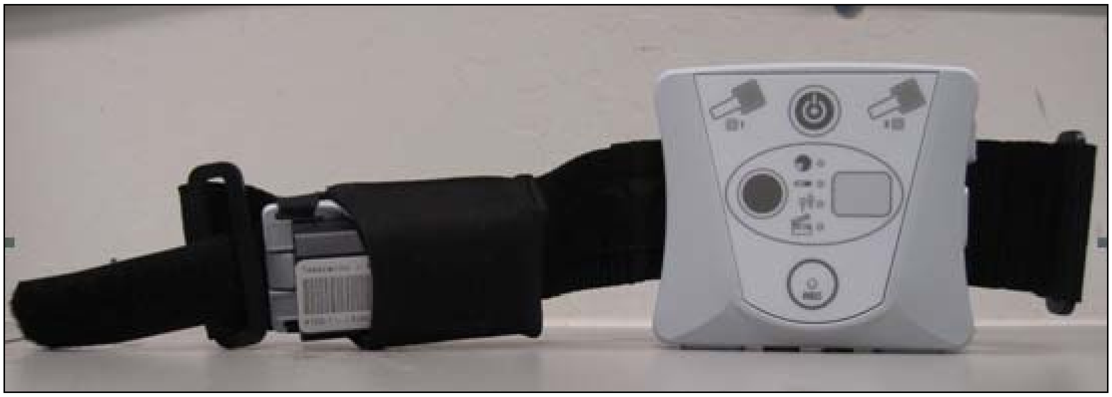
Photograph 1. Body Test Configuration



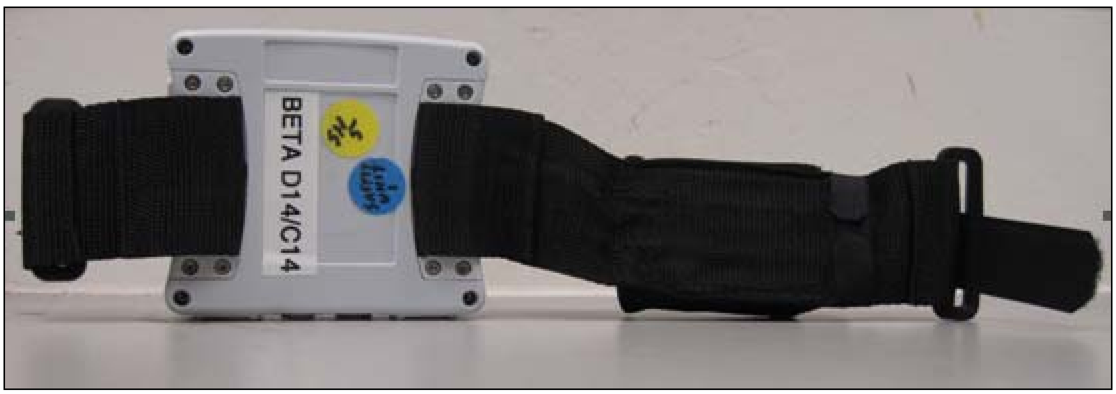
Photograph 2. Body Test Configuration

Photograph 3. Body Test Configuration

EUT PICTURES



Photograph 4. EUT – Versatek Wireless Datalogger VWD-1 Front View



Photograph 5. EUT – Versatek Wireless Datalogger VWD-1 Rear View

Photograph 6. EUT – Bottom View

Photograph 7. EUT – Side View

Photograph 8. Battery

Photograph 9. Battery

Photograph 10. Battery

APPENDIX A – SAR MEASUREMENT DATA

2412 MHz Body Holster, Channel 1, b-mode

Date/Time: 8/23/2010 4:30:17 PM

DUT: Tekscan Inc.; Type: Versatek Wireless Datalogger VWD-1

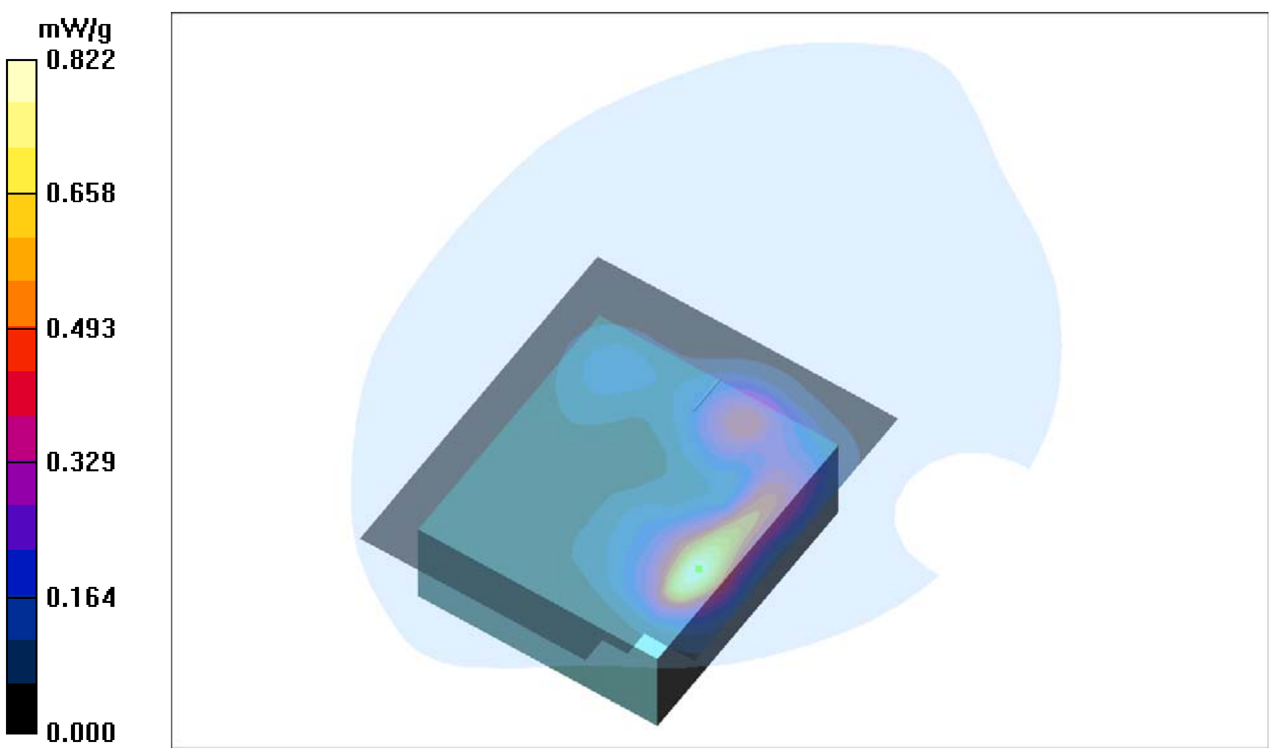
Medium Notes: Ambient Temp: 22.0 deg C; Fluid Temp: 21.6 deg C

Communication System: DTS ; ; Frequency: 2412 MHz;Duty Cycle: 1:1
Medium: M2450 Medium parameters used: f = 2412 MHz; σ = 1.92 mho/m; ε_r = 51.8; ρ = 1000 kg/m^3
Phantom section: Flat Section

- Probe: EX3DV4 - SN3722; ConvF(6.82, 6.82, 6.82); Calibrated: 5/19/2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 4/26/2010
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

Area Scan (141x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.822 mW/g

Zoom Scan (7x7x11)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=3mm
Reference Value = 7.70 V/m; Power Drift = -0.57 dB
Peak SAR (extrapolated) = 1.20 W/kg
SAR(1 g) = 0.574 mW/g; SAR(10 g) = 0.280 mW/g
Maximum value of SAR (measured) = 0.737 mW/g



2437 MHz Body Holster, Channel 6, b-mode

Date/Time: 8/23/2010 3:40:44 PM

DUT: Tekscan Inc.; Type: Versatek Wireless Datalogger VWD-1

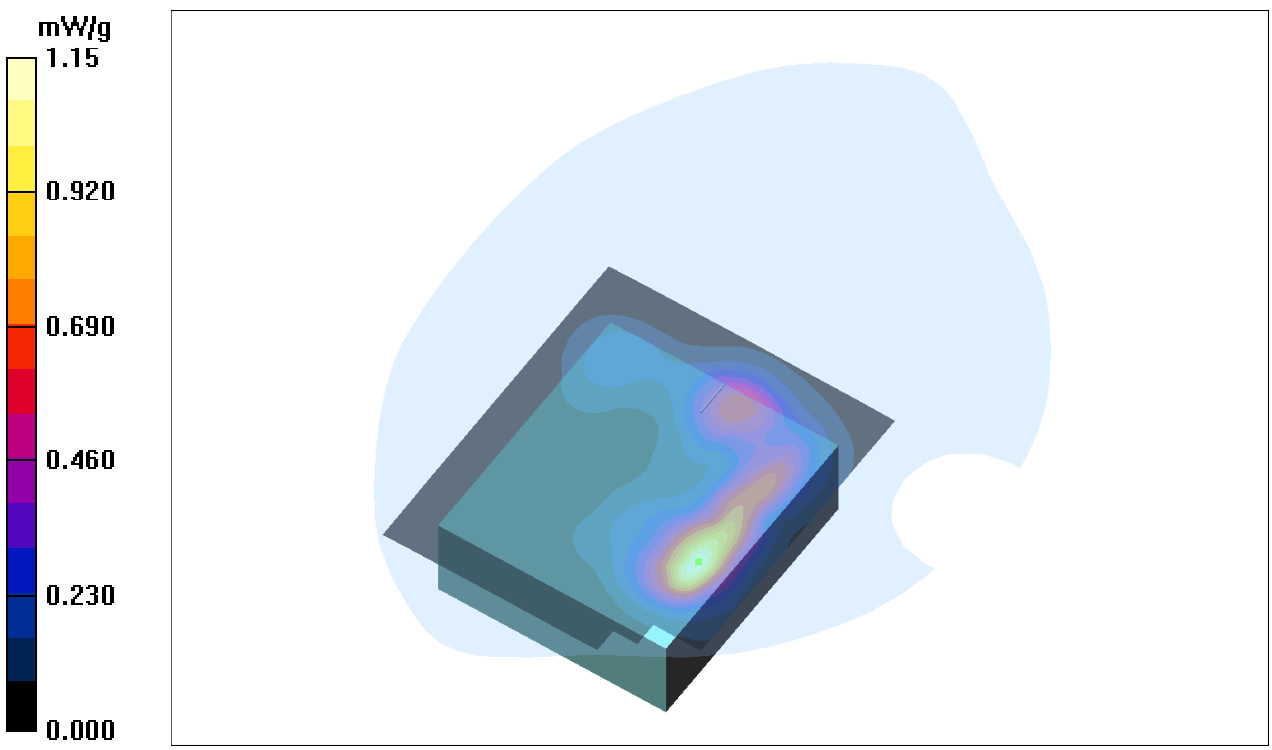
Medium Notes: Ambient Temp: 22.0 deg C; Fluid Temp: 21.6 deg C

Communication System: DTS ; ; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium: M2450 Medium parameters used: f = 2437 MHz; $\sigma = 1.95$ mho/m; $\varepsilon_r = 51.8$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section

- Probe: EX3DV4 - SN3722; ConvF(6.82, 6.82, 6.82); Calibrated: 5/19/2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 4/26/2010
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

Area Scan (141x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.15 mW/g

Zoom Scan (7x7x11)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=3mm
Reference Value = 10.3 V/m; Power Drift = 0.694 dB
Peak SAR (extrapolated) = 1.63 W/kg
SAR(1 g) = 0.800 mW/g; SAR(10 g) = 0.392 mW/g
Maximum value of SAR (measured) = 1.02 mW/g



2462 MHz Body Holster, Channel 11, b-mode

Date/Time: 8/23/2010 5:02:33 PM

DUT: Tekscan Inc.; Type: Versatek Wireless Datalogger VWD-1

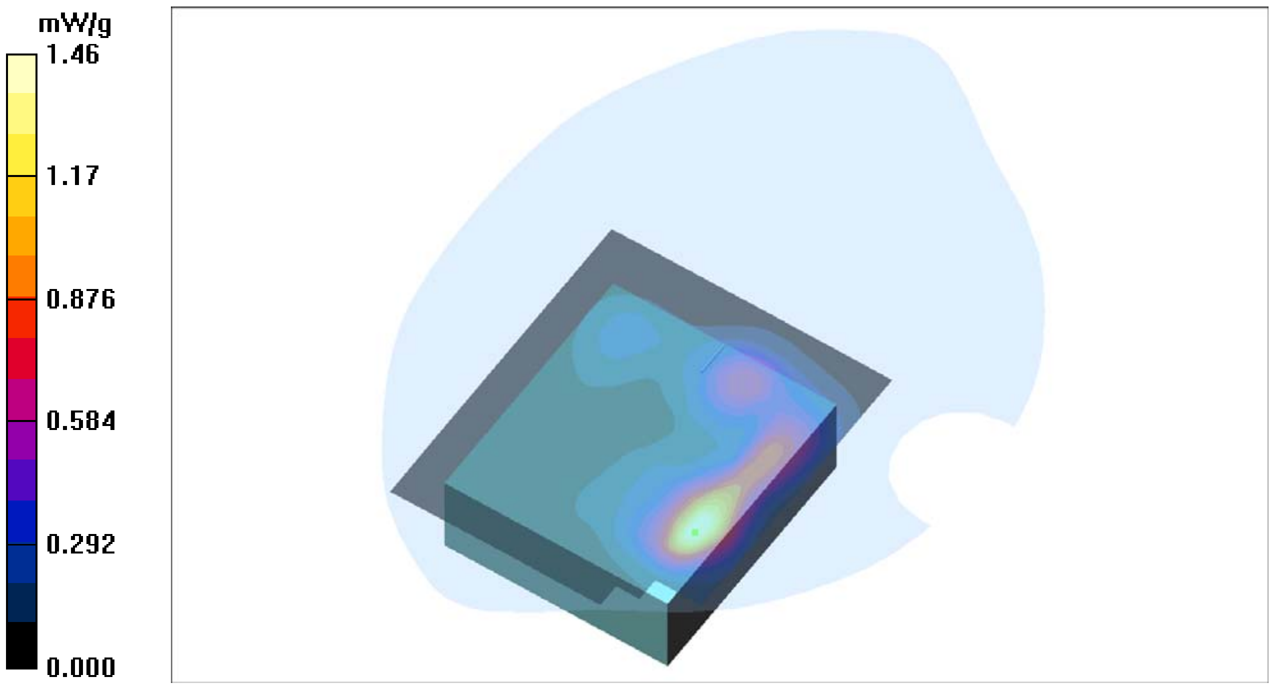
Medium Notes: Ambient Temp: 22.0 deg C; Fluid Temp: 21.6 deg C

Communication System: DTS ; ; Frequency: 2462 MHz;Duty Cycle: 1:1
Medium: M2450 Medium parameters used: f = 2462 MHz; σ = 1.98 mho/m; ε_r = 51.6; ρ = 1000 kg/m^3
Phantom section: Flat Section

- Probe: EX3DV4 - SN3722; ConvF(6.82, 6.82, 6.82); Calibrated: 5/19/2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 4/26/2010
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

Area Scan (141x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 1.46 mW/g

Zoom Scan (7x7x11)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=3mm
Reference Value = 9.43 V/m; Power Drift = -0.314 dB
Peak SAR (extrapolated) = 2.31 W/kg
SAR(1 g) = 1.08 mW/g; SAR(10 g) = 0.516 mW/g
Maximum value of SAR (measured) = 1.42 mW/g



2437MHz Body Holster, Channel 6, g mode

Date/Time: 8/23/2010 5:32:57 PM

DUT: Tekscan Inc.; Type: Versatek Wireless Datalogger VWD-1

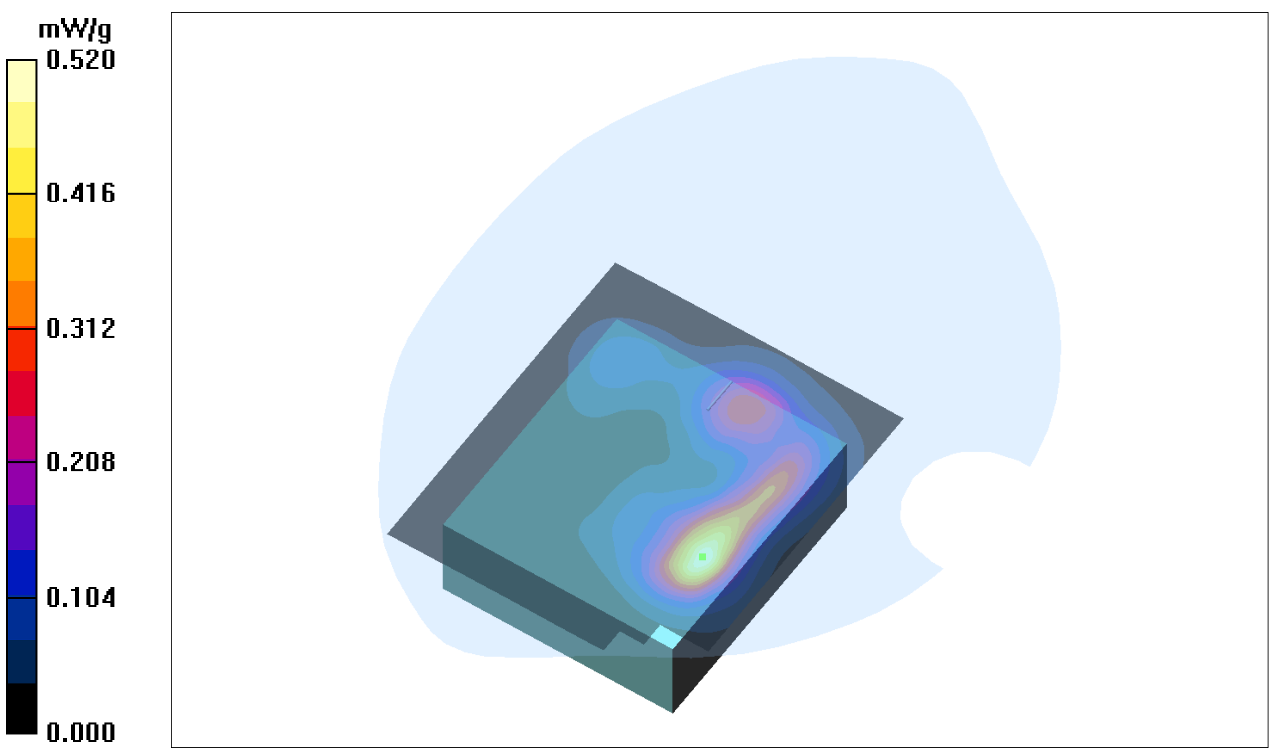
Medium Notes: Ambient Temp: 22.0 deg C; Fluid Temp: 21.6 deg C

Communication System: DTS ; ; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium: M2450 Medium parameters used: f = 2437 MHz; σ = 1.95 mho/m; ε_r = 51.8; ρ = 1000 kg/m^3
Phantom section: Flat Section

- Probe: EX3DV4 - SN3722; ConvF(6.82, 6.82, 6.82); Calibrated: 5/19/2010
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 4/26/2010
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

Area Scan (141x121x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 0.520 mW/g

Zoom Scan (7x7x11)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=3mm
Reference Value = 7.41 V/m; Power Drift = -0.087 dB
Peak SAR (extrapolated) = 0.811 W/kg
SAR(1 g) = 0.394 mW/g; SAR(10 g) = 0.193 mW/g
Maximum value of SAR (measured) = 0.505 mW/g



APPENDIX B – SYSTEM VALIDATION CHECK

2450 MHz Body System Verification

Date/Time: 8/23/2010 2:29:36 PM

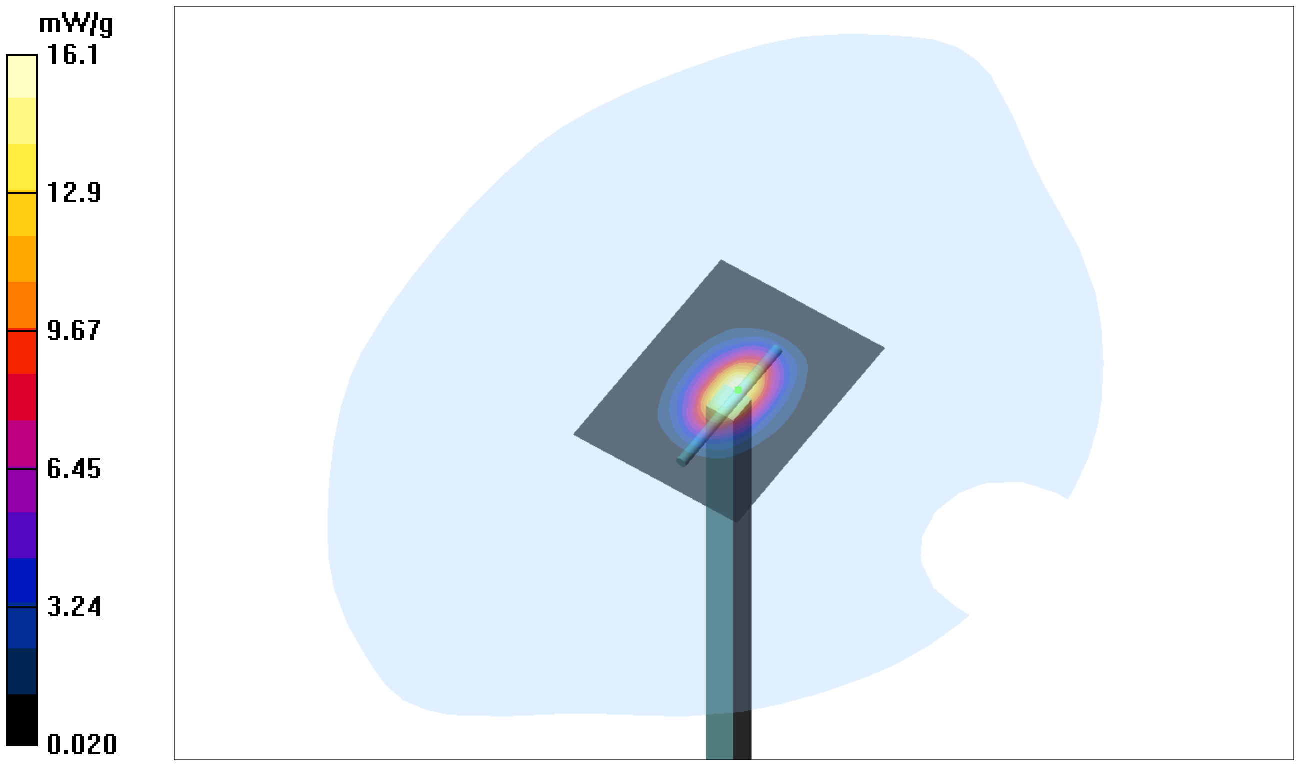
DUT: Dipole 2450 MHz; Type: 1S2570

Communication System: CW; ; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: M2450 Medium parameters used: f = 2450 MHz; σ = 1.97 mho/m; ε_r = 51.7; ρ = 1000 kg/m^3
Phantom section: Flat Section

- Probe: EX3DV4 - SN3722; ConvF(6.82, 6.82, 6.82); Calibrated: 5/19/2010
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 4/26/2010
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

Area Scan (61x81x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 16.1 mW/g

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.5 V/m; Power Drift = -0.116 dB
Peak SAR (extrapolated) = 30.1 W/kg
SAR(1 g) = 13.5 mW/g; SAR(10 g) = 5.93 mW/g
Maximum value of SAR (measured) = 15.4 mW/g



APPENDIX C – PROBE CALIBRATION CERTIFICATE

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

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

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

Accreditation No.: SCS 108

Client **MET Laboratories**

Certificate No: EX3-3722_May10

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3722
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:	May 19, 2010

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-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41495277	1-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41498087	1-Apr-10 (No. 217-01136)	Apr-11
Reference 3 dB Attenuator	SN: S5054 (3c)	30-Mar-10 (No. 217-01159)	Mar-11
Reference 20 dB Attenuator	SN: S5086 (20b)	30-Mar-10 (No. 217-01161)	Mar-11
Reference 30 dB Attenuator	SN: S5129 (30b)	30-Mar-10 (No. 217-01160)	Mar-11
Reference Probe ES3DV2	SN: 3013	30-Dec-09 (No. ES3-3013_Dec09)	Dec-10
DAE4	SN: 660	20-Apr-10 (No. DAE4-660_Apr10)	Apr-11

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:	Niels Kuster	Quality Manager	

Issued: May 19, 2010

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

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

Probe EX3DV4

SN:3722

Manufactured:	August 14, 2009
Calibrated:	May 19, 2010

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: EX3DV4 SN:3722

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.54	0.52	0.58	± 10.1%
DCP (mV)[B]	90.5	90.8	88.9	

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 E^2-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:3722

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)
2000	± 50 / ± 100	40.0 ± 5%	1.40 ± 5%	7.10	7.10	7.10	0.64	0.68	± 11.0%
2450	± 50 / ± 100	39.2 ± 5%	1.80 ± 5%	6.65	6.65	6.65	0.41	0.89	± 11.0%
2600	± 50 / ± 100	39.0 ± 5%	1.96 ± 5%	6.58	6.58	6.58	0.34	1.06	± 11.0%
5200	± 50 / ± 100	36.0 ± 5%	4.66 ± 5%	4.65	4.65	4.65	0.40	1.95	± 13.1%
5500	± 50 / ± 100	35.6 ± 5%	4.96 ± 5%	4.30	4.30	4.30	0.40	1.95	± 13.1%
5800	± 50 / ± 100	35.3 ± 5%	5.27 ± 5%	4.09	4.09	4.09	0.45	1.95	± 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.

DASY - Parameters of Probe: EX3DV4 SN:3722

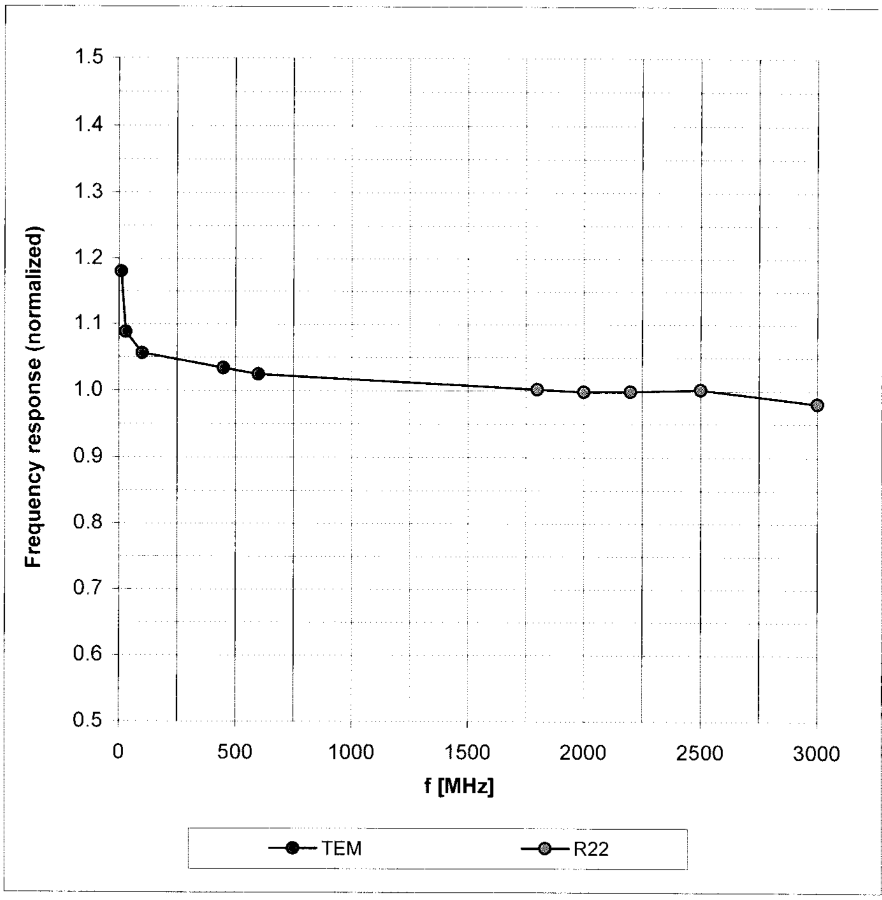
Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz]	Validity [MHz][C]	Permittivity	Conductivity	ConvF X	ConvF Y	ConvF Z	Alpha	Depth	Unc (k=2)
2000	± 50 / ± 100	53.3 ± 5%	1.52 ± 5%	7.04	7.04	7.04	0.53	0.78	± 11.0%
2450	± 50 / ± 100	52.7 ± 5%	1.95 ± 5%	6.82	6.82	6.82	0.41	0.86	± 11.0%
2600	± 50 / ± 100	52.5 ± 5%	2.16 ± 5%	6.73	6.73	6.73	0.45	0.80	± 11.0%
5200	± 50 / ± 100	49.0 ± 5%	5.30 ± 5%	4.07	4.07	4.07	0.50	1.95	± 13.1%
5500	± 50 / ± 100	48.6 ± 5%	5.65 ± 5%	3.63	3.63	3.63	0.55	1.95	± 13.1%
5800	± 50 / ± 100	48.2 ± 5%	6.00 ± 5%	3.68	3.68	3.68	0.60	1.95	± 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.

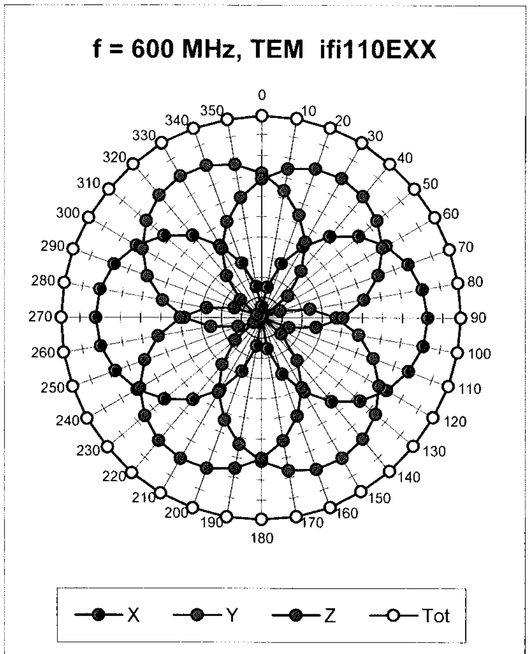
Frequency Response of E-Field

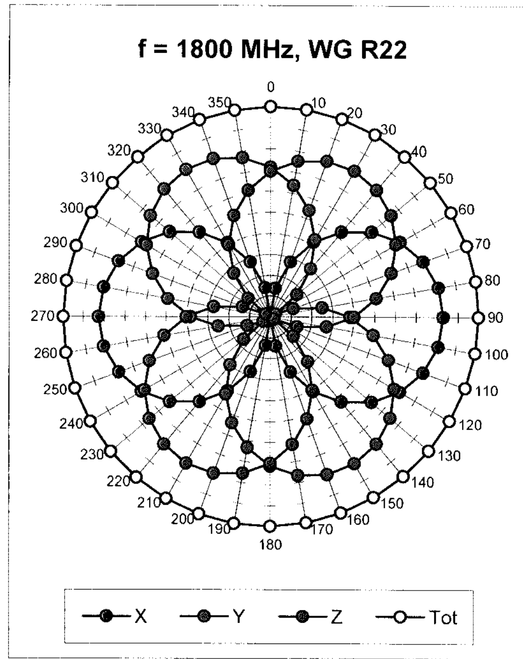
(TEM-Cell:ifi110 EXX, Waveguide: R22)

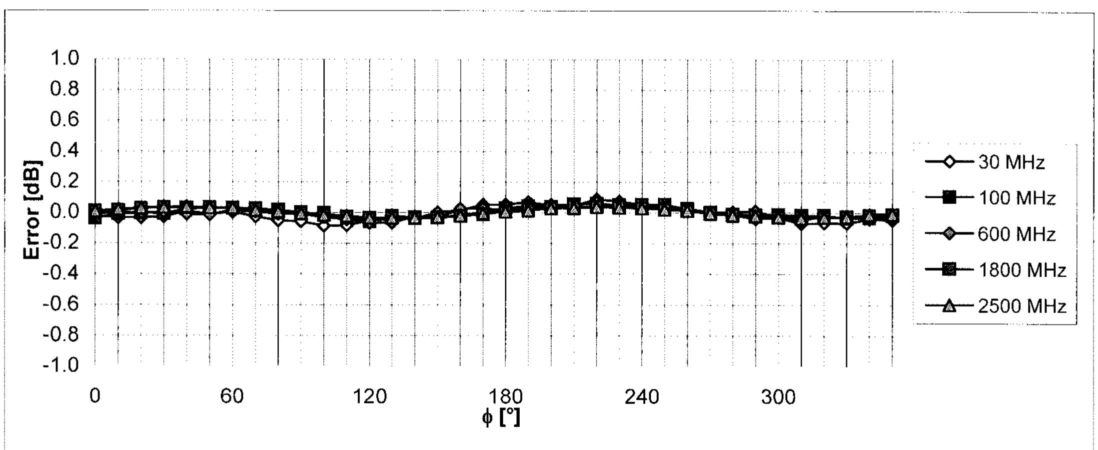


Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Receiving Pattern (ϕ), $\vartheta = 0°$



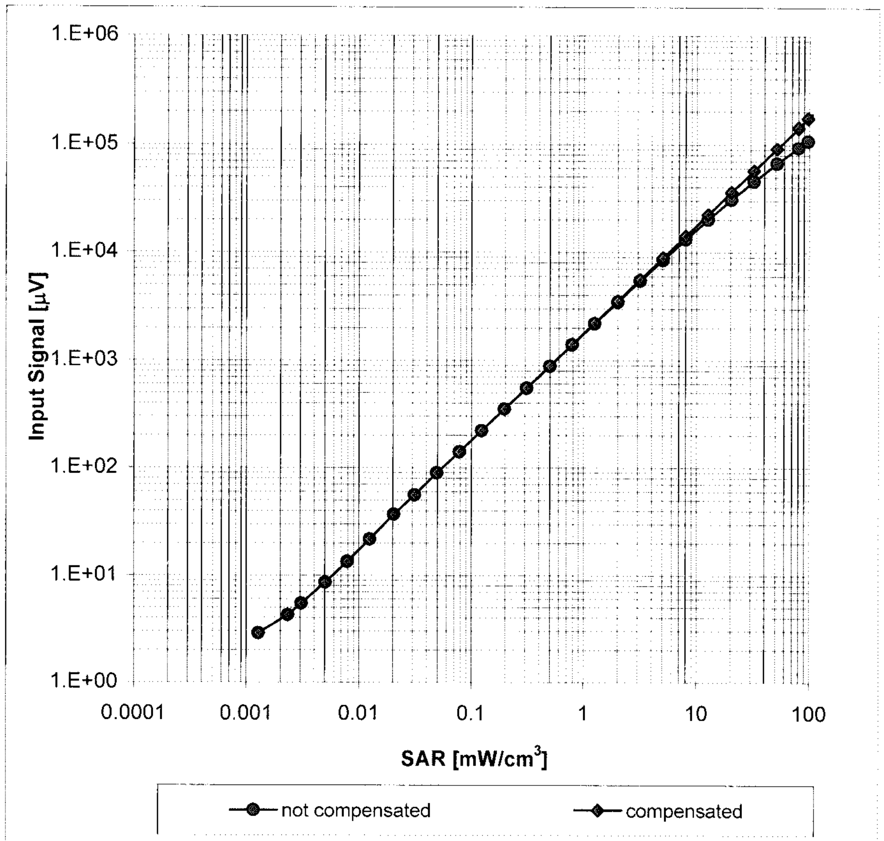


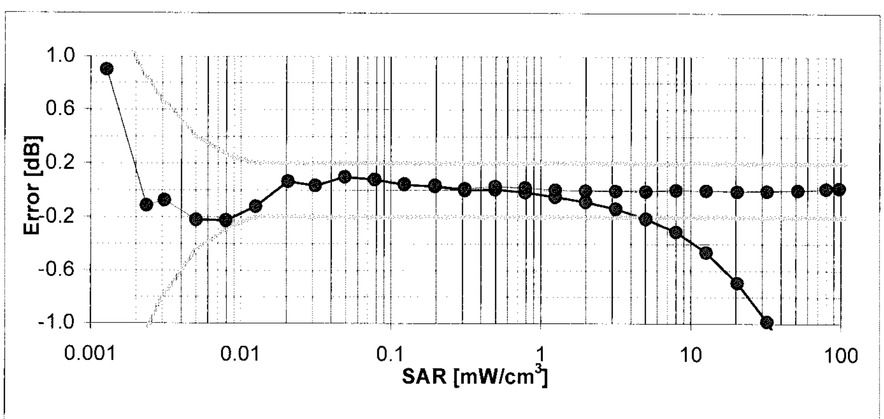


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

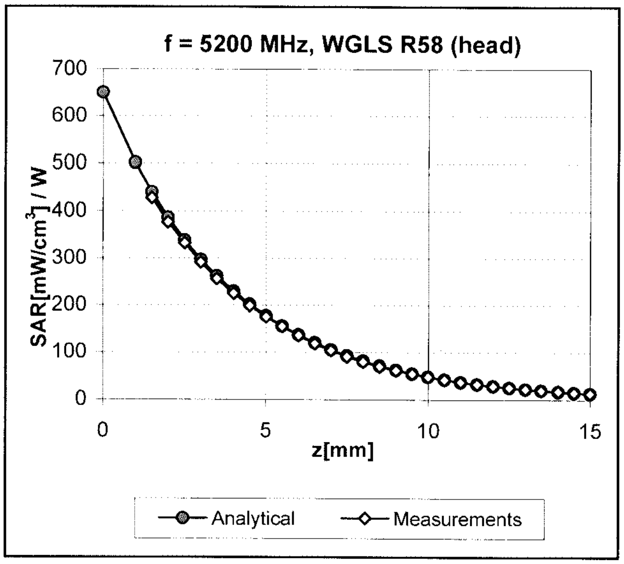
(Waveguide R22, f = 1800 MHz)

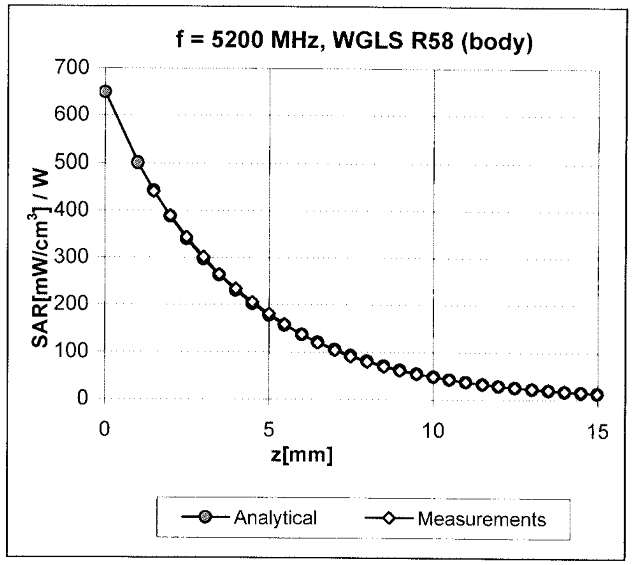




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

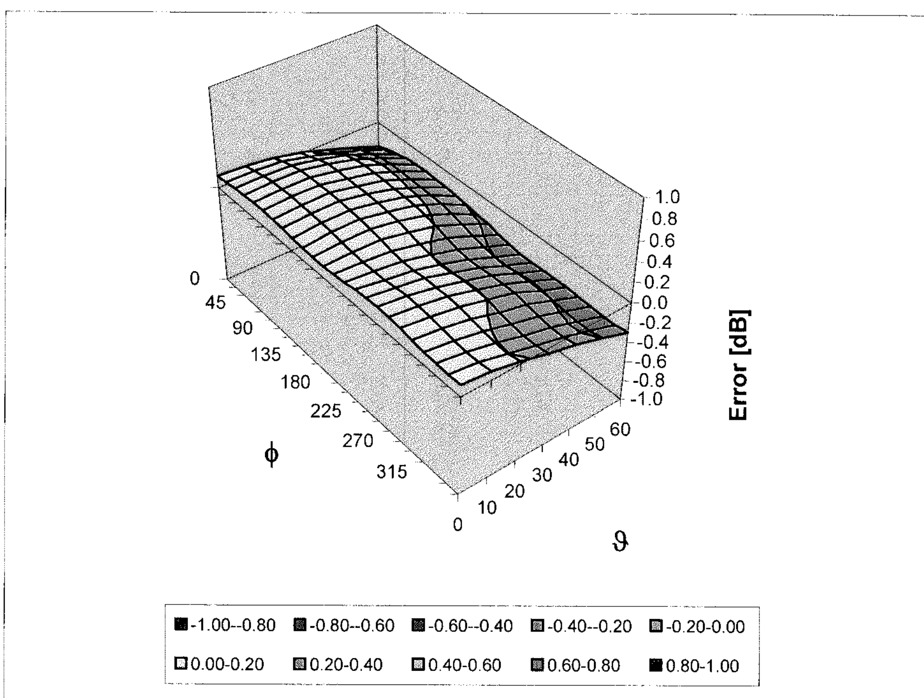
Conversion Factor Assessment





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

APPENDIX D – DIPOLE CALIBRATION CERTIFICATE

CALIBRATION CERTIFICATE

Object: 2450MHz Validation Dipole

Calibration Procedure: Calibration procedure for a validation dipole

Calibration Date: 05/25/2010

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 a closed laboratory facility: environment temperature (22 ± 3) ^{o}C and humidity < 70%

Calibration equipment used

Model Type	Serial Number	MET Asset #	Cal Date
Anritsu Power Meter ML2488A	6K00001832	1S2430	May 2009
Anritsu Power Sensor	030864	1S2432	May 2009
HP E4418B Power Meter	GB40205140	1S2276	October 2008
HP 8482A Power Sensor	2607A11286	1S2140	May 2010
83650B Signal Generator	3844A00910	1S2278	August 2009
HP 8722D Vector Network Analyzer	3S36140188	1S2272	April 2010

Calibrated by: Anderson Soungpanya (Name) — Test Technician (Function) — Signature

This calibration certificate shall not be reproduced except in full

Date of Issue: May 25, 2010

Calibration procedure for validation dipole

Calibration is performed according to the following standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques", December 2003
b) CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300MHz – 3GHz), July 2001
c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Bulletin 65 Supplement C (Edition01-01).

Additional Documents

d) DASY4 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 check: The antenna is checked for straightness using a straight edge placed parallel to the dipole arms prior to installing it against the phantom surface.
- 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.
- Antenna flatness: The spacer thickness used for the 2450MHz dipole is 10.00mm +/- 0.2mm. To insure the antenna is within +/- 2 degrees of flatness to the phantom surface use a caliper to measure the dipole ends from the surface of the phantom.
- Vector Network Analyzer: The network analyzer is calibrated as per the user's manual.
- 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. A Return Loss >20dB 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 1W at the antenna connector. No Uncertainty required
- SAR for nominal head and muscle parameters: The measured TSL parameters are used to calculate the SAR results.

Measurement Conditions

DASY system configuration

DASY Version	DASY4	V4.6
Extrapolation	Advanced Extrapolation	
Phantom	Planar Validation Phantom	1S2450
Dipole Spacer		
Distance Dipole Center-TSL	10.00mm ± 0.2mm	With spacer
Area Scan resolution	dx, dy = 10mm	
Zoom Scan resolution	dx, dy, dz = 5mm	
Frequency	2450MHz ± 1MHz	

Measurement Uncertainty of Dipole Calibration

Error Description	**Uncertainty Value ±%**	**Probability Distribution**	**Divisor**	**c_i 1g**	**Standard Uncertainty ±% (1g)**
Anritsu Power Meter ML2488A	± 1.4	normal	2	1	± 0.7
Anritsu Power Sensor	± 1.4	normal	2	1	± 0.7
HP E4418B Power Meter	± 0.2	normal	2	1	± 0.1
HP 8482A Power Sensor	± 0.8	normal	2	1	± 0.4
83650B Signal Generator	± 2.0	normal	2	1	± 1.0
HP 8722D Vector Network Analyzer	± 2.0	normal	2	1	± 1.0
Combined Standard Uncertainty					± 3.9

Head TSL Parameters

The following parameters and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Head TSL Parameters	22.0 ^{o}C	38.80	1.89
Measured Head TSL Parameters	22.0 ^{o}C	38.80 ±5%	1.89 ±5%

SAR results with Head TSL and system uncertainty

SAR averaged over 1 cm^3 (1g) of Head TSL	Condition	15.50 mW/g
SAR Normalized	Normalized to 1 W	62.00 mW/g
SAR for nominal Head TSL Parameters	Normalized to 1W	62.00 ± 24.29% mW/g (k=2)

SAR averaged over 1 cm^3 (10g) of Head TSL	Condition	6.79 mW/g
SAR Normalized	Normalized to 1 W	27.16 mW/g
SAR for nominal Head TSL Parameters	Normalized to 1 W	27.16 ± 23.51% mW/g (k=2)

Muscle TSL Parameters

The following parameters and calculations were applied

	Temperature	Permittivity	Conductivity
Nominal Head TSL Parameters	22.0 ^{o}C	52.40	2.01
Measured Head TSL Parameters	22.0 ^{o}C	52.40 ±5%	2.01 ±5%

SAR results with Muscle TSL and system uncertainty

SAR averaged over 1 cm^3 (1g) of Head TSL	Condition	13.90 mW/g
SAR Normalized	Normalized to 1 W	55.60 mW/g
SAR for nominal Head TSL Parameters	Normalized to 1 W	55.60 ± 24.29% mW/g (k=2)

SAR averaged over 1 cm^3 (10g) of Head TSL	Condition	6.12 mW/g
SAR Normalized	Normalized to 1 W	24.48 mW/g
SAR for nominal Head TSL Parameters	Normalized to 1 W	24.48 ± 23.51% mW/g (k=2)

2450MHz Head

Date/Time: 5/25/2010 7:39:58 PM

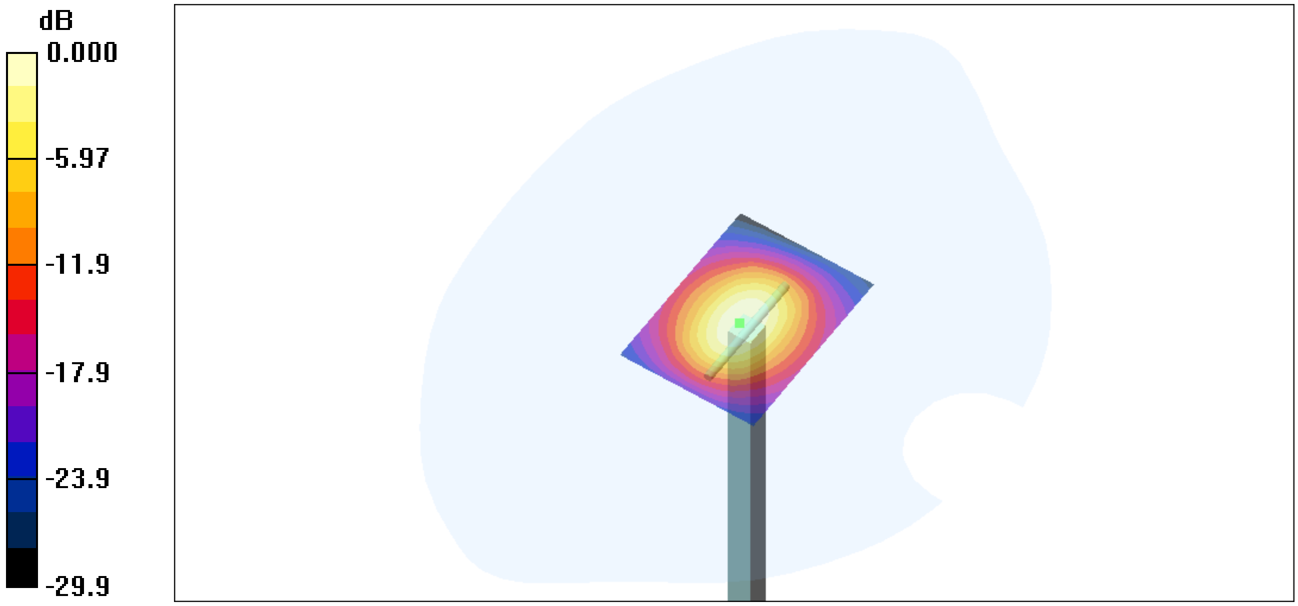
DUT: Dipole 2450 MHz; Type: 1S2570

Communication System: CW; ; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: H2450 Medium parameters used: f = 2450 MHz; σ = 1.89 mho/m; ε_r = 38.8; ρ = 1000 kg/m^3
Phantom section: Flat Section

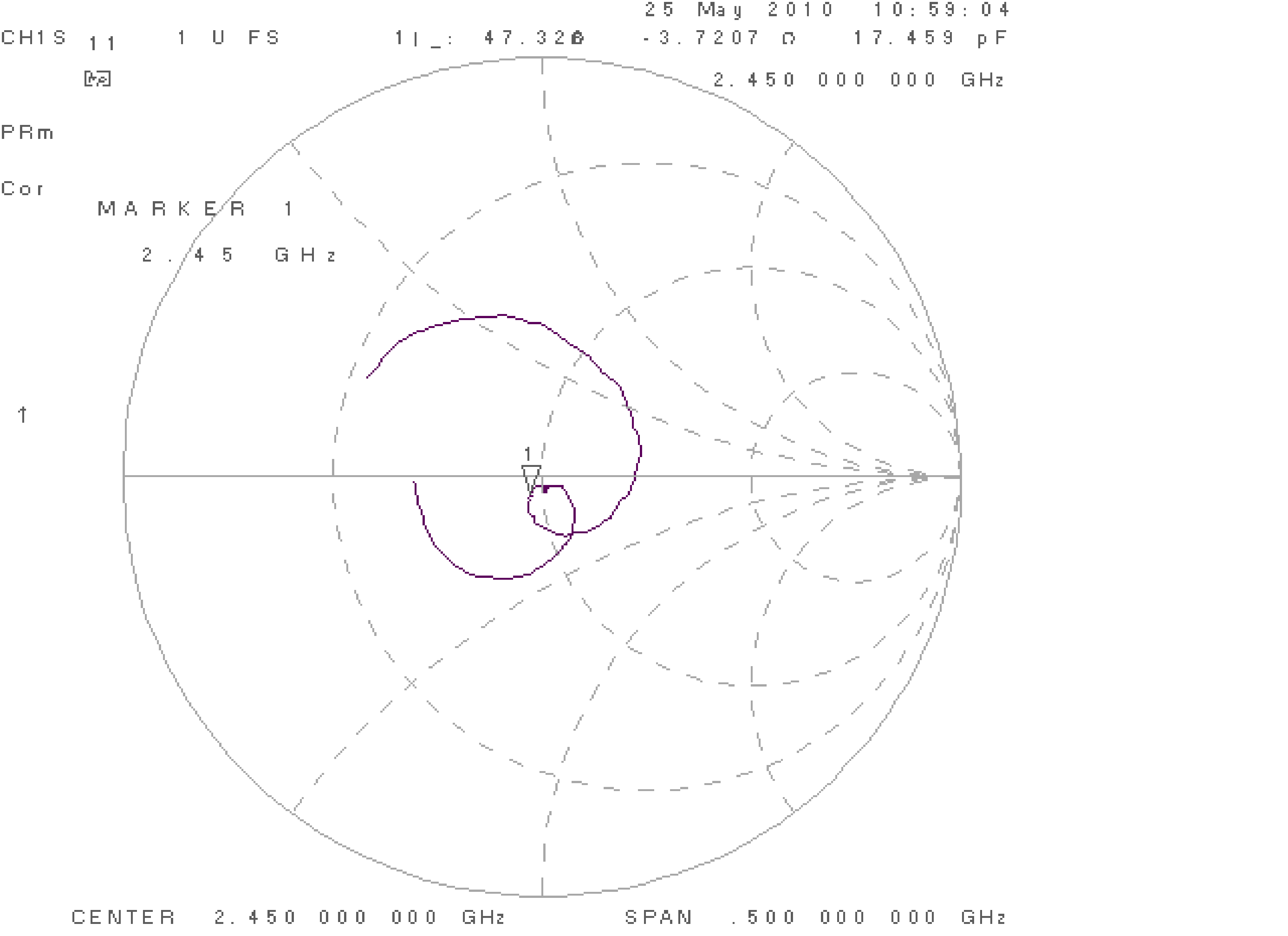
- Probe: EX3DV4 - SN3722; ConvF(6.65, 6.65, 6.65); Calibrated: 5/19/2010
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 4/26/2010
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

Area Scan (61x81x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 18.1 mW/g

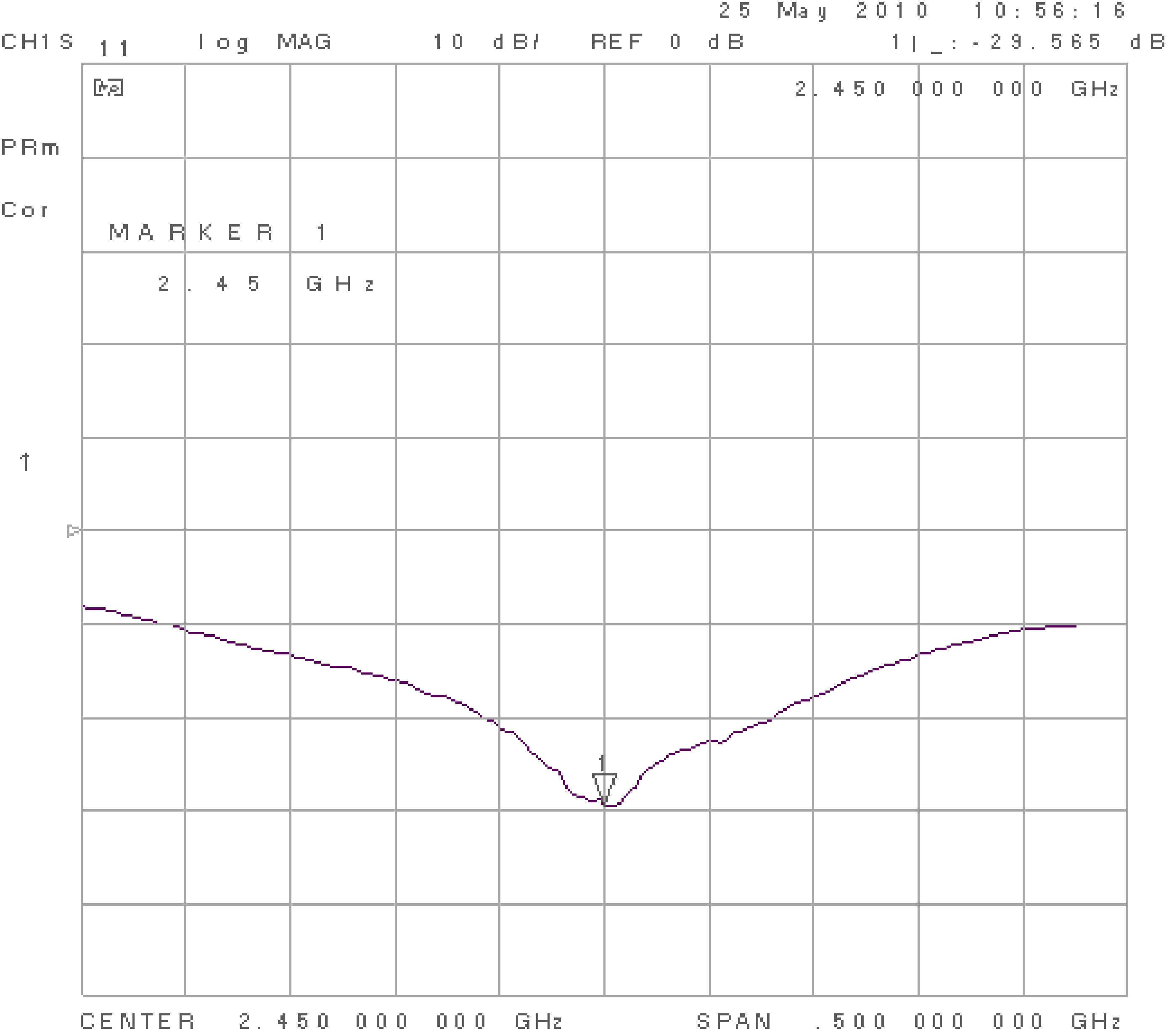
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 95.9 V/m; Power Drift = -0.023 dB
Peak SAR (extrapolated) = 35.2 W/kg
SAR(1 g) = 15.5 mW/g; SAR(10 g) = 6.79 mW/g
Maximum value of SAR (measured) = 17.6 mW/g



0 dB = 17.6mW/g



25 May 2010 10:59:04
CH1 S11 1 U FS 1: 47.326 Ω -3.7207 Ω 17.459 pF
2.450 000 000 GHz
PRm
Cor
MARKER 1
2.45 GHz
1
1
CENTER 2.450 000 000 GHz
SPAN .500 000 000 GHz


25 May 2010 10:56:16
CH1 S11 log MAG 10 dB/ REF 0 dB 1_: -29.565 dB
2.450 000 000 GHz
PRm
Cor
MARKER 1
2.45 GHz
CENTER 2.450 000 000 GHz
SPAN .500 000 000 GHz

2450MHz Body

Date/Time: 5/25/2010 5:23:24 PM

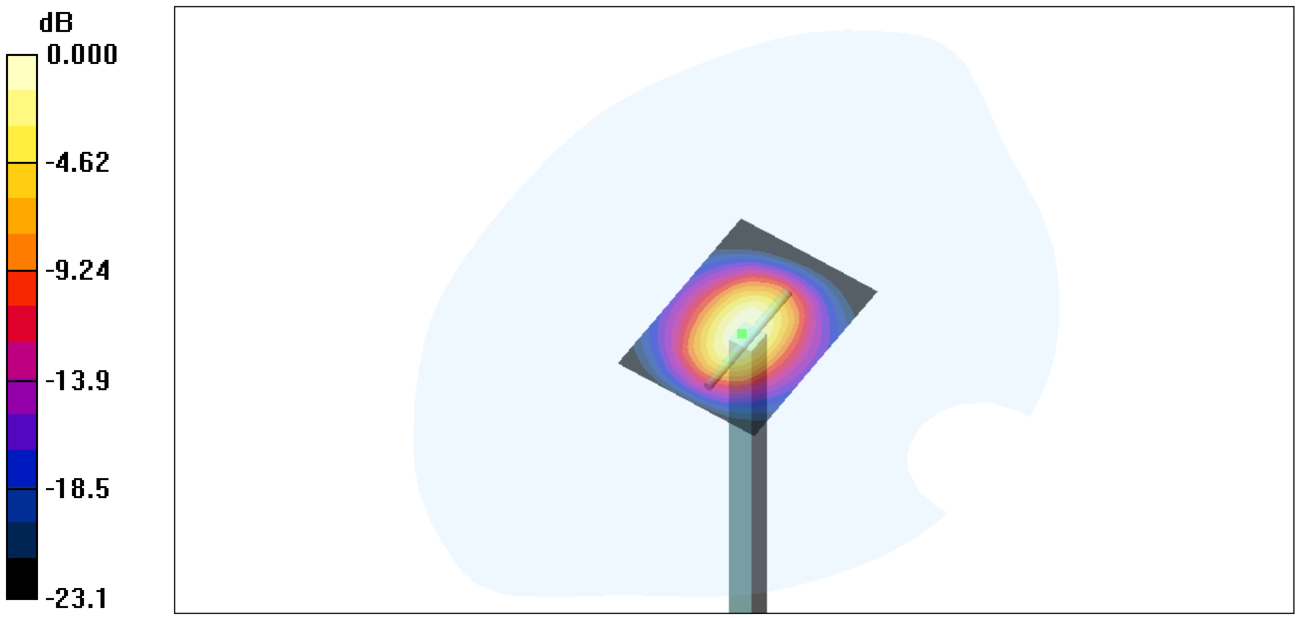
DUT: Dipole 2450 MHz; Type: 1S2570

Communication System: CW; ; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium: M2450 Medium parameters used: f = 2450 MHz; σ = 2.01 mho/m; ε_r = 52.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

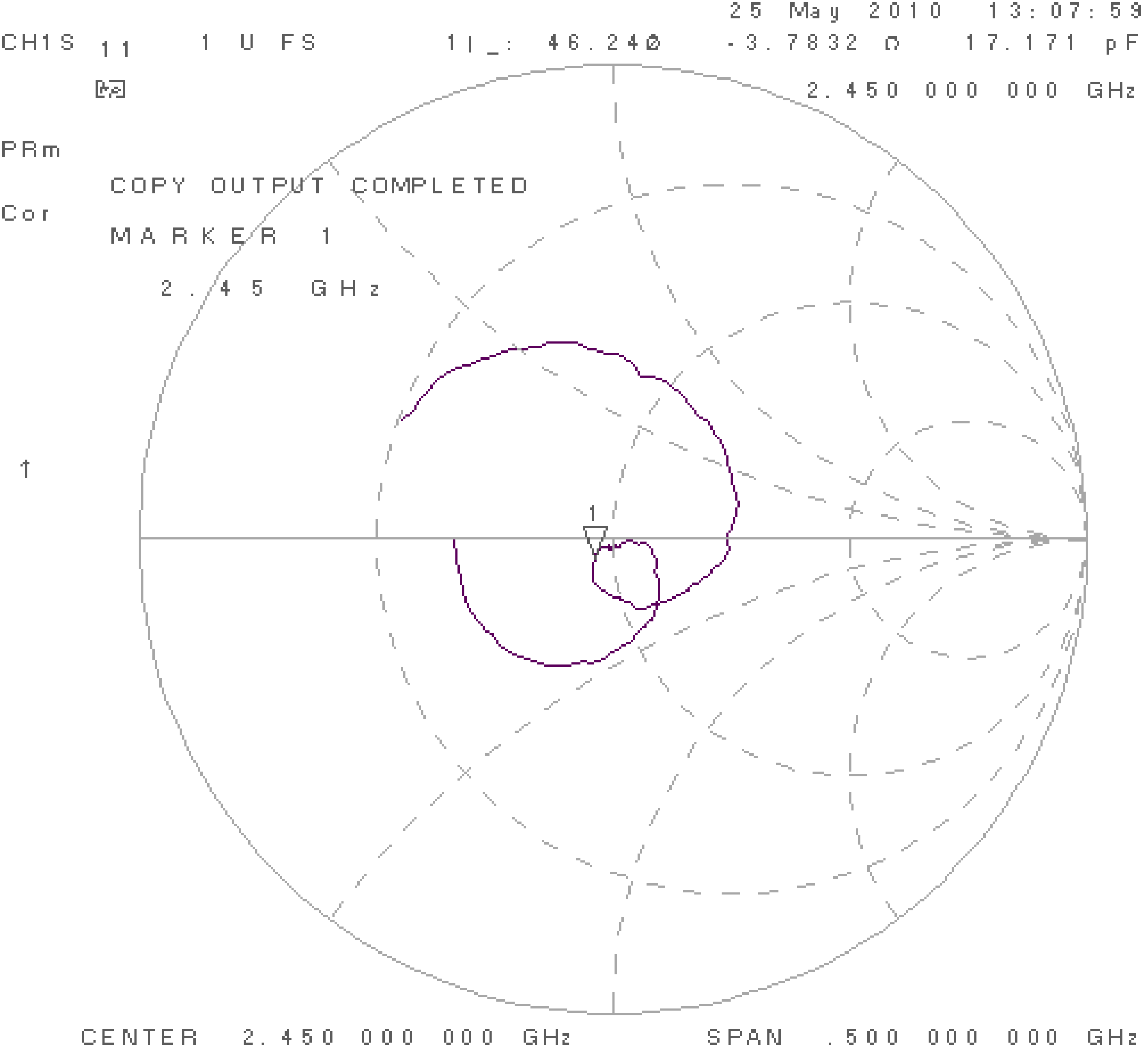
- Probe: EX3DV4 - SN3722; ConvF(6.82, 6.82, 6.82); Calibrated: 5/19/2010
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 4/26/2010
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

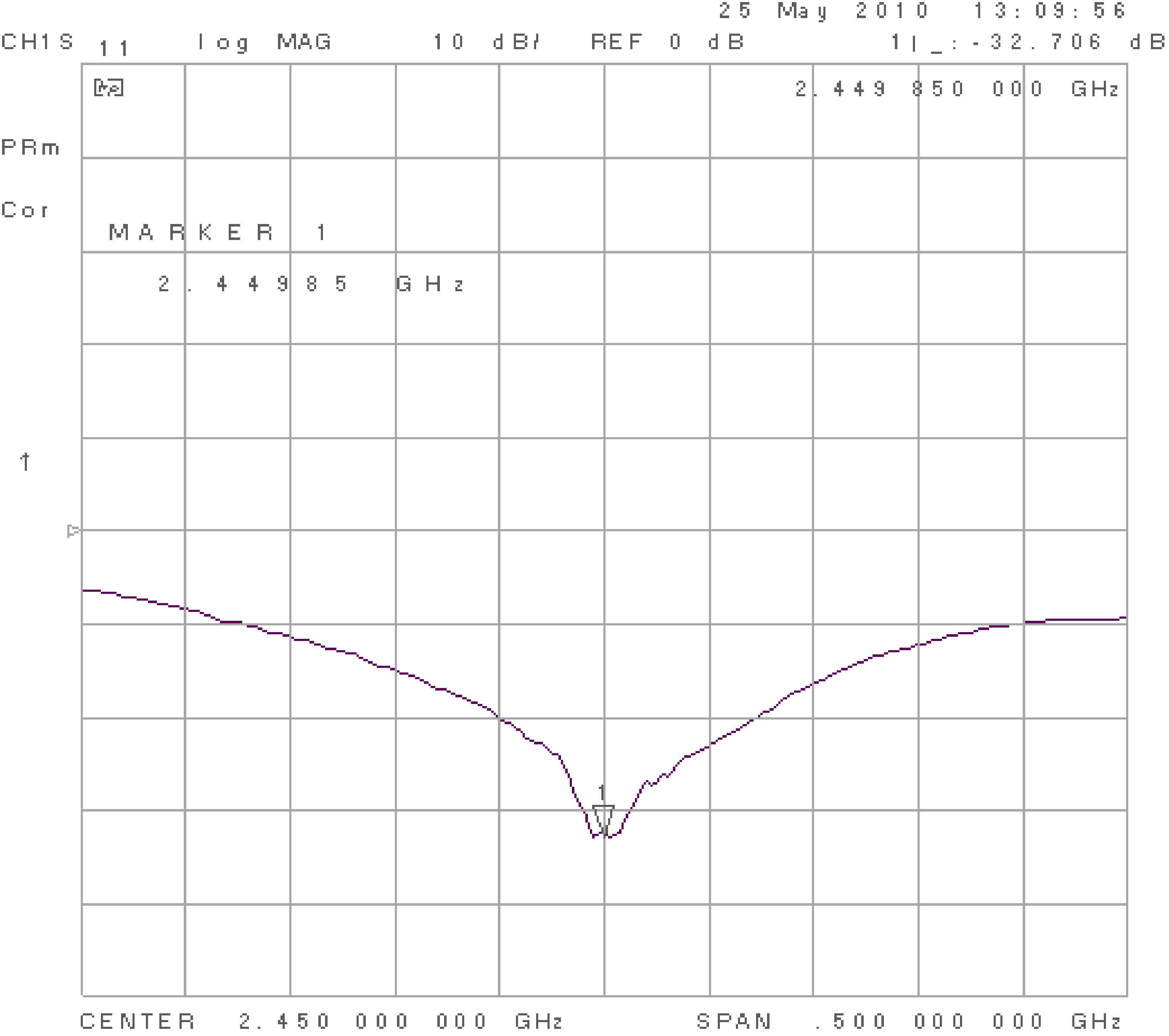
Area Scan (61x81x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 16.1 mW/g

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.5 V/m; Power Drift = -0.122 dB
Peak SAR (extrapolated) = 30.0 W/kg
SAR(1 g) = 13.9 mW/g; SAR(10 g) = 6.12 mW/g
Maximum value of SAR (measured) = 15.8 mW/g



0 dB = 15.8mW/g


25 May 2010 13:07:59
CH1 S11 1 U FS 1: 46.240 Ω -3.7832 Ω 17.171 pF
2.450 000 000 GHz
PRm
COPY OUTPUT COMPLETED
Cor
MARKER 1
2.45 GHz
1
CENTER 2.450 000 000 GHz
SPAN .500 000 000 GHz



25 May 2010 13:09:56
CH1 S11 log MAG 10 dB/ REF 0 dB 1_: -32.706 dB
2.449 850 000 GHz
PRm
Cor
MARKER 1
2.44985 GHz
1
1
CENTER 2.450 000 000 GHz SPAN .500 000 000 GHz

APPENDIX E – MEASURED FLUID DIELECTRIC PARAMETERS

Title

SubTitle

August 23, 2010 08:12 AM

Frequency	e'	e''
2.400000000 GI	51.829	14.2499
2.402000000 GI	51.824	14.2632
2.404000000 GI	51.812	14.2693
2.406000000 GI	51.809	14.2787
2.408000000 GI	51.800	14.3090
2.410000000 GI	51.811	14.2971
2.412000000 GI	51.809	14.3120
2.414000000 GI	51.804	14.3346
2.416000000 GI	51.804	14.3363
2.418000000 GI	51.803	14.3464
2.420000000 GI	51.790	14.3562
2.422000000 GI	51.788	14.3636
2.424000000 GI	51.780	14.3731
2.426000000 GI	51.769	14.3724
2.428000000 GI	51.782	14.3770
2.430000000 GI	51.768	14.3953
2.432000000 GI	51.762	14.4101
2.434000000 GI	51.763	14.4116
2.436000000 GI	51.747	14.4131
2.438000000 GI	51.751	14.4227
2.440000000 GI	51.740	14.4332
2.442000000 GI	51.735	14.4368
2.444000000 GI	51.729	14.4535
2.446000000 GI	51.711	14.4466
2.448000000 GI	51.713	14.4534
2.450000000 GI	51.696	14.4586
2.452000000 GI	51.695	14.4591
2.454000000 GI	51.685	14.4648
2.456000000 GI	51.675	14.4545
2.458000000 GI	51.671	14.4719
2.460000000 GI	51.651	14.4735
2.462000000 GI	51.640	14.4830
2.464000000 GI	51.628	14.4812
2.466000000 GI	51.627	14.4881
2.468000000 GI	51.607	14.4804

2.470000000 GI	51.593	14.4843
2.472000000 GI	51.583	14.4898
2.474000000 GI	51.573	14.4907
2.476000000 GI	51.568	14.5118
2.478000000 GI	51.551	14.5122
2.480000000 GI	51.541	14.5196
2.482000000 GI	51.526	14.5320
2.484000000 GI	51.518	14.5383
2.486000000 GI	51.506	14.5495
2.488000000 GI	51.509	14.5532
2.490000000 GI	51.502	14.5734
2.492000000 GI	51.482	14.5675
2.494000000 GI	51.479	14.5892
2.496000000 GI	51.468	14.5985
2.498000000 GI	51.470	14.5994
2.500000000 GI	51.451	14.6186

APPENDIX F – PHANTOM CERTIFICATE OF CONFORMITY

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 1 245 9700, Fax +41 1 245 9779
info@speag.com, http://www.speag.com

Certificate of conformity / First Article Inspection

Item	SAM Twin Phantom V4.0
Type No	QD 000 P40 C
Series No	TP-1150 and higher
Manufacturer / Origin	Untersee Composites Hauptstr. 69 CH-8559 Fruthwilen Switzerland

Tests

The series production process used allows the limitation to test of first articles.
Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

Test	Requirement	Details	Units tested
Shape	Compliance with the geometry according to the CAD model.	IT'IS CAD File (*)	First article, Samples
Material thickness	Compliant with the requirements according to the standards	2mm +/- 0.2mm in specific areas; 6mm +/- 0.2mm at ERP	First article, Samples
Material parameters	Dielectric parameters for required frequencies	200 MHz – 3 GHz Relative permittivity < 5 Loss tangent < 0.05.	Material sample TP 104-5
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions	DEGMBE based simulating liquids	Pre-series, First article, Samples

Standards

[1] CENELEC EN 50361
[2] IEEE Std 1528-200x Draft CD 1.1 (Dec 02)
[3] IEC 62209/CD (Nov 02)
(*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

Date 7.8.2003

Signature / Stamp

s p e a g
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info@speag.com, http://www.speag.com