

RF EXPOSURE EVALUATION

SPECIFIC ABSORPTION RATE

SAR TEST REPORT

FOR

ZEBRA TECHNOLOGIES CORPORATION

PORTABLE PRINTER WITH 802.11b WLAN

MODEL: RW220

FCC ID: I28MD-RW4137

IC: 3798A-RW4137

Test Report Serial Number

021506I28-T722-S15W


Test Report Issue No.

S722-022206-R0

Test Lab

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	Test Report Serial No.:	021506I28-T722-S15W	Report Issue No.:	S722-022206-R0
	Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
	Description of Test(s):	RF Exposure SAR	FCC 47 CFR §2.1093	IC RSS-102 Issue 2



DECLARATION OF COMPLIANCE SAR RF EXPOSURE EVALUATION

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FCC IDENTIFIER: IC IDENTIFIER: Model(s):	I28MD-RW4137 3798A-RW4137 RW220
SAR Test Requirement(s): SAR Test Procedure(s): FCC Device Classification: IC Device Classification: Device Description: Internal Transmitter: Mode(s) of Operation:	FCC 47 CFR §2.1093; Health Canada Safety Code 6 FCC OET Bulletin 65, Supplement C (Edition 01-01) Industry Canada RSS-102 Issue 2 Digital Transmission System (DTS) Low Power Licence-Exempt Radiocommunication Device (RSS-210) Portable Printer with 802.11b WLAN Symbol LA-4137 Compact Flash 802.11b WLAN Card Direct Sequence Spread Spectrum (DSSS)
Transmit Frequency Range: Max. RF Output Power Tested: Max. Data Rate Tested: Antenna Type(s) Tested: Battery Type(s) Tested:	2412 - 2462 MHz 20.0 dBm (0.100 Watts) Peak Conducted (2412 MHz) 1 Mbps Internal Li-ion 7.4 VDC (P/N: CT17497-1)
Body-Worn Accessories Tested: Audio Accessories Tested:	Plastic Belt-Clip None (not applicable)
Max. SAR Level(s) Evaluated:	Body-Worn: 0.011527 W/kg (Peak SAR measured from Area Scan)
Class II Permissive Change(s):	Add New Model RW220

Celltech Labs Inc. declares under its sole responsibility that this wireless portable device has demonstrated compliance with the Specific Absorption Rate (SAR) RF exposure requirements specified in FCC 47 CFR §2.1093 and Health Canada's Safety Code 6. The device was tested in accordance with the measurement standards and procedures specified in FCC OET Bulletin 65, Supplement C (Edition 01-01) and Industry Canada RSS-102 Issue 2 for the General Population / Uncontrolled Exposure environment. All measurements were performed in accordance with the SAR system manufacturer recommendations.

I attest to the accuracy of data. All measurements 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.

This test report shall not be reproduced partially, or in full, without the prior written approval of Celltech Labs Inc. The results and statements contained in this report pertain only to the device(s) evaluated.

Tested By:  <hr/> Sean Johnston Compliance Technologist Celltech Labs Inc.	Reviewed By:  <hr/> Spencer Watson Senior Compliance Technologist Celltech Labs Inc.
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Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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			IC RSS-102 Issue 2

1.0 INTRODUCTION

This measurement report demonstrates that the Zebra Technologies Corporation Model(s): RW220 Wireless Portable Printer with 802.11b WLAN FCC ID: I28MD-RW4137, with the Class II Permissive Change(s) described in this report, complies with the SAR (Specific Absorption Rate) RF exposure requirements specified in FCC 47 CFR §2.1093 (see reference [1]), and Health Canada's Safety Code 6 (see reference [2]) for the General Population / Uncontrolled Exposure environment. The test procedures described in FCC OET Bulletin 65, Supplement C, Edition 01-01 (see reference [3]), and Industry Canada RSS-102 Issue 2 (see reference [4]) were employed. A description of the product, operating configuration, detailed summary of the test results, methodology and procedures used in the evaluation, equipment used, and the various provisions of the rules are included within this test report.

2.0 DESCRIPTION of DEVICE UNDER TEST (DUT)

SAR Test Requirement(s)	FCC Rule Part 47 CFR §2.1093	Health Canada Safety Code 6		
SAR Test Procedure(s)	FCC OET Bulletin 65, Supplement C (01-01)			
	Industry Canada RSS-102 Issue 2			
FCC Device Classification	Digital Transmission System (DTS)		§15C	
IC Device Classification	Low Power License-Exempt Radiocommunication Device		RSS-210 Issue 6	
Device Description	Portable Printer with 802.11b WLAN			
Internal Transmitter	Symbol LA-4137 Compact Flash 802.11b WLAN Card			
RF Exposure Category	General Population / Uncontrolled Environment			
FCC IDENTIFER	I28MD-RW4137			
IC IDENTIFER	3798A-RW4137			
Model(s)	RW220			
Test Sample Serial No.(s)	XXRD05-50-5119	Production Unit		
Transmission Type(s)	Direct Sequence Spread Spectrum (DSSS)			
Transmit Frequency Range	2412 - 2462 MHz			
Max. RF Conducted Output Power Measured	Peak Conducted Power	Data Rate	Frequency	Channel
	20.0 dBm	0.100 Watts	1 Mbps	2412 MHz
	17.9 dBm	0.062 Watts	1 Mbps	2437 MHz
	16.4 dBm	0.044 Watts	1 Mbps	2462 MHz
	19.3 dBm	0.085 Watts	2 Mbps	2412 MHz
	19.9 dBm	0.098 Watts	5.5 Mbps	2412 MHz
	20.0 dBm	0.100 Watts	11 Mbps	2412 MHz
Max. Data Rate(s) Tested	1 Mbps			
Antenna Type(s) Tested	Internal			
Battery Type(s) Tested	Lithium-ion	7.4 VDC	P/N: CT17497-1	
Body-Worn Accessories Tested	Plastic Belt-Clip			
Audio Accessories Tested	None (not applicable)			
Class II Permissive Change(s)	Add New Model RW220			

Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
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3.0 SAR MEASUREMENT SYSTEM


Celltech Labs Inc. SAR measurement facility utilizes the Dosimetric Assessment System (DASY™) manufactured by Schmid & Partner Engineering AG (SPEAG™) of Zurich, Switzerland. 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). A cell controller system contains 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.



DASY4 SAR Measurement System with planar phantom



DASY4 SAR Measurement System with planar phantom and validation dipole


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4.0 MEASUREMENT SUMMARY

BODY-WORN SAR EVALUATION RESULTS											
Freq. ² (MHz)	Chan.	Test Mode	Data Rate ³	Battery Type	Antenna Position	DUT Position to Planar Phantom	Body-worn Accessory	Separation Distance to Planar Phantom	Conducted Power Before Test (dBm)	SAR Drift During Test ⁵ (dB)	Peak SAR Measured from Area Scan ⁴ (W/kg)
2412	1	DSSS	1 Mbps	Li-ion	Internal	Back Side	Belt-Clip	Touch	20.0	0.554	0.008279
2412	1	DSSS	1 Mbps	Li-ion	Internal	Back Side	none	Touch	20.0	-0.548	0.011527
ANSI / IEEE C95.1 1999 SAFETY LIMIT				BODY: 1.6 W/kg (averaged over 1 gram)				Spatial Peak Uncontrolled Exposure / General Population			
Test Date(s)		February 20, 2006				Relative Humidity		30	%		
Measured Fluid Type		2450 MHz Body				Atmospheric Pressure		97.9	kPa		
Dielectric Constant ϵ_r		IEEE Target		Measured	Deviation	Ambient Temperature		23.8	°C		
		52.7	± 5%	50.3	-4.6%	Fluid Temperature		23.0	°C		
Conductivity σ (mho/m)		IEEE Target		Measured	Deviation	Fluid Depth		≥ 15	cm		
		1.95	± 5%	1.86	-4.6%	ρ (Kg/m³)		1000			

Note(s):

- The measurement results were obtained with the DUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum SAR location of the DUT are reported in Appendix A.
- If the SAR levels measured at the highest output channel were ≥ 3 dB below the SAR limit, SAR evaluation for all other selected channels was optional (per October 2005 TCB Council Workshop - see reference [6]).
- Higher data rates were not evaluated based on the output power levels were not > 0.25 dB from the output power measured at the lowest data rate (per October 2005 TCB Council Workshop - see reference [6]).
- The 1g-averaged SAR was not measured because the peak SAR value from the area scan evaluations for each test configuration was less than 1% of the 1g average limit. The peak SAR values measured during the area scan evaluations for each test configuration are reported. The mathematical formula used to extrapolate the SAR value at the surface from the zoom scan SAR values measured at 5 mm steps leading away from the surface assumes a curving slope (i.e. the SAR values gradually decrease as the probe moves away from the surface). When the peak SAR of a device is so low that the RF noise level is competing with the level of the SAR, the Zoom Scan measurements leading away from the surface are no longer a curving slope and the extrapolation formula cannot accurately estimate the 1g average SAR. In this manner, we have reported the peak values from the area scan in place of the 1g averaged SAR values whenever the peak values are less than 1% of the average limit. This avoids gross uncertainties in the 1g average SAR calculation while maintaining a conservative estimation of the SAR level.
- The power drifts reported were measured at the reference point of the phantom with low SAR. The drift values reported are inaccurate due to the SAR value at the reference point is close to the measurement noise floor.
- The DUT battery was fully charged prior to the SAR evaluations.
- The ambient and fluid temperatures were measured prior to, and during, the fluid dielectric parameter check and the SAR evaluation. The temperatures reported were consistent for all measurement periods.
- The dielectric parameters of the simulated tissue mixture were measured prior to the SAR evaluation using an ALS-PR-DIEL Dielectric Probe Kit and an HP 8753ET Network Analyzer (see Appendix C).
- The SAR evaluation was performed within 24 hours of the system performance check.

Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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5.0 DETAILS OF SAR EVALUATION

The Zebra Technologies Corporation Model(s): RW220 Portable Printer with 802.11b WLAN FCC ID: I28MD-RW4137, with the Class II Permissive Change(s) described in this report, was compliant for localized Specific Absorption Rate (General Population / Uncontrolled Exposure) based on the test provisions and conditions described below. Detailed photographs of the measurement setup are shown in Appendix D.

1. The DUT was tested for body-worn SAR on the back side (battery side) of the device with the plastic belt-clip accessory attached. The back side of the DUT was positioned parallel to the outer surface of the planar phantom. The belt-clip accessory was placed touching the outer surface of the planar phantom.
2. The DUT was tested for body-worn SAR on the back side (battery side) of the device without the plastic belt-clip accessory (body-worn SAR for use with optional shoulder strap accessory). The back side of the DUT was positioned parallel to, and touching, the outer surface of the planar phantom.
3. The DUT was placed into test mode via keypad commands using internal software and operating at maximum power in modulated DSSS continuous transmit mode for the duration of the tests.
4. The conducted power levels were measured prior to the SAR evaluations using a Gigatronics 8652A Universal Power Meter according to the procedures described in FCC 47 CFR §2.1046.
5. The power drifts of the DUT during of the SAR evaluations were measured by the DASY4 system.
6. Each SAR evaluation was performed with a fully charged battery in the DUT.
7. The ambient and fluid temperatures were measured prior to, and during, the fluid dielectric parameter check and the SAR evaluation. The temperatures reported were consistent for all measurement periods.
8. The dielectric parameters of the simulated tissue mixture were measured prior to the evaluations using an ALS-PR-DIEL Dielectric Probe Kit and an HP 8753ET Network Analyzer (see Appendix C).
9. SAR evaluation was performed within 24 hours of the system performance check.

6.0 EVALUATION PROCEDURES


- a. (i) The evaluation was performed in the applicable area of the phantom depending on the type of device being tested. 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.
- b. The SAR was determined by a pre-defined procedure within the DASY4 software. Upon completion of a reference and optical surface 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:

- c. 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.
- d. 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:

- e. Extrapolation is used to find the points between the dipole center of the probe and the surface of the phantom. This data cannot be measured, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.4 mm (see probe calibration document in Appendix F). The extrapolation was based on trivariate quadratics computed from the previously calculated 3D interpolated points nearest the phantom surface.
- f. 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).
- g. A zoom scan volume of 32 mm x 32 mm x 30 mm (5 x 5 x 7 points) centered at the peak SAR location determined from the area scan is used for all zoom scans for devices with a transmit frequency < 800 MHz. Zoom scans for frequencies ≥ 800 MHz are determined with a scan volume of 30 mm x 30 mm x 30 mm (7 x 7 x 7) to ensure complete capture of the peak spatial-average SAR.

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7.0 SYSTEM PERFORMANCE CHECK

Prior to the SAR evaluation a system check was performed using a planar phantom with a 2450MHz dipole (see Appendix E for system validation procedures). The dielectric parameters of the simulated tissue were measured prior to the system performance check using an ALS-PR-DIEL Dielectric Probe Kit and an HP 8753ET Network Analyzer (see Appendix C). A forward power of 250 mW was applied to the dipole and the system was verified to a tolerance of $\pm 10\%$ (see Appendix B for system performance check test plot). See Table 1 below for the SAR system manufacturer's reference body SAR values from the DASY4 Operation Manual (see reference [7]).

SYSTEM PERFORMANCE CHECK EVALUATION																
Test Date	Equiv. Tissue	SAR 1g (W/kg)			Dielectric Constant ϵ_r			Conductivity σ (mho/m)			ρ (Kg/m ³)	Amb. Temp. (°C)	Fluid Temp. (°C)	Fluid Depth (cm)	Humid. (%)	Barom. Press. (kPa)
		IEEE Target	Meas.	Dev.	IEEE Target	Meas.	Dev.	IEEE Target	Meas.	Dev.						
2/20/06	2450MHz Body	12.8 $\pm 10\%$	12.8	0.0%	52.7 $\pm 5\%$	50.3	-4.6%	1.95 $\pm 5\%$	1.86	-4.6%	1000	23.0	23.0	≥ 15	30	98.0

Note(s):
 1. The ambient and fluid temperatures were measured prior to, and during, the fluid dielectric parameter check and the system performance check. The temperatures reported in the table above were consistent for all measurement periods.

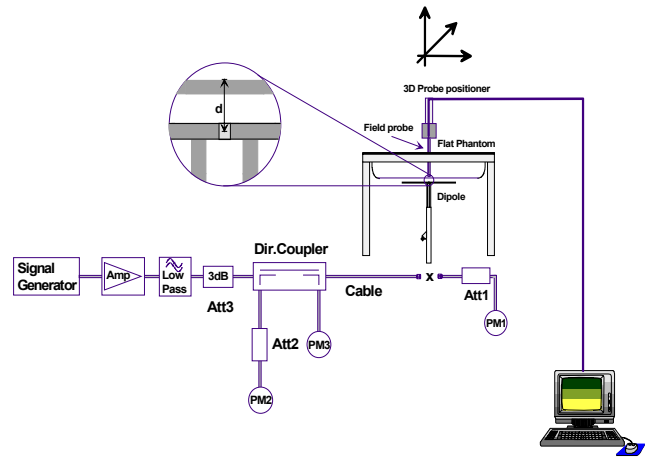
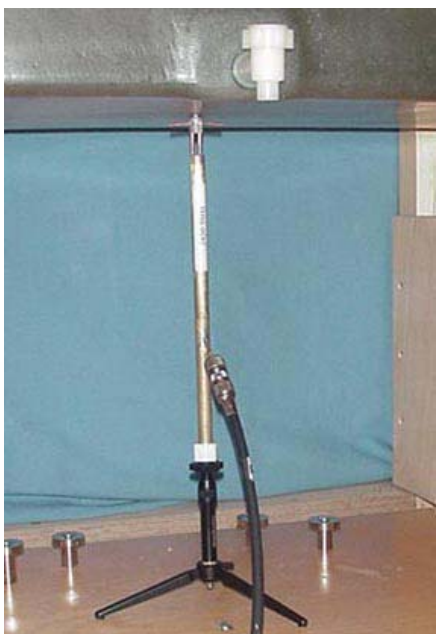


Figure 1. System Performance Check Setup Diagram




2450MHz Dipole Setup

Dipole Type	Distance [mm]	Frequency [MHz]	SAR (1g) [W/kg]	SAR (10g) [W/kg]	SAR (peak) [W/kg]
D300V2	15	300	3.02	2.06	4.36
D450V2	15	450	5.01	3.36	7.22
D835V2	15	835	9.71	6.38	14.1
D900V2	15	900	11.1	7.17	16.3
D1450V2	10	1450	29.6	16.6	49.8
D1500V2	10	1500	30.8	17.1	52.1
D1640V2	10	1640	34.4	18.7	59.4
D1800V2	10	1800	38.5	20.3	67.5
D1900V2	10	1900	39.8	20.8	69.6
D2000V2	10	2000	40.9	21.2	71.5
D2450V2	10	2450	51.2	23.7	97.6
D3000V2	10	3000	61.9	24.8	136.7

Table 32.1: Numerical reference SAR values for SPEAG dipoles and flat phantom filled with body-tissue simulating liquid. Note: All SAR values normalized to 1 W forward power.

Table 1. SAR system manufacturer's reference body SAR values

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8.0 SIMULATED EQUIVALENT TISSUES

The 2450MHz body simulated tissue mixtures consist of Glycol-monobutyl, water, and salt (body mixture only). The fluid was prepared according to standardized procedures and measured for dielectric parameters (permittivity and conductivity).


SIMULATED TISSUE MIXTURES		
INGREDIENT	2450 MHz Body	2450 MHz Body
	System Performance Check	DUT Evaluation
Water	69.98 %	69.98 %
Glycol Monobutyl	30.00 %	30.00 %
Salt	0.02 %	0.02 %


9.0 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 1 g of tissue)	1.60	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

Notes:

1. Uncontrolled environments are defined as locations where there is potential exposure of individuals who have no knowledge or control of their potential exposure.
2. Controlled environments are defined as locations where there is potential exposure of individuals who have knowledge of their potential exposure and can exercise control over their exposure.

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10.0 ROBOT SYSTEM SPECIFICATIONS

Specifications

POSITIONER: Stäubli Unimation Corp. Robot Model: RX60L
Repeatability: 0.02 mm
No. of axis: 6

Data Acquisition Electronic (DAE) System

Cell Controller

Processor: AMD Athlon XP 2400+
Clock Speed: 2.0 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.: 1590
Construction: Triangular core fiber optic detection system
Frequency: 10 MHz to 6 GHz
Linearity: ± 0.2 dB (30 MHz to 3 GHz)

Phantom(s)

Type: Planar Phantom
Shell Material: Fiberglass
Thickness: 2.0 ± 0.1 mm
Volume: Approx. 72 liters

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11.0 PROBE SPECIFICATION (ET3DV6)

Construction:	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g. glycol)
Calibration:	In air from 10 MHz to 2.5 GHz In brain simulating tissue at frequencies of 900 MHz and 1.8 GHz (accuracy $\pm 8\%$)
Frequency:	10 MHz to >6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)
Directivity:	± 0.2 dB in brain tissue (rotation around probe axis) ± 0.4 dB in brain tissue (rotation normal to probe axis)
Dynamic Range:	5 μ W/g to >100 mW/g; Linearity: ± 0.2 dB
Surface Detection:	± 0.2 mm repeatability in air and clear liquids over diffuse reflecting surfaces
Dimensions:	Overall length: 330 mm Tip length: 16 mm Body diameter: 12 mm Tip diameter: 6.8 mm Distance from probe tip to dipole centers: 2.7 mm
Application:	General dosimetry up to 3 GHz Compliance tests of mobile phone



**ET3DV6
E-Field Probe**

12.0 PLANAR PHANTOM

The planar phantom is a fiberglass shell phantom with a 2.0 mm (+/-0.2mm) thick device measurement area at the center of the phantom for SAR evaluations of devices with a larger surface area than the planar section of the SAM phantom. The planar phantom is integrated in a wooden table (see Appendix G for dimensions and specifications of the planar phantom).




Planar Phantom


13.0 DEVICE HOLDER

The DASY4 device holder has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. For evaluations of larger devices, a Plexiglas platform is attached to the device holder.




Device Holder


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14.0 TEST EQUIPMENT LIST

USED	TEST EQUIPMENT	ASSET NO.	SERIAL NO.	DATE CALIBRATED		CALIBRATION DUE DATE
	DESCRIPTION					
x	Schmid & Partner DASY4 System	-	-	-	-	-
x	-DASY4 Measurement Server	00158	1078	N/A	N/A	N/A
x	-Robot	00046	599396-01	N/A	N/A	N/A
x	-DAE4	00019	353	15Jun05	15Jun06	15Jun06
	-ET3DV6 E-Field Probe	00016	1387	18Mar05	18Mar06	18Mar06
x	-ET3DV6 E-Field Probe	00017	1590	20May05	20May06	20May06
	-300MHz Validation Dipole	00023	135	25Oct05	25Oct06	25Oct06
	-450MHz Validation Dipole	00024	136	25Oct05	25Oct06	25Oct06
	-835MHz Validation Dipole	00022	411	Brain	30Mar05	30Mar06
				Body	12Apr05	12Apr06
	-900MHz Validation Dipole	00020	054	Brain	10Jun05	10Jun06
				Body	10Jun05	10Jun06
	-1800MHz Validation Dipole	00021	247	Brain	14Jun05	14Jun06
				Body	14Jun05	14Jun06
	-1900MHz Validation Dipole	00032	151	Brain	17Jun05	17Jun06
				Body	22Apr05	22Apr06
x	-2450MHz Validation Dipole	00025	150	Brain	20Sep05	20Sep06
				Body	22Apr05	22Apr06
	-SAM Phantom V4.0C	00154	1033	N/A	N/A	N/A
x	-Barski Planar Phantom	00155	03-01	N/A	N/A	N/A
	-Plexiglas Side Planar Phantom	00156	161	N/A	N/A	N/A
	-Plexiglas Validation Planar Phantom	00157	137	N/A	N/A	N/A
	HP 85070C Dielectric Probe Kit	00033	N/A	N/A	N/A	N/A
x	ALS-PR-DIEL Dielectric Probe Kit	00160	260-00953	N/A	N/A	N/A
	Gigatronics 8652A Power Meter	00110	1835801	16Apr05	16Apr06	16Apr06
x	Gigatronics 8652A Power Meter	00008	1835267	29Apr05	29Apr06	29Apr06
x	Gigatronics 80701A Power Sensor	00012	1834350	12Sep05	12Sep06	12Sep06
	Gigatronics 80701A Power Sensor	00014	1833699	07Sep05	07Sep06	07Sep06
x	Gigatronics 80701A Power Sensor	00109	1834366	16Apr05	16Apr06	16Apr06
x	HP 8753ET Network Analyzer	00134	US39170292	04May05	04May06	04May06
x	HP 8648D Signal Generator	00005	3847A00611	29Apr05	29Apr06	29Apr06
x	Rohde & Schwarz SMR40 Signal Generator	00006	100104	12Apr05	12Apr06	12Apr06
x	Amplifier Research 5S1G4 Power Amplifier	00106	26235	N/A	N/A	N/A


Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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	Test Report Serial No.:	021506I28-T722-S15W	Report Issue No.:	S722-022206-R0
	Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
	Description of Test(s):	RF Exposure SAR	FCC 47 CFR §2.1093	IC RSS-102 Issue 2

15.0 MEASUREMENT UNCERTAINTIES

UNCERTAINTY BUDGET FOR DEVICE EVALUATION						
Error Description	Uncertainty Value ±%	Probability Distribution	Divisor	ci 1g	Uncertainty Value ±% (1g)	V _i or V _{eff}
Measurement System						
Probe calibration	5.9	Normal	1	1	5.9	∞
Axial isotropy of the probe	4.7	Rectangular	1.732050808	0.7	1.9	∞
Spherical isotropy of the probe	9.6	Rectangular	1.732050808	0.7	3.9	∞
Spatial resolution	0	Rectangular	1.732050808	1	0.0	∞
Boundary effects	1	Rectangular	1.732050808	1	0.6	∞
Probe linearity	4.7	Rectangular	1.732050808	1	2.7	∞
Detection limit	1	Rectangular	1.732050808	1	0.6	∞
Readout electronics	0.3	Normal	1	1	0.3	∞
Response time	0.8	Rectangular	1.732050808	1	0.5	∞
Integration time	2.6	Rectangular	1.732050808	1	1.5	∞
RF ambient conditions	3	Rectangular	1.732050808	1	1.7	∞
Mech. constraints of robot	0.4	Rectangular	1.732050808	1	0.2	∞
Probe positioning	2.9	Rectangular	1.732050808	1	1.7	∞
Extrapolation & integration	1	Rectangular	1.732050808	1	0.6	∞
Test Sample Related						
Device positioning	2.9	Normal	1	1	2.9	12
Device holder uncertainty	3.6	Normal	1	1	3.6	8
Power drift	5	Rectangular	1.732050808	1	2.9	∞
Phantom and Setup						
Phantom uncertainty	4	Rectangular	1.732050808	1	2.3	∞
Liquid conductivity (target)	5	Rectangular	1.732050808	0.64	1.8	∞
Liquid conductivity (measured)	2.5	Normal	1	0.64	1.6	∞
Liquid permittivity (target)	5	Rectangular	1.732050808	0.6	1.7	∞
Liquid permittivity (measured)	2.5	Normal	1	0.6	1.5	∞
Combined Standard Uncertainty					10.79	
Expanded Uncertainty (k=2)					21.59	

Measurement Uncertainty Table in accordance with IEEE Standard 1528-2003 (see reference [5])


Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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	Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
	Description of Test(s):	RF Exposure SAR	FCC 47 CFR §2.1093	IC RSS-102 Issue 2

MEASUREMENT UNCERTAINTIES (Cont.)

UNCERTAINTY BUDGET FOR SYSTEM VALIDATION						
Error Description	Uncertainty Value ±%	Probability Distribution	Divisor	ci 1g	Uncertainty Value ±% (1g)	V _i or V _{eff}
Measurement System						
Probe calibration	5.9	Normal	1	1	5.9	∞
Axial isotropy of the probe	4.7	Rectangular	1.732050808	1	2.7	∞
Spherical isotropy of the probe	0	Rectangular	1.732050808	1	0.0	∞
Spatial resolution	0	Rectangular	1.732050808	1	0.0	∞
Boundary effects	1	Rectangular	1.732050808	1	0.6	∞
Probe linearity	4.7	Rectangular	1.732050808	1	2.7	∞
Detection limit	1	Rectangular	1.732050808	1	0.6	∞
Readout electronics	0.3	Normal	1	1	0.3	∞
Response time	0	Rectangular	1.732050808	1	0.0	∞
Integration time	0	Rectangular	1.732050808	1	0.0	∞
RF ambient conditions	3	Rectangular	1.732050808	1	1.7	∞
Mech. constraints of robot	0.4	Rectangular	1.732050808	1	0.2	∞
Probe positioning	2.9	Rectangular	1.732050808	1	1.7	∞
Extrapolation & integration	1	Rectangular	1.732050808	1	0.6	∞
Test Sample Related						
Dipole Positioning	2	Normal	1.732050808	1	1.2	∞
Power & Power Drift	4.7	Normal	1.732050808	1	2.7	∞
Phantom and Setup						
Phantom uncertainty	4	Rectangular	1.732050808	1	2.3	∞
Liquid conductivity (target)	5	Rectangular	1.732050808	0.64	1.8	∞
Liquid conductivity (measured)	2.5	Normal	1	0.64	1.6	∞
Liquid permittivity (target)	5	Rectangular	1.732050808	0.6	1.7	∞
Liquid permittivity (measured)	2.5	Normal	1	0.6	1.5	∞
Combined Standard Uncertainty					9.04	
Expanded Uncertainty (k=2)					18.08	


Measurement Uncertainty Table in accordance with IEEE Standard 1528-2003 (see reference [5])

Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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	Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
	Description of Test(s):	RF Exposure SAR	FCC 47 CFR §2.1093	IC RSS-102 Issue 2

16.0 REFERENCES

- [1] Federal Communications Commission, "Radiofrequency radiation exposure evaluation: portable devices", Rule Part 47 CFR §2.1093: 1999.
- [2] Health Canada, "Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz", Safety Code 6: 1999.
- [3] Federal Communications Commission, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields", OET Bulletin 65, Supplement C (Edition 01-01), FCC, Washington, D.C.: June 2001.
- [4] Industry Canada, "Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)", Radio Standards Specification RSS-102 Issue 2: November 2005.
- [5] IEEE Standard 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques": December 2003.
- [6] FCC TCB Council Workshop, "RF Exposure (RFx) Mobile and Portable Device Review and Approval Procedures": October 2005.
- [7] Schmid & Partner Engineering AG, "DASY4 Manual", V4.5: March 2005.

Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
Description of Test(s):	RF Exposure	SAR	FCC 47 CFR §2.1093 IC RSS-102 Issue 2

APPENDIX A - SAR MEASUREMENT DATA

	Test Report Serial No.:	021506I28-T722-S15W	Report Issue No.:	S722-022206-R0
	Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
	Description of Test(s):	RF Exposure SAR	FCC 47 CFR §2.1093	IC RSS-102 Issue 2

Date Tested: 02/20/2006

Body-Worn SAR - Back Side of DUT with Belt-Clip - Channel 1 - 2412 MHz - 1 Mbps

DUT: Zebra Model: RW220; Type: Portable Printer with 802.11b WLAN; Serial: XXRD05-50-5119

Body-Worn Accessory: Plastic Belt-Clip; Audio Accessory: None (not applicable)

Ambient Temp: 23.8 °C; Fluid Temp: 23.0 °C; Barometric Pressure: 97.9 kPa; Humidity: 30%

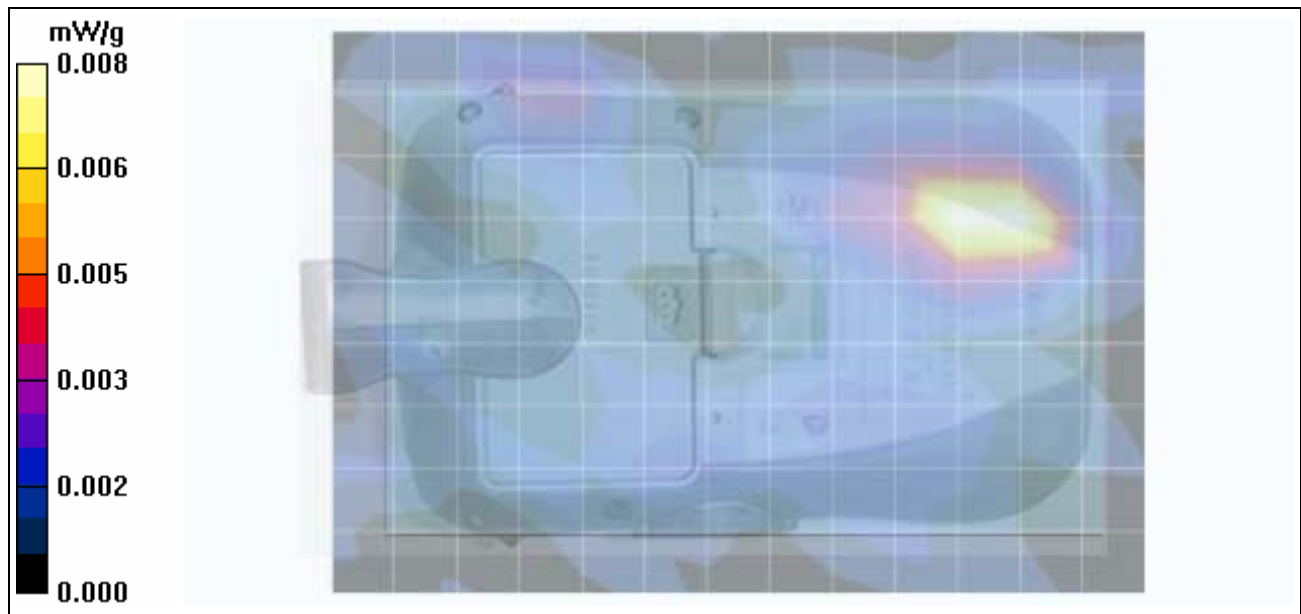
Communication System: DSSS WLAN
 RF Output Power: 20.0 dBm (Conducted)
 7.4 VDC Li-ion Battery Pack (P/N: CT17497-1)
 Frequency: 2412 MHz; Channel 1; Duty Cycle: 1:1
 Medium: M2450 ($\sigma = 1.86 \text{ mho/m}$; $\epsilon_r = 50.3$; $\rho = 1000 \text{ kg/m}^3$)


- Probe: ET3DV6 - SN1590; ConvF(4.22, 4.22, 4.22); Calibrated: 20/05/2005
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 15/06/2005
- Phantom: Barski Industries; Type: Fiberglass Planar; Serial: 03-01
- Measurement SW: DASY4, V4.6 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 159


Body-Worn - Back Side of DUT - Belt-Clip Touching Planar Phantom - Low Channel

Area Scan (10x14x1): Measurement grid: dx=15mm, dy=15mm

Maximum Peak Value of SAR (measured) = 0.008279 mW/g



Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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	Test Report Serial No.:	021506I28-T722-S15W	Report Issue No.:	S722-022206-R0
	Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
	Description of Test(s):	RF Exposure SAR	FCC 47 CFR §2.1093	IC RSS-102 Issue 2

Date Tested: 02/20/2006

Body-Worn SAR - Back Side of DUT (without belt-clip) - Channel 1 - 2412 MHz - 1 Mbps

DUT: Zebra Model: RW220; Type: Portable Printer with 802.11b WLAN; Serial: XXRD05-50-5119

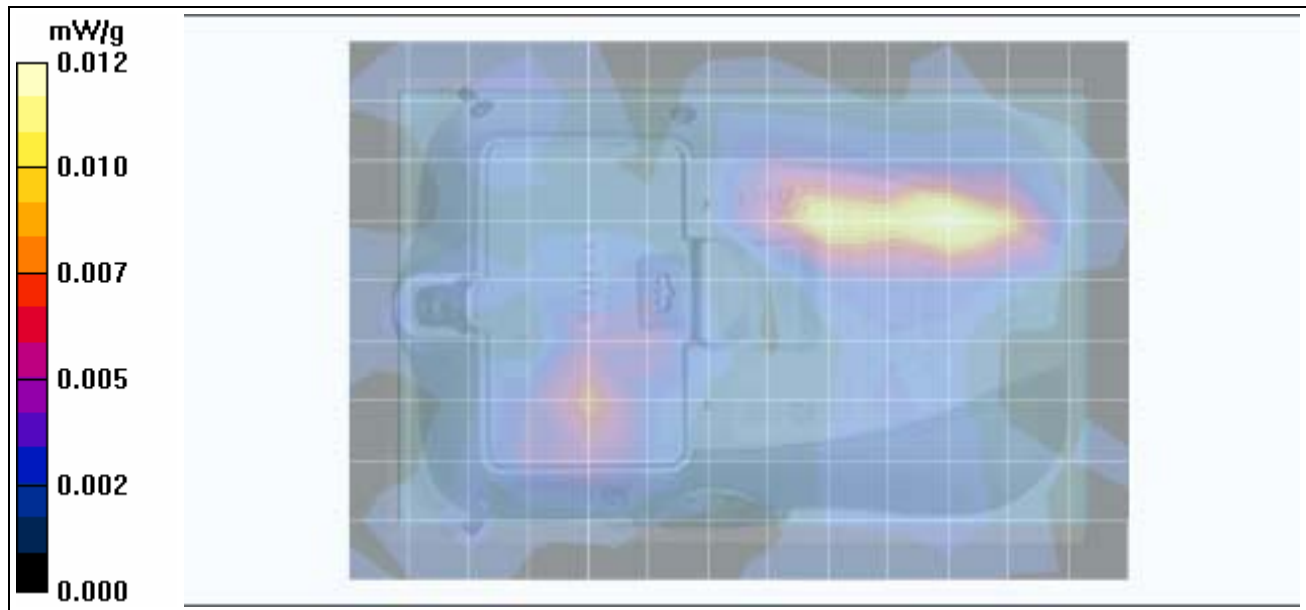
Body-Worn Accessory: None; Audio Accessory: None (not applicable)


Ambient Temp: 23.8 °C; Fluid Temp: 23.0 °C; Barometric Pressure: 97.9 kPa; Humidity: 30%

Communication System: DSSS WLAN
 RF Output Power: 20.0 dBm (Conducted)
 7.4 VDC Li-ion Battery Pack (P/N: CT17497-1)
 Frequency: 2412 MHz; Channel 1; Duty Cycle: 1:1
 Medium: M2450 ($\sigma = 1.86 \text{ mho/m}$; $\epsilon_r = 50.3$; $\rho = 1000 \text{ kg/m}^3$)

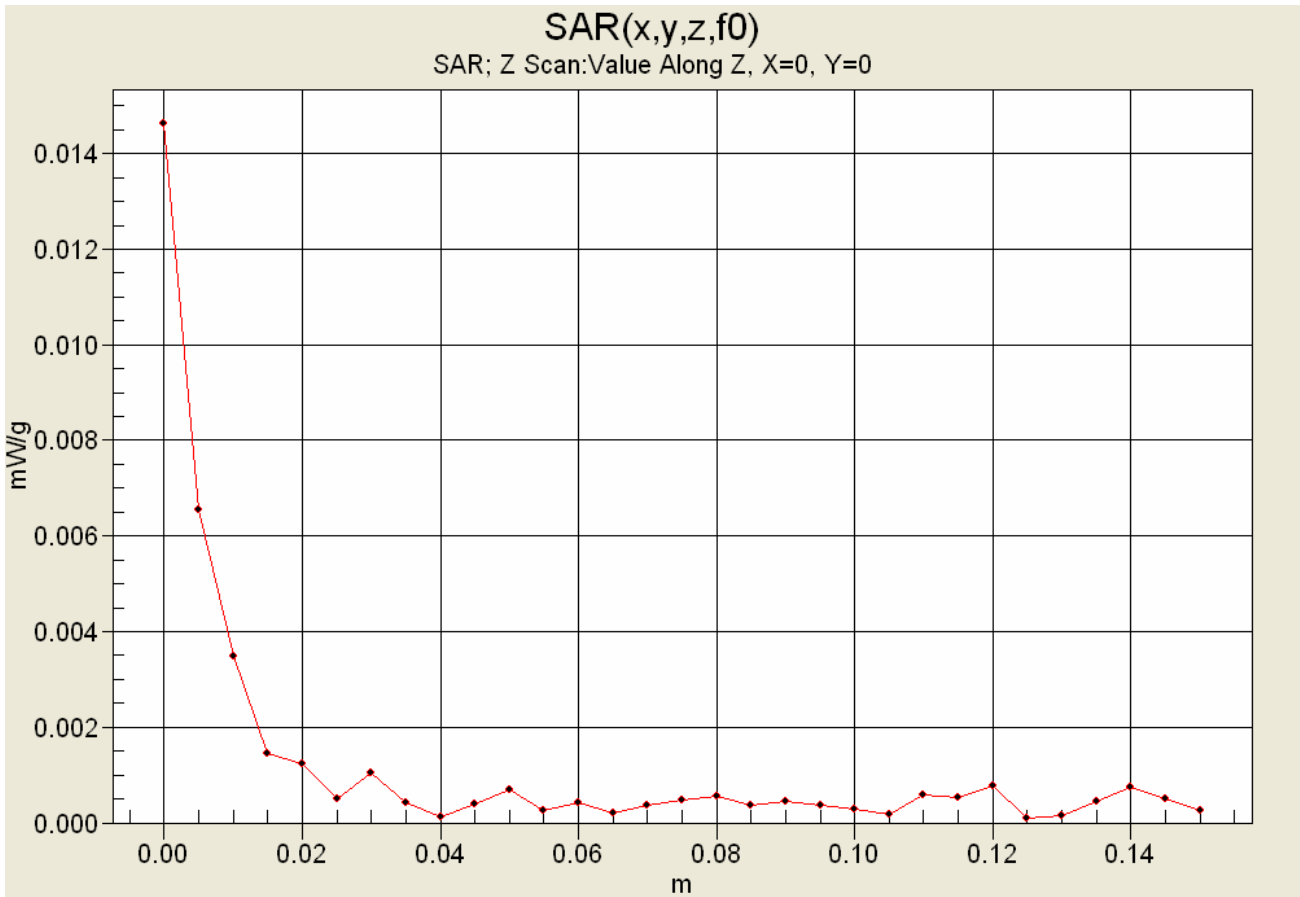
- Probe: ET3DV6 - SN1590; ConvF(4.22, 4.22, 4.22); Calibrated: 20/05/2005
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 15/06/2005
- Phantom: Barski Industries; Type: Fiberglas Planar; Serial: 03-01
- Measurement SW: DASY4, V4.6 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 159

Body-Worn - Back Side of DUT Touching Planar Phantom - Low Channel Area Scan (10x14x1): Measurement grid: dx=15mm, dy=15mm
Maximum Peak Value of SAR (measured) = 0.011527 mW/g




Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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Z-Axis Scan





Fluid Depth (≥ 15 cm)



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	Description of Test(s):	RF Exposure SAR	FCC 47 CFR §2.1093	IC RSS-102 Issue 2

APPENDIX B - SYSTEM PERFORMANCE CHECK DATA

Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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	Test Report Serial No.:	021506I28-T722-S15W	Report Issue No.:	S722-022206-R0
	Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
	Description of Test(s):	RF Exposure SAR	FCC 47 CFR §2.1093	IC RSS-102 Issue 2

Date Tested: 02/20/2006

System Performance Check (Body) - 2450 MHz Dipole

DUT: Dipole 2450 MHz; Model: D2450V2; Type: System Performance Check; Serial: 150; Calibrated: 04/22/2005

Ambient Temp: 23.0 °C; Fluid Temp: 23.0 °C; Barometric Pressure: 98.0 kPa; Humidity: 30%

Communication System: CW

Forward Conducted Power: 250 mW

Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: M2450 ($\sigma = 1.86 \text{ mho/m}$; $\epsilon_r = 50.3$; $\rho = 1000 \text{ kg/m}^3$)

- Probe: ET3DV6 - SN1590; ConvF(4.22, 4.22, 4.22); Calibrated: 20/05/2005
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn353; Calibrated: 15/06/2005
- Phantom: Barski Industries; Type: Fiberglass Planar; Serial: 03-01
- Measurement SW: DASY4, V4.6 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 159

2450 MHz Dipole - System Performance Check/Area Scan (6x10x1):

Measurement grid: dx=10mm, dy=10mm

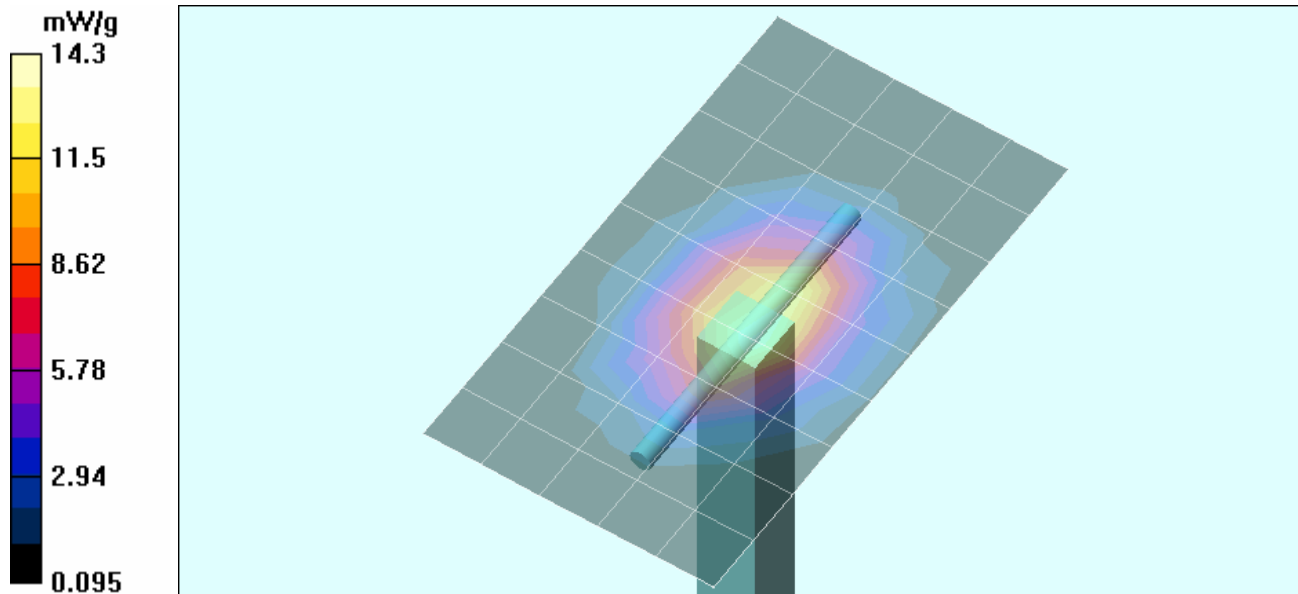
2450 MHz Dipole - System Performance Check/Zoom Scan (7x7x7)/Cube 0:


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

Reference Value = 89.0 V/m; Power Drift = 0.062 dB

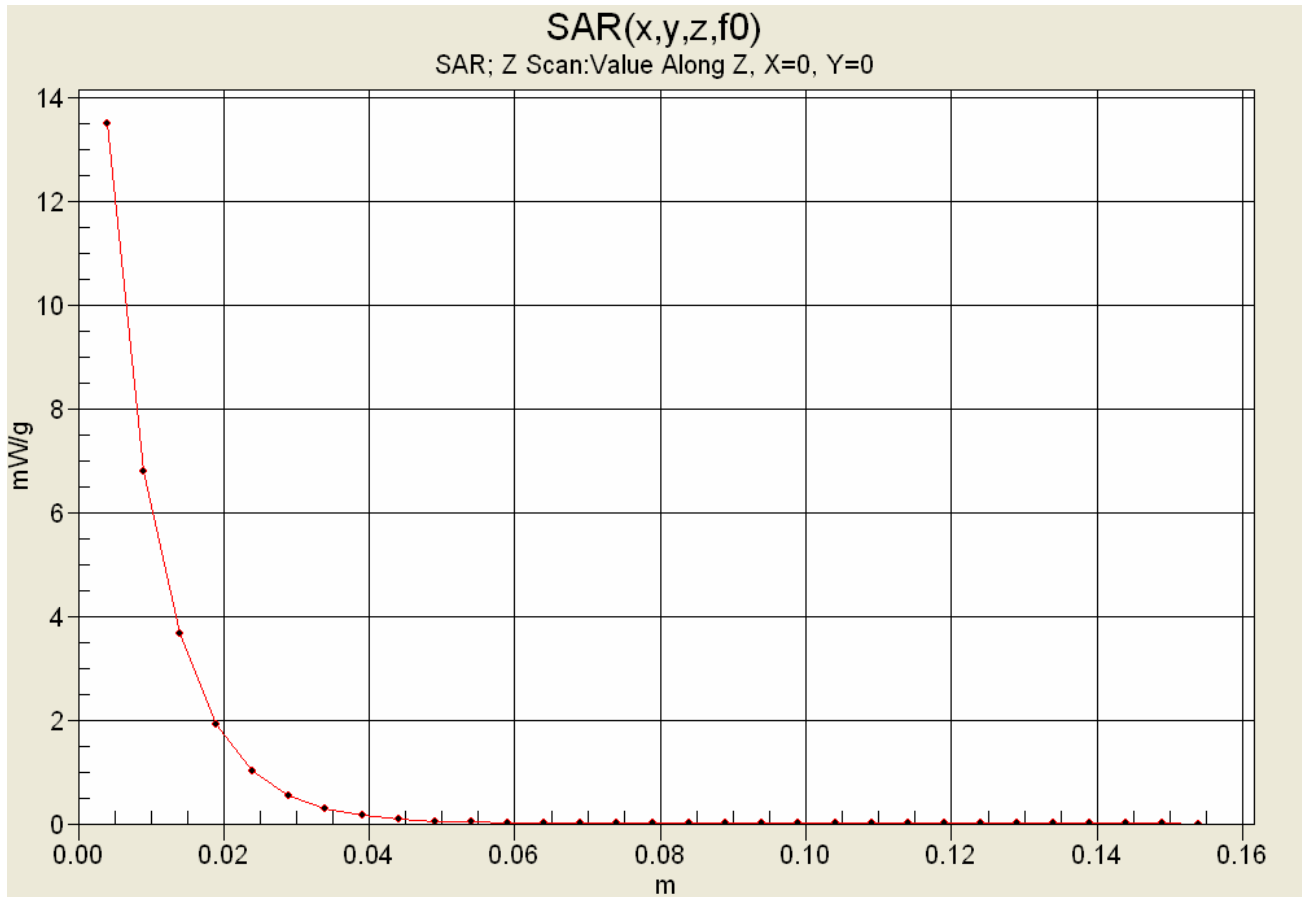
Peak SAR (extrapolated) = 28.7 W/kg


SAR(1 g) = 12.8 mW/g; SAR(10 g) = 5.84 mW/g




Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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Z-Axis Scan



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	Description of Test(s):	RF Exposure	SAR	FCC 47 CFR §2.1093

APPENDIX C - MEASURED FLUID DIELECTRIC PARAMETERS

Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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Description of Test(s):	RF Exposure	SAR	FCC 47 CFR §2.1093
			IC RSS-102 Issue 2


2450 MHz System Performance Check & DUT Evaluation (Body)

Celltech Labs Inc.
 Test Result for UIM Dielectric Parameter
 Mon 20/Feb/2006
 Frequency(GHz)

FCC_eHFCC Bulletin 65 Supplement C (June 2001) Limits for Head Epsilon
 FCC_sHFCC Bulletin 65 Supplement C (June 2001) Limits for Head Sigma
 FCC_eB FCC Limits for Body Epsilon
 FCC_sB FCC Limits for Body Sigma
 Test_e Epsilon of UIM
 Test_s Sigma of UIM

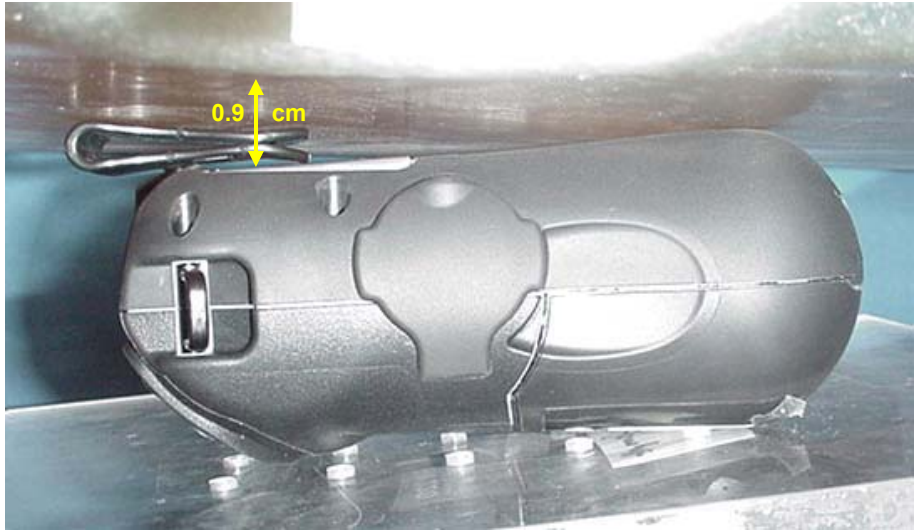
Freq	FCC_eB	FCC_sB	Test_e	Test_s
2.3500	52.83	1.85	50.49	1.77
2.3600	52.82	1.86	50.49	1.78
2.3700	52.81	1.87	50.42	1.79
2.3800	52.79	1.88	50.46	1.80
2.3900	52.78	1.89	50.43	1.80
2.4000	52.77	1.90	50.39	1.81
2.4100	52.75	1.91	50.34	1.81
2.4200	52.74	1.92	50.29	1.83
2.4300	52.73	1.93	50.35	1.84
2.4400	52.71	1.94	50.38	1.85
2.4500	52.70	1.95	50.32	1.86
2.4600	52.69	1.96	50.21	1.87
2.4700	52.67	1.98	50.25	1.90
2.4800	52.66	1.99	50.07	1.89
2.4900	52.65	2.01	50.05	1.92
2.5000	52.64	2.02	49.87	1.93
2.5100	52.62	2.04	50.06	1.95
2.5200	52.61	2.05	49.89	1.96
2.5300	52.60	2.06	50.01	1.97
2.5400	52.59	2.08	49.86	1.98
2.5500	52.57	2.09	49.79	1.97

Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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	Test Report Serial No.:	021506I28-T722-S15W	Report Issue No.:	S722-022206-R0
	Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
	Description of Test(s):	RF Exposure SAR	FCC 47 CFR §2.1093	IC RSS-102 Issue 2

APPENDIX D - SAR TEST SETUP PHOTOGRAPHS

BODY-WORN SAR TEST SETUP PHOTOGRAPHS
Back Side of DUT (Battery Side) with Plastic Belt-Clip Touching Planar Phantom



BODY-WORN SAR TEST SETUP PHOTOGRAPHS
Back Side of DUT (Battery Side) Touching Planar Phantom



DUT PHOTOGRAPHS



Top Side of DUT (LCD Side)



Bottom Side of DUT



Front Side of DUT (Antenna/Printer Side)



Back Side of DUT (Battery Side) with Plastic Belt-Clip Accessory



Back Side of DUT (Battery Side) without Belt-Clip Accessory

DUT PHOTOGRAPHS



Left Side of DUT



Right Side DUT

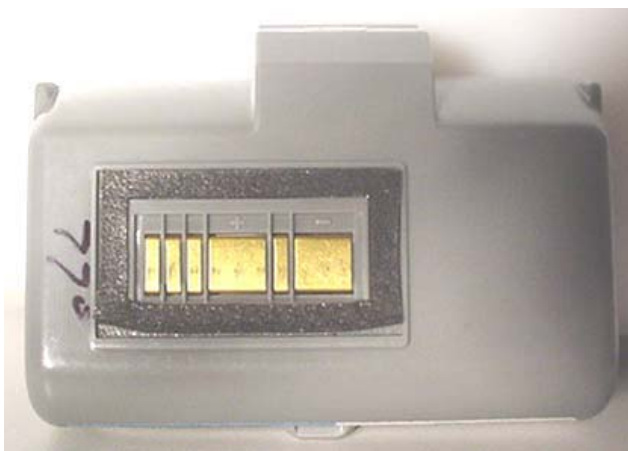
DUT PHOTOGRAPHS



Back Side of DUT - Battery Compartment




DUT Printer Cover Open




7.4V Lithium-ion Battery Pack (P/N: CT17497-1)



7.4V Lithium-ion Battery Pack (P/N: CT17497-1)

	Test Report Serial No.:	021506I28-T722-S15W	Report Issue No.:	S722-022206-R0
	Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
	Description of Test(s):	RF Exposure SAR	FCC 47 CFR §2.1093	IC RSS-102 Issue 2

APPENDIX E - SYSTEM VALIDATION

Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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2450 MHz SYSTEM VALIDATION DIPOLE

Type:

2450 MHz Validation Dipole

Serial Number:

150

Place of Calibration:

Celltech Labs Inc.

Date of Calibration:

April 22, 2005

Celltech Labs Inc. hereby certifies that this device has been calibrated on the date indicated above.

Calibrated by:



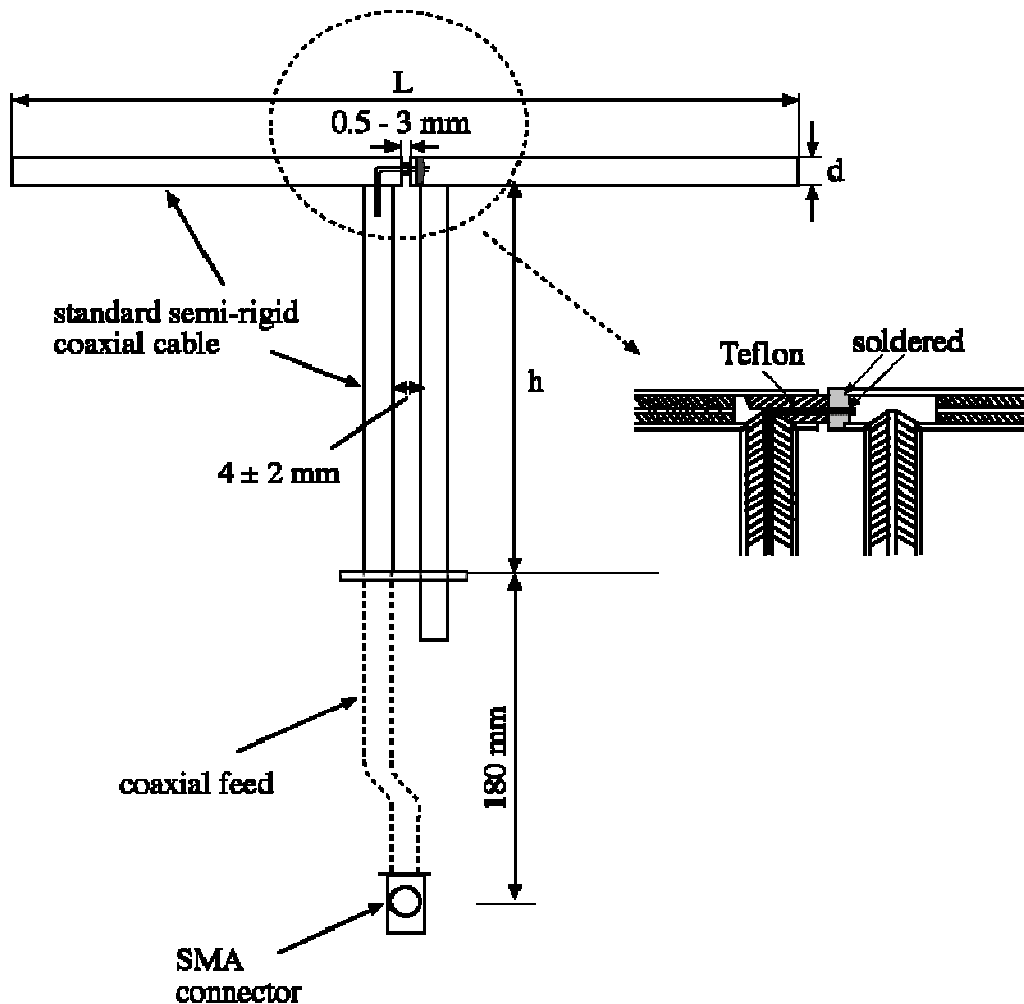
Approved by:



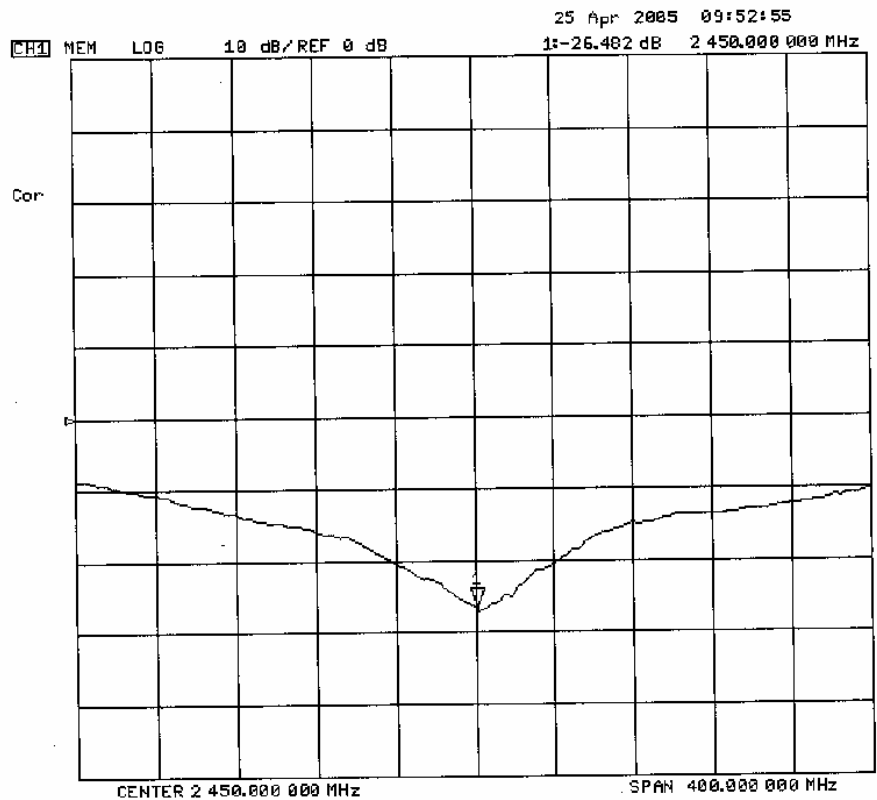
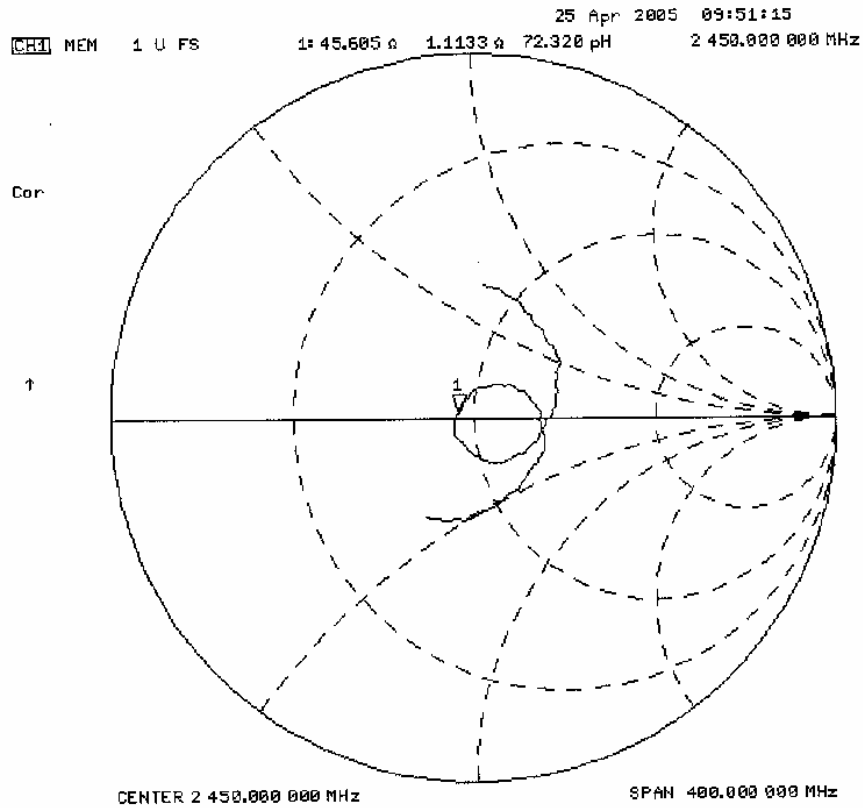
1. Dipole Construction & Electrical Characteristics

The validation dipole was constructed in accordance with the IEEE Std “Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”. The electrical properties were measured using an HP 8753E Network Analyzer. The network analyzer was calibrated to the validation dipole N-type connector feed point using an HP85032E Type N calibration kit. The dipole was placed parallel to a planar phantom at a separation distance of 10.0mm from the simulating fluid using a loss-less dielectric spacer. The measured input impedance is:

Feed point impedance at 2450 MHz	$Re\{Z\} = 45.605\Omega$
	$Im\{Z\} = 1.1133\Omega$
Return Loss at 2450 MHz	-26.482 dB



2. Validation Dipole VSWR Data



3. Validation Dipole Dimensions

Frequency (MHz)	L (mm)	H (mm)	D (mm)
300	420.0	250.0	6.2
450	288.0	167.0	6.2
835	161.0	89.8	3.6
900	149.0	83.3	3.6
1450	89.1	51.7	3.6
1800	72.0	41.7	3.6
1900	68.0	39.5	3.6
2000	64.5	37.5	3.6
2450	51.8	30.6	3.6
3000	41.5	25.0	3.6

4. Validation Phantom

The validation phantom is a Fiberglass shell planar phantom manufactured by Barski Industries Ltd. The phantom is in conformance with the requirements defined by IEEE SCC34-SC2 for the dosimetric evaluations of body-worn and lap-held operating configurations. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids.

Shell Thickness: 2.0 ± 0.2 mm
Filling Volume: Approx. 55 liters
Dimensions: 44 cm (W) x 94 cm (L)

5. 2450 MHz System Validation Setup



6. 2450 MHz Dipole Setup



7. Measurement Conditions

The phantom was filled with 2450 MHz Body simulating tissue:

Relative Permittivity: 50.2
 Conductivity: 1.97 mho/m
 Fluid Temperature: 23.9 °C
 Fluid Depth: ≥ 15.0 cm

Environmental Conditions:

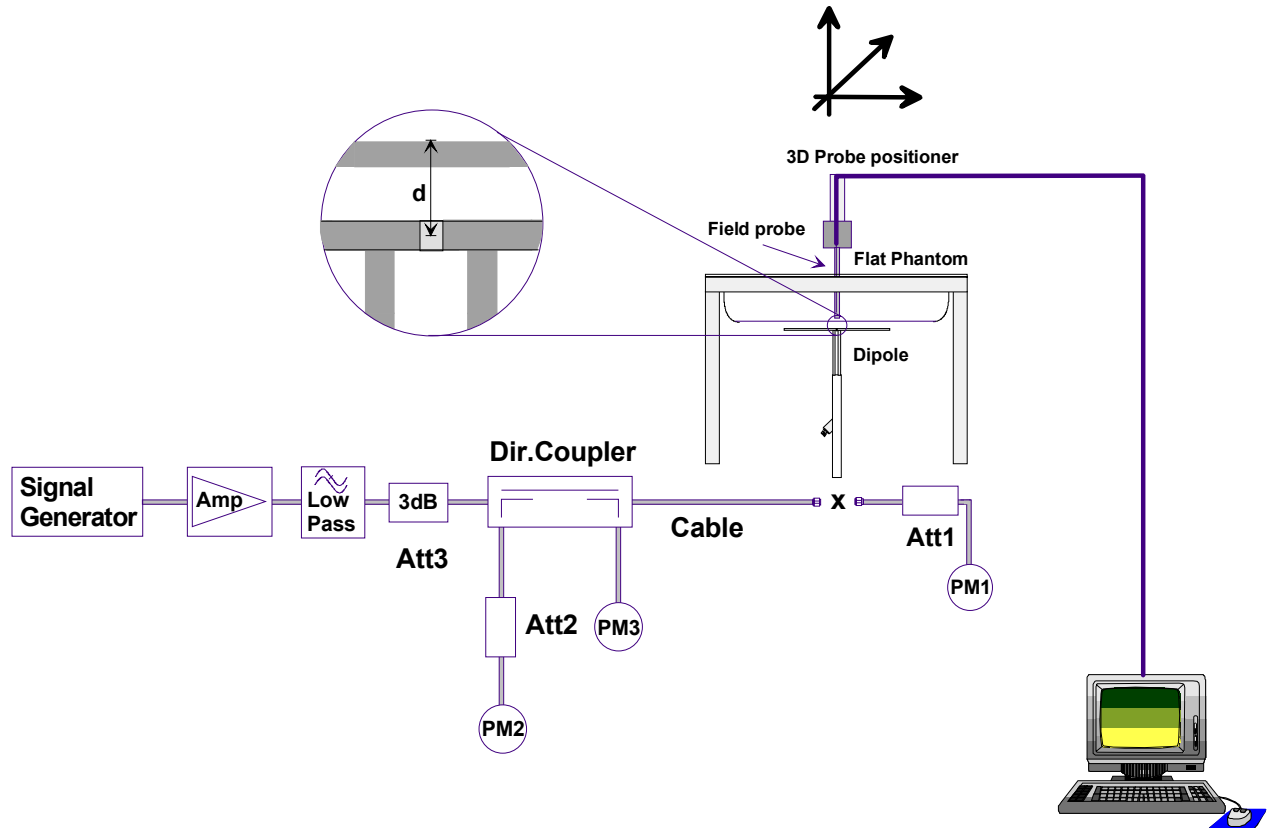
Ambient Temperature: 25.7 °C
 Humidity: 30 %
 Barometric Pressure: 102.6 kPa

The 2450 MHz simulated Body tissue mixture consists of the following ingredients:

Ingredient	Percentage by weight
Water	69.98%
Glycol Monobutyl	30.00%
Salt	0.02%
Target Dielectric Parameters at 22°C	$\epsilon_r = 52.7 (+/-5\%)$ $\sigma = 1.95 \text{ S/m } (+/-5\%)$

8. SAR Measurement

The SAR measurement was performed with the E-field probe in mechanical detection mode only. The setup and determination of the forward power into the dipole was performed using the following procedures.



First the power meter PM1 (including attenuator Att1) is connected to the cable to measure the forward power at the location of the dipole connector (X). The signal generator is adjusted for the desired forward power at the dipole connector (taking into account the attenuation of Att1) as read by power meter PM2. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter PM2. If the signal generator does not allow adjustment in 0.01dB steps, the remaining difference at PM2 must be taken into consideration. PM3 records the reflected power from the dipole to ensure that the value is not changed from the previous value. The reflected power should be 20dB below the forward power.

9. Validation Dipole SAR Test Results

Ten SAR measurements were performed in order to achieve repeatability and to establish an average target value.

Validation Measurement	SAR @ 0.25W Input averaged over 1g	SAR @ 1W Input averaged over 1g	SAR @ 0.25W Input averaged over 10g	SAR @ 1W Input averaged over 10g	Peak SAR @ 0.25W Input
Test 1	12.6	50.4	5.86	23.44	27.7
Test 2	12.6	50.4	5.86	23.44	27.4
Test 3	12.6	50.4	5.87	23.48	27.4
Test 4	12.6	50.4	5.86	23.44	27.3
Test 5	12.6	50.4	5.86	23.44	27.4
Test 6	12.6	50.4	5.87	23.48	27.8
Test 7	12.7	50.8	5.88	23.52	27.7
Test 8	12.7	50.8	5.88	23.52	27.8
Test 9	12.6	50.4	5.87	23.48	27.6
Test10	12.7	50.8	5.88	23.52	27.7
Average Value	12.63	50.52	5.869	23.48	27.58

The results have been normalized to 1W (forward power) into the dipole.

Target SAR @ 1 Watt Input averaged over 1 gram (W/kg)		Measured SAR @ 1 Watt Input averaged over 1 gram (W/kg)	Deviation from Target (%)	Target SAR @ 1 Watt Input averaged over 10 grams (W/kg)		Measured SAR @ 1 Watt Input averaged over 10 grams (W/kg)	Deviation from Target (%)
51.2	+/- 10%	50.52	- 1.3	23.7	+/- 10%	23.48	- 0.93

Dipole Type	Distance [mm]	Frequency [MHz]	SAR (1g) [W/kg]	SAR (10g) [W/kg]	SAR (peak) [W/kg]
D300V2	15	300	3.02	2.06	4.36
D450V2	15	450	5.01	3.36	7.22
D835V2	15	835	9.71	6.38	14.1
D900V2	15	900	11.1	7.17	16.3
D1450V2	10	1450	29.6	16.6	49.8
D1500V2	10	1500	30.8	17.1	52.1
D1640V2	10	1640	34.4	18.7	59.4
D1800V2	10	1800	38.5	20.3	67.5
D1900V2	10	1900	39.8	20.8	69.6
D2000V2	10	2000	40.9	21.2	71.5
D2450V2	10	2450	51.2	23.7	97.6
D3000V2	10	3000	61.9	24.8	136.7

Table 32.1: Numerical reference SAR values for SPEAG dipoles and flat phantom filled with body-tissue simulating liquid. Note: All SAR values normalized to 1 W forward power.

2450 MHz System Validation - April 22, 2005

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 150; Calibrated: 04/22/2005
Ambient Temp: 25.7 °C; Fluid Temp: 23.9 °C; Barometric Pressure: 102.6 kPa; Humidity: 30%
Communication System: CW
Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: M2450 Medium parameters used: $f = 2450$ MHz; $\sigma = 1.97$ mho/m; $\epsilon_r = 50.2$; $\rho = 1000$ kg/m³
- Probe: ET3DV6 - SN1590; ConvF(4.22, 4.22, 4.22); Calibrated: 24/05/2004
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn353; Calibrated: 06/07/2004
- Phantom: Barski Industries; Type: Fiberglass Planar; Serial: 03-01
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

2450 MHz System Validation/Area Scan (6x10x1): Measurement grid: dx=10mm, dy=10mm

2450 MHz System Validation/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 88.7 V/m; Power Drift = -0.010 dB
Peak SAR (extrapolated) = 27.7 W/kg
SAR(1 g) = 12.6 mW/g; SAR(10 g) = 5.86 mW/g

2450 MHz System Validation/Zoom Scan 2 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.1 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 27.4 W/kg
SAR(1 g) = 12.6 mW/g; SAR(10 g) = 5.86 mW/g

2450 MHz System Validation/Zoom Scan 3 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.0 V/m; Power Drift = 0.015 dB
Peak SAR (extrapolated) = 27.4 W/kg
SAR(1 g) = 12.6 mW/g; SAR(10 g) = 5.87 mW/g

2450 MHz System Validation/Zoom Scan 4 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.9 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 27.3 W/kg
SAR(1 g) = 12.6 mW/g; SAR(10 g) = 5.86 mW/g

2450 MHz System Validation/Zoom Scan 5 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.5 V/m; Power Drift = 0.010 dB
Peak SAR (extrapolated) = 27.4 W/kg
SAR(1 g) = 12.6 mW/g; SAR(10 g) = 5.86 mW/g

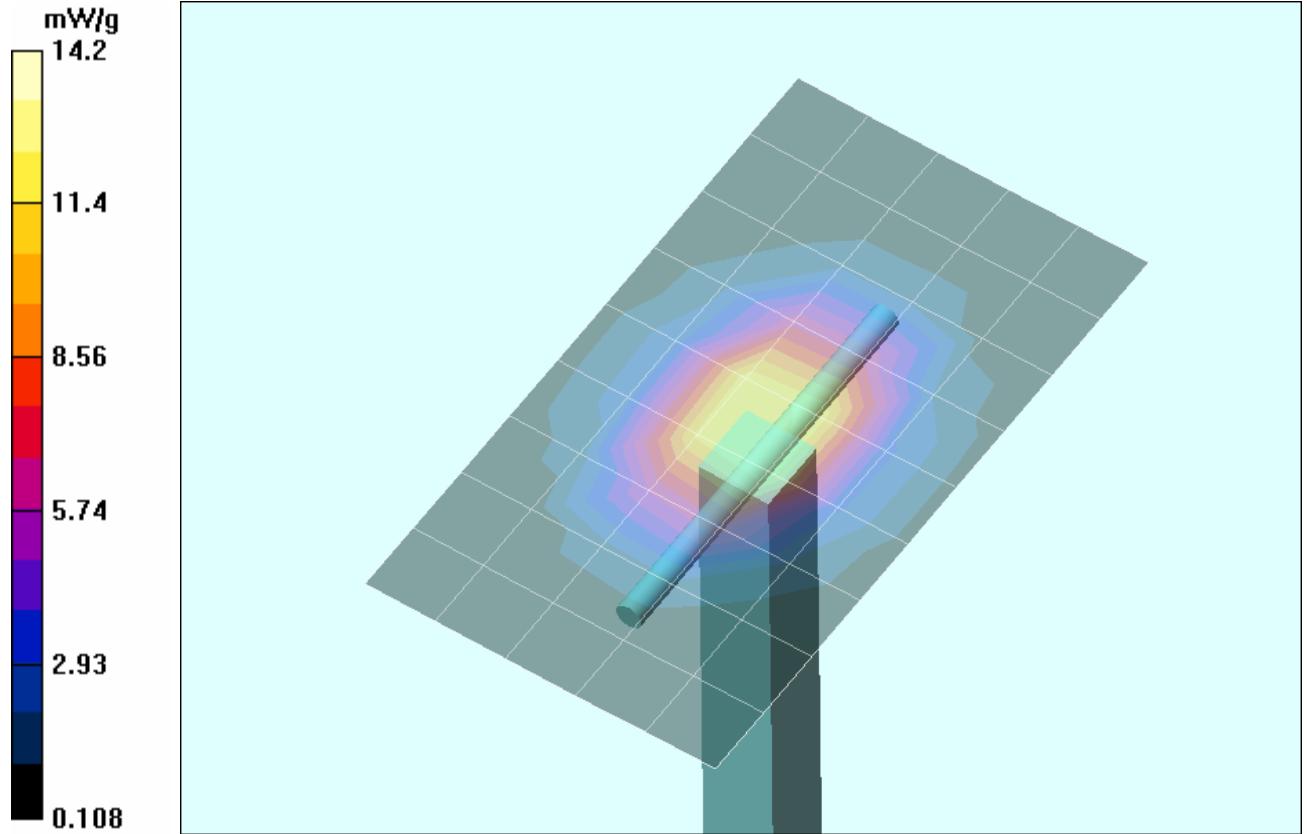
2450 MHz System Validation/Zoom Scan 6 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.0 V/m; Power Drift = -0.042 dB
Peak SAR (extrapolated) = 27.8 W/kg
SAR(1 g) = 12.6 mW/g; SAR(10 g) = 5.87 mW/g

2450 MHz System Validation/Zoom Scan 7 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.7 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 27.7 W/kg
SAR(1 g) = 12.7 mW/g; SAR(10 g) = 5.88 mW/g

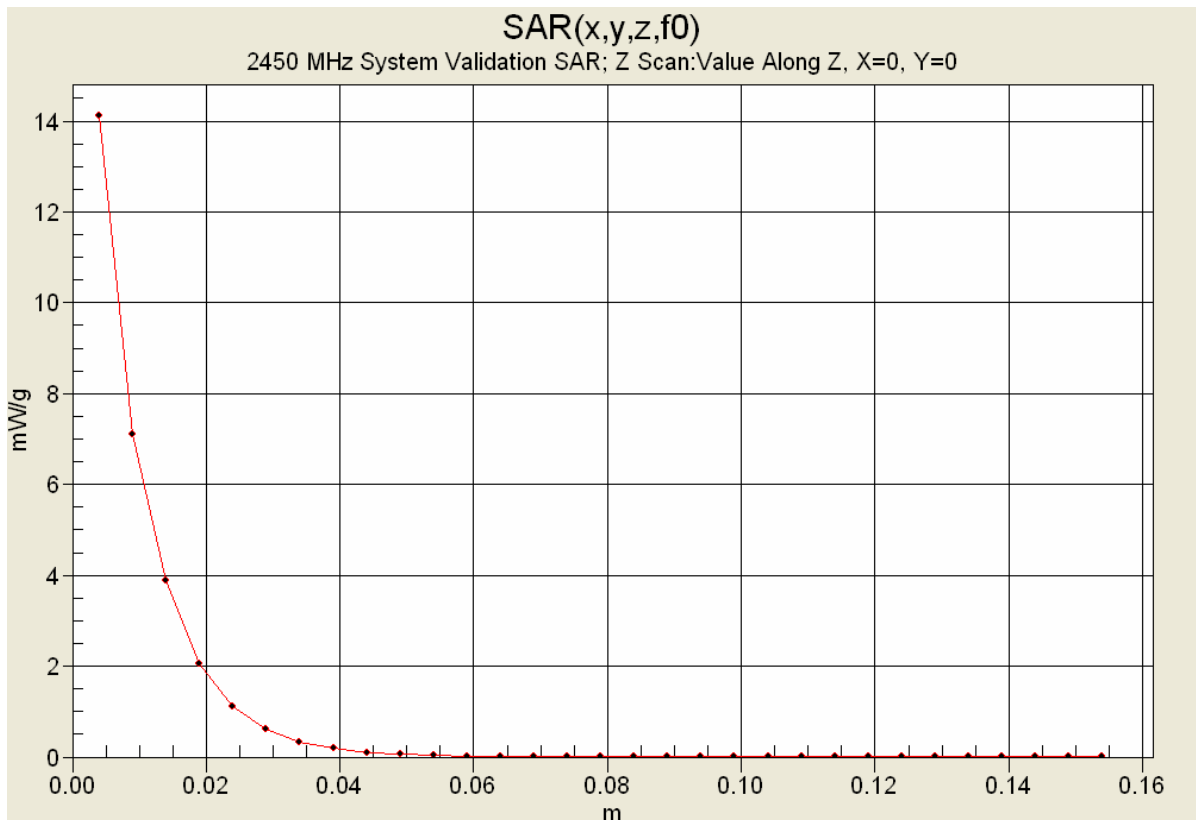
2450 MHz System Validation/Zoom Scan 8 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.4 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 27.8 W/kg
SAR(1 g) = 12.7 mW/g; SAR(10 g) = 5.88 mW/g

2450 MHz System Validation/Zoom Scan 9 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.3 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 27.6 W/kg
SAR(1 g) = 12.6 mW/g; SAR(10 g) = 5.87 mW/g

2450 MHz System Validation/Zoom Scan 10 (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 89.6 V/m; Power Drift = -0.025 dB
Peak SAR (extrapolated) = 27.7 W/kg
SAR(1 g) = 12.7 mW/g; SAR(10 g) = 5.88 mW/g



1 g average of 10 measurements: 12.63 mW/g
10 g average of 10 measurements: 5.869 mW/g




10. Measured Fluid Dielectric Parameters

System Validation - 2450 MHz Dipole


Measured Fluid Dielectric Parameters (Muscle)

April 22, 2005

Frequency	e'	e''
2.350000000 GHz	50.4884	14.1016
2.360000000 GHz	50.4542	14.1475
2.370000000 GHz	50.4295	14.1756
2.380000000 GHz	50.4094	14.2063
2.390000000 GHz	50.3750	14.2541
2.400000000 GHz	50.3395	14.2965
2.410000000 GHz	50.2961	14.3310
2.420000000 GHz	50.2408	14.3481
2.430000000 GHz	50.2047	14.3861
2.440000000 GHz	50.1822	14.4193
2.450000000 GHz	50.1500	14.4611
2.460000000 GHz	50.1035	14.5137
2.470000000 GHz	50.0825	14.5504
2.480000000 GHz	50.0515	14.6073
2.490000000 GHz	50.0191	14.6410
2.500000000 GHz	49.9867	14.6647
2.510000000 GHz	49.9442	14.7231
2.520000000 GHz	49.9042	14.7502
2.530000000 GHz	49.8769	14.7804
2.540000000 GHz	49.8259	14.8081
2.550000000 GHz	49.7900	14.8467

	Test Report Serial No.:	021506I28-T722-S15W	Report Issue No.:	S722-022206-R0
	Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
	Description of Test(s):	RF Exposure SAR	FCC 47 CFR §2.1093	IC RSS-102 Issue 2

APPENDIX F - PROBE CALIBRATION

Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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Accredited by the Swiss Federal Office of Metrology and Accreditation
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 **Celltech**

Certificate No: **ET3-1590_May05**

CALIBRATION CERTIFICATE

Object **ET3DV6 - SN:1590**

Calibration procedure(s) **QA CAL-01.v5
Calibration procedure for dosimetric E-field probes**

Calibration date: **May 20, 2005**

Condition of the calibrated item **In Tolerance**

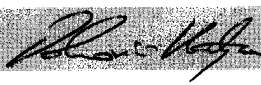
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

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 (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	3-May-05 (METAS, No. 251-00466)	May-06
Power sensor E4412A	MY41495277	3-May-05 (METAS, No. 251-00466)	May-06
Power sensor E4412A	MY41498087	3-May-05 (METAS, No. 251-00466)	May-06
Reference 3 dB Attenuator	SN: S5054 (3c)	10-Aug-04 (METAS, No. 251-00403)	Aug-05
Reference 20 dB Attenuator	SN: S5086 (20b)	3-May-05 (METAS, No. 251-00467)	May-06
Reference 30 dB Attenuator	SN: S5129 (30b)	10-Aug-04 (METAS, No. 251-00404)	Aug-05
Reference Probe ES3DV2	SN: 3013	7-Jan-05 (SPEAG, No. ES3-3013_Jan05)	Jan-06
DAE4	SN: 617	19-Jan-05 (SPEAG, No. DAE4-617_Jan05)	Jan-06
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (SPEAG, in house check Dec-03)	In house check: Dec-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-04)	In house check: Nov 05

Calibrated by: **Nico Vetterli** Function: **Laboratory Technician** Signature: 

Approved by: **Katja Pokovic** Technical Manager 

Issued: May 21, 2005

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



Accredited by the Swiss Federal Office of Metrology and Accreditation
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
ConF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
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
- CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz), July 2001

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 E^2 -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 (no uncertainty required). DCP does not depend on frequency nor media.
- 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 ET3DV6

SN:1590

Manufactured:	March 19, 2001
Last calibrated:	May 24, 2004
Recalibrated:	May 20, 2005

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ET3DV6 SN:1590

Sensitivity in Free Space^A

Diode Compression^B

NormX	1.82 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP X	87 mV
NormY	1.97 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP Y	87 mV
NormZ	1.70 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP Z	87 mV

Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 8.

Boundary Effect

TSL 900 MHz Typical SAR gradient: 5 % per mm

Sensor Center to Phantom Surface Distance		3.7 mm	4.7 mm
SAR _{be} [%]	Without Correction Algorithm	7.6	3.9
SAR _{be} [%]	With Correction Algorithm	0.1	0.2

TSL 1810 MHz Typical SAR gradient: 10 % per mm

Sensor Center to Phantom Surface Distance		3.7 mm	4.7 mm
SAR _{be} [%]	Without Correction Algorithm	11.8	8.3
SAR _{be} [%]	With Correction Algorithm	0.6	0.1

Sensor Offset

Probe Tip to Sensor Center **2.7 mm**

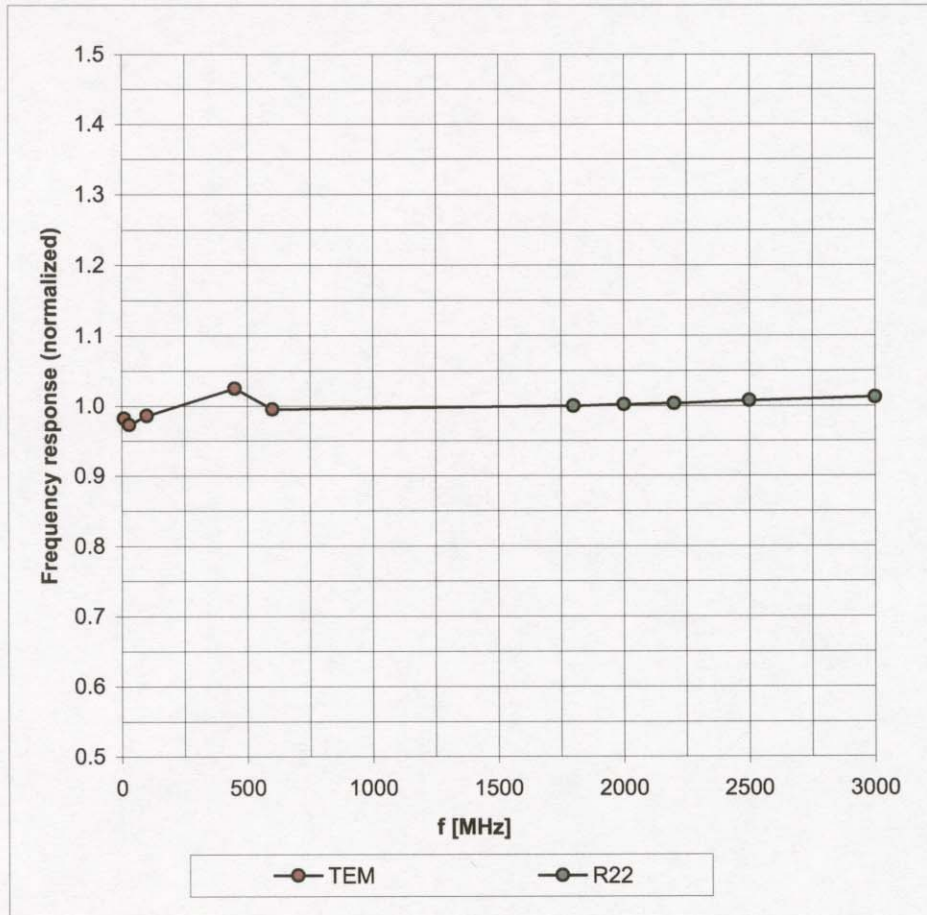
The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^A The uncertainties of NormX,Y,Z do not affect the E²-field uncertainty inside TSL (see Page 8).

^B Numerical linearization parameter: uncertainty not required.

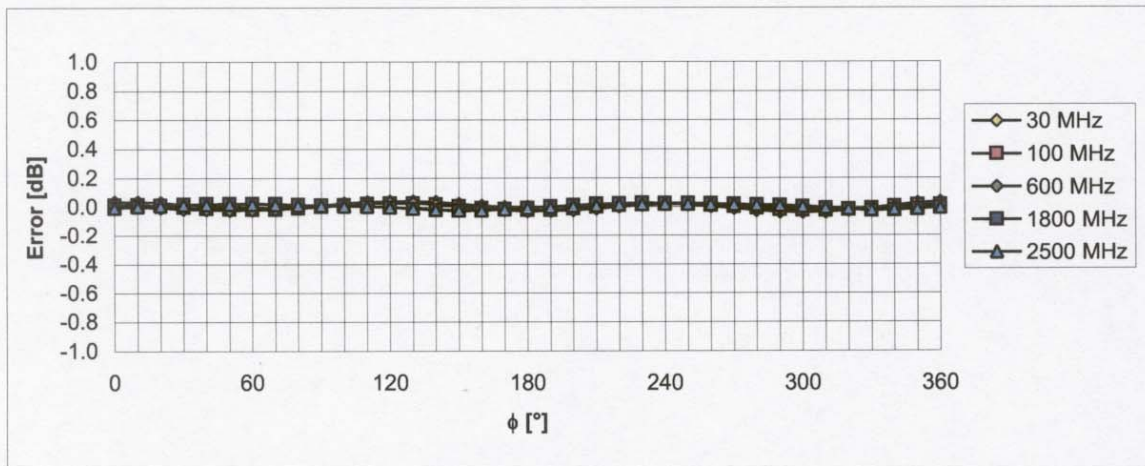
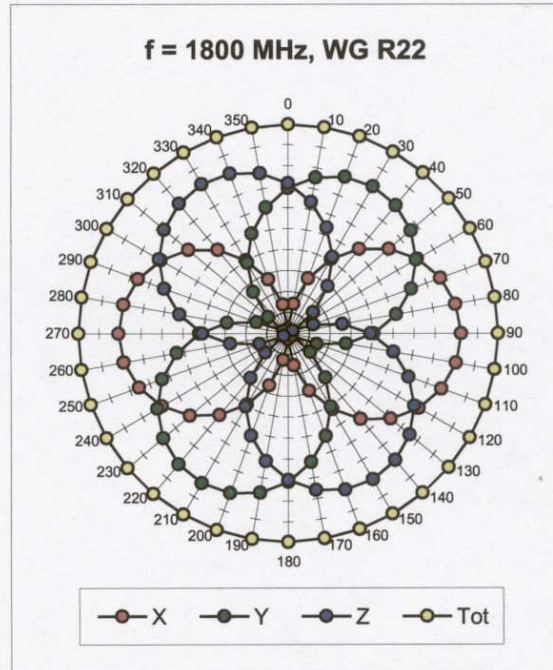
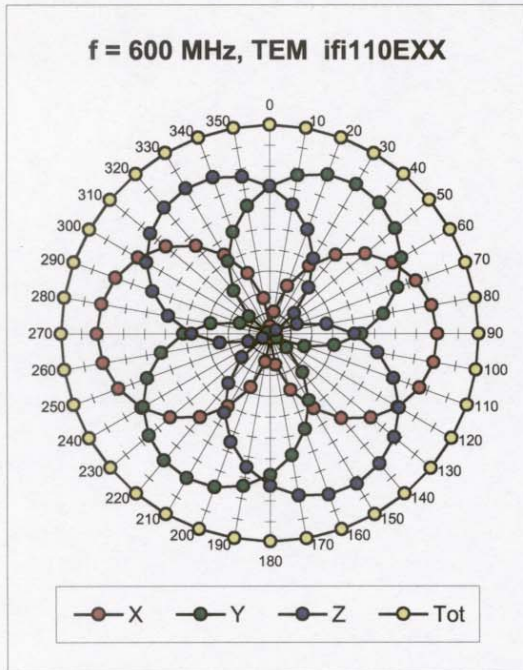
Frequency Response of E-Field

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



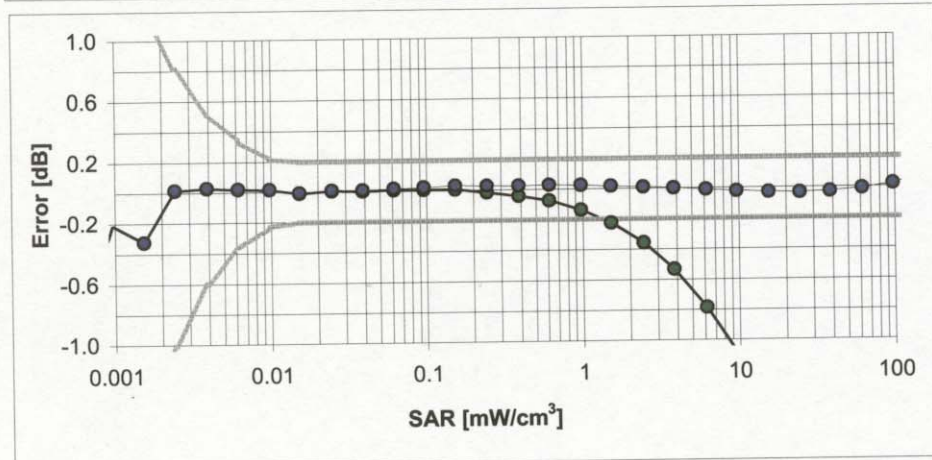
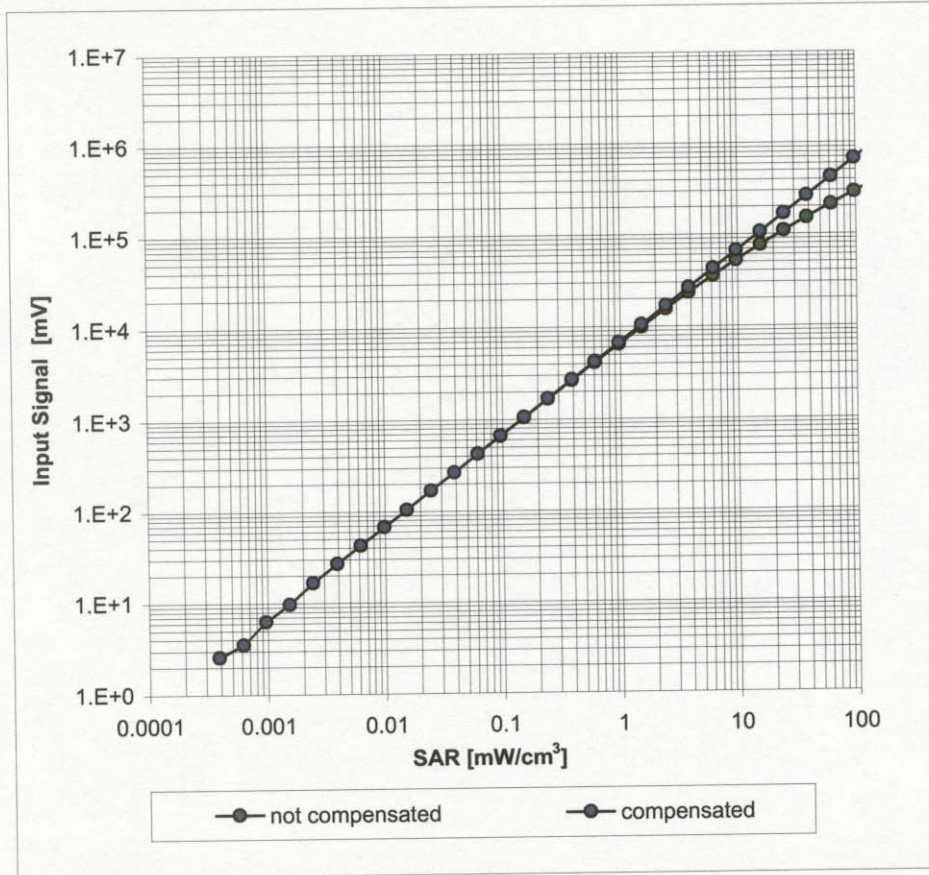
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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



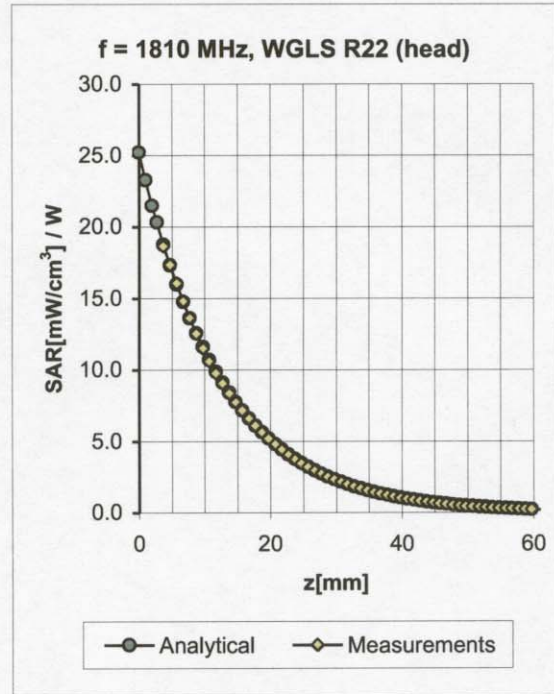
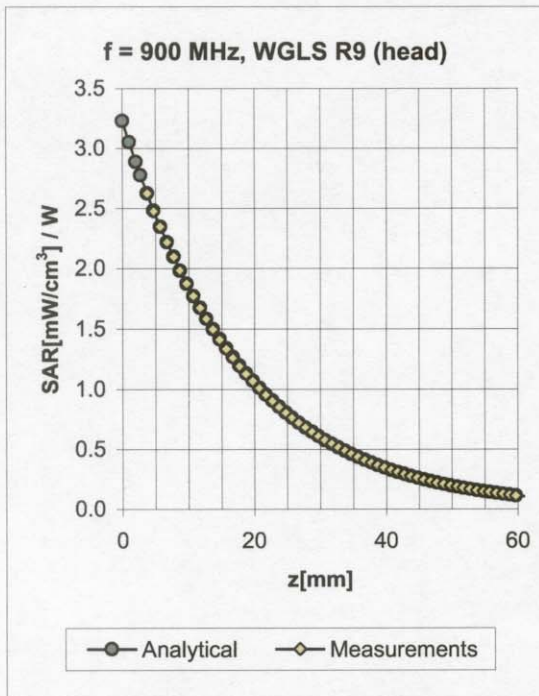
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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



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

Conversion Factor Assessment

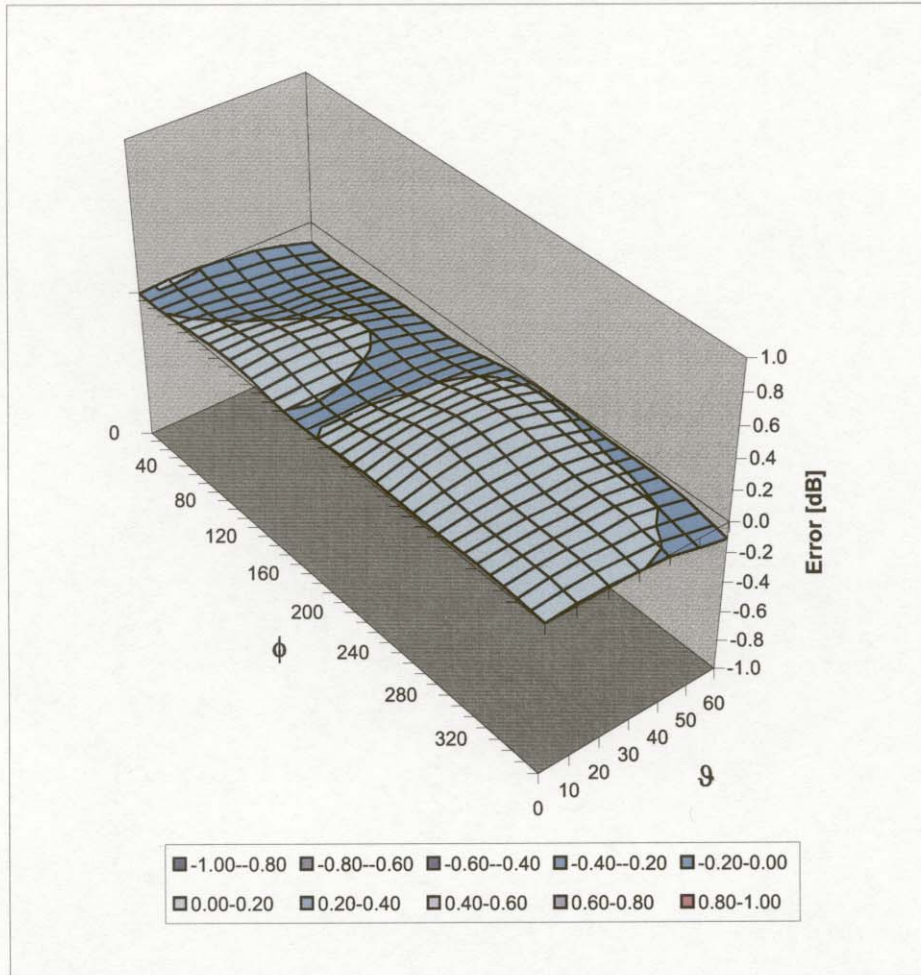


f [MHz]	Validity [MHz] ^c	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
900	± 50 / ± 100	Head	41.5 ± 5%	0.97 ± 5%	0.54	1.81	6.67 ± 11.0% (k=2)
1810	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.46	2.62	5.44 ± 11.0% (k=2)
2450	± 50 / ± 100	Head	39.2 ± 5%	1.80 ± 5%	0.50	2.53	4.56 ± 11.8% (k=2)
900	± 50 / ± 100	Body	55.0 ± 5%	1.05 ± 5%	0.46	2.09	6.47 ± 11.0% (k=2)
1810	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.44	3.00	4.85 ± 11.0% (k=2)
2450	± 50 / ± 100	Body	52.7 ± 5%	1.95 ± 5%	0.50	2.42	4.22 ± 11.8% (k=2)

^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.

Deviation from Isotropy in HSL

Error (ϕ, ϑ), $f = 900$ MHz



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ ($k=2$)

Additional Conversion Factors for Dosimetric E-Field Probe

Type:

ET3DV6

Serial Number:

1590

Place of Assessment:

Zurich

Date of Assessment:

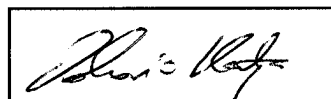
May 23, 2005

Probe Calibration Date:

May 20, 2005

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. Since the evaluation is coupled with measured conversion factors, it has to be recalculated yearly, i.e., following the re-calibration schedule of the probe. The uncertainty of the numerical assessment is based on the extrapolation from measured value at 900 MHz or at 1800 MHz.

Assessed by:



Dosimetric E-Field Probe ET3DV6 SN:1590


Conversion factor (\pm standard deviation)

f = 150 MHz	ConvF	9.1 \pm 10%	$\epsilon_r = 52.3 \pm 5\%$ $\sigma = 0.76 \pm 5\%$ mho/m (head tissue)
f = 300 MHz	ConvF	8.1 \pm 9%	$\epsilon_r = 45.3 \pm 5\%$ $\sigma = 0.87 \pm 5\%$ mho/m (head tissue)
f = 450 MHz	ConvF	7.8 \pm 8%	$\epsilon_r = 43.5 \pm 5\%$ $\sigma = 0.87 \pm 5\%$ mho/m (head tissue)
f = 150 MHz	ConvF	8.6 \pm 10%	$\epsilon_r = 61.9 \pm 5\%$ $\sigma = 0.80 \pm 5\%$ mho/m (body tissue)
f = 450 MHz	ConvF	7.7 \pm 8%	$\epsilon_r = 56.7 \pm 5\%$ $\sigma = 0.94 \pm 5\%$ mho/m (body tissue)


Important Note:

For numerically assessed probe conversion factors, parameters Alpha and Delta in the DASY software must have the following entries: Alpha = 0 and Delta = 1.

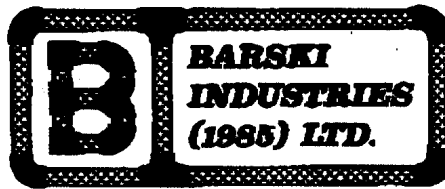
Please see also Section 4.7 of the DASY4 Manual.

	Test Report Serial No.:	021506I28-T722-S15W	Report Issue No.:	S722-022206-R0
	Date(s) of Evaluation:	February 20, 2006	Report Issue Date:	February 22, 2006
	Description of Test(s):	RF Exposure	SAR	FCC 47 CFR §2.1093

APPENDIX G - PLANAR PHANTOM CERTIFICATE OF CONFORMITY

Applicant:	Zebra Technologies Corporation	FCC ID:	I28MD-RW4137	IC ID:	3798A-RW4137	
Model(s):	RW220	Device Type:	Portable Printer with 802.11b WLAN	Freq.:	2412 - 2462 MHz	
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E-mail: barskiind@shaw.ca
Web: www.bcfiberglass.com

FIBERGLASS FABRICATORS

Certificate of Conformity

Item : Flat Planar Phantom Unit # 03-01
Date: June 16, 2003
Manufacturer: Barski Industries (1985 Ltd)

Test	Requirement	Details
Shape	Compliance to geometry according to drawing	Supplied CAD drawing
Material Thickness	Compliant with the requirements	2mm +/- 0.2mm in measurement area
Material Parameters	Dielectric parameters for required frequencies Based on Dow Chemical technical data	100 MHz-5 GHz Relative permittivity < 5 Loss Tangent < 0.05

Conformity

Based on the above information, we certify this product to be compliant to the requirements specified.

Signature: _____

A handwritten signature in black ink, appearing to read 'Daniel Chailer', is written over a horizontal line.

Daniel Chailer



Fiberglass Planar Phantom - Top View



Fiberglass Planar Phantom - Front View



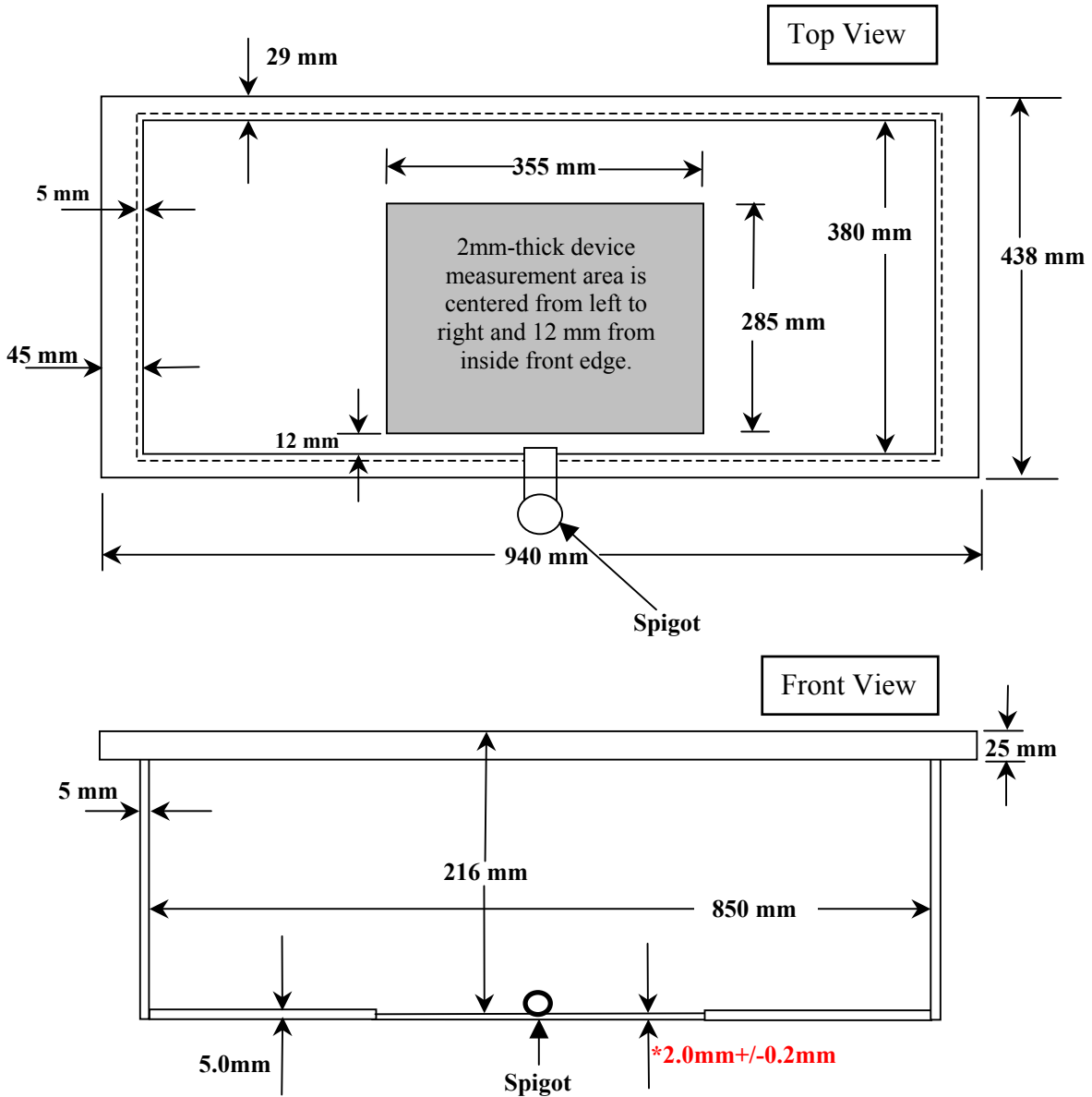
Fiberglass Planar Phantom - Back View



Fiberglass Planar Phantom - Bottom View

Dimensions of Fiberglass Planar Phantom

(Manufactured by Barski Industries Ltd. - Unit# 03-01)



**Note: Measurements that aren't repeated for the opposite sides are the same as the side measured.
This drawing is not to scale.**