MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*

914 WEST PATAPSCO AVENUE ! BALTIMORE, MARYLAND 21230-3432 ! PHONE (410) 354-3300 ! FAX (410) 354-3313

July 29, 2002

Novatel Wireless Technologies
Suite 200, 6715 - 8th Street NE
Calgary, AB T2E-7H7

Reference: Merlin G301 PCMCIA Card
FCC ID: NBZNRM-MG301

Dear Mr. Owen Thistle:

Enclosed is the EMC SAR Evaluation Report for the Novatel Wireless Technologies Merlin G301 PCMCIA Card. The Merlin G301 PCMCIA Card was tested in accordance with the measurement procedures specified in FCC OET 65 Supplement C:01-01 and shown to be capable to be in compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE Std. C95.1-1992.

Thank you for using the testing services of MET Laboratories. If you have any questions regarding these results or if MET can be of further assistance to you, please feel free to contact me. We appreciate your business and look forward to working with you again soon.

Kindest Regards,
MET LABORATORIES, INC.

Marianne Bosley

Marianne Bosley

Documentation Department

Enclosures: (\Novatel Wireless\EMC12352-FCCSAR.rpt)

DOCTEM-23 Jan 02

Dosimetric Assessment

Test Report

for the

Novatel Wireless Technologies
Merlin G301 PCMCIA Card

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

MET REPORT: **EMC12352-FCCSAR**

July 29, 2002

PREPARED FOR:

Novatel Wireless Technologies
Suite 200, 6715-8th Street NE
Calgary, AB, T2E-7H7

PREPARED BY:

MET Laboratories, Inc.
914 West Patapsco Avenue
Baltimore, Maryland 21230-3432

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Suite 200, 6715 - 8th Street NE
Calgary, AB, T2E 7H7

Report Prepared By: **Report Reviewed By:**

Marianne T. Bosley
EMC ADMINISTRATOR

Asad Bajwa
TEST ENGINEER

Final Review By:

CHRISTOPHER R. HARVEY
EMC LAB DIRECTOR

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.

CHRISTOPHER R. HARVEY
EMC LAB DIRECTOR

SAR EVALUATION
CERTIFICATE OF COMPLIANCE

FCC ID: NBZNRM-MG301
APPLICANT: Novatel Wireless Technologies

APPLICANT NAME AND ADDRESS:		**DATE OF TEST:**	June 14 , 2002
Novatel Wireless Technologies		**TEST LOCATION**:	MET LABORATORIES INC.
Suite 200, 6715-8th Street NE			914 West Patapsco Avenue
Calgary, AB, T2E-7H7			Baltimore, Maryland 21230

EUT:	GSM/GPRS PCS 1900 PCMCIA Card
Date of Receipt:	June 14, 2002
Device Category:	GSM/GPRS PCS 1900 PCMCIA Card
RF exposure environment:	Uncontrolled
Power supply:	Powered by PC
Antenna:	Detachable (Not operational without antenna)
Measured Standards:	PCS 1900
Modulation:	GMSK
Crest Factor:	GSM = 8
TX Range:	GSM PCS 1900 1850.2 MHz - 1909.8 MHz
RX Range:	GSM PCS 1900 1930.2 MHz - 1989.8 MHz
Used TX Channels:	GSM PCS 1900: low: ch.512, center: ch. 660, high: ch. 810
Maximum RF Power Output:	1.0 W EIRP GSM PCS 1900 (30 dBm)
Maximum SAR Measurement: (Averaged over 1g)	0.051 W/kg PCS GSM Body

This wireless portable device has been tested in accordance with the measurement procedures specified in FCC/OET Bulletin 65 Supplement C (2001) and IEEE Std. 1528-200X (July 2001), and has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE Std. C95.1 - 1992.

I attest to the accuracy of this data. All reported 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..

I also certify that no party to this application has been denied the FCC benefits pursuant to Section 5.301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 862.

Chris Harvey
Director, EMC Laboratory

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List of Terms and Abbreviations

AC	**Al**ternating **C**urrent
ANSI	American National Standards Institute
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**De**ci**b**els
dBFA	**De**ci**b**els above one **micro**amp
dBFV	**De**ci**b**els above one **micro**volt
dBFA/m	**De**ci**b**els above one **micro**amp **per m**eter
dBFV/m	**De**ci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
CISPR	**C**omite **I**nternational **S**pecial des **P**erturbations **R**adioelectriques (International Special Committee on Radio Interference)
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
Hz	**H**ert**z**
IEC	**International Electrotechnical Commission**
IEEE	**Institute for Electrical and Electronic Engineers**
kHz	**k**ilo**h**ert**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
MPE	**Maximum Permissible Exposure**
F**H**	**microh**enry
F**F**	**microf**arad
Fs	**micros**econds
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
SAR	**S**pecific **A**bsorption **R**ate
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter

I. Objective

The Merlin G301 PCMCIA Card is a Type II PC card GSM/GPRS (Global System for Mobil communications/General Packet Radio System) wireless modem from Novatel Wireless Technologies that operates in the 900 MHz (GSM), 1800 MHz (DCS) and 1900 MHz (PCS) bands.

The objective of the procedure was to perform a dosimetric assessment of the PCMCIA card in the GSM 1900 standard. The measurements have been carried out with the dosimetric assessment system “SARA2", and were made according to the Supplement C to OET Bulletin 65 of the Federal Communications Commission (FCC) Guidelines [FCC 2001] for evaluating compliance of mobile and portable devices with FCC limits for human exposure in the general population to radio frequency emissions.

Figure 1: Photograph of the top of device under test

Figure 2: Photograph of bottom of device under test

Figure 3: Photograph of front view and attachments

II. Introduction

A. Exposure Criteria

In the United States, the most recent FCC RF exposure criteria is documented in the publication OET 65 Supplement C Edition 01-01 [FCC 2001] are based upon the IEEE Standard C95.1[IEEE1999], which sets limits for human exposure to radio frequency electromagnetic fields in the frequency range 3kHz to 300GHz.

B. Exposed Population, Duration of Exposure and Frequencies

According to the American Standard [IEEE 1999], controlled environments are locations where there is exposure
that may be incurred by persons who are aware of the potential for exposure; for example, as a hazard of employment. Uncontrolled environments are locations where there is the exposure of individuals who have no knowledge or control of their exposure. The exposures may occur in living quarters or workplaces. For exposure in controlled environments higher field strengths are admissible, and the duration of exposure is considered.

C. Maximum Permissible Exposure and SAR Limits

Specific absorption rate (SAR) is the biological relevant parameter describing the effects of electromagnetic fields in the frequency range of interest. It is a measure of the power absorbed per unit mass and may be spatially averaged over the total mass of an exposed body or its parts. The SAR is calculated from the r.m.s. electric field strength E inside the human body with the conductivity F and the mass density D of the biological tissue:

$$\text{SAR} = \frac{*E*^2\, F}{D}$$

It can be difficult to determine the SAR just by measurement (e.g. whole body averaged SAR), so the standard specifies maximum permissible exposures (MPE) in terms of external electric field strength, magnetic field strength, and power density, which is more readily measurable, derived from the SAR limits. The limits for these factors have been fixed so that even under worst case conditions, the SAR limits are not exceeded.

The MPE for the relevant frequency range may be exceeded if the exposure can be shown, by appropriate techniques, to produce SAR values below the corresponding limits.

D. SAR Limit

The comparison between the American exposure limits and the measured data is made using the spatial peak SAR. The power level of the device under test guarantees that the whole body averaged SAR is not exceeded.

The SAR limit is valid for uncontrolled environment and mobile, respectively portable transmitters. Table 1 shows the SAR values have to be averaged over a mass of 1g (SAR_{1g}) with the shape of a cube.

Standard	Status	SAR limit [W/kg]
OET 65 Supplement C Edition 01-01	In Force	1.6

Table 1. SAR Limit

III. FCC Measurement Procedure Requirements

A. FCC Measurement Procedure

The Federal Communications Commission (FCC) published a report and order in August 1996 [FCC 1996], requiring routine dosimetric assessment of mobile telecommunications devices prior to equipment authorization or use. In 2001 the Commission's Office of Engineering and Technology released Edition 01-01 of Supplement C to OET Bulletin 65. This edition replaced Edition 97-01, and provided additional guidance and information for evaluating compliance of mobile and portable devices with FCC limits for human exposure to radio frequency emissions [FCC 2001].

B. General Requirements

Body-worn and Other Configurations

a. Phantom Requirements - A flat phantom shall be used for body-worn configurations. The phantom shall consist of material with electrical properties similar to the corresponding tissues.

b. Test Position - The body-worn configurations shall be tested with the supplied accessories (belt-clips, holsters, etc.) attached to the device in normal use configuration. Devices with a headset output shall be tested with a connected headset.

c. Test To Be Performed - In order to determine test requirements, accessories shall be divided into two categories: those that do contain metallic components, and those that do not.

For multiple accessories that do not contain metallic components, the device may be tested only with that accessory which provides the closest spacing to the body.

For multiple accessories that contain metallic components, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component, only the accessory that provides the closest spacing to the body must be tested.

If there are no body-worn accessories, a separation distance of 1.5 cm between the back of the device and the flat phantom is recommended. Other separation distances may be used, but they shall not exceed 2.5 cm. In these cases, the device may use body-worn accessories that provide a separation distance greater than that tested for the device, provided the accessory contains no metallic components.

The SAR test shall be performed with the antenna fully extended and retracted for devices with retractable antenna. All factors that may affect the exposure shall also be tested; i.e. optional antennas or optional battery packs which may significantly change the volume, lengths, flip open/closed, etc. of the device, or any other accessories which might have the potential to considerably increase the peak spatial-average SAR value.

The SAR test shall be performed at the high, middle and low frequency channels of each operating mode. However, if the SAR measured at the middle channel for each test configuration is at least 2.0 dB lower than the SAR limit, testing at the high and low channels is optional.

IV Measurement System Used

A. Measurement System - SARA2 System Specification

The SAR measurement system being used is the IndexSAR SARA2 system, which consists of a Mitsubishi RV-E2 6-axis robot arm and controller, IndexSAR probe and amplifier and SAM phantom Head Shape. The robot is used to articulate the probe to programmed positions inside the phantom head to obtain the SAR readings from the EUT.

The system is controlled remotely from a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans.

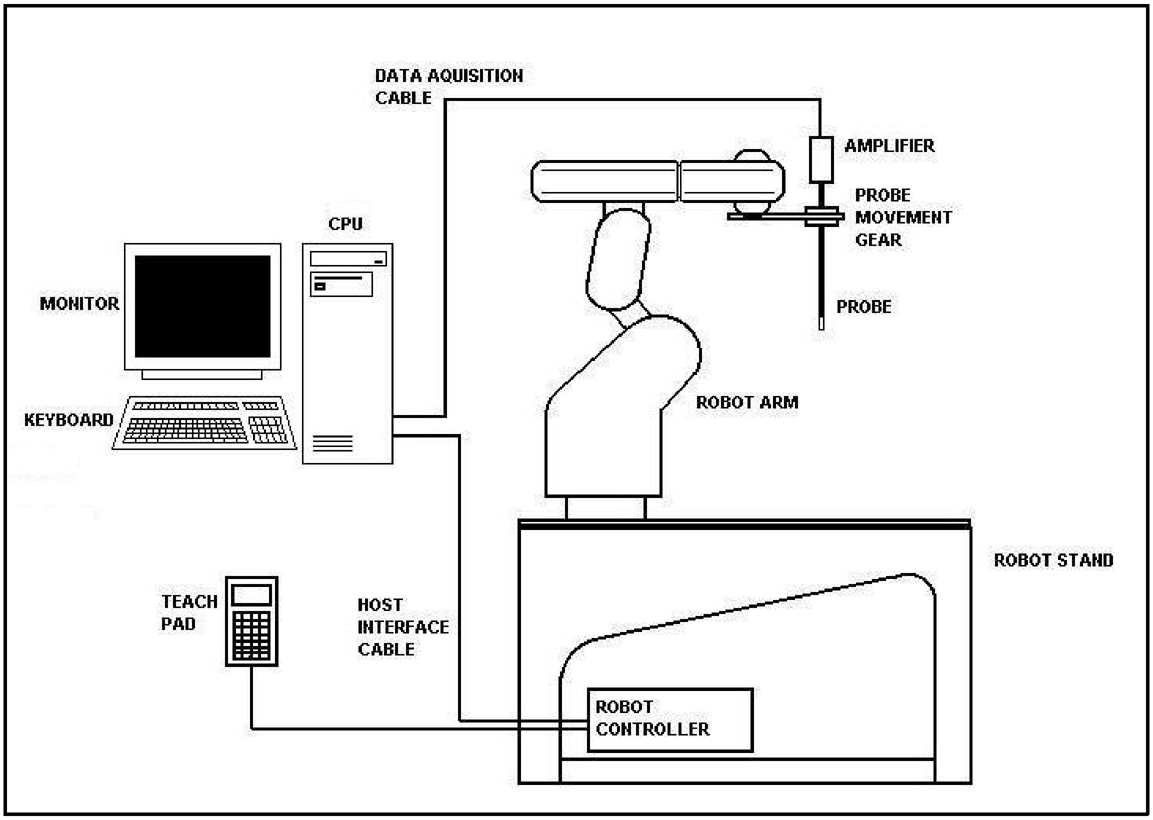


Figure 4. Block Diagram of SARA 2 System

The position and digitized shape of the phantom heads/flat baths are made available to the software for accurate positioning of the probe and reduction of set-up time.

The SAM phantom heads/flat baths are individually digitized using a Mitutoyo CMM machine to a precision of 0.001mm. The data is then converted into a shape format for the software, providing an accurate description of the phantom shell.

In operation, the system first performs an area (2D) scan at a fixed depth within the liquid from the inside wall of the phantom. When the maximum SAR point has been found, the system will then carry out a 3D scan centred at that point to determine volume averaged SAR level.

Robot/Controller:

Model	Mitsibishi Movemaster RV-2E 6 Axis Robot
Repeatability	+/-0.04mm
Speed	Up to 3500 mm/sec

Data Acquisition (Minimum requirements):

Processor	Pentium III
Clock Speed	700MHz
Operating System	Windows 98 or 2000
I/O	Two RS232, or One RS232 and One USB
Software	SARA2 Ver.xx, IXU-010X Utility Software Ver.xx, Microsoft Excel
Memory	10GB Hard drive, CDROM

IXP-050 IndexSAR isotropic immersible SAR probe

The probes are constructed using three orthogonal dipole sensors arranged on an interlocking, triangular prism core. The probes have built-in shielding against static charges and are contained within a PEEK cylindrical enclosure material at the tip. Probe calibration is described in the Calibration report appendix.

IXP-010 Amplifier

The amplifier unit has multi-pole connector to connect to the probe and a multiplexer selects between the 3-channel single-ended inputs. A 16-bit AtoD converter with programmable gain is used along with an on-board micro-controller with non-volatile firmware. Battery life is around 150 hours and data are transferred to the PC via 3m of duplex optical fibre and a self-powered RS232 to optical converter.

Phantoms:

SAM Twin Horizontal Phantom per IEEE Draft 1528:

The SAM Twin Horizontal is fabricated to the CAD files as specified by FCC OET 65 Supplement C 01-01 and IEEE Draft 1528. It is mounted on a dielectric table which includes mounting brackets for EUT positioners and a shelf for dipole holders. The phantom has three integrated positioning reference points.

SAM Upright Phantom per CENELEC EN50361:

The SAM Upright Phantom is fabricated to the CAD files as specified by CENELEC EN50361. It is mounted on the base table which holds the robotic positioner. The phantom and robot alignment is assured by both mechanical and laser registration systems.

Flat Bath Phantom for testing above 800 MHz:

The Flat Bath Box Phantom is fabricated to the specifications of the OET 65 Supplement C and CENELEC EN50361 standard. It is mounted on a similar rotational base to that of which the SAM upright phantom is attached to. It is positioned in place of the SAM upright head when doing validations or flat bath testing

Phantom Properties:

Phantom Type	Material	Permittivity (ɡ)	Conductivity (F - S/m)
SAM Upright Phantom	Head:polyurethane Resin Base:PVC	<3.15 above 200 MHz	<0.02 below 2 GHz
Box Phantom/holder	Clear: Perspex	<2.85 above 500 MHz	<0.015 below 2 GHz

Table 2. Phantom Properties

Test Environment: Dedicated test area
Climate Control: Temperature and Humidity
Shielded Chamber: Anechoic material strategically positioned to minimize room reflections
Ambient Noise: very low

B. Measurement Procedure

Figure 5. Photograph of SARA 2 System

The major components of the test bench are shown in the picture above. A test set and dipole antenna control the handset via an air link and a low-mass phone holder can position the phone at either ear. Graduated scales are provided to set the phone in the 15 degree position. The upright phantom head holds approx. 7 liters of simulant liquid. The phantom is filled and emptied through a 45mm diameter penetration hole in the top of the head.

After an area scan has been performed at a fixed distance of 8mm from the surface of the phantom on the source side, a 3D scan is set up around the location of the maximum spot SAR. First, a point within the scan area is visited by the probe and a SAR reading taken at the start of testing. At the end of testing, the probe is returned to the same point and a second reading is taken. Comparison between these start and end readings enables the power drift during measurement to be assessed.

SARA2 Interpolation and Extrapolation schemes

SARA2 software contains support for both 2D cubic B-spline interpolation as well as 3D cubic B-spline interpolation. In addition, for extrapolation purposes, a general n^{-th} order polynomial fitting routine is implemented following a singular value decomposition algorithm presented in [4]. A 4^{th} order polynomial fit is used by default for data extrapolation, but a linear-logarithmic fitting function can be selected as an option. The polynomial fitting procedures have been tested by comparing the fitting coefficients generated by the SARA2 procedures with those obtained using the polynomial fit functions of Microsoft Excel when applied to the same test input data.

Interpolation of 2D area scan

The 2D cubic B-spline interpolation is used after the initial area scan at fixed distance from the phantom shell wall. The initial scan data are collected with approx. 10mm spatial resolution and spline interpolation is used to find the location of the local maximum to within a 1mm resolution for positioning the subsequent 3D scanning.

Extrapolation of 3D scan

For the 3D scan, data are collected on a spatially regular 3D grid having (by default) 6.4 mm steps in the lateral dimensions and 3.5 mm steps in the depth direction (away from the source). SARA2 enables full control over the selection of alternative step sizes in all directions.

The digitized shape of the head/flat bath is available to the SARA2 software, which decides which points in the 3D array are sufficiently well within the shell wall to be 'visited' by the SAR probe. After the data collection, the data are extrapolated in the depth direction to assign values to points in the 3D array closer to the shell wall. A notional extrapolation value is also assigned to the first point outside the shell wall so that subsequent interpolation schemes will be applicable right up to the shell wall boundary.

Interpolation of 3D scan and volume averaging

The procedure used for defining the shape of the volumes used for SAR averaging in the SARA2 software follow the method of adapting the surface of the 'cube' to conform with the curved inner surface of the phantom. This is called, here, the conformal scheme.

For each row of data in the depth direction, the data are extrapolated and interpolated to less than 1mm spacing and average values are calculated from the phantom surface for the row of data over distances corresponding to the requisite depth for 10g and 1g cubes. This results in two 2D arrays of data, which are then cubic B-spline interpolated to sub mm lateral resolution. A search routine then moves an averaging square around through the 2D array and records the maximum value of the corresponding 1g and 10g volume averages. For the definition of the surface in this procedure, the digitized position of the head-shell surface is used for measurement in head-shaped phantoms. For measurements in rectangular, box phantoms, the distance between the phantom wall and the closest set of gridded data points is entered into the software.

For measurements in box-shaped phantoms, this distance is under the control of the user. The effective distance must be greater than 2.5mm as this is the tip-sensor distance and to avoid interface proximity effects, it should be at least 5mm. A value of 6 or 8mm is recommended. This distance is called **dbe** in EN 50361.

For automated measurements inside the head, the distance cannot be less than 2.5mm, which is the radius of the probe tip and to avoid interface proximity effects, a minimum clearance distance of x mm is retained. The actual value of dbe will vary from point to point depending upon how the spatially-regular 3D grid points fit within the shell. The greatest separation is when a grid point is just not visited due to the probe tip dimensions. In this case the distance could be as large as the step-size plus the minimum clearance distance (i.e with x=5 and a step size of 3.5, dbe will be between 3.5 and 8.5mm).

The default step size (**dstep** in EN 50361) used is 3.5mm, but this is under user-control. The compromise is with time of scan, so it is not practical to make it much smaller or scan times become long and power-drop influences become larger. The robot positioning system specification for the repeatability of the positioning (**dss** in EN50361) is +/- 0.04mm.

The phantom shell is made by an industrial molding process from the CAD files of the SAM shape, with both internal and external molds. For the upright phantoms, the external shape is subsequently digitized on a Mitutoyo CMM machine (Euro C574) to a precision of 0.001mm. Wall thickness measurements made non-destructively with an ultrasonic sensor indicate that the shell thickness (**dph**) away from the ear is 2.0 +/- 0.1mm. The ultrasonic measurements were calibrated using additional mechanical measurements on available cut surfaces of the phantom shells. See support document IXS-020x.

For the upright phantom, the alignment is based upon registration of the rotation axis of the phantom on its 253mm diameter baseplate bearing and the position of the probe axis when commanded to go to the axial position. A laser alignment tool is provided (procedure detailed elsewhere). This enables the registration of the phantom tip (dmis) to be assured to within approx. 0.2mm. This alignment is done with reference to the actual probe tip after installation and probe alignment. The rotational positioning of the phantom is variable – offering advantages for special studies, but locating pins ensure accurate repositioning at the principal positions (LH and RH ears).

C. Uncertainty Assessment - Table 3. Uncertainty budget of SARA2

Uncertainty Component	Sec.	Tol. (+/-)			Prob. Dist.	Divisor (descrip)	Divisor (value)	c1	Standard Uncertainty (%)	
		(dB)		(%)						sqr
Measurement System										
Probe Calibration	E1.1			10	N	1 or k	2	1	5.00	25.00
Axial Isotropy	E1.2	0.25	5.93	5.93	R	√3	1.73	0	0.00	0.00
Hemispherical Isotropy	E1.2	0.5	12.20	12.20	R	√3	1.73	1	7.04	49.63
Boundary effects	E1.3		4	4.00	R	√3	1.73	1	2.31	5.33
Linearity	E1.4	0.04	0.93	0.93	R	√3	1.73	1	0.53	0.29
System Detection Limits	E1.5		1	1.00	R	√3	1.73	1	0.58	0.33
Readout Electronics	E1.6		1	1.00	N	1 or k	1.00	1	1.00	1.00
Response time	E1.7		0	0.00	R	√3	1.73	1	0.00	0.00
Integration time	E1.8		1.8	1.80	R	√3	1.73	1	1.04	1.08
RF Ambient Conditions	E5.1		3	3.00	R	√3	1.73	1	1.73	3.00
Probe Positioner Mechanical Tolerance	E5.2		0.6	0.60	R	√3	1.73	1	0.35	0.12
Probe Position wrt. Phantom Shell	E5.3		5	3.80	R	√3	1.73	1	2.19	4.81
SAR Evaluation Algorithms	E4.2		8	4.00	R	√3	1.73	1	2.31	5.33
Test Sample Related										
Test Sample Positioning	E3.2.1		10	10.00	R	√3	1.73	1	5.77	33.33
Device Holder Uncertainty	E3.1.1		10	8.00	R	√3	1.73	1	4.62	21.33
Output Power Variation	E5.6.2		5	5.00	R	√3	1.73	1	2.89	8.33
Phantom and Tissue Parameters										
Phantom Uncertainty (shape and thickness)	E2.1		4	4.00	R	√3	1.73	0.5	1.15	1.33
Liquid conductivity (Deviation from target)	E2.2		5	5.00	R	√3	1.73	0.5	1.44	2.08
Liquid conductivity (measurement uncert.)	E2.2		10	10.00	R	√3	1.73	0.5	2.89	8.33
Liquid permittivity (Deviation from target)	E2.2		5	5.00	R	√3	1.73	0.5	1.44	2.08
Liquid permittivity (measurement uncert.)	E2.2		5	5.00	R	√3	1.73	0.5	1.44	2.08
Combined standard uncertainty					**RSS**			13.2		
Expanded uncertainty k=2 (95% Confidence Level)				**25.9%**						

Table 3 includes the preliminary uncertainty budget. The expanded uncertainty is assessed to be 25.9%. This uncertainty includes probe calibration, positioning and evaluation errors, as well as errors of the correct dielectric parameters for the tissue simulating liquid, etc.

V. SAR Results Summary

The table below contains the measured SAR values averaged over a mass of 1 g in the shape of a cube.

SAR results for PCS 1900MHz band for PCMCIA card - GSM/GPRS

PCMCIA TEST POSITION	CHANNEL NUMBER (Note: EGSM)	FREQUENCY (GHz)	Max.1g SAR (W/kg)
Antenna vertical and parallel to phantom without headset	MID (660)	1.8802	0.015
Antenna vertical and parallel to phantom with headset	MID (660)	1.8802	0.017
Antenna parallel - PCMCIA card parallel to phantom without headset	MID (660)	1.8802	0.051
Antenna parallel - PCMCIA card parallel to phantom with headset	MID (660)	1.8802	0.032

Table 4. SAR Results - 1900MHz

The above antenna test results represent the maximum SAR values with antenna attached. The device is not operational with the antenna detached.

Before the measurements, the test site ambient conditions were checked performing SAR measurements with the PMCIA card not operational.

Note 1: The measurements are first performed at the middle channel of the operating band of the EUT. If the SAR value of the middle channel for each test configuration is at least 2dB below the SAR limit, testing at the high and low channels is optional for such test configurations.

VI. Test Details

A. Administrative Data

Date of validation: 1900 MHz, Body: June 14, 2002

Date of measurement: PCS 1900, Body: June 14, 2002

B. Description of Test Sample and Test Conditions

EUT:	PCS PCMCIA Card/Production Sample
Date of Receipt:	June 14, 2002
FCC ID:	FCC ID: NBZNRM-MG301
Device Category:	GSM/GPRS PCS 1900 PCMCIA Card
RF exposure environment:	Uncontrolled
Power supply:	Powered by PC
Antenna:	Detachable (Not operational without antenna)
Measured Standards:	PCS 1900
Modulation:	GMSK
Crest Factor:	GSM = 8
TX Range:	GSM PCS 1900: 1850.25MHz - 1909.8 MHz
RX Range:	GSM PCS 1900: 1930.2 MHz - 1989.8 MHz
Used TX Channels:	GSM PCS 1900: low: ch.512, center: ch. 660, high: ch. 810

During SAR testing, the EUT was operated and controlled by a Rohde & Schwartz CMU200.

The EUT was set to maximum RF power output on low (CH512), center (CH660) and high (CH810) by CMU 200.

C. Tissue Recipes

The following recipe is provided in percentage by weight.

1900 MHz, Body:

55% De-Ionized Water
0.2% Salt
00% Sugar
44.8% DGBE

D. Material Parameters

Simulant	Freq [MHz]	Room Temp [C]	Liquid Temp [C]	Parameters	Target Value	Measured Value	Deviation [%]	Limit [%]
Body	1900	24.3	24.6	χ_r	39.9	38.7	2.7	+/- 5%
				F	1.42	1.415	0.08	+/- 5%

Table 5: Parameters of the tissue simulating liquid, June 14, 2002

Parameters were measured before and after testing. These values reflect both measurements.

E. System Validation:

Following equipment is used for the system validation:

Signal Generator (Agilent E4432B)
RF Amplifier (Mini-Circuits ZHL-42)
Dual Directional Coupler (HP 778D)
The HP 8564E Spectrum Analyzer (used for RF power measurement)
Cables, Attenuate and Adapters

The recommended (IEEE Std 1528) set-up was used:

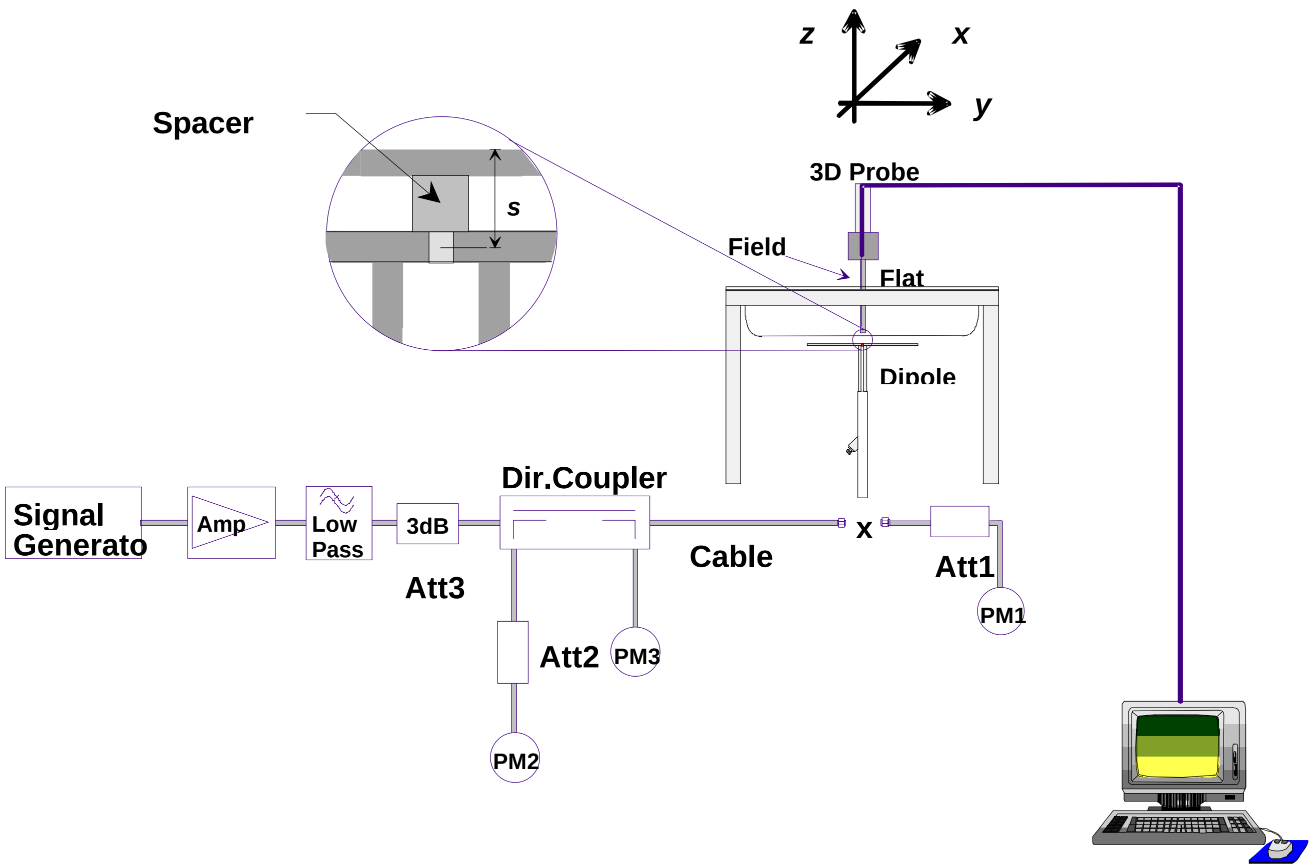
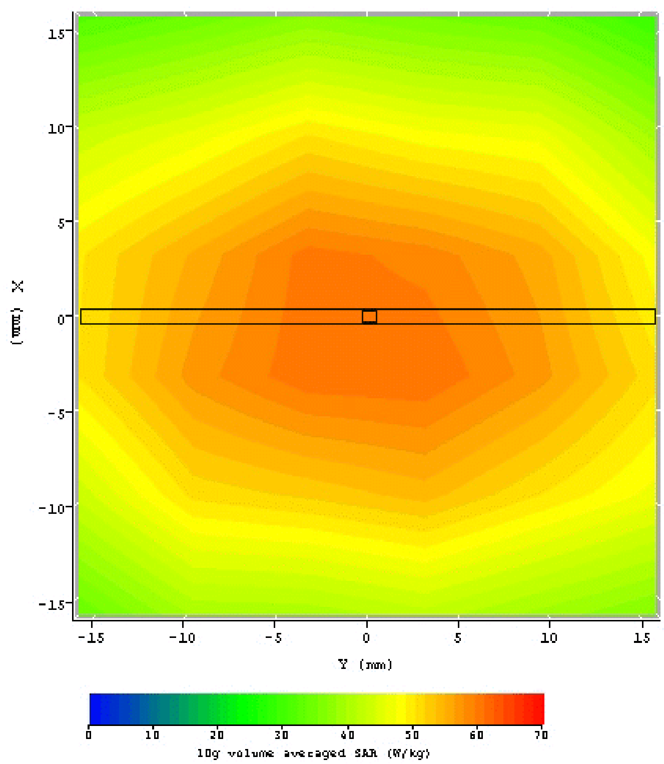


Figure 6. Performance Check Setup Diagram

F. Performance Checking

System Validation results Summary.- June 14, 2002

Simulant	Freq [MHz]	Room Temp [C]	Liquid Temp [C]	Parameters	Target Value	Measured Value	Deviation [%]	Limit [%]
Body	1800	24.3	24.6	χ_r	39.9	38.7	3	+/- 5
				F	1.42	1.415	0.35	+/- 5
				1g SAR	38.1	35.75	6.153	+/- 10



1 Watts (CW) RF forward power @ 1800 MHz
Max 1g SAR (W/Kg) = 35.756 (Measured)
RF forward Power = 0.261 W
1 Watt Target SAR/IEEE Std. = 38.1 (W/Kg) @ 1800 MHz
Validation was done within 100 MHz of test frequency

Figure 7. Validation Measurement - 1800 MHz in flat bath

G. Photographs of Device Under Test

Figure 8. Top view without antenna

Figure 9. Bottom view without antenna

Figure 10. Front view - antenna attached

Figure 11. Top view - antenna attached

Figure 12. Top view with antenna

Figure 13. Front view with headset and antenna

H. Test Positions for the Device Under Test

There are four test positions employed in the testing as described in the FCC Policy for PCMCIA cards. In each position the card is inserted into a laptop computer.

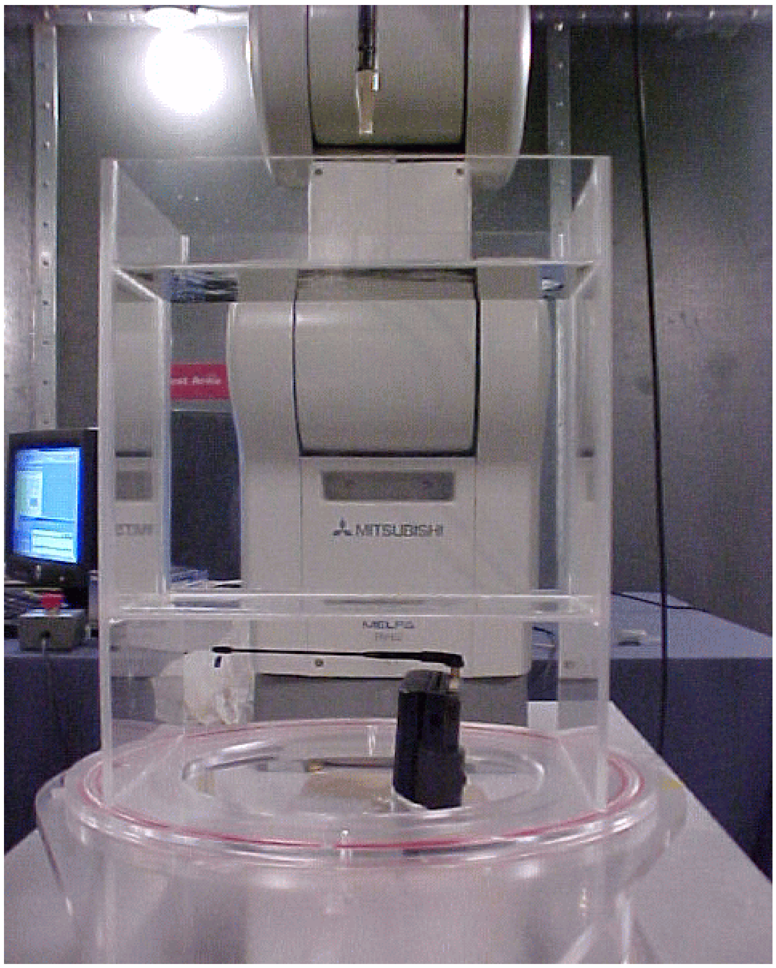


Figure 14. Position #1 - Antenna vertical and parallel to the phantom - PCS 1900 MHz

The PCMCIA Card's antenna is separated from the flat phantom by 2.5cm

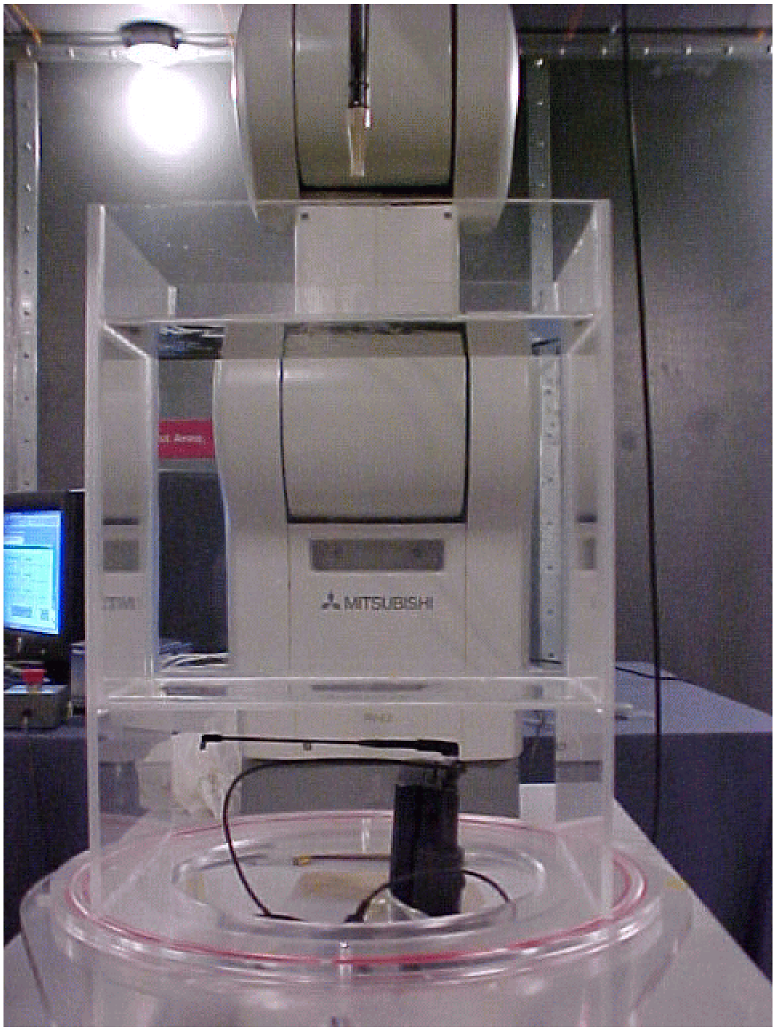


Figure 15. Position #2 - Antenna vertical and parallel to the phantom with headset - PCS 1900 MHz

The antenna of the PCMCIA card is separated from the phantom by 2.5 cm.

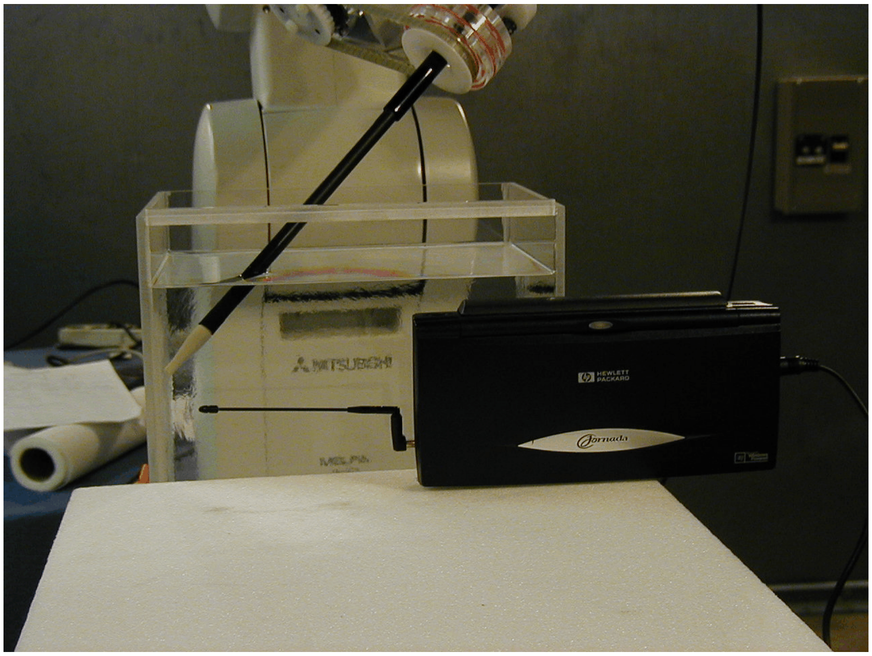


Figure 16. Position #3 - Antenna horizontal and parallel to the phantom without headset PCS 1900 MHz

The bottom of the PCMCIA card is separated from the phantom by 2.5 cm.

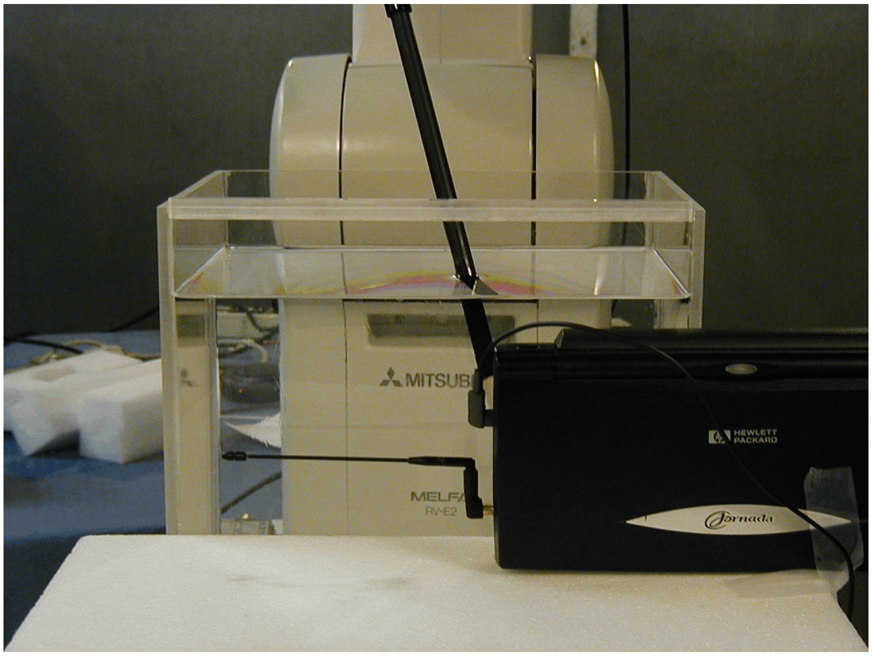


Figure 17. Position #4 - Antenna horizontal and parallel to the phantom with headset - PCS 1900 MHz

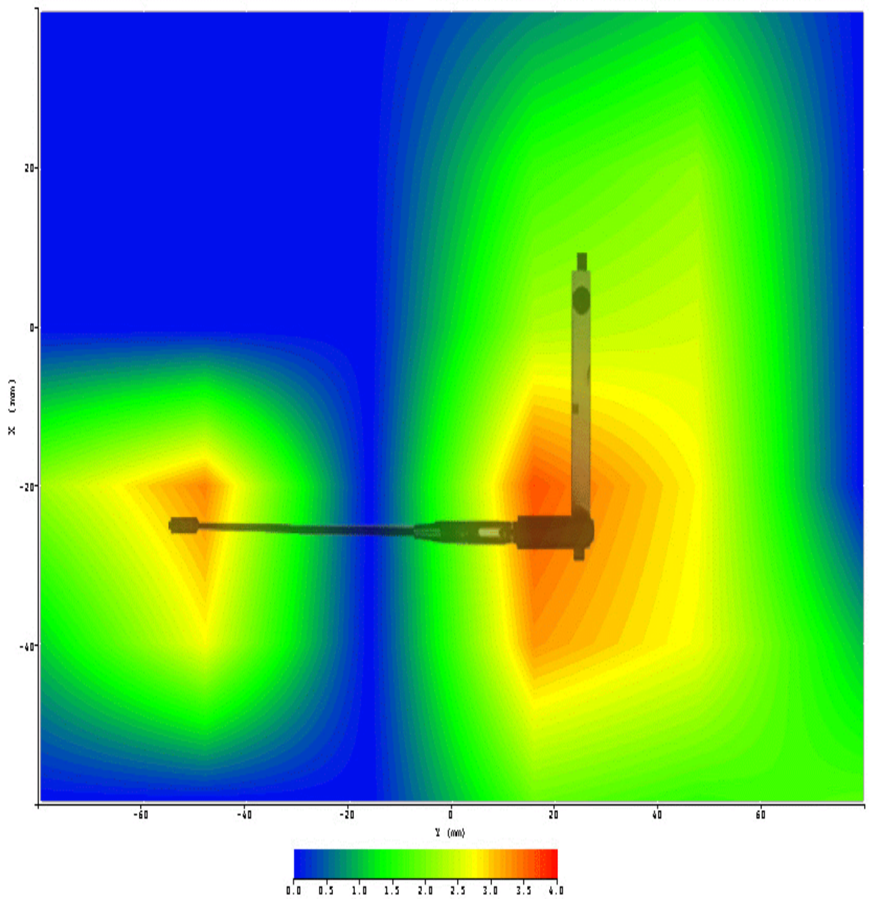
The bottom of the PCMCIA card is separated from the phantom by 2.5 cm.

PCMCIA card is not operational when the antenna is detached. Therefore, all tests were performed with antenna attached.

Appendix A. SAR DISTRIBUTIONS (AREA SCANS)

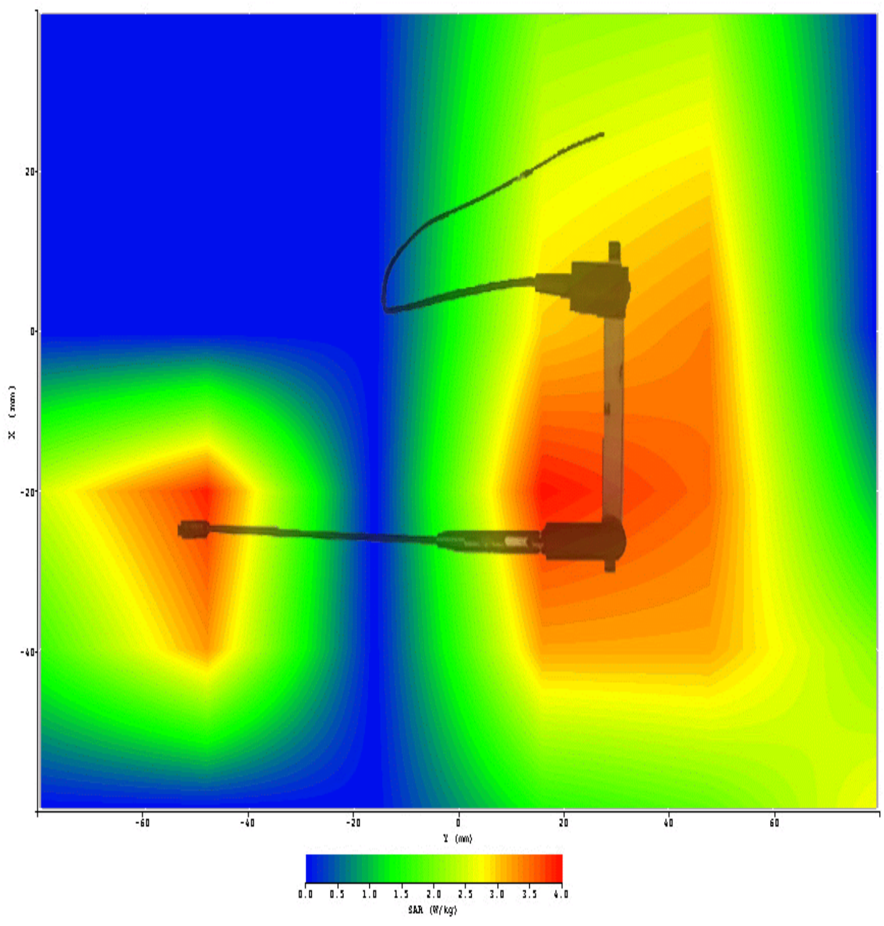
Novatel Wireless Technologies **FCCID: NBZNRM-MG301** **Merlin G301 PCMCIA Card**

Test Position: Antenna vertical and parallel to phantom without headset
Probe: IXP-050 – S/N 0082 –SARf(0.51, 0.53, 0.53)**- Probe Cal Date** 03/2002
Med. Parameters 1900 MHz**;** χ_r = 38.7; **F** = 1.415
Room Temperature: 24.3 C
Simulant Liquid Temperature: 24.6 C
CH 660; **Crest Factor** = 8 (GSM)
SAR (1g):.015 W/kg ; June 14, 2002



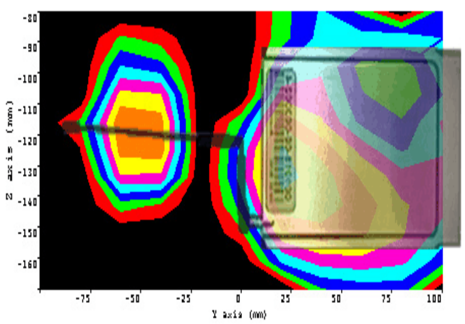
Novatel Wireless Technologies **FCCID: NBZNRM-MG301** **Merlin G301 PCMCIA Card**

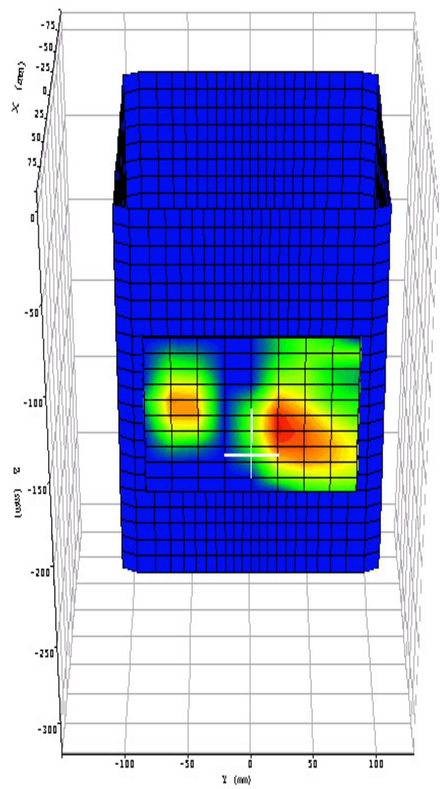
Test Position: Antenna vertical and parallel to phantom with headset
Probe: IXP-050 – S/N 0082 –SARf(0.51, 0.53, 0.53)**- Probe Cal Date** 03/2002
Med. Parameters 1900 MHz**;** χ_r = 38.7; **F** = 1.415
Room Temperature: 24.3 C
Simulant Liquid Temperature: 24.6 C
CH 660**; Crest Factor =** 8 (GSM)
SAR (1g):.017 W/kg ; June 14, 2002



Novatel Wireless Technologies **FCCID: NBZNRM-MG301** **Merlin G301 PCMCIA Card**

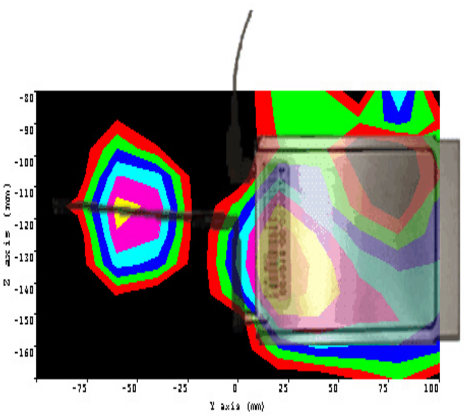
Test Position: Antenna horizontal and parallel to phantom without headset
Probe: IXP-050 – S/N 0082 –SARf(0.51, 0.53, 0.53)**-** Probe Cal Date 03/2002
Med. Parameters 1900 MHz; X_r = 38.7; F = 1.415
Room Temperature: 24.4 C
Simulant Liquid Temperature: 24.6 C
CH 660; **Crest Factor** = 8 (GSM)
SAR (1g): .051 W/kg June 14, 2002

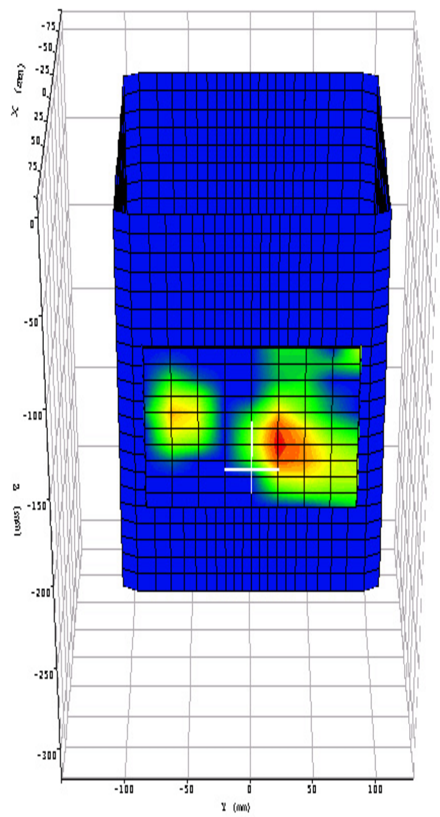




Novatel Wireless Technologies **FCCID: NBZNRM-MG301** **Merlin G301 PCMCIA Card**

Test Position: Antenna horizontal and parallel to phantom with headset
Probe: IXP-050 – S/N 0082 –SARf(0.51, 0.53, 0.53)- Probe Cal Date 03/2002
Med. Parameters 1900 MHz; χ_r = 38.7; F = 1.415
Room Temperature: 24.3 C
Simulant Liquid Temperature: 24.6 C
CH 660; **Crest Factor** = 8 (GSM)
SAR (1g): .032 W/kg June 14, 2002





END OF REPORT