Lucent Technologies Bell Labs innovatIons

Global Product Compliance Laboratory
Specific Absorption Rate (SAR) Test Report
CDPD/CS Modem

April 22, 1998

Prepared by:

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Client:

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INET, INC Worldwide Headquarters
1255 W. 15 Street
Plano, TX 75075

Preparedby: ______________________ Date: ____4-30-98________
(S. E. Gordon)
GPCL Compliance Engineer

Reviewed by: ______________________ Date: ______4-30-98_____
(C. A. Nicholas)
GPCL SAR Reviewer

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Equipment Under Test (EUT): CDPD/CS Modem

Model Number: SPIDER II **Serial Number: 8**

Company: INET, INC Worldwide Headquarters
1255 W. 15 Street
Plano, TX 75075

Manufacturer: INET, INC Worldwide Headquarters
1255 W. 15 Street
Plano, TX 75075

Measurement Procedure: **ANSI** *I* **IEEE** ***C95.1*** **(1991)**

Test Requirements: **FCC Rule Section 2.1091 and 2.1093**

TEST PERFORMED BY: Lucent Technologies
Bell Labs Innovations
Global Product Compliance Laboratory
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NVLAP LAB CODE: 100275-0
Product Engineer(s): Scott Constien

TEST RESULTS:

CDPD/CD Modem as tested did meet the Specific Absorption Rate test requirements of the above listed specifications. The maximum Specific Absorption Rate was (0.0854) W/g over any 1g tissue.

Please note that maimfacturer or party responsible must also follow the Code Of Federal Regulations 47 requirements for supplying the appropriate Labeling Information and/or Information to the user.

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ENGINEER'S REPORT

1.1 INTRODUCTION

Specific Absorption Rate (SAR) measurements were performed on the **CDPD/CS Modem,** hereinafter referred to as the EUT. Testing was performed at the Lucent Technologies, Global Product Compliance Laboratory, (GPCL) located in Holmdel, New Jersey.

1.2 COMPLIANCE STATEMENT

TIus is to certiy that the **CDPD/CS Modem** complies with the FCC Rule section 2.1091 and 2.1093, based on the test data obtained by using DASY2 dosimetric assessment system, ET3DV4 3D E-field probe and body phantom for dosimetric measurements commercially available from Schmid & Partner Engineering AG (SPEAG), Switzerland.

Frequencv (MHz)	Test Data (WIkg)	Limits (W/kg)	Margin (WIkg
836.01	0.0854	4.0	3.9146

1.3 EQUIPMENT UNDER TEST (EUT) INFORMATION

The CDPDICS Modem is designed to be compliant with Cellular Digital Packet Data Sysyem Specification -Release 1.1 and the Mobile Station - Land Station Compatability Specification - EIA/TIA-553. The modem is a completely self contained unit consisting of a processor and memory for data packetizing, encryption, encoding, decryption and decoding. It contains all of the RF transmit and receive circuitry required for AMPS call processing as well as creating and receiving a CDPD data stream on any standard cellular channel.The technology used in the construction of the modem mimics that of an AMPS cellular phone with its wideband data and voice capabilities. In addition, the modem has provisions for performing GMSK data bursts.

The product is packaged in a PCMCIA Type II housing and is solely powered and controlled through a PCMCIA PC Card version 2.1 interface.Tliis specifies the DC voltage to be provided to the PCMCIA Peripheral as a regulated 5 volts *+1-5%*. The interface protocol is designed to emulate a standard *16550* UART interface and can be configured on the PC side as a standard Communication Port connection.

The data flow into and out of the modem is metered by the modem processor. The data rate of transmission at the antenna terminals fixed at 19.2 KHz in CDPD mode and 14.4 KHz in circuit switchedlAMPS modem mode and is independent of any user application running on the PC side.The modem processor takes care of implementing all protocol controls on the CDPD channel and the aspects of the CDPD channel that are not apparent to the users application. The protocols controls in AMPS mode are handled by the processor in conjunction with a TCM8O3O Baseband Processor for Analog Cellular Telephones.

1.4 Electrical modes of Operation

Modes of Operation - The modem is designed to be installed in a laptop computer with a Type II PCMCIA connector. The location of the modem during operation is dependent upon the laptop being used.

Test Frequency -836.01
Channel - 367
Maximum Output Power - 28dBm
Antenna Position - The SpiderII has a removable '/2-wave dipole antenna with an SSMB coaxial connector.

1.5 SAR TEST INFORMATION AND SUMMARY

SAR measurements were performed in an absorber-lined shielded chamber at the Global Product Compliance Laboratory in Holmdel, New Jersey. A summary of the SAR measurement results and test information is presented in the SAR Test Summary Sheet.

1.6 TEST PROCEDURES

All tests were performed in accordance with the following procedures:

ANSUWEE ***C95.*** 1(1991) entitled: "IEEE Standard for Safety Levels with Respect to Hurnan Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz", American National Standards Institute, Institute of Electrical and Electronic Engineers, Inc., New York, NY 10017-2394, USA.

1.7 SAR TEST PROCEDURE

SAR tests were performed in an appropriate absorber lined shielded test chamber. Prior to the SAR tests being performed, the body tissue simulating liquid is calibrated to determine if the conductivity and relative dielectricity is in tolerance with the specifications. Prior to the test, a systems calibration is performed to validate the system. For testing, the EUT is configured, installed, arranged, and operated in a manner that is most representative of the equipment as typically used. The DASY software is used to systematically scan, locate the maximum SAR position and record the measurement.

A coarse scan is performed over the inside surface of the entire phantom within the defined border. When the coarse scan is finished, the location of the interpolated maximum is provided by the system. A cubic scan is performed over the peak area. The spatial peak SAR results - value for 1 and 10 grams is evaluated after the cube measurements have been done.

1.8 PHANTOM INFORMATION

The phantom shell is made from fiberglass with a thickness of 2 ± 0.2 mm. The flat portion of the phantom was used for testing body muscle tissue. Styrofoam was used as the mounting device to hold the EUT into position for the duration of the test.

1.9 E-FIELD PROBE

One of the most critical component of the dosimetric assessment system is the E-field probe. The probe requirements are

- High sensitivity and linear response over a broad frequency range,
- High spatial resolution,
- Isotropy in different media,
- Low interaction with the measuring field, and
- Small in size

For optimal performance of SAR measurement in liquids with high permittivity, Scilmid & Partner Engineering AG designed and developed the triangular E-Field probe. The probe has a smaller outline and is installed a surface detector in the center of the probe. The triangular design is very compact to ensure a high spatial resolution. The distance between the probe tip and the dipole center is 2.7 mm. This distance between the dipole centers is less than 2 mm.. The surface detection unit enables the probe tip reach the phantom surface at lmm distance with the accuracy +/- 0.2 mm.

Each probe consists of three small dipoles (3 mm) directly loaded with a Schottky diode and connected with high resistive lines to the data acquisition unit. The theory of this type of probe has been discussed in various publications, such as *Electric Field Probes - A Review,* IEEE Trans. Antennas Propagation, vol.31, no.5, pp.710-718, Sept 1983 by H. I. Bassen and G.S. Smith.

There are several possible secondary modes of reception in the probe. One is produced by normal mode signals coupled into the resistive lines and rectified in the diode. Another mode is produced by common mode signals coupled into the lines and converted at the diode into normal mode signals by asymmetrical loading of the dipole halves due to constructional asymmetries. These mode signals are reduced by introducing a distributed filter between the dipole and the resistive lines in the probe, ET3DV4 by Schmid & Partner Engineering AG. Also the high degree of constructional symmetry improves the efficiency of the filter for secondary reception modes. The thick film technique is used for the construction of the dipole and lines on the probe. This permits the use of lines with different sheet resistance on the same substrate, and the production of much higher sheet resistance than the thin film technique.

Any dielectric material around electric dipoles have an effect on the local signal strength. It's been verified by Schmid & Partner Engineering AG that the triangular probe has better isotropy in the solutions which simulate the electric properties of tissues with high water content. Although proved to be unusable in air, all the SAR measurement tests are performed in the tissue simulation solution. The maximum error introduced by the lack of isotropy is much less than the deviation of +/-0.6 dB in the solution.

The disturbance caused by the probe in homogeneous fields depends on the probe material/geometry and the field itself. This problem is corrected by measuring the SAR at different distances from the surface and extrapolating the SAR values to the surface. The extrapolation procedure is also necessary because of the separation of the dipole center from the probe tip.

The total measurement uncertainty of the DASY2 system from SPEAG for the spatial peak SAR values of less than 20% (rss value of the worst-case errors). The detail error analysis is given in the paper, ***Dosimetric Evaluation** of* ***Handheld Mobile Communications Equipment with Knoivn Precision*** by Niels Kuster, Ralph Kastle and Thomas Schmid, IEICE Transactions on Communications Vol. E80-B, No 5 May 1997.

1.10 ABSORBER-LINED SHIELDED CHAMBER

The Absorber-Lined Shielded Chamber is a steel constructed 12 foot wide x 12 foot long x 12 foot high shielded chamber with inner surfaces lined with pyramidal absorber along the walls and ceiling. Finger-stock gasketing is placed along the edge of the door to provide a good bond between the chamber and the door. The floor is constructed of specially reinforced absorber made of fiberglass-foam laminate material. RF Line Filters are installed to the outer walls with the line coming through pipe nipples into the room to remove RF ambients on the power input lines. These filters are encased in shielded electrical enclosures.

1.11 SAR DETERMINATION

The SAR can be determined by measuring the total RMS electric field (E_{tot} in the unit V / m) at a point inside the exposed tissue

$SAR=E_{tot}2\ \sigma/\ \rho$

where σ is the conductivity (S/ m) and ρ is the density (kg /m3)of the tissue at the site of measurement.

The SAR distribution is determined by measuring the electric field with miniaturized E-field probes.
Measurements are performed in the shell phantom filled with tissue simulating solution. As we know, different head and body simulating shell phantom and different phone positions as of the shape of the phantom may give different SAR measurement results. The simplified body and head phantom designed by Schmid & Partner
Engineering AG was used in all the SAR tests.

The SAR calculation formula can be rewritten as

$SAR=E_{tot}2\ \ \sigma/\ lOOO\rho=\ E_{tot}2\ \sigma\ /\ 1000$

where E~ is the total field strength in V I in, a is the conductivity in Siemens (inho) and p is the density
(kg / m^3)of the tissue at the site of measurement. The density is normally set to 1 to account for the actual brain density rather than the density of the simulation solution.

1.12 DATA ACQUISITION AND ANALYSIS

The improved probe characteristics are obtained by the improved signal amplifier. The probes have source impedance of 5 to 8 MΩ due to the high resistive lines and the decoupling filters. The rectified signals range from 1 μV to 200 mV. Signal noise is reduced by using separated battery power data acquisition unit and connected with fiber-optic links to the main data evaluation system.

The data acquisition system is semi-automatic. Data acquisition, surface detection, robot control, administration of all calibration parameters of the system, evaluation and visualization of the measured data are performed by the DASY2 V2.3d software.

The robot which controls the movement of the probe is completely controlled by the software and its movements can be monitored on the screen. Several measuring options allow users completely measure in user defined coarse volumes or planes. After the coarse measurement, the probe can then be moved to the maximum SAR area and performed pre-defined fine grid volume SAR measurement. The filtered raw data is stored in data files together with all the calibration parameters. The data can be interpolated and extrapolated to find the maximum SAR value.

The data acquisition system takes 2600 complete field measurements per second for 3-D probes. The program reads and filters the incoming data during the measuring or surface detection cycle. Depending on the received signal strength, the program switches the gain of the amplifier unit and launches calibration cycles accordingly. The program calculates an accuracy estimate of the filtered signal and stops the measuring cycle upon reaching the desired accuracy. The measuring time per grid point varies with the desired accuracy and the received signal-to-noise ratio.

Because of the low cutoff frequency the system can not follow pulsed HF signals, but provides an average value of the rectified signal. As long as the signal strength stays within the square law range of the detector diode, the reading is the average of the absorbed power. If the peak signal strength is higher, the compression of the diode is compensated by the software depending on the duty cycle parameter. The system then calculates the peak power, compensates for the diode compression and gives the new average value. The formula for each channel can be given as:

$$V_i \; U_i + U_i^2 x(dc/2DCP)$$

where V is the compensated signal of channel x, y or z., U_1 is the input signal of channel x, y or z, dc is the duty cycle of the RF field (DASY2 system parameter), DCP is the diode compression point in microvolts (DASY2 system parameter). From the compensated input signals the primary field data for each channel is evaluated as follows,

$$E_i = (V_i / (Norm_1 x ConvF)^{1/2}$$

where E is the measured channel electric field strength in V/m of channel x, y or z, Vi is the compensated signal of channel x, y or z, $Norm_1$ is the sensor sensitivity of channel x, y or z in μ*V/(V/m)2.* ConvF is the sensitivity enhancement in solution. The total field strength can be calculated by taking the RMS value of the channel field components.

$$E_{tot} = \; (E_x^2 + E_x^2 + E_x^2)_{l/2}$$

1.13 DATA EVALUATION and VISUALIZATION

The program evaluates the raw data with the calibration parameters and can produce a two-dimensional or three-dimensional output with interpolated isolines. SAR values can be numerically integrated over 1 g or 10 g of simulated tissue.

$SAR_{1g} \approx \int_{1g\ Cubic} SAR\ dVol\ \ 1/1000 \times \Sigma_{1000} SAR$

A thorough error analysis made by Eidgenossische Technische Hochschule (ETH) shows that the measurement uncertainty of DASY2 system is less than 20% for the spatial peak SAR values. The long term stability and the proper functioning of the system is ensured by means of an easy-to-use validation kit, which has a reproducibility of better than 5%.

The algorithm that finds the maximal averaged volume is divided into three stages,

First, the data between the dipole center of the probe and the surface of the phantom is extrapolated. This data can not be measured, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance betveen the surface and the lowest measuring point is 1 mm. The extrapolated data from a cube measurement can be visualized in graphics.

Then, the maximal interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1 or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume can not be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.

Thirdly, all neighboring volumes are evaluated until no neighboring volume with a higher average value is found.

Extrapolation is based on the least square. Through the points in one z-axis a polynomial of order four is calculated. This polynomial is then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from one another.

Interpolation of the points is done with a 3d-spline. The 3d-spline is composed of three one-dimensional splines with the "Not a knot" -condition.

For volume averaging, the size of the cube is first calculated. The volume is integrated with the trapezoidal algorithm. 1000 points (10x10x10) are interpolated to calculate the average.

PRODUCT EQUIPMENT LIST

List of all equipment associated with tes including peripheals	Serial Number	FCC ID Number	Sample type prototype (P) tool-made (T) production (M)
CDPD/CS Modem	8	MIVWG9701A	P
Toshiba Satelite Computer	11581604-1	N/A	M

Footnote: Customer assumes responsibility for verification and operation of all equipment.

CUSTOMER PROVIDED AUXILLARY EQUIPMENT

List of all equipment associated with test including peripherals	Serial Number	FCC ID Number
None	**None**	**None**

Footnote: Customer assumes responsibility for verification and operation of all equipment.

SAR SPECIAL TEST CONSIDERATIONS

This page discusses any special test procedures or considerations.

(x) There were no special test considerations.
( ) The following special considerations occurred during the test.

SPECIFIC NOTES:

MITIGATION APPLIED TO EUT TO ATTAIN COMPLIANCE:
(x) No mitigation required for compliance.

( ) The following mitigation was applied to obtain compliance:

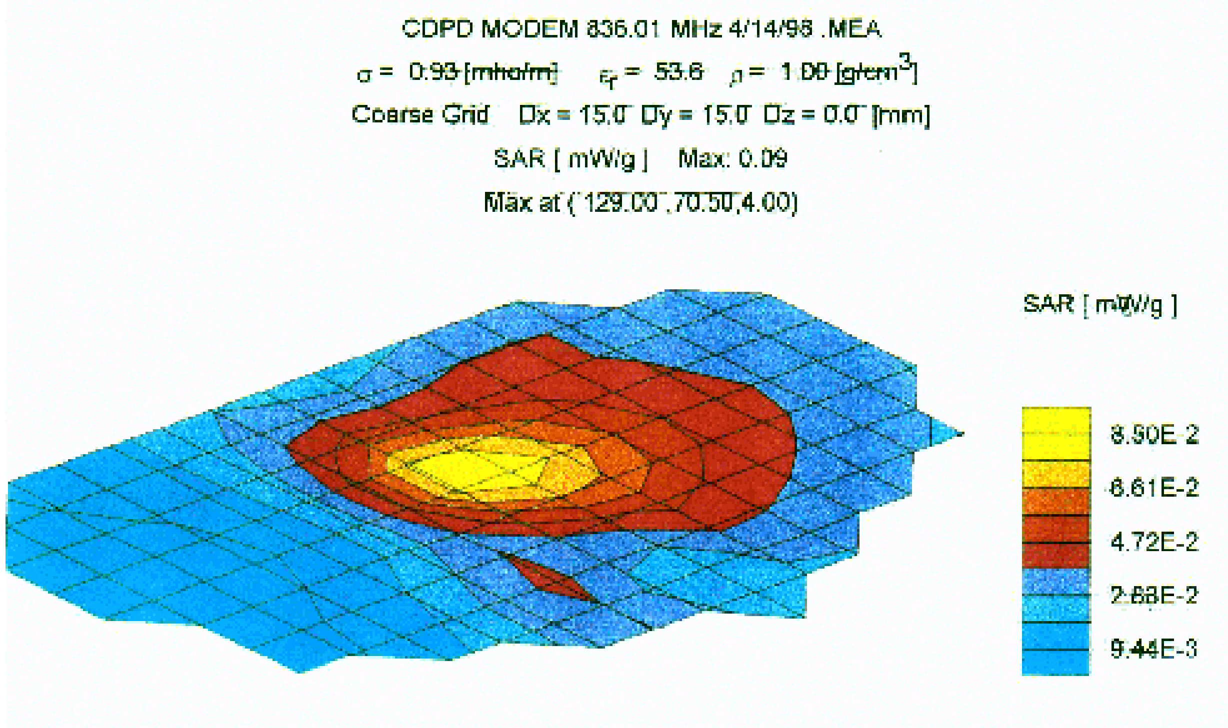
SAR TEST SUMMARY SHEET

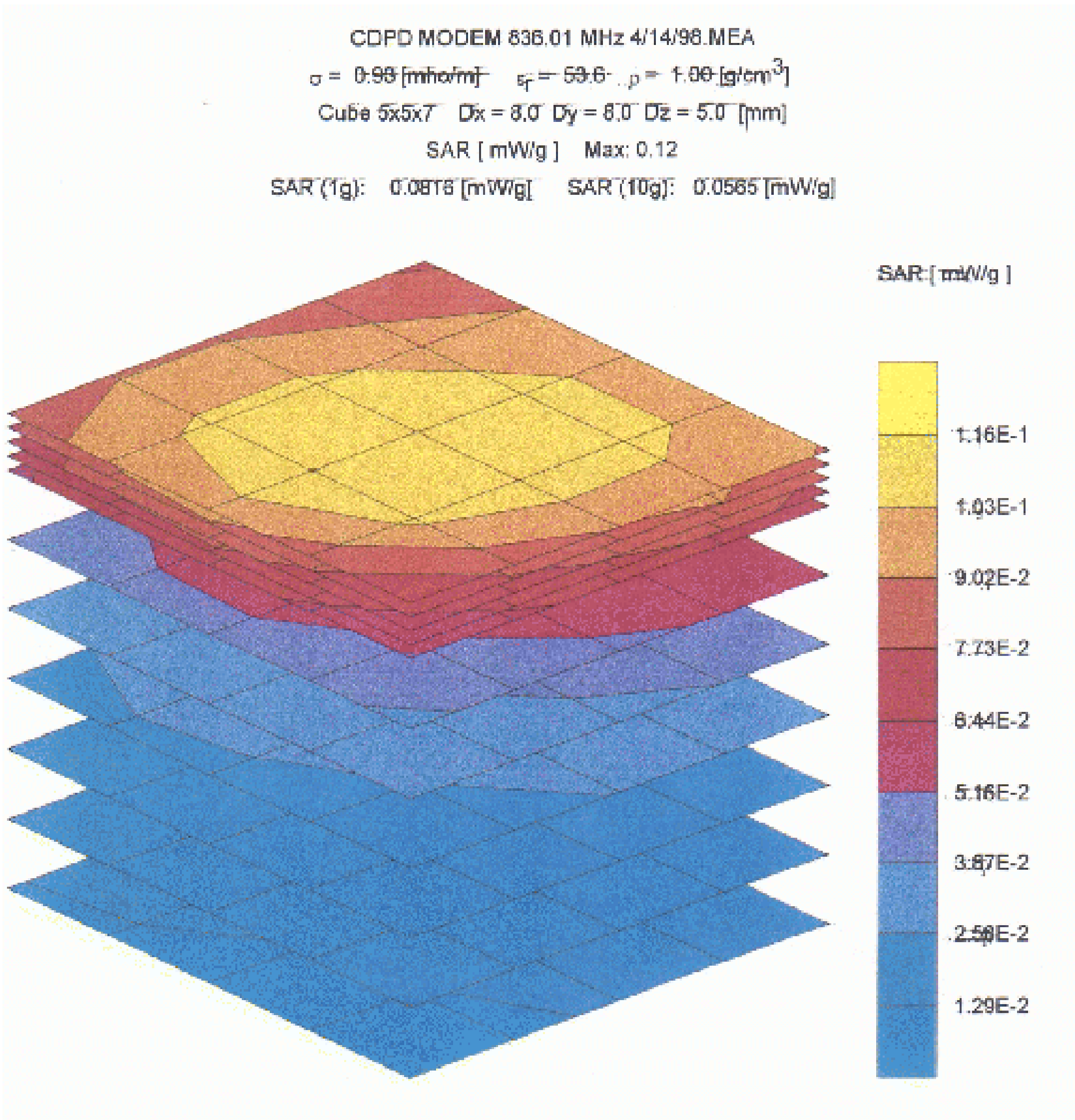
Official Name of the EUT: **CDPD/CS Modem**	Serial Number**: 8**
Test Date: 4/14/98	Test facility used**: SAR Room**
Operating Frequency**: 836.01 MHz**	
EUT Ambient Temperature**: 25°C**	EUT Relative Humidity**: 39%**
Product Engineer: S. Constien	EMC Engineer: S.E. Gordon

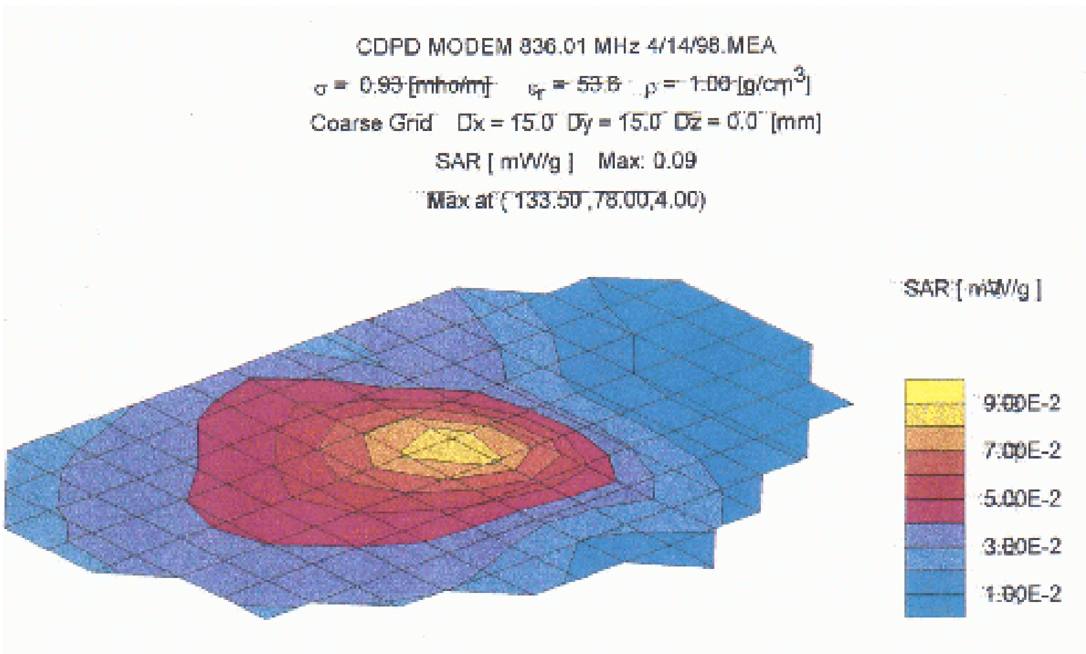
Phantom Side	Frequency MHz	Reading (mW/g) over 1g tissue	Limit (mW/g) over 1g tissue	Margin mW/g
Body	836.01	0.08544	4.0	3.9146

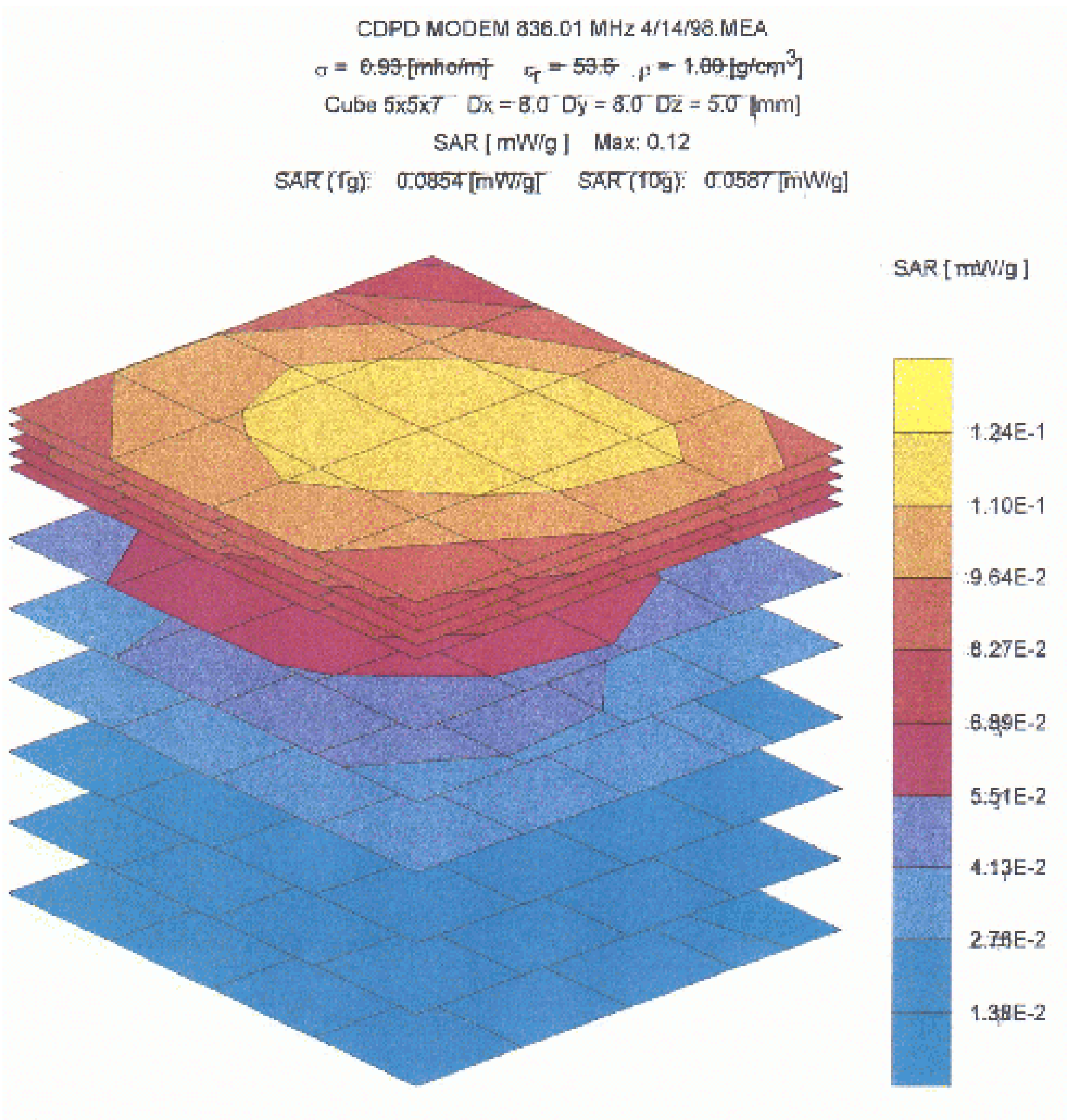
Complete SAR profile for all configurations are provided as the data plots on the following pages.

SAR DATA

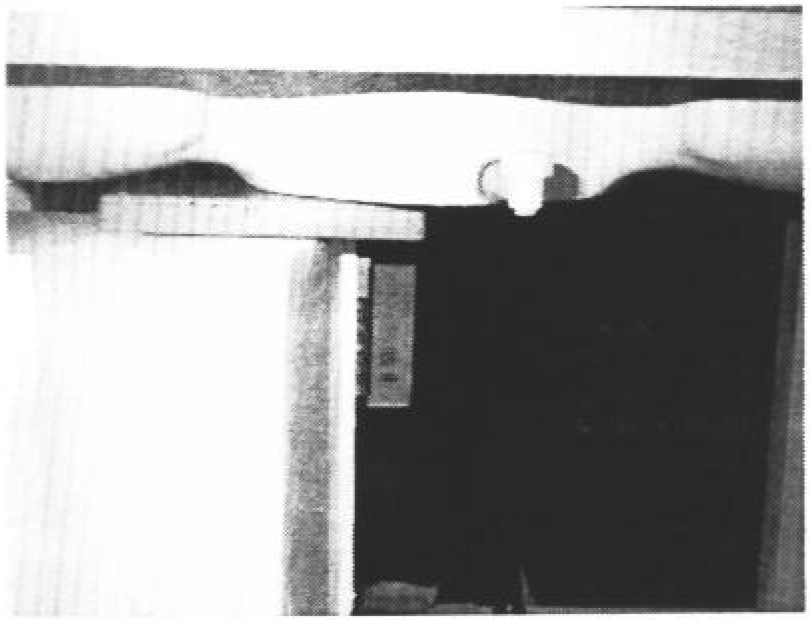

CDPD MODEM 836.01 MHz 4/14/98 .MEA
σ = 0.93 [mho/m]   εr = 53.6   ρ = 1.00 [g/cm3]
Coarse Grid   Dx = 15.0 Dy = 15.0 Dz = 0.0 [mm]
SAR [mW/g]   Max: 0.09
Max at (129.00, 70.50, 4.00)
SAR [mW/g]
8.50E-2
6.61E-2
4.72E-2
2.83E-2
9.44E-3

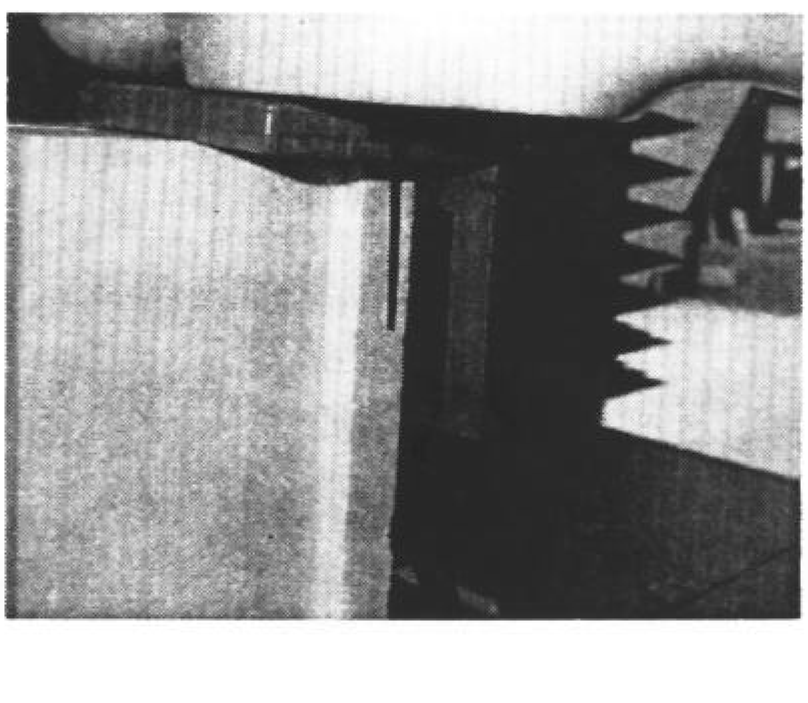

CDPD MODEM 836.01 MHz 4/14/98.MEA
σ = 0.98 [mho/m] εr = 59.6 ρ = 1.00 [g/cm3]
Cube 5x5x7 Dx = 8.0 Dy = 8.0 Dz = 5.0 [mm]
SAR [mW/g] Max: 0.12
SAR (1g): 0.0878 [mW/g] SAR (10g): 0.0565 [mW/g]
SAR [mW/g]
1.16E-1
1.03E-1
9.02E-2
7.73E-2
6.44E-2
5.16E-2
3.87E-2
2.58E-2
1.29E-2

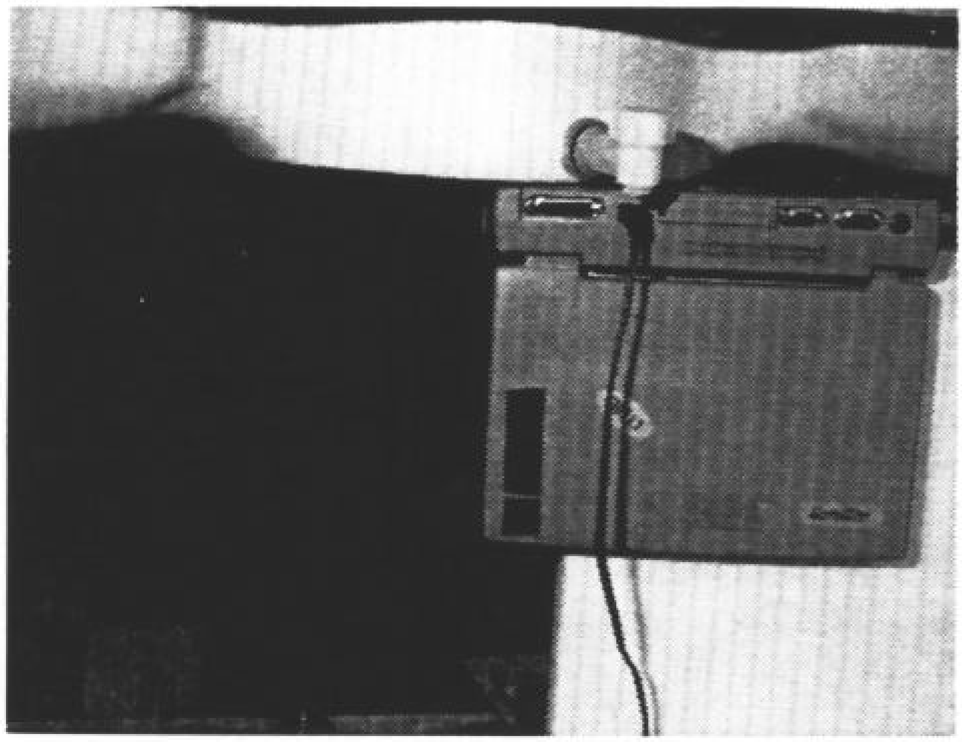

CDPD MODEM 836.01 MHz 4/14/98.MEA
σ = 0.93 [mho/m] εr = 53.8 ρ = 1.00 [g/cm3]
Coarse Grid Dx = 15.0 Dy = 15.0 Dz = 0.0 [mm]
SAR [mW/g] Max: 0.09
Max at (133.50 ,78.00,4.00)
SAR [mW/g]
9.00E-2
7.00E-2
5.00E-2
3.00E-2
1.00E-2


CDPD MODEM 836.01 MHz 4/14/98.MEA
σ = 0.93 [mho/m] εr = 53.5 ρ = 1.00 [g/cm3]
Cube 5x5x7 Dx = 8.0 Dy = 8.0 Dz = 5.0 [mm]
SAR [mW/g] Max: 0.12
SAR (1g): 0.0854 [mW/g] SAR (10g): 0.0587 [mW/g]
SAR [mW/g]
1.24E-1
1.10E-1
9.64E-2
8.27E-2
6.89E-2
5.51E-2
4.13E-2
2.76E-2
1.38E-2

PHOTOGRAPH(S) (copy) of EUT ARRANGEMENT DURING SAR TEST







TEST EQUIPMENT CALIBRATION LIST

Manufacturer	Model Number	Serial Number	Description	Last Calibrated dd/mm/yy	Cal Cycle Month
Schmid & Partner Engineering AG	ET3DV4	1123	Probe	Sept 97	12
HP	83623a	3009A00184	Synthesized Sweeper	16/12/97	12
HP	437B	3125U20156	Power Meter	7/08/97	12
HP	8481A	3318A94086	Power Sensor	19/02/97	12
Amplifier Research	100W1000M1A	17464	RF Power Amplifier	N/A	N/A
Weinchel	46-10-34	BC5340	Attenuator	2/5/97	12
Weinchel	46-20-34	BD5843	Attenuator	14/5/97	12

Body Muscle Tissue Simulating Liquid Data

RECIPE I

Water	48.1%
Sugar	50.0%
Hydroxyethylcellulosis (HEC)	1.0%
Preservative substance	1.0%

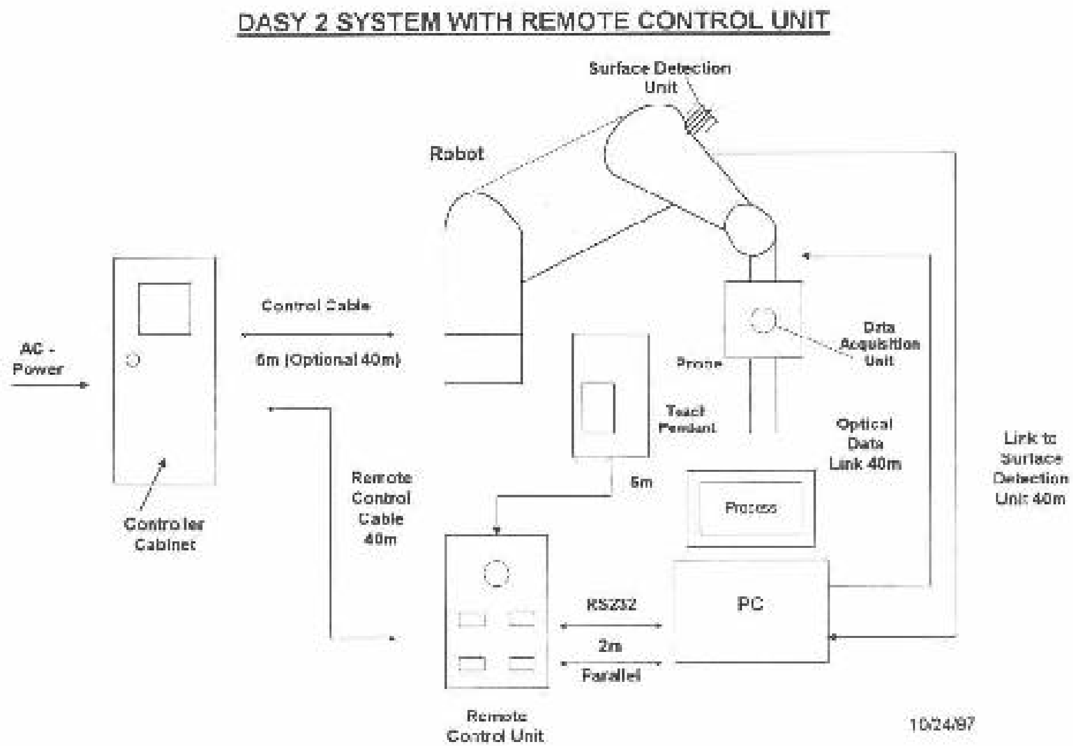
836 MHz: $\varepsilon r = 56.1 \pm 5\%$ and $s = 0.95 \pm 10\%$ mho/m, ConvF = $6.0 \pm 10\%$

Simulates tissue according to the data provided by C. Gabriel at 900 MHz

System Diagram

Test Setup

The diagram below is the test setup for specific absorption rate measurements.



Document Number EMC-T3-34.01-9706 Sheet 1 of 3 Version 1.0 6/9/97

System Uncertainty Data

Uncertainty

Field measurement errors: <±13% (includes isotropy error in tissue-simulation liquid: <+0.2dB for the assessment procedure; frequency response: <+0.1dB; linearity: <+0.2dB: data acquisition and evaluation error: <±0 *05dB;* probe calibration uncertainty: <±10%: ELF and RF disturbance: <±10uW/g)

Errors in evaluating spatial peak SAR values: <±7% (includes extrapolation and interpolation errors and positioning errors: <±0.1dB at 900 MHz and <±0.2dB at 1800 MHz when using the surface detection with transparent, homogeneous sugar-water solutions. Whereby the angle between surface and probe ranges from 75 to 105 degrees; integration and maximum search routine: <±0.1dB for the fine cube measurement grid defined in the software (cube size: 32x32c30imm3; number of measurement points: *5x5x7);* inaccuracies in the cube's shape: <±0.2dB for angles between surface and probe ranging from 75 to 105 degrees).

Dosimetric Assessment System Calibration Data

**Schmid & Partner
Engineering AG**

Staffelstrasse 8, 8045 Zurich, Switzerland, Telefon +41 1 280 08 60, Fax +41 1 280 08 64

DASY - DOSIMETRIC ASSESSMENT SYSTEM

CALIBRATION REPORT

DATA ACQUISITION ELECTRONICS

MODEL: DAE V2

SERIAL NUMBER: 222

This Data Acquisition Unit was calibrated and tested using a FLUKE 702 Process Calibrator. Calibration and verification were performed at an ambient temperature of 23 ± 5 ^{0}C and a relative humidity of <70%.

Measurements were performed using the standard DASY software for converting binary values, offset compensation and noise filtering. Software settings are indicated in the reports.

Results from this calibration relate only to the unit calibrated.

Calibrated by: P Merian

Calibration Date: 11. 01. 97

DASY **Software Version: 2. 3b**

1. DC Voltage Measurement

DA - Converter Values from DAE
LowGain: 1LSB= 6.1µV, full range = 400 mV
High Gain: 1LSB = 6lnV full range = 4 mV

Software Set-up
Calibration time: 3 sec
Measuring time: 3 sec

Low Gain	Input	Reading in µV	% Error
Channel X +Input	20mV	20013.71100	0.07
	200mV	200135.49648	0.07
Channel X -Input	20mV	19992.53024	-0.04
Channel Y +Input	20mV	19973.84252	-0.13
	200mV	199735.77724	-0.13
Channel Y -Input	20mV	19960.27550	-0.20
Channel X +Input	20mV	20001.09394	0.01
	200mV	199968.56220	-0.02
Channel Z	20mV	19988.90412	-0.06

High Gain	Input	Reading in	
Channel X +Input	0.2mV	200.35630	0.18
	2mV	2003.78565	0.19
Channel X -Input	0.2mV	200.40077	0.20
Channel Y +Input	0.2mV	200.44540	0.22
	2mV	2002.58799	0.13
Channel Y -Input	0.2mV	200.25017	0.13
Channel Z +Input	0.2mV	200.83218	0.42
	2mV	2006.96047	0.35
Channel Z -Input	0.2mV	200.15879	0.08

2. Common mode sensitivity

Software set-up
Calibration time: 3 sec
Measuring time: 3 sec

in µV	Common mode Input Voltage	Low Gain Reading	High Gain Reading
Channel X	200mV	2.86943	1.39792
	-200mV	-3.13549	-2.58731
Channel Y	200mV	-5.56515	-4.41801
	-200mV	2.55800	4.27949
Channel Z	200mV	8.64899	7.43785
	-200mV	-8.22879	-6.92366

3. Channel separation

Software Set-up
Calibration time: 3 sec
Measuring time: 3 sec

in µV	Input Voltage	Channel X	Channel Y	Channel Z
Channel X	200mV	-	24.49466	39.15640
Channel Y	200mV	32.40341	-	23.94300
Channel Z	200mV	-6.78899	3.54943	-

4. AD-Converter Values with inputs shorted

in LSB	Low Gain	High Gain
Channel X	16520.75026	16032.51308
Channel Y	16522.36756	17157.69846
Channel Z	16516.80423	16722.60397

5. Input Offset Measurement

Measured after 15 mm warm-up time of the Data Acquisition Electronic. Every Measurement is preceded by a calibration cycle.

Software set-up:

Calibration time: 3 sec
Measuring time: 3 sec
Number of measurements: 100

Input open

in µV	min. Offset	max. Offset	Average	Std. Deviation
Channel X	-01.33	00.84	-00.40	00.37
Channel Y	-01.59	00.46	-00.30	00.34
Channel Z	-01.28	00.93	-00.15	00.36

Input shorted

in µV	min. Offset	max. Offset	Average	Std. Deviation
Channel X	-01.12	00.84	-00.09	00.27
Channel Y	-01.16	01.39	00.05	00.31
Channel Z	-00.77	02.19	-00.03	00.37

6. Input Offset Current

in µV	Input Offset Current
Channel X	<100
Channel Y	<100
Channel Z	<100

7. Input Resistance

in kΩ	Calibrating	Measuring
Channel X	199.2	20’160
Channel Y	199.2	20’180
Channel Z	199.2	20’130

8. Low Battery Alarm Voltage

in V	Alarm Level
Digital Supply (VCC)	4.8V
Analog Supply (+Vcc)	5.4V
Analog Supply (-Vcc)	-5.6V

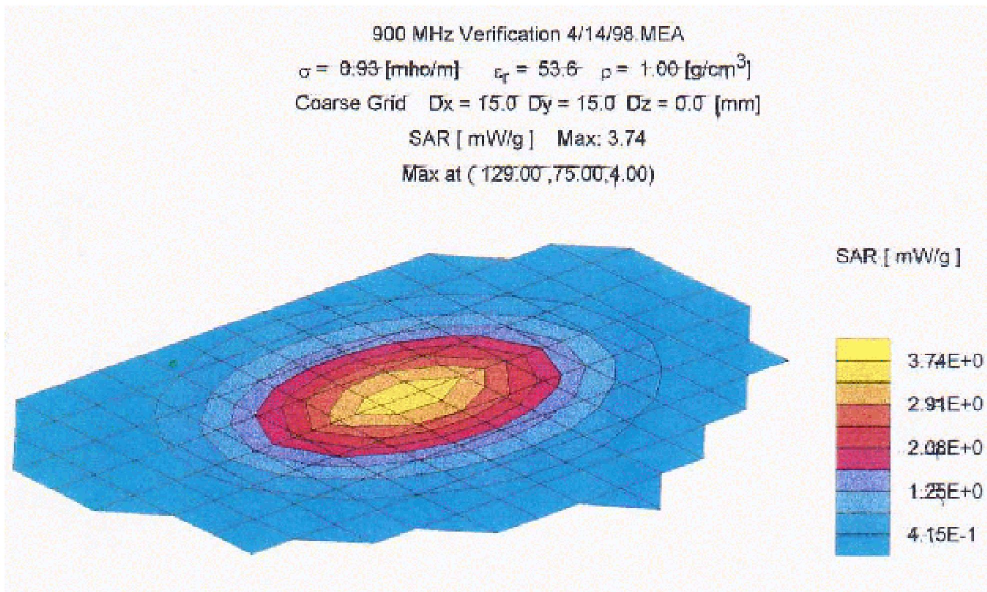
9. Power Consumption

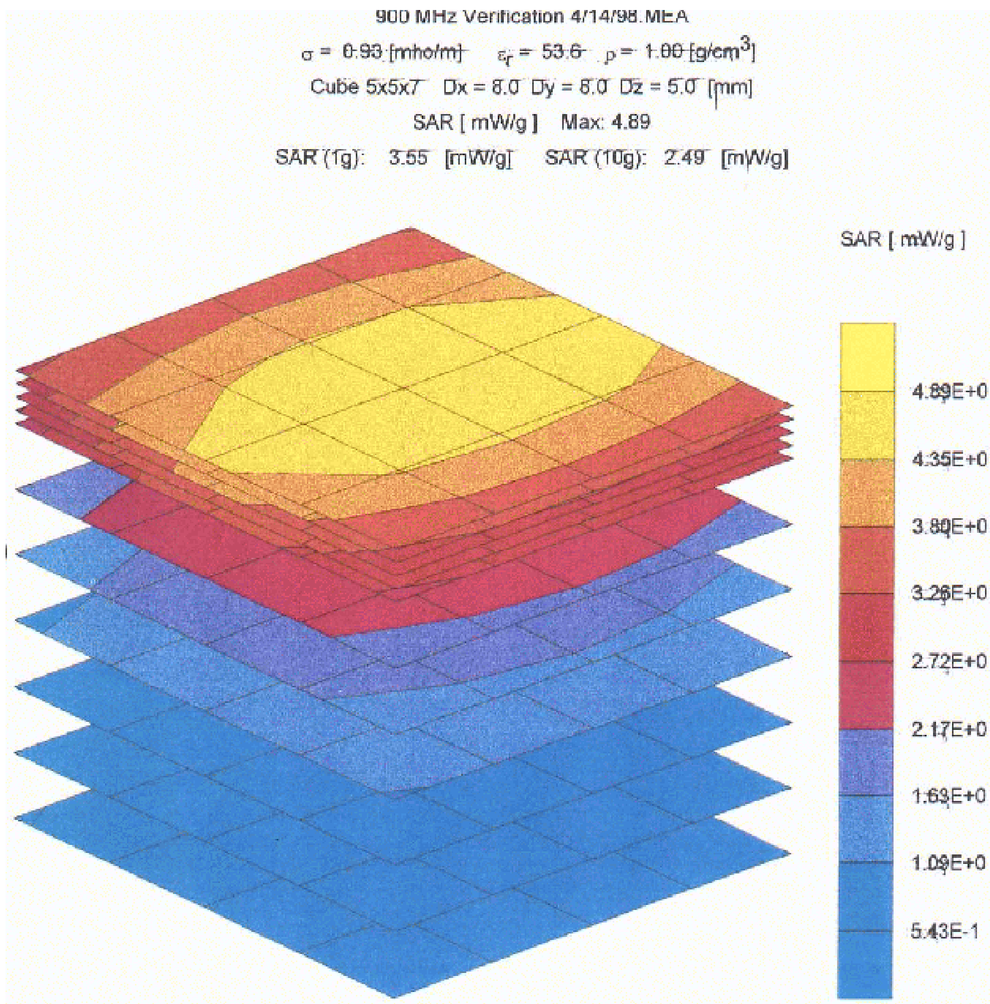
in mA	Switched off	Stand by	Transmitting
Digital Supply (VCC)	0.01	4.75	9.0
Analog Supply (+Vcc)	0.003	9.98	9.75
Analog Supply (-Vcc)	0.0	-9.6	-9.56

10. Functional test

Relay pulse length	3.5ms
Touch async pulse	ok
Touch status bit	ok
Channel synchronisation bit	ok
Power off pulse	ok
Power down mode	ok

System Validation Data/ Dipole Validation Kit


900 MHz Verification 4/14/98.MEA
σ = 0.93 [mho/m] εr = 53.6 ρ = 1.00 [g/cm3]
Coarse Grid Dx = 15.0 Dy = 15.0 Dz = 0.0 [mm]
SAR [mW/g] Max: 3.74
Max at (129.00 ,75.00,4.00)
SAR [mW/g]
3.74E+0
2.91E+0
2.08E+0
1.25E+0
4.15E-1


900 MHz Verification 4/14/98.MEA
σ = 0.93 [mho/m] εr = 53.6 ρ = 1.00 [g/cm3]
Cube 5x5x7 Dx = 8.0 Dy = 8.0 Dz = 5.0 [mm]
SAR [mW/g] Max: 4.89
SAR (1g): 3.55 [mW/g] SAR (10g): 2.49 [mW/g]
SAR [mW/g]
4.89E+0
4.35E+0
3.80E+0
3.26E+0
2.72E+0
2.17E+0
1.63E+0
1.09E+0
5.43E-1

DASY

Dipole Validation Kit

Type : D900V2

Ser.: 011

Manufactured:	**June 1996**
Calibrated:	**June 1996**
Recalibrated:	**July 1997**

3. Dipole Impedance and return loss

The impedance was measured at the SMA-connector with a network analyser and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:	1.419 **ns**	(one direction)
Transmission factor:	0.985	(voltage transmission, one direction)

The dipole was positioned at the flat phantom sections according to section 1 and the distance holder was in place during impedance measurements.

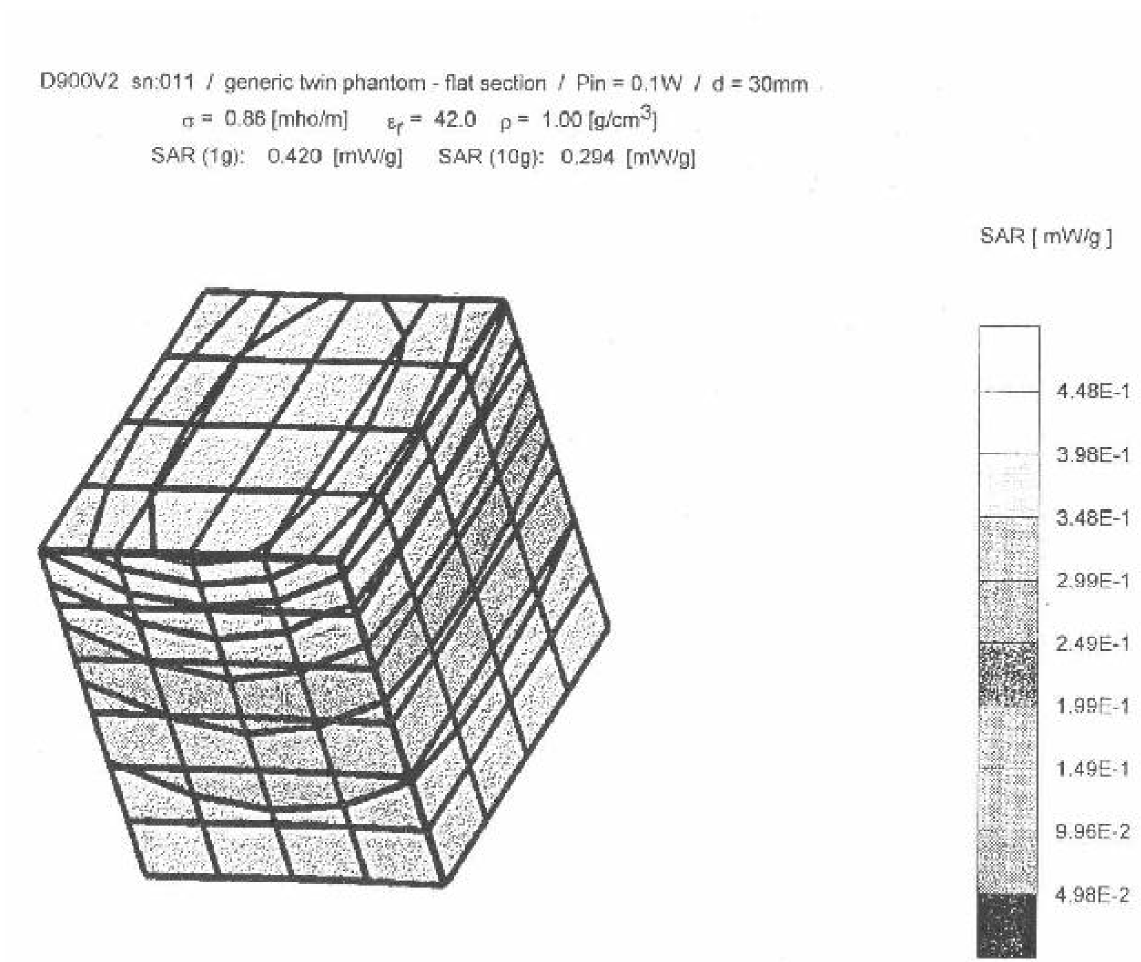
Feedpoint impedance at 900 MHz:	Re{Z}= 43.9Ω
	Im {Z} = 1.7Ω
Return Loss at 900 MHz	-23.2 dB

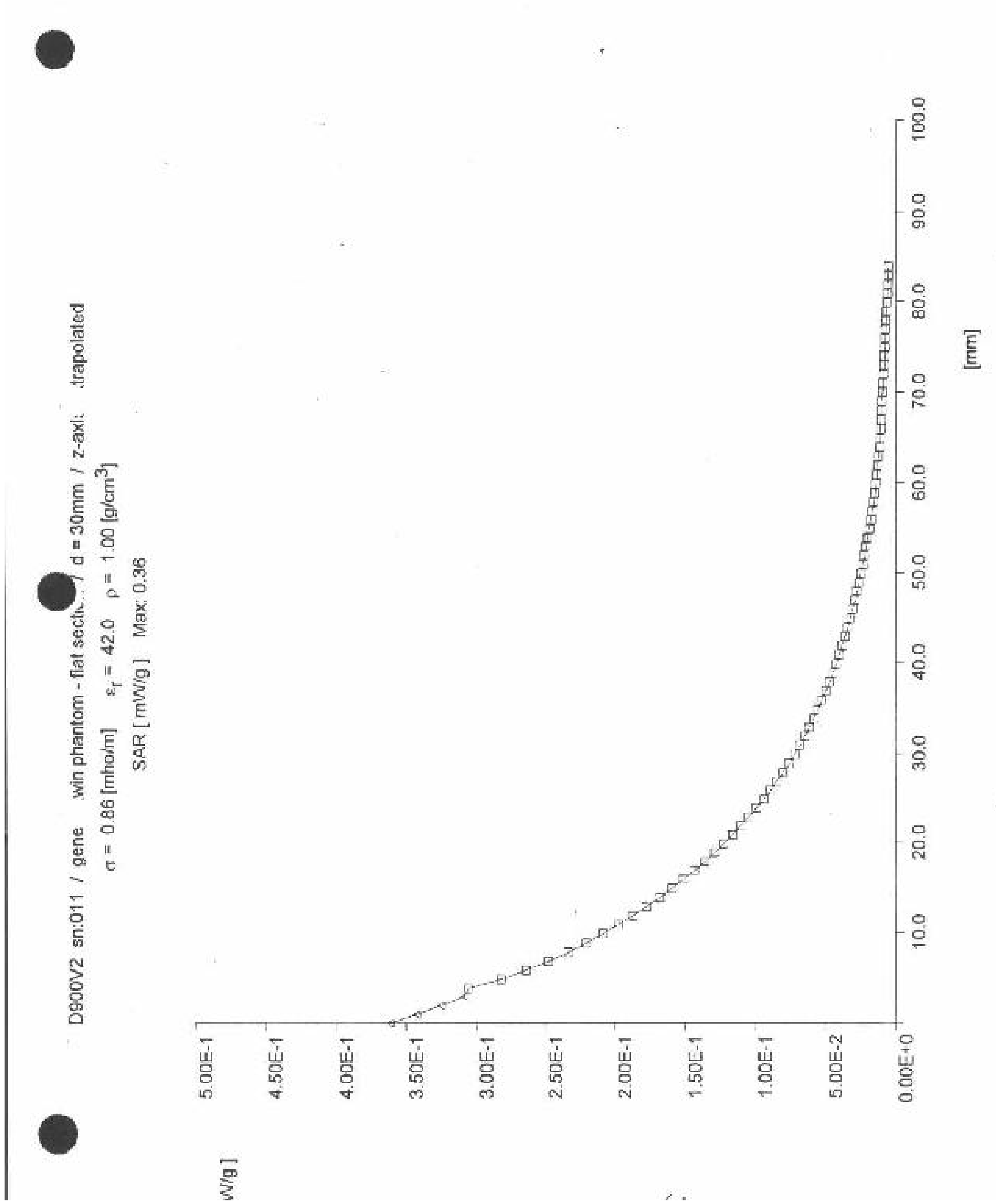
4. Handling

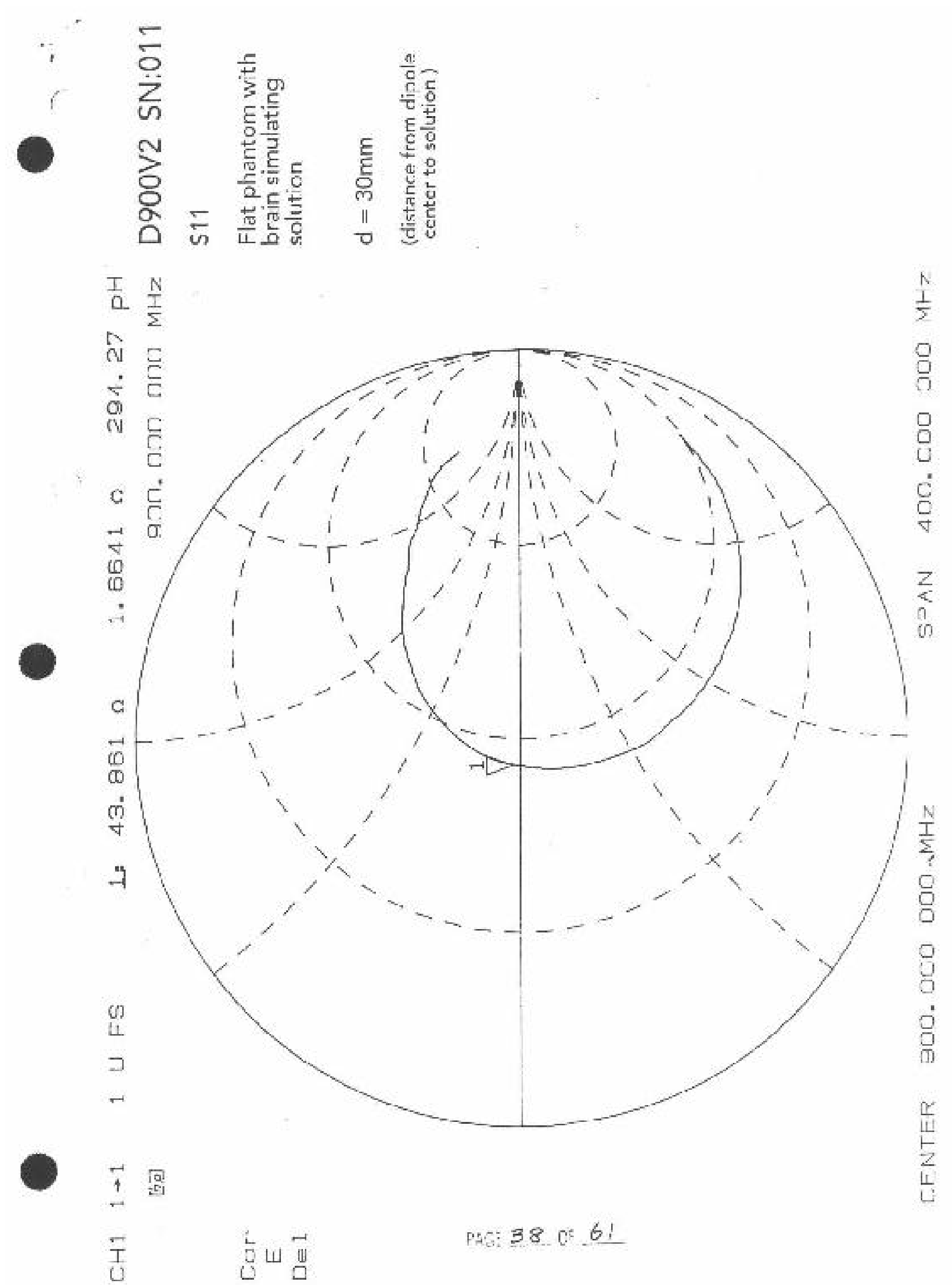
The dipole is made of standard sernirigid coaxial cable. The centre conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

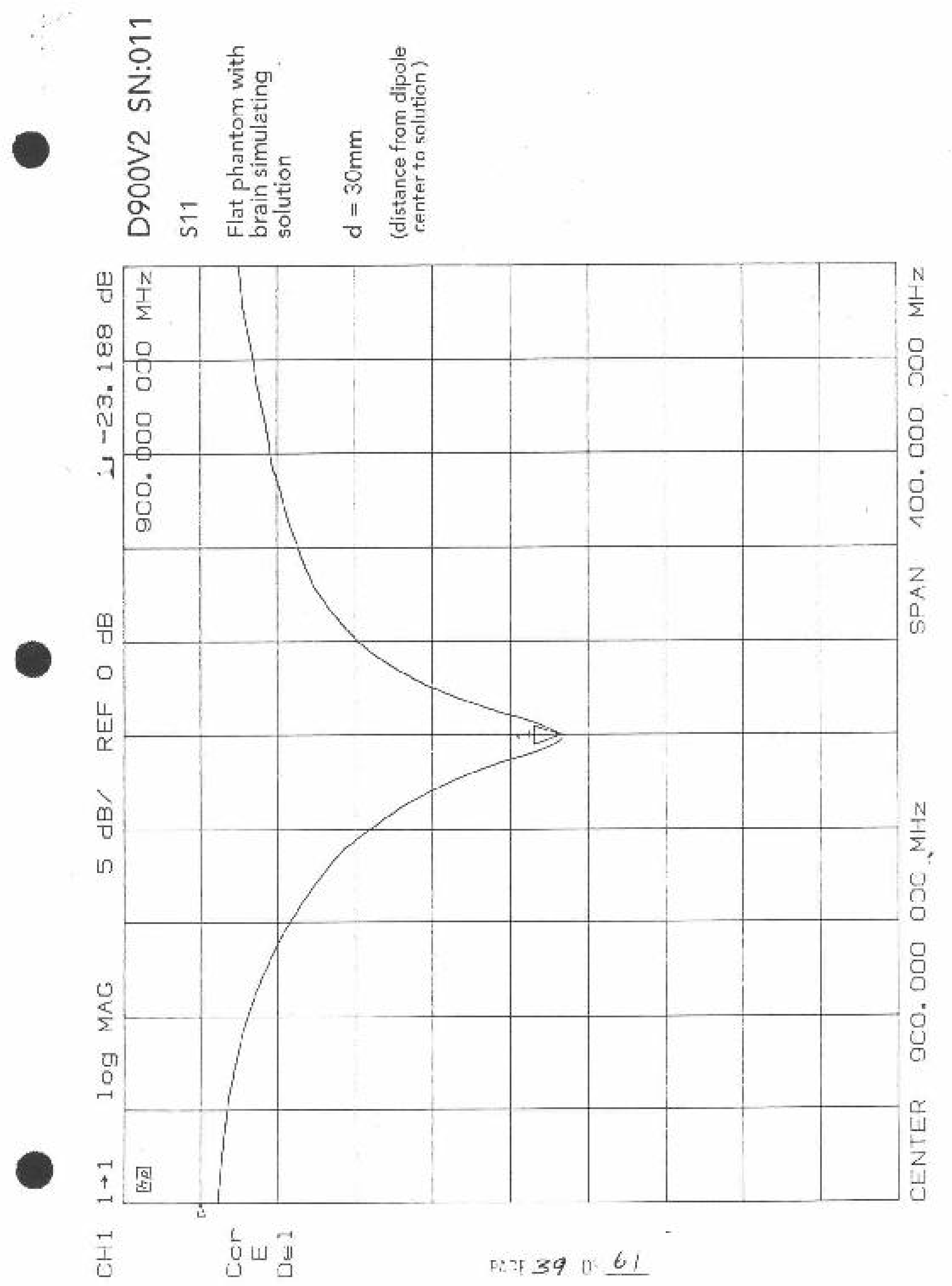
Do not apply excessive force to the dipole arms, because they might bend. if the dipole arms have to be bent back, take care to release stress to the soldered connections near the feedpoint; they might come off.

After prolonged use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.


D900V2 sn:011 / generic twin phantom - flat section / Pin = 0.1W / d = 30mm
σ = 0.86 [mho/m] εr = 42.0 ρ = 1.00 [g/cm3]
SAR (1g): 0.420 [mW/g] SAR (10g): 0.294 [mW/g]
SAR [mW/g]
4.48E-1
3.98E-1
3.48E-1
2.99E-1
2.49E-1
1.99E-1
1.49E-1
9.96E-2
4.98E-2


D900V2 sn:011 / gene win phantom - flat sectio / d = 30mm / z-axis trapolated
σ = 0.86 [mho/m] εr = 42.0 ρ = 1.00 [g/cm3]
SAR [mW/g] Max: 0.36
W/g]
5.00E-1
4.50E-1
4.00E-1
3.50E-1
3.00E-1
2.50E-1
2.00E-1
1.50E-1
1.00E-1
5.00E-2
0.00E+0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
[mm]


CH1 1→1 1 U FS 1: 43.861 Ω 1.6641 Ω 294.27 pH
900.000 000 MHz
Cor
E
Del
D900V2 SN:011
S11
Flat phantom with brain simulating solution
d = 30mm
(distance from dipole center to solution)
CENTER 300.000 000 MHz SPAN 400.000 000 MHz
PAGE 38 OF 61


D900V2 SN:011
S11
Flat phantom with brain simulating solution
d = 30mm
(distance from dipole center to solution)
CH1 S11 log MAG 5 dB/ REF 0 dB
1: -23.188 dB
900.000 000 MHz
CENTER 900.000 000 MHz
SPAN 400.000 000 MHz
PAGE 39 OF 61

1. Measurement Conditions

The measurements were performed in the flat section of the new generic twin phantom (shell thickness 2mm) filled with brain simulating sugar solution of the following electrical parameters at 900 MHz:

Relative Dielectricity	42.0	t5%
Conductivity	0.86 mho/m	t5%

The DASY2 System (Soffware version 2.3d) with a dosimetric E-field probe ET3DV4 (SN: 1302) was used for the measurements. The Conversion Factor (probe parameter) for this probe was 5.2.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the centre marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 3Omm from dipole centre to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 15mm was aligned with the dipole. The 5x5x7 fine cube was chosen for cube integration. Probe isotropy errors were cancelled by measuring the SAR with normal and 900 turned probe orientations and averaging. The dipole input power (forward power) was 100mW t 3 %. The results are normalised to 1W input power.

2. SAR Measurement

Standard SAR-measurements were performed with the phantom according to the measurement conditions described in section 1. The results have been normalised to a dipole input power of 1W (forward power). The resulting averaged SAR-values are:

averaged over 1 cm^3 (1 g) of tissue:	4.18 mW/g
averaged over 10 cm^3 (10 g) of tissue:	2.93 mW/g

If the liquid parameters for validation are slightly different from the ones used for initial calibration, the SAR-values will be different as well. The estimated sensitivities of SAR-values and penetration depths to the liquid parameters are listed in the DASY Application Note 4: 'SAR Sensitivities'.

Probe Calibration Data

Probe ET3DV4

SN: 1123

Manufactured: April 96
Recalibrated: 20 September 97

Introduction

The performance of all probes is measured before delivery. This includes an assessment of the characteristic parameters, receiving patterns as a flinction of frequency, frequency response and relative accuracy. Furthermore, each probe is tested in use according to a dosimetric assessment protocol. The sensitivity parameters (NormX, NormY, NormZ), the diode compresion parameter (DCP) and the conversion factor (ConvF) of the probe and some of the measurement diagrams are given in the following.

The performance of the individual probes varies slightly due to tolerances arising from the manufacturing process. Since the lines are highly resistive (several MOhms), the offset and noise problem is greatly increased if signals in the low µV range are measured. Accurate measurement below 10 µW/g are possible if the following precautions are taken. ~) check the current grounding with the *multimeter* i.e., low noise levels, 2) compensate the current *offset*[1], 3) use long integration time (approx. 10 seconds), 4) *calibrate*[1] before each measurement,
5) persons should avoid moving around the lab while measuring.

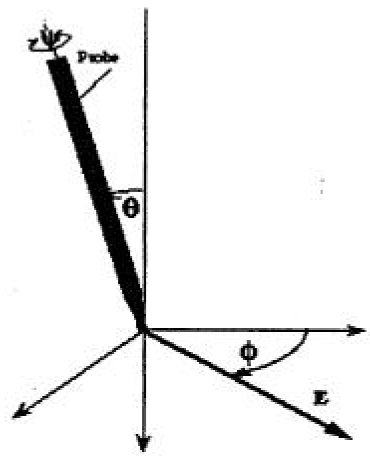


Fig 1: Due to the field distortion caused by the supporting material, the probe has two characteristic directions, referred to as angle ψ and θ.

Since the field distortion caused by the supporting material and the sheath is quite high in the θ direction, the receiving pattern is poor in air. However, the distortion in tissue equivalent material is much less because of its high dielectricity. In addition, the fields induced in the phantoms by dipole structures close to
the body are dominently parallel to the surface. Thus, the error due to non-isotropy is much better than 1 dB for dosimetric assessments.

The probes are calibrated in the TEM cell ifi 110 although the field distribution in the cell is not very uniform and the frequency response is not very flat. To ensure consistency, a strict protocol is followed. The conversion factor (ConF) between this calibration and the measurement in the tissue simulation solution is performed by comparison with temperature measurements and computer simulations. This conversion factor is only valid for the specified tissue simulating liquids at the specified frequencies. If measurements have to be performed in solutions with other electrical properties or at other frequencies, the conversion factor has to be assessed by the same procedure.

As the probes have been constructed with printed resistive lines on ceramic substrates (thick film technique), the probe is very delicate with respect to mechanical shocks.

Attention:

Do not drop the probe or let the probe collide with any solid object. Never let the robot move without first activating the emergency stop feature (i.e., without first turning the data acquisition electronics on).

1. Feature of the DASY2 Software Tool.

Parameters of Probe ET3DV4 SN:1123

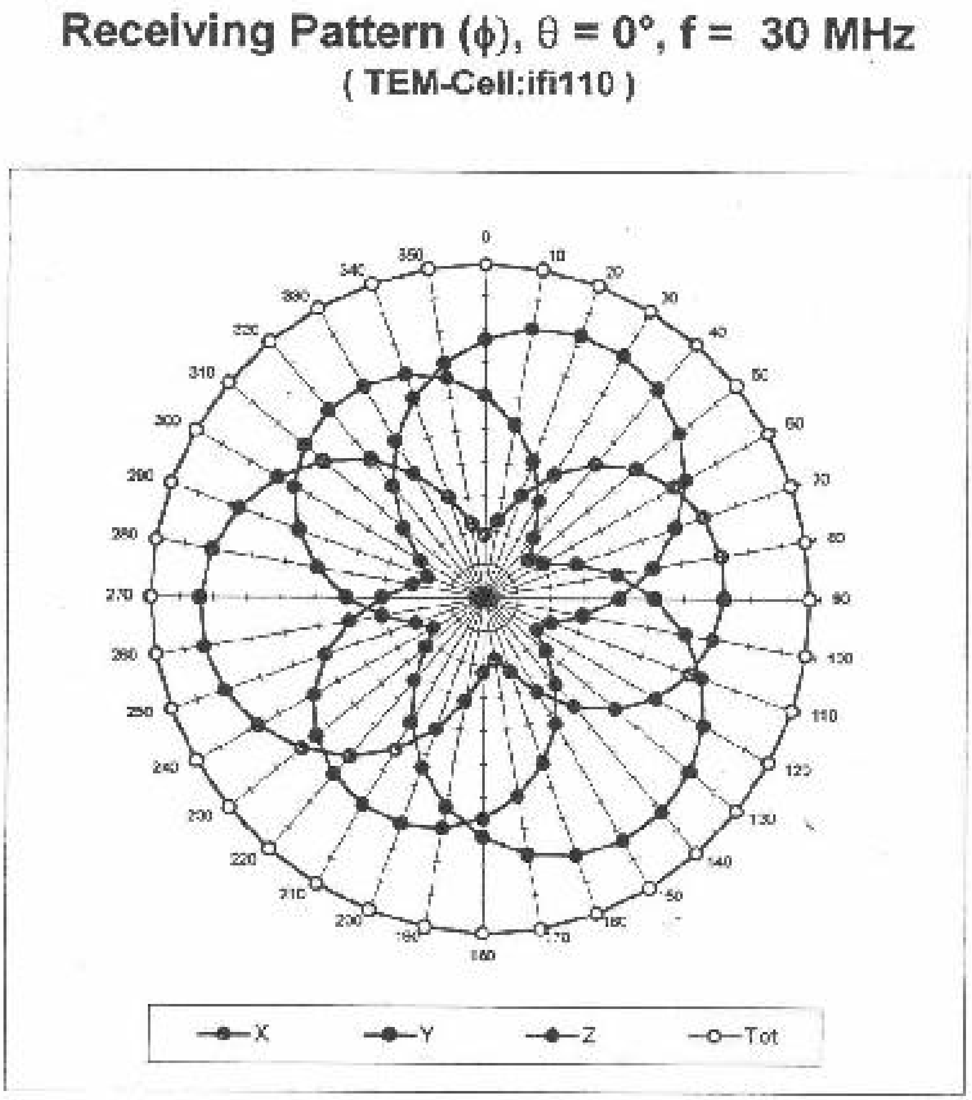
NormX	**1.75**	$\mu V/(V/m)^2$
NormY	**1.82**	$\mu V/(V/m)^2$
NormZ	**1.71**	$\mu V/(V/m)^2$
DCP	**41000**	µV

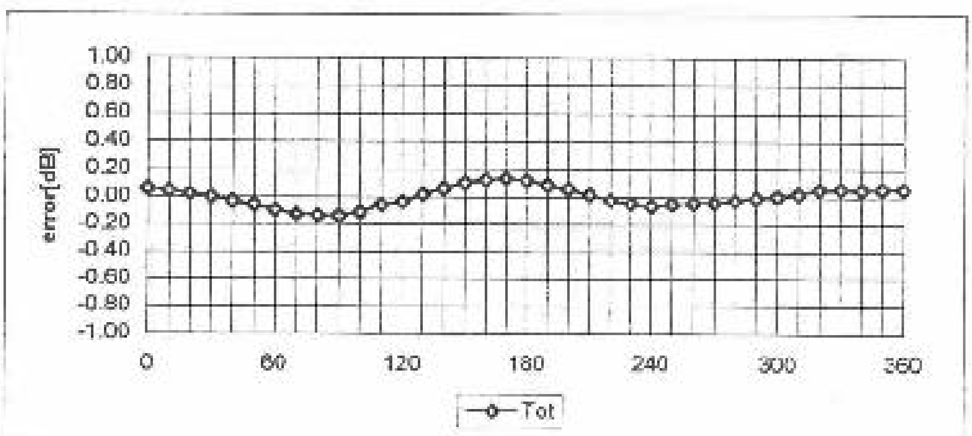
ConvF(450MHz)	**6.6 ± 10%**	**εr = 47.2 ± 5%; σ= 0.45 ± 10% mho/m**[1]
ConvF(9OOMHz)	**5.7 ± 10%**	**εr = 42.5 ± 5%; σ= 0.85 ± 10% mho/m**
ConvF(800MHz)	**4.8 ± 10%**	**εr = 41.0 ± 5%; σ= 1.69 ± 10% mho/m**

$d_{probe\_tip - center\_dipoles}$	2.7	mm
$d_{surface - probe\_tip}$	1.3 ± 0.2	mm

[1] Brain tissue simulating liquids

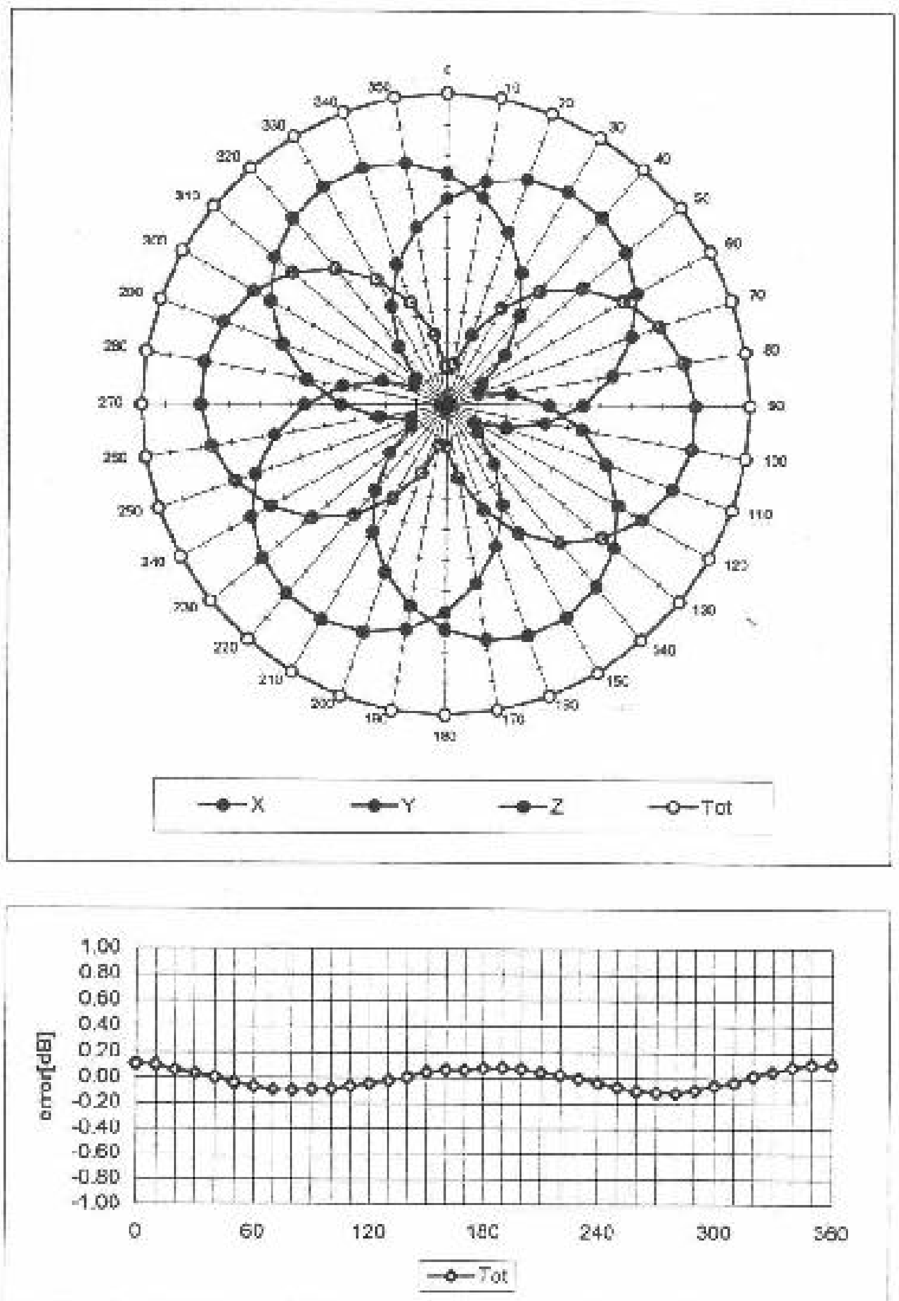
ET'3DV4 SN:1123



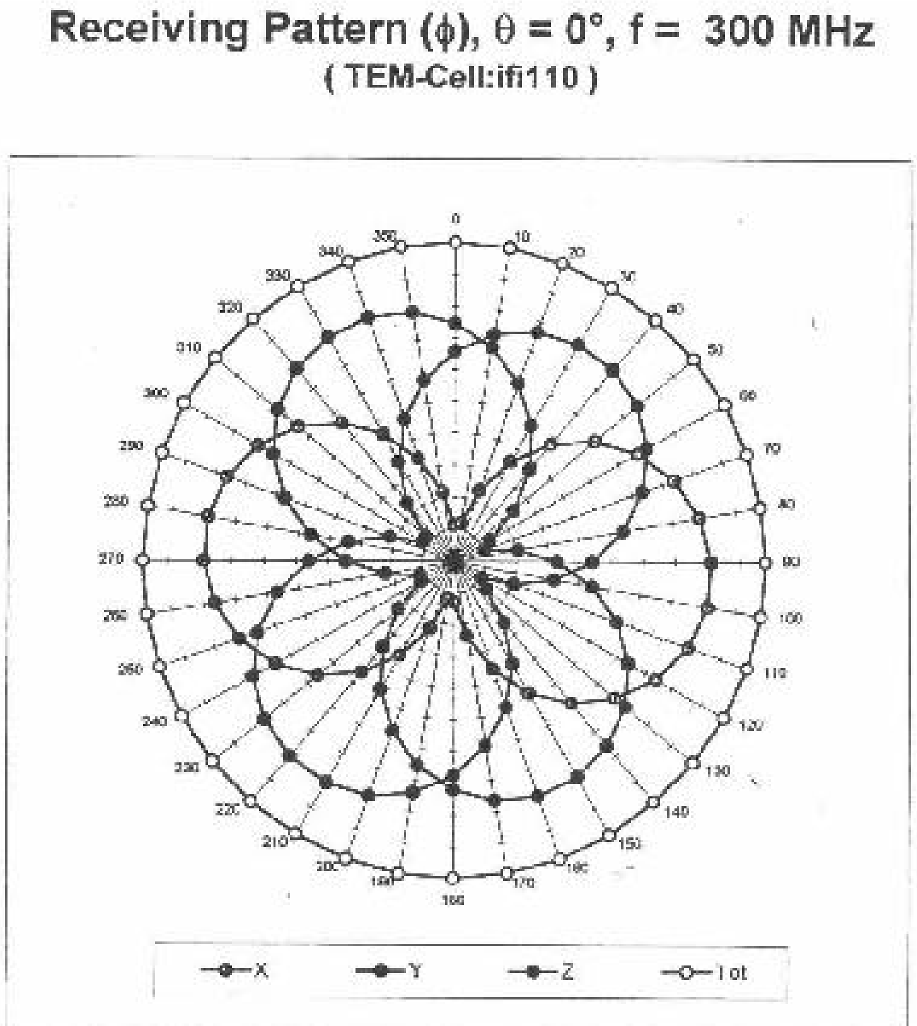


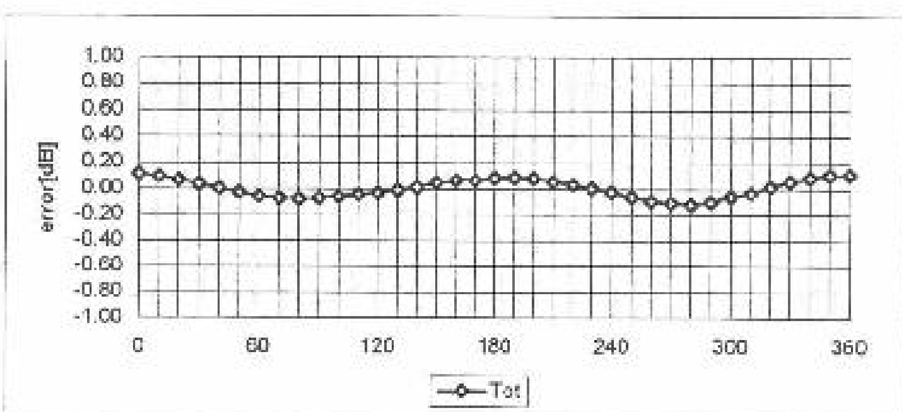
ET'3DV4 SN:1123

Receiving Pattern (ϕ), θ = 0°, f = 100 MHz
(TEM-Cell:ifi110)

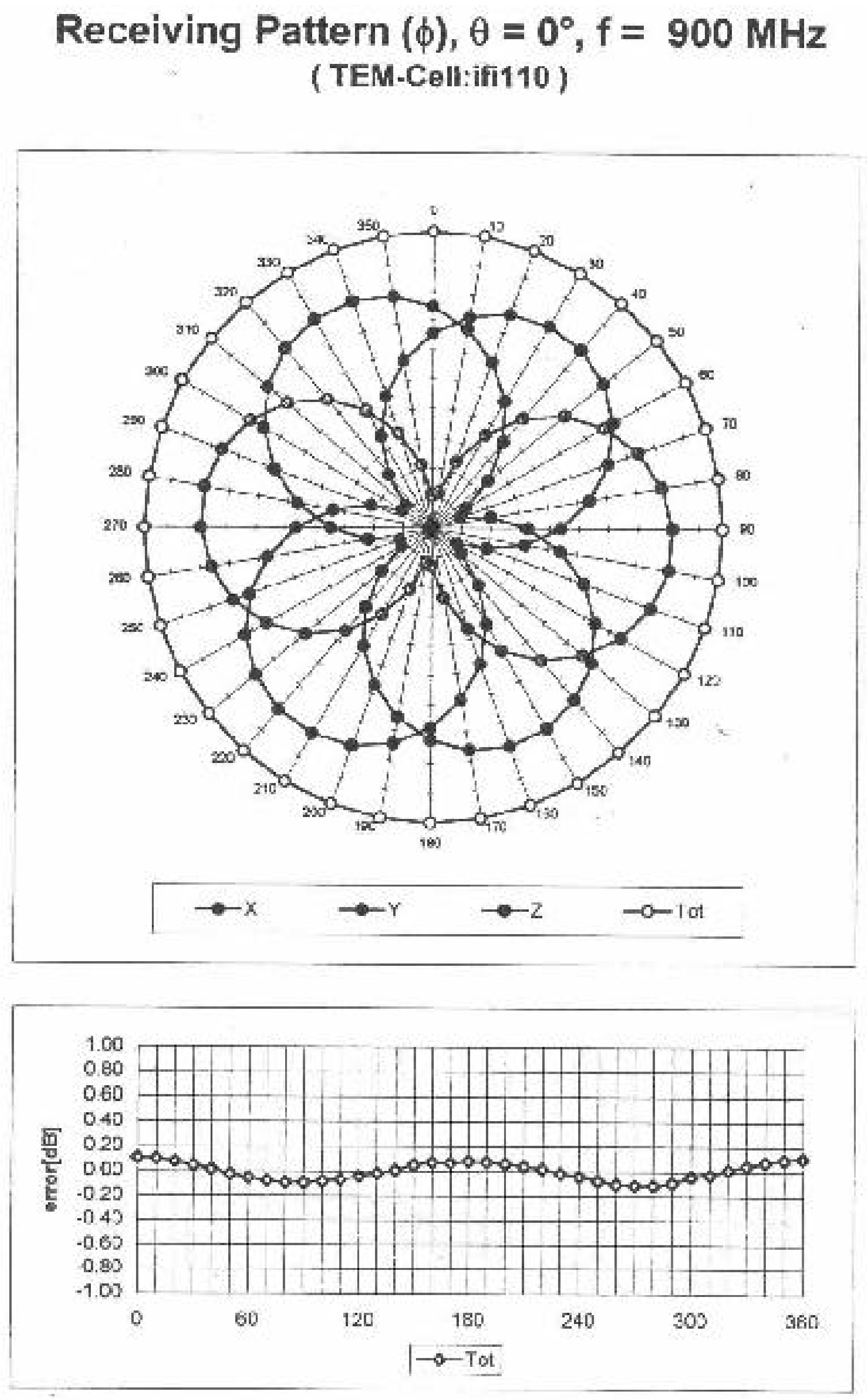


ET'3DV4 SN:1123



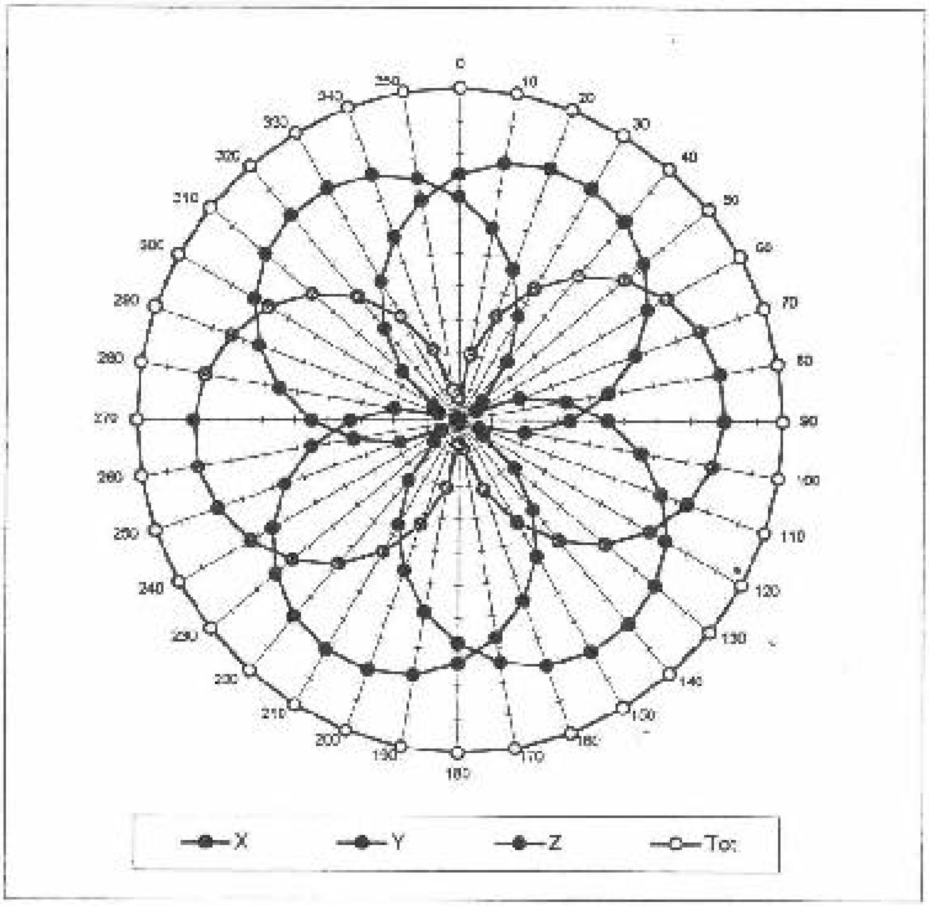


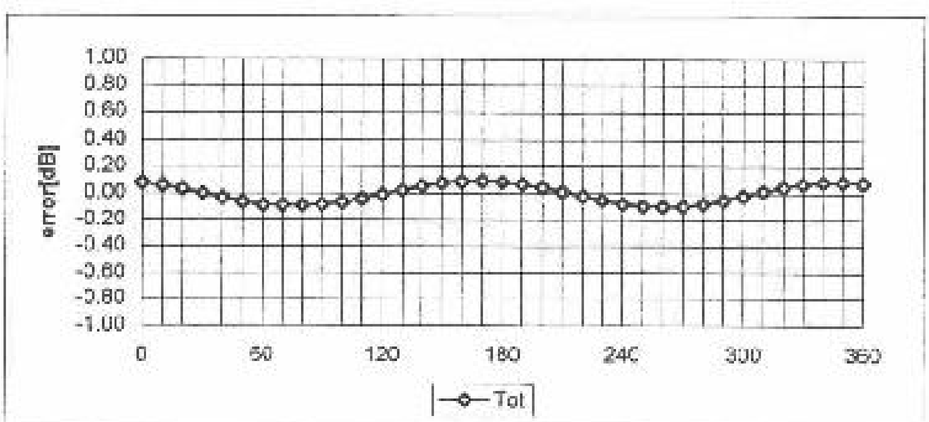
ET'3DV4 SN:1123



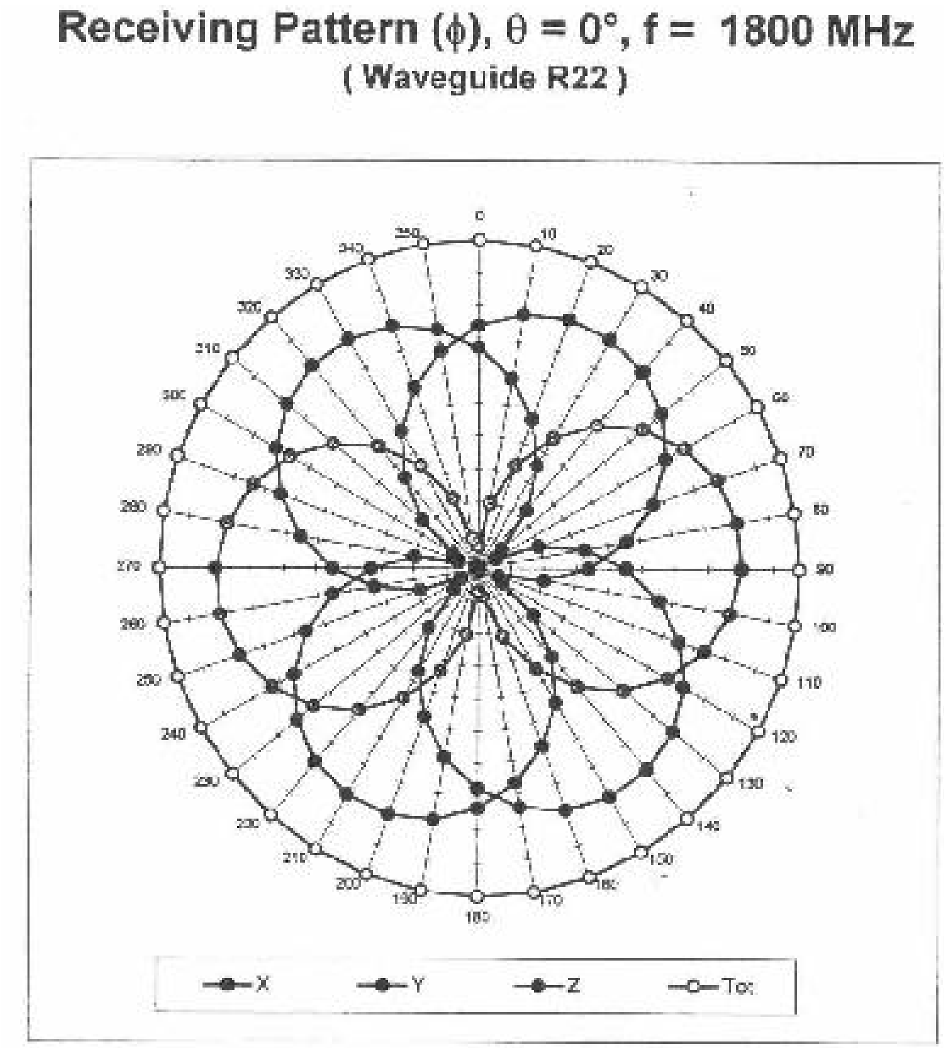
ET'3DV4 SN:1123

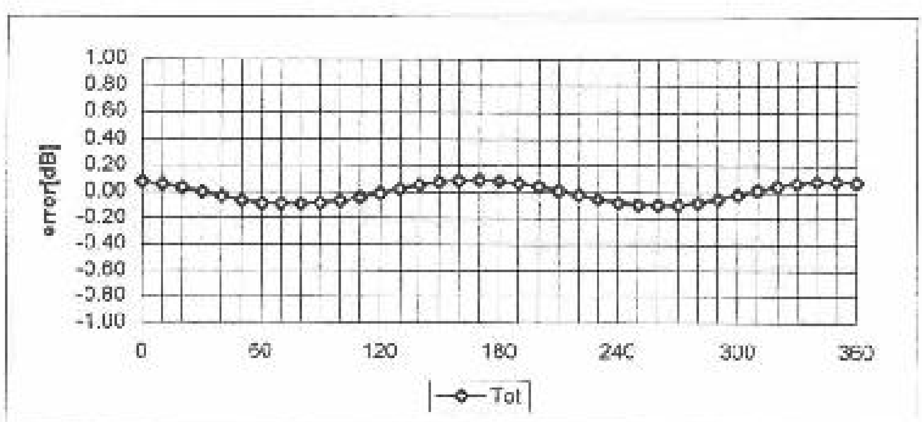
Receiving Pattern (φ), θ = 0°, f = 1800 MHz
(Waveguide R22)





ET'3DV4 SN:1123

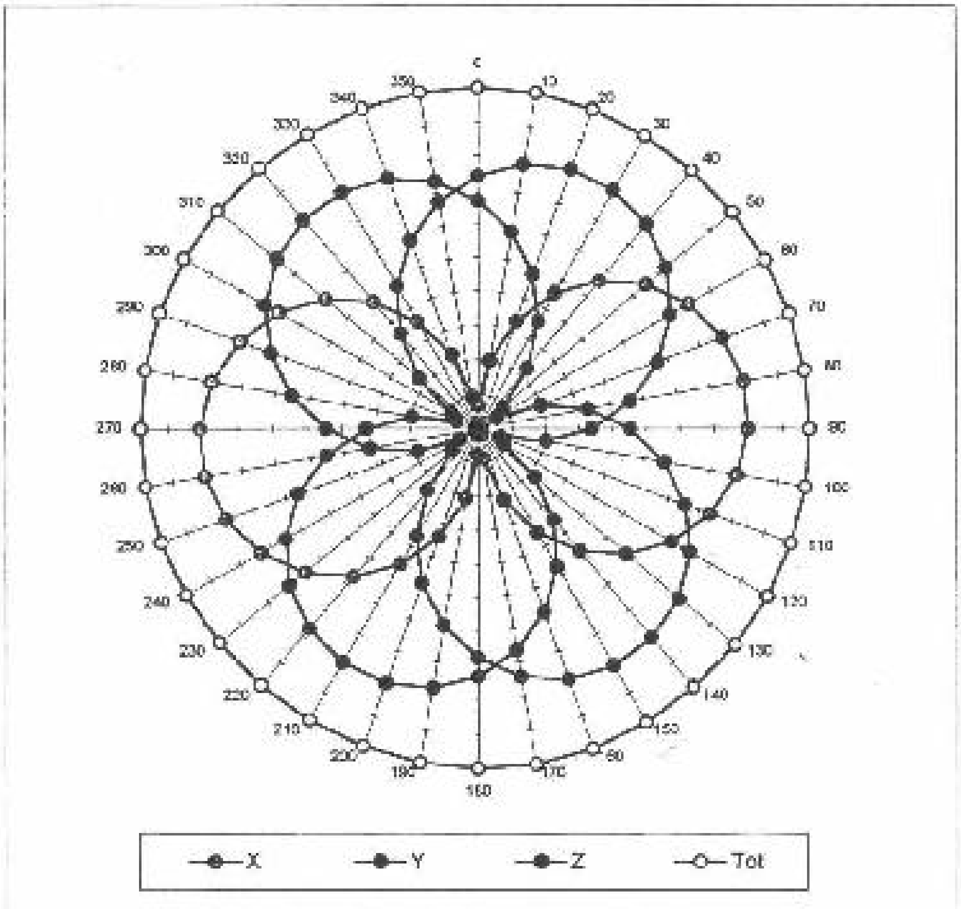


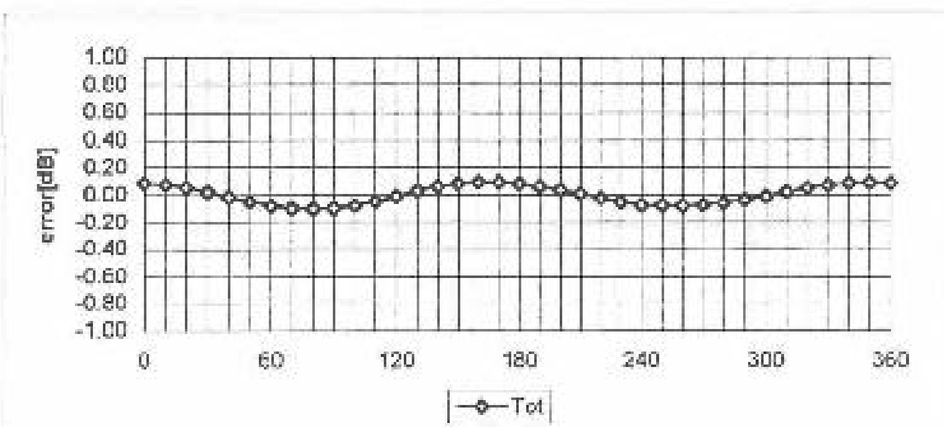


ET'3DV4 SN:1123

Receiving Pattern (ϕ), θ = 0°, f = 2500 MHz

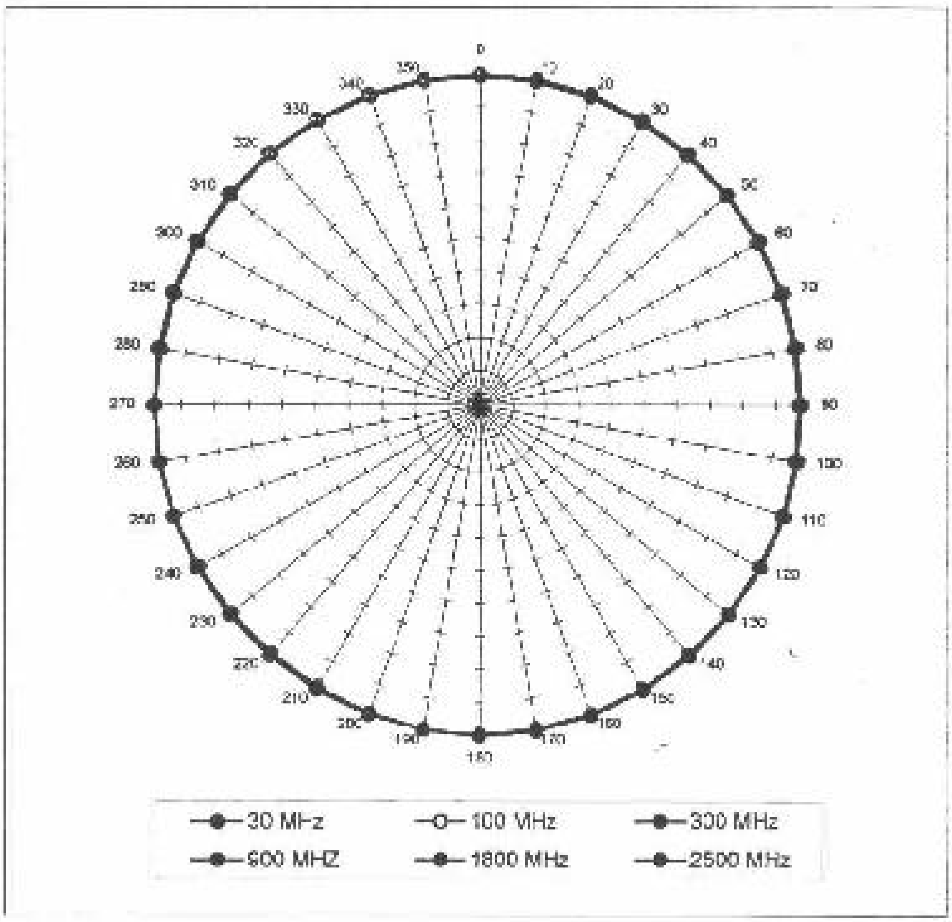
(Waveguide R26)

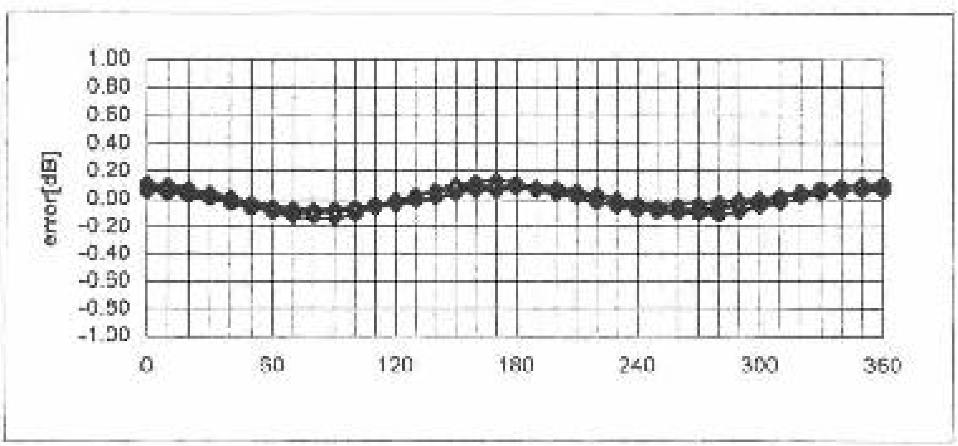




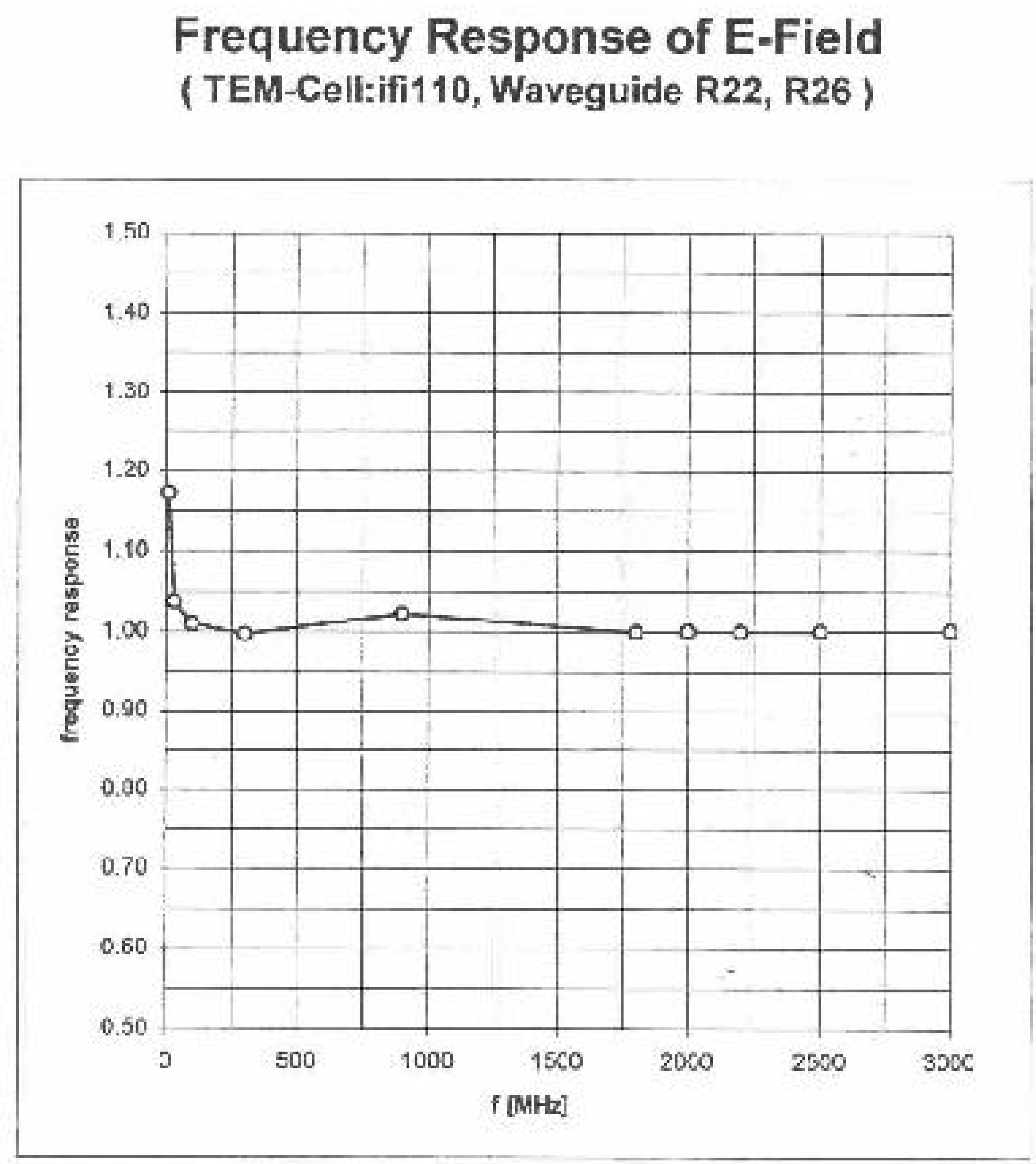
ET'3DV4 SN:1123

Receiving Pattern (φ,f), θ = 0°



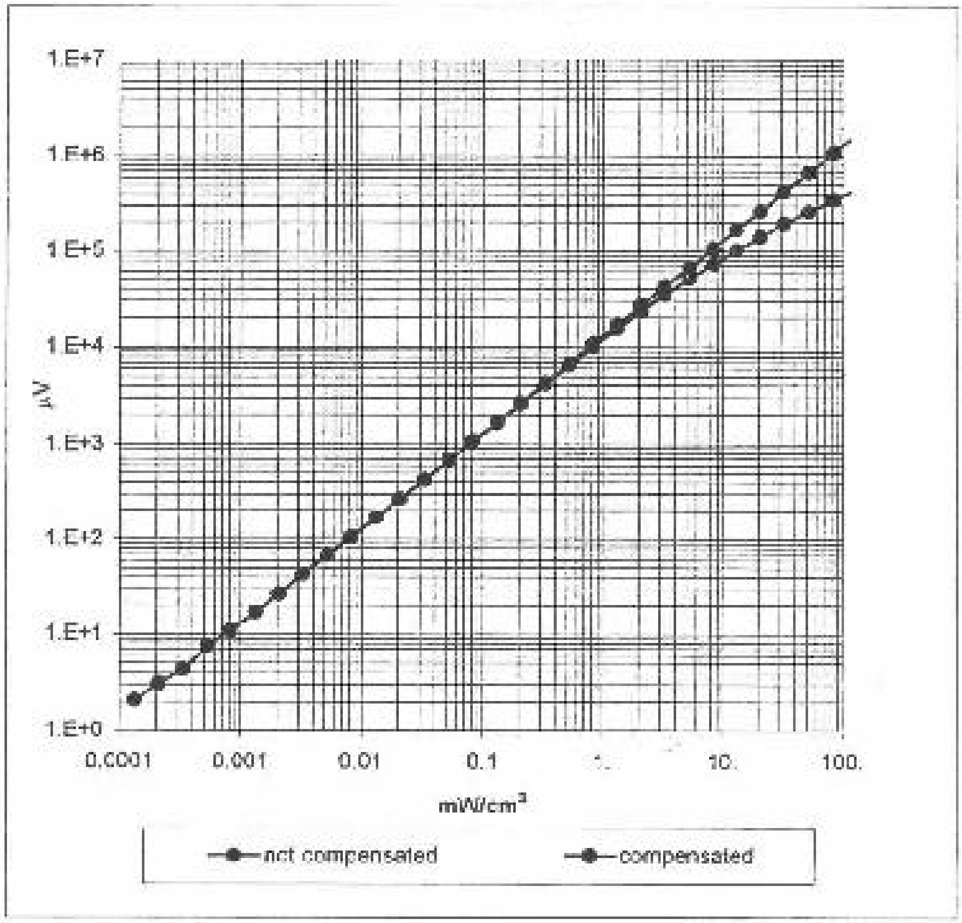


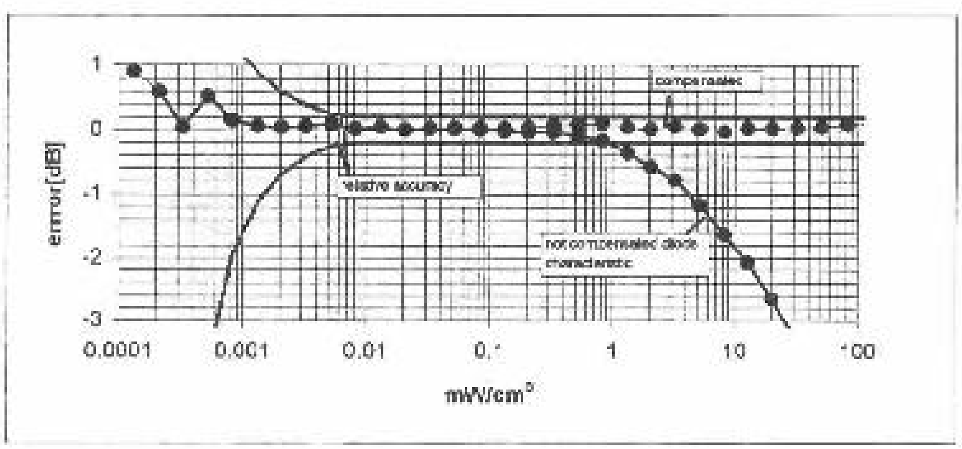
ET'3DV4 SN:1123



ET'3DV4 SN:1123

Dynamic Range f(SAR_{brain})
(TEM-Cell:ifi110)

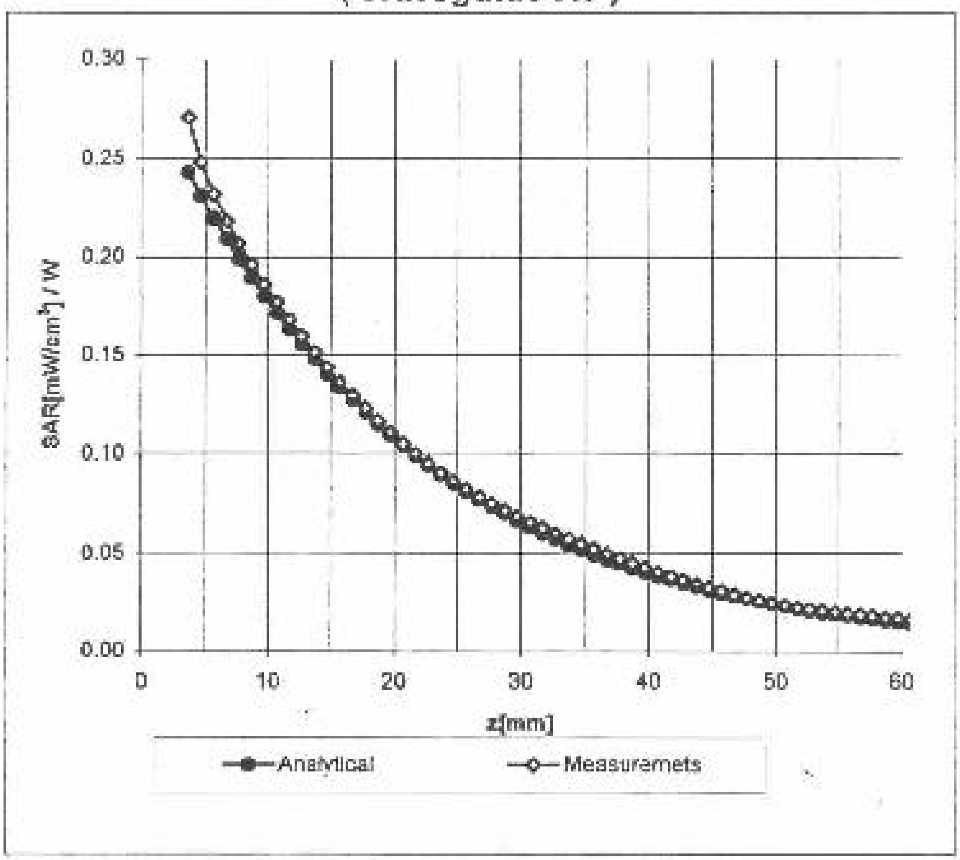




ET'3DV4 SN:1123

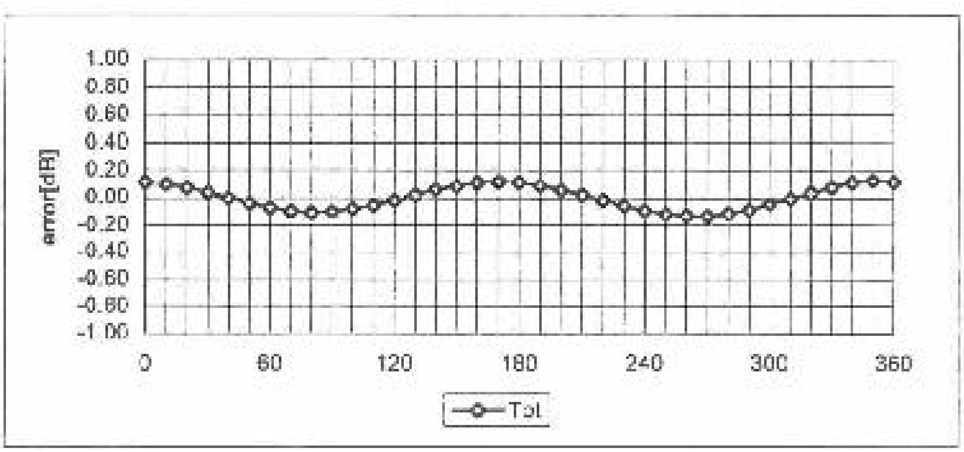
Conversion Factor Assessment, f = 900 MHz

(Waveguide R9)



Receiving Pattern (ϕ)

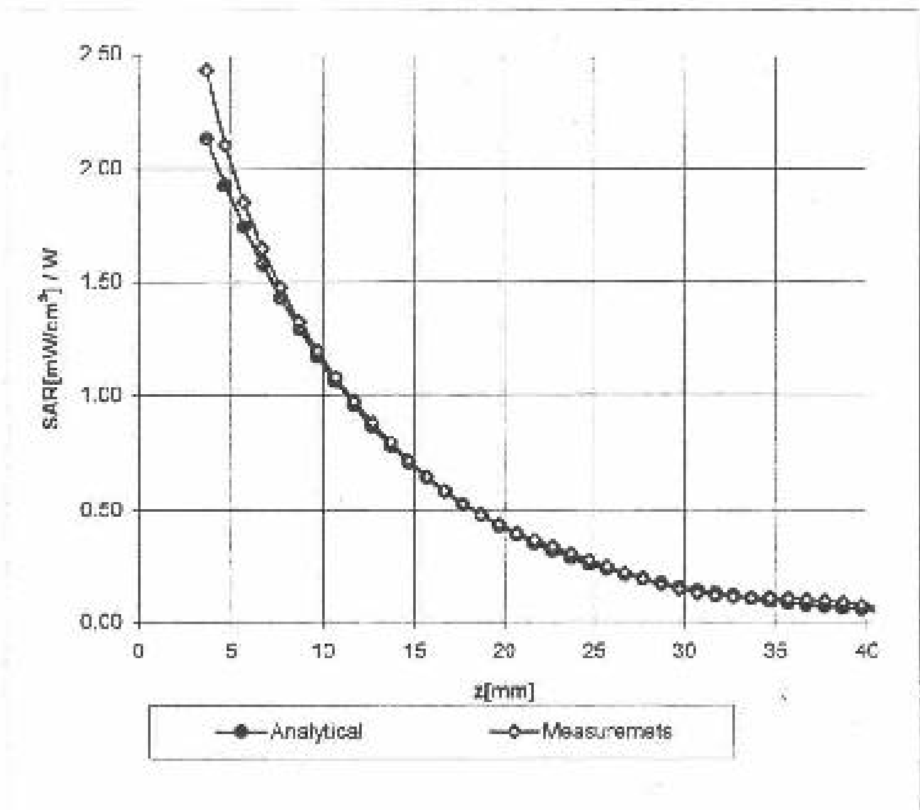
(in brain tissue, z = 5 mm)



ET'3DV4 SN:1123

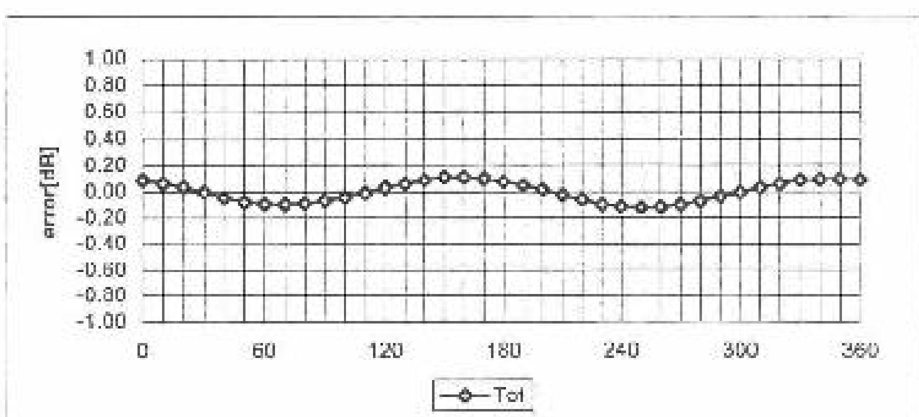
Conversion Factor Assessment, f = 1800 MHz

(Waveguide R22)



Receiving Pattern (ϕ)

(in brain tissue, z = 5 mm)

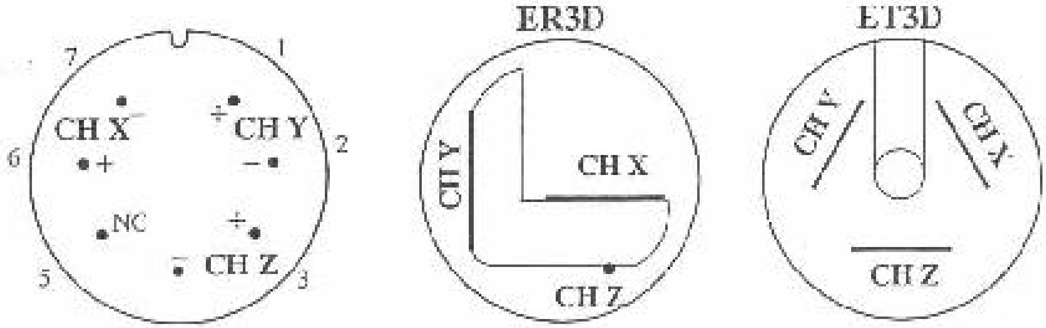


Additional Information

about Probes & Calibration

Connector Layout

Connector Plan



Connector
(seen from back)

Probes
(seen from front)

The antistatic shielding inside the probe is connected to the probe connector case.

It is recommended to connect the probes with the amplifier using a short and well shielded cable and to connect the cable shielding with the connector case.

Voltage Conversions

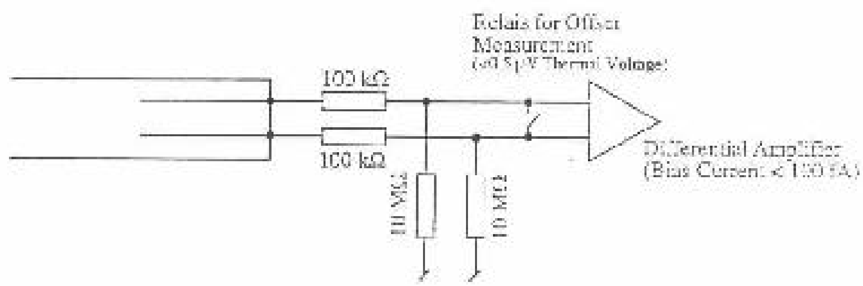
Conversion of Connector Voltage u_i to E-Field E_i

$$E_i = \sqrt{\frac{u_i + (u_i^2 \cdot CF)/(2 \cdot DCP)}{Norm_i \cdot ConvF}}$$

whereby

E_i:	electric field in V/m
u_i:	voltage of channel i at the connector in µV
$Norm_i$:	sensitivity of channel i in $\mu V/(V/m)^2$
$ConvF$:	enhancement factor in liquid (ConvF=1 for Air)
DCP:	diode compression point in µV
CF:	crest factor (peak power/average power)

Conditions of Calibration



please note:

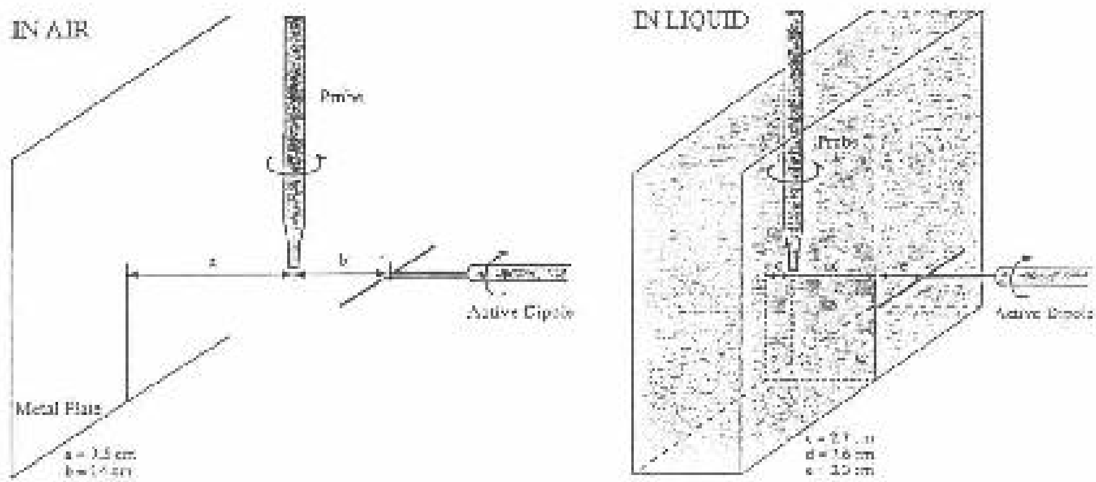
- a different input impedance of the amplifier will result in different sensitivity factors $Norm_i$ and DCP.
- larger bias currents will cause higher offset levels

Calibration Setups

Calibration Setups

The calibration technique used is presented in detail in the attached publication: "Broadband Calibration of E-Field Probes in Lossy Media"

In addition, the deviation for all polarizations was assessed with the following setup



Please note: The setups were chosen to have a homogeneous field in the calibration site. In inhomogeneous fields an additional isotropy error due to the spacing between probe axis and probe dipole centers will appear.

ISO Certificate

KEMA REGISTERED QUALITY

AFFILIATED WITH N.V. KEMA IN THE NETHERLANDS
A MEMBER OF THE EUROPEAN NETWORK FOR QUALITY SYSTEM ASSESSMENT AND CERTIFICATION (EQNET)

CERTIFICATE

Number: 10083.01

The quality system of:

Lucent Technologies Inc.
Bell Labs Innovations
Global Product Compliance Laboratory
101 Crawfords Corner Road - Room 11C-165
P.O. Box 3030
Holmdel, NJ 07733-3030

including its implementation, meets the requirements of the standard

ISO 9002:1994

Scope:
Electromagnetic Compatibility, Product Safety, and Telecommunications Network Interconnect International Conformity Assessment Test Services.

Reports that form the basis of this certificate:
10083.01.P001; 10083.01.P002; 10083.01.P003; 10083.01.C001; 10083.01.C002; 10083.01.C003; 10083.01.CH01 up to and including 10083.01.S001

This certificate is valid until: February 1, 1998
Revision date: August 6, 1996
Issued for the first time: February 1, 1995

Jan Blom, Director
Board of Directors
KEMA-Registered Quality, Inc.

The method of operation for quality system certification is defined in the KRQ Regulations for Quality System Certification. Integral publication of this certificate and adjoining reports is allowed.

KEMA-REGISTERED QUALITY, INC.
4379 County Line Road
Chalfont, PA 18914
Phone: (215) 822-4258 Fax: (215) 822-4285

ACCREDITED BY:

The Dutch Council for Accreditation (RvA)
The Registrar Accreditation Board (RAB)

NVLAP Certificate

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

ISO/IEC GUIDE 25:1990
ISO 9002:1987

Certificate of Accreditation

LUCENT TECHNOLOGIES, GLOBAL PRODUCT COMPLIANCE LAB
HOLMDEL, NJ

is recognized under the National Voluntary Laboratory Accreditation Program for satisfactory compliance with criteria established in Title 15, Part 285 Code of Federal Regulations. These criteria encompass the requirements of ISO/IEC Guide 25 and the relevant requirements of ISO 9002 (ANSI/ASQC Q92-1987) as suppliers of calibration or test results. Accreditation is awarded for specific services, listed on the Scope of Accreditation for:

ELECTROMAGNETIC COMPATIBILITY AND TELECOMMUNICATIONS
FCC

September 30, 1998
Effective through

For the National Institute of Standards and Technology
NVLAP Lab Code: 100275-0

NVLAP-01C (11-95)