

# SAR EVALUATION REPORT

For

## MAXON ELECTRONICS AUSTRALIA PTY. LTD.

36A Gibson Ave, Padstow  
New South Wales 2212, Australia

**FCC ID: Q2FMM-5100U**

2004-02-13

<b>This Report Concerns:</b> <input checked="" type="checkbox"/> Original Report	<b>Equipment Type:</b> CDMA Voice/Data Modem
<b>Test Engineer:</b> Eric Hong / 	
<b>Report No.:</b> R0401121S	
<b>Test Date:</b> 2004-01-29 	
<b>Reviewed By:</b> Hans Mellberg/	
<b>Prepared By:</b> Bay Area Compliance Laboratory Corporation 230 Commercial Street Sunnyvale, CA 94085 Tel: (408) 732-9162 Fax: (408) 732 9164	

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## SUMMARY

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The US Federal Communications Commission has released the report and order "Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996 [1].

The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 mW/g as recommended by the ANSI/IEEE standard C95.1-1992 [6] for an uncontrolled environment (Paragraph 65). According to the Supplement C of OET Bulletin 65 "Evaluating Compliance with FCC Guide-lines for Human Exposure to Radio frequency Electromagnetic Fields", released on Jun 29, 2001 by the FCC, the device should be evaluated at maximum output power (radiated from the antenna) under "worst-case" conditions for normal or intended use, incorporating normal antenna operating positions, device peak performance frequencies and positions for maximum RF energy coupling.

This report describes the methodology and results of experiments performed on wireless data terminal. The objective was to determine if there is RF radiation and if radiation is found, what is the extent of radiation with respect to safety limits. SAR (Specific Absorption Rate) is the measure of RF exposure determined by the amount of RF energy absorbed by human body (or its parts) – to determine how the RF energy couples to the body or head which is a primary health concern for body worn devices. The limit below which the exposure to RF is considered safe by regulatory bodies in North America is 1.6 mW/g average over 1 gram of tissue mass.

The test configurations were laid out on a specially designed test fixture to ensure the reproducibility of measurements. Each configuration was scanned for SAR. Analysis of each scan was carried out to characterize the above effects in the device.

The investigation was limited to the worst-case scenario from the device usage point of view. For the clarity of data analysis, and clarity of presentation, only one tissue simulation was used for the head and body simulation. This means that if SAR was found at the headset position, the magnitude of SAR would be overestimated comparing to SAR to a headset placed in the ear region.

There was no SAR of any concern measured on the device for any of the investigated configurations, please see following table for testing result summary:

## 1 - REFERENCE

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- [1] Federal Communications Commission, \Report and order: Guidelines for evaluating the environmental effects of radiofrequency radiation", Tech. Rep. FCC 96-326, FCC, Washington, D.C. 20554, 1996.
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- [5] CENELEC, \Considerations for evaluating of human exposure to electromagnetic fields (EMFs) from mobile telecommunication equipment (MTE) in the frequency range 30MHz - 6GHz", Tech. Rep., CENELEC, European Committee for Electrotechnical Standardization, Brussels, 1997.
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- [12] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recepies in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992. Dosimetric Evaluation of Sample device, month 1998 9
- [13] NIS81 NAMAS, \The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.
- [14] Barry N. Taylor and Christ E. Kuyatt, \Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994. Dosimetric Evaluation of Sample device, month 1998 10

## 2 - TESTING EQUIPMENT

Type / Model	Cal. Date	S/N:
DASY3 Professional Dosimetric System	N/A	N/A
Robot RX60L	N/A	F00/5H31A1/A/01
Robot Controller	N/A	F01/5J72A1/A/01
Dell Computer Optiplex GX110	N/A	N/A
Pentium III, Windows NT	N/A	N/A
SPEAG EDC3	N/A	N/A
SPEAG DAE3	6/04	456
SPEAG E-Field Probe ET3DV6	9/7/02	1604
SPEAG Dummy Probe	N/A	N/A
SPEAG Generic Twin Phantom	N/A	N/A
SPEAG Light Alignment Sensor	N/A	278
Apprel Validation Dipole D-1800-S-2	11/6/04	BCL-049
SPEAG Validation Dipole D900V2	9/3/04	122
Brain Equivalent Matter (800MHz)	Daily	N/A
Brain Equivalent Matter (1900MHz)	Daily	N/A
Brain Equivalent Matter (2450MHz)	Daily	N/A
Muscle Equivalent Matter (800MHz)	Daily	N/A
Muscle Equivalent Matter (1900MHz)	Daily	N/A
Muscle Equivalent Matter (2450MHz)	Daily	N/A
Robot Table	N/A	N/A
Phone Holder	N/A	N/A
Phantom Cover	N/A	N/A
HP Spectrum Analyzer HP8593GM	6/20/04	3009A00791
Microwave Amp. 8349B	N/A	2644A02662
Power Meter HP436A	4/2/04	2709A29209
Power Sensor HP8482A	4/2/04	2349A08568
Signal Generator RS SMIQ O3	2/10/04	1084800403
Network Analyzer HP-8753ES	7/30/04	820079
Dielectric Probe Kit HP85070A	N/A	N/A
Apprel Validation Dipole D-2450-S-1	10/1/04	BCL-141
Dipole Antenna AD-100 (450MHz)	5/7/04	02220

### 2.2 Equipment Calibration Certificate

Please see the attached file.

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

**Client** Bay Area Comp. Lab (BACL)

## CALIBRATION CERTIFICATE

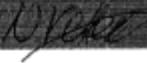
Object(s)	ES3DV2 - SN:3019
Calibration procedure(s)	QA.CAL-01.v2 Calibration procedure for dosimetric E-field probes
Calibration date:	October 9, 2003
Condition of the calibrated item	In Tolerance (according to the specific calibration document)

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 International standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM E4419B	GB41293674	2-Apr-03 (METAS, No 252-0250)	Apr-04
Power sensor E4412A	MY41495277	2-Apr-03 (METAS, No 252-0250)	Apr-04
Reference 20 dB Attenuator	SN: 5086 (20b)	3-Apr-03 (METAS No. 251-0340)	Apr-04
Fluke Process Calibrator Type 702	SN: 6295803	8-Sep-03 (Sintrel SCS No. E-030020)	Sep-04
Power sensor HP 8481A	MY41092180	18-Sep-02 (Agilent, No. 20020918)	In house check: Oct 03
RF generator HP 8684C	US3642U01700	4-Aug-00 (SPEAG, In house check Aug-02)	In house check: Aug-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (Agilent, No. 24BR1033101)	In house check: Oct 03

Calibrated by:	Name	Function	Signature
	Nico Waller	Technician	
Approved by:	Katja Pokorny	Laboratory Director	

Date issued: October 9, 2003

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

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Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, http://www.speag.com

# Probe ES3DV2

**SN:3019**

## Additional Conversion Factors

Manufactured: December 5, 2002  
Last calibration: July 12, 2003  
Add. calibration: October 9, 2003

## Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

Page 1 of 6

**DASY - Parameters of Probe: ES3DV2 SN:3019****Sensitivity in Free Space**

NormX	<b>1.05</b> $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	<b>1.14</b> $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	<b>0.98</b> $\mu\text{V}/(\text{V}/\text{m})^2$

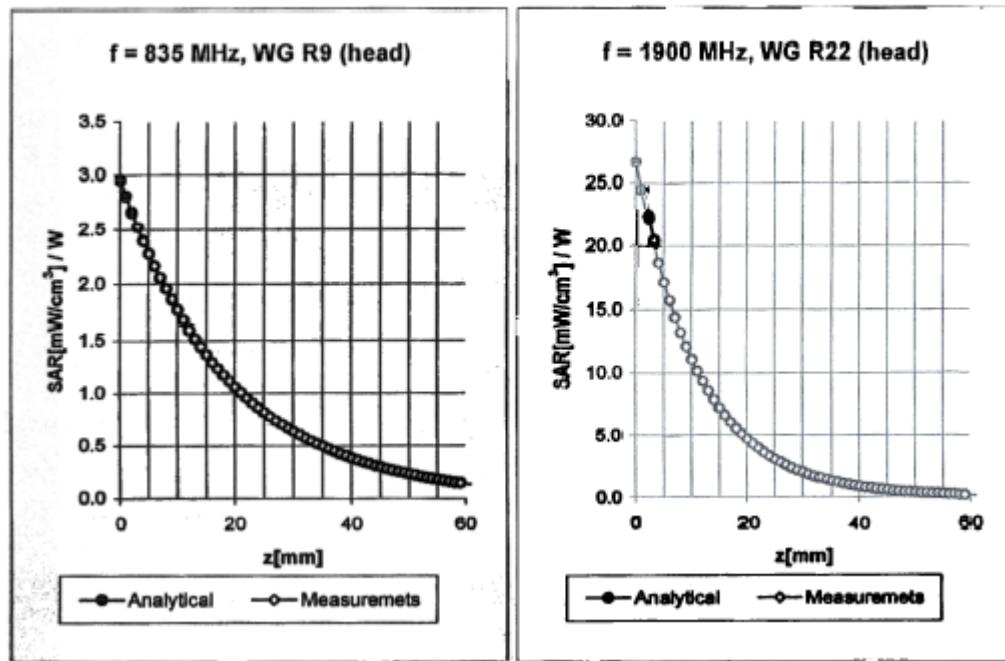
**Diode Compression**

DCP X	<b>99</b>
DCP Y	<b>99</b>
DCP Z	<b>99</b>

**Sensor Offset**

Probe Tip to Sensor Center	<b>2.1</b>	mm
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## Conversion Factor Assessment



Head                    835 MHz                     $\epsilon_r = 41.5 \pm 5\%$                      $\sigma = 0.90 \pm 5\% \text{ mho/m}$

Valid for f=793-877 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

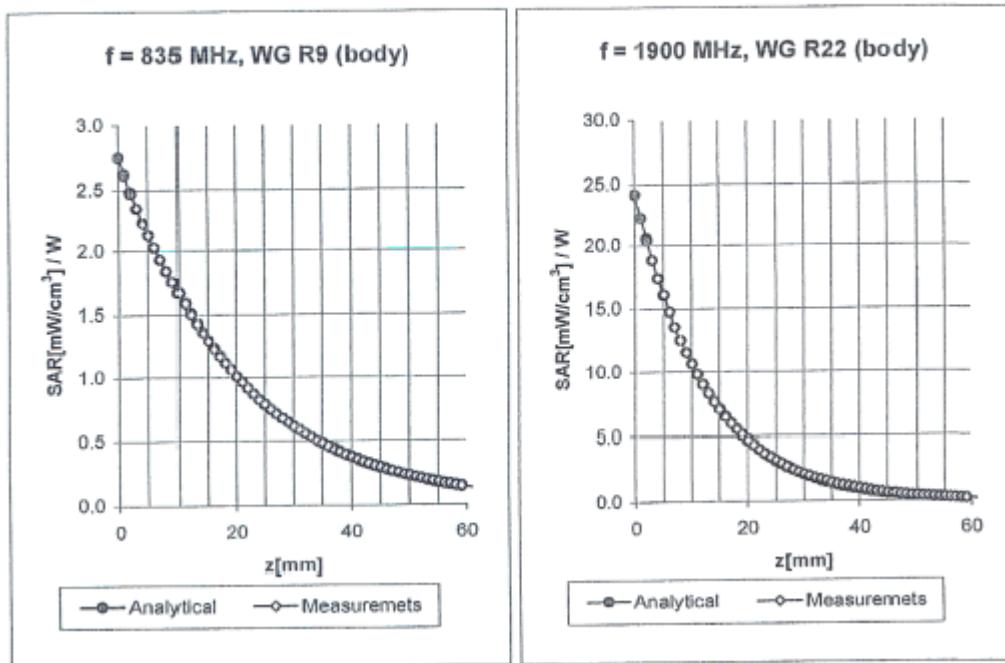
ConvF X	<b>6.5</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>6.5</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.35</b>
ConvF Z	<b>6.5</b> $\pm 9.5\%$ (k=2)	Depth <b>1.46</b>

Head                    1900 MHz                     $\epsilon_r = 40.0 \pm 5\%$                      $\sigma = 1.40 \pm 5\% \text{ mho/m}$

Valid for f=1805-1995 MHz with Head Tissue Simulating Liquid according to EN 50361, P1528-200X

ConvF X	<b>4.7</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>4.7</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.22</b>
ConvF Z	<b>4.7</b> $\pm 9.5\%$ (k=2)	Depth <b>3.48</b>

## Conversion Factor Assessment



**Body                    835 MHz                     $\epsilon_r = 55.2 \pm 5\%$                      $\sigma = 0.97 \pm 5\% \text{ mho/m}$**

Valid for f=793-877 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

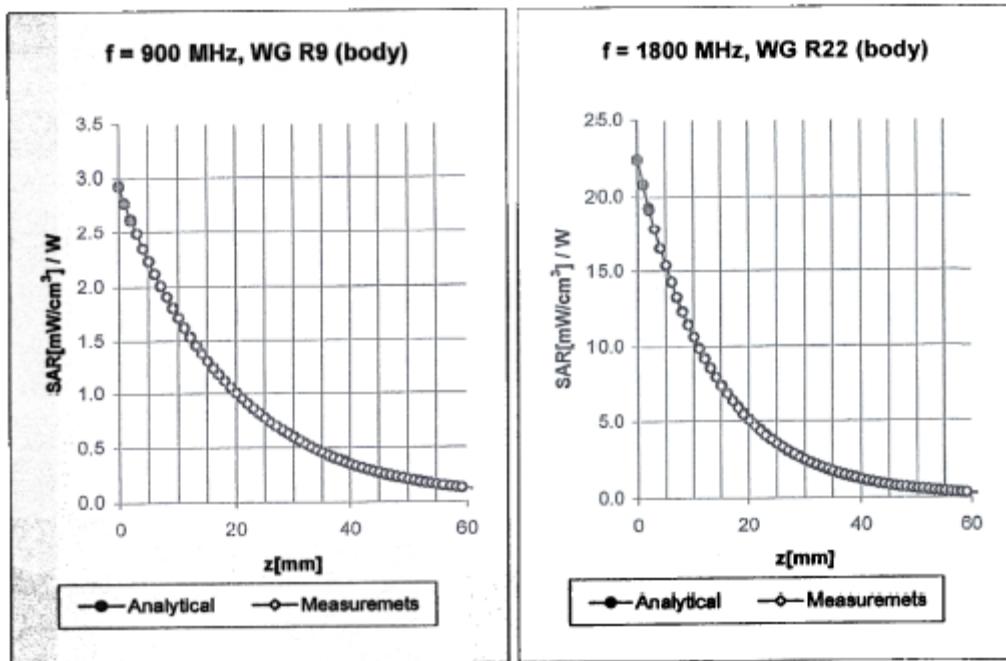
ConvF X	<b>6.1</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>6.1</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.24</b>
ConvF Z	<b>6.1</b> $\pm 9.5\%$ (k=2)	Depth <b>2.00</b>

**Body                    1900 MHz                     $\epsilon_r = 53.3 \pm 5\%$                      $\sigma = 1.52 \pm 5\% \text{ mho/m}$**

Valid for f=1805-1995 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	<b>4.6</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>4.6</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.24</b>
ConvF Z	<b>4.6</b> $\pm 9.5\%$ (k=2)	Depth <b>2.64</b>

## Conversion Factor Assessment



Body                    900 MHz                     $\epsilon_r = 55.0 \pm 5\%$                      $\sigma = 1.05 \pm 5\% \text{ mho/m}$

Valid for f=855-945 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

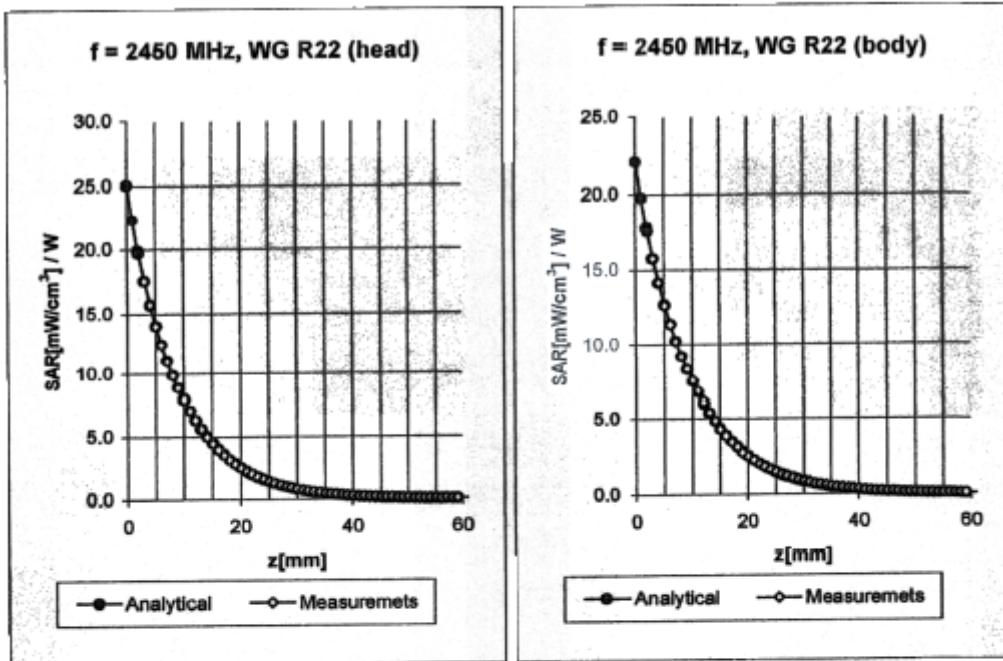
ConvF X	<b>6.1</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>6.1</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.27</b>
ConvF Z	<b>6.1</b> $\pm 9.5\%$ (k=2)	Depth <b>1.82</b>

Body                    1800 MHz                     $\epsilon_r = 53.3 \pm 5\%$                      $\sigma = 1.52 \pm 5\% \text{ mho/m}$

Valid for f=1710-1890 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	<b>4.7</b> $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	<b>4.7</b> $\pm 9.5\%$ (k=2)	Alpha <b>0.23</b>
ConvF Z	<b>4.7</b> $\pm 9.5\%$ (k=2)	Depth <b>2.99</b>

## Conversion Factor Assessment

**Head****2450 MHz** $\epsilon_r = 39.2 \pm 5\%$  $\sigma = 1.80 \pm 5\% \text{ mho/m}$ Valid for  $f=2400-2500 \text{ MHz}$  with Head Tissue Simulating Liquid according to EN 60361, P1528-200X

ConvF X	<b>4.5</b> $\pm 9.5\%$ (k=2)
ConvF Y	<b>4.5</b> $\pm 9.5\%$ (k=2)
ConvF Z	<b>4.5</b> $\pm 9.5\%$ (k=2)

Boundary effect:	
Alpha	<b>0.40</b>
Depth	<b>1.62</b>

**Body****2450 MHz** $\epsilon_r = 52.7 \pm 5\%$  $\sigma = 1.95 \pm 5\% \text{ mho/m}$ Valid for  $f=2400-2500 \text{ MHz}$  with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	<b>4.2</b> $\pm 9.5\%$ (k=2)
ConvF Y	<b>4.2</b> $\pm 9.5\%$ (k=2)
ConvF Z	<b>4.2</b> $\pm 9.5\%$ (k=2)

Boundary effect:	
Alpha	<b>0.32</b>
Depth	<b>1.98</b>

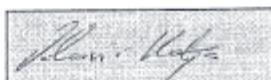
Zeughausstrasse 43, 8004 Zurich, Switzerland  
Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, http://www.speag.com

## Additional Conversion Factors for Dosimetric E-Field Probe

Type:	ES3DV2
Serial Number:	3019
Place of Assessment:	Zurich
Date of Assessment:	October 13, 2003
Probe Calibration Date:	October 9, 2003

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:



ES3DV2-SN:3019

October 13, 2003

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

**Dosimetric E-Field Probe ES3DV2 SN:3019**Conversion factor ( $\pm$  standard deviation)

150 MHz	ConvF	8.7 $\pm$ 8%	$\epsilon_r = 52.3 \pm 5\%$ $\sigma = 0.76 \pm 5\%$ mho/m (head tissue)
150 MHz	ConvF	8.3 $\pm$ 8%	$\epsilon_r = 61.9 \pm 5\%$ $\sigma = 0.80 \pm 5\%$ mho/m (body tissue)
450 MHz	ConvF	7.4 $\pm$ 8%	$\epsilon_r = 43.5 \pm 5\%$ $\sigma = 0.87 \pm 5\%$ mho/m (head tissue)
450 MHz	ConvF	7.3 $\pm$ 8%	$\epsilon_r = 56.7 \pm 5\%$ $\sigma = 0.94 \pm 5\%$ mho/m (body tissue)

**ES3DV2-SN:3019****October 13, 2003**

## 835 MHz Body Liquid Validation

frequency	$\epsilon'$	$\epsilon''$	835 MHz Body Liquid Validation (M)
815000000.0000	55.4412		20.9128
815800000.0000	55.4957		20.9233
816600000.0000	55.4561		20.9415
817400000.0000	55.4845		20.9737
818200000.0000	55.4384		20.9828
819000000.0000	55.4578		20.9914
819800000.0000	55.4369		20.9962
820600000.0000	55.4401		21.0170
821400000.0000	55.4348		21.0163
822200000.0000	55.4523		20.9641
823000000.0000	55.3814		20.9376
823800000.0000	55.3776		20.9463
824600000.0000	55.3993		20.9587
825400000.0000	55.3809		20.9171
826200000.0000	55.3610		20.8360
827000000.0000	55.3861		20.9328
827800000.0000	55.3486		20.9149
828600000.0000	55.3737		20.9924
829400000.0000	55.2808		20.9645
830200000.0000	55.3112		20.9050
831000000.0000	55.3565		20.9038
831800000.0000	55.2958		20.9256
832600000.0000	55.3460		20.9267
833400000.0000	55.2971		20.8959
834200000.0000	55.3258		20.8562
835000000.0000	55.3272		20.9021
835800000.0000	55.3161		20.9042
836600000.0000	55.2927		20.8766
837400000.0000	55.3552		20.8939
838200000.0000	55.3247		20.8925
839000000.0000	55.2474		20.8794
839800000.0000	55.2915		20.8926
840600000.0000	55.2557		20.8513
841400000.0000	55.2972		20.7965
842200000.0000	55.2431		20.8850
843000000.0000	55.2461		20.8228
843800000.0000	55.2390		20.8371
844600000.0000	55.2228		20.7865
845400000.0000	55.3074		20.8343
846200000.0000	55.2957		20.8130
847000000.0000	55.2884		20.8101
847800000.0000	55.1749		20.8421
848600000.0000	55.2674		20.7511
849400000.0000	55.2313		20.7832
850200000.0000	55.1267		20.8245
851000000.0000	55.1997		20.8195
851800000.0000	55.1834		20.7681
852600000.0000	55.1625		20.7477
853400000.0000	55.1241		20.6662
854200000.0000	55.1362		20.6578
855000000.0000	55.1558		20.6284

$$\sigma = \omega \epsilon_0 \epsilon'' = 2 \pi f \epsilon_0 \epsilon'' = 0.9709$$

where  $f = 835 \times 10^6$   
 $\epsilon_0 = 8.854 \times 10^{-12}$   
 $\epsilon'' = 20.9021$

## 835 MHz Head Liquid Validation

frequency	$\epsilon'$	$\epsilon''$	835 MHz Head Liquid Validation (M)
815000000.0000	40.8316	19.6241	
815800000.0000	40.8580	19.6385	
816600000.0000	40.8150	19.6736	
817400000.0000	40.8074	19.6325	
818200000.0000	40.7624	19.6372	
819000000.0000	40.7719	19.6385	
819800000.0000	40.7566	19.6454	
820600000.0000	40.7920	19.5584	
821400000.0000	40.7753	19.5697	
822200000.0000	40.8014	19.5561	
823000000.0000	40.7221	19.5534	
823800000.0000	40.7159	19.5459	
824600000.0000	40.7116	19.5468	
825400000.0000	40.6385	19.4474	
826200000.0000	40.6352	19.4362	
827000000.0000	40.6549	19.4457	
827800000.0000	40.6645	19.4695	
828600000.0000	40.6683	19.4377	
829400000.0000	40.6563	19.4431	
830200000.0000	40.6186	19.4562	
831000000.0000	40.6328	19.4570	
831800000.0000	40.5827	19.4226	
832600000.0000	40.6405	19.4471	
833400000.0000	40.5872	19.3986	
834200000.0000	40.5968	19.4415	
835000000.0000	40.5414	19.4213	0.9022
835800000.0000	40.5743	19.4472	
836600000.0000	40.5203	19.4359	
837400000.0000	40.5171	19.4512	
838200000.0000	40.5960	19.4581	
839000000.0000	40.5269	19.3862	
839800000.0000	40.5315	19.5138	
840600000.0000	40.5458	19.4323	
841400000.0000	40.5589	19.4588	
842200000.0000	40.5201	19.4474	
843000000.0000	40.5822	19.4493	
843800000.0000	40.5428	19.4191	
844600000.0000	40.5424	19.4496	
845400000.0000	40.5312	19.4725	
846200000.0000	40.5308	19.4185	
847000000.0000	40.6013	19.5186	
847800000.0000	40.5715	19.4878	
848600000.0000	40.5187	19.5217	
849400000.0000	40.5221	19.5123	
850200000.0000	40.5211	19.4787	
851000000.0000	40.4825	19.4319	
851800000.0000	40.5363	19.4833	
852600000.0000	40.5606	19.5121	
853400000.0000	40.5481	19.5294	
854200000.0000	40.5338	19.5617	
855000000.0000	40.5353	19.5349	

$$\sigma = \omega \epsilon_0 \epsilon'' = 2 \pi f \epsilon_0 \epsilon'' = 0.9022$$

where  $f = 835 \times 10^6$   
 $\epsilon_0 = 8.854 \times 10^{-12}$   
 $\epsilon'' = 19.4213$

frequency	$\epsilon'$	$\epsilon''$	835 Body Liquid (M)
81000000.0000	53.5172		20.0571
81100000.0000	53.4584		20.0443
81200000.0000	53.4115		19.9978
81300000.0000	53.3628		19.9731
81400000.0000	53.3536		19.9954
81500000.0000	53.3502		19.9981
81600000.0000	53.3125		19.9240
81700000.0000	53.2833		19.9585
81800000.0000	53.2798		19.9792
81900000.0000	53.2637		19.9739
82000000.0000	53.1570		19.9584
82100000.0000	53.1199		19.9276
82200000.0000	53.1383		19.9371
82300000.0000	53.1358		19.9852
82400000.0000	53.1464		19.9696
82500000.0000	53.1821		20.0313
82600000.0000	53.1556		19.9941
82700000.0000	53.1658		20.0316
82800000.0000	53.1980		20.0334
82900000.0000	53.2021		20.1778
83000000.0000	53.1964		20.2388
83100000.0000	53.1932		20.3029
83200000.0000	53.1535		20.3140
83300000.0000	53.1251		20.3396
83400000.0000	53.2292		20.3874
83500000.0000	53.2748		20.3467
83600000.0000	53.3011		20.3966
83700000.0000	53.3084		20.4692
83800000.0000	53.3973		20.5052
83900000.0000	53.3817		20.4817
84000000.0000	53.3958		20.4419
84100000.0000	53.4049		20.4714
84200000.0000	53.4132		20.4592
84300000.0000	53.4247		20.4823
84400000.0000	53.4310		20.4753
84500000.0000	53.4465		20.4294
84600000.0000	53.4392		20.4140
84700000.0000	53.4294		20.4796
84800000.0000	53.4139		20.3715
84900000.0000	53.4098		20.3101
85000000.0000	53.3975		20.4066
85100000.0000	53.3986		20.3431
85200000.0000	53.3852		20.3852
85300000.0000	53.3886		20.3880
85400000.0000	53.3747		20.3696
85500000.0000	53.3661		20.4647
85600000.0000	53.3530		20.3341
85700000.0000	53.3694		20.3672
85800000.0000	53.3735		20.3603
85900000.0000	53.3770		20.2815
86000000.0000	53.3793		20.2537

0.9452

MonG

$$\sigma = \omega \epsilon_0 \epsilon'' = 2 \pi f \epsilon_0 \epsilon'' = 0.9452$$

where  $f = 835 \times 10^6$

$$\epsilon_0 = 8.854 \times 10^{-12}$$

$$\epsilon'' = 20.3467$$

frequency	$\epsilon'$	$\epsilon''$	835 head Liquid (M)
810000000.0000	41.0164	19.7334	
811000000.0000	41.0073	19.6775	
812000000.0000	40.9508	19.6321	
813000000.0000	40.9312	19.6240	
814000000.0000	40.8638	19.5834	
815000000.0000	40.8431	19.5651	
816000000.0000	40.8403	19.5747	
817000000.0000	40.8155	19.5682	
818000000.0000	40.8092	19.6151	
819000000.0000	40.7967	19.5640	
820000000.0000	40.7708	19.5583	
821000000.0000	40.7603	19.5670	
822000000.0000	40.7345	19.6255	
823000000.0000	40.7257	19.6328	
824000000.0000	40.7303	19.6283	
825000000.0000	40.7282	19.5439	
826000000.0000	40.6783	19.5265	
827000000.0000	40.5411	19.5242	
828000000.0000	40.5872	19.5357	
829000000.0000	40.5434	19.5416	
830000000.0000	40.4847	19.4835	
831000000.0000	40.4609	19.4727	
832000000.0000	40.3842	19.4611	
833000000.0000	40.4233	19.4592	
834000000.0000	40.3817	19.4635	
835000000.0000	40.3362	19.3709	0.8998
836000000.0000	40.2798	19.4317	
837000000.0000	40.2553	19.4106	
838000000.0000	40.1587	19.3823	
839000000.0000	40.1698	19.3960	
840000000.0000	40.1205	19.3744	
841000000.0000	40.0757	19.3891	
842000000.0000	40.0332	19.3507	
843000000.0000	39.9853	19.3619	
844000000.0000	40.0285	19.3571	
845000000.0000	39.9231	19.3312	
846000000.0000	39.9078	19.3012	
847000000.0000	39.8673	19.3378	
848000000.0000	39.7868	19.2912	
849000000.0000	39.8024	19.2815	
850000000.0000	39.7973	19.2774	
851000000.0000	39.7607	19.2746	
852000000.0000	39.8054	19.2656	
853000000.0000	39.7823	19.2752	
854000000.0000	39.7441	19.3371	
855000000.0000	39.7349	19.3549	
856000000.0000	39.6975	19.3301	
857000000.0000	39.7089	19.3210	
858000000.0000	39.6932	19.3252	
859000000.0000	39.7285	19.3384	
860000000.0000	39.6561	19.2975	

$$\sigma = \omega \epsilon_0 \epsilon'' = 2 \pi f \epsilon_0 \epsilon'' = 0.8998$$

where  $f = 835 \times 10^6$

$$\epsilon_0 = 8.854 \times 10^{-12}$$

$$\epsilon'' = 19.3709$$

### 3 - EUT DESCRIPTION

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Applicant: Maxon Electronics Australia Pty. Ltd  
Product Description: CDMA Voice/Data Modem  
FCC ID: Q2FMM-5100U  
Serial Number: 3B003776  
Transmitter Frequency: 824.64~848.37MHz  
Maximum Output Power: 0.293  
Dimension: 58mm L x 38mm W x 12mm H approximately  
RF Exposure environment: General Population/Uncontrolled  
Applicable Standard: FCC CFR 47, Part 22  
Application Type: Certification

*<sup>1</sup> Specific Absorption Rate (SAR) is a measure of the rate of energy absorption due to exposure to an RF transmitting source (wireless portable device).*

*<sup>2</sup> IEEE/ANSI Std. C95.1-1992 limits are used to determine compliance with FCC ET Docket 93-62.*

*Note: The test data gathered are from production sample, serial number: 3B003776, provided by the manufacturer.*

## **4 - SYSTEM TEST CONFIGURATION**

### **4.1 Justification**

The system was configured for testing in a typical fashion (as normally used by a typical user).

### **4.2 EUT Exercise Procedure**

The EUT exercising program used during SAR testing was designed to exercise the various system components in a manner similar to a typical use. The EUT was tested by pushing the PTT bottom during the testing.

### **4.3 Equipment Modifications**

No modification(s) were made to the EUT.

## 5 – CONDUCTED OUTPUT POWER

### 5.1 Provision Applicable

According to FCC §2.1046 and §22.913 (a), the ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 watts.

### 5.2 Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

### 5.3 Test equipment

Hewlett Packard HP8564E Spectrum Analyzer, Calibration Date: 2003-08-01.

Hewlett Packard HP 7470A Plotter, Calibration not required.

A.H. Systems SAS200 Horn Antenna, Calibration Date: 2003-05-31

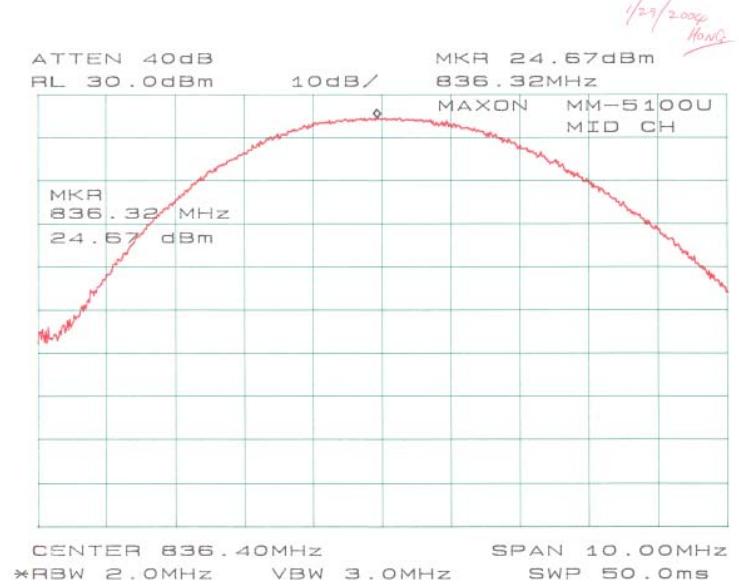
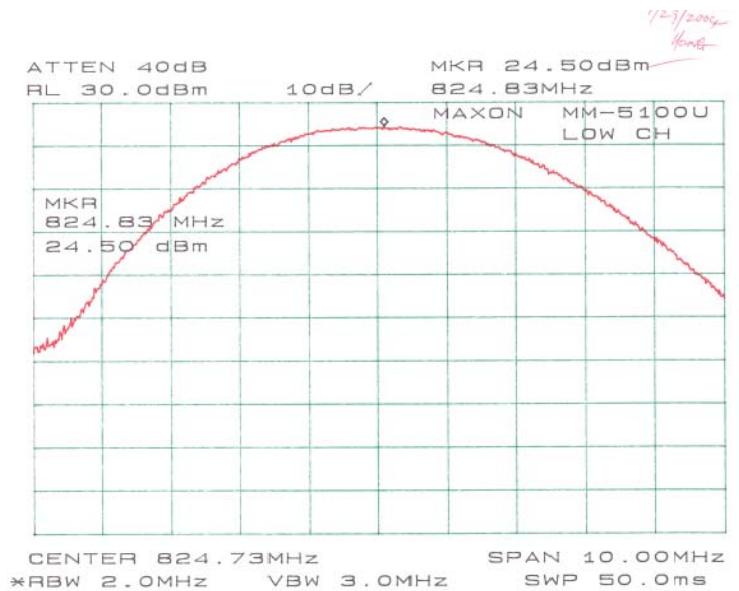
Com-Power AB-100 Dipole Antenna, Calibration Date: 2003-09-05

### 5.4 Test Results

Frequency (MHz)	Output Power in dBm	Output Power in W	Limit (W, ERP)
824.83	24.50	0.282	7
836.32	24.67	0.293	7
848.29	24.50	0.282	7

Note: The output power measured is conducted. During SAR, it is more convenient to measure conducted power rather than EIRP. EMC measurements only required EIRP and results are within 9% between EIRP and conducted.

Please refer to the following plots.



## 6 - DOSIMETRIC ASSESSMENT SETUP

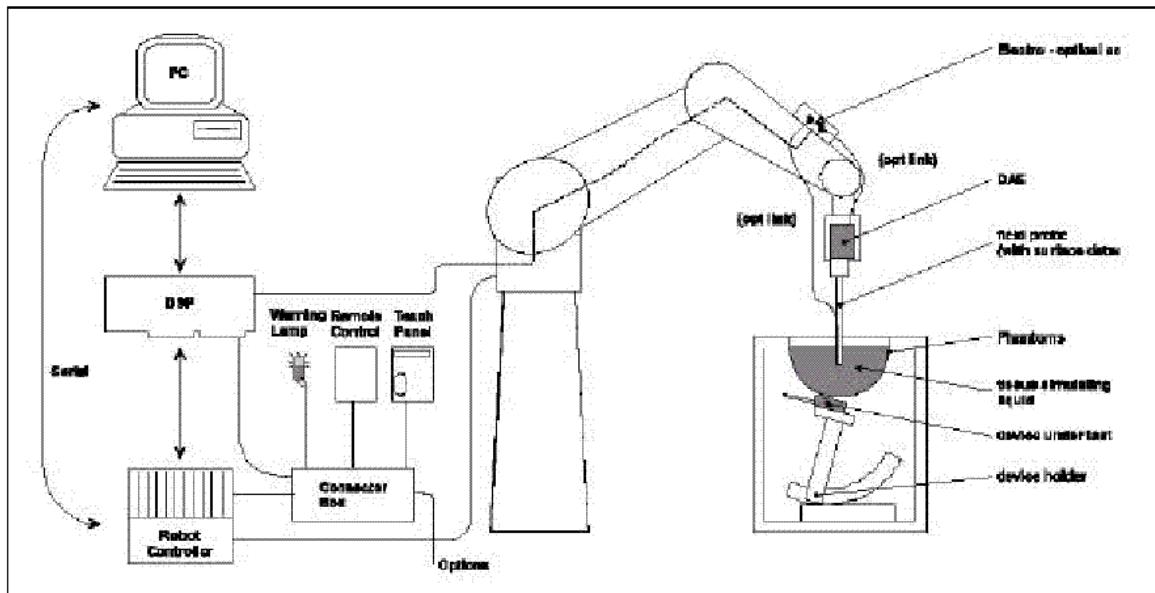
These measurements were performed with the automated near-field scanning system DASY3 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m) which positions the probes with a positional repeatability of better than  $\pm 0.02\text{mm}$ . Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The system is described in detail in [3].

The SAR measurements were conducted with the dosimetric probe ET3DV6 SN: 1604 (manufactured by SPEAG), designed in the classical triangular configuration [3] and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure described in [7] with accuracy of better than  $\pm 10\%$ . The spherical isotropy was evaluated with the procedure described in [8] and found to be better than  $\pm 0.25\text{dB}$ .

The phantom used was the 'Generic Twin Phantom" described in [4]. The ear was simulated as a spacer of 4 mm thickness between the earpiece of the phone and the tissue simulating liquid. The Tissue simulation liquid used for each test is in accordance with the FCC OET65 supplement C as listed below.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (Nacl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton x-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	41.5	55.2	42.0	55.9	39.9	53.3	39.8	53.6
Conductivity (s/m)	0.85	0.83	0.9	0.97	1.0	0.98	1.42	1.52	1.88	1.81

## 6.1 Measurement System Diagram



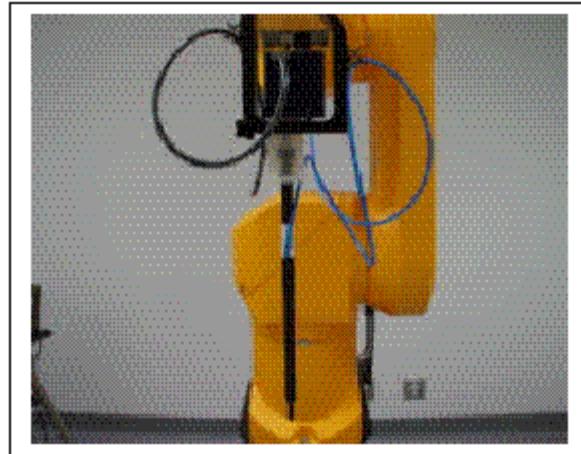
The DASY3 system for performing compliance tests consist of the following items:

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
2. An arm extension for accommodating the data acquisition electronics (DAE).
3. A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
4. A data acquisition electronic (DAE), which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
5. A unit to operate the optical surface detector, which is connected to the EOC. The Electro-optical coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the PC plug-in card. The functions of the PC plug-in card based on a DSP is to perform the time critical task such as signal filtering, surveillance of the robot operation fast movement interrupts.
6. A computer operating Windows 95 or larger
7. DASY3 software
8. Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling testing left-hand and right-hand usage.
10. The device holder for handheld EUT.
11. Tissue simulating liquid mixed according to the given recipes (see Application Note).
12. System validation dipoles to validate the proper functioning of the system.

## 6.2 System Components

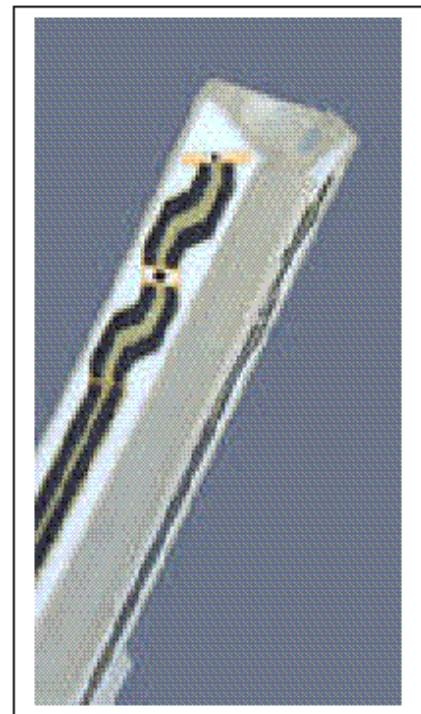
### ET3DV6 Probe Specification

Construction Symmetrical design with triangular core  
 Built-in optical fiber for surface detection System  
 Built-in shielding against static charges  
 Calibration In air from 10 MHz to 2.5 GHz  
 In brain and muscle simulating tissue at  
 Frequencies of 450 MHz, 900 MHz and  
 1.8 GHz (accuracy  $\pm$  8%)  
 Frequency 10 MHz to  $>$  6 GHz; Linearity:  $\pm$  0.2 dB  
 (30 MHz to 3 GHz)  
 Directivity  $\pm$  0.2 dB in brain tissue (rotation around  
 probe axis)  
 $\pm$  0.4 dB in brain tissue (rotation normal probe axis)  
 Dynamic 5 mW/g to  $>$  100 mW/g;  
 Range Linearity:  $\pm$  0.2 dB  
 Surface  $\pm$  0.2 mm repeatability in air and clear liquids  
 Detection 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 dosimetric up to 3 GHz  
 Compliance tests of mobile phones  
 Fast automatic scanning in arbitrary phantoms



**Photograph of the probe**

The SAR measurements were conducted with the dosimetric probe ET3DV6 designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY3 software reads the reflection during a software approach and looks for the maximum using a 2 nd order fitting. The approach is stopped when reaching the maximum.



**Inside view of  
 ET3DV6 E-field Probe**

## E-Field Probe Calibration Process

Each probe is calibrated according to a dosimetric assessment procedure described in [6] with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in [7] and found to be better than +/-0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a waveguide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

## Data Evaluation

The DASY3 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe Parameter:	-Sensitivity	Norm <sub>i</sub> , a <sub>i0</sub> , a <sub>i1</sub> , a <sub>i2</sub>
	-Conversion Factor	ConvFi
	-Diode compression point	Dcp <sub>i</sub>
Device parameter:	-Frequency	f
	-Crest Factor	cf
Media parameter:	-Conductivity	$\sigma$
	-Density	$\rho$

These parameters must be set correctly in the software. They can either be found in the component documents or be imported into the software from the configuration files issued for the DASY3 components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + (U_i)^2 \cdot cf / dcp_i$$

With  $V_i$  = compensated signal of channel i ( $i = x, y, z$ )

$U_i$  = input signal of channel i ( $i = x, y, z$ )

$cf$  = crest factor of exciting field (DASY parameter)

$dcp_i$  = diode compression point (DASY parameter)

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

$$\text{E-field probes: } E_i = \sqrt{\frac{V_i}{\text{Norm}_i \cdot \text{ConF}}}$$

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

With  $V_i$  = compensated signal of channel i (i = x, y, z)  
 $\text{Norm}_i$  = sensor sensitivity of channel i (i = x, y, z)  
 $\mu\text{V}/(\text{V/m})^2$  for E-field probes  
 $\text{ConF}$  = sensitivity enhancement in solution  
 $a_{ij}$  = sensor sensitivity factors for H-field probes  
 $f$  = carrier frequency [GHz]  
 $E_i$  = electric field strength of channel i in V/m  
 $H_i$  = diode compression point (DASY parameter)

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

$$E_{\text{tot}} = \text{Square Root} [(E_x)^2 + (E_y)^2 + (E_z)^2]$$

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

$$\text{SAR} = (E_{\text{tot}})^2 \cdot \sigma / (\rho \cdot 1000)$$

With  $\text{SAR}$  = local specific absorption rate in mW/g  
 $E_{\text{tot}}$  = total field strength in V/m  
 $\sigma$  = conductivity in [mho/m] or [Siemens/m]  
 $\rho$  = equivalent tissue density in g/cm<sup>3</sup>

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

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

$$P_{\text{pwe}} = (E_{\text{tot}})^2 / 3770 \text{ or } P_{\text{pwe}} = (H_{\text{tot}})^2 \cdot 37.7$$

With  $P_{\text{pwe}}$  = equivalent power density of a plane wave in mW/cm<sup>3</sup>  
 $E_{\text{tot}}$  = total electric field strength in V/m  
 $H_{\text{tot}}$  = total magnetic field strength in V/m

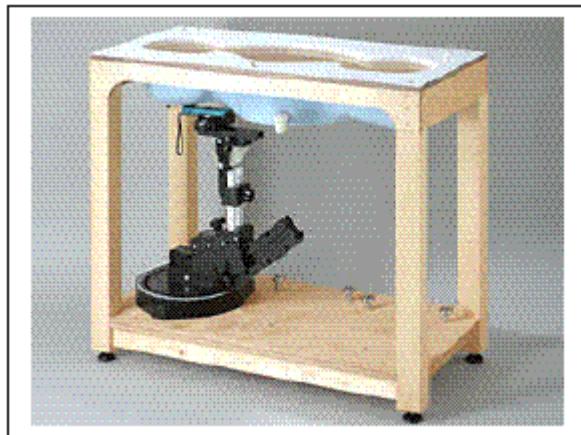
### Generic Twin Phantom

The Generic Twin Phantom is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users [9][10]. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allows the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

Shell Thickness  $2 \pm 0.1$  mm

Filling Volume Approx. 20 liters

Dimensions 810 x 1000 x 500 mm (H x L x W)



**Generic Twin Phantom**

### Device Holder

In combination with the Generic Twin Phantom V3.0, the Mounting Device enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation points is the ear opening. The devices can be easily, accurately, and repeatedly positioned according to the FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

\* Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produce infinite number of configurations [10]. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.



**Device Holder**

### 6.3 Measurement Uncertainty

The uncertainty budget has been determined for the DASY3 measurement system according to the NIS81 [13] and the NIST1297 [14] documents and is given in the following Table.

Measurement Uncertainty Analysis per IEEE P1528-2002									
Description	Section	Reported Variance (%)	Probability Distribution type	Divisor	Ci (1g)	Ui (1g)	Vi	welc/satt series term	
Probe Calibration	E.2.1	4.80	N	1	1	4.80	1.00E+09	5.30842E-07	
Axial isotropy	E.2.2	4.70	R	1.732	0.707107	1.92	1.00E+09	1.35563E-08	
Hemispherical isotropy	E.2.2	9.60	R	1.732	0.707107	3.92	1.00E+09	2.35957E-07	
Boundary effects	E.2.3	8.30	R	1.732	1	4.79	1.00E+09	5.27377E-07	
Linearity	E.2.4	4.70	R	1.732	1	2.71	1.00E+09	5.4225E-08	
System Detection Limit	E.2.5	1.00	R	1.732	1	0.58	1.00E+09	1.11124E-10	
Readout Electronics	E.2.6	0.00	N	1	1	0.00	1.00E+09	0	
Response time	E.2.7	0.00	R	1.732	1	0.00	1.00E+09	0	
Integration time	E.2.8	0.00	R	1.732	1	0.00	1.00E+09	0	
RF Ambient conditions	E.6.1	3.00	R	1.732	1	1.73	1.00E+09	9.00106E-09	
Probe positioning mechanical tolerance	E.6.2	0.40	R	1.732	1	0.23	1.00E+09	2.84478E-12	
Probe positioning wrt phantom shell	E.6.3	2.90	R	1.732	1	1.67	1.00E+09	7.8596E-09	
Extra/inter-polation & integration algorithms for max SAR evaluation	E.5.2	3.90	R	1.732	1	2.25	1.00E+09	2.57079E-08	
Test sample positioning	8, E.4.2	6.00	R	1.732	1	3.46	1.00E+09	1.44017E-07	
Device holder distance tolerance	E.4.1	5.00	N	1	1	5.00	1.00E+09	0.000000625	
Output power and SAR drift measurement	8, E.6.6.2	5.00	R	1.732	1	2.89	1.00E+09	6.94526E-08	
Phantom uncertainty, shell thickness tolerance	E.3.1	4.00	R	1.732	1	2.31	1.00E+09	2.84478E-08	
Liquid conductivity, deviation from target values	E.3.2	5.00	R	1.732	0.64	1.85	1.00E+09	1.16522E-08	
Liquid conductivity, measurement uncertainty	E.3.3	5.00	N	1	0.64	3.20	5	20.97152	
Liquid permitivity, deviation from target values	E.3.2	5.00	R	1.732	0.6	1.73	1.00E+09	9.00106E-09	
Liquid permitivity, measurement uncertainty	E.3.3	5.00	N	1	0.6	3.00	5	16.2	
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<b>Probe isotropy sensitivity coefficient</b>	<b>0.5</b>								
<b>Combined Standard Uncertainty</b>						<b>12.65</b>	<b>%</b>		
<b>Expanded Uncertainty, 95% confidence</b>		<b>k=</b>	<b>2.004</b>			<b>25.34</b>	<b>%</b>		