

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

This Report Concerns: <input checked="" type="checkbox"/> Original Report	Equipment Type: CDMA Voice/Data Modem
Test Engineer: Eric Hong / 	
Report No.: R0401121S	
Test Date: 2004-01-29	
Reviewed By:  Hans Mellberg/	
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SUMMARY

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

- [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.
- [2] David L. Means Kwok Chan, Robert F. Cleveland, \Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields", Tech. Rep., Federal Communication Commission, Office of Engineering & Technology, Washington, DC, 1997.
- [3] Thomas Schmid, Oliver Egger, and Niels Kuster, \Automated E-field scanning system for dosimetric assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp. 105{113, Jan. 1996.
- [4] Niels Kuster, Ralph Kastle, and Thomas Schmid, \Dosimetric evaluation of mobile communications equipment with known precision", IEEE Transactions on Communications, vol. E80-B, no. 5, pp. 645{652, May 1997.
- [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.
- [6] ANSI, ANSI/IEEE C95.1-1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.
- [7] Katja Pokovic, Thomas Schmid, and Niels Kuster, \Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies", in ICECOM _ 97, Dubrovnik, October 15{17, 1997, pp. 120-24.
- [8] Katja Pokovic, Thomas Schmid, and Niels Kuster, \E-field probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23{25 June, 1996, pp. 172-175.
- [9] Volker Hombach, Klaus Meier, Michael Burkhardt, Eberhard Kuhn, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 900 MHz", IEEE Transactions on Microwave Theory and Techniques, vol. 44, no. 10, pp. 1865-1873, Oct. 1996.
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- [12] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recipes 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 of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client Bay Area Comp. Lab (BACL)

CALIBRATION CERTIFICATE

Object(s) E33DV2 - 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	GB41293874	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: 5066 (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 8461A	MY41092180	18-Sep-02 (Agilent, No. 20020918)	In house check: Oct 03
RF generator HP 8684C	US3642U01700	4-Aug-99 (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 Niso Vetterli Function Technician Signature 

Approved by: Name Katja Rokovic Function Laboratory Director Signature 

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.

880-KP0301061-A

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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!)

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

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

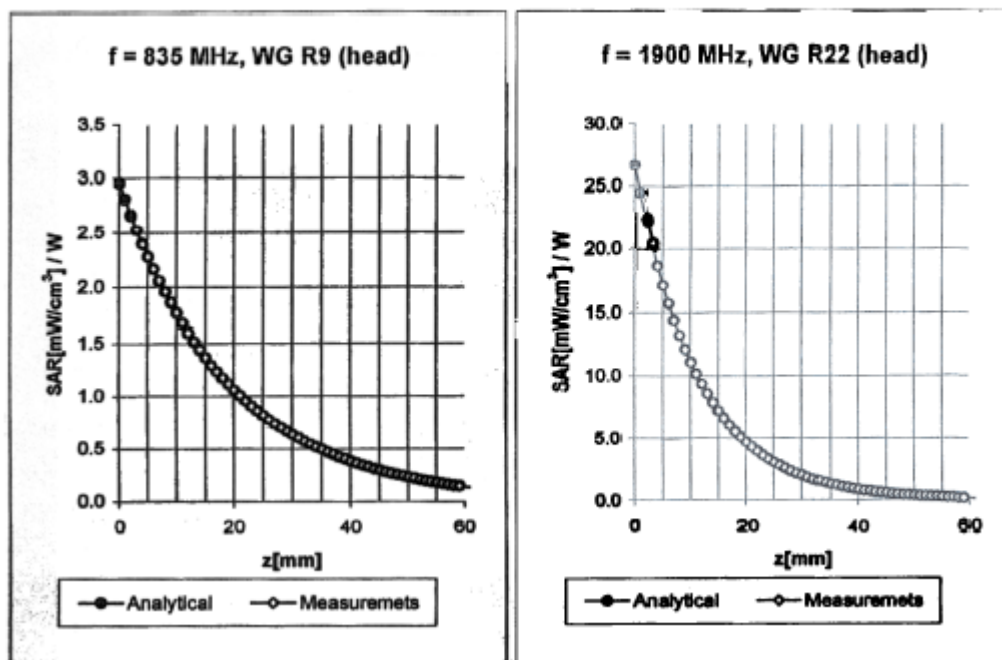
Diode Compression

DCP X	99
DCP Y	99
DCP Z	99

Sensor Offset

Probe Tip to Sensor Center	2.1	mm
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Conversion Factor Assessment



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

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

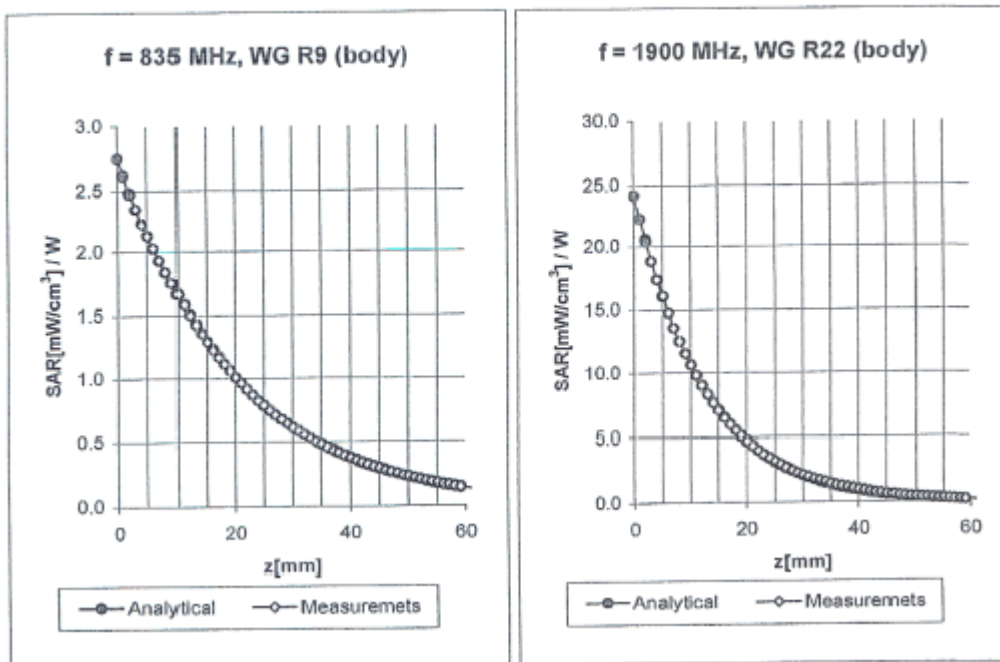
ConvF X	6.5 $\pm 9.5\%$ (k=2)	Boundary effect:	
ConvF Y	6.5 $\pm 9.5\%$ (k=2)	Alpha	0.35
ConvF Z	6.5 $\pm 9.5\%$ (k=2)	Depth	1.46

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

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

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

Conversion Factor Assessment



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

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

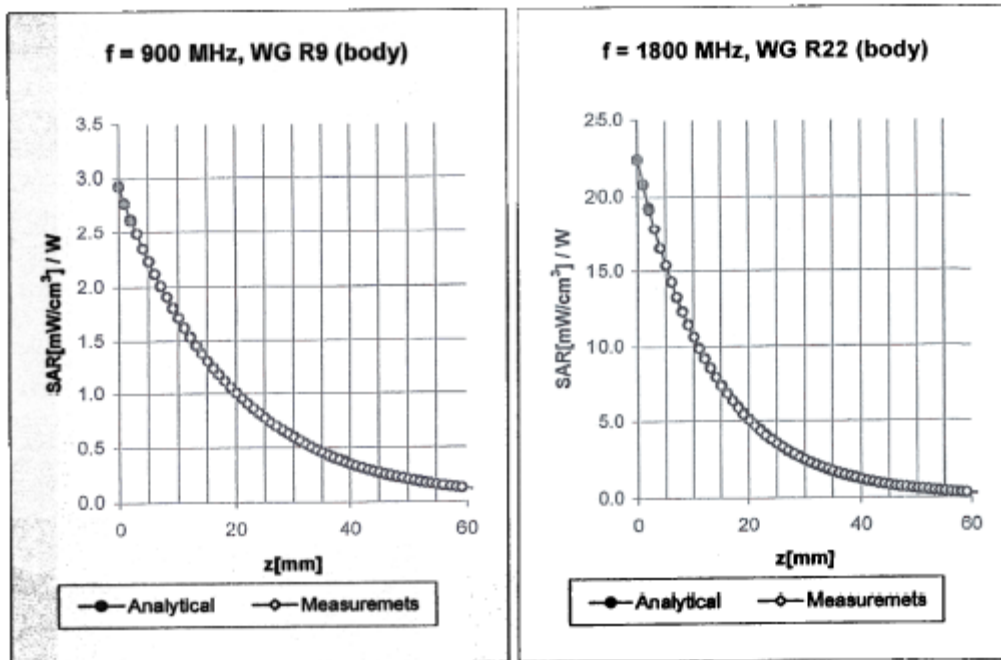
ConvF X	6.1 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	6.1 $\pm 9.5\%$ (k=2)	Alpha 0.24
ConvF Z	6.1 $\pm 9.5\%$ (k=2)	Depth 2.00

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

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

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

Conversion Factor Assessment



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

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

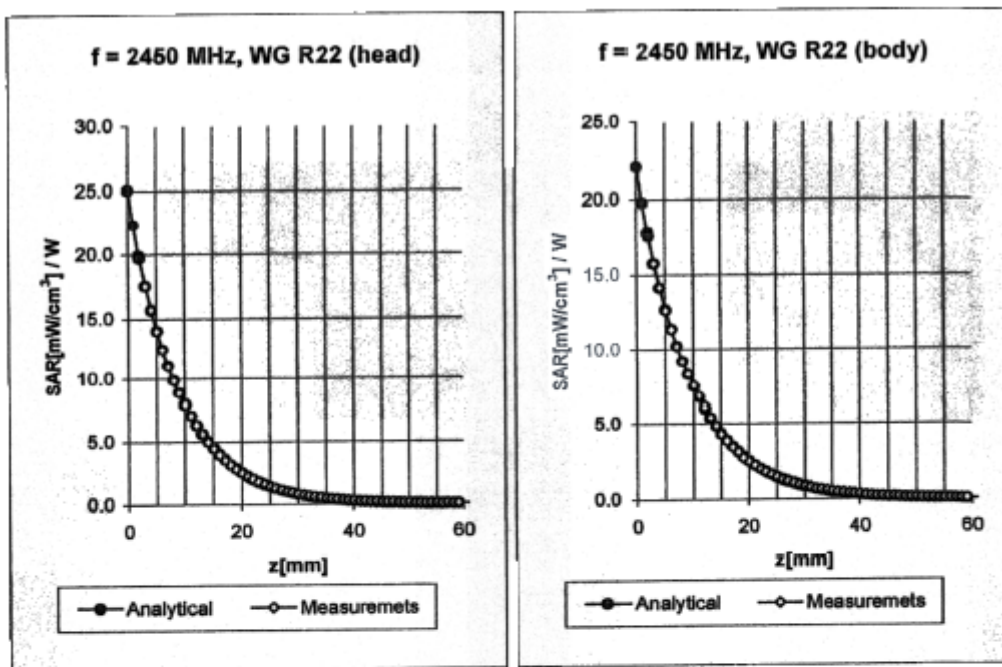
ConvF X	6.1 \pm 9.5% (k=2)	Boundary effect:
ConvF Y	6.1 \pm 9.5% (k=2)	Alpha 0.27
ConvF Z	6.1 \pm 9.5% (k=2)	Depth 1.82

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

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

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

Conversion Factor Assessment



Head **2450 MHz** $\epsilon_r = 39.2 \pm 5\%$ $\sigma = 1.80 \pm 5\%$ mho/m

Valid for f=2400-2500 MHz with Head Tissue Simulating Liquid according to EN 60381, P1528-200X

ConvF X	4.5 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	4.5 $\pm 9.5\%$ (k=2)	Alpha 0.40
ConvF Z	4.5 $\pm 9.5\%$ (k=2)	Depth 1.62

Body **2450 MHz** $\epsilon_r = 52.7 \pm 5\%$ $\sigma = 1.95 \pm 5\%$ mho/m

Valid for f=2400-2500 MHz with Body Tissue Simulating Liquid according to OET 65 Suppl. C

ConvF X	4.2 $\pm 9.5\%$ (k=2)	Boundary effect:
ConvF Y	4.2 $\pm 9.5\%$ (k=2)	Alpha 0.32
ConvF Z	4.2 $\pm 9.5\%$ (k=2)	Depth 1.98

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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

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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

1/29/2004

835 MHz Body Liquid Validation (M)

Frequency	ϵ'	ϵ''
81500000.0000	55.4412	20.9128
81580000.0000	55.4957	20.9233
81660000.0000	55.4561	20.9415
81740000.0000	55.4845	20.9737
81820000.0000	55.4384	20.9828
81900000.0000	55.4578	20.9914
81980000.0000	55.4369	20.9962
82060000.0000	55.4401	21.0170
82140000.0000	55.4348	21.0163
82220000.0000	55.4523	20.9641
82300000.0000	55.3814	20.9376
82380000.0000	55.3776	20.9463
82460000.0000	55.3993	20.9587
82540000.0000	55.3809	20.9171
82620000.0000	55.3610	20.8360
82700000.0000	55.3861	20.9328
82780000.0000	55.3486	20.9149
82860000.0000	55.3737	20.9924
82940000.0000	55.2808	20.9645
83020000.0000	55.3112	20.9050
83100000.0000	55.3565	20.9038
83180000.0000	55.2958	20.9256
83260000.0000	55.3460	20.9267
83340000.0000	55.2971	20.8959
83420000.0000	55.3258	20.8562
83500000.0000	55.3272	20.9021
83580000.0000	55.3161	20.9042
83660000.0000	55.2927	20.8766
83740000.0000	55.3552	20.8939
83820000.0000	55.3247	20.8925
83900000.0000	55.2474	20.8794
83980000.0000	55.2915	20.8926
84060000.0000	55.2557	20.8513
84140000.0000	55.2972	20.7965
84220000.0000	55.2431	20.8850
84300000.0000	55.2461	20.8228
84380000.0000	55.2390	20.8371
84460000.0000	55.2228	20.7865
84540000.0000	55.3074	20.8343
84620000.0000	55.2957	20.8130
84700000.0000	55.2884	20.8101
84780000.0000	55.1749	20.8421
84860000.0000	55.2674	20.7511
84940000.0000	55.2313	20.7832
85020000.0000	55.1267	20.8245
85100000.0000	55.1997	20.8195
85180000.0000	55.1834	20.7681
85260000.0000	55.1625	20.7477
85340000.0000	55.1241	20.6662
85420000.0000	55.1362	20.6578
85500000.0000	55.1558	20.6284

0.9709

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

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

835 MHz Head Liquid Validation

835 MHz Head Liquid Validation (M)		
frequency	ϵ'	ϵ''
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
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

None

1/22/2004

0.9022

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

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

1/30/2009

frequency	e'	e''	835 Body Liquid (M)
810000000.0000	53.5172		20.0571
811000000.0000	53.4584		20.0443
812000000.0000	53.4115		19.9978
813000000.0000	53.3628		19.9731
814000000.0000	53.3536		19.9954
815000000.0000	53.3502		19.9981
816000000.0000	53.3125		19.9240
817000000.0000	53.2833		19.9585
818000000.0000	53.2798		19.9792
819000000.0000	53.2637		19.9739
820000000.0000	53.1570		19.9584
821000000.0000	53.1199		19.9276
822000000.0000	53.1383		19.9371
823000000.0000	53.1358		19.9852
824000000.0000	53.1464		19.9696
825000000.0000	53.1821		20.0313
826000000.0000	53.1556		19.9941
827000000.0000	53.1658		20.0316
828000000.0000	53.1980		20.0334
829000000.0000	53.2021		20.1778
830000000.0000	53.1964		20.2388
831000000.0000	53.1932		20.3029
832000000.0000	53.1535		20.3140
833000000.0000	53.1251		20.3396
834000000.0000	53.2292		20.3874
835000000.0000	53.2748		20.3467
836000000.0000	53.3011		20.3966
837000000.0000	53.3084		20.4692
838000000.0000	53.3973		20.5052
839000000.0000	53.3817		20.4817
840000000.0000	53.3958		20.4419
841000000.0000	53.4049		20.4714
842000000.0000	53.4132		20.4592
843000000.0000	53.4247		20.4823
844000000.0000	53.4310		20.4753
845000000.0000	53.4465		20.4294
846000000.0000	53.4392		20.4140
847000000.0000	53.4294		20.4796
848000000.0000	53.4139		20.3715
849000000.0000	53.4098		20.3101
850000000.0000	53.3975		20.4066
851000000.0000	53.3986		20.3431
852000000.0000	53.3852		20.3852
853000000.0000	53.3886		20.3880
854000000.0000	53.3747		20.3696
855000000.0000	53.3661		20.4647
856000000.0000	53.3530		20.3341
857000000.0000	53.3694		20.3672
858000000.0000	53.3735		20.3603
859000000.0000	53.3770		20.2815
860000000.0000	53.3793		20.2537

0.9452

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

where $f = 835 \times 10^6$
 $\epsilon_0 = 8.854 \times 10^{-12}$
 $\epsilon'' = 20.3467$

frequency	ϵ'	ϵ''	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
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

1/20/2004

Mong

0.8998

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

where $f = 835 \times 10^6$
 $\epsilon_0 = 8.854 \times 10^{-12}$
 $\epsilon'' = 19.3709$

3 - EUT DESCRIPTION

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

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

²IEEE/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

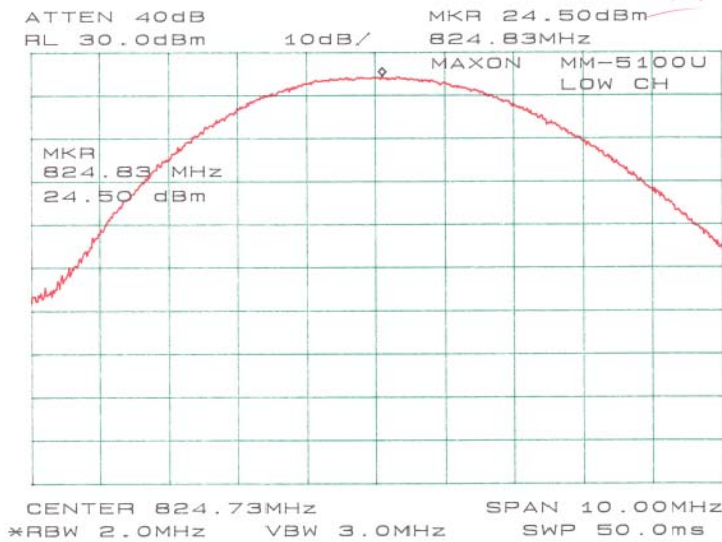
Com-Power AB-100 Dipole Antenna, Calibration Date: 2003-09-05

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

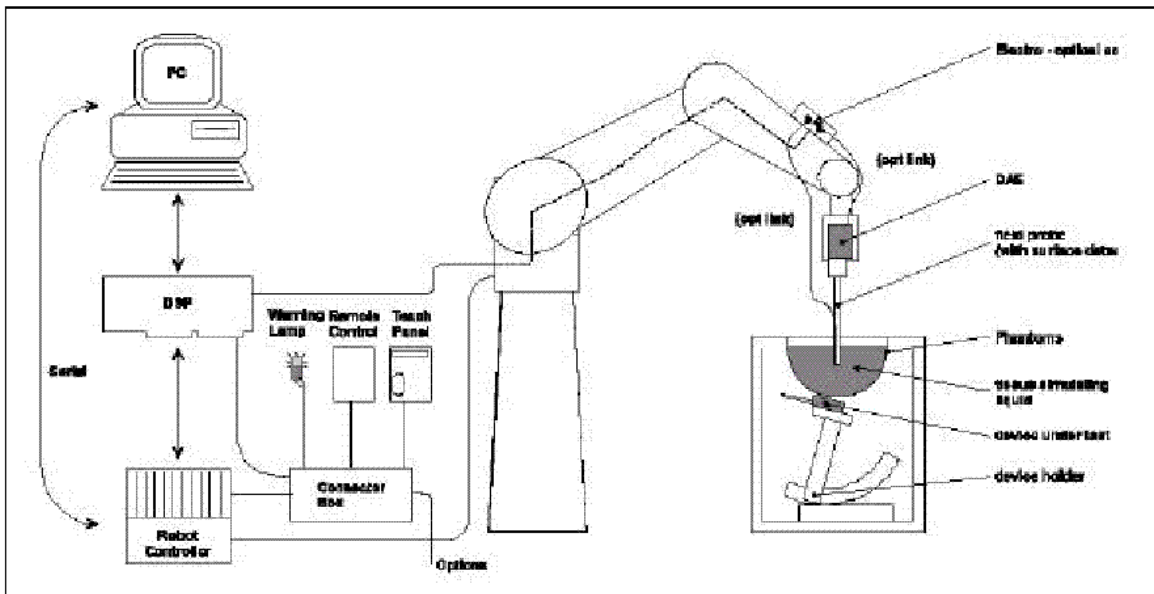
These measurements were performed with the automated near-field scanning system DASY3 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m) which positions the probes with a positional repeatability of better than $\pm 0.02\text{mm}$. 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 according 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



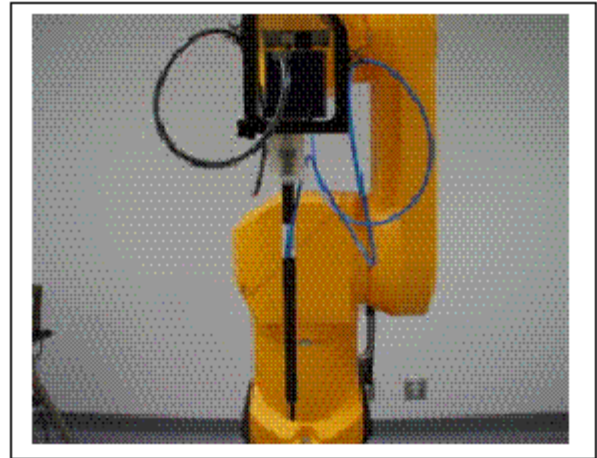
The DASY3 system for performing compliance tests consist of the following items:

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.

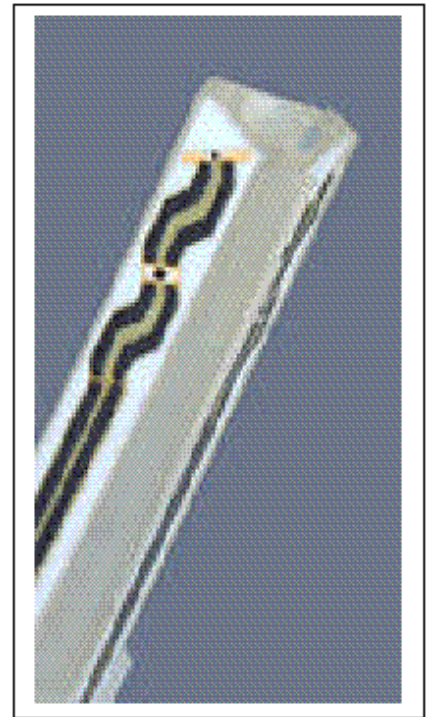
6.2 System Components

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: ± 0.2 dB
 (30 MHz to 3 GHz)
 Directivity ± 0.2 dB in brain tissue (rotation around
 probe axis)
 ± 0.4 dB in brain tissue (rotation normal probe axis)
 Dynamic 5 mW/g to > 100 mW/g;
 Range Linearity: ± 0.2 dB
 Surface ± 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



Inside view of
ET3DV6 E-field 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 2nd order fitting. The approach is stopped when reaching the maximum.

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 _i , a _{i0} , a _{i1} , a _{i2}
	-Conversion Factor	ConvFi
	-Diode compression point	Dcp _i
Device parameter:	-Frequency	f
	-Crest Factor	cf
Media parameter:	-Conductivity	σ
	-Density	ρ

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:

$$V_i = U_i + (U_i)^2 \text{ cf} / \text{dcp}_i$$

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:

$$\begin{aligned} \text{E-field probes:} \quad E_i &= \sqrt{\frac{V_i}{\text{Norm}_i \cdot \text{ConvF}}} \\ \text{H-field probes:} \quad H_i &= \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f} \end{aligned}$$

With V_i = compensated signal of channel i (i=x, y, z)
 Norm_i = sensor sensitivity of channel i (i=x, y, z)
 $\mu\text{V}/(\text{V/m})^2$ for E-field probes
 ConvF = sensitivity enhancement in solution
 a_{ij} = sensor sensitivity factors for H-field probes
 f = carrier frequency [GHz]
 E_i = electric field strength of channel i in V/m
 H_i = 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 SAR = local specific absorption rate in mW/g
 E_{tot} = total field strength in V/m
 σ = conductivity in [mho/m] or [Siemens/m]
 ρ = equivalent tissue density in g/cm^3

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_{pwe} = equivalent power density of a plane wave in mW/cm³
 E_{tot} = total electric field strength in V/m
 H_{tot} = total magnetic field strength in V/m

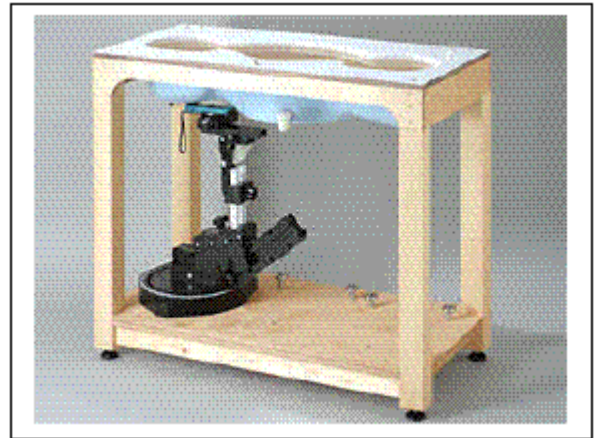
Generic Twin Phantom

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 ± 0.1 mm

Filling Volume Approx. 20 liters

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

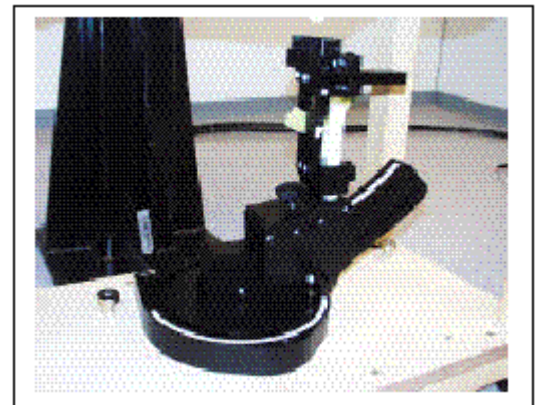


Generic Twin Phantom

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 produced 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 Distributio n 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 permittivity, deviation from target values	E.3.2	5.00	R	1.732	0.6	1.73	1.00E+09	9.00106E-09
Liquid permittivity, measurement uncertainty	E.3.3	5.00	N	1	0.6	3.00	5	16.2
								689
Probe isotropy sensitivity coefficient	0.5							
Combined Standard Uncertainty						12.65 %		
Expanded Uncertainty, 95% confidence		k=	2.004			25.34 %		