SAR EVALUATION REPORT

For

RELM Communications Corp.

7100 Technology Drive
West Melbourne, FL 32904

FCC ID: ARURPV599A

December 4, 2002

This Report Concerns:	**Equipment Type:**
☒ Original Report	VHF Portable 2-way Radio

Test Engineer:	Jeff Lee
Report No.:	R0208193S
Test Date:	December 2, 2002
Reviewed By:	Benjamin Jing
Prepared By:	Bay Area Compliance Laboratory Corporation 230 Commercial Street Sunnyvale, CA 94085 Tel: (408) 732-9162 Fax: (408) 732 9164

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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.

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, O_ce of Engineering & Technology, Washington, DC, 1997.

[3] Thomas Schmid, Oliver Egger, and Niels Kuster, \Automated E-_eld scanning system for dosimetric assessments", IEEE Transactions on Microwave Theory and Techniques, vol. 44, pp. 105{113, Jan. 1996.

[4] Niels Kuster, Ralph K.astle, and Thomas Schmid, \ Dosimetric evaluation of mobile communications equipment with known precision", IEICE 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-_eld 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 K. uhn, and Niels Kuster, \The depen-dence 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.

[10] Klaus Meier, Ralf Kastle, Volker Hombach, Roger Tay, and Niels Kuster, \The dependence of EM energy absorption upon human head modeling at 1800 MHz", IEEE Transactions on Microwave Theory and Techniques, Oct. 1997, in press.

[11] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.

[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 uncertainity 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

2.1 Equipments List & Calibration Info

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	6/02	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	11/6/01	BCL-049
SPEAG Validation Dipole D900V2	9/3/02	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	6/20/02	3009A00791
Microwave Amp. 8349B	N/A	2644A02662
Power Meter HP436A	4/2/02	2709A29209
Power Sensor HP8482A	4/2/02	2349A08568
Signal Generator RS SMIQ O3	2/10/02	1084800403
Network Analyzer HP-8753ES	7/30/02	820079
Dielectric Probe Kit HP85070A	N/A	N/A
Apprel Validation Dipole D-2450-S-1	10/1/02	BCL-141
Dipole Antenna AD-100 (450MHz)	5/7/02	02220

2.2 Equipment Calibration Certificate

Please see the attached file.

Engineering

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

Additional Conversion Factors

for Dosimetric E-Field Probe

Type	ET3DV6
Serial Number:	1604
Place of Assessment	Zurich
Date of Assessment:	October 4, 2002
Probe Calibration Date:	August 26, 2002

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:

Calibrated by:

Approved by:

Conversion Factor (± standard deviation)

150 MHz	ConvF	**9.2 ± 8%**	ε_r = 52.3 σ = 0.76 mho/m (head tissue)
300 MHz	ConvF	**8.0 ± 8%**	ε_r = 45.3 σ = 0.87 mho/m (head tissue)
450 MHz	ConvF	**7.3 ± 8%**	ε_r = 43.5 σ = 0.87 mho/m (head tissue)
2450 MHz	ConvF	**4.7 ± 8%**	ε_r = 39.2 σ = 1.80 mho/m (head tissue)
150 MHz	ConvF	**8.8 ± 8%**	ε_r = 61.9 σ = 0.80 mho/m (body tissue)
450 MHz	ConvF	**7.7 ± 8%**	ε_r = 56.7 σ = 0.94 mho/m (body tissue)
2450 MHz	ConvF	**4.3 ± 8%**	ε_r = 52.7 σ = 1.95 mho/m (body tissue)

Schmid & Partner
Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

Calibration Certificate

Dosimetric E-Field Probe

Type:	ET3DV6
Serial Number:	1604
Place of Calibration:	Zurich
Date of Calibration:	August 26, 2002
Calibration Interval:	12 months

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

Wherever applicable, the standards used in the calibration process are traceable to international standards. In all other cases the standards of the Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland have been applied.

Calibrated by:	N.Vetter
Approved by:	[signature]

DASY3 - Parameters of Probe: ET3DV6 SN:1604

Sensitivity in Free Space

NormX	**1.73**	$\mu V/(V/m)^2$
NormY	**1.68**	$\mu V/(V/m)^2$
NormZ	**1.72**	$\mu V/(V/m)^2$

Diode Compression

DCP X	**93**	mV
DCP Y	**93**	mV
DCP Z	**93**	mV

Sensitivity in Tissue Simulating Liquid

Head **900 MHz** ε_r **= 41.5 ± 5%** σ **= 0.97 ± 5% mho/m**
Head **835 MHz** ε_r **= 41.5 ± 5%** σ **= 0.90 ± 5% mho/m**

ConvF X	**6.5**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**6.5**	± 9.5% (k=2)	Alpha	**0.36**
ConvF Z	**6.5**	± 9.5% (k=2)	Depth	**2.82**

Head **1800 MHz** ε_r **= 40.0 ± 5%** σ **= 1.40 ± 5% mho/m**
Head **1900 MHz** ε_r **= 40.0 ± 5%** σ **= 1.40 ± 5% mho/m**

ConvF X	**5.5**	± 9.5% (k=2)	Boundary effect:	
ConvF Y	**5.5**	± 9.5% (k=2)	Alpha	**0.50**
ConvF Z	**5.5**	± 9.5% (k=2)	Depth	**2.46**

Boundary Effect

Head **900 MHz** **Typical SAR gradient: 5 % per mm**

Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	11.1	6.6
SAR_{be} [%]	With Correction Algorithm	0.4	0.6

Head **1800 MHz** **Typical SAR gradient: 10 % per mm**

Probe Tip to Boundary		**1 mm**	**2 mm**
SAR_{be} [%]	Without Correction Algorithm	12.3	8.1
SAR_{be} [%]	With Correction Algorithm	0.1	0.1

Sensor Offset

Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.3 ± 0.2**	mm

Body 450MHz validation 12-2-02

frequency	e'	e'
400000000.0000	58.5621	40.9168
402000000.0000	58.5726	40.7571
404000000.0000	58.4356	40.7785
406000000.0000	58.4180	40.7451
408000000.0000	58.2845	40.5955
410000000.0000	58.2977	40.5859
412000000.0000	58.1518	40.4422
414000000.0000	58.1688	40.3863
416000000.0000	58.0633	40.1885
418000000.0000	57.9652	40.2110
420000000.0000	57.9386	40.0476
422000000.0000	57.7958	39.9551
424000000.0000	57.8067	39.8440
426000000.0000	57.7810	39.8709
428000000.0000	57.7097	39.7315
430000000.0000	57.4993	39.6767
432000000.0000	57.3956	39.6006
434000000.0000	57.3197	39.4367
436000000.0000	57.3169	39.3491
438000000.0000	57.1691	39.3687
440000000.0000	57.2279	39.3156
442000000.0000	57.1132	39.2902
444000000.0000	56.9826	39.1038
446000000.0000	56.9500	39.1069
448000000.0000	56.9074	38.9984
450000000.0000	56.7025	38.9446
452000000.0000	56.7629	38.7940
454000000.0000	56.7023	38.6439
456000000.0000	56.5934	38.5937
458000000.0000	56.5217	38.5475
460000000.0000	56.4543	38.4655
462000000.0000	56.4514	38.4352
464000000.0000	56.3543	38.3911
466000000.0000	56.2432	38.2962
468000000.0000	56.1854	38.2626
470000000.0000	56.2076	38.1712
472000000.0000	56.1252	38.0978
474000000.0000	56.0554	38.0418
476000000.0000	55.9102	37.9819
478000000.0000	55.8466	37.8508
480000000.0000	55.7540	37.9594
482000000.0000	55.7407	37.9021
484000000.0000	55.7781	37.7895
486000000.0000	55.8062	37.7137
488000000.0000	55.7150	37.7282
490000000.0000	55.7192	37.6603
492000000.0000	55.5410	37.5163
494000000.0000	55.5564	37.5256
496000000.0000	55.3776	37.5026
498000000.0000	55.3867	37.4878
500000000.0000	55.4378	37.3551

$s = w e_o e'' = 2 p f e_o e'' = 0.97$

where $f = 450$

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

$e'' = 38.9446$

Head 450MHz validation 12-2-02

frequency	e'	e''
400000000.0000	44.4508	35.0608
402000000.0000	44.3990	34.9942
404000000.0000	44.3102	34.9907
406000000.0000	44.3313	34.9675
408000000.0000	44.2069	34.9055
410000000.0000	44.2979	34.8877
412000000.0000	44.1853	34.6892
414000000.0000	44.0359	34.6659
416000000.0000	44.0325	34.5690
418000000.0000	44.0003	34.5615
420000000.0000	44.0060	34.4412
422000000.0000	43.8695	34.4245
424000000.0000	43.8263	34.3111
426000000.0000	43.8107	34.3589
428000000.0000	43.7301	34.3217
430000000.0000	43.6381	34.2376
432000000.0000	43.4397	34.2110
434000000.0000	43.5045	34.2521
436000000.0000	43.4787	34.1667
438000000.0000	43.4147	34.1773
440000000.0000	43.3961	34.1689
442000000.0000	43.2829	34.1223
444000000.0000	43.2238	33.9845
446000000.0000	43.2069	33.9767
448000000.0000	43.1858	33.9002
450000000.0000	42.9580	33.8039
452000000.0000	43.0561	33.7797
454000000.0000	42.9348	33.7117
456000000.0000	42.8995	33.6278
458000000.0000	42.7634	33.5997
460000000.0000	42.7877	33.5553
462000000.0000	42.6783	33.5684
464000000.0000	42.6533	33.4906
466000000.0000	42.5162	33.5188
468000000.0000	42.4590	33.3703
470000000.0000	42.5017	33.3626
472000000.0000	42.3885	33.2515
474000000.0000	42.3217	33.2083
476000000.0000	42.2659	33.2023
478000000.0000	42.1448	33.1027
480000000.0000	42.1410	33.0893
482000000.0000	42.0872	33.0836
484000000.0000	42.0272	33.0537
486000000.0000	41.9041	33.0292
488000000.0000	41.9381	32.9601
490000000.0000	41.8150	32.9754
492000000.0000	41.8389	32.7808
494000000.0000	41.7277	32.8322
496000000.0000	41.6157	32.8326
498000000.0000	41.5818	32.7467
500000000.0000	41.6055	32.6828

$s = w e_o e'' = 2 p f e_o e'' = 0.85$

where $f = 450$

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

$e'' = 33.8039$

Body 150MHz validation

12-2-02

frequency	e"	e'
100000000.0000	75.6001	102.8900
102000000.0000	74.3741	102.3748
104000000.0000	73.7551	102.1182
106000000.0000	72.6432	101.4242
108000000.0000	71.8142	101.3512
110000000.0000	70.5130	100.5716
112000000.0000	70.0699	100.4351
114000000.0000	69.2819	100.1202
116000000.0000	68.4673	99.2912
118000000.0000	67.7239	98.6752
120000000.0000	67.2074	98.8760
122000000.0000	65.9348	98.2794
124000000.0000	65.5143	97.6607
126000000.0000	64.9210	97.3937
128000000.0000	64.3662	97.3090
130000000.0000	63.8354	96.4897
132000000.0000	63.5271	96.3978
134000000.0000	62.8503	95.9299
136000000.0000	62.5861	95.6391
138000000.0000	61.8092	95.2723
140000000.0000	61.3461	95.1659
142000000.0000	60.6475	94.4532
144000000.0000	61.1700	94.4468
146000000.0000	60.2963	93.9025
148000000.0000	60.0422	94.0316
150000000.0000	59.1494	93.8177
152000000.0000	59.1684	93.0544
154000000.0000	58.4539	92.9713
156000000.0000	58.6679	92.5610
158000000.0000	57.9707	92.4157
160000000.0000	57.8450	91.9919
162000000.0000	57.2435	91.8316
164000000.0000	57.0519	91.6262
166000000.0000	56.5815	91.3578
168000000.0000	56.3512	91.0157
170000000.0000	56.1521	90.7455
172000000.0000	55.7471	90.5251
174000000.0000	55.3169	90.1658
176000000.0000	55.2567	89.9472
178000000.0000	54.9758	89.6331
180000000.0000	54.4629	89.2134
182000000.0000	53.9903	89.0205
184000000.0000	53.5980	88.8853
186000000.0000	53.3992	88.5113
188000000.0000	52.9940	88.1734
190000000.0000	52.5744	88.1191
192000000.0000	52.4446	87.6970
194000000.0000	51.8832	87.3725
196000000.0000	51.5538	87.1571
198000000.0000	51.4737	86.7956
200000000.0000	51.2433	86.4910

$s = w e_o e" = 2 p f e_o e" = 0.78$

where $f = 150$

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

$e" = 93.8177$

Head 150MHz validation 12-2-02

frequency	e'	e''
100000000.0000	77.1745	103.4794
102000000.0000	76.0028	102.1773
104000000.0000	75.0952	101.6591
106000000.0000	74.2725	100.8884
108000000.0000	73.0474	100.6930
110000000.0000	72.1921	99.7479
112000000.0000	71.2312	99.6106
114000000.0000	70.5526	98.8278
116000000.0000	62.5676	97.9639
118000000.0000	61.6590	97.4848
120000000.0000	61.4444	97.0129
122000000.0000	60.9582	96.3849
124000000.0000	60.4307	95.7123
126000000.0000	59.5418	95.2881
128000000.0000	59.0385	94.5210
130000000.0000	58.5188	93.5173
132000000.0000	57.8515	93.6456
134000000.0000	56.1045	92.9728
136000000.0000	55.7110	92.2771
138000000.0000	54.9867	91.9978
140000000.0000	54.1448	91.6014
142000000.0000	54.8194	90.8088
144000000.0000	53.7653	90.6603
146000000.0000	52.8032	89.7312
148000000.0000	52.3175	89.5825
150000000.0000	52.0028	89.3209
152000000.0000	51.8111	88.3681
154000000.0000	51.7509	88.4380
156000000.0000	51.7123	87.6678
158000000.0000	51.4531	87.4214
160000000.0000	51.0583	86.8036
162000000.0000	50.3810	86.4023
164000000.0000	50.3600	86.0435
166000000.0000	49.5887	85.5559
168000000.0000	49.3595	85.1254
170000000.0000	48.4180	84.7656
172000000.0000	48.0777	84.4546
174000000.0000	48.2943	83.9167
176000000.0000	48.2418	83.4174
178000000.0000	48.0498	83.2923
180000000.0000	47.5239	82.8491
182000000.0000	47.2489	82.4112
184000000.0000	46.6898	82.1532
186000000.0000	46.4964	81.7528
188000000.0000	46.3634	81.3207
190000000.0000	45.9391	81.3727
192000000.0000	45.9957	80.7417
194000000.0000	45.5842	80.4071
196000000.0000	45.1310	80.3258
198000000.0000	44.9799	89.9485
200000000.0000	45.0251	89.5031

$s = w\, e_o\, e'' = 2\, p\, f\, e_o\, e'' = 0.75$

where $f = 150$

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

$e'' = 89.3209$

Body 450MHz validation-12-13-02

frequency	e'	e''
400000000.0000	55.7869	38.7639
402000000.0000	55.8430	38.6987
404000000.0000	55.7287	38.5173
406000000.0000	55.8611	38.4428
408000000.0000	55.8106	38.2644
410000000.0000	55.7257	38.1350
412000000.0000	55.6965	37.9777
414000000.0000	55.6237	37.9562
416000000.0000	55.7331	37.8898
418000000.0000	55.7030	37.8200
420000000.0000	55.5709	37.4941
422000000.0000	55.5260	37.4229
424000000.0000	55.4497	37.3755
426000000.0000	55.3972	37.2699
428000000.0000	55.3804	37.1262
430000000.0000	55.3574	37.0750
432000000.0000	55.2259	36.9478
434000000.0000	55.2443	36.9095
436000000.0000	55.2273	36.7624
438000000.0000	55.1146	36.7002
440000000.0000	55.0683	36.6361
442000000.0000	54.9425	36.4328
444000000.0000	54.9252	36.3922
446000000.0000	54.8249	36.3375
448000000.0000	54.7950	36.2723
450000000.0000	54.7698	36.2782
452000000.0000	54.6393	36.0470
454000000.0000	54.6657	36.0546
456000000.0000	54.5190	35.9732
458000000.0000	54.5731	35.8957
460000000.0000	54.6484	35.8198
462000000.0000	54.4728	35.6503
464000000.0000	54.4722	35.6313
466000000.0000	54.3460	35.6117
468000000.0000	54.3818	35.5693
470000000.0000	54.3294	35.3571
472000000.0000	54.1065	35.3038
474000000.0000	54.0798	35.2321
476000000.0000	54.9931	35.1159
478000000.0000	54.0306	34.9527
480000000.0000	54.0015	34.8702
482000000.0000	54.0006	34.9367
484000000.0000	53.8745	34.8685
486000000.0000	53.8413	34.6472
488000000.0000	53.7862	34.6351
490000000.0000	53.8291	34.6357
492000000.0000	53.7627	34.5337
494000000.0000	53.7779	34.4360
496000000.0000	53.7957	34.4641
498000000.0000	53.6870	34.3959
500000000.0000	53.6166	34.2056

$s = w e_o e'' = 2 p f e_o e''=0.91$
where $f = 450$
$e_o = 8.854 \times 10^{-12}$
$e'' = 36.2782$

Head 450MHz validation-12-13-02

frequency	e'	e''
400000000.0000	44.2310	35.3608
402000000.0000	44.2510	35.2640
404000000.0000	44.1156	35.0752
406000000.0000	44.0032	34.9220
408000000.0000	44.0696	34.8273
410000000.0000	43.9282	34.4790
412000000.0000	43.8486	34.5652
414000000.0000	43.8272	34.4827
416000000.0000	43.8189	34.4282
418000000.0000	43.6692	34.1792
420000000.0000	43.6073	33.9601
422000000.0000	43.4251	33.9134
424000000.0000	43.3026	33.7900
426000000.0000	43.3488	33.8898
428000000.0000	43.4654	33.6845
430000000.0000	43.0142	33.5353
432000000.0000	42.8737	33.4850
434000000.0000	42.8587	33.4106
436000000.0000	42.7204	33.3614
438000000.0000	42.7323	33.4181
440000000.0000	42.6832	33.2388
442000000.0000	42.6970	33.3022
444000000.0000	42.6946	33.2138
446000000.0000	42.5756	33.2057
448000000.0000	42.5837	33.2350
450000000.0000	42.4970	33.1722
452000000.0000	42.3963	33.0714
454000000.0000	42.3570	33.1660
456000000.0000	42.2120	33.1099
458000000.0000	42.2477	33.1613
460000000.0000	42.2569	33.1495
462000000.0000	42.1954	33.0912
464000000.0000	42.0752	33.1066
466000000.0000	42.0365	33.1189
468000000.0000	42.0816	33.0464
470000000.0000	42.0229	32.8955
472000000.0000	41.8921	32.9413
474000000.0000	41.9907	32.8058
476000000.0000	41.8654	32.7448
478000000.0000	41.7931	32.6800
480000000.0000	41.7046	32.5666
482000000.0000	41.7891	32.5552
484000000.0000	41.7335	32.4102
486000000.0000	41.7166	32.4143
488000000.0000	41.5751	32.3804
490000000.0000	41.6430	32.2631
492000000.0000	41.6538	32.1524
494000000.0000	41.6134	32.0729
496000000.0000	41.6624	31.9041
498000000.0000	41.6330	31.8746
500000000.0000	41.5710	31.8970

$s = w e_o e'' = 2 p f e_o e''=0.83$
where $f = 450$
$e_o = 8.854 \times 10^{-12}$
$e'' = 33.1722$

Head 150MHz validation-12-13-02

frequency	e'	e''
100000000.0000	56.8980	111.4906
102000000.0000	56.2778	110.1488
104000000.0000	56.0948	108.3585
106000000.0000	56.2943	106.9375
108000000.0000	55.6029	105.5743
110000000.0000	55.9643	103.8739
112000000.0000	55.0170	102.9444
114000000.0000	55.1332	101.4921
116000000.0000	55.0364	100.6542
118000000.0000	54.9261	99.2548
120000000.0000	54.5208	98.1170
122000000.0000	54.5720	96.2446
124000000.0000	54.4280	95.5949
126000000.0000	54.0761	94.2892
128000000.0000	54.2227	93.4408
130000000.0000	53.9422	92.3598
132000000.0000	53.4582	91.4164
134000000.0000	53.3296	90.4084
136000000.0000	53.4079	99.2844
138000000.0000	53.5469	98.9480
140000000.0000	53.0877	97.9822
142000000.0000	53.0911	97.0055
144000000.0000	52.9036	96.1933
146000000.0000	52.9767	95.3408
148000000.0000	52.5912	94.7088
150000000.0000	52.2432	93.9547
152000000.0000	51.8434	93.3992
154000000.0000	51.4321	92.8223
156000000.0000	51.5798	92.0792
158000000.0000	51.5467	91.2402
160000000.0000	51.0929	90.6256
162000000.0000	51.2318	89.6459
164000000.0000	51.2826	88.5538
166000000.0000	51.5443	88.2277
168000000.0000	51.5050	87.2023
170000000.0000	51.3948	86.8818
172000000.0000	51.0377	86.1144
174000000.0000	50.9466	85.5756
176000000.0000	50.7023	84.9975
178000000.0000	50.3636	84.2603
180000000.0000	50.5515	83.8138
182000000.0000	50.3794	83.2188
184000000.0000	50.1227	82.7096
186000000.0000	49.8525	82.4831
188000000.0000	49.8316	82.0319
190000000.0000	49.4698	81.5948
192000000.0000	49.3264	80.9751
194000000.0000	49.1623	80.4314
196000000.0000	49.0807	80.0712
198000000.0000	49.2509	79.6758
200000000.0000	49.1990	78.9119

$s = w e_o e'' = 2 p f e_o e''=0.78$
where $f = 150$
$e_o = 8.854 \times 10^{-12}$
$e'' = 93.9547$

3 - EUT DESCRIPTION

Applicant:	RELM Communications Corp.
Product Description:	VHF Portable 2-way Radio (prototype)
Product Name:	RPV599A
FCC ID:	ARURPV599A
Serial Number:	None
Transmitter Frequency:	148~174MHz
Maximum Output Power:	4.37W (EIRP)
Dimension:	3.8” L x 2.5”W x 0.2”H approximately
RF Exposure environment:	Occupational
Power Supply:	Fed by RELM AC/DC adapter, M/N: 48-12-900D
Applicable Standard	FCC CFR 47, Part 22, 74, 80 and 90
Application Type:	Certification

1 Specific Absorption Rate (SAR) is a measure of the rate of energy absorption due to exposure to an RF transmitting source (wireless portable device).
2 IEEE/ANSI Std. C95.1-1992 limits are used to determine compliance with FCC ET Docket 93-62.

Note: The test data was good for test sample only. It may have deviation for other test samples.

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 Special Accessories

All interface cables used for compliance testing are shielded as normally supplied by INMAC, Monster Cable and their respective support equipment manufacturer. The EUT is featured shielded metal connectors.

4.4 Equipment Modifications

No modification(s) were made to ensure that the EUT complies with the applicable limits.

5 - CONDUCTED OUTPUT POWER MEASUREMENT

5.1 Measurement Procedure

1. The EUT was placed at 1.5m height turnaround table and in a position for normal use declared by the manufacturer.
2. The test antenna was oriented initially for vertical position with 3m away from EUT.
3. The output of the antenna was connected to the measuring receiver and the quasi-peak detector is used for the measurement.
4. The transmitter was turned on and the measuring receiver was tuned to the frequency of the transmitter under the testing.
5. The test antenna was raised and lowered through specified ranged of height until the maximum signal level was detected by the measuring receiver.
6. The transmitter was rotated through 360 in the horizontal plane until the maximum signal level was detected.
7. The transmitter was then replaced by a horn antenna which is a substitution antenna.
8. The substitution antenna was oriented for vertical polarization and then connected to a calibrated signal generator.
9. The input attenuator of measuring receiver was adjusted to increased the sensitivity.
10. The substitution antenna was raised and lowered to ensure the maximum signal level was detected.
11. The input signal to the substitution antenna was adjusted to the level to produce a level which was equal to the level noted while the transmitter radiated power was measured, corrected for the change of the input attenuator of the measuring receiver.
12. The input level to the substitution antenna was recorded as power level in dBm, corrected for any change of input attenuator of the measuring receiver.
13. The measurement was repeated with the test antenna and the substitution antenna oriented for horizontal polarization.
14. The measure of the radiated output power is the larger one of the two level recorded, at the input to the substitution antenna, corrected for gain of the substitution antenna if necessary.

5.2 Test Results

Channel	Output Power in W
148	4.37
163	4.07
174	3.89

Note: The power output may depend on the intended use of the EUT. For all tests, the EUT was set to maximum conditions.

6 - DOSIMETRIC ASSESSMENT SETUP

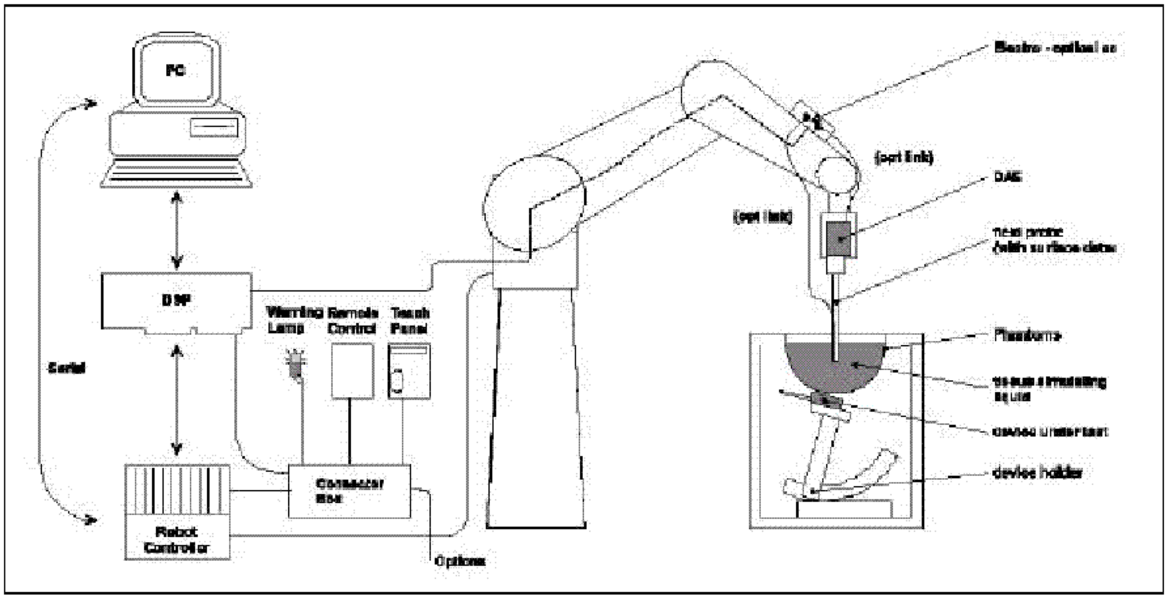
These measurements were performed with the automated near-field scanning system DASY3 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m) which positions the probes with a positional repeatability of better than ±0.02mm. Special 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: 1577 (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 ±10%. The spherical isotropy was evaluated with the procedure described in [8] and found to be better than ±0.25dB.

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)													
	150		300		450		835		900		1800		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.35	46.6	37.56	46.6	38.56	51.16	41.45	52.4	40.71	56.0	54.90	40.4	62.7	73.2
Salt (Nacl)	5.15	2.6	5.95	2.6	3.95	1.49	1.45	1.4	1.48	0.76	0.18	0.5	0.5	0.04
Sugar	55.5	49.7	55.32	49.7	56.32	46.78	56.0	45.0	56.63	41.76	0.0	58.0	0.0	0.0
HEC	0.9	1.0	0.98	1.0	0.98	0.52	1.0	1.0	0.99	1.21	0.0	1.0	0.0	0.0
Bactericide	0.1	0.1	0.19	0.1	0.19	0.05	0.1	0.1	0.19	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	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.7
Dielectric Constant	52.3	61.9	45.3	61.9	43.5	58.0	41.5	56.1	41.5	56.8	40.0	54.0	39.8	52.5
Conductivity (s/m)	0.76	0.80	0.87	0.80	0.87	0.83	0.90	0.95	0.97	1.07	1.40	1.45	1.88	1.78

6.1 Measurement System Diagram



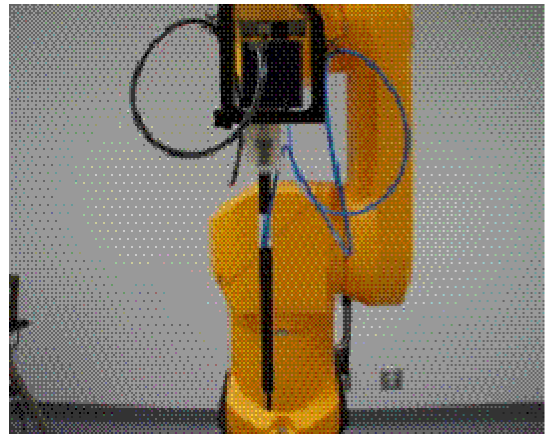
The DASY3 system for performing compliance tests consist of the following items:

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

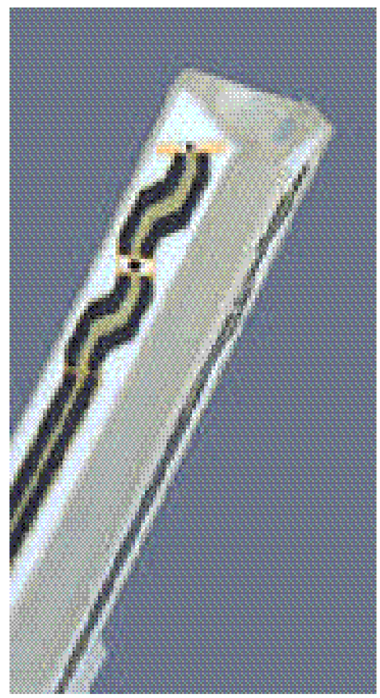
ET3DV5 Probe Specification

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 ± 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

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 bellow 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	ó
	-Density	ñ

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:

$$Vi = Ui + (Ui)^2 \, cf / dcp_i$$

With Vi = compensated signal of channel i (i =x, y, z)
Ui = 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:

E-field probes: $$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

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

With Vi = compensated signal of channel i (i =x, y, z)
$Norm_i$ = sensor sensitivity of channel i (i =x, y, z)
ìV/ $(V/m)^2$ for E-field probes
ConF = sensitivity enhancement in solution
a_{ij} = sensor sensitivity factors for H-field probes
f = carrier frequency [GHz]
Ei = electric field strenggy 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):

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

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

$$SAR = (E_{tot})^2 \text{ ó/(ñ } 1000)$$

With SAR = local specific absorption rate in mW/g
E_{tot} = total field strength in V/m
ó = conductivity in [mho/m] or [Siemens/m]
ñ = 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.

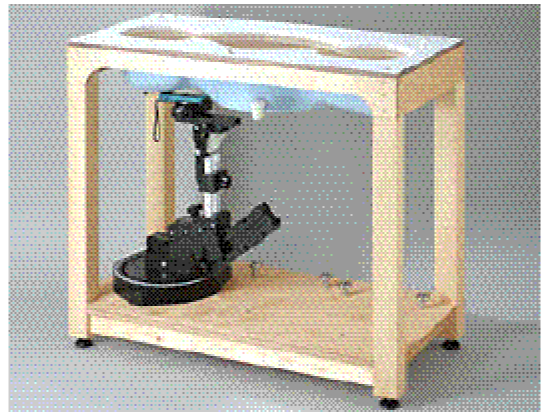
The power flow density is calculated assuming the excitation field as a free space field.

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

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

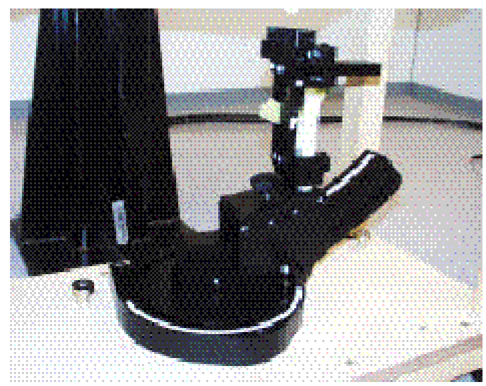


Generic Twin Phantom

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.

Uncertainty Description	Error	Distrib.	Weight	Std. Dev.	Offset
Probe Uncertainty					
Axial isotropy	± 0.2 dB	U-shape	0.5	±2.4 %	/
Spherical isotropy	±0.4 dB	U-shape	0.5	±4.8 %	/
Isotropy from gradient	±0.5 dB	U-shape	0	/	/
Spatial resolution	±0.5 %	Normal	1	±0.5 %	/
Linearity error	±0.2 dB	Rectangle	1	±2.7 %	/
Calibration error	±3.3 %	Normal	1	± 3.3 %	/
SAR Evaluation Uncertainty					
Data acquisition error	±1%	Rectangle	1	±0.6 %	/
ELF and RF disturbances	±0.25 %	Normal	1	±0.25 %	/
Conductivity assessment	±10 %	Rectangle	1	± 5.8 %	/
Spatial Peak SAR Evaluation Uncertainty					
Extrapol boundary effect	±3%	Normal	1	±3%	± 5%
Probe positioning error	±0.1 mm	Normal	1	± 1%	/
Integrat. and cube orient	±3%	Normal	1	±3%	/
Cube shape inaccuracies	±2%	Rectangle	1	±1.2 %	/
Device positioning	±6%	Normal	1	± 6%	/
Combined Uncertainties	/	/	1	±11.7 %	± 5%
Extended uncertainty (K = 2)	/	/	/	± 23.5 %.	/

7 - SYSTEM EVALUATION

7.1 Simulated Tissue Liquid Parameter Confirmation

The dielectric parameters were checked prior to assessment using the HP85070A dielectric probe kit. The dielectric parameters measured are reported in each correspondent section:

7.2 Evaluation Procedures

Maximum Search

The maximum search is automatically performed after each coarse scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for most SAR distributions even with relatively large grid spacings. After the coarse scan measurement, the probe is automatically moved to a position at the interpolated maximum. The following scan can directly use this position for reference, e.g., for a finer resolution grid or the cube evaluations.

Extrapolation

The extrapolation can be used in z-axis scans with automatic surface detection. The SAR values can be extrapolated to the inner phantom surface. The extrapolation distance is the sum of the probe sensor offset, the surface detection distance and the grid offset. The extrapolation is based on fourth order polynomal functions. The extrapolation is only available for SAR values.

Boundary Corrections

The correction of the probe boundary effect in the vicinity of the phantom surface can be done in two different ways. In the standard (worse case) evaluation, the boundary effect is reduced by different weights for the lowest measured points in the extrapolation routine. The result is a slight overestimation of the extrapolated SAR values (2% to 8%) depending on the SAR distribution and gradient. The advanced evaluation makes a full compensation of the boundary effect before doing the extrapolation. This is only possible of probes with specifications on the boundary effect.

Peak Search for 1g and 10g cube averaged SAR

The 1g and 10g peak evaluations are only available for the predefined cube 4x4x7 and cube 5x5x7 scans. The routine are verified and optimized for the grid dimensions used in these cube measurements. The measured volume of 32x32x35mm contains about 35g of tissue. The first procedure is an extrapolation (incl. Boundary correction) to get the points between the lowest measured plane and the surface. The next step uses 3D interpolation get all points within the measured volume in a 1mm grid (35000 points). In the last step, a 1g cube is place numerically into the volume and its averaged SAR is calculated. This cube is the moved around until the highest averaged SAR is found. This last procedure is repeated for a 10g cube. If the highest SAR is found at the edge of the measured volume, the system will issue a warning,: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

7.3 System Accuracy Verification

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of ±10%. The validation results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

IEEE P1528 recommended reference value

Frequency (MHz)	1 g SAR	10 g SAR	Local SAR at surface (above feed point)	Local SAR at surface (v=2cm offset from feed point)
300	3.0	2.0	4.4	2.1
450	4.9	3.3	7.2	3.2
835	9.5	6.2	14.1	4.9
900	10.8	6.9	16.4	5.4
1450	29.0	16.0	50.2	6.5
1800	38.1	19.8	69.5	6.8
1900	39.7	20.5	72.1	6.6
2000	41.1	21.1	74.6	6.5
2450	52.4	24.0	104.2	7.7
3000	63.8	25.7	140.2	9.5

Validation Dipole SAR Reference Test Result for Body (450 MHz)

Validation Measurement	SAR @ 9.225W Input averaged over 1g	SAR @ 1W Input averaged over 1g	SAR @ 9.225W Input averaged over 10g	SAR @ 1W Input averaged over 10g
Test 1	0.0451	0.89	0.0315	3.4
Test 2	0.0447	4.85	0.0312	3.38
Test 3	0.0448	4.86	0.0313	3.39
Test 4	0.0450	4.88	0.0313	3.39
Test 5	0.0451	4.89	0.0313	3.39
Test 6	0.0450	4.88	0.0315	3.4
Test 7	0.0451	4.89	0.0314	3.4
Test 8	0.0449	4.87	0.0312	3.38
Test 9	0.0449	4.87	0.0312	3.38
Test 10	0.0448	4.86	0.0311	3.37
Average	0.0449	4.874	0.0313	3.388

System validation result

12/2/02:

Ambient Temperature (ºC): 23.0
Relative Humidity (%): 49.3

Simulant	Freq [MHz]	Parameters	Liquid Temp [ºC]	Target Value	Measured Value	Deviation [%]	Limits [%]
Body	450	ε	22	56.7	56.7	0	±5
		σ	22	0.94	0.97	3.19	±5
		1g SAR	22	4.874	4.473	-8.23	±10
Head	450	ε	22	43.5	43.0	-1.15	±5
		σ	22	0.87	0.85	-2.30	±5
		1g SAR	22	4.9	4.51	-7.96	±10

ε = relative permittivity, σ = conductivity and ρ=1000kg/m^3
Note: Forward power = 18.197mW

12/13/02:

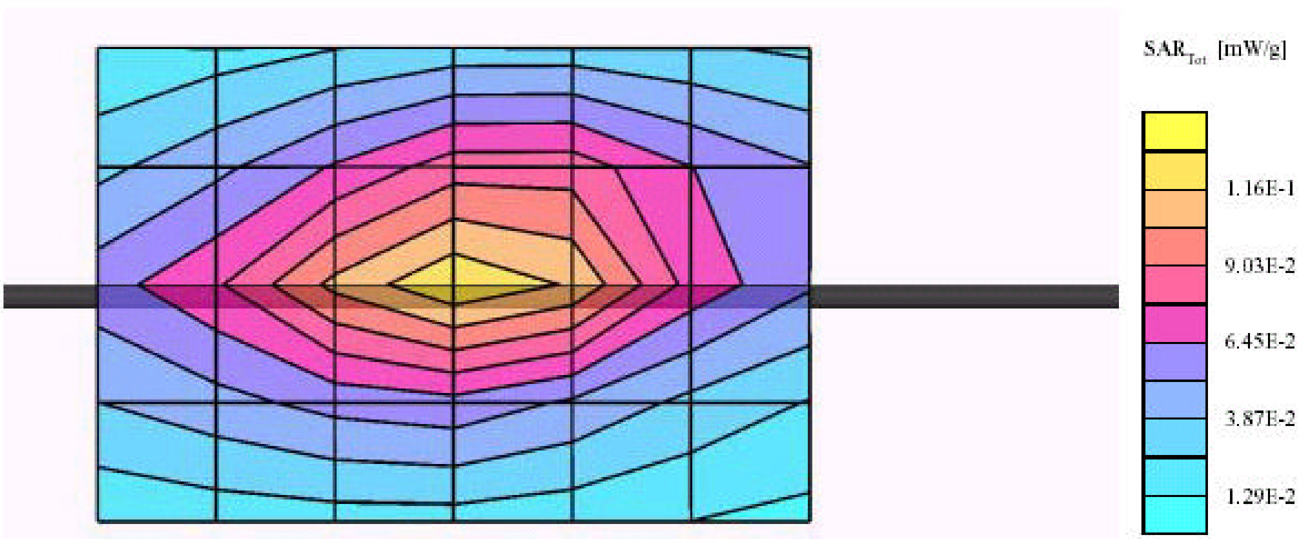
Ambient Temperature (ºC): 23.0
Relative Humidity (%): 49.3

Simulant	Freq [MHz]	Parameters	Liquid Temp [ºC]	Target Value	Measured Value	Deviation [%]	Limits [%]
Body	450	ε	22	56.7	54.8	-3.35	±5
		σ	22	0.94	0.91	-3.19	±5
		1g SAR	22	4.874	4.495	-7.78	±10
Head	450	ε	22	43.5	42.5	-2.30	±5
		σ	22	0.87	0.83	-4.60	±5
		1g SAR	22	4.9	4.561	-6.92	±10

ε = relative permittivity, σ = conductivity and ρ=1000kg/m^3
Note: Forward power = 18.197mW

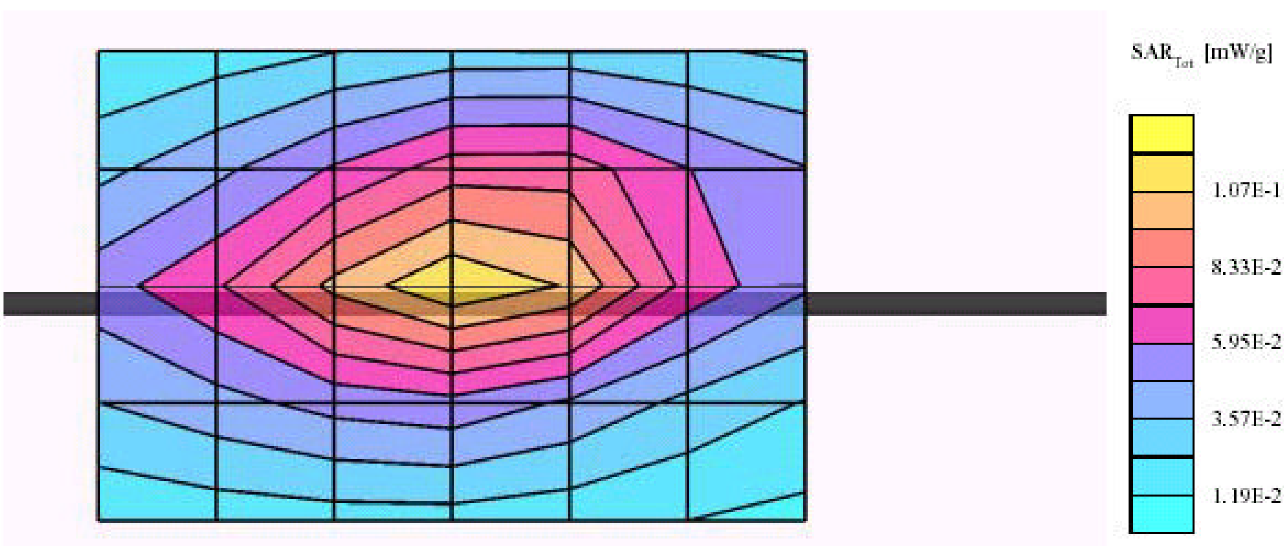
450 MHz system validation (22 Deg C, 12/2/02) Forward power = 12.6 dBm

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 450 MHz
Probe: ET3DV6 - SN1604; ConvF(7.70,7.70,7.70); Crest factor: 1.0; Flat (Body) 450 MHz: σ = 0.97 mho/m ε_r = 56.7 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 0.0814 mW/g, SAR (10g): 0.0569 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.23 dB



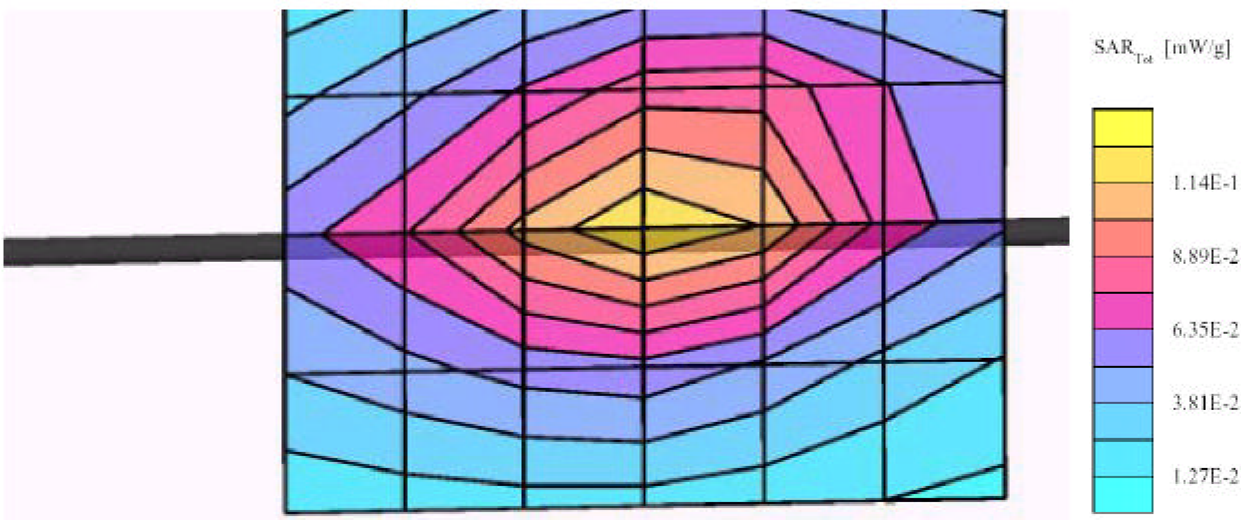
450 MHz system validation (21 Deg C, 12/2/02) Forward power = 12.6 dBm

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 450 MHz
Probe: ET3DV6 - SN1604; ConvF(7.30,7.30,7.30); Crest factor: 1.0; Flat (Head) 450 MHz: σ = 0.85 mho/m ε_r = 43.0 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 0.0821 mW/g, SAR (10g): 0.0575 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.23 dB



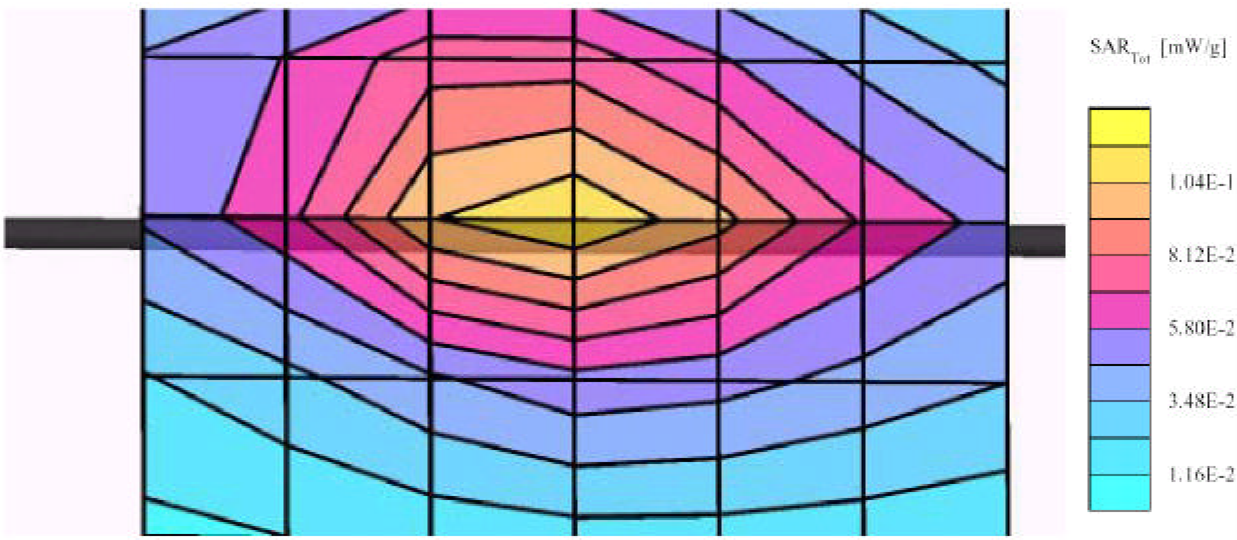
450 MHz System validation Validation (22 Deg. C, 12/13/02) Forward power = 12.6 dBm

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 450 MHz
Probe: ET3DV6 - SN1604; ConvF(7.30,7.30,7.30); Crest factor: 1.0; Flat (Body) 450 MHz: σ = 0.91 mho/m ε_r = 54.8 ρ = 1.00 g/cm³
Cubes (2): SAR (1g): 0.0818 mW/g ± 0.02 dB, SAR (10g): 0.0572 mW/g ± 0.02 dB, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.23 dB



450 MHz System validation Validation (22 Deg. C, 12/13/02) Forward power = 12.6 dBm

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 450 MHz
Probe: ET3DV6 - SN1604; ConvF(7.30,7.30,7.30); Crest factor: 1.0; Flat (Head) 450 MHz: σ = 0.83 mho/m ε_r = 42.5 ρ = 1.00 g/cm³
Cubes (2): SAR (1g): 0.0830 mW/g ± 0.05 dB, SAR (10g): 0.0578 mW/g ± 0.02 dB, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.23 dB



7.4 SAR Evaluation Procedure

The evaluation was performed with the following procedure:

Step 1: Measurement of the SAR value at a fixed location above the ear point or central position was used as a reference value for assessing the power drop.

Step 2: The SAR distribution at the exposed side of the head was measured at a distance of 3.9 mm from the inner surface of the shell. The area covered the entire dimension of the head or EUT and the horizontal grid spacing was 20 mm x 20 mm. Based on these data, the area of the maximum absorption was determined by spline interpolation.

Step 3: Around this point, a volume of 32 mm x 32 mm x 34 mm was assessed by measuring 5 x 5 x 7 points. On the basis of this data set, the spatial peak SAR value was evaluated under the following procedure:

1. The data at the surface were extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2 mm. The extrapolation was based on a least square algorithm [11]. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

2. The maximum interpolated value was searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g or 10 g) were computed by the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three onedimensional splines with the “Not a knot"-condition (in x, y and z-directions) [11], [12]. The volume was integrated with the trapezoidal-algorithm. One thousand points (10 x 10 x 10) were interpolated to calculate the average.

3. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

Step 4: Re-measurement of the SAR value at the same location as in Step 1. If the value changed by more than 5%, the evaluation was repeated.

7.5 Exposure Limits

Table 1: Limits for Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands. Wrists. Feet and Ankles
0.4	8.0	20.0

Table 2: Limits for General Population/Uncontrolled Exposure (W/kg)

Whole-Body	Partial-Body	Hands. Wrists. Feet and Ankles
0.08	1.6	4.0

Note: Whole-body SAR is averaged over the entire body, partial-body SAR is averaged over any 1 gram of tissue defined as a tissue volume in the shape of a cube SAR for hands, writs, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

Occupational/Controlled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).