SAR EVALUATION REPORT

For

Midland Radio Corporation

1120 Clay Street
North Kansas City, MO 64116

FCC ID: MMAG300

2003-06-11

This Report Concerns: ☒ Original Report	**Equipment Type:** FRS & GMRS

Test Engineer: Eric Hong / Hong

Report No.: R0304017S

Test Date: 2003-04-14

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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:

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

Worst case SAR reading

EUT position	Frequency (MHz)	Output Power (W)	Test Type	Antenna Type	Liquid	Phantom	Notes / Accessories	Measured (mW/g)	Limit (mW/g)
Back touching phantom	462.54	3.04	Body worn	Built-in	body	flat	With belt clip & headset	0.215	1.6
Back touching phantom	467.7125	0.41	Body worn	Built-in	body	flat	With belt clip & headset	0.220	1.6
Front, 2.5cm separation from phantom	462.54	3.04	Face-held	Built-in	head	flat	None	0.145	1.6
Front, 2.5cm separation from phantom	467.7125	0.41	Face-held	Built-in	head	flat	None	0.134	1.6

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-field 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 Equipment 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.

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

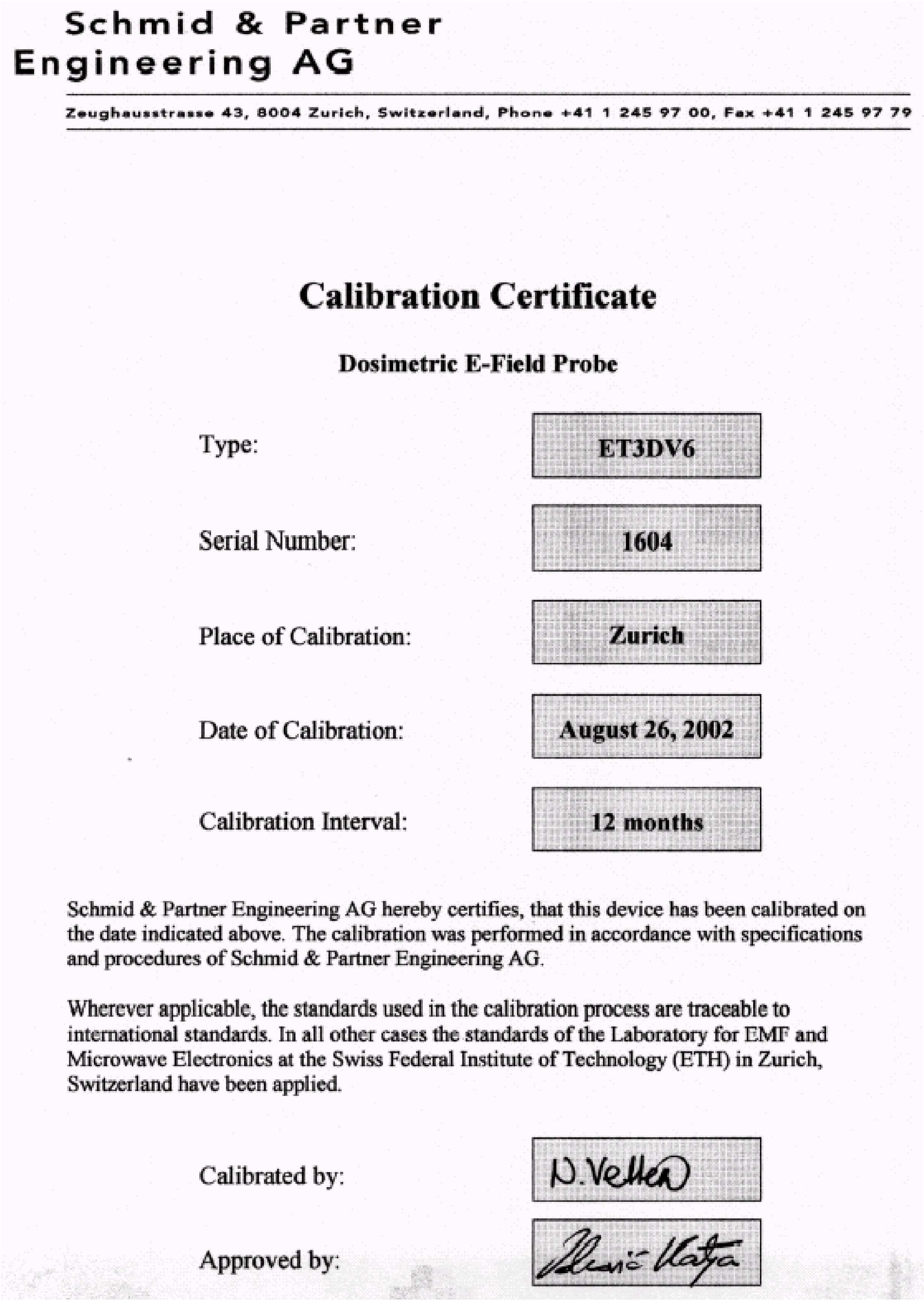
Type	ET3DV6
Serial Number:	1604
Place of Assessment	Zurich
Date of Assessment:	October 4, 2002
Probe Calibration Date:	August 26, 2002

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

Conversion Factor (± standard deviation)

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

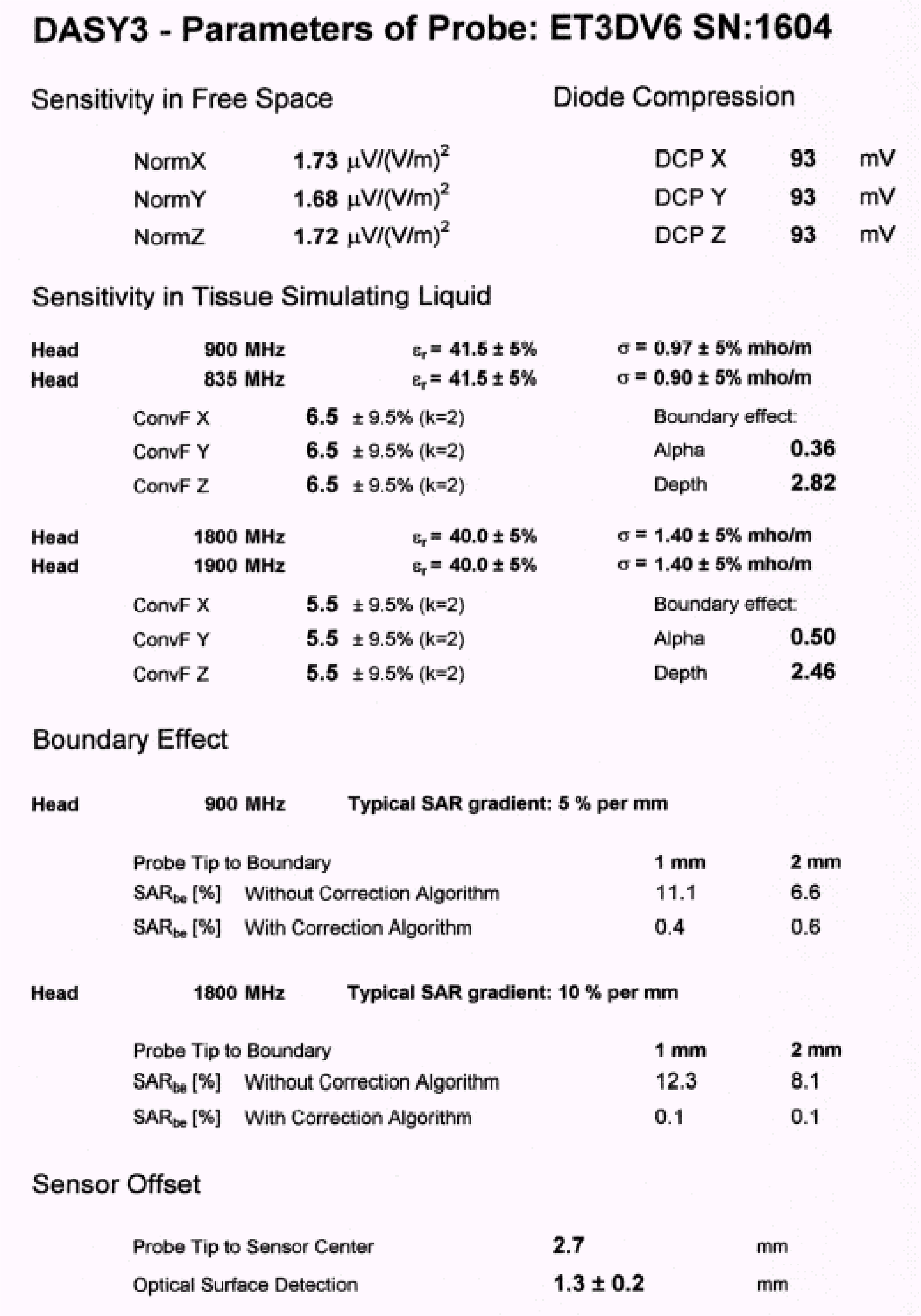
Dosimetric E-Field Probe

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:	Katja



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

450MHz Body Liquid Validation

frequency	e'	e''
430000000.0000	57.9424	36.8529
430800000.0000	57.9753	36.9010
431600000.0000	58.1364	36.9346
432400000.0000	58.1371	36.9988
433200000.0000	58.1652	36.8497
434000000.0000	58.1430	36.8836
434800000.0000	58.2336	36.8267
435600000.0000	58.1325	36.8905
436400000.0000	58.2835	36.8162
437200000.0000	58.2180	36.7242
438000000.0000	58.2162	36.7013
438800000.0000	58.1859	36.7810
439600000.0000	58.2041	36.7017
440400000.0000	58.2252	36.6578
441200000.0000	58.2179	36.6656
442000000.0000	58.2300	36.7398
442800000.0000	58.1928	36.6193
443600000.0000	58.3233	36.6300
444400000.0000	58.2944	36.6368
445200000.0000	58.2469	36.6778
446000000.0000	58.2471	36.6116
446800000.0000	58.2743	36.5161
447600000.0000	58.2606	36.5972
448400000.0000	58.3074	36.5962
449200000.0000	58.2903	36.4926
450000000.0000	58.2747	36.4659
450800000.0000	58.2152	36.4906
451600000.0000	58.2800	36.4272
452400000.0000	58.3626	36.4720
453200000.0000	58.2316	36.4176
454000000.0000	58.1502	36.3627
454800000.0000	58.1248	36.3056
455600000.0000	58.1499	36.2053
456400000.0000	58.1246	36.1486
457200000.0000	58.1014	36.0984
458000000.0000	58.0641	36.0947

458800000.0000	57.9563	36.1122
459600000.0000	57.9502	36.0712
460400000.0000	57.8955	36.0311
461200000.0000	57.9374	36.0107
462000000.0000	57.8776	35.8612
462800000.0000	57.8306	35.9374
463600000.0000	57.8715	35.7996
464400000.0000	57.7502	35.7667
465200000.0000	57.6951	35.7002
466000000.0000	57.7477	35.6702
466800000.0000	57.6410	35.5923
467600000.0000	57.6766	35.5745
468400000.0000	57.6215	35.5295
469200000.0000	57.5235	35.5457
470000000.0000	57.4328	35.4503

$\sigma = \omega \varepsilon_o \varepsilon'' = 2 \pi f \varepsilon_o \varepsilon''=0.91$
where $f = 450x\ 10^6$
$\varepsilon_o = 8.854\ x\ 10^{-12}$
$\varepsilon'' = 36.4659$

450MHz Head Liquid Validation

frequency	e'	e''
400000000.0000	44.4521	36.6697
402000000.0000	44.2045	36.6797
404000000.0000	44.2203	36.4782
406000000.0000	44.1983	36.3163
408000000.0000	44.0291	36.0954
410000000.0000	43.9969	36.0287
412000000.0000	43.8174	35.8214
414000000.0000	43.9608	35.8468
416000000.0000	43.9326	35.7592
418000000.0000	43.9002	35.6144
420000000.0000	43.6795	35.4075
422000000.0000	43.6071	35.3470
424000000.0000	43.5519	35.2256
426000000.0000	43.5277	35.1134
428000000.0000	43.4313	35.0675
430000000.0000	43.5304	34.9598
432000000.0000	43.4117	34.9056
434000000.0000	43.3557	34.7396
436000000.0000	43.3260	34.6967
438000000.0000	43.4464	34.4321
440000000.0000	43.1819	34.3078
442000000.0000	43.1117	34.3319
444000000.0000	43.1370	34.0826
446000000.0000	42.9474	34.0292
448000000.0000	42.9461	34.0520
450000000.0000	42.9050	34.0345
452000000.0000	42.8857	33.8368
454000000.0000	42.7824	33.7545
456000000.0000	42.7154	33.6177
458000000.0000	42.6018	33.4518
460000000.0000	42.4633	33.4140
462000000.0000	42.4680	33.3521
464000000.0000	42.4255	33.2276
466000000.0000	42.3010	33.1821
468000000.0000	42.3352	33.8637
470000000.0000	42.2226	33.7782

472000000.0000	42.2161	33.7815
474000000.0000	42.1218	33.7130
476000000.0000	42.0927	33.7282
478000000.0000	42.0596	33.6664
480000000.0000	41.9049	32.5808
482000000.0000	41.8212	32.5188
484000000.0000	41.7368	32.4513
486000000.0000	41.7135	32.3961
488000000.0000	41.6629	32.3603
490000000.0000	41.6519	32.2459
492000000.0000	41.5545	32.2789
494000000.0000	41.4917	32.1840
496000000.0000	41.4983	32.1431
498000000.0000	41.3435	32.0270
500000000.0000	41.1384	31.9051

$\sigma = \omega \varepsilon_o \varepsilon'' = 2 \pi f \varepsilon_o \varepsilon''=0.85$

where $f = 450x\ 10^6$

$\varepsilon_o = 8.854 \text{ x } 10^{-12}$

$\varepsilon'' = 34.0345$

3 - EUT DESCRIPTION

Applicant:	Midland Radio Corporation
Product Description:	FRS & GMRS
Product Name:	G-300
FCC ID:	MMAG300
Serial Number:	None
Transmitter Frequency:	462.55~467.7125 MHz
Maximum Output Power:	3.05 W for GMRS 0.41W for FRS
Dimension:	2.5” L x 1.5”W x 13”H approximately
RF Exposure environment:	General Population/Uncontrolled
Power Supply:	Battery
Applicable Standard	FCC CFR 47, Part 95
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 Equipment Modifications

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

5 – CONDUCTED OUTPUT POWER

5.1 Provision Applicable

Per FCC §2.1046 and FCC § 95.639 (d), no FRS unit, under any condition of modulation, shall exceed 0.500W effective radiated power (ERP).

Per FCC §2.1046 and FCC § 95.639 (a) (1), no GMRS unit, under any condition of modulation, shall exceed 50W Carrier Power (average TP during one unmodulated RF cycle) when transmission type A1D, F1D, .G1D, A3E, F3E or G3E.

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

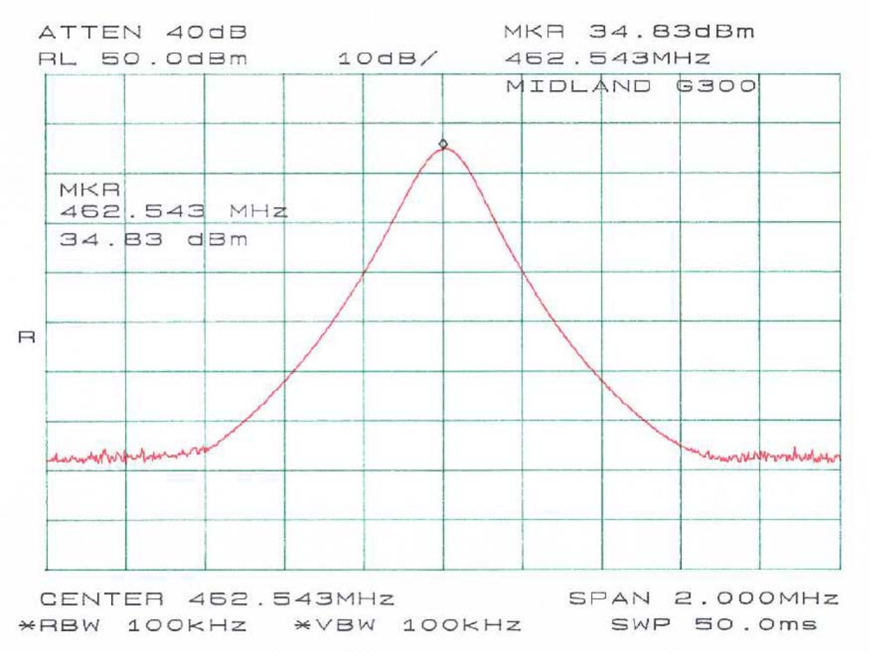
Hewlett Packard HP8564E Spectrum Analyzer, Calibration Due Date: 2003-08-01.
Hewlett Packard HP 7470A Plotter, Calibration not required.
A.H. Systems SAS200 Horn Antenna, Calibration Due Date: 2003-05-31
Com-Power AB-100 Dipole Antenna, Calibration Due Date: 2003-09-05

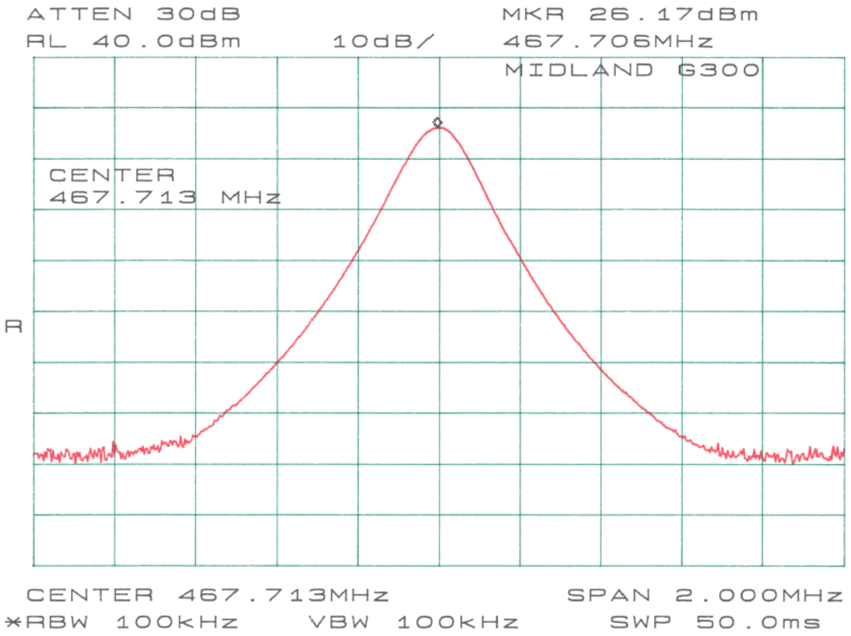
5.4 Test Results

Frequency (MHz)	Output Power in dBm	Output Power in W	Limit (W, ERP)
462.543 (GMRS)	34.84	3.05	50
467.706 (FRS)	26.17	0.41	0.5

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.


ATTEN 40dB
RL 50.0dBm
10dB/
MKR 34.83dBm
462.543MHz
MIDLAND G300
MKR
462.543 MHz
34.83 dBm
R
CENTER 462.543MHz
SPAN 2.000MHz
*RBW 100kHz
*VBW 100kHz
SWP 50.0ms


ATTEN 30dB
RL 40.0dBm
10dB/
MKR 26.17dBm
467.706MHz
MIDLAND G300
CENTER
467.713 MHz
R
CENTER 467.713MHz
SPAN 2.000MHz
*RBW 100kHz
VBW 100kHz
SWP 50.0ms

6 - DOSIMETRIC ASSESSMENT SETUP

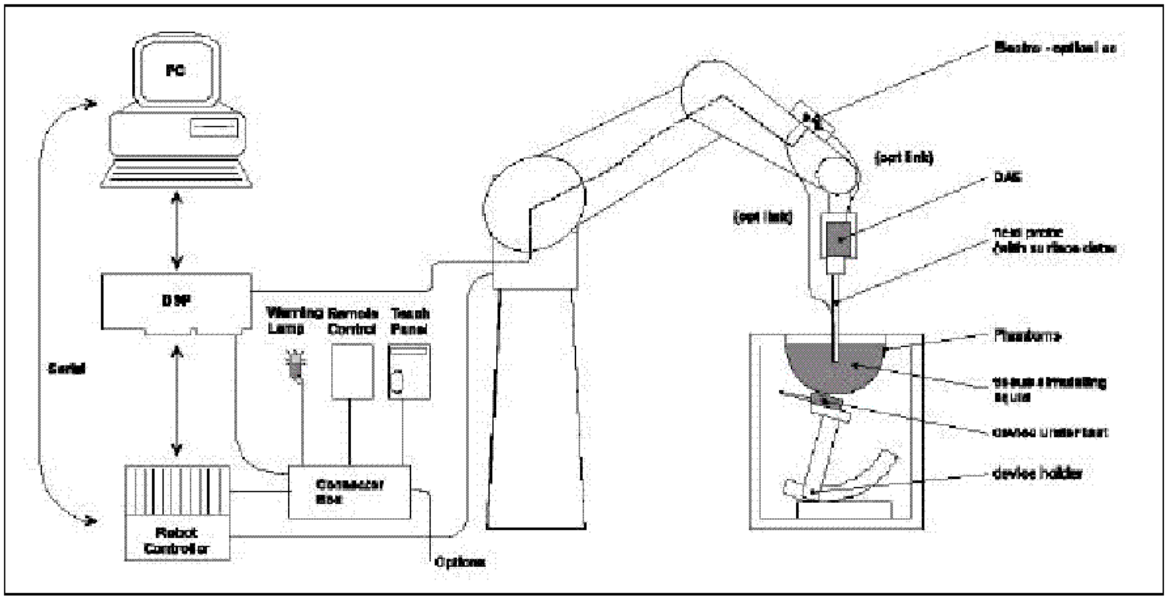
These measurements were performed with the automated near-field scanning system DASY3 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m) which positions the probes with a positional repeatability of better than ±0.02mm. Special 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: 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 ±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)									
	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	43.5	56.7	42.54	55.2	42.0	55.9	39.9	53.3	39.8	53.6
Conductivity (s/m)	0.87	0.94	0.91	0.97	1.0	0.98	1.42	1.52	1.88	1.81

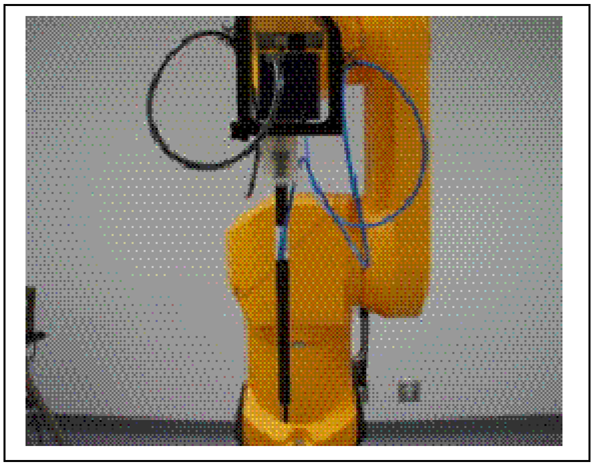
6.1 Measurement System Diagram



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

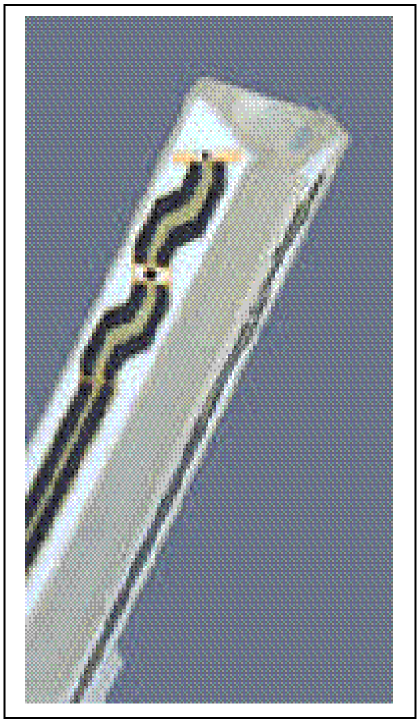
1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
2. An arm extension for accommodating the data acquisition electronics (DAE).
3. A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is 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



Photograph of the probe

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 ± 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



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 2 nd 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 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	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:

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

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)
$\mu V/(V/m)^2$ 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.

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

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.

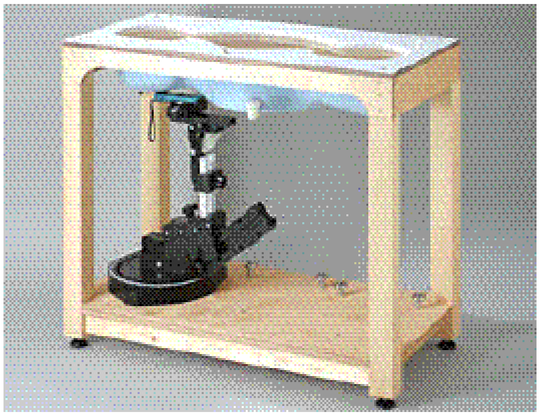
The power flow density is calculated assuming the excitation field as a free space field.

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

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)

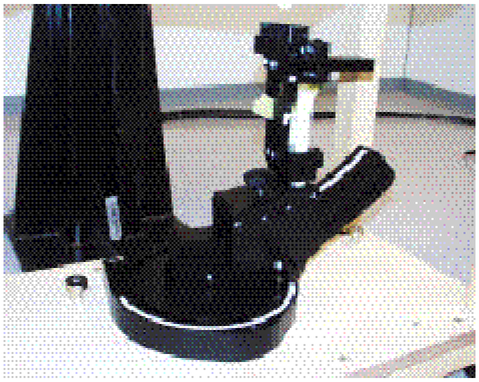


Generic Twin Phantom

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 @ 9.225mW Input averaged over 1g	SAR @ 1W Input averaged over 1g	SAR @ 9.225mW Input averaged over 10g	SAR @ 1W Input averaged over 10g
Test 1	0.0451	4.89	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

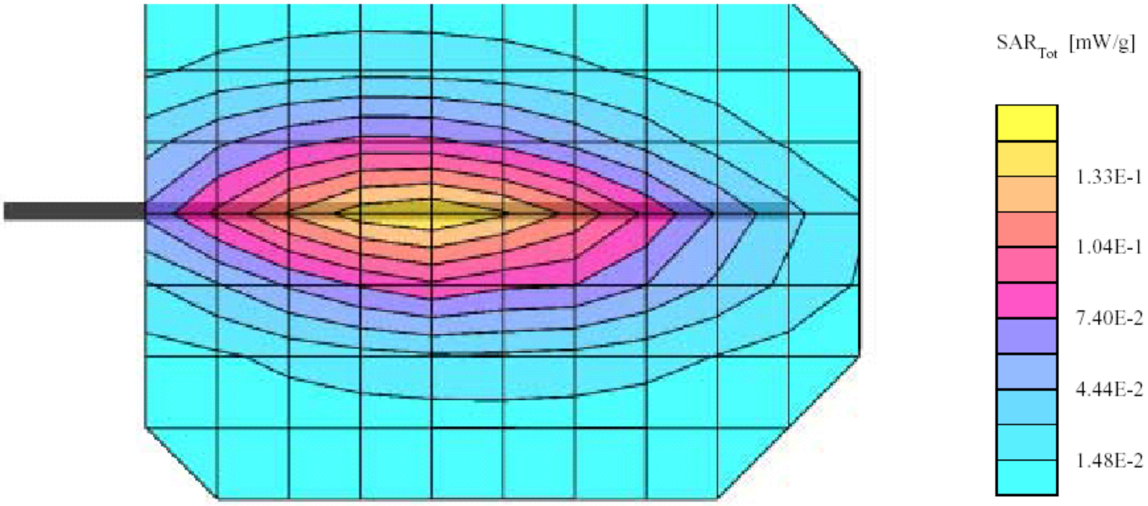
Ambient Temperature (ºC): 23.0
Relative Humidity (%): 49.3

Simulant	Freq [MHz]	Parameters	Liquid Temp [ºC]	Target Value	Measured Value	Deviation [%]	Limits [%]
Body	450	ε	23	56.7	58.3	-2.82	±5
		σ	23	0.94	0.91	-3.19	±5
		1g SAR	23	4.874	4.79	-1.72	±10
Head	450	ε	23	43.5	42.9	-1.38	±5
		σ	23	0.87	0.85	-2.30	±5
		1g SAR	23	4.9	4.81	-1.84	±10

ε = relative permittivity, σ = conductivity and $\rho=1000 kg/m^3$
Note: Body Forward power = 30.27 mW
Head Forward power = 42.41 mW

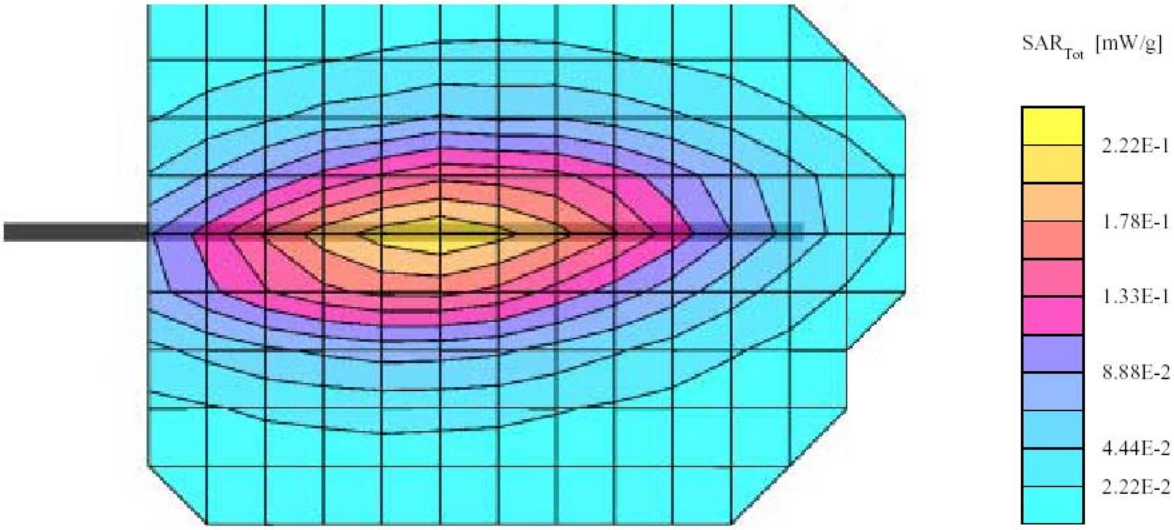
450 MHz Body Liquid (Ambient Temp = 23 Deg C, Liquid Temp = 21 Deg C, 4/9/2003)

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 450 MHz
Probe: ET3DV6 - SN1604; ConvF(7.70,7.70,7.70); Crest factor: 1.0; (Body liquid) 450 MHz: $\sigma = 0.91$ mho/m $\varepsilon_r = 58.3$ $\rho = 1.00$ g/cm^3
Cube 5x5x7: SAR (1g): 0.145 mW/g, SAR (10g): 0.0989 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 14.0
Powerdrift: -0.02 dB



450 MHz Head Liquid (Ambient Temp = 23 Deg C, Liquid Temp = 21 Deg C, 4/14/2003)

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 450 MHz
Probe: ET3DV6 - SN1604; ConvF(7.31,7.31,7.31); Crest factor: 1.0; (Head liquid) 450 MHz: σ = 0.85 mho/m ε_r = 42.9 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.204 mW/g, SAR (10g): 0.137 mW/g, (Worst-case extrapolation)
Coarse: Dx = 16.0, Dy = 16.0, Dz = 10.0
Powerdrift: 0.01 dB



7.4 SAR Evaluation Procedure

a. The evaluation was performed in the applicable area of the phantom depending on the type of device being tested. For device held to the dear during normal operation, both the left and right ear positions were evaluated in accordance with FCC OET Bulletin 65, Supplement C (Edition 01-01) using the SAM phantom. For body-worn and face-held devices a planar phantom was used. The EUT in the test setup for body-worn and face-held devices was placed in three different positions (relative to the phantom): with belt clip, without belt clip and 2.5cm facing left head side and 2.5cm facing right head side.
b. The SAR was determined by a pre-defined procedure within the DASY3 software. Upon completion of a reference and optical surface check, the exposed region of the phantom was scanned near the inner surface with a grid spacing of 20mm x 20mm.
c. A 5x5x7 matrix was performed around the greatest special SAR distribution found during the area scan of the applicable exposed region. SAR values were then calculated using a 3-D spline interpolation algorithm and averaged over spatial volumes of 1 and 10 grams.
d. The depth of the simulating tissue in the planar used for the SAR evaluation and system validation was no less than 15.0cm.
e. For this particular evaluation, a stack of low-density, low-loss dielectric foamed polystyrene was used in place of the device holder.
f. Re-measurement of the SAR value at the same location as in a. 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.

Population/Uncontrolled Environments are defined as locations where there is the exposure of individual who have no knowledge or control of their exposure.

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).

Population/uncontrolled environments Partial-body limit 1.6W/kg applied to the EUT.

8 - TEST RESULTS

This page summarizes the results of the performed dosimetric evaluation. The plots with the corresponding SAR distributions, which reveal information about the location of the maximum SAR with respect to the device could be found in the following pages.

According to the data in section 8.1, the EUT complied with the FCC 2.1093 RF Exposure standards, with worst case of 2.75W.

8.1 SAR Test Data

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

Worst case SAR reading

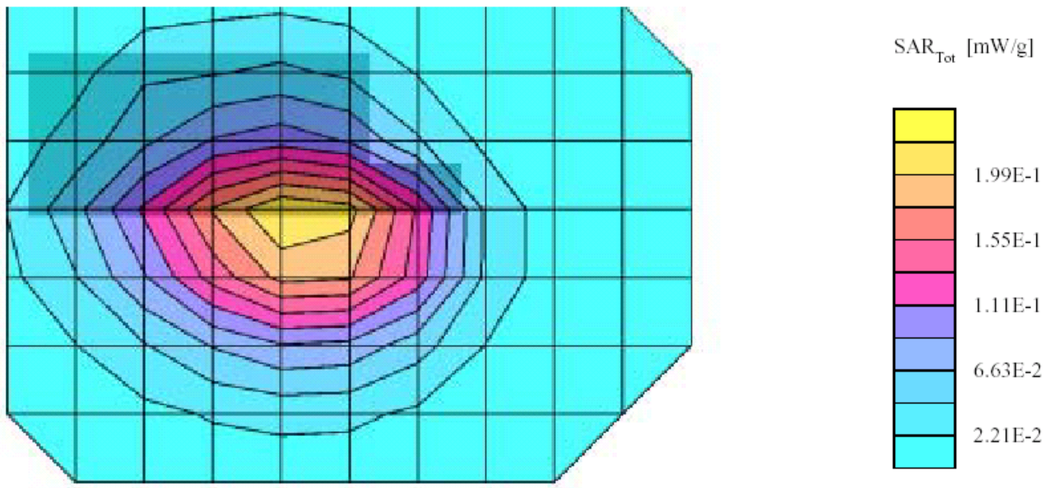
EUT position	Frequency (MHz)	Output Power (W)	Test Type	Antenna Type	Liquid	Phantom	Notes / Accessories	Measured (mW/g)	Limit (mW/g)
Back touching phantom	462.54	3.04	Body worn	Built-in	body	flat	With belt clip & headset	0.215	1.6
Back touching phantom	467.7125	0.41	Body worn	Built-in	body	flat	With belt clip & headset	0.220	1.6
Front, 2.5cm separation from phantom	462.54	3.04	Face-held	Built-in	head	flat	None	0.145	1.6
Front, 2.5cm separation from phantom	467.7125	0.41	Face-held	Built-in	head	flat	None	0.134	1.6

8.2 Plots of Test Result

The plots of test result were attached as reference.

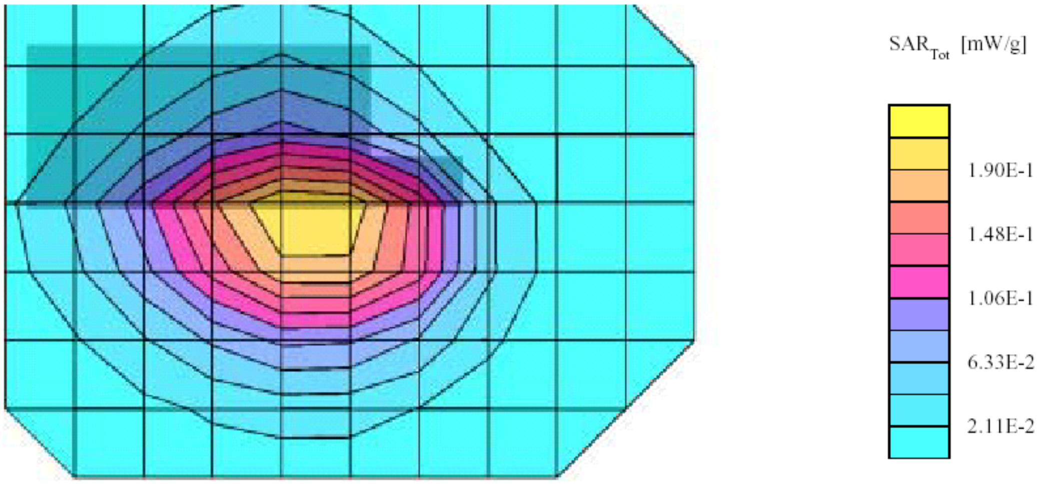
Midland Radio, G300 (Body-Worn with Belt Clip and headset in touch with phantom, Ambient Temp = 23 Deg C, Liquid Temp = 21 Deg C, 4/14/2003)

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 462.55 MHz
Probe: ET3DV6 - SN1604; ConvF(7.70,7.70,7.70); Crest factor: 1.0; (Body liquid) 450 MHz: σ = 0.91 mho/m ε_r = 58.3 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 0.220 mW/g, SAR (10g): 0.158 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 14.0
Powerdrift: - 0.02 dBm



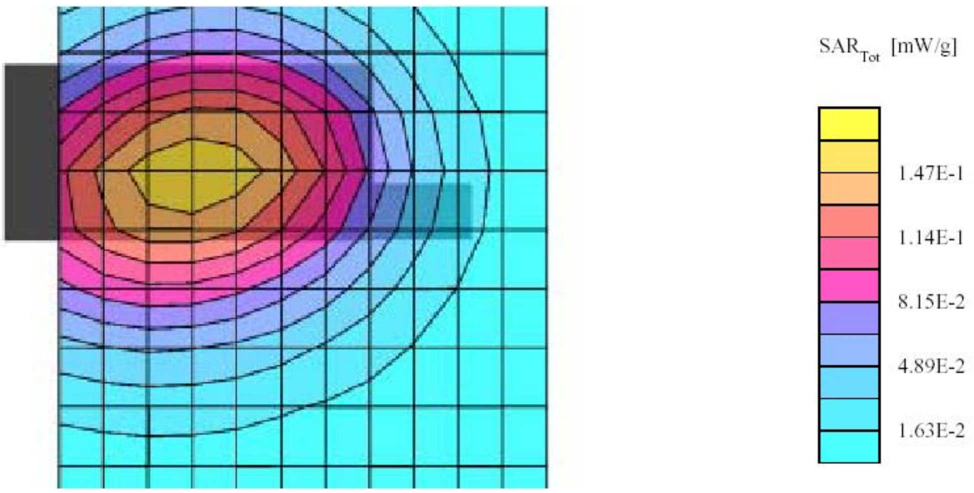
Midland Radio, G300 (Body-worn with Belt Clip and headset in touch with phantom, Ambient Temp = 23 Deg C, Liquid Temp = 21 deg C, 4/14/2003)

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 467.7125 MHz
Probe: ET3DV6 - SN1604; ConvF(7.70,7.70,7.70); Crest factor: 1.0; (Body liquid) 450 MHz: $\sigma = 0.91$ mho/m $\varepsilon_r = 58.3$ $\rho = 1.00$ g/cm^3
Cube 5x5x7: SAR (1g): 0.215 mW/g, SAR (10g): 0.154 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 14.0
Powerdrift: - 0.04 dB



Midland Radio, G300 (Face-held SAR at 2.5 cm separation to flat phantom, Ambient Temp = 23 Deg C, Liquid Temp = 21 Deg C, 4/14/2003)

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 462.55 MHz
Probe: ET3DV6 - SN1604; ConvF(7.30,7.30,7.30); Crest factor: 1.0; (Head liquid) 450 MHz: $\sigma = 0.85$ mho/m $\varepsilon_r = 42.9$ $\rho = 1.00$ g/cm^3
Cube 5x5x7: SAR (1g): 0.145 mW/g, SAR (10g): 0.102 mW/g, (Worst-case extrapolation)
Coarse: Dx = 16.0, Dy = 12.0, Dz = 10.0
Powerdrift: 0.01 dB



Midland Radio, G300 (Face-held SAR at 2.5 cm separation to flat phantom, Ambient Temp = 23 Deg C, Liquid Temp = 21 Deg C, 4/14/2003)

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 467.7125 MHz
Probe: ET3DV6 - SN1604; ConvF(7.30,7.30,7.30); Crest factor: 1.0; (Head liquid) 450 MHz: $\sigma = 0.85$ mho/m $\varepsilon_r = 42.9$ $\rho = 1.00$ g/cm^3
Cube 5x5x7: SAR (1g): 0.134 mW/g, SAR (10g): 0.0933 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 14.0
Powerdrift: 0.01 dB

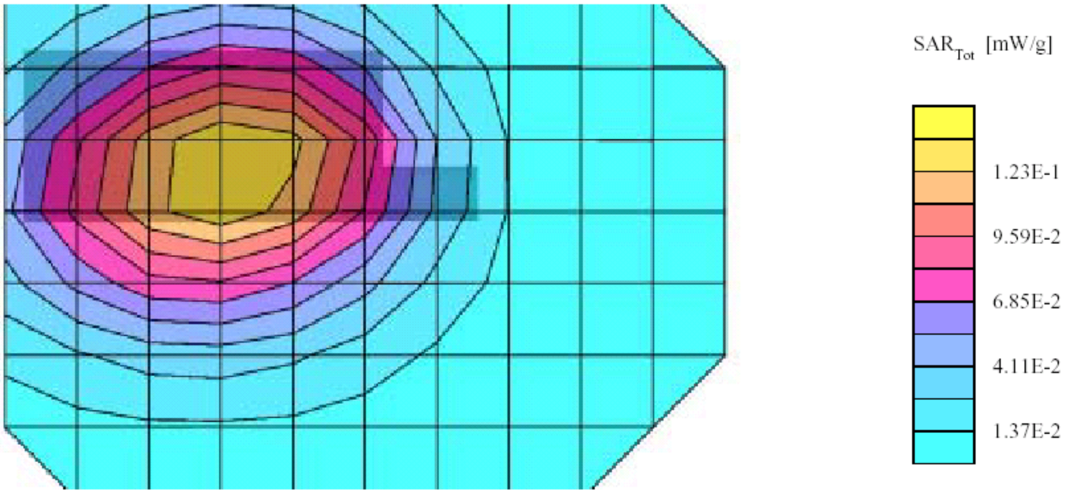


EXHIBIT A - SAR SETUP PHOTOGRAPHS

Body-Worn with Belt Clip & Headset in Touching with Phantom

Front View

Side View

2.5cm Separation to Flat Phantom

Front View

Side View

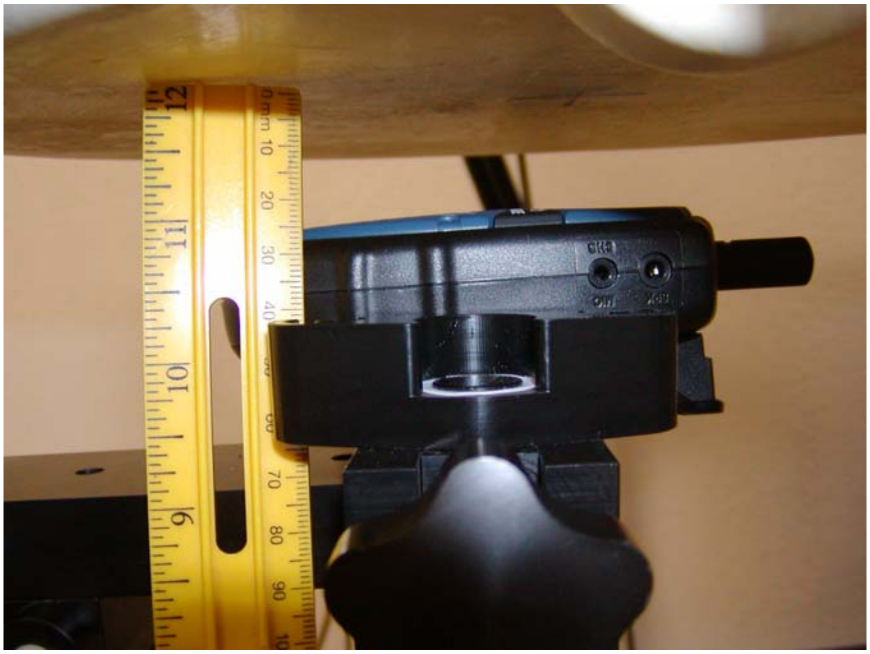
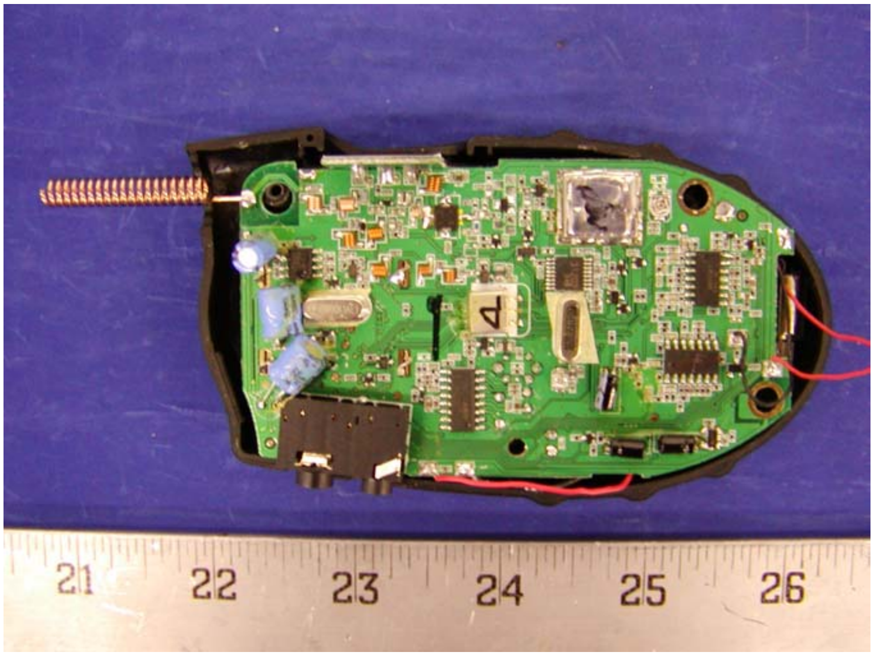


EXHIBIT B - EUT PHOTOGRAPHS

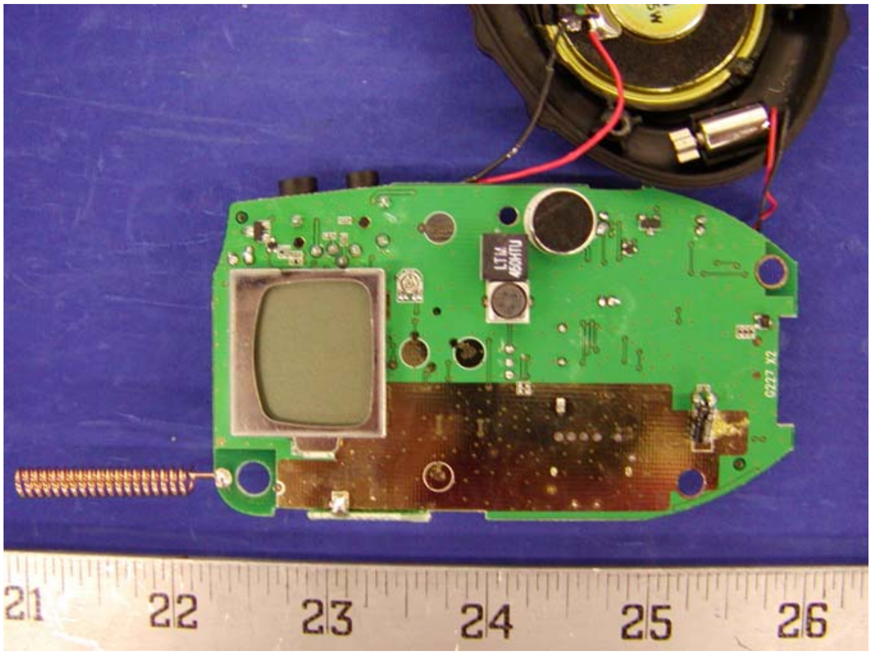
Chassis - Front View

Chassis – Rear View

EUT - Component View



EUT – Solder View



EUT – Antenna Connection View

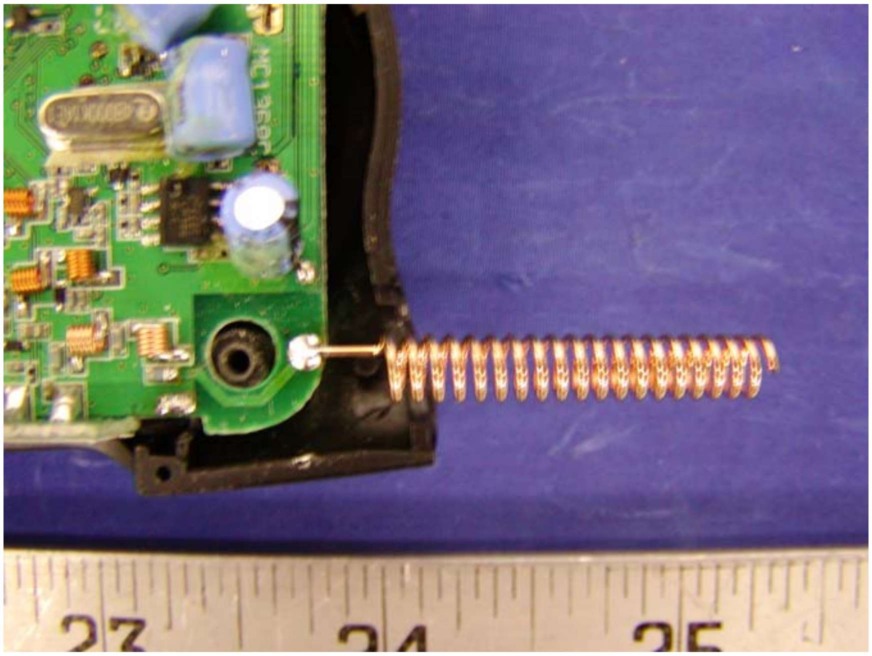


EXHIBIT C – Z-Axis

Midland Radio, G300 (Face-held SAR at 2.5 cm separation to flat phantom, Ambient Temp = 23 Deg C, Liquid Temp = 21 Deg C, 4/14/2003)

SAM Phantom; Section; Position: ; Frequency: 462.55 MHz
Probe: ET3DV6 - SN1604; ConvF(7.30,7.30,7.30); Crest factor: 1.0; (Head liquid) 450 MHz: σ = 0.85 mho/m ε_r = 42.9 ρ = 1.00 g/cm³
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Z-Axis: Dx = 0.0, Dy = 0.0, Dz = 2.0