SAR EVALUATION REPORT

For

AlphaSmart Inc.

973 University Ave.
Los Gatos, CA 95032

FCC ID: K2VDANA002

2003-07-25

This Report Concerns:	**Equipment Type:**
☒ Original Report	Wireless Keyboard

Test Engineer:	Ling Zhang
Report No.:	R0306181S
Test Date:	2003-07-17
Reviewed By:	Hans Mellberg
Prepared By:	Bay Area Compliance Laboratory Corporation (BACL) 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, please see following table for testing result summary:

Ambient Temperature (ºC): 22.0
Relative Humidity (%): 49.3

Worst case SAR reading

EUT position	Frequency (MHz)	Output Power (W)	Test Type	Antenna Type	Liquid	Phantom	Measured (mW/g)	Limit (mW/g)
Back touching phantom	2437	0.017	Body worn	Built-in	body	flat	0.0954	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 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

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%**	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 2450 Mhz Liquid Measurement, 2003-07-17

frequency	e'	e''
2000000000.0000	54.2998	12.5761
2010000000.0000	54.2170	12.6064
2020000000.0000	54.1080	12.6729
2030000000.0000	54.0141	12.7685
2040000000.0000	54.0026	12.8431
2050000000.0000	53.9533	12.8807
2060000000.0000	54.0414	13.0178
2070000000.0000	54.0589	13.1050
2080000000.0000	54.1280	13.1804
2090000000.0000	54.1428	13.2300
2100000000.0000	54.1283	13.2673
2110000000.0000	54.1124	13.2852
2120000000.0000	54.0466	13.3029
2130000000.0000	53.9502	13.3207
2140000000.0000	53.8533	13.3517
2150000000.0000	53.7021	13.3783
2160000000.0000	53.5852	13.4547
2170000000.0000	53.5382	13.5048
2180000000.0000	53.5361	13.5976
2190000000.0000	53.5510	13.6925
2200000000.0000	53.6213	13.8679
2210000000.0000	53.6801	13.9518
2220000000.0000	53.6738	13.9594
2230000000.0000	53.6757	14.0170
2240000000.0000	53.6144	14.0338
2250000000.0000	53.5640	14.0855
2260000000.0000	53.4515	14.0999
2270000000.0000	53.3455	14.0880
2280000000.0000	53.2735	14.1075
2290000000.0000	53.2133	14.1858
2300000000.0000	53.2102	14.2186
2310000000.0000	53.1880	14.2651
2320000000.0000	53.2165	14.3260
2330000000.0000	53.2640	14.4363
2340000000.0000	53.2944	14.5350
2350000000.0000	53.3015	14.5775
2360000000.0000	53.2799	14.6295
2370000000.0000	53.2630	14.6403
2380000000.0000	53.2215	14.6838
2390000000.0000	53.1176	14.6742
2400000000.0000	53.0549	14.7345
2410000000.0000	52.9810	14.7523
2420000000.0000	52.9122	14.8107
2430000000.0000	52.9425	14.8611
2440000000.0000	52.9649	14.9279
2450000000.0000	52.9911	14.8807
2460000000.0000	52.9843	15.1144
2470000000.0000	52.9854	15.1849
2480000000.0000	52.9194	15.2991
2490000000.0000	52.8990	15.3657
2500000000.0000	52.8153	15.3857

$s = w e_o e'' = 2 p f e_o e'' = 2.03$

where $f = 2450 x 10^6$

$e_o = 8.854 x 10^{-12}$

$e'' = 14.8807$

Head 2450 Mhz Liquid Measurement, 2003-07-17

frequency	e'	e''
2425000000.0000	39.8294	13.6397
2426000000.0000	39.9185	13.6792
2427000000.0000	40.0178	13.7043
2428000000.0000	40.0417	13.6872
2429000000.0000	39.8901	13.6453
2430000000.0000	39.6703	13.5458
2431000000.0000	39.5529	13.4899
2432000000.0000	39.7084	13.5551
2433000000.0000	39.8644	13.6207
2434000000.0000	40.0388	13.6236
2435000000.0000	40.0783	13.6516
2436000000.0000	40.0141	13.6349
2437000000.0000	39.9134	13.5818
2438000000.0000	39.8767	13.5688
2439000000.0000	39.7014	13.5228
2440000000.0000	39.7136	13.5248
2441000000.0000	39.8376	13.5713
2442000000.0000	40.0487	13.6461
2443000000.0000	40.2307	13.6743
2444000000.0000	40.1397	13.6568
2445000000.0000	39.9609	13.5906
2446000000.0000	39.9034	13.5524
2447000000.0000	39.9612	13.5839
2448000000.0000	40.0729	13.6145
2449000000.0000	40.0977	13.5894
2450000000.0000	40.0304	13.6026
2451000000.0000	40.0642	13.5918
2452000000.0000	40.0165	13.5888
2453000000.0000	39.9705	13.5740
2454000000.0000	39.9302	13.5757
2455000000.0000	39.8940	13.5591
2456000000.0000	39.8075	13.5480
2457000000.0000	39.7917	13.5327
2458000000.0000	39.8310	13.5387
2459000000.0000	39.8655	13.5731
2460000000.0000	39.8941	13.5824
2461000000.0000	39.9904	13.6316
2462000000.0000	39.8564	13.5885
2463000000.0000	39.7534	13.5403
2464000000.0000	39.7377	13.5524
2465000000.0000	39.7007	13.5374
2466000000.0000	39.7520	13.5748
2467000000.0000	39.8200	13.5943
2468000000.0000	39.8401	13.5976
2469000000.0000	39.9142	13.6082
2470000000.0000	39.9692	13.6902
2471000000.0000	39.9169	13.6694
2472000000.0000	39.8860	13.6669
2473000000.0000	39.7928	13.6261
2474000000.0000	39.7841	13.6345
2475000000.0000	39.8348	13.6543

$s = w e_o e'' = 2 p f e_o e'' = 1.85$

where $f = 2450 x 10^6$

$e_o = 8.854 x 10^{-12}$

$e'' = 13.6026$

3 - EUT SUMMARY

Applicant:	AlphaSmart Inc.
Product Description:	Wireless Keyboard
Model Name:	DANA WIRELESS
FCC ID:	K2VDANA002
Serial Number:	None
Transmitter Frequency:	2412-2462 MHz
Maximum Output Power:	0.103W
RF Exposure environment:	General Population/Uncontrolled
Power Supply:	ALPHA SMART AC Adapter, M/N: 41-7.5-500D
Applicable Standard	FCC CFR 47, Part 15 Subpart C
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 Software and 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 software, PRISM utilities, contained on the hard drive, is auto starting on power-up. Once loaded, the program sequentially exercises each system component.

The testing procedure is as follows:

1. Click PRISM test utilities on Window
2. Select wireless LAN Adapter under adapters list
3. Select low, mid and high channels under Radio Channels
4. Select Tx Rate of 11MB
5. Click on “continuous Tx” bottom

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.

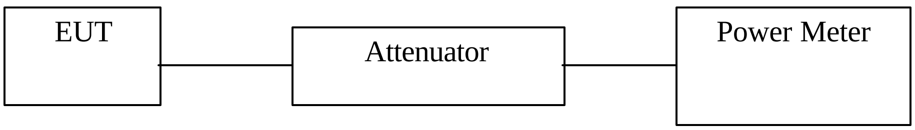
4.4 Equipment Modifications

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

5 - CONDUCTED OUTPUT POWER MEASUREMENT

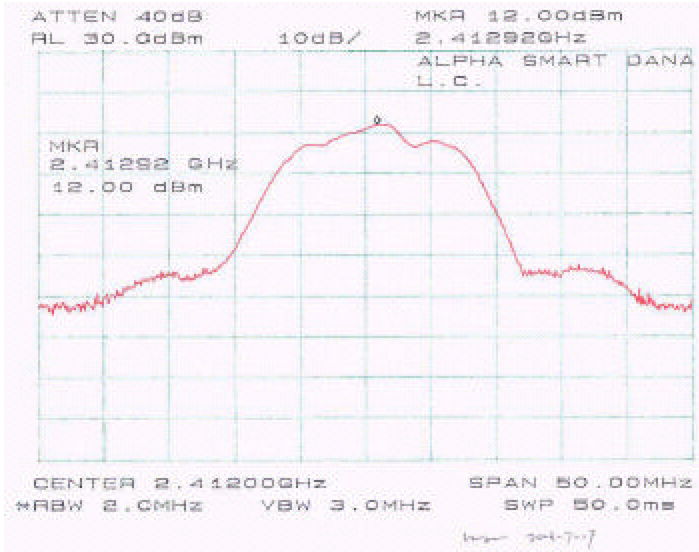
5.1 Measurement Procedure

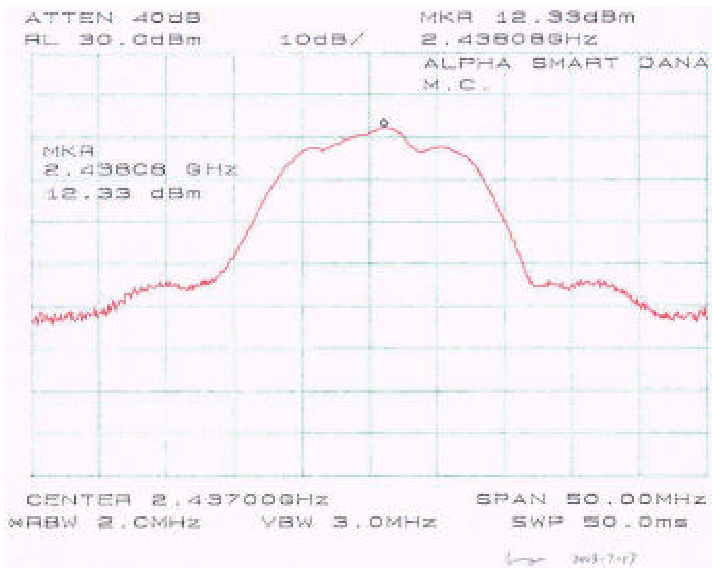
1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to a spectrum analyzer.
3. Add a correction factor to the display.

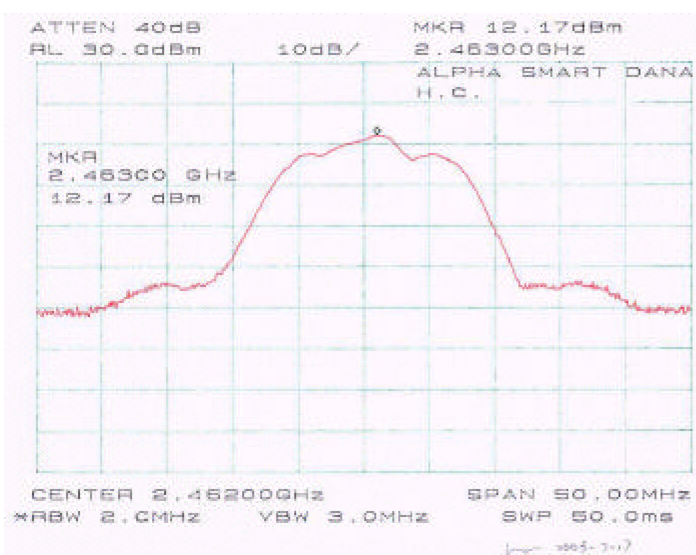


5.2 Test Results

Frequency (MHz)	Peak Output Power (dBm)	Correction Factor (dBm)	Corrected Factor (dBm)	Output Power (W)	Standard (W)	Result
2412	12.00	7.78	19.78	0.095	≤ 1 W	Compliant
2437	12.33	7.78	20.11	0.103	≤ 1 W	Compliant
2462	12.17	7.75	19.92	0.982	≤ 1 W	Compliant


ATTEN 40dB
RL 30.0dBm
10dB/
MKR 12.00dBm
2.41292GHz
ALPHA SMART DANA
L.C.
MKR
2.41292 GHz
12.00 dBm
CENTER 2.41200GHz
SPAN 50.00MHz
*RBW 2.0MHz
VBW 3.0MHz
SWP 50.0ms


ATTEN 40dB
RL 30.0dBm
10dB/
MKR 12.33dBm
2.43808GHz
ALPHA SMART DANA
M.C.
MKR
2.43808 GHz
12.33 dBm
CENTER 2.43700GHz
SPAN 50.00MHz
*RBW 2.0MHz
VBW 3.0MHz
SWP 50.0ms


ATTEN 40dB
RL 30.0dBm
10dB/
MKR 12.17dBm
2.46300GHz
ALPHA SMART DANA
H.C.
MKR
2.46300 GHz
12.17 dBm
CENTER 2.46200GHz
SPAN 50.00MHz
*RBW 2.0MHz
VBW 3.0MHz
SWP 50.0ms

6 - DOSIMETRIC ASSESSMENT SETUP

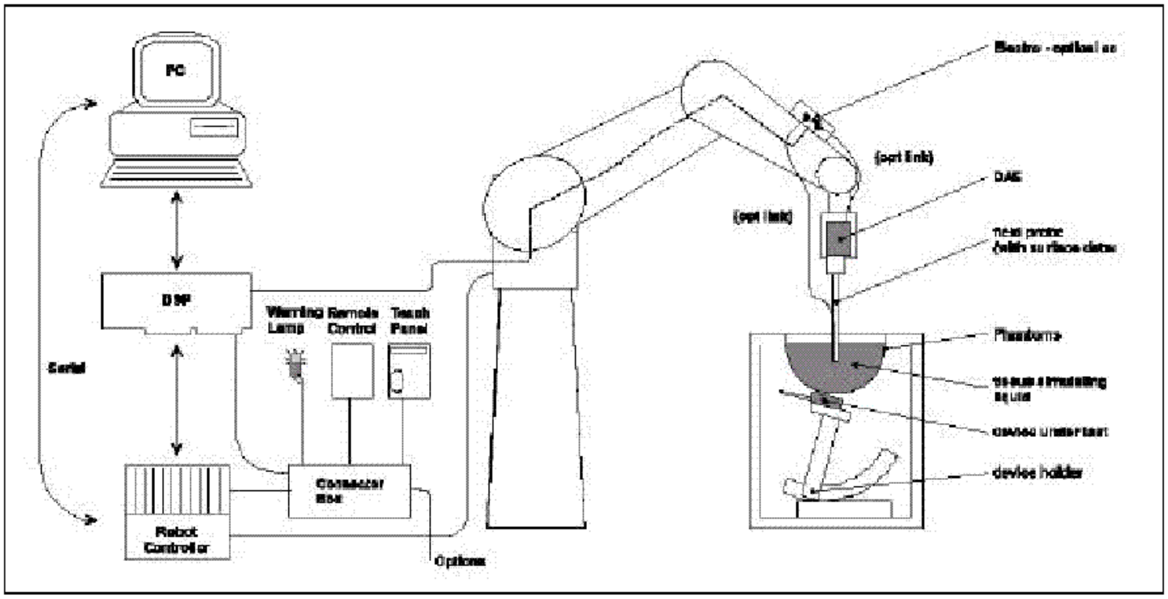
These measurements were performed with the automated near-field scanning system DASY3 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9m) which positions the probes with a positional repeatability of better than ±0.02mm. Special 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	Frequency (MHz)									
(% by weight)	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (Nacl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton x-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	55.2	42.0	55.9	39.9	53.3	39.8	52.7
Conductivity (s/m)	0.85	0.83	0.91	0.97	1.0	0.98	1.42	1.52	1.88	1.95

6.1 Measurement System Diagram

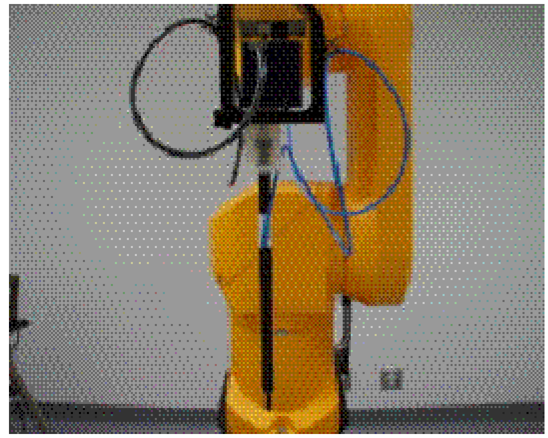


The DASY3 system for performing compliance tests consist of the following items:

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

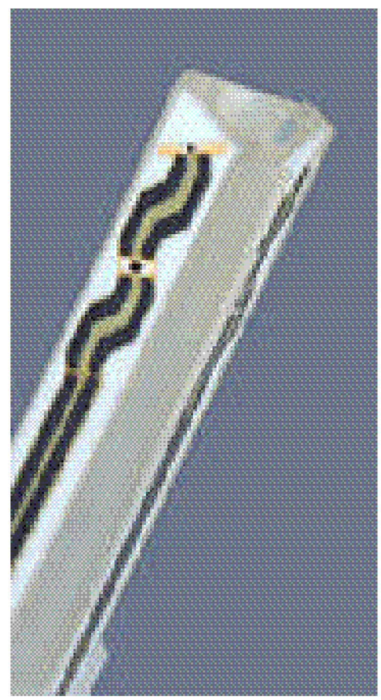
6.2 System Components

ET3DV6 Probe Specification
Construction Symmetrical design with triangular core
Built-in optical fiber for surface detection System
Built-in shielding against static charges
Calibration In air from 10 MHz to 2.5 GHz
In brain and muscle simulating tissue at
Frequencies of 450 MHz, 900 MHz and
1.8 GHz (accuracy ± 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.

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

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.

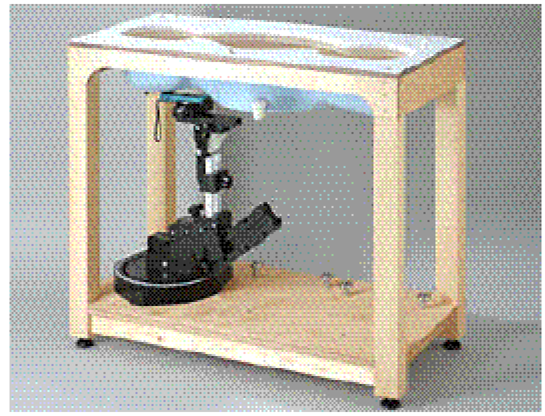
The power flow density is calculated assuming the excitation field as a free space field.

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

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)

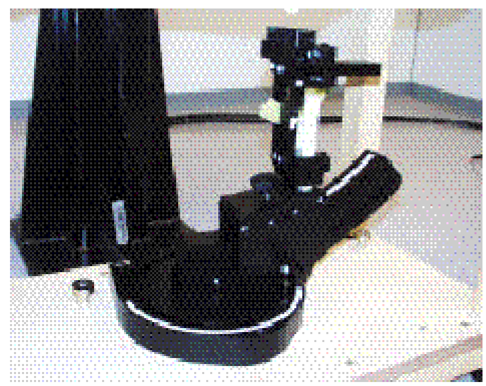


Generic Twin Phantom

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.

Measurement Uncertainty Analysis per IEEE P1528-2002

Description	Section	Reported Variance (%)	Probability Distribution type	Divisor	Ci (1g)	Ui (1g)	Vi	welc/satt series term
Probe Calibration	E.2.1	4.80	N	1	1	4.80	1.00E+09	5.30842E-07
Axial isotropy	E.2.2	4.70	R	1.732	0.707107	1.92	1.00E+09	1.35563E-08
Hemispherical isotropy	E.2.2	9.60	R	1.732	0.707107	3.92	1.00E+09	2.35957E-07
Boundary effects	E.2.3	8.30	R	1.732	1	4.79	1.00E+09	5.27377E-07
Linearity	E.2.4	4.70	R	1.732	1	2.71	1.00E+09	5.4225E-08
System Detection Limit	E.2.5	1.00	R	1.732	1	0.58	1.00E+09	1.11124E-10
Readout Electronics	E.2.6	0.00	N	1	1	0.00	1.00E+09	0
Response time	E.2.7	0.00	R	1.732	1	0.00	1.00E+09	0
Integration time	E.2.8	0.00	R	1.732	1	0.00	1.00E+09	0
RF Ambient conditions	E.6.1	3.00	R	1.732	1	1.73	1.00E+09	9.00106E-09
Probe positioning mechanical tolerance	E.6.2	0.40	R	1.732	1	0.23	1.00E+09	2.84478E-12
Probe positioning wrt phantom shell	E.6.3	2.90	R	1.732	1	1.67	1.00E+09	7.8596E-09
Extra/inter-polation & integration algorithmsfor max SAR evaluation	E.5.2	3.90	R	1.732	1	2.25	1.00E+09	2.57079E-08
Test sample positioning	8, E.4.2	6.00	R	1.732	1	3.46	1.00E+09	1.44017E-07
Device holder distance tolerance	E.4.1	5.00	N	1	1	5.00	1.00E+09	0.000000625
Output power and SAR drift measurement	8, E.6.6.2	5.00	R	1.732	1	2.89	1.00E+09	6.94526E-08
Phantom uncertainty, shell thickness tolerance	E.3.1	4.00	R	1.732	1	2.31	1.00E+09	2.84478E-08
Liquid conductivity, deviation from target values	E.3.2	5.00	R	1.732	0.64	1.85	1.00E+09	1.16522E-08
Liquid conductivity, measurement uncertainty	E.3.3	5.00	N	1	0.64	3.20	5	20.97152
Liquid permitivity, deviation from target values	E.3.2	5.00	R	1.732	0.6	1.73	1.00E+09	9.00106E-09
Liquid permitivity, measurement uncertainty	E.3.3	5.00	N	1	0.6	3.00	5	16.2
								689
Probe isotropy sensitivity coefficient	**0.5**							
Combined Standard Uncertainty						**12.65 %**		
Expanded Uncertainty, 95%		**k=**	**2.0036**			**25.34 %**		

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 for Head

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 (2450 MHz)

Validation Measurement	SAR @ 0.025W Input averaged over 1g	SAR @ 1W Input averaged over 1g	SAR @ 0.025W Input averaged over 10g	SAR @ 1W Input averaged over 10g
Test 1	14.2	56.80	6.33	25.32
Test 2	14.3	57.20	6.34	25.36
Test 3	14.2	56.80	6.33	25.32
Test 4	14.1	56.40	6.32	25.28
Test 5	14.3	57.20	6.33	25.32
Test 6	14.0	56.00	6.31	25.24
Test 7	14.2	56.80	6.33	25.32
Test 8	14.2	56.80	6.33	25.32
Test 9	14.4	57.60	6.34	25.36
Test 10	14.2	56.80	6.32	25.28
Average	14.21	56.84	6.32	25.31

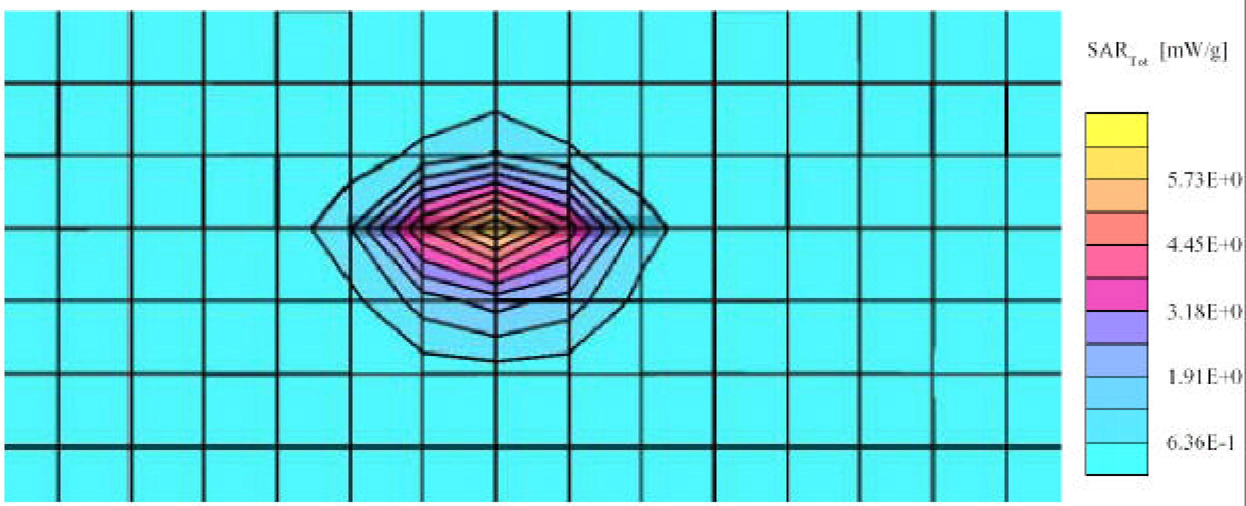
7.4 System Validation Result

Simulant	Freq [MHz]	Parameters	Liquid Temp [ºC]	Target Value	Measured Value	Deviation [%]	Limits [%]
Body	2450	ε	21	52.7	53.0	0.57	±5
		σ	21	1.95	2.03	4.10	±5
		1g SAR	21	56.84	52.94	-6.86	±10
Head	2450	ε	21	39.2	40.0	2.04	±5
		σ	21	1.80	1.85	2.78	±5
		1g SAR	21	52.4	49.3	-5.92	±10

ε = relative permittivity, σ = conductivity and ρ=1000kg/m^3
Note: Forward power = 102 mW

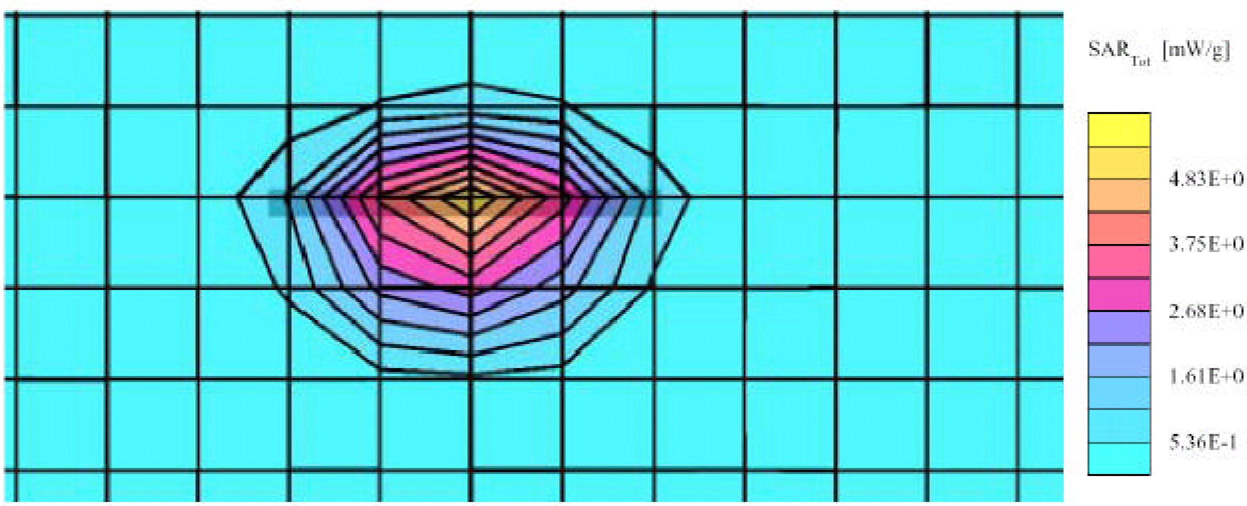
System Validation for 2450 MHz Body Liquid (Ambient Temp = 22 Deg C, Liquid Temp = 21 Deg C, 7/17/2003)

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 2450 MHz
Probe: ET3DV6 - SN1604; ConvF(4.30,4.30,4.30); Crest factor: 1.0; 2450 MHz: σ = 2.03 mho/m ε_r = 53.0 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 5.40 mW/g, SAR (10g): 2.50 mW/g, (Worst-case extrapolation)
Coarse: Dx = 12.0, Dy = 12.0, Dz = 10.0
Powerdrift: -0.02 dB



System Validation for 2450 MHz Head Liquid (Ambient Temp = 22 Deg C, Liquid Temp = 21 Deg C, 7/17/2003)

SAM Phantom: Flat Section; Position: (90°,90°); Frequency: 2450 MHz
Probe: ET3DV6 - SN1604; ConvF(4.70,4.70,4.70); Crest factor: 1.0; 2450 MHz: σ = 1.85 mho/m ε_r = 40.0 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 5.03 mW/g, SAR (10g): 2.29 mW/g, (Worst-case extrapolation)
Coarse: Dx = 12.0, Dy = 12.0, 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): parallel, bystand (perpendicular) and 1.5cm separation.
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 6.1, the EUT complied with the FCC 2.1093 RF Exposure standards, with worst case of **0.0954**.

8.1 SAR Body-Worn Test Data

Ambient Temperature (ºC): 22.0
Relative Humidity (%): 49.3

Worst case SAR reading

EUT position	Frequency (MHz)	Output Power (W)	Test Type	Antenna Type	Liquid	Phantom	Measured (mW/g)	Limit (mW/g)
Back touching phantom	2437	0.017	Body worn	Built-in	body	flat	0.0954	1.6

8.2 Plots of Test Result

The plots of test result were attached as reference.

Alpha Smart DANA wireless (Body back touch with flat phantom, Middle channel, Ambient Temp = 22 Deg C, Liquid Temp = 21 Deg C, 7/17/2003)

SAM Phantom; Flat Section; Position: (90°,90°); Frequency: 2437 MHz
Probe: ET3DV6 - SN1604; ConvF(4.30,4.30,4.30); Crest factor: 1.0; 2450 MHz: σ = 2.03 mho/m ε_r = 53.0 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 0.0954 mW/g, SAR (10g): 0.0506 mW/g, (Worst-case extrapolation)
Coarse: Dx = 12.0, Dy = 12.0, Dz = 10.0
Powerdrift: 0.01 dB

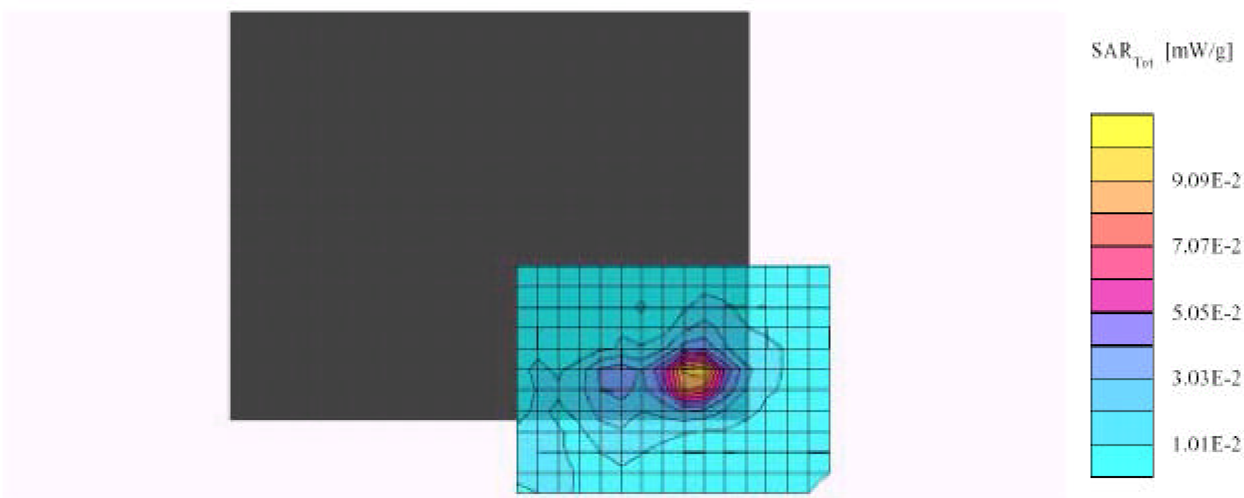


EXHIBIT A - SAR SETUP PHOTOGRAPHS

Back Touching Flat Phantom

EXHIBIT B - EUT PHOTOGRAPHS

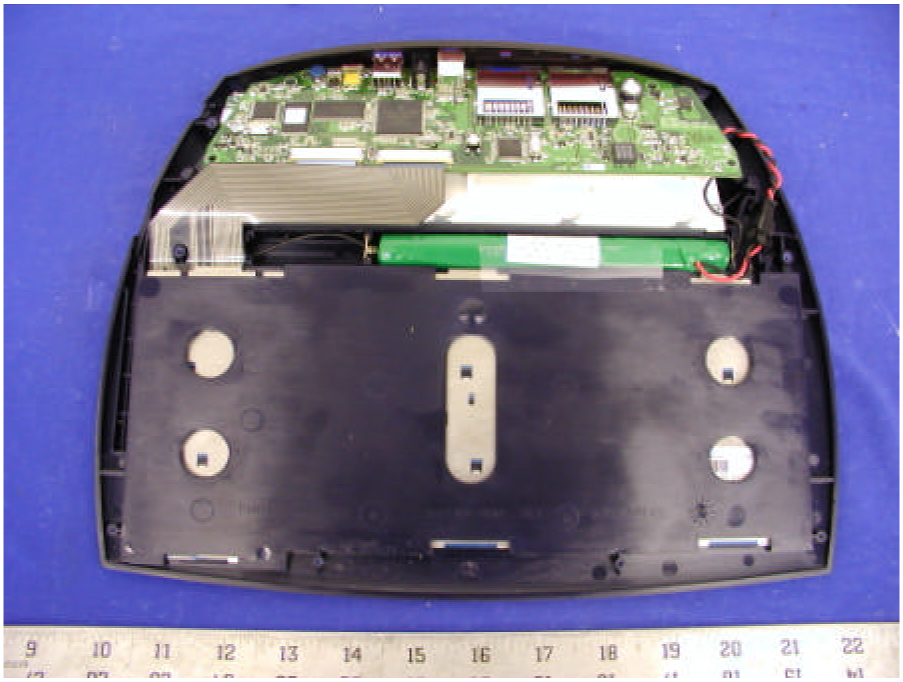
EUT – Top View

EUT – Bottom View

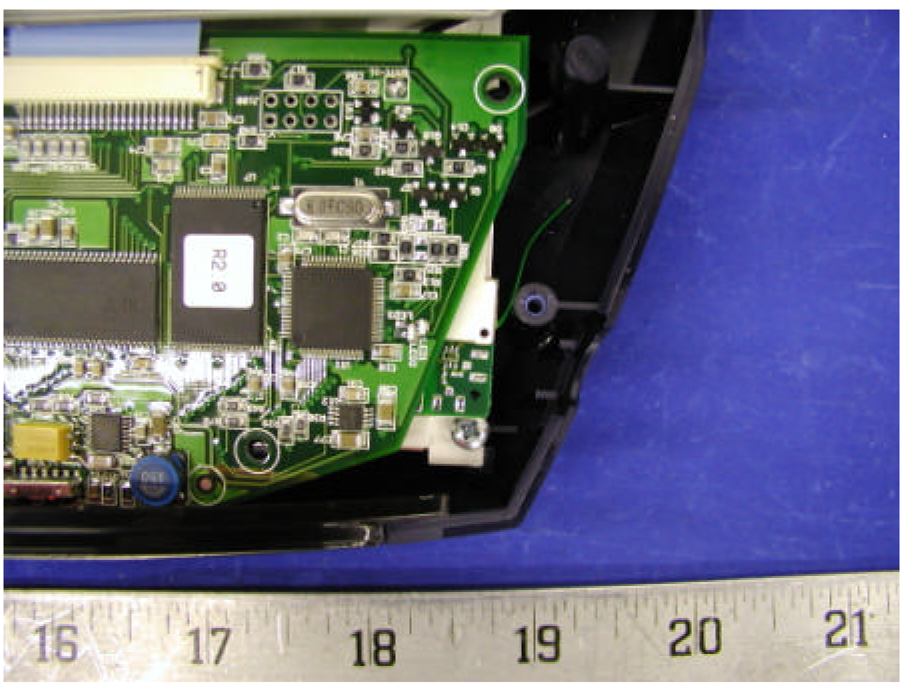
EUT – Rear View

AC Power Adapter View

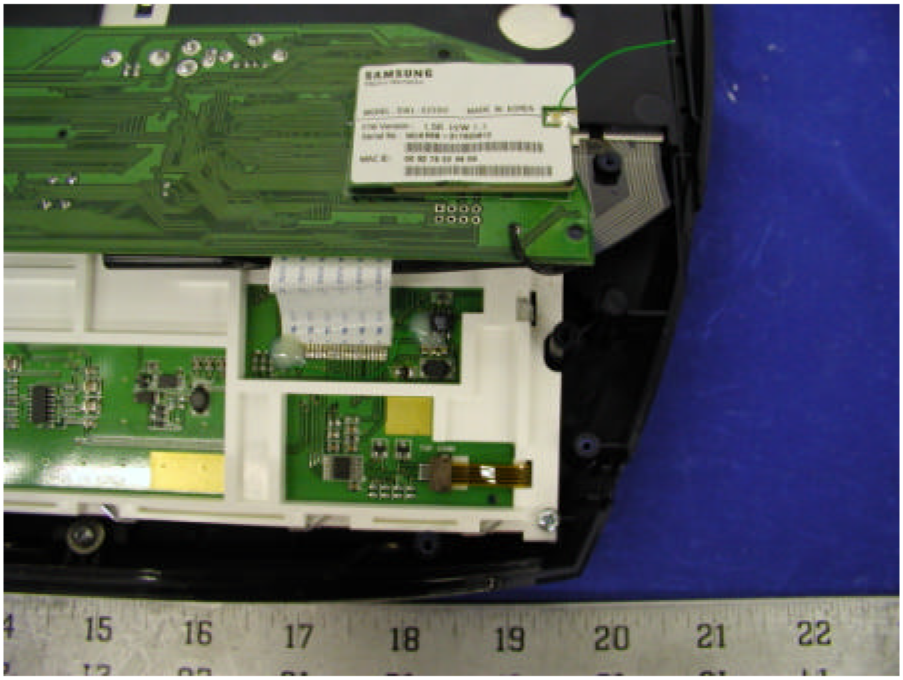
Chassis Cover off View



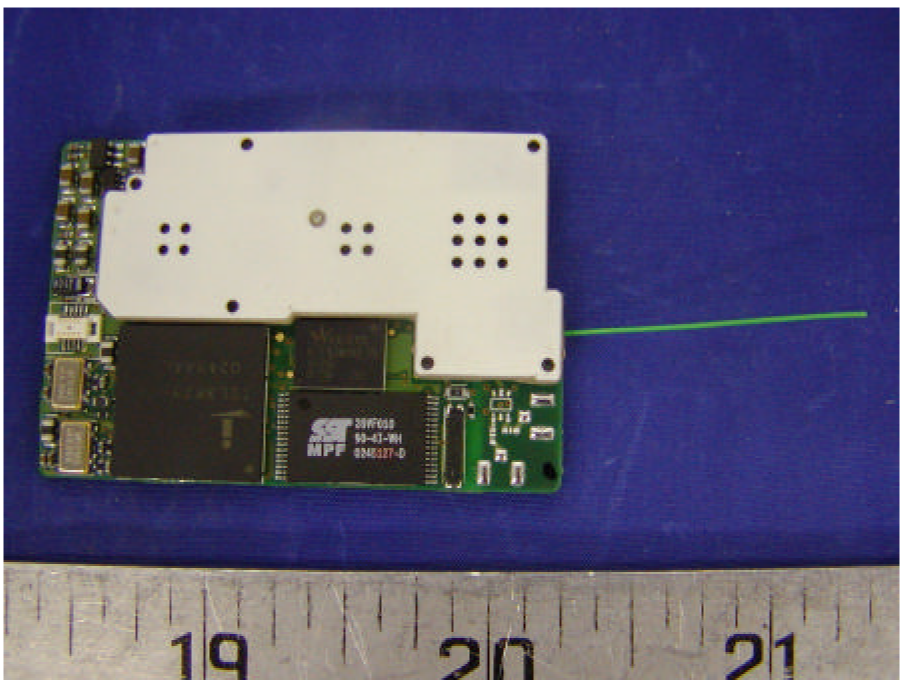
Embedded Wireless LAN Module in EUT View1



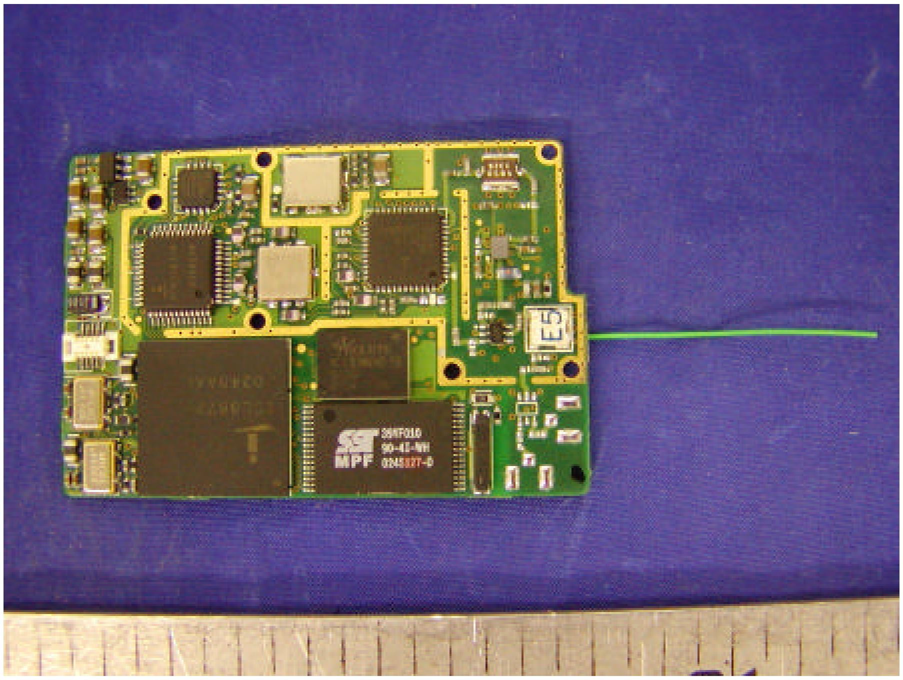
Embedded Wireless LAN Module in EUT View2



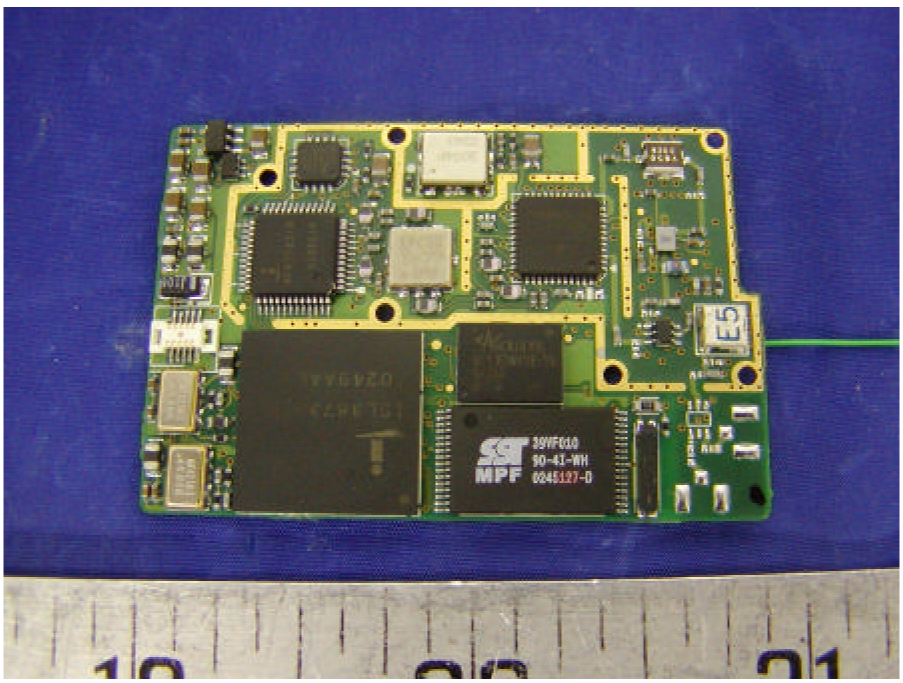
Wireless LAN Module Component with Shield View



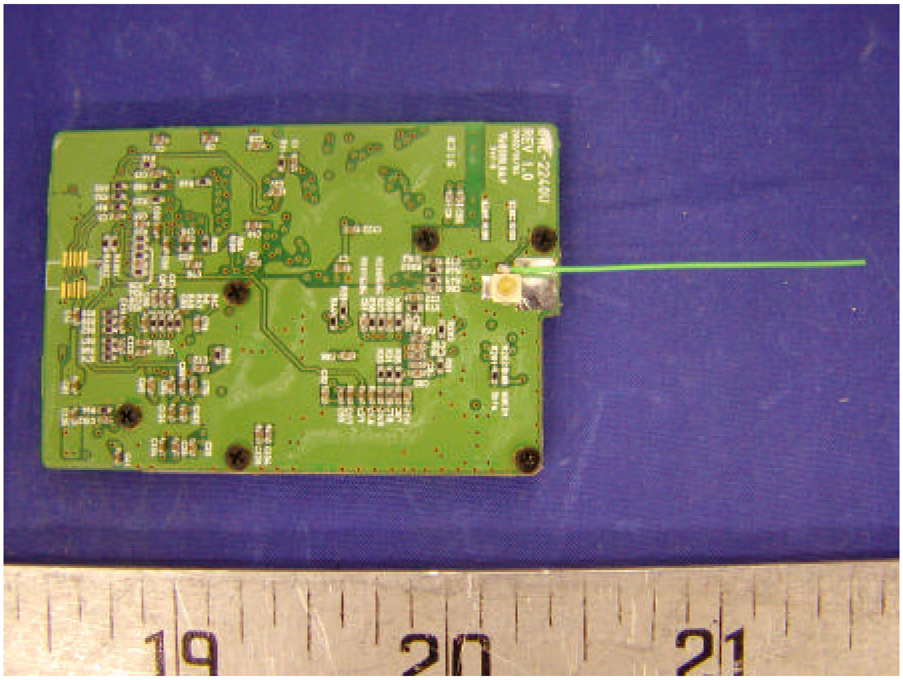
Wireless LAN Module Component View 1



Wireless LAN Module Component View 2



Wireless LAN Module Solder View



Wireless LAN Module Solder View with Label

Antenna Connection View

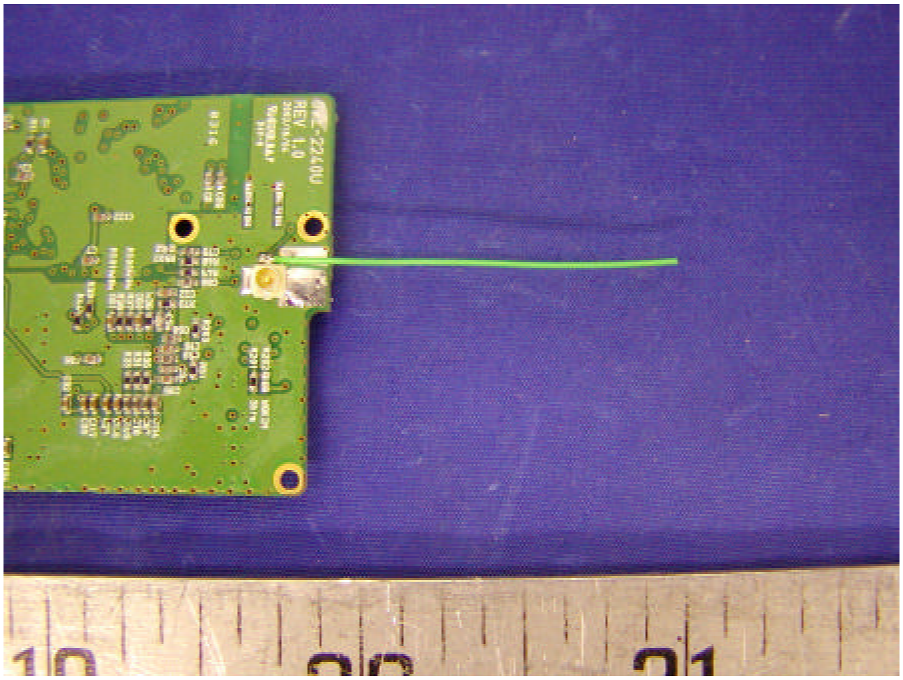


EXHIBIT C – Z-Axis

Alpha Smart DANA wireless (Body back touch with flat phantom, Middle channel, Ambient Temp = 22 Deg C, Liquid Temp = 21 Deg C, 7/17/2003)

SAM Phantom; Section; Position: ; Frequency: 2437 MHz

Probe: ET3DV6 - SN1604; ConvF(4.30,4.30,4.30); Crest factor: 1.0; 2450 MHz: σ = 2.03 mho/m ε_r = 53.0 ρ = 1.00 g/cm³

: , 0

Z-Axis: Dx = 0.0, Dy = 0.0, Dz = 2.0