Celltech
Testing and Engineering Services Lab

December 18, 2001

Federal Communications Commission
Equipment Approval Services
7435 Oakland Mills Road
Columbia, MD 21046
Attn: Stan Lyles

SUBJECT: Relm Communications Corp.
FCC ID: ARURPV516A
731 Confirmation No.: EA811923
Correspondence Ref. No.: 21473

Dear Stan:

Submitted on behalf of Relm Communications Corp. is our response to SAR items 8-11 referenced in your e-mail dated December 12, 2001 requesting additional information for the subject application.

1. Please find attached the re-evaluated body SAR test data and probe calibration information with the appropriate muscle tissue conversion factor from the system manufacturer. In addition, please see attached document stating the probe conversion factors for 150 MHz. (Referenced to question 8).
2. The depth of the simulating tissue in the planar area of the SAM phantom used in the SAR evaluation was maintained at a level of at least 15.0cm. Attached is the Z-axis scan data for the highest SAR test points for both head and body. (Referenced to question 9).
3. Please find attached the measured tissue parameters for the SAR tests and system validation. Please note that the target tissue parameters for 150MHz were used in the SAR evaluation software. If there was any appreciable variation in the measured tissue parameters from the target values specified then the SAR was adjusted using the sensitivities to SAR (see attached "SAR Sensitivities"). (Referenced to question 10).
4. The SAR measurement data reported for both face and body-worn configurations was below the maximum limit of 1.6 w/kg required for general population/uncontrolled exposure compliance. Please see attached revised SAR test report stating compliance of the device with general population/uncontrolled exposure requirements. (Referenced to question 11).

If you have any further questions regarding the above, please do not hesitate to contact me.

Sincerely,

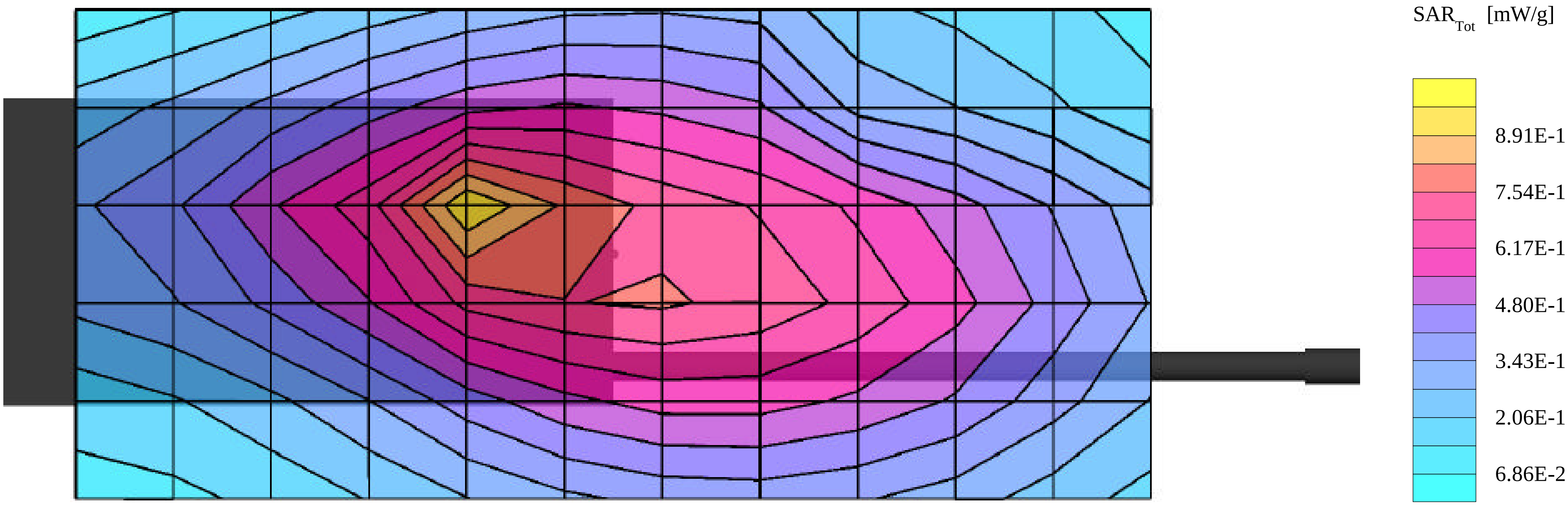
Shawn McMillen
General Manager
Celltech Research Inc.
Testing & Engineering Lab

cc: Relm Communications Corp.
U.S. Technologies

RELM Wireless Corporation FCC ID: ARURPV516A

SAM Phantom; Flat Section; Position: (270°,270°)
Probe: ET3DV6 - SN1590; ConvF(7.65,7.65,7.65); Crest factor: 1.0
150 MHz Muscle: σ = 0.80 mho/m ε_r = 61.9 ρ = 1.00 g/cm^3
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Cube 4x4x7
SAR (1g): 0.965 mW/g, SAR (10g): 0.612 mW/g

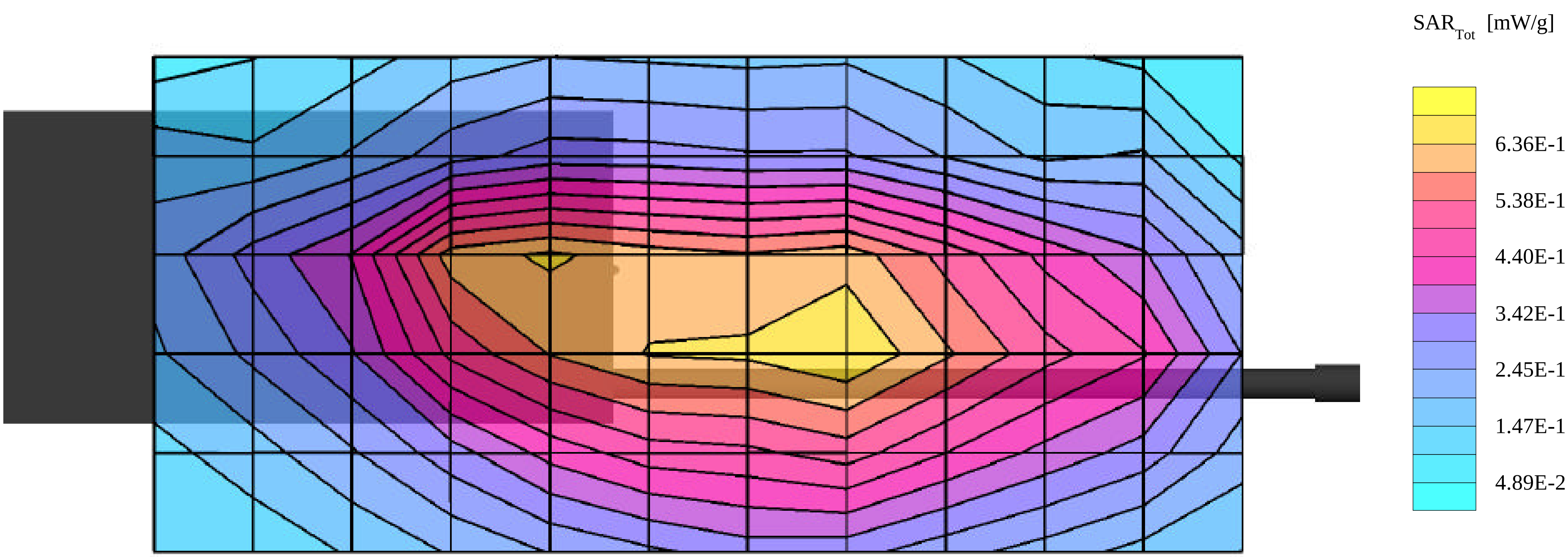
Body SAR with 1.4 cm Belt-Clip Separation
Relm Wireless Model: RPV516A
Continuous Wave Mode
Low Channel (150.05 MHz)
Conducted Power: 5.3 Watts
Date Tested: October 16, 2001



RELM Wireless Corporation FCC ID: ARURPV516A

SAM Phantom; Flat Section; Position: (270°,270°)
Probe: ET3DV6 - SN1590; ConvF(7.65,7.65,7.65); Crest factor: 1.0
150 MHz Muscle: $\sigma = 0.80$ mho/m $\varepsilon_r = 61.9$ $\rho = 1.00$ g/cm³
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Cube 4x4x7
SAR (1g): 0.645 mW/g, SAR (10g): 0.468 mW/g

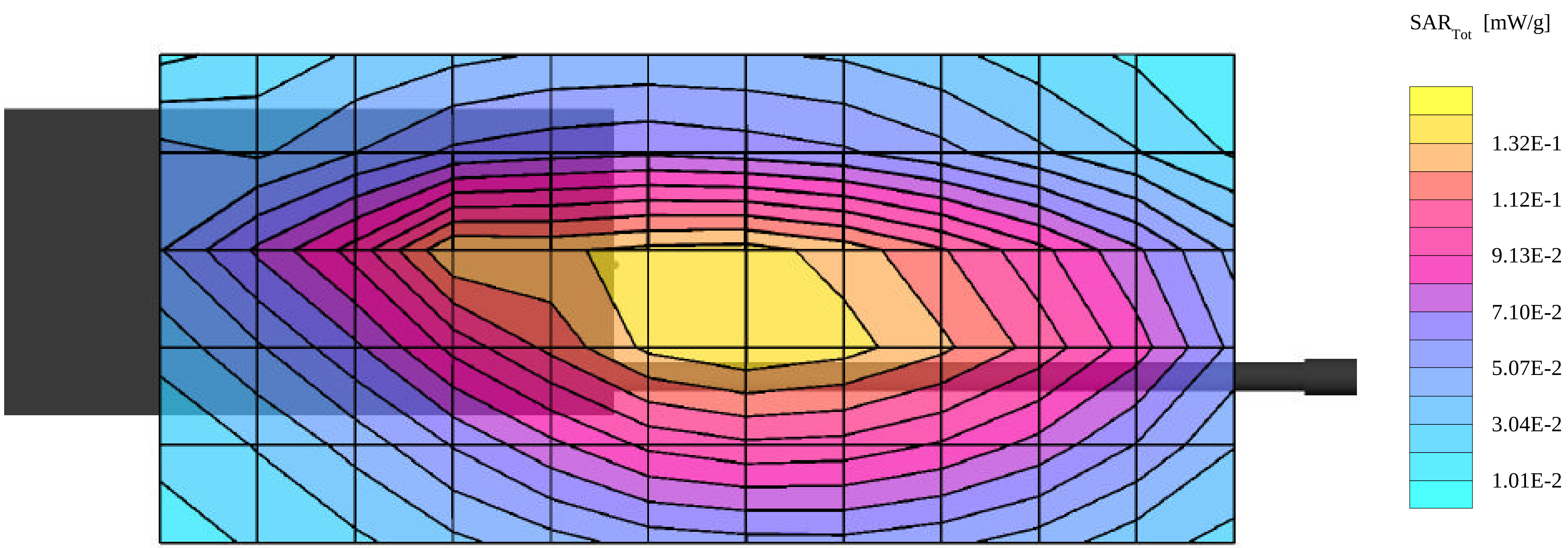
Body SAR with 1.4 cm Belt-Clip Separation
Relm Wireless Model: RPV516A
Continuous Wave Mode
Mid Channel (162.50 MHz)
Conducted Power: 5.3 Watts
Date Tested: October 16, 2001



RELM Wireless Corporation FCC ID: ARURPV516A

SAM Phantom; Flat Section; Position: (270°,270°)
Probe: ET3DV6 - SN1590; ConvF(7.65,7.65,7.65); Crest factor: 1.0
150 MHz Muscle: σ = 0.80 mho/m ε_r = 61.9 ρ = 1.00 g/cm^3
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Cube 4x4x7
SAR (1g): 0.138 mW/g , SAR (10g): 0.103 mW/g

Body SAR with 1.4 cm Belt-Clip Separation
Relm Wireless Model: RPV516A
Continuous Wave Mode
High Channel (173.95 MHz)
Conducted Power: 5.3 Watts
Date Tested: October 16, 2001



Determination of Probe Conversion Factors for 150MHz

Since at this time there exists no experimental method in determining E-field probe conversion factors for frequencies below 800MHz, the following procedure was carried out to give an approximation of the probe conversion factors for 150MHz.

The accuracy of the system was determined based on the two calibrated test frequencies of 900 and 1800MHz, using validation dipoles as supplied by the manufacturer. The measured results were found to be within the specified tolerances. For conversion factors outside these two frequencies a linear extrapolation was performed as per the manufacturer's recommendations. In order to determine the accuracy of the conversion factors, 300 and 450MHz dipoles were constructed in accordance with IEEE Std. P1528. The two dipoles were then characterized for SAR using the appropriate head simulating fluid for the given frequencies in a planar phantom as prescribed in IEEE Std. P1528. The table below indicates the analytical target values for each dipole with the associated measured results.

Frequency (MHz)	Analytical SAR @ 1W input averaged over 1 gram	Measured SAR @ 1W input averaged over 1 gram	Delta D	Fluid Parameters
300	3.0	3.51	17.0%	ε_r=45.3
				σ=0.87
450	4.9	5.77	17.8%	ε_r=43.5
				σ=0.87

The extrapolated head conversion factors determined for 300 and 450MHz resulted in SAR values being 17.0% and 17.8% greater than expected for each frequency respectively. It is assumed that as this extrapolation is extended down to 150MHz, the resulting SAR will again be overestimated by at least 17%.
The body conversion factors were determined based on a combination of the obtained data from the validations, and numerical modeling results from an identical probe from the same manufacturer.

The following two pages show examples of the conversion factors that were derived through numerical modeling for a probe of similar properties.

Dosimetric E-Field Probe ET3DV6

EXAMPLE

Head Tissue Conversion Factor (± standard deviation)

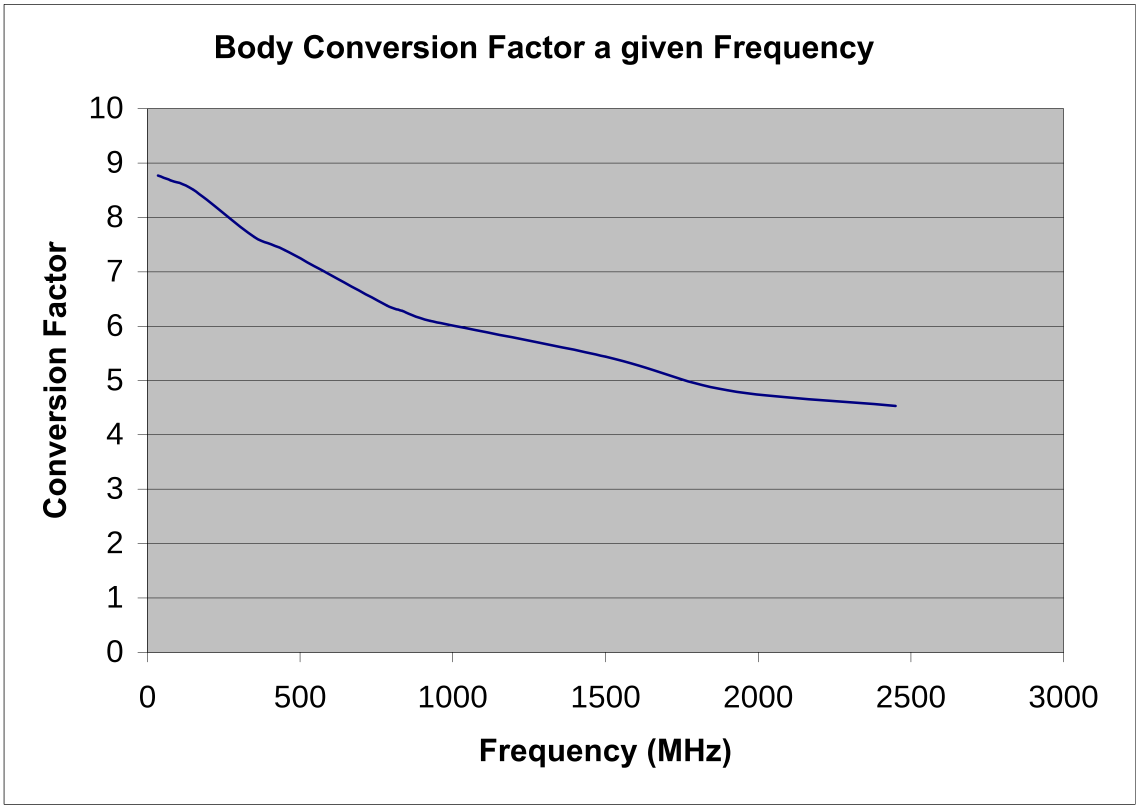
400 MHz	ConvF	7.64 ± 8%	ε_r = 44.4 σ = 0.87 mho/m CENELEC Head Tissue
835 MHz	ConvF	6.54 ± 8%	ε_r = 42.5 σ = 0.98 mho/m CENELEC Head Tissue
900 MHz	ConvF	6.41 ± 8%	ε_r = 42.3 σ = 0.99 mho/m CENELEC Head Tissue
350 MHz	ConvF	7.76 ± 8%	ε_r = 44.7 σ = 0.87 mho/m IEEE Head Tissue
450 MHz	ConvF	7.52 ± 8%	ε_r = 43.5 σ = 0.87 mho/m IEEE Head Tissue
835 MHz	ConvF	6.53 ± 8%	ε_r = 41.5 σ = 0.90 mho/m IEEE Head Tissue
925 MHz	ConvF	6.37 ± 8%	ε_r = 41.45 σ = 0.98 mho/m IEEE Head Tissue
1500 MHz	ConvF	6.04 ± 8%	ε_r = 40.43 σ = 1.23 mho/m IEEE Head Tissue
1900 MHz	ConvF	5.41 ± 8%	ε_r = 40.0 σ = 1.40 mho/m IEEE Head Tissue
2450 MHz	ConvF	5.18 ± 8%	ε_r = 39.2 σ = 1.8 mho/m IEEE Head Tissue
2450 MHz	ConvF	5.40 ± 8%	ε_r = 37.2 σ = 2.09 mho/m H1800 at 2450 MHz

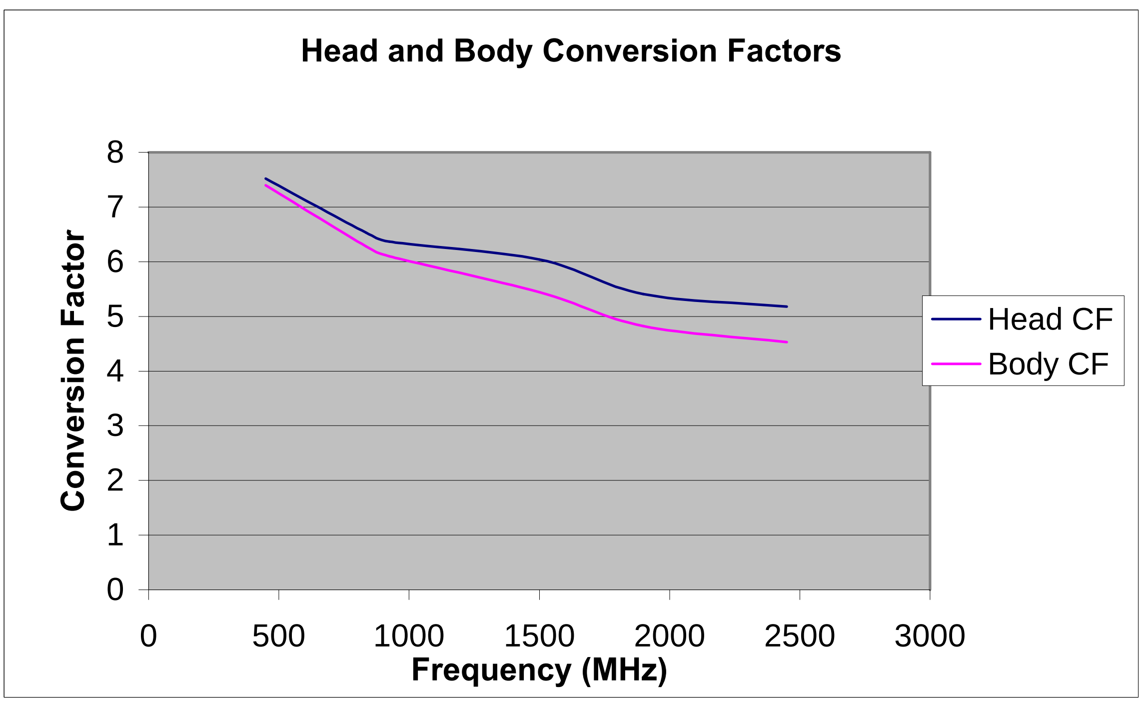
Dosimetric E-Field Probe ET3DV6

EXAMPLE

Body Tissue Conversion Factor (± standard deviation)

35 MHz	ConvF	8.77 ± 15%	ε_r = 85.19 σ = 0.69 mho/m FCC Body Tissue
75 MHz	ConvF	8.68 ± 10%	ε_r = 69.93 σ = 0.72 mho/m FCC Body Tissue
150 MHz	ConvF	8.51 ± 8%	ε_r = 62.68 σ = 0.75 mho/m FCC Body Tissue
350 MHz	ConvF	7.64 ± 8%	ε_r = 58.41 σ = 0.80 mho/m FCC Body Tissue
450 MHz	ConvF	7.40 ± 8%	ε_r = 57.62 σ = 0.83 mho/m FCC Body Tissue
784 MHz	ConvF	6.38 ± 8%	ε_r = 56.25 σ = 0.93 mho/m FCC Body Tissue
835 MHz	ConvF	6.28 ± 8%	ε_r = 56.11 σ = 0.95 mho/m FCC Body Tissue
925 MHz	ConvF	6.10 ± 8%	ε_r = 55.9 σ = 0.98 mho/m FCC Body Tissue
1500 MHz	ConvF	5.44 ± 8%	ε_r = 54.87 σ = 1.23 mho/m FCC Body Tissue
1900 MHz	ConvF	4.82 ± 8%	ε_r = 54.3 σ = 1.45 mho/m FCC Body Tissue
2450 MHz	ConvF	4.53 ± 8%	ε_r = 53.57 σ = 1.81 mho/m FCC Body Tissue


Body Conversion Factor a given Frequency
Conversion Factor
10
9
8
7
6
5
4
3
2
1
0
0
500
1000
1500
2000
2500
3000
Frequency (MHz)


Head and Body Conversion Factors
Conversion Factor
8
7
6
5
4
3
2
1
0
0
500
1000
1500
2000
2500
3000
Frequency (MHz)
Head CF
Body CF

Frequency	Head Conversion Factors	Body Conversion Factors	Delta D
450	7.52	7.40	1.62
835	6.53	6.28	3.98
925	6.37	6.10	4.43
1500	6.04	5.44	11.02
1900	5.41	4.82	12.24
2450	5.18	4.53	14.35

Conclusion:

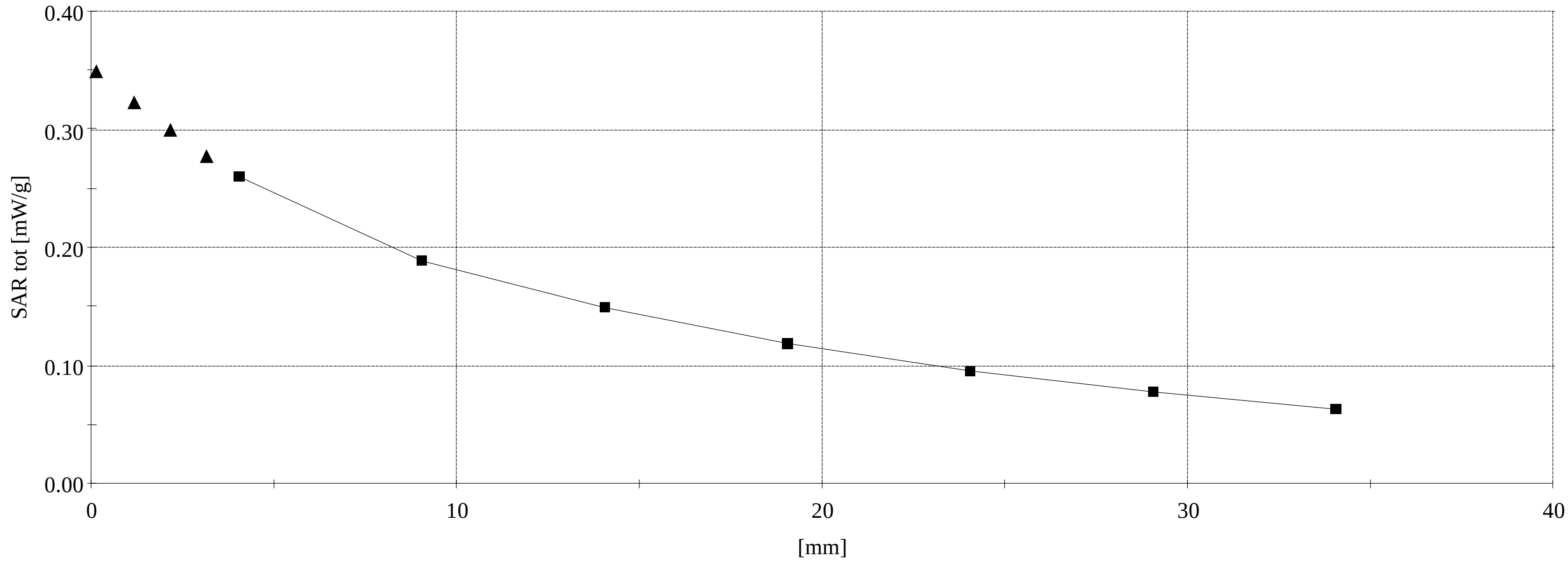
Based on the results from the 300 and 450MHz validations, the derived conversion factors should over-estimate the SAR for a device operating in the 150MHz band by approximately 17%. In addition, the above graphs and tabular results show that the probe conversion factors vary only slightly between head and body as the frequency approaches 450MHz. It is therefore safe to assume that as the frequency is further extended to 150MHz, the difference in the conversion factors between head and body will be less significant. Therefore, for this reason only one conversion factor is reported for both head and body at 150MHz.

RELM Wireless Corporation FCC ID: ARURPV516A

SAM Phantom; Flat Section
Probe: ET3DV6 - SN1590; ConvF(7.71,7.71,7.71); Crest factor: 1.0
150 MHz Brain : σ = 0.76 mho/m ε_r = 52.3 ρ = 1.00 g/cm^3
Cube 4x4x7

Z-Axis Extrapolation at Peak SAR Location

Face SAR at 2.5 cm Separation Distance
Relm Wireless Model: RPV516A
Continuous Wave Mode
Low Channel (150.05 MHz)
Conducted Power: 5.3 Watts
Date Tested: October 16, 2001

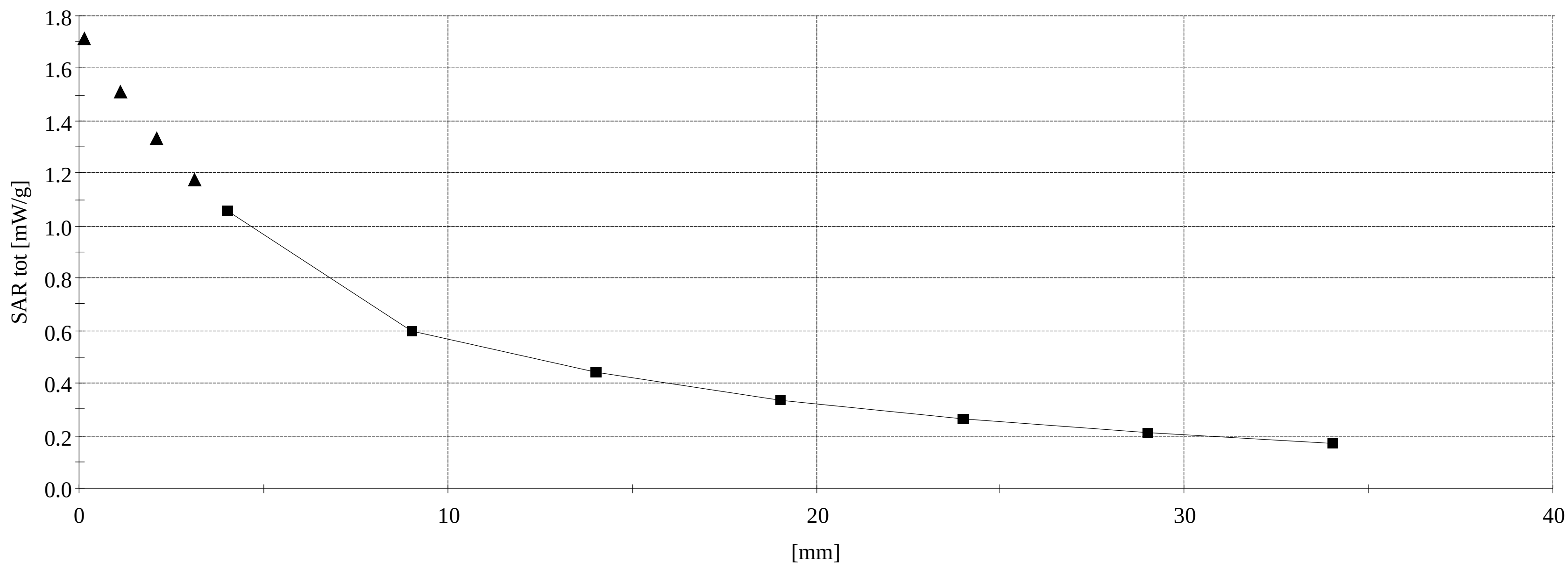


RELM Wireless Corporation FCC ID: ARURPV516A

SAM Phantom; Flat Section
Probe: ET3DV6 - SN1590; ConvF(7.65,7.65,7.65); Crest factor: 1.0;
150 MHz Muscle: $\sigma = 0.80$ mho/m $\varepsilon_r = 61.9$ $\rho = 1.00$ g/cm^3
Cube 4x4x7

Z-Axis Extrapolation at Peak SAR Location

Body SAR with 1.4 cm Belt-Clip Separation
Relm Wireless Model: RPV516A
Continuous Wave Mode
Low Channel (150.05 MHz)
Conducted Power: 5.3 Watts
Date Tested: October 16, 2001



Application Note: SAR Sensitivities

Introduction

The measured SAR-values in homogeneous phantoms depend strongly on the electrical parameters of the liquid. Liquids with exactly matching parameters are difficult to produce; there is always a small error involved in the production or measurement of the liquid parameters. The following sensitivities allow the estimation of the influence of small parameter errors on the measured SAR values. The calculations are based on an approximation formula [1] for the SAR of an electrical dipole near the phantom surface and a adapted plane wave approximation for the penetration depth. The sensitivities are given in percent SAR change per percent change in the controlling parameter:

$$S(x) = \frac{d\,SAR / SAR}{d\,x / x}$$

The controlling parameters x are:

- ε : permitivity
- σ : conductivity
- ρ : brain density (= one over integration volume)

For example: If The liquid permitivity increases by 2 percent and the sensitivity of the SAR to permitivity is -0.6 then the SAR will decrease by 1.2 percent.

The sensitivities are given for surface SAR values and averaged SAR values for 1 g and 10 g cubes and for dipole distances d of 10mm (for frequencies below 1000 MHz) and 15mm (for frequencies above 1000 MHz) from the liquid surface.

Liquid parameters are as proposed in the new standards (e.g., IEEE 1528).

References

[1] N. Kuster and Q. Balzano, “Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300 MHz”, *IEEE Transacions on Vehicular Technology*, vol. 41(1), pp. 17-23, 1992.

Parameter	ε	σ	ρ
f=300 MHz (εr=45.3, σ=0.87S/m, ρ=1g/cm³)			
d=15mm: Surface	- 0.41	+ 0.48	—
1 g	- 0.33	+ 0.28	0.08
10 g	- 0.26	+ 0.09	0.16
f=450 MHz (εr=43.5, σ=0.87S/m, ρ=1g/cm³)			
d=15mm: Surface	- 0.56	+ 0.67	—
1 g	- 0.46	+ 0.43	0.09
10 g	- 0.37	+ 0.22	0.17
f=835 MHz (εr=41.5, σ=0.90S/m, ρ=1g/cm³)			
d=15mm: Surface	- 0.70	+ 0.86	—
1 g	- 0.57	+ 0.59	0.10
10 g	- 0.45	+ 0.35	0.18
f=900 MHz (εr=41.5, σ=0.97S/m, ρ=1g/cm³)			
d=15mm: Surface	- 0.69	+ 0.86	—
1 g	- 0.55	+ 0.57	0.10
10 g	- 0.44	+ 0.32	0.19
f=1450 MHz (εr=40.5, σ=1.20/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.73	+ 0.91	—
1 g	- 0.55	+ 0.55	0.12
10 g	- 0.42	+ 0.27	0.22
f=1800 MHz (εr=40.0, σ=1.40S/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.73	+ 0.92	—
1 g	- 0.52	+ 0.51	0.14
10 g	- 0.38	+ 0.21	0.24
f=1900 MHz (εr=40.0, σ=1.40S/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.73	+ 0.93	—
1 g	- 0.53	+ 0.51	0.14
10 g	- 0.39	+ 0.22	0.24
f=2000 MHz (εr=40.0, σ=1.40S/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.74	+ 0.94	—
1 g	- 0.53	+ 0.52	0.14
10 g	- 0.39	+ 0.22	0.24
f=2450 MHz (εr=39.2, σ=1.80S/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.74	+ 0.93	—
1 g	- 0.49	+ 0.41	0.17
10 g	- 0.34	+ 0.12	0.28
f=3000 MHz (εr=38.5, σ=2.40S/m, ρ=1g/cm³)			
d=10mm: Surface	- 0.75	+ 0.90	—
1 g	- 0.45	+ 0.28	0.21
10 g	- 0.32	+ 0.02	0.31