



MOTOROLA

**ELECTROMAGNETIC EXPOSURE (EME)
TESTING LABORATORY**

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Fort-Lauderdale, Florida

S.A.R. TEST REPORT
FCC ID #: AZ489FT5801
(i2000Plus – H32UAH6RR7AN)

September 29, 2000 - Rev. B

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1.0 Introduction:

This report is a revision of the previous SAR report for Portable Radio, model number H32UAH6RR7AN (FCC ID: AZ489FT5801) which dated 8/31/2000.

The purposes for this revision are:

- To improve the clarity of FCC report, all the non-relevant FCC data is excluded from this report, specifically SAR data results at GSM mode.
- Tables in sections 7.1 and 7.3 have been consolidated into one table located in section 7.1 to include both measured and maximum calculated SAR data.

This report details the test setup, test equipment, and test results of the Specific Absorption Rate (SAR) measurement performed at CGISS EME laboratory for the i2000Plus Portable Radio, model number H32UAH6RR7AN (FCC ID: AZ489FT5801).

2.0 Applicable Regulations and Standards

- United States Federal Communications Commission, Code of Federal Regulations; 47 CFR part 2 sub-part J
- American National Standards Institute (ANSI) / Institute of Electrical and Electronic Engineers (IEEE) C95. 1-1992
- Institute of Electrical and Electronic Engineers (IEEE) C95.1-1999 Edition
- National Council on Radiation Protection and Measurements (NCRP) of the United States, Report 86, 1986.
- Ministry of Health (Canada) Safety Code 6. Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz, 1999.

3.0 Description of Test Sample



The portable radio, Model number H32UAH6RR7AN is capable of operating in 806-825 MHz band with a rated conducted power 0.6W pulse average, and capable of operating as a telephone, traditional two-way (dispatch) radio, or RF modem (packet data mode). An associated base station allocates a number of 15 msec. Time Division Multiplex (TDM) time slots in which the transceiver transmits depending on the service mode. The trunking system protocol for voice transmission uses a 90 msec. frame divided into six 15 msec. time slots. PSTN (phone mode) interconnect calls utilize 2 time slots (2/6 multiplexing) with a 33.33% duty cycle. Two-way radio dispatch transmissions are accomplished using one time slot (1/6 multiplexing) with a 16.67% duty cycle. In the packet data mode, the protocol uses a multiple of voice/circuit data mode frames with a duty cycle that varies with the RF environment. The worst case duty cycle of 67.5% occurring with 81/120 time slots.

3.1 Antenna Description:

3.1.1 Antenna type:

Half wave whip when extended and quarter wave helix when retracted

Monopole ☐ Dipole ☐ Helix ☐ Patch ☐ Other ☒

3.1.2 Antenna Location on Device

Left ☐ Right ☒ Top ☒ Bottom ☐ Front ☐ Back ☐

3.1.3 Antenna Dimensions

Length - cm (extended)	11.5
Diameter - cm (at tip of antenna)	0.58
Diameter - cm (at middle of antenna)	0.17
Diameter - cm (at base of antenna)	0.26

3.1.4 Antenna Configuration

Fixed ☐ Retractable ☒ External ☐ Other ☐

3.1.5 Antenna Gain

iDen mode

Extended Retracted

3.2 Test Signal

Test Signal Source:

Test Mode ☒ Base Station ☐ Simulator ☐ Other ☐

Signal Modulation:

CW	
TDMA	16.67%
Other	

3.3 Test Frequency and Output Power

Output power measurement conditions:

Free Space Radiated ☐ SAR test configuration ☒ Conducted ☒ Other ☐

Output Power measured with:

Power meter ☒ Base Station Simulator ☐ Spectrum Analyzer ☐ Other ☐

Test Frequency (MHz)	Measured Power before SAR (W)	Measured Power after SAR (dB)
806.0125	0.559	-0.01
813.5625	0.611	-0.01
820.9875	0.544	0
824.9875	0.532	0

4.0 Description of Test Equipment

4.1 Descriptions of SAR Measurement System

The laboratory utilizes a Dosimetric Assessment System (DASY™) SAR measurement system manufactured by Schmid & Partner Engineering AG (SPEAG™), of Zurich Switzerland. This system utilizes a computer controlled six axis robot to move a measurement probe to measure the SAR. The SAR measurements were conducted with the probe ET3DV6 serial number 1384. It was calibrated at SPEAG™, and has a calibration date June 1, 2000. A copy of the calibration certificate is included as appendix C. Dipole Validation Kit type 835MHz (serial number 835-002), was used to validate the system accuracy at 800MHz .

DIPOLE VALIDATION RESULT

Dipole Antenna (S/N)	Validation Type (Freq/Tissue)	SAR Meas. @ 0.50W (w/ drift)	Calculated SAR @ 1W	Target SAR @ 1W
835-002	835 - Muscle	4.61 mW/g	9.22 mW/g	9.38 mW/g $\pm$ 10%

The Dipole validation table indicated the result is within the required accuracy of $\pm$ 10% (Dipole SAR Validation Certificate for Dipole S/N 835-002), and thus the measured SAR values are considered correct. See appendix B for printout of the validation test results from the DASY™ measurement system.

The DASY™ system is operated per the instructions in the DASY™ Users Manual. The entire manual is available directly from SPEAG™.

4.2 Description of Phantom

Human shaped, solid shell device made of fiberglass and mounted on a nonmetallic base or stand.

4.2.1 Full Body Phantom

Abdomen Thickness	0.15 cm
Face Thickness	0.15 cm

4.2.2 Half Body Phantom

Left Ear

Shell Thickness	0.15 cm
Ear Spacer Thickness	0.50 cm
Total Thickness	0.65 cm

Right Ear

Shell Thickness	0.15 cm
Ear Spacer Thickness	0.50 cm
Total Thickness	0.65 cm

4.3 Simulated Tissue Properties:

4.3.1 Type of Simulated Tissue

	Full Body	Half Body
Muscle	X	
Brain		X

4.3.2 Simulated Tissue Composition

	Muscle	Brain
	835MHz	838MHz
Di-Water	53.50 %	43.75 %
Sugar	44.25 %	54.00 %
Salt	1.15 %	1.15 %
HEC	1.00 %	1.00 %
Dowicil75	0.10 %	0.10 %

Note: HEC (HYDROXYETHYL CELLULOSE) is a gelling agent and Dowicil 75 is anti bacterial compound.

Characterization of Simulated tissue materials and ambient conditions:

Simulated tissue prepared for SAR measurements are measured at room temperature and verified to be in spec prior to actual SAR measurements by filling a coaxial slotted line with the tissue and probing the amplitude and phase changes versus distance in the simulated tissue. A HP8753D Network Analyzer is used to perform the measurements.

Measured simulated tissue dielectric constant and conductivity used in SAR runs as of 8/16/00, and 8/21/00.

	Muscle	Brain
	835 MHz	835 MHz
Di-electric Constant	51.8	45.2
Conductivity – S/m	1.07	0.87

5.0 Description of Test Procedure

Several accessories marketed as separate items are available which influence possible operating conditions of this handheld transceiver. These include leather carry cases with belt clip which are intended to be attached to a user's belt, and various audio accessories with interconnecting cable. The combination of carrying case and audio accessory/data cable devices when worn on the body permits the handheld transceiver to be operated in iDen mode as a telephone with a 33.33% duty cycle, or as two-way radio with a 16.67% duty cycle, or RF modem (packet data mode) with 67.5% duty cycle .

The following accessories tested include body attach accessory and representative data cables and audio accessory cables:

- Lithium Ion 500mAh slim battery (kit # NTN8615B)
- Lithium Ion 900mAh high capacity battery (kit # NTN8614A)
- Leather carry case (kit # NTN9247A)
- Leather carry case (kit # NTN9551A)
- Over the head headset (kit # NTN8496)
- TEMCO adjustable headset (kit # NTN8513)
- Programming cable (kit # NKN6522)
- Audio Adapter (kit # NTN8654).

All SAR measurements performed with the radio positioned in the described test positions and test modes were done while the radio was operating in iDen mode as a 16.67% duty cycle for 806-825MHz.

5.1 Description of Test Positions

The following describes the three test positions used to perform SAR measurements on the portable radio:

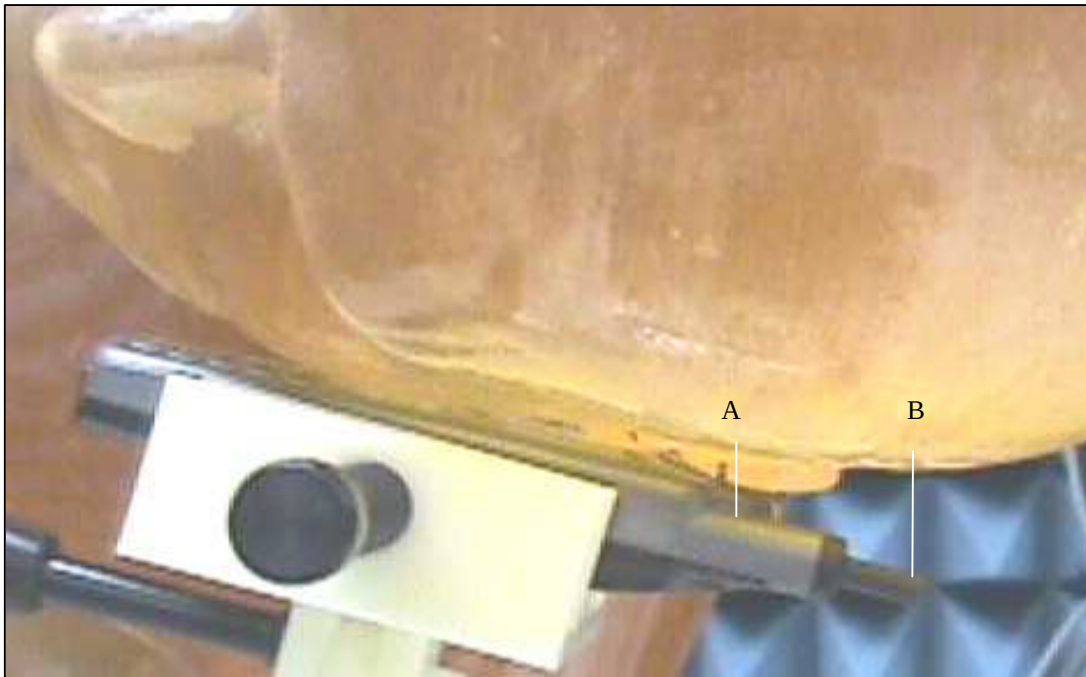
Head - The portable radio is positioned in a normal telephone operating position by aligning the axis of the radio with a line from the center of the ear to the corner of the lips, center the listening area of the test radio over the ear canal. Next, position the radio as close as possible to the phantom, preferably with three points of contact with the phantom to allow for best coupling to the simulated tissue. SAR measurements were performed with the radio antenna extended and retracted.

Face - The portable radio in the leather carry case without belt clip is positioned in the right hand of a full body phantom in a normal two-way radio operating position and the radio's normal speaking area is aligned the center of the phantom's mouth. SAR measurements were performed with the radio antenna extended and retracted.

Abdomen - The portable radio is positioned in a leather carry case with belt clip attached beneath the abdomen of the full body phantom with the back of the radio facing the abdomen, the keypad/display facing the floor. An interface cable between the radio connector and a head set or data cable is connected to the radio to allow telephone or two-way radio or RF modem (packet data mode) operation. SAR measurements were performed with the radio antenna extended and retracted.

Reference figures: 1, 2, and 3 for portable radio antenna orientation and distances relative to phantoms

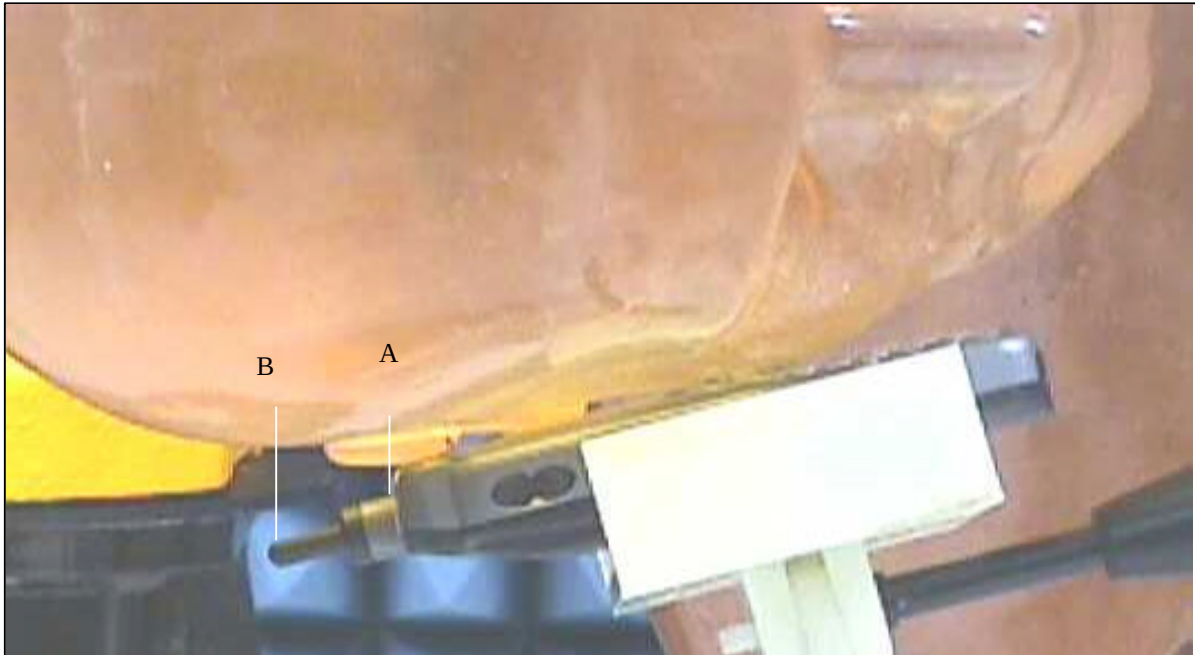
Figure 1a: Head Position – Left Ear.



DIM A = Distance from surface of antenna base to phantom head = 13 mm

DIM B = Distance from surface of antenna tip to phantom head = 22 mm

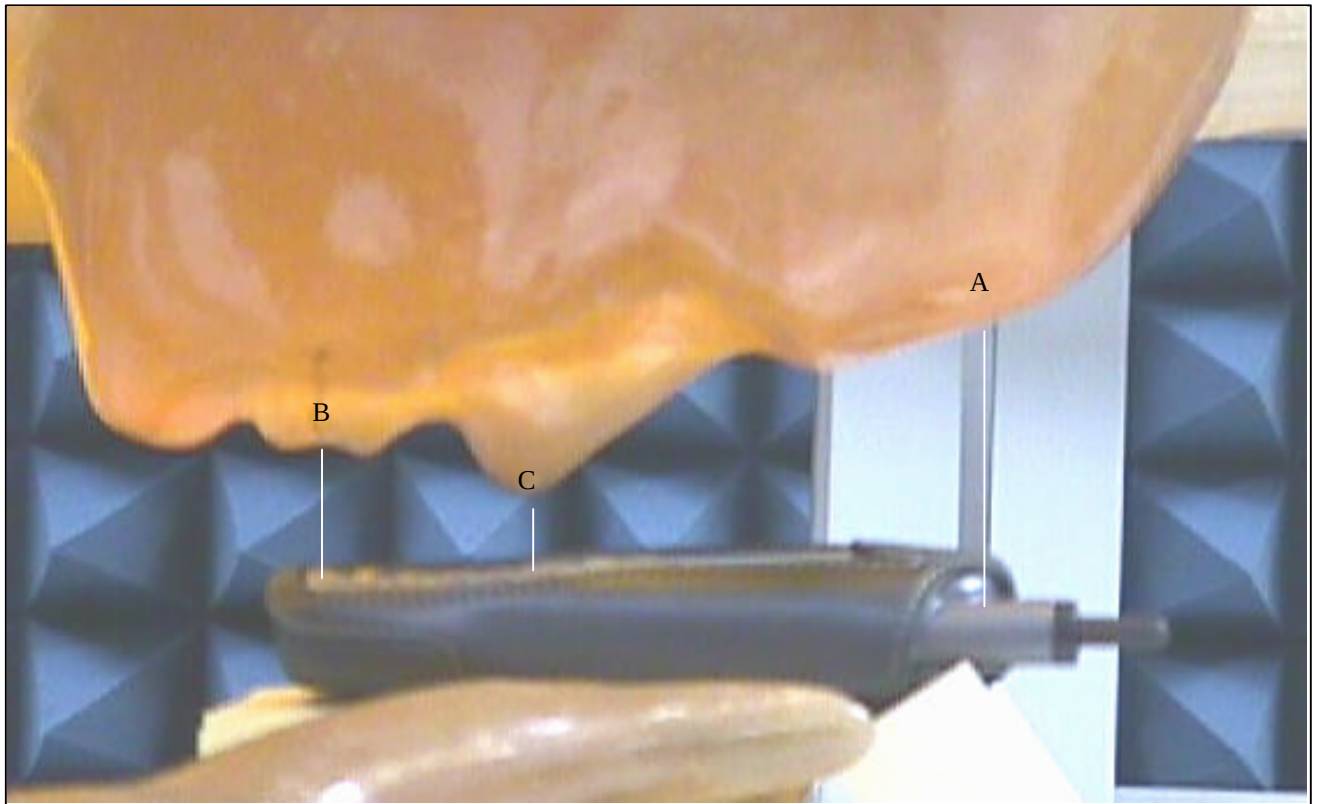
Figure 1b: Head Position - Right Ear.



DIM A = Distance from surface of antenna base to phantom head = 20 mm

DIM B = Distance from surface of antenna tip to phantom head = 31 mm

Figure 2: Facial Position

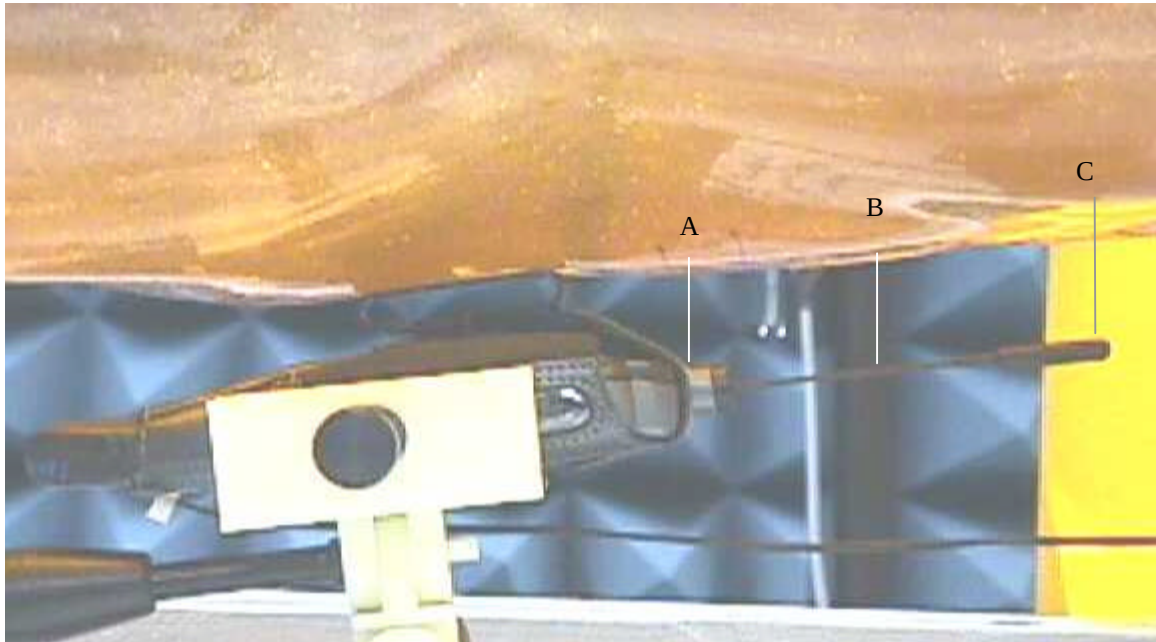


DIM A = Distance from center of phantom's forehead to antenna surface when the antenna is in the retracted position = 51 mm

DIM B = Distance between phantom's mouth and radio surface = 25 mm

DIM C = Closest distance between phantom's nose tip and radio surface = 13 mm

Figure 3: Abdominal Position



Dim A = Distance from surface of antenna base to phantom surface = 25 mm

Dim B= Distance from surface of antenna center to phantom surface = 30 mm

Dim C= Distance from antenna surface tip to phantom = 30 mm

5.2 Probe Scan Procedures

The E-field probe is first scanned in a coarse grid over a large area inside the phantom in order to locate the maximum for most SAR distributions even with relatively large grid spacing. 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 for a finer resolution grid or the cube evaluations.

6.0 Measurement Uncertainty:

The table below list an estimate of the possible errors that are associated with the measurement system.

Uncertainty Description	Standard Uncertainty
Probe Uncertainty	
- Axial Isotropy	$\pm 2.4 \%$
- Spherical Isotropy	$\pm 4.8 \%$
- Spatial Resolution	$\pm 0.5 \%$
- Linearity Error	$\pm 2.7 \%$
- Calibration Error	$\pm 8 \%$
Evaluation Uncertainty	
- Data Acquisition Error	$\pm 0.60 \%$
- ELF and RF Disturbances	$\pm 0.25 \%$
- Conductivity Assessment	$\pm 5 \%$
Spatial Peak SAR Evaluation Uncertainty	
- Extrapolation and boundary effects	$\pm 3\%$
- Probe positioning	$\pm 1 \%$
- Integration and cube orientation	$\pm 3 \%$
- Cube shape inaccuracies	$\pm 1.2 \%$
- Device positioning	$\pm 1.0 \%$

The Total Measurement Uncertainty is $\pm 12.1 \%$. The Expanded Measurement Uncertainty is $\pm 24.2 \%$ (k=2)

7.0 SAR Test Results:

SAR was fully investigated with the batteries and accessories indicate in section 5.0 of this report. The highest measured results are summarized below in table 7.1. The highest maximum calculated values for each body position are indicated in bold and full data set output from DASY™ measurement system for these results are provided in Appendix A.

7.1 iDen Mode:

Test Freq. (MHz)	Ant. Pos.	Cond. Power	Highest Measured SAR (mW/g)					Max Calculated SAR (mW/g)				
			Face	Left Ear	Right Ear	Abdomen		Face	Left Ear	Right Ear	Abdomen	
			(16.67%)	(16.67%)	(16.67%)	Audio Cable (16.67%)	Data Cable (16.67%)	PTT Mode (16.67%)	Phone Mode (33.33%)	Phone Mode (33.33%)	Phone Mode (33.33%)	Data Mode (67.5%)
806	In	0.559	0.11	0.28	0.25	0.06	0.09	0.14	0.72	0.65	0.15	0.47
813	In	0.611	0.12	0.29	0.30	0.08	0.09	0.14	0.67	0.70	0.19	0.43
821	In	0.544	0.10	0.26	0.28	0.06	0.08	0.13	0.69	0.75	0.16	0.43
825	In	0.532	0.08	0.23	0.28	0.05	0.07	0.11	0.61	0.75	0.14	0.38
806	Out	0.559	0.18	0.31	0.26	0.15	0.14	0.23	0.80	0.66	0.37	0.72
		0.535		0.30	0.26				0.81	0.70		
813	Out	0.611	0.19	0.32	0.28	0.16	0.11	0.23	0.75	0.66	0.38	0.53
821	Out	0.544	0.16	0.24	0.21	0.13	0.11	0.21	0.63	0.56	0.34	0.58
825	Out	0.532	0.15	0.21	0.20	0.14	0.10	0.20	0.57	0.54	0.38	0.55

The calculated maximum 1 gram averaged SAR value is determined by scaling up the SAR by the same ratio as the maximum power delivered to the radio antenna connector under any conditions of permissible tuning, frequency, voltage and temperature; which is 0.72W Pulse average for this radio. For this reason, the radio Maximum Calculated 1 gram averaged peak SAR becomes:

$$\text{Maximum Calculated 1-gram Average Peak SAR} = \text{SAR}_{\text{meas}} \times [P_{\text{max}} \div P_{\text{end}}] \times [D1 \times D2].$$

SAR_{meas} = Measured 1 gram averaged peak SAR .

P_{max} = Maximum power delivered to the antenna connector under any conditions of permissible tuning, frequency, voltage and temperature.

P_{end} = Lowest measured power at end of SAR.

D1 = the transmission mode duty cycle, i.e., the ratio of the service mode and the tested mode.

D2 = the Push To Talk duty cycle.

For two-way radio (dispatch for controlled environment) = 0.5,

For two-way radio (dispatch for uncontrolled/ general population) = 1,

For data and telephony = 1.

$$\begin{array}{llll} \text{Maximum Calculated 1-gram} & & & \\ \text{Average Peak SAR for phone} & = & 0.30 \times [0.72 \div 0.609] \times [(33.33\%/16.67\%) \times 1] & = 0.81 \text{ mW/g} \\ \text{mode at the head} & & & \end{array}$$

$$\begin{array}{llll} \text{Maximum Calculated 1-gram} & & & \\ \text{Average Peak SAR for phone} & = & 0.16 \times [0.72 \div 0.610] \times [(33.33\%/16.67\%) \times 1] & = 0.38 \text{ mW/g} \\ \text{mode at Abdomen} & & & \end{array}$$

$$\begin{array}{llll} \text{Maximum Calculated 1-gram} & & & \\ \text{Average Peak SAR for data} & = & 0.14 \times [0.72 \div 0.558] \times [(67.5\%/16.67\%) \times 1] & = 0.72 \text{ mW/g} \\ \text{mode at Abdomen} & & & \end{array}$$

8.0 Conclusion

The highest Operational Maximum Calculated 1-gram average SAR values found for the portable radio model number H32UAH6RR7AN was 0.81mW/g. This indicated the SAR results are below the maximum levels of 1.6 mW/g.

Appendix A: Data Results

i2000Plus_iDen_Ab; Test Date: 08/16/00

Run #:i2000Plus_00081602. Time: 36 min

Model #:H32UAH6RR7AN, S/N: 805AAL0043.

Meas Power: 0.559 W, Tx_Freq: 806.0125MHz

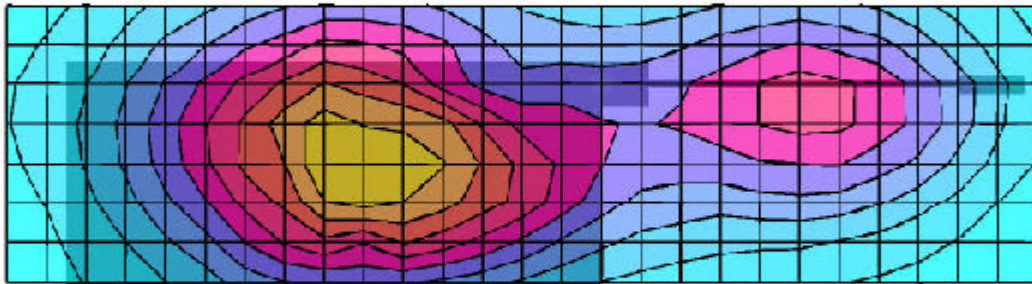
Batt:NTN8615B, Ant: out,

Leather carry case: NTN9247A,Data cable:NKN6522A

Full bodyPhantom; Full Body_Abdomen

Probe: ET3DV6 - SN1384; ConvF(6.45,6.45,6.45); Crest factor: 6.0; Muscle 835 MHz : $s = 1.07 \text{ mho/m}$ $\epsilon_r = 51.8$ $\rho = 1.07 \text{ g/cm}^3$

Cube 5x5x7:SAR (1g): 0.137 mW/g, (Worst-case extrapolation)



i2000Plus_iDen_Ab; Test Date: 08/15/00

Run #:i2000Plus_00081504. Time: 36 min

Model #:H32UAH6RR7AN, S/N: 805AAL0043.

Meas Power: 0.611 W, Tx_Freq: 813.5625MHz

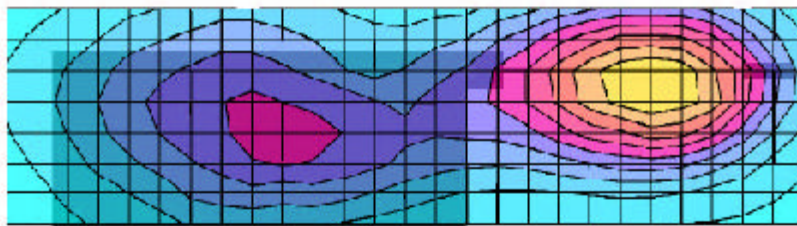
Batt:NTN8615B, Ant: out,

Leather carry case: NTN9247A, over the ear headset: NTN8513A

Full bodyPhantom; Full Body_Abdomen

Probe: ET3DV6 - SN1384; ConvF(6.45,6.45,6.45); Crest factor: 6.0; Muscle 835 MHz : $s = 1.07 \text{ mho/m}$ $\epsilon_r = 51.8$ $\rho = 1.07 \text{ g/cm}^3$

Cube 5x5x7:SAR (1g): 0.163 mW/g, (Worst-case extrapolation)



i2000Plus_iDen_Face; Test Date: 08/18/00

Run #:i2000Plus _00081801. Time: min

Model #:H32UAH6RR7AN, S/N: 805AAL0043.

Meas Power: 0.611 W, Tx_Freq: 813.5625MHz

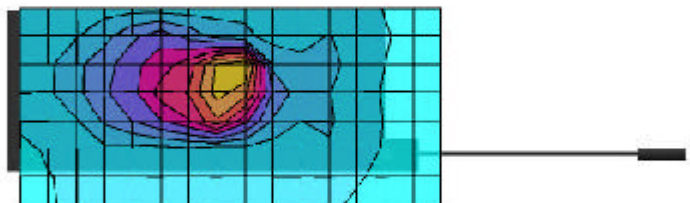
Batt:NTN8615B, Ant: out,

Leather carry case: NTN9247A w/o clip, radio is positioned 2.5cm from the phantom mouth

Full bodyPhantom; i2000

Probe: ET3DV6 - SN1384; ConvF(6.45,6.45,6.45); Crest factor: 6.0; Muscle 835 MHz : $s = 1.07 \text{ mho/m}$ $\epsilon_r = 51.8$ $\rho = 1.07 \text{ g/cm}^3$

Cube 5x5x7:SAR (1g): 0.192 mW/g, (Worst-case extrapolation)



i2000Plus _iDen_Left Head; Test Date: 08/23/00

Run #:i2000Plus _00082309. Time: 26-32 min

Model #:H32UAH6RR7AN, S/N: 805AAL003F.

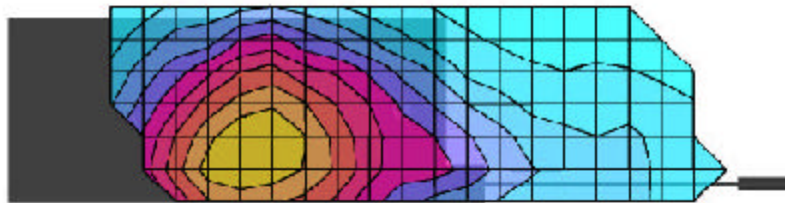
Meas Power: 0.535 W, Tx_Freq: 806.0125 MHz

Batt:NTN8614A, Ant : out

Left Head Phantom; left ear

Probe: ET3DV6 - SN1384; ConvF(6.50,6.50,6.50); Crest factor: 6.0; Brain 835 MHz: $s = 0.87$ mho/m $\epsilon_r = 45.2$ $\rho = 1.04$ g/cm³

Cubes (2):SAR (1g): 0.300 mW/g $\pm$ 0.03 dB, (Worst-case extrapolation)



Appendix B: Dipole Validation Data Results

835 CGISS Dipole 002; Test Date:08/14/00

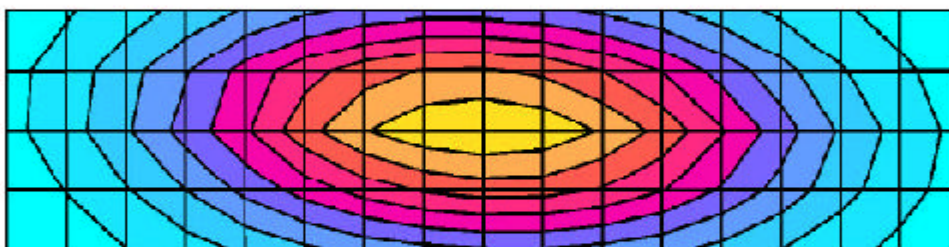
Flat Phantom;

Probe: ET3DV6 - SN1384; ConvF(6.45,6.45,6.45); Crest factor: 1.0; Muscle 835 MHz : $s = 1.08$ mho/m $\epsilon_r = 53.5$ $\rho = 1.07$ g/cm³

Cube 5x5x7: Peak: 7.14 mW/g, SAR (1g): 4.61 mW/g, SAR (10g): 2.99 mW/g, (Worst-case extrapolation)

Penetration depth: 12.3 (11.1, 13.8) [mm]

Powerdrift: -0.00 dB



Appendix C: Measurement Probe Calibration Certificate

Calibration Certificate

Dosimetric E-Field Probe

Type:

ET3DV6

Serial Number:

1384

Place of Calibration:

Zurich

Date of Calibration:

June 1, 2000

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:

Heinz Klotz

Approved by:

Thomas Schmid

Schmid & Partner Engineering AG

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

Certificate

Numerical Assessment of Conversion Factor for Dosimetric E-Field Probe

Type:

ET3DV6

Serial Number:

1384

Place of Assessment:

Zurich

Date of Assessment:

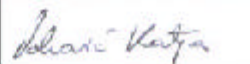
June 2, 2000

Probe Calibration Due Date:

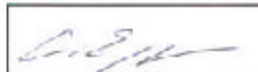
June 1, 2001

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The calibration 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 recalibration schedule of the probe.

Performed by:



Approved by:



Dosimetric E-Field Probe ET3DV6 SN:1384

Conversion factor ($\pm$ standard deviation)

450 MHz	ConvF	7.14 $\pm$ 8%	$\epsilon_r = 47.0$ $\sigma = 0.63$ mho/m (brain tissue)
835 MHz	ConvF	6.50 $\pm$ 8%	$\epsilon_r = 44.0$ $\sigma = 0.90$ mho/m (brain tissue)
925 MHz	ConvF	6.33 $\pm$ 8%	$\epsilon_r = 44.0$ $\sigma = 0.93$ mho/m (brain tissue)
1500 MHz	ConvF	6.00 $\pm$ 8%	$\epsilon_r = 41.1$ $\sigma = 1.00$ mho/m (brain tissue)
1900 MHz	ConvF	5.46 $\pm$ 8%	$\epsilon_r = 39.9$ $\sigma = 1.42$ mho/m (brain tissue)
150 MHz	ConvF	8.46 $\pm$ 8%	$\epsilon_r = 70.00$ $\sigma = 0.75$ mho/m (muscle tissue)
450 MHz	ConvF	7.12 $\pm$ 8%	$\epsilon_r = 58.0$ $\sigma = 1.00$ mho/m (muscle tissue)
835 MHz	ConvF	6.45 $\pm$ 8%	$\epsilon_r = 52.0$ $\sigma = 1.10$ mho/m (muscle tissue)
925 MHz	ConvF	6.31 $\pm$ 8%	$\epsilon_r = 52.0$ $\sigma = 1.20$ mho/m (muscle tissue)
1500 MHz	ConvF	6.18 $\pm$ 8%	$\epsilon_r = 41.2$ $\sigma = 1.48$ mho/m (muscle tissue)
1920 MHz	ConvF	5.20 $\pm$ 8%	$\epsilon_r = 51.5$ $\sigma = 1.95$ mho/m (muscle tissue)