



Certificate Number 1449-02



MOTOROLA

**ELECTROMAGNETIC EXPOSURE (EME)
TESTING LABORATORY**

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Fort-Lauderdale, Florida

S.A.R. TEST REPORT
FCC ID: AZ489FT4844
JMUE1021A

April 06, 2001

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REVISION HISTORY

Date	Revision	Comments
05 April 2001	O	Original release
06 April 2001	A	Body-worn accessory kit number correction in section 3.0

1.0 Introduction

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 Portable Radio Product, model number JMUE1021A (FCC ID: AZ489FT4844).

2.0 Reference Standards and Guidelines

This product is designed to comply with the following national and international standards and guidelines.

- 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
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998
- 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
- Australian Communications Authority Radiocommunications (Electromagnetic Radiation - Human Exposure) Standard 1999 (applicable to wireless phones only)

3.0 Description of Test Sample



JMUE1021A with
NAE6483A 16cm
antenna.



JMUE1021A with
PMAE4003A 9cm
antenna.

The FM Portable Radio, Model number JMUE1021A operates in 403-470 MHz band with a rated conducted power of 4W. This radio is marketed as a handheld transceiver capable of operating as a traditional two-way (Push-To-Talk) radio with optional antennas, batteries and accessories, listed below. (Refer to appendix D for a complete illustration of Body-worn accessories.)

Antenna:

- PMAE4002A ¼ wave 9cm helical, non-retractable, freq. range 403-433MHz, gain -6.0 to -3.0 dBi
- PMAE4003A ¼ wave 9cm helical, non-retractable, freq. range 430-480MHz, gain -6.0 to -3.0 dBi
- NAE6483A ¼ wave 16cm whip, non-retractable, freq. range 403-520MHz, gain -3.0 to -1.0 dBi

Battery:

- JMNN4024A AFAT Li-ion ultra high capacity
- JMNN4023A AA Li-ion high capacity

Body-worn accessories:

- JMZN4019A Soft leather case with swivel belt clip
- PMLN4421B Soft leather case with swivel belt clip
- JMZN4023A Plastic carry holder with swivel belt clip

Audio: (these are representative samples of available audio accessories.)

- JMMN4067A Yaesu Remote Speaker Microphone
- JMMN4062A Ashida 2 piece microphone

3.1 Test Signal:

Test Signal Source:

Test Mode Base Station Simulator Native Transmission Mode

Signal Modulation:

CW	X
TDMA	
Other	

3.2 Test Output Power

The conducted output power was measured across the transmit band using a HP power meter model 437B.

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. The SAR measurements were conducted with the ET3DV6 serial number 1383 probe. It was calibrated at SPEAG™, and has a calibration date Aug. 30,2000. A copy of the calibration certificate is included as appendix C. Dipole Validation Kit type 450MHz (serial number 450-002) was used to validate the system accuracy at 450 MHz. The Dipole validation result is 5.41mW/g when normalized to 1W compared to the target of 5.16mW/g, which is within the required accuracy of ±10% (Dipole SAR Validation Certificate for Dipole S/N 450-002, and thus the measured SAR values are considered correct. See appendix B for print out 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 (cm)	0.15
Face Thickness (cm)	0.15

4.3 Simulated Tissue Properties:

4.3.1 Type of Simulated Tissue:

Muscle	X
Brain	NA

4.3.2 Simulated Tissue Composition

Percentage by weight

	Frequency (450MHz)	
	Muscle	Brain
Di-Water	52.00	NA
Sugar	44.9	NA
Salt	2.00	NA
HEC	1.00	NA
Dowicil75	0.10	NA

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 within $\pm 5\%$ of target parameters prior to actual SAR measurements. This measurement was done 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.

Target tissue parameters for 436MHz

	436MHz	
	Muscle	Brain
Di-electric Constant	58.60	NA
Conductivity – S/m	0.99	NA

5.0 Description of Test Procedure

All antennas, batteries, and audio accessories listed in section 3.0 were included in the SAR search pattern over transmit frequency band to determine the combinations providing the highest measured SAR results.

All SAR measurements were performed with the radio positioned in the described test position and in continuous transmit mode (100% duty cycle).

5.1 Description of Test Positions

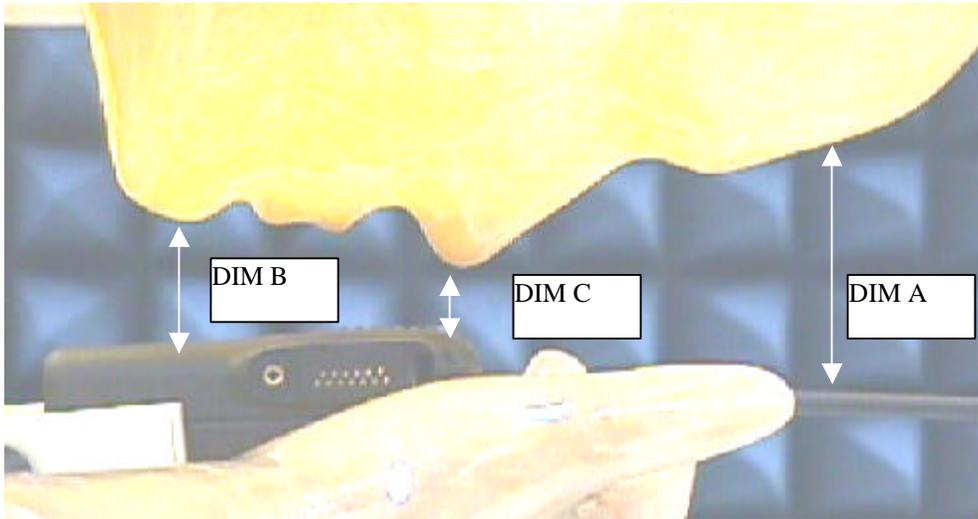
The following describes the test positions used to perform SAR measurements on the portable radio:

Face - The portable radio, 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.

Abdomen - The portable radio is positioned in a carry case and/or belt clip attached beneath the abdomen of the full body phantom with the back of the carry accessory facing and parallel to the abdomen. An interface cable between the radio connector and an audio accessory is connected to the radio to allow two-way radio operation while carried on the user.

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

Figure 1: Facial Position



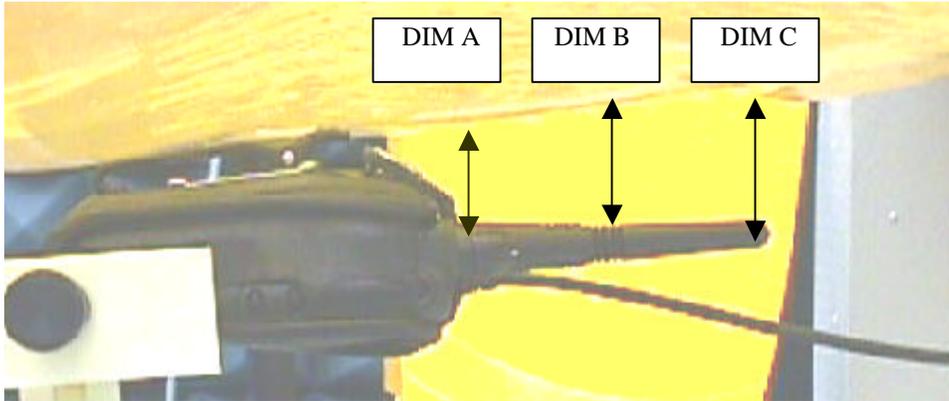
DIM A = Distance from center of phantom's forehead to antenna surface = 52mm

DIM B = Distance between phantom's chin and radio surface = 30mm

DIM C = Closest distance between phantom's nose tip and radio surface = 14mm

Note: Radio is positioned with microphone 2.5cm from mouth.

Figure 2: Abdominal Position



Dim A = Distance from surface of antenna base to phantom surface = 26mm

Dim B= Distance from surface of antenna center to phantom surface = 31mm

Dim C= Distance from antenna surface tip to phantom = 38mm

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 interpolated maximum SAR distribution. After the coarse scan measurement, the probe is automatically moved to a position at the interpolated maximum. The subsequent scan can directly use this position for reference for the cube evaluations.

6.0 Measurement Uncertainty:

The table below list the uncertainty 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

The highest measured and calculated SAR results yielded by the tests described in Section 5.0 are listed in the table below for each body position. The DASY™ measurement system's output files are provided in appendix A.

Transmit Freq. (MHz)	Initial Cond. Power (W)	DB loss from initial power at completion of test	Body position	Highest Measured SAR	Max calculated SAR
469.975	4.60	-1.02	Abdomen	6.40	5.27
436.425	4.30	-1.02	Face	6.06	5.35

The configuration for the abdomen results included the PMAE4003A antenna, JMNN4023A battery, PMLN4421B carry case. The configuration for the face results included the NAE6483A antenna, JMNN4023A battery.

The calculated maximum 1-gram averaged SAR value is determined by scaling up the SAR to adjust for any condition of permissible factory tuning, frequency, voltage and temperature, which is 6.0W in this case. For this reason, the radio Maximum Calculated 1-gram averaged peak SAR becomes:

$$\text{Maximum Calculated 1-gram Average Peak SAR} = \frac{P_{\max}}{P_{\text{end}}} \times (D1 \times D2) \times \text{SAR}_{\text{meas.}}$$

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.

$\text{SAR}_{\text{meas.}}$ = Measured 1 gram averaged peak 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.

$$\begin{array}{l} \text{Maximum} \\ \text{Calculated 1-gram} \\ \text{Average Peak SAR} \\ \text{at the abdomen} \end{array} = \frac{6.00\text{W}}{3.64\text{W}} \times (1 \times 0.5) \times 6.40\text{mW/g} = 5.27\text{mW/g}$$

$$\begin{array}{l} \text{Maximum} \\ \text{Calculated 1-gram} \\ \text{Average Peak SAR} \\ \text{at the face} \end{array} = \frac{6.00\text{W}}{3.40\text{W}} \times (1 \times 0.5) \times 6.06\text{mW/g} = 5.35\text{mW/g}$$

8.0 Conclusion

The highest Operational Maximum Calculated 1-gram average SAR values found for the portable radio model number JMUE1021A was 5.35mW/g. These results are fully compliant to the Occupational /Controlled Exposure limit 8.0mW/g.

Appendix A: Data Results

Minnow Face; Test Date:04/03/01

Run: 01040306, Run Time: 25 min.

Model #: JMUE1021A, SN: 004TBC0200

TX Freq: 436.425 MHz, Antenna Position: Fixed

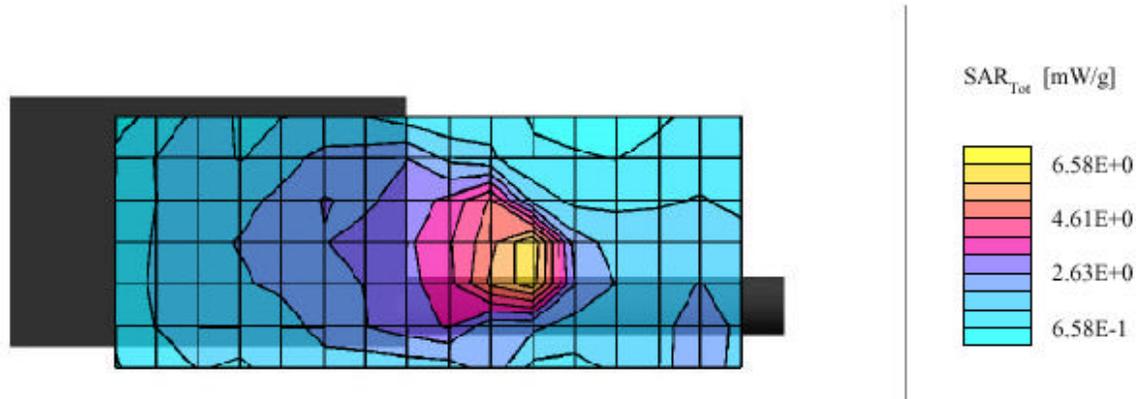
Accessories w/Kit #: Ant: NAE6483A, Battery: JMNN4023A

Full body Phantom; Full Body _Face Section;

Probe: ET3DV6 - SN1383; ConvF(7.12,7.12,7.12);

Crest factor: 1.0; Muscle_436 MHz: $s = 0.95$ mho/m $\epsilon_r = 57.5$ $r = 1.07$ g/cm³

Cube 5x5x7: SAR (1g): 6.06 mW/g, (Worst-case extrapolation)



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Minnow Abdomen Test Date:04/03/01

Run: 01040301, Run Time: 26 min.

Model #: JMUE1021A, SN: 004TBC0200

TX Freq: 469.975 MHz, Antenna Position: Fixed

Accessories w/Kit #: Ant: PMAE4003A, Battery: JMNN4023A, RSM: JMMN4067A,

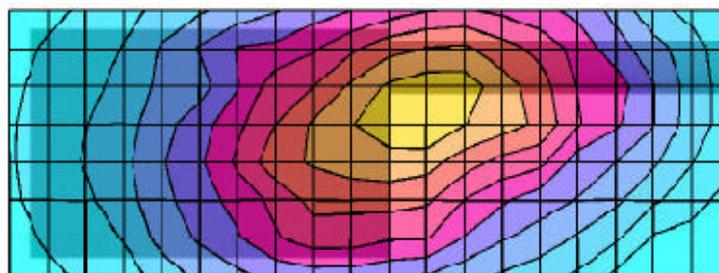
Leather Case: JMZN4421B

Full body Phantom; Full Body_Abdomen Section;

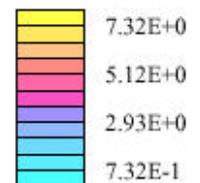
Probe: ET3DV6 - SN1383; ConvF(7.12,7.12,7.12);

Crest factor: 1.0; Muscle_436 MHz: $s = 0.95$ mho/m $\epsilon_r = 57.5$ $\rho = 1.07$ g/cm³

Cube 5x5x7: SAR (1g): 6.40 mW/g, (Worst-case extrapolation)



SAR_{Tot} [mW/g]



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Appendix B: Dipole Validation Data Results

450 CGISS Dipole 002; Test Date: 04/02/01

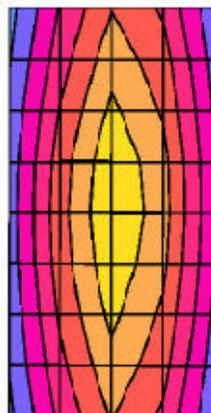
450 MHz Dipole validation. Target SAR @ 1 W = 5.16 mW/g

P. Moller's Flat Phantom (2mm bottom thickness) w/Lid Phantom; Section;

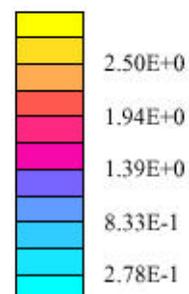
Probe: ET3DV6 - SN1383; ConvF(7.12,7.12,7.12);

Crest factor: 1.0; Muscle_450 MHz: $s = 0.99$ mho/m $\epsilon_r = 56.9$ $r = 1.07$ g/cm³

Cube 5x5x7: SAR (1g): 2.68 mW/g, (Worst-case extrapolation) Drift -0.04



SAR_{Tot} [mW/g]



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Appendix C: Measurement Probe Calibration Certificate

Schmid & Partner Engineering AG

Zughauserstrasse 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:

1383

Place of Calibration:

Zurich

Date of Calibration:

August 30, 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:

Nicolosi Noviana

Approved by:

Alain Kofe

Schmid & Partner Engineering AG

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:

1383

Place of Assessment:

Zurich

Date of Assessment:

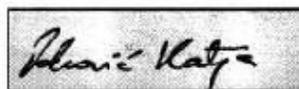
September 20, 2000

Probe Calibration Due Date:

August 30, 2001

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 recalibration 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.

Approved by:



Dosimetric E-Field Probe ET3DV6 SN:1383

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	5.89 \pm 8%	$\epsilon_r = 41.1$ $\sigma = 1.00$ mho/m (brain tissue)
1900 MHz	ConvF	5.36 \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	6.07 \pm 8%	$\epsilon_r = 41.2$ $\sigma = 1.48$ mho/m (muscle tissue)
1920 MHz	ConvF	5.11 \pm 8%	$\epsilon_r = 51.5$ $\sigma = 1.95$ mho/m (muscle tissue)

Appendix D: Illustrations of Body-worn Accessories

Illustration of Body-worn Accessories

The purpose of this appendix is to illustrate the body-worn carry accessories for the FM Portable Radio JMUD1021A.

Photos 1, 2 and 3 illustrate the JMZN4023A plastic carry holder with a swivel belt clip.



Photo 1
Front view



Photo 2
Side view



Photo 3
Rear view

Metallic support

Photos 4, 5 and 6 illustrate the JMZN4421B soft leather carry holder with a swivel belt clip.



Photo 4
Front view



Photo 5
Side view



Photo 6
Rear view

Metallic support

Photos 7, 8 and 9 illustrate the JMZN4019A soft leather carry holder with a swivel belt clip



Photo 7
Front view



Photo 8
Side view

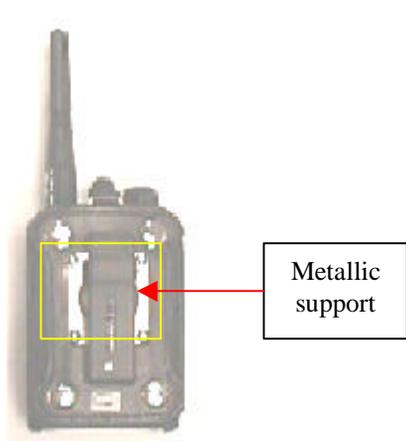


Photo 9
Rear view

Metallic support