

Specific Absorption Rate (SAR) Test Report
 for
Communication Network Interface, Inc.
 on the
TWM3 (Two-Way Messenger) Digital Data Communication Equipment
Model: CNI-930M

Job # J2012657
 Test Report: 20126572
 Date of Report: May 12, 2000



NVLAP Laboratory Code 200201-0
 Accredited for testing to FCC Parts 15

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1 JOB DESCRIPTION

1.1 Client Information

The EUT has been tested at the request of

Company: Communication Network Interface, Inc.

Address: 51-2, Sungsan 1-Dong, Mapo-gu
Seoul, Korea 121-251

Name of contact: Mr. Wonsuk Lee

Telephone: 82-341-706-3704

Fax: 82-341-706-3704

1.2 Equipment under test (EUT)

Product Descriptions:

Equipment	TWM3 (Two-Way Messenger) Digital Data Communication Equipment		
Trade Name	CNI	Model No.	CNI-930M
FCC ID	N79CNI-930M	S/N No.	Not Labeled
Category	Portable	RF Exposure	Uncontrolled Environment
Frequency Band (uplink)		System	

EUT Antenna Description			
Type	Monopole	Configuration	Internal, Fixed
Dimensions	60 mm (L)	Gain	0 dBi
Location	Internal at top		

Use of Product : Data communications

Manufacturer: SAME as above.

Production is planned: [X] Yes, [] No

EUT receive date: 05/08/00

EUT received condition: Good working condition, prototype

Test start date: 05/08/00

Test end date: 05/09/00

1.3 Test plan reference

FCC rule part 2.1093, FCC Docket 96-326 & Supplement C to OET Bulletin 65

1.4 System test configuration

1.4.1 System block diagram & Support equipment

The EUT is a stand alone device.

The diagram shown below details test configuration of the equipment under test .



S: Shielded	U: Unshield	F: With Ferrite Core
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1.4.2 Test Position

The EUT was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in C95.1 (1992) and Supplement C of OET 65 (1998). The EUT was placed in the intended use position, i.e. touching the human body or hand. Please refer to figure 1 below for the position details:

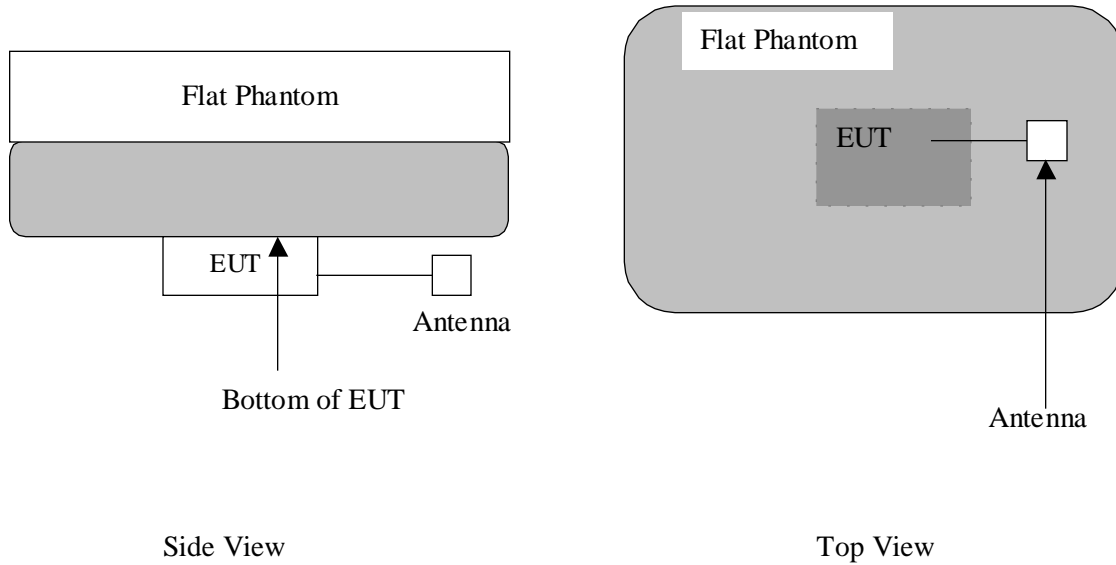


Figure 1: Intended use position

1.4.3 Test Condition

During tests, the worst case data (max. RF coupling) was determined with following conditions:

EUT Antenna	Fixed	Orientation	N/A
Usage	Body-worn and hand-held	Distance between base of EUT and the liquid surface:	2 mm
Simulating human hand	Not Used	EUT Battery	Fully Charged
Power output	2W Conducted		

The spatial peak SAR values were accessed for lowest, middle and highest operating channels defined by the manufacturer. Tests were performed at CW mode (2W conducted). Care was taken to ensure that performance of the EUT power amplifier would not be degrade using CW test mode. A peak radiated field strength test was performed in both CW and pulse (7.8 % duty cycle) modes, and data show that peak power output in both operation modes were the same.

Radiated emission measurement was performed, before and after the SAR tests to ensure that the EUT operated at the highest power level.

1.5 Modifications required for compliance

No modifications were implemented by Intertek Testing Services.

1.6 Additions, deviations and exclusions from standards

No additions, deviations or exclusions have been made from standard.

2 SAR EVALUATION

2.1 SAR Limits

The following FCC limits for SAR apply to devices operate in General Population/Uncontrolled Exposure environment:

EXPOSURE (General Population/Uncontrolled Exposure environment)	SAR (W/kg)
Average over the whole body	0.08
Spatial Peak (1g)	1.60
Spatial Peak for hands, wrists, feet and ankles (10g)	4.00

2.2 Configuration Photographs

Worst-Case SAR measurement



Face Down



Face Up

2.3 System Verification

Prior to the assessment, the system was verified to the $\pm 5\%$ of the specifications by using the system validation kit. The validation was performed at 900 MHz.

Validation kit	Targeted SAR _{1g} (mW/g)	Measured SAR _{1g} (mW/g)
D900V2, S/N #: 013	4.03	3.97

2.4 Evaluation Procedures

The SAR evaluation was performed with the following procedures:

- a. SAR was measured at a fixed location above the reference point and used as a reference value for the assessing the power drop.
- b. The SAR distribution at the exposed side of the flat phantom was measured at a distance of 2.0 mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 20 mm x 20 mm. Based on this data, the area of the maximum absorption was determined by spline interpolation.
- c. Around this point, a volume of 32 mm x 32 mm x 34 mm was assessed by measuring 5 x 5 x 7 points. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure:
 - i) The data at the surface were extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measurement point is 1.6 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in Z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.
 - ii) The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were computed using the 3-D spline interpolation algorithm. The 3-D spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y and z directions). The volume was integrated with the trapezoidal algorithm. 1000 points (10 x 10 x 10) were interpolated to calculate the average.
 - iii) All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
- d. Re-measurement of the SAR value at the same location as in step a. above. If the value changed by more than 5 %, the evaluation was repeated.

2.5 Test Results

The results on the following page(s) were obtained when the device was tested in the condition described in this report. Detail measurement data and plots which reveal information about the location of the maximum SAR with respect to the device, are reported in Appendix A.

The maximum spatial peak SAR values average over 1g assessed in “touch” position was 0.472 mW/g for the 7.8% duty cycle (50ms or 64ms off. In actual usage, the average transmission is only 7.8% (please refer to the manufacturer justification in section 8 of this report). In considering the 7.8% duty cycle to the measured SAR data, the unit is in compliance with the requirements of the FCC for body requirements.

The maximum spatial peak SAR values average over 10g assessed in “touch” position was 0.288 mW/g for 7.8 % duty cycle. The unit is in compliance with the requirements of the FCC for hands and feet requirements.

Trade Name:	CNI	Model No.:	CNI-930M
Serial No.:	Unit # 1	Test Engineer:	XM Yang

TEST CONDITIONS			
Ambient Temperature	23.8 °C	Relative Humidity	48 %
Test Signal Source	Test Mode	Signal Modulation	7.8 % Unmodulated
Output Power Before SAR Test	2.0 W	Output Power After SAR Test	2.0 W
Test Duration	25 Min.	Number of Battery Change	Every Scan

Usage (Touch position)						
Plots Number	Channel (MHz)	Operating Mode	Position	Antenna	Measured SAR _{1g} (mW/g)	Measured SAR _{10g} (mW/g)
1	896	7.8 % Unmodulated	Face up	Extended	0.308	0.159
2	896	7.8 % Unmodulated	Face up	Retracted	0.194	0.0964
3	901	7.8 % Unmodulated	Face up	Extended	0.360	0.148
4	901	7.8 % Unmodulated	Face up	Retracted	0.190	0.0682
5	896	7.8 % Unmodulated	Face down	Extended	0.472	0.288
6	896	7.8 % Unmodulated	Face down	Retracted	0.353	0.137
7	901	7.8 % Unmodulated	Face down	Extended	0.451	0.275
8	901	7.8 % Unmodulated	Face down	Retracted	0.324	0.119

Note: a) Worst case data were reported
b) Duty cycle factor included in the measured SAR data
c) Uncertainty of the system is not included
d) Transmission duty cycle not included.

3 TEST EQUIPMENT

3.1 Equipment List

The Specific Absorption Rate (SAR) tests were performed with the SPEAG model DASY 3 automated near-field scanning system which is package optimized for dosimetric evaluation of mobile radios [3]. The following major equipment/components were used for the SAR evaluations:

SAR Measurement System			
EQUIPMENT	SPECIFICATIONS	S/N #	CAL. DATE
Robot	Stäubi RX60L Repeatability: ± 0.025 mm Accuracy: 0.806×10^{-3} degree Number of Axes: 6	597412-01	N/A
E-Field Probe	ET3DV5 Frequency Range: 10 MHz to 6 GHz Linearity: ± 0.2 dB Directivity: ± 0.1 dB in brain tissue	1333	03/18/99
Data Acquisition	DAE3 Measurement Range: $1\mu\text{V}$ to $>200\text{mV}$ Input offset Voltage: $< 1\mu\text{V}$ (with auto zero) Input Resistance: 200 M	317	N/A
Phantom	Generic Twin V3.0 Type: Generic Twin, Homogenous Shell Material: Fiberglass Thickness: 2 ± 0.1 mm Capacity: 20 liter Ear spacer: 4 mm (between EUT ear piece and tissue simulating liquid)	N/A	N/A
Simulated Tissue	Mixture Please see section 3.2 for details	N/A	11/01/99
Power Meter	HP 435A w/ 8481H sensor Frequency Range: 100kHz to 18 GHz Power Range: $300\mu\text{W}$ to 3W	1312A01255	02/16/00

3.2 Muscle Tissue Simulating Liquid

Ingredient	Frequency (800 - 850 MHz)
Water	54.05 %
Sugar	45.05 %
Salt	0.1 %
Bactericide	0.8 %

The dielectric parameters were verified prior to assessment using the HP 85070A dielectric probe kit and the HP 8753C network Analyzer. The dielectric parameters were:

Frequency (MHZ)	ϵ^*	σ^* (mho/m)	ρ^{**} (kg/m ³)
815	56.5 ± 5%	0.94 ± 10%	1000

* worst case uncertainty of the HP 85070A dielectric probe kit

** worst case assumption

3.3 E-Field Probe Calibration

Probes were calibrated by the manufacturer in the TEM cell ifi 110. To ensure consistency, a strict protocol was followed. The conversion factor (ConF) between this calibration and the measurement in the tissue simulation solution was performed by comparison with temperature measurement and computer simulations. Probe calibration factors are included in Appendix C.

3.4 Measurement Uncertainty

The uncertainty budget has been determined for the DASY3 measurement system according to the NIS81 [5] and the NIST 1297 [6] documents and is given in the following table. The extended uncertainty (K=2) was assessed to be 23.5 %

UNCERTAINTY BUDGET				
Uncertainty Description	Error	Distrib.	Weight	Std.Dev.
Probe Uncertainty				
Axial isotropy	±0.2 dB	U-shape	0.5	±2.4 %
Spherical isotropy	±0.4 dB	U-shape	0.5	±4.8 %
Isotropy from gradient	±0.5 dB	U-shape	0	
Spatial resolution	±0.5 %	Normal	1	±0.5 %
Linearity error	±0.2 dB	Rectang.	1	±2.7 %
Calibration error	±3.3 %	Normal	1	±3.3 %
SAR Evaluation Uncertainty				
Data acquisition error	±1 %	Rectang.	1	±0.6 %
ELF and RF disturbances	±0.25 %	Normal	1	±0.25 %
Conductivity assessment	±10 %	Rectang.	1	±5.8 %
Spatial Peak SAR Evaluation Uncertainty				
Extrapol boundary effect	±3 %	Normal	1	±3 %
Probe positioning error	±0.1 mm	Normal	1	±1 %
Integrat. And cube orient	±3 %	Normal	1	±3 %
Cube shape inaccuracies	±2 %	Rectang.	1	±1.2 %
Device positioning	±6 %	Normal	1	±6 %
Combined Uncertainties				±11.7 %

3.5 Measurement Tractability

All measurements described in this report are traceable to National Institute of Standards and Technology (NIST) standards or appropriate national standards.

4 WARNING LABEL INFORMATION - USA

Not Applicable

5 REFERENCES

- [1] ANSI, *ANSI/IEEE C95.1-1991: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300 Ghz*, The Institute of electrical and Electronics Engineers, Inc., New York, NY 10017, 1992
- [2] Federal Communications Commission, “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields”, OET Bulletin 65, FCC, Washington, D.C. 20554, 1997
- [3] Thomas Schmid, Oliver Egger, and Niels Kuster, “Automated E-field scanning system for dosimetric assessments”, *IEEE Transaction on Microwave Theory and Techniques*, vol. 44, pp. 105-113, Jan. 1996.
- [4] Niels Kuster, Ralph Kastle, and Thomas Schmid, “Dosimetic evaluation of mobile communications equipment with know precision”, *IEICE Transactions on Communications*, vol. E80-B, no. 5, pp.645-652, May 1997.
- [5] NIS81, NAMAS, “The treatment of uncertainty in EMC measurement”, Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddinton, Middlesex, England, 1994.
- [6] Barry N. Taylor and Chris E. Kuyatt, “Guidelines for evaluating and expressing the uncertainty of NIST measurement results”, Tech. Rep., National Institute of Standards and Technology, 1994.

