June 17, 2002

RESPONSES TO FCC QUESTIONS ON THE SAR COMPLIANCE TESTING OF CISCO MODEL AIR-CB20A-A-K9 (FCC ID# LDK102044) PC CARD INSERTED INTO A LAPTOP COMPUTER

1. Discussion of how the EUT was operated/controlled during the test to assure the testing of all appropriate modes, maximum power, and any duty factor driven parameters, per Supplement C Appendix B part I 2. If possible, provide post test power data to confirm that the EUT was operating at full power throughout the test.

Response:

Cisco supplied a DOS-based test utility that allowed the transmitter to be keyed up in a continuous transmit mode (100% duty cycle) at all data rates and at all available power levels. The test utility commands provided for SAR testing enabled the transmitter to operate at the highest data rate (54 Mbps) and at the highest power level of 13.2 dBm or 20.9 mW.

2. Please submit pictures of device modeling geometry, per Supplement C, Appendix B III 6 b.

Response:

The geometry used to simulate the PC card shown in Fig. 3 of the SAR Report using the FDTD method is sketched in Fig. a attached here. Because of the very small FDTD cells of dimensions 0.4 × 0.4 × 0.4 mm, most of the modeled dimensions are within a fraction of a millimeter relative to the dimensions of the PC card.

As previously stated in the SAR test report Section III, the radiation characteristics of the FDTD-modeled PC card are nearly identical to the measured values. The calculated gain for the midband frequency of 5.25 GHz is 5.8 dBi as compared to the manufacturer measured gain of 5.6-5.7 dBi (less than 3% difference).

3. Measurement of device transmit power "before and after" the SAR test to demonstrate that the unit was transmitting at maximum power.

Response:

We used the FCC-recommended channel power spectrum analyzer method. Using the Hewlett Packard Model HP8592B Spectrum Analyzer, the power before and after making the SAR measurements was found to be within 0.5 dB. The fact that output power is controlled by a power feedback loop helped to maintain power variation at relatively constant levels.

4. Submit system verification data taken within 100 MHz of the test frequency, per Supplement C Appendix D.

Response:

Supplement C, Appendix D does not spell out the procedure to use e.g. for tissue separation etc. for system verification and electric field calibration for frequencies above 3000 MHz. However, the draft standard P1528 [a] does suggest a recommended procedure for probe calibration (see Section 4.4.1 of [a]) for frequencies above 800 MHz where waveguide size is manageable. Calibration using a rectangular waveguide is recommended. As stated in Section V of the SAR report, we have used a rectangular waveguide WR159 (of internal dimensions 1.590 ×

0.795 inches) filled with the tissue-simulant solution of composition given in Section IV of the SAR report. As stated in the SAR test report, the measured dielectric properties of this fluid at a midband frequency of 5.30 GHz are $\varepsilon_r = 48.5 \pm 1.7$ and $\sigma = 5.4 \pm 0.08$ S/m.

As suggested in the Draft Standard P1526, this waveguide (WR159) filled with the tissue-simulant fluid was maintained vertically. From microwave field theory, the transverse field distribution in the liquid corresponds to the fundamental mode (TE_{10}) with an exponential decay in the vertical direction (z-axis). The liquid level was 15 cm deep which is deep enough to guarantee that reflections from the top liquid surface do not affect the calibration. By comparing the square of the decaying electric fields expected in the tissue from the analytical expressions for the TE_{10} mode of the rectangular waveguide, we obtained a calibration factor of 2.98 (mW/kg)/μv with a variability of less than ±2% for measurement frequencies of 5.15, 5.25, and 5.35 GHz, respectively.

5. Z-axis scan plots taken at the highest SAR location for each test.

Response:

The measured variations of SAR vs. depth into the liquid at the peak SAR locations from Tables 1-3 (Above-lap position) are plotted in Fig. b, while those from Tables 4-6 (End-on position) are plotted in Fig. c. Both Figs. b and c are attached here.

6. Description of the probe used for testing including a physical description, additional calibration information and measurement errors, per Supplement C, Appendix B, part II 2.

Response:

As described in Section V of the SAR Test Report, we have used the Narda Model 8021 Miniature Broadband Electric Field Probe of tip diameter 4 mm (internal dipole dimensions on the order of 2.5 mm). This triaxial (3 dipole) E-field probe was originally developed by Howard Bassen and colleagues of FDA [b, c] and has been manufactured under license by Narda Microwave Corporation, Hauppage, New York. The probe is described in detail in references b, c. It uses three orthogonal pick up dipoles each of length about 2.5 mm with their own leadless zero voltage Schottky barrier diodes operating in the square law region. The sum of the three diode outputs read by three microvoltmeters [described in Ref. 15 of the SAR Test Report] gives an output proportional to E^2.

As given in response to Question 4, for a probe calibration factor of 2.98 (mW/kg)/μv, the probe measurement error is on the order of ±4%.

The data for calibration of the E-field probe closest to the SAR tests given in this report was May 23, 2002.

7. A description of how the SAR measurements are actually performed once setup: include coarse scan, determination of peak SAR location, scans to measure points in 1 gram volume, and procedure to determine SAR value from the measurement points. Per Supplement C, Appendix B, part II 7 and 8.

Response:

The procedure used for SAR measurements is described in Section VI of the SAR Test Report. For each of the measurement frequencies 5.18, 5.26, and 5.32 GHz, the highest SAR region was identified in the first instance by using a coarser sampling with a step size of 8.0 mm over three overlapping areas for a total scan area of 8.0 × 9.6 cm at a time. The area immediately under the PC card for "Above-lap" position and above the end of the PC card for the "End-on" position was found to be the area with the highest SARs. After identifying the region of the very highest SAR (generally one or two points of the coarse grid), this region was measured with a resolution of 2 mm in order to obtain peak 1 cm^3 or 1 g SAR. The SAR measurements were performed at 4, 6, 8, 10, and 12 mm height from the body-simulant fluid. The SARs thus measured were extrapolated using a second-order least-square fit to the measured data to obtain values at 1, 3, 5, 7, and 9 mm height and used to obtain 1-g SARs. The SAR values thus determined with a step size of 2 mm are given in Tables 1-6 of the SAR Test Report. The 1-g SAR value is determined by taking the average SAR for a grid size of 5 × 5 × 5 = 125 points covering a volume of 1 cm^3.

8. All measured SAR plots if available. Please include all data required by Supplement C.

Response:

As explained in response to question 7, the data for the highest SAR region for each of the placements of the PC card is measured with a stepper-motor-controlled step size of 2 mm. The extrapolated SARs with 2 mm resolution for xy planes at heights z of 1, 3, 5, 7 and 9 mm for each of the placements of the PC card relative to the flat phantom are given in Tables 1 to 6 of the SAR Test Report. The individual SAR values for this grid of 5 × 5 × 5 or 125 points are averaged to obtain the peak 1-g SAR values (for a volume of 1 cm^3) and are given in Table 7 of the SAR Test Report.

A format for presenting the SAR data is given on p. 40 of Supplement C. Unfortunately, this format is pertinent to SAR tests of a hand-held cellular telephone. Table 7 of the SAR Test Report gives all of the needed peak 1-g SARs for three measurement frequencies for two required placements of the PC relative to the flat phantom.

For the Cisco PC Card Model AIR-CB20A-A-K9, the peak 1-g SAR is on the order of 0.064 to 0.127 W/kg which is over a factor of 12 times smaller than the FCC limit of 1.6 W/kg.

References

a. IEEEs Draft Standard P1528, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communication Devices: Experimental Techniques," Draft CBD1.0, April 4, 2002 (IEEE Standards Coordinating Committee 34).

b. H. Bassen, M. Swicord, and J. Abita, "A Miniature Broadband Electric Field Probe," Ann. New York Academy of Sciences, Vol. 247, pp. 481-493, 1974.

c. H. Bassen and T. Babij, "Experimental Techniques and Instrumentation," Chapter 7 in *Biological Effects and Medical Applications of Electromagnetic Energy*, O. P. Gandhi, Editor, Prentice Hall Inc., Englewood Cliffs, NJ, 1990.

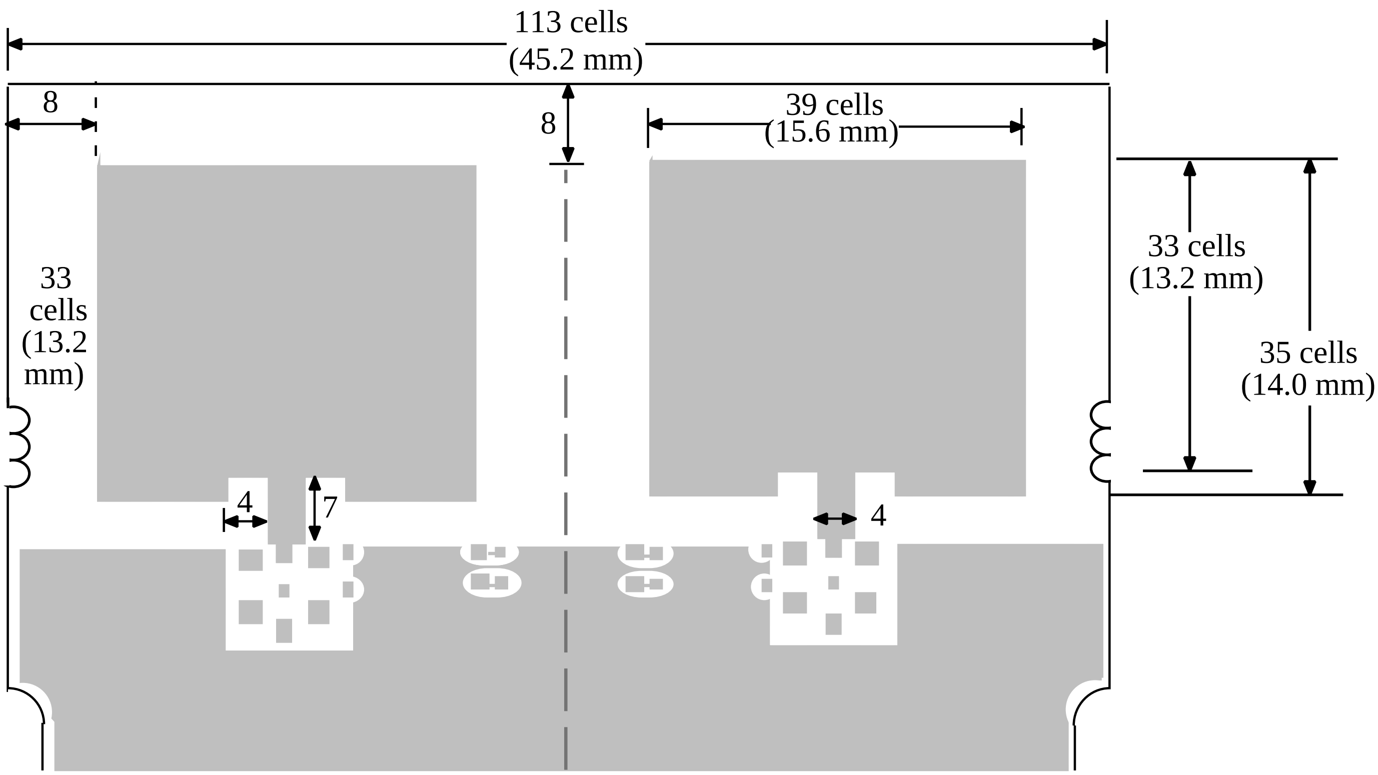

Fig. a. The geometry used to simulate the PC card shown in Fig. 3 of the SAR Report using the FDTD method. Various dimensions are given in terms of number of FDTD cells of size 0.4 × 0.4 × 0.4 mm. Some of the dimensions are also given in mm (in parentheses).

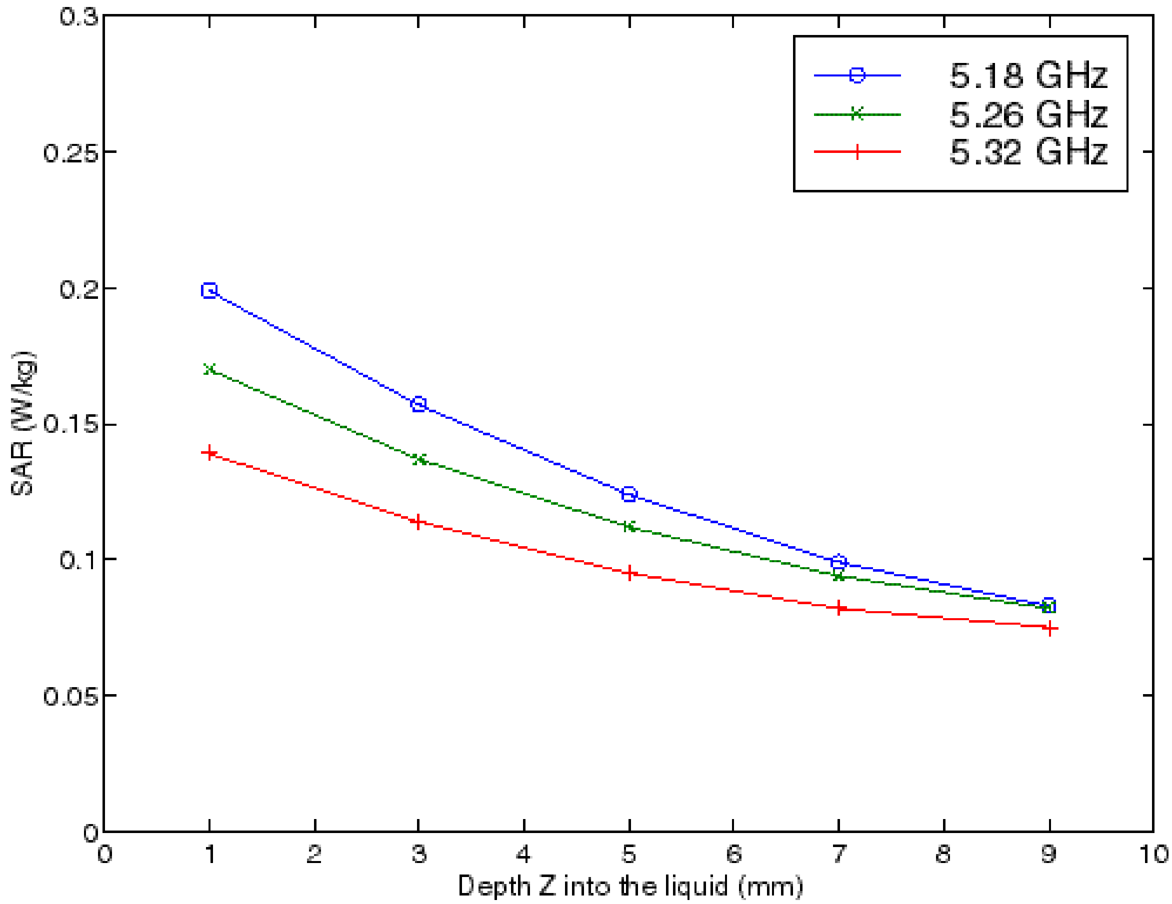

Fig. b. Plot of the SAR variations as a function of depth Z in the liquid for locations of highest SAR from Tables 1-3 (Above-lap position) of the SAR Compliance Test Report.

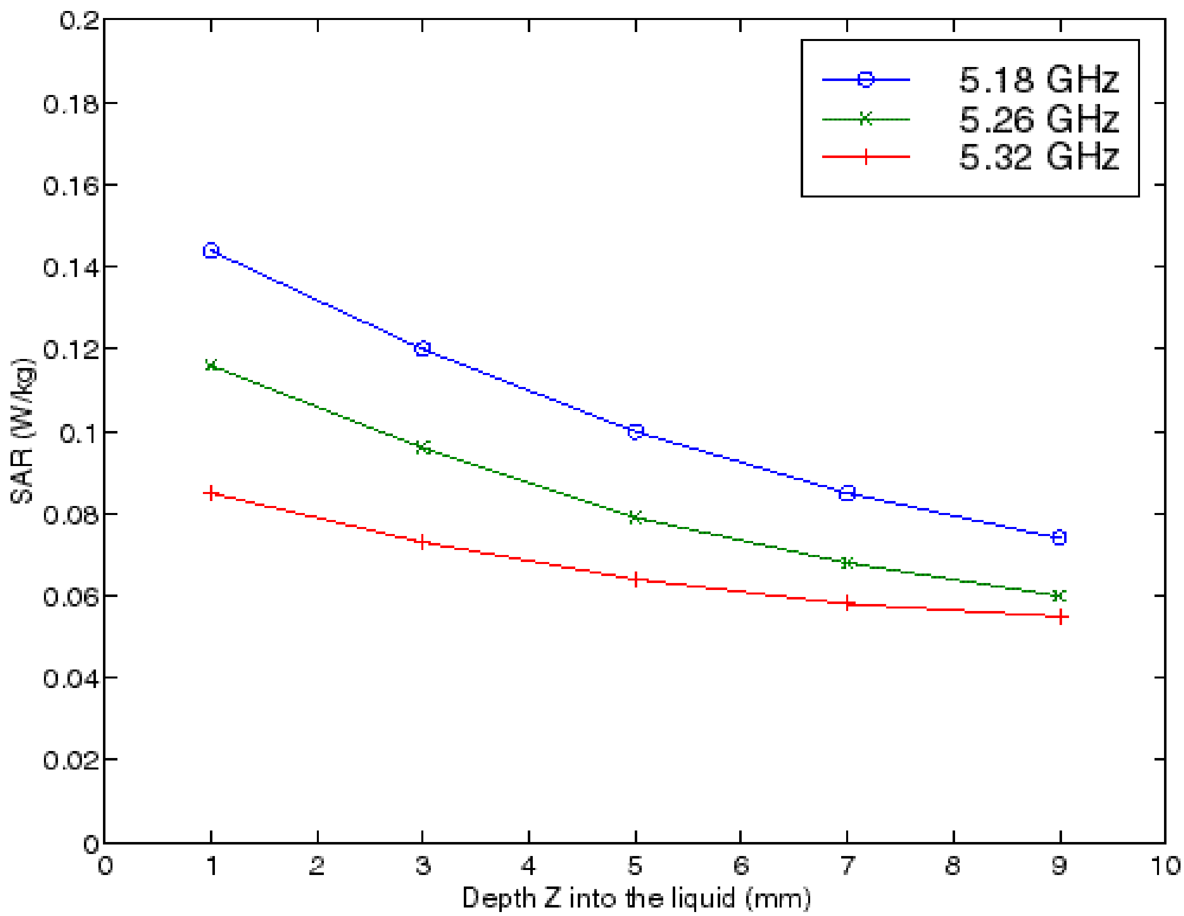

Fig. c. Plot of the SAR variations as a function of depth Z in the liquid for locations of highest SAR from Tables 4-6 (End-on position) of the SAR Compliance Test Report.