

September 16, 2002

**RESPONSES TO QUESTIONS ON THE SAR COMPLIANCE TESTING OF
VOCERA COMMUNICATIONS MODEL B1000 BADGE
(FCC ID# QGC-B1000)**

1. *The SAR report did not provide the calibration data nor pictures of the probe as required by the FCC. Please provide this data and photos of the probe.*

Response:

The procedure used to calibrate the E-field probe is given in Section III of the previously-submitted SAR Test Report. A photograph of the Narda Model 8021 Broadband Electric Field Probe is included here as Fig. a. As given in Appendix A of the SAR Test Report (p. 238 of the journal article), the isotropy of the E-field probe was determined to be less than ± 0.23 dB and the deviation of the probe from the square law behavior was less than $\pm 3\%$.

As detailed in the SAR Test Report, pp. 4-5, this probe is calibrated using the waveguide procedure suggested in the IEEE Draft Standard [a]. The calibration factor is obtained to be 0.573 (mW/kg)/ μ V with a variability of less than $\pm 2\%$ for measurement frequencies of 2.412, 2.442, and 2.462 GHz (corresponding to Channels 1, 7, and 11), respectively.

2. *The FCC requires that for each set of data measurements, the temperature and power drift be provided. Please provide this data for each set of measurements taken.*

Response:

Because of the temperature control of the laboratory, the temperature of the anechoic chamber containing the SAR test setup was measured to be $25 \pm 1^\circ C$.

The power drift has been measured by Karl Hannestad at Vocera Communications Inc. The maximum conducted power output for Model B1000 Badge using the FCC-recommended channel power spectrum analyzer method for the "pattern test mode" (used for SAR measurements) is 16.1 ± 0.2 dBm over any 60 minute period which is considerably longer than 30 minutes needed for SAR measurements for each of the channels.

3. *The photos of the test setups are not clear. Please provide photos that detail the test in a clear and easily viewed manner.*

Response:

A photograph of the test setup used for SAR measurements is included as Fig. b. Only the flat planar phantom is shown. This photograph compliments Figs. 2 and 3 of the SAR Test Report that were focused only on the respective phantom models to show

the actual mounting of the Vocera Communications Model B1000 relative to the two phantoms. Additional photographs focusing on the phantom model for use for SAR measurements with various accessories are included as Figs. e, f, g, and h, respectively (see also response to question 6).

4. *The FCC has stated that the maximum variation between conducted power in the SAR report and the EMC report can be no more than 0.3 dB and if there is a difference, the highest must be in the SAR report. Please note that the SAR report says the maximum power conducted is 15 dBm while the EMC report says the maximum conducted power is 16.1 dBm. This is an unacceptable variation between the reports. Please retest SAR to show equal or higher conducted power but still within +/- 0.3 dB.*

Response:

This discrepancy has arisen due to the various modes that may be used to send the data. The Vocera Communications Model B1000 Badge may radiate a maximum conducted power up to 16.1 dBm if the "pattern test mode" is used while it would radiate a somewhat lower power of 15 dBm if the "packet transmit mode" is used. With advice from Karl Hannestad of Vocera Communications, we used the "pattern test mode" for all SAR testing. For this 100% duty cycle mode, the maximum conducted power measured by Vocera Communications is 16.1 dBm. The previously-submitted SAR test report should, therefore, be modified to reflect this change. All of the captions of the SAR Tables 3-9 have, therefore, been modified to reflect this change. The modified SAR Tables 3-9 reflecting this change are attached herewith.

Karl Hannestad at Vocera Communications has measured the maximum conducted power output for Model B1000 Badge using the FCC-recommended channel power spectrum analyzer method. The conducted power variation over any 60 minute period was found to be less than ± 0.2 dB. This time span is considerably longer than 30 minutes needed for SAR measurements for each of the channels.

5. *The SAR report does not appear to contain the required verification tests. While similarities between certain types of cell phones may provide gross comparisons and gross verification, they do not provide the accuracy required to verify the SAR system. OET 65 states, "Besides probe calibration, the accuracy of the SAR measurement system should also be verified using calibrated RF signal source(s) within the transmitting frequency band(s) of the test device." Please provide the verification data required by the FCC to be in the SAR report.*

Response:

The automated SAR measurement system developed at the University of Utah is described in reference b which is attached as Appendix A of the SAR Test Report (An electronic copy of Appendix A is attached here again). As given in Appendix A [b] of the SAR Test Report, a half-wave dipole at 1900 MHz ($\lambda/2 = 78.95$ mm) was used for system verification. A dipole at 1900 MHz was used in the absence of a dipole at 2450 MHz. This dipole of length 76.0 mm and diameter 1.5 mm and $h = 39.5$ mm is shown in Fig. c. The measured SAR distributions for variable spacings of 10, 15, 20, and 25 mm of the dipole for a flat phantom and spacings of 5, 15, and 25 mm of the dipole for a sphere phantom are given in Figs. 5 and 7 of Appendix A. Also given in the same figures are the SAR values calculated using the FDTD numerical method. The agreement of the

measured SAR distributions with those obtained numerically using the FDTD method is very good. Taken from Tables IV and V of Appendix A, the difference between measured and calculated peak 1-g SARs are less than ± 5 percent at 1900 MHz.

6. *SAR measurements are also to be made using any and all appropriate accessories. The manual states a number of accessories, however, no SAR evaluation has been done to show the device is compliant with these accessories. Please provide the SAR data to show which accessories have been tested. Please provide the necessary plots of SAR data for these accessories.*

Response:

A photograph of the various accessories used for the Vocera Communications Model B1000 is given as Fig. d. The accessories from left to right are: a pocket clip, a universal clip, a lanyard and the strap for neck mounting, and the holster for waist mounting. Given in Figs. d, e, f, and g are the photographs of the body-simulant planar phantom with Vocera Communications Model B1000 mounted in the aforementioned accessories, respectively, and pressed against the bottom of the phantom to simulate placement against the body for actual use conditions. Given in Table 9 of the previously-submitted SAR Test Report (with corrected caption also attached here) are the peak 1-g SARs for Channels 1, 7, and 11 for the body-simulant phantom. It may be recalled that the SARs for the Vocera Model B-1000 are fairly low due to the fact that the antenna is further away from the body and is fairly well shielded by means of an internal ground plane from coupling to the body. Hence, the peak 1-g SARs in Table 9 are extremely low and only 0.043, 0.037, and 0.035 W/kg for Channels 1, 7, and 11, respectively. For determination of peak 1-g SARs with the four accessories of Fig. c, we, therefore, focused on Channel 1 which had the highest peak 1-g SAR in Table 9. The measured peak 1-g SARs for the highest SAR Channel 1 are given in the new table a attached here. The measured SAR distributions for each of the accessories are given in Tables b-e, respectively.

As seen in Table a, the effect of the metallic springs in the various clips is fairly minimal and the peak 1-g SARs are less than 10-12 percent different than the SAR without any of accessories. The peak 1-g SAR for the Badge mounted in the holster is, however, considerably lower and only about half as much as for the Badge held directly against the body. This is due to an additional spacing of nearly 2.5 cm from the planar phantom (see Fig. h) due to the thickness of the holster.

7. *The calibration of the test equipment used in SAR testing has not been provided. Please provide the calibration dates for all equipment used in SAR measurements.*

Response:

The response to this question has previously been given in response to question 5. The most recent data of calibration of the SAR Test Setup is July 15, 2002.

Additional References

- a. IEEE 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. Q. Yu, O. P. Gandhi, M. Aronsson, and D. Wu, "An Automated SAR Measurement System for Compliance Testing of Personal Wireless Devices," *IEEE Transactions on Electromagnetic Compatibility*, Vol. 41(3), pp. 234-245, August 1999 (attached as Appendix A of the SAR Compliance Test Report as well as here).

Table a. The peak 1-g SARs measured for Channel 1 for the Vocera Communications Badge (conducted power of 16.1 ± 0.2 dBm) for the body-mounted configurations for the various accessories.

1-g SAR in W/kg

Without any accessory	0.043
With the pocket clip (Fig. e)	0.038
With universal clip (Fig. f)	0.041
With lanyard and strap for neck mounting (Fig. g)	0.042
With holster for waist mounting (Fig. h)	0.022

Table b. SARs measured for the pocket clip - Vocera Badge combination pressed against the base of the body-simulant phantom for Channel 1 at 2412 MHz.

1-g SAR = 0.038 W/kg

a. At depth of 1 mm

0.056	0.067	0.061	0.062	0.056
0.065	0.068	0.065	0.063	0.061
0.064	0.067	0.068	0.067	0.061
0.062	0.069	0.069	0.067	0.063
0.059	0.066	0.071	0.069	0.067

b. At depth of 3 mm

0.043	0.050	0.046	0.046	0.043
0.049	0.050	0.049	0.048	0.046
0.048	0.050	0.051	0.050	0.046
0.046	0.051	0.051	0.050	0.047
0.045	0.049	0.052	0.052	0.051

c. At depth of 5 mm

0.032	0.037	0.033	0.033	0.032
0.036	0.035	0.036	0.035	0.033
0.034	0.037	0.037	0.037	0.033
0.034	0.037	0.036	0.036	0.034
0.033	0.036	0.037	0.039	0.039

d. At depth of 7 mm

0.023	0.026	0.023	0.023	0.023
0.025	0.024	0.025	0.025	0.023
0.024	0.026	0.026	0.026	0.023
0.024	0.025	0.025	0.025	0.023
0.024	0.026	0.026	0.028	0.029

e. At depth of 9 mm

0.017	0.018	0.016	0.016	0.017
0.017	0.016	0.017	0.017	0.015
0.016	0.017	0.018	0.018	0.016
0.016	0.017	0.016	0.017	0.016
0.017	0.018	0.018	0.020	0.022

Table c. SARs measured for the universal clip - Vocera Badge combination pressed against the base of the body-simulant phantom for Channel 1 at 2412 MHz.

1-g SAR = 0.041 W/kg

a. At depth of 1 mm

0.065	0.064	0.065	0.064	0.058
0.063	0.068	0.068	0.065	0.061
0.064	0.071	0.071	0.065	0.065
0.063	0.065	0.070	0.068	0.062
0.060	0.063	0.069	0.067	0.062

b. At depth of 3 mm

0.050	0.051	0.050	0.049	0.045
0.049	0.052	0.053	0.051	0.048
0.051	0.054	0.054	0.051	0.050
0.049	0.050	0.053	0.052	0.048
0.047	0.049	0.052	0.051	0.048

c. At depth of 5 mm

0.038	0.039	0.039	0.037	0.034
0.037	0.040	0.040	0.039	0.037
0.039	0.041	0.041	0.039	0.037
0.037	0.037	0.039	0.039	0.037
0.035	0.038	0.039	0.038	0.036

d. At depth of 7 mm

0.028	0.030	0.029	0.028	0.026
0.028	0.030	0.030	0.029	0.027
0.030	0.030	0.030	0.029	0.027
0.028	0.027	0.029	0.028	0.028
0.026	0.029	0.028	0.027	0.027

e. At depth of 9 mm

0.022	0.022	0.023	0.021	0.019
0.021	0.023	0.023	0.022	0.020
0.022	0.022	0.022	0.022	0.020
0.021	0.020	0.021	0.021	0.021
0.020	0.022	0.021	0.020	0.021

Table d. SARs measured for the lanyard and the strap for neck mounting attached to the Vocera Model B1000 Badge for Channel 1 at 2412 MHz.

1-g SAR = 0.042 W/kg

a. At depth of 1 mm

0.065	0.065	0.062	0.057	0.055
0.063	0.063	0.061	0.061	0.058
0.065	0.064	0.061	0.063	0.062
0.059	0.061	0.065	0.065	0.067
0.059	0.063	0.062	0.067	0.068

b. At depth of 3 mm

0.052	0.052	0.050	0.047	0.045
0.051	0.050	0.049	0.049	0.047
0.051	0.051	0.050	0.050	0.049
0.048	0.049	0.052	0.052	0.054
0.047	0.049	0.050	0.053	0.053

c. At depth of 5 mm

0.042	0.041	0.034	0.038	0.037
0.041	0.040	0.039	0.039	0.038
0.040	0.040	0.040	0.039	0.039
0.039	0.039	0.041	0.041	0.042
0.038	0.038	0.040	0.041	0.042

d. At depth of 7 mm

0.034	0.033	0.032	0.032	0.031
0.033	0.032	0.032	0.031	0.031
0.032	0.031	0.032	0.031	0.030
0.031	0.031	0.032	0.033	0.033
0.030	0.029	0.031	0.032	0.032

e. At depth of 9 mm

0.028	0.027	0.026	0.026	0.026
0.027	0.026	0.026	0.026	0.025
0.026	0.025	0.026	0.025	0.024
0.025	0.025	0.026	0.027	0.026
0.024	0.022	0.024	0.025	0.025

Table e. SARs measured for the Model B1000 Badge mounted in a holster for Channel 1 at 2412 MHz. The holster with the clip side pressed against the base of the body-simulant phantom is used for SAR measurements.

1-g SAR = 0.022 W/kg

a. At depth of 1 mm

0.032	0.034	0.032	0.030	0.027
0.031	0.030	0.030	0.032	0.025
0.030	0.031	0.029	0.030	0.027
0.029	0.032	0.029	0.032	0.031
0.028	0.028	0.030	0.030	0.032

b. At depth of 3 mm

0.027	0.028	0.027	0.026	0.024
0.026	0.025	0.026	0.026	0.022
0.025	0.026	0.025	0.025	0.022
0.025	0.025	0.025	0.027	0.026
0.024	0.024	0.026	0.025	0.028

c. At depth of 5 mm

0.023	0.023	0.023	0.023	0.021
0.022	0.021	0.022	0.021	0.020
0.022	0.022	0.022	0.021	0.019
0.021	0.020	0.021	0.022	0.021
0.020	0.021	0.022	0.022	0.025

d. At depth of 7 mm

0.020	0.019	0.020	0.020	0.019
0.019	0.018	0.019	0.017	0.017
0.019	0.019	0.019	0.018	0.016
0.018	0.016	0.017	0.019	0.017
0.017	0.018	0.018	0.019	0.022

e. At depth of 9 mm

0.018	0.017	0.017	0.018	0.017
0.016	0.015	0.017	0.015	0.015
0.016	0.016	0.016	0.015	0.014
0.015	0.013	0.014	0.016	0.014
0.014	0.015	0.016	0.016	0.019



Fig. a. Photograph of the Narda Model 8021 Broadband Electric Field Probe used for SAR measurements.

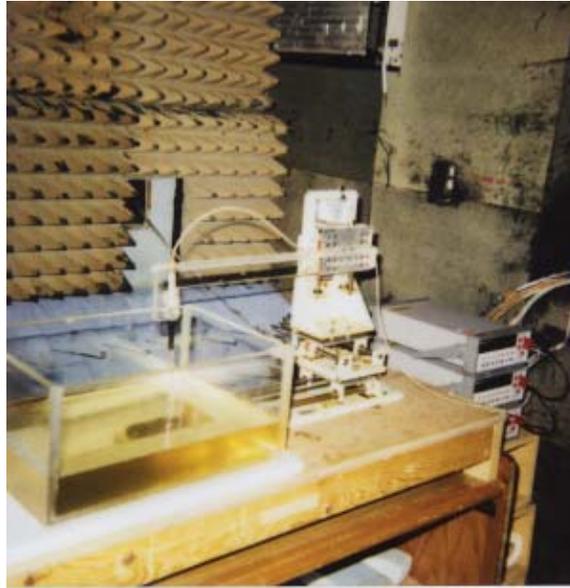


Fig. b. Photograph of the three-dimensional stepper-motor-controlled SAR measurement system using a planar phantom (for a detailed examination of the placement of Vocera Communications Badge relative to this phantom, see Fig. 2 of the SAR test report).



Fig. c. Photograph of the half-wave dipole at 1900 MHz used for system verification.



Fig. d. Photograph of the various accessories used for the Vocera Communications Model B1000. Accessories from left to right are: a pocket clip, a universal clip (with the Badge mounted as for actual use, a lanyard and the strap for neck mounting, and the holster for waist mounting.

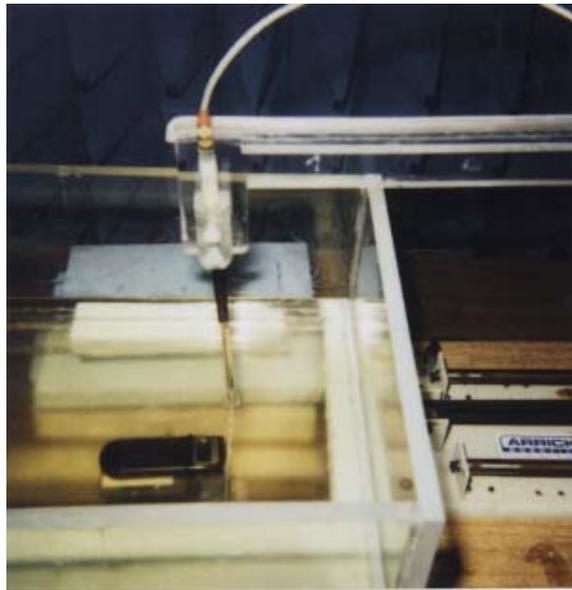


Fig. e. Photograph of the pocket clip mounted on the Model B1000 Badge. Picture shows the entire combination with the clip band pressed against the base of the body-simulant phantom.

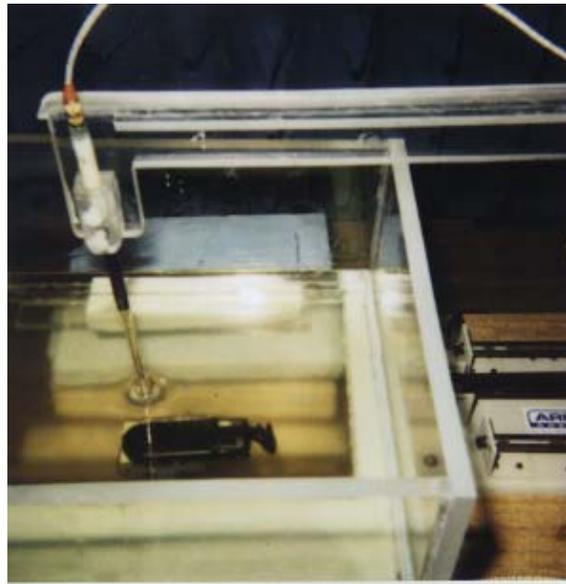


Fig. f. Photograph of the universal clip mounted on the Model B1000 Badge. Picture shows the entire combination pressed against the base of the body-simulant phantom.

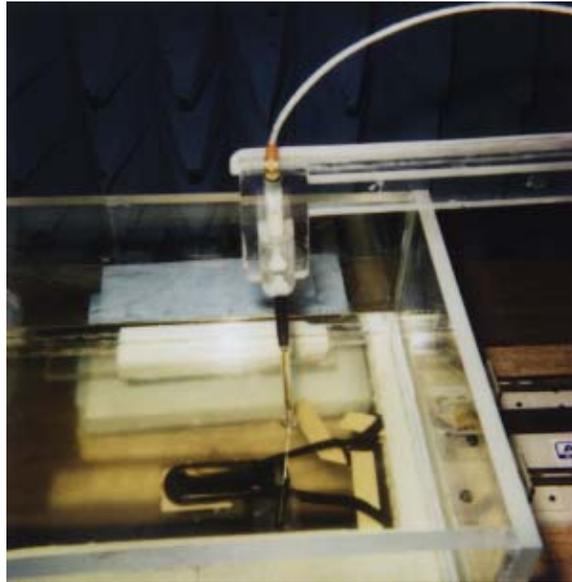


Fig. g. Photograph of the lanyard and the strap for neck mounting attached to the Model B1000 Badge. The entire combination is pressed against the base of the body-simulant phantom for SAR measurements.

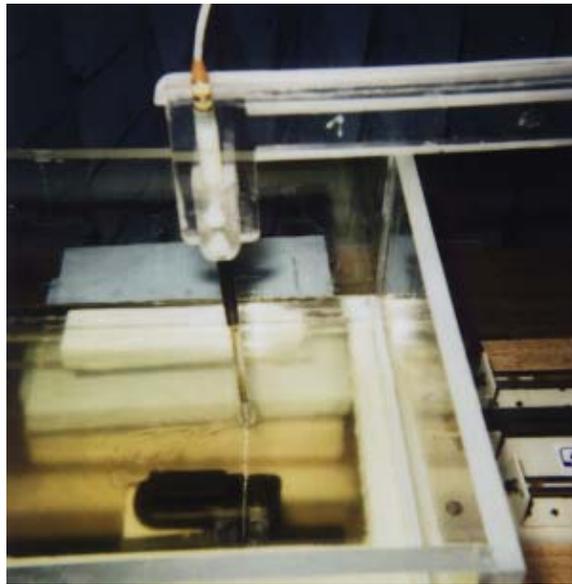


Fig. h. Photograph of the holster containing the Model B1000 Badge. The holster with the clip side pressed against the base of the body-simulant phantom is used for SAR measurements.