Calculating the Currents Induced on Wires Attached to Opposite Sides of a Thin Plate

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Geometry:

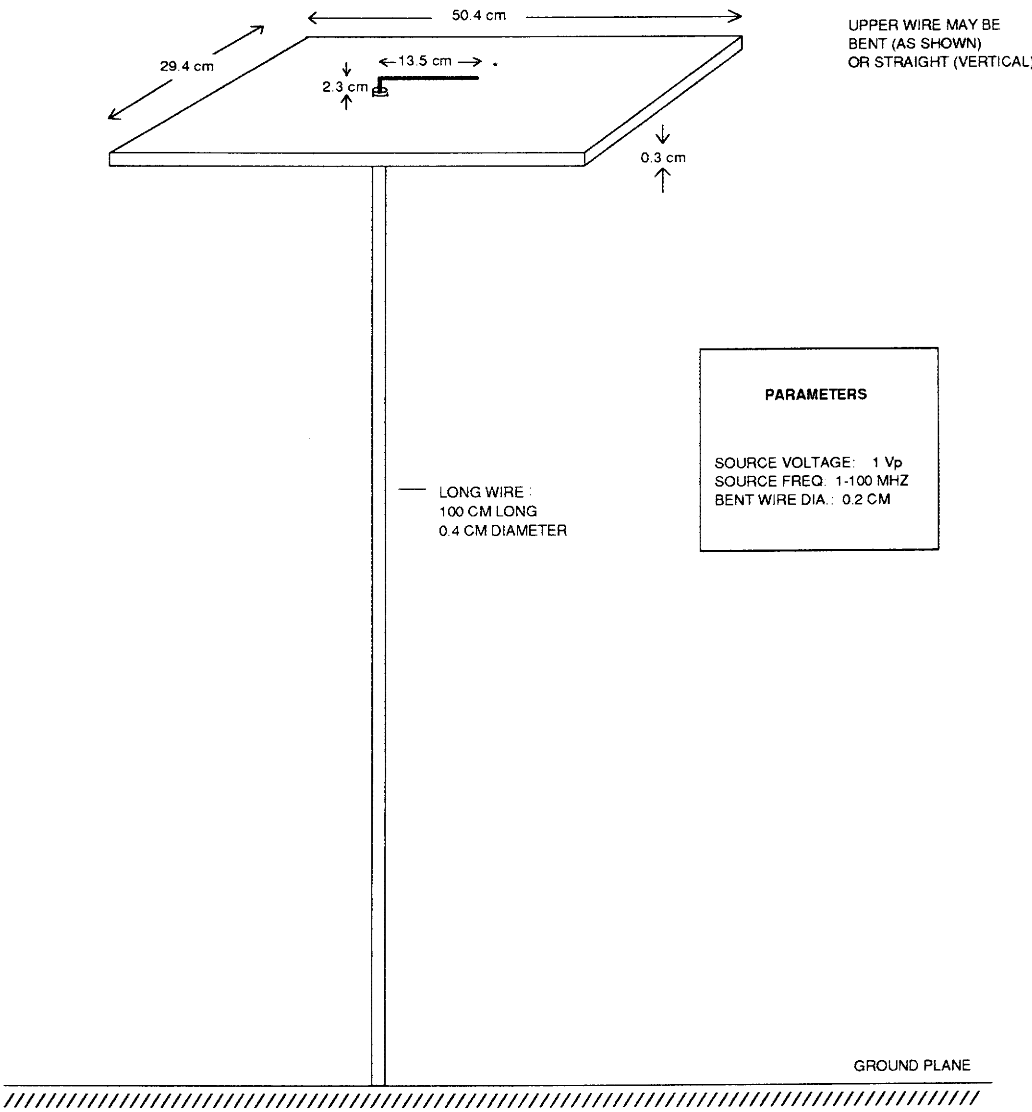

Figure 1: Thin Plate with Two Wire Attachments Over a Ground Plane

Problem Description

This configuration represents a class of electromagnetic radiation modeling problems that arise when attempting to predict the level of electromagnetic interference from table-top computing devices [1]. The method used to analyze this configuration must be able to model electrically small, thin plates with wires attached to opposite sides of the plate. The amplitude of the current at the base of the long wire is the parameter that must be calculated. This parameter was chosen because it is relatively easy to measure and because there is a high degree of correlation between this current and the radiated field strength.

Measurements

A model of this configuration was built and measured in a semi-anechoic chamber. The test set-up is illustrated in Figure 2.

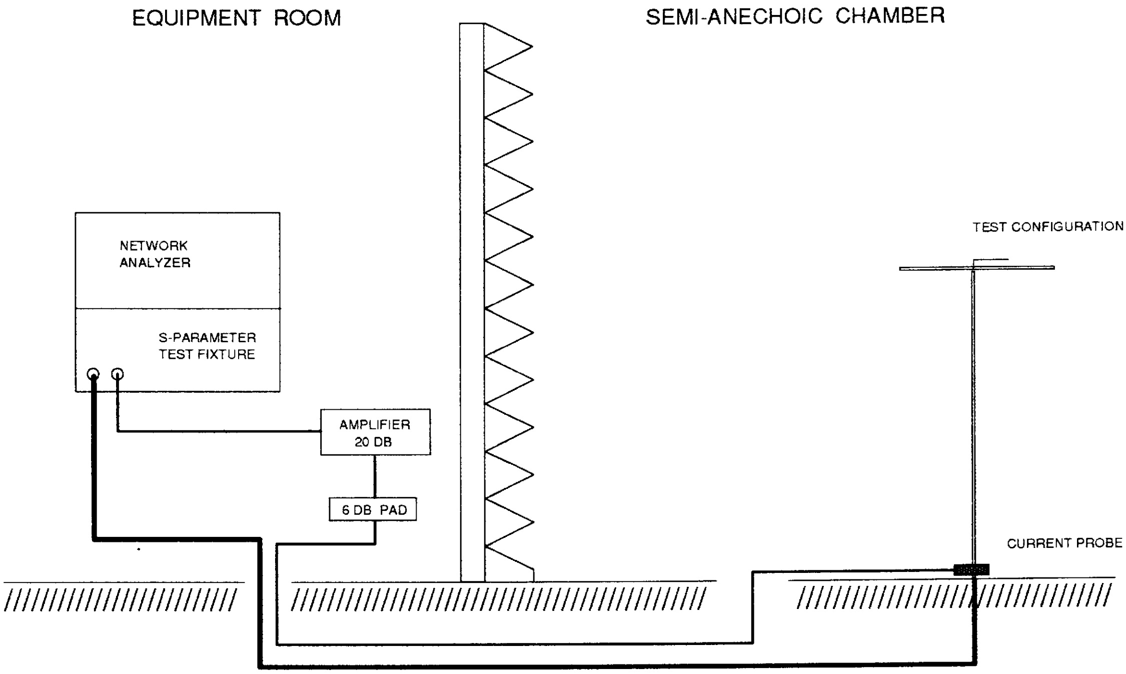

Figure 2: Apparatus Used to Test the Thin-Plate Geometry

A network analyzer with an S-parameter test fixture was used to measure the ratio between the measured current and the source voltage at frequencies between 1 MHz and 100 MHz. The signal was carried from the network analyzer to the metal plate through a 50-ohm coaxial cable. The cable shield was bonded to the metal plate using a panel-mount BNC connector. A metal rod was soldered to the center lead of the BNC connector on the top side of the plate. The external surface of the coaxial cable served as the lower wire attachment.

Measurements of the transfer ratio, S_{12}, were converted to a current measurement and normalized to a 1 volt source potential. The results for both a bent upper wire (as illustrated in Figure 1) and a straight upper wire are plotted in Figure 3.

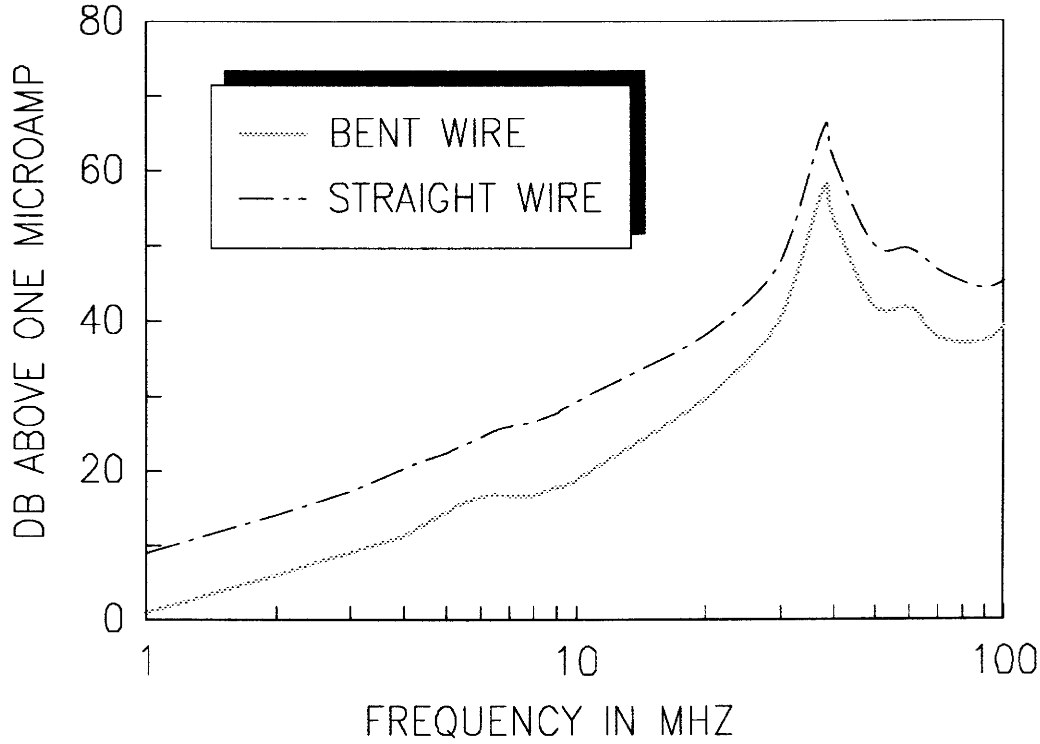

Figure 3: Normalized Current Measured with the Upper Wire Both Bent and Straight

Wire-Grid Model

Surface patch moment-method models reviewed by the author were unable to model this configuration accurately. However, a relatively sparse wire-grid model provided reasonably accurate results given the simplicity of the model. The wire-grid analysis was done using the Numerical Electromagnetics Code [2]. The wire-grid model is illustrated in Figure 4. It uses 268 segments to form a two-layer, closed surface model of the plate and 31 additional segments to model the upper and lower wires. The results are plotted in Figures 5 and 6. The effect of bending the upper wire is calculated with reasonable accuracy using this model. Single-layer wire-grid models and surface patch models evaluated by the author were not able to model this configuration.

Although this model is accurate enough to be useful for many purposes, wire-grid models are difficult to work with and sometimes unpredictable. Another technique capable of analyzing this type of configuration accurately and reliably would be a tremendous asset to the growing number of engineers attempting to numerically model sources of electromagnetic interference.

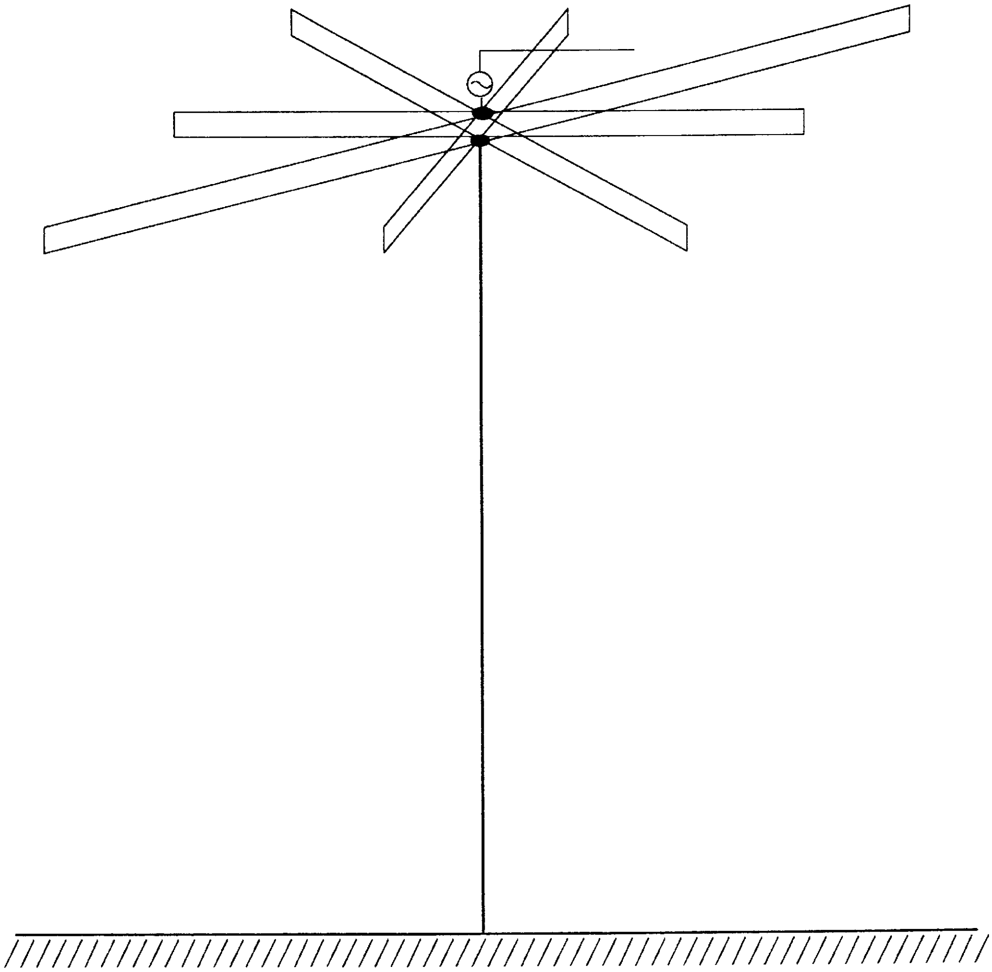

Figure 4: Two-Layer Wire-Grid Configuration Used to Model This Problem

References

[1] T. H. Hubing and J. F. Kauffman, *Modeling the Electromagnetic Radiation from Electrically Small Table-Top Products*, IEEE Transactions on Electromagnetic Compatibility, Vol. EMC-31, 1989, pp. 74-84.

[2] G. J. Burke and A. J. Poggio, *Numerical Electromagnetics Code (NEC) - Method of Moments, Naval Ocean Syst. Center, San Diego, CA, NOSC Tech. Document 116, Jan. 1981.*

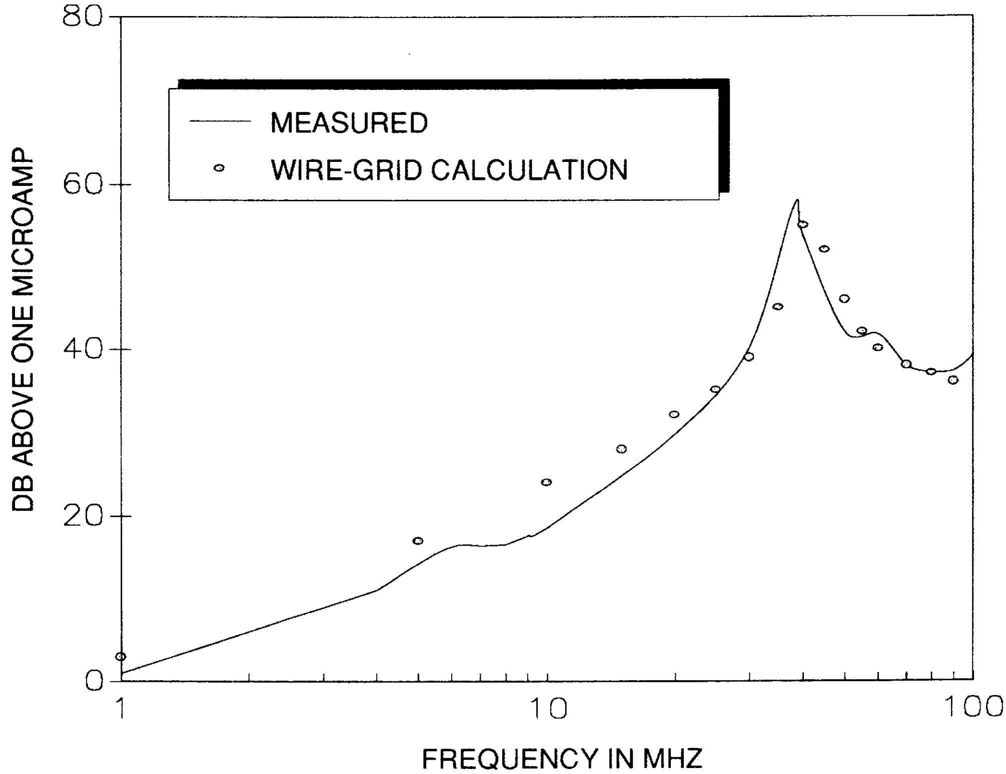

Figure 5: Calculated Results for the Bent-Wire Configuration Using a Two-Layer Wire Grid

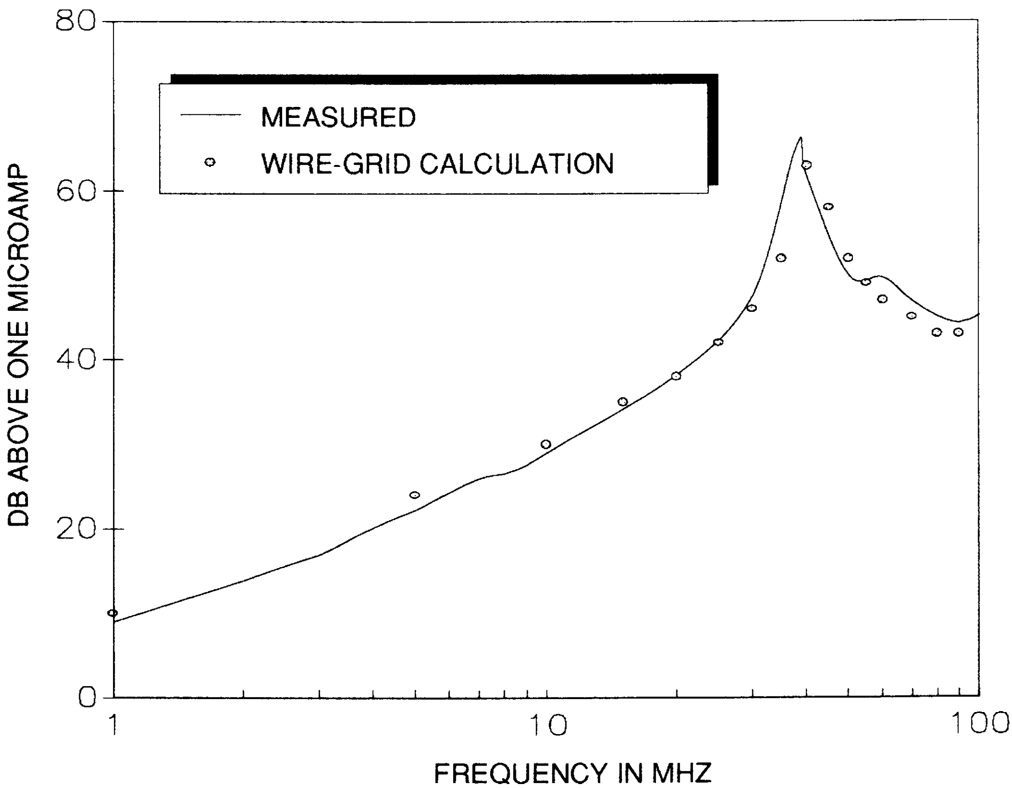

Figure 6: Calculated Results for the Straight-Wire Configuration Using a Two-Layer Wire Grid