

REDUCTION OF THE EDGE DIFFRACTION OF A CIRCULAR GROUND PLANE BY USING  
RESISTIVE EDGE LOADING

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Many antenna designs require ground planes as a part of the antenna structure, but often may be cumbersome due to their large size and are expensive to implement in practice. Where smaller ground planes are used instead, the edge diffractions and reflections can affect the antenna radiation patterns and the input impedance. To reduce the edge interaction, edge treatment techniques such as edge serrations, curving or bending of the edges, and application of absorbing material near the edge can be used [1]. Here we present some results of a study of a monopole above a circular ground plane where the edge of a ground plane is made of resistive material with gradually increasing resistivity from zero to above 1000 ohms per square at the outer edge.

The antenna was studied numerically and experimentally. For numerical studies the problem was formulated using a body of revolution technique [2,3] with added resistive sheet boundary conditions and solved for antenna impedance, currents on the monopole and the ground plane, and the far field patterns. To verify the computations two antenna models were made and measured, one with metal ground plane and the other with the ground plane made of resistive material.

The resistive material was made by spraying resistive paints of different conductivities on a paper base to obtain the desired resistance variation. Since the resistivity of the sprayed sheet cannot be accurately predetermined, non-destructive methods were devised to measure resistivity both in dc and microwave frequency regimes.

The insert in Fig. 1 shows the dimensions of the resistive ground plane model. The monopole at the center is an extension of the SMA bulkhead connector and is 2.68 cm high and 0.048 cm in radius. Beneath the monopole is a 3.0 cm radius metal disc from which the resistance material extends outward to 12.0 cm radius. The curve shows the measured resistance variation along the ground plane. At the center the resistance is zero and then gradually increases in a parabolic manner to above 1000 ohms/sq at the outer edge.

The resonant frequency for the antenna is 2.5 GHz and for this frequency the computed currents on metallic and resistive ground planes are shown in Fig. 2. As expected the currents on

the metal ground plane show an oscillatory standing wave behavior, going to zero at the outer edge. On the resistive ground plane the current rises (unexpectedly) and then rapidly decreases toward the outer edge. The rise could be attributed to the resonance effect of the monopole at this particular frequency. The far field pattern for the antennas was computed and measured and show very close agreement. Figure 3 shows the E-plane pattern measured at 2.5 GHz. The main difference in the patterns is that resistive ground plane suppresses the side lobes below the ground plane level. Also, the lossy ground plane reduces the gain approximately 1.0 dB.

### References

- [1] Griffin, D. W., "Monopole antenna method of diagnosing the effectiveness of ground plane edge scattering techniques," IEEE AP-S Symposium Digest, Vol. 1, 223-225, 1982.
- [2] Glisson, A. W. and Wilton, D. R., "Simple and Efficient Numerical Techniques for Revolution," Technical Report for RADC Contract No. F30602-78-C-0120, University of Mississippi, 1979.
- [3] Glisson, A. W. and Wilton, D. R., "Simple and Efficient Numerical Methods for Problems of Electromagnetic Radiation and Scattering from Surfaces," IEEE Trans. Antennas Propagat., AP-28, 593-603, 1980.

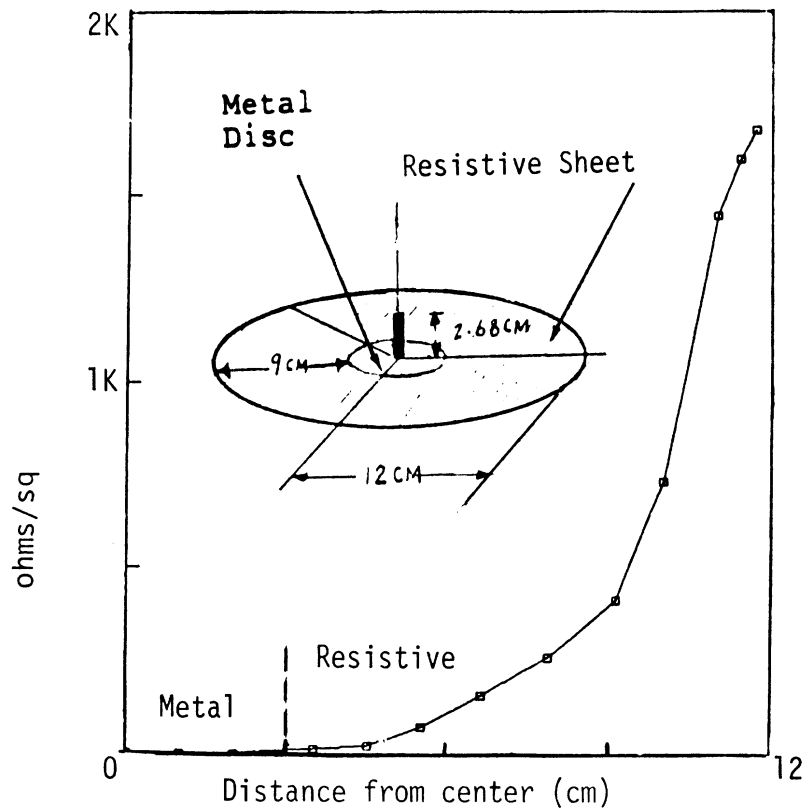


Fig. 1: Antenna geometry.

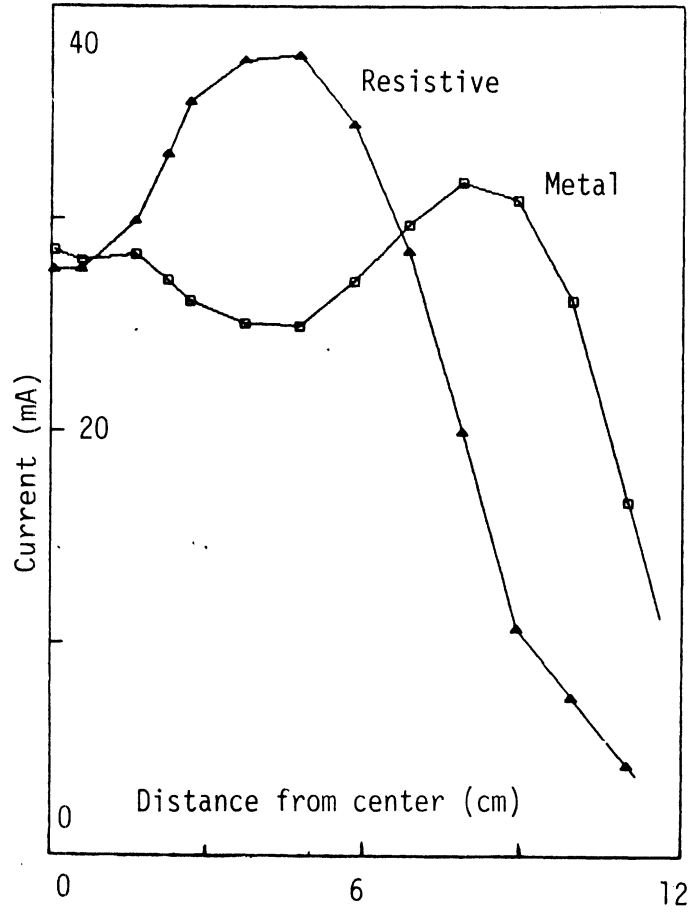


Fig. 2: Current along the ground plane.

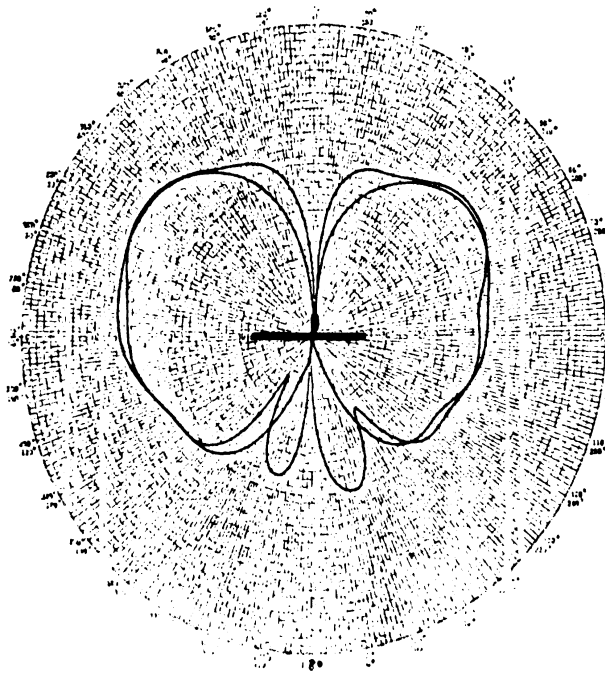


Fig. 3: Measured E-plane pattern.