JOURNAL OF RESEARCH of the National Bureau of Standards—D. Radio Propagation
Vol. 64D, No. 2, March–April 1960

Impedance of a Corner-Reflector Antenna as a Function of the Diameter and Length of the Driven Element

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(September 21, 1959)

Impedance measurements have been made for a monopole in a corner reflector over an image plane as a function of the monopole length, diameter, and position within the corner-reflector structure. The results are presented as a family of curves which should be useful in the design of the driven element for a corner-reflector antenna of the size described in this paper and for other corner-reflector antennas with similar parameters.

1. Introduction

In connection with an NBS-sponsored project to study meteor multipath, a requirement arose for an antenna having a half-power beamwidth in the E-plane of approximately 50° and a capability of radiating a 6-megawatt peak power at a frequency of 40 Mc. On the basis of past experience, a corner-reflector antenna driven by a half-wave dipole was selected for the application.

On the basis of previously measured gains [1] [1] and radiation patterns [2] obtainable for corner-reflector antennas having various combinations of lengths and widths, a corner reflector having a length of reflecting planes, $L/\lambda=1.0$, width of reflecting planes, $W/\lambda=1.3$, and an aperture angle of 110° was selected. From figure 48 of reference [2] the beamwidth can be seen to be between 48° and 50° as required. The "first" dipole position, distance from apex of corner reflector, for an aperture angle of 110° can be found in figure 3 of reference [1] to be in the range of 0.2λ to 0.35λ. The gain of a corner-reflector antenna with these parameters should be approximately 12.2 db over an isotropic radiator.

In order to design the driven element for the corner-reflector antenna to radiate the required 6-megawatt peak power, a knowledge of the resistance and reactance values as a function of diameter, length of the driven element, and position within the corner-reflector structure was required.

Theoretical computations of impedance of an antenna with a corner reflector almost always assume reflecting surfaces infinite in extent and aperture angles equal to 45°, 60°, 90°, etc. Assuming perfectly conducting reflecting sheets of infinite extent, the method of images can be applied to obtain an approximation of the corner-reflector antenna impedance [3, 4]. Assuming a dipole position (distance from apex of corner reflector) to be 0.25λ, the distance from the dipole to the reflecting planes may be computed to be 0.205λ for a 110° aperture angle. Using a value of 0.205λ from dipole to reflecting planes for purposes of comparison, the impedance of corner-reflector antennas with 90° and 120° aperture angles may be computed to be approximately $41+j96.5$ and $63+j114$ ohms respectively. For these computations the dipole length was assumed to be one-half wavelength in free space and infinitesimally thin. The effect of the aperture angle can be seen to be significant.

Since a knowledge of the impedance of the corner-reflector antenna as a function of the dipole diameter and length was desired, and also since the parameters of the reflecting surfaces of the corner-reflector antenna selected for this application are small compared with the length of the antenna and an aperture angle of 110° was used, it was necessary to obtain the impedance values experimentally. The results of these measurements are presented in this paper.

2. Experimental Procedure

A scaled experimental model of this antenna was constructed for operation at 400 Mc (a scaling factor of 10). The measurements were made by using a monopole in a corner reflector on an image plane with a corner-reflector width $W/\lambda=0.65$ (one-half 1.3λ). Figure 1 shows a view of the corner reflector on the image plane. The monopoles used in the measurements were made using eight different sizes

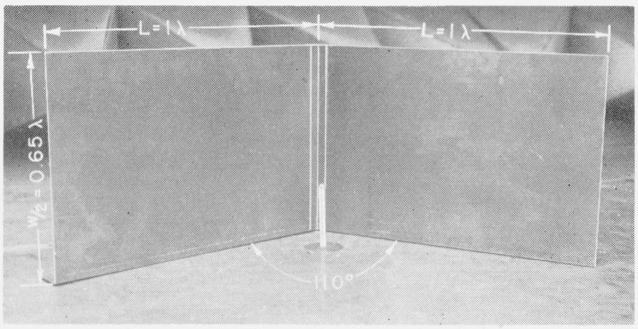

FIGURE 1. *A view of the corner-reflector and monopole on the image plane.*

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[1] Figures in brackets indicate the literature references at the end of this paper.

of silver-plated brass tubes fitted with rounded plugs in the free end and a 45° taper plug in the driven end. The diameters of the monopoles used were as follows:

Diameter in inches	Diameter in wave-lengths, D/λ	Diameter at 40 Mc in inches	Result curves
1/8	0. 00424	1. 25	A
3/16	0. 00636	1. 875	B
1/4	0. 00848	2. 50	C
3/8	0. 0127	3. 75	D
1/2	0. 0170	5. 00	E
3/4	0. 0254	7. 50	F
1	0. 0339	10. 00	G
1 1/4	0. 0424	12. 50	H

The resistance and reactance values for the monopoles at a fixed position in the corner reflector, and with variable length, were determined, using a commercially available impedance-plotting device.

3. Results

Figure 2 presents the resistance and reactance values which were measured for a monopole diameter, $D/\lambda=0.0170$, with monopole lengths l/λ of 0.247, 0.225, 0.212, and 0.200 with the monopole position, distance from apex, variable over the range of 0.15 to 0.4λ. The reactive component was measured to be nearly zero for a monopole length of 0.212λ and a monopole position of 0.25λ. Since these measurements (fig. 2) were obtained for a monopole diameter in the midrange or average of the eight different monopole diameters to be tested, the monopole position for zero reactance should not differ greatly for the other monopole diameters. A monopole position of 0.25λ from apex was used for the remaining measurements of resistance and reactance.

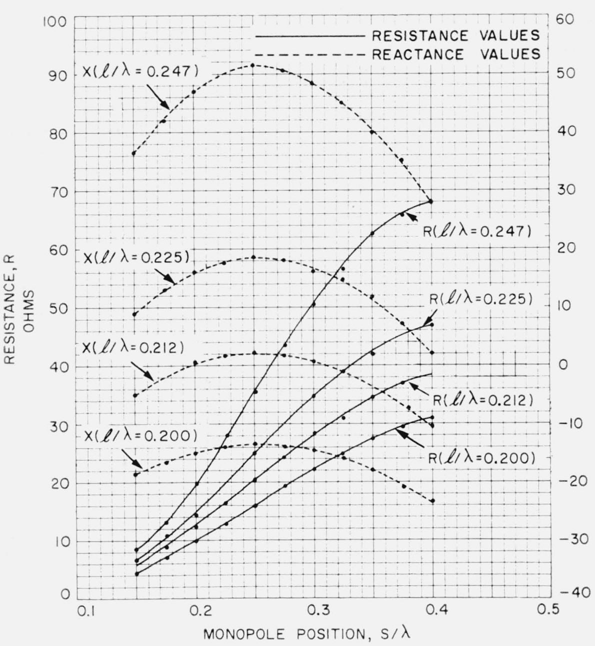

Figure 2. *Resistance and reactance curves for a monopole diameter, $D/\lambda=0.0170$, and monopole lengths, $l/\lambda=0.200$ to 0.247, as a function of monopole position, S/λ, in a corner reflector on the image plane.*

Figures 3, 4, and 5 present the curves of resistance and reactance values measured for the monopoles (*A* through *H*) with monopole lengths variable from 0.5λ down to 0.161λ at the fixed monopole position of 0.25λ. (Intermediate values of D/λ can be obtained by interpolating between the curves.)

A corner-reflector antenna has been constructed and is in use for meteor multipath studies. A dipole diameter, $D/\lambda=0.01526$, was chosen for strength availability of standard-size aluminum tubing. On the basis of the measurements described in this report, the remaining corner-reflector antenna parameters were selected as follows: dipole length $l/\lambda=0.42$, and dipole distance from apex=0.25λ.

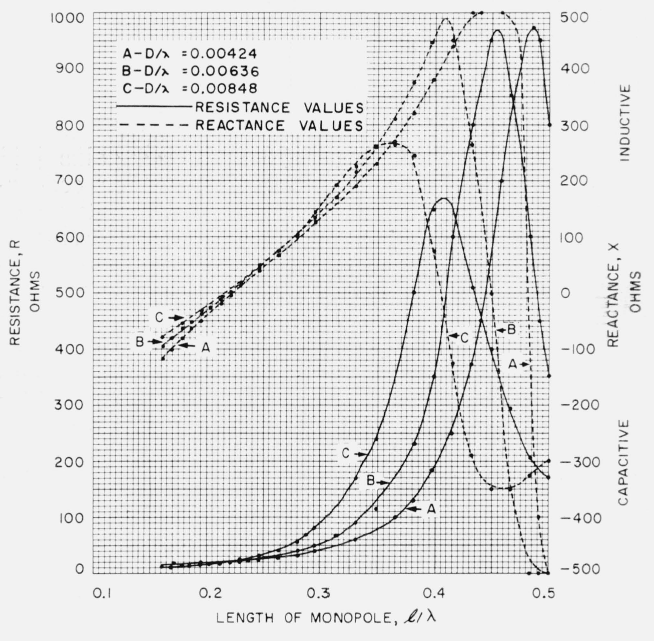

Figure 3. *Resistance and reactance curves for different monopole diameters in a corner reflector as a function of length of monopole, l/λ.*

4. Conclusions

This paper is intended to record the basis for the design of the antenna for a meteor multipath measurement project. The measurements presented in this report may also serve as a guide as to what can be expected for corner-reflector antennas with similar parameters. The dipole element diameter may be selected as required for size, strength, power to be radiated, etc., and the dipole length determined.

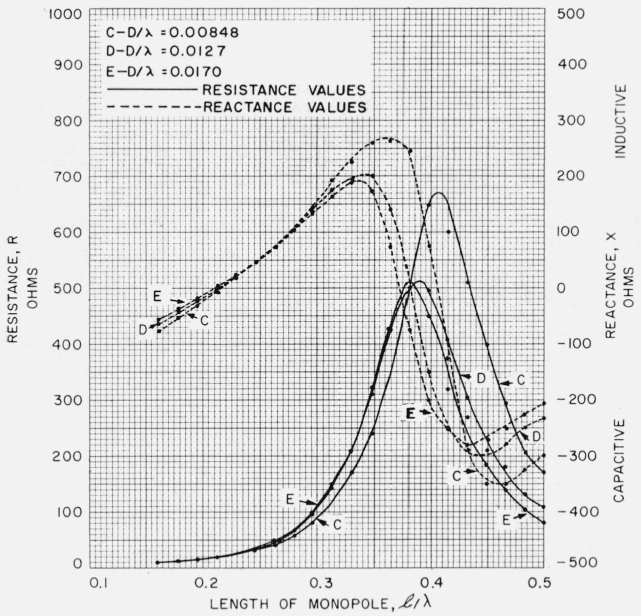

FIGURE 4. *Resistance and reactance curves for different monopole diameters in a corner reflector as a function of length of monopole, l/λ.*

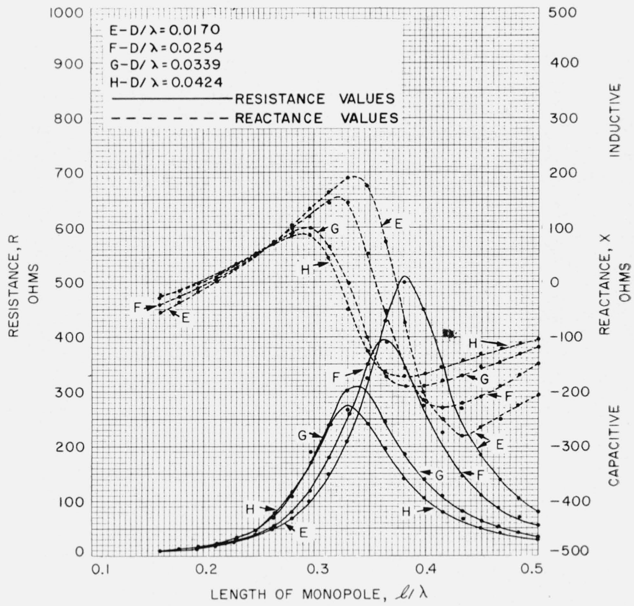

FIGURE 5. *Resistance and reactance curves for different monopole diameters in a corner reflector as a function of length of monopole, l/λ.*

This work was carried out in support of the National Bureau of Standards Meteor Multipath Project at the request of, and under the general guidance of, R. J. Carpenter and G. R. Ochs. The measurements required for this paper were carried out by V. L. Meier.

BOULDER COLO. (Paper 64D2–47)

5. References

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