ANALYSIS OF PROBE-FED CAVITIES OF ARBITRARY SHAPE

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Abstract

A method for calculating the probe impedance and fields in a cavity of arbitrary shape, either with or without slots in the walls, is given. Using the classical probe-fed rectangular cavity as a test case, experimentally confirmed theoretical curves for the probe impedance and interior fields are given.

Discussion

The design of a cavity backed slot radiator wherein the cavity is of arbitrary shape is largely an experimental trial and error task. The work to be described here constitutes the first of several steps directed toward the attainment of a technique for the analysis and design of probe-fed cavity-backed slots of arbitrary geometry and perhaps ultimately to a synthesis technique for designing such devices.

One advantage of present-day numerical approaches to electromagnetic problems such as the method of moments[1] is the inherent ability to readily accommodate structures of arbitrary geometry.[2] Utilizing the method of moments, work has been done on exterior problems such as wire antenna analysis.[3] Waveguide scattering problems have also been considered.[4] To date, however, the application of numerical techniques to the interior problem has not received adequate attention.

To start our investigation we have first considered a solid-wall probe-fed rectangular cavity as shown in Fig. 1. The walls of the cavity are modelled using the wire-grid concept.[2] Since there is no aperture in the cavity and losses in the metal may be considered negligible at this frequency, the real part of the probe impedance is zero and only the imaginary part is shown in Fig. 1. As can be seen the agreement with experiment is excellent. Further evidence of the accuracy of the method is evidenced by the curves in Fig. 2 which depicts the calculated and measured (by Méndez[5]) fields inside a probe excited cavity. Similar calculated results could, of course, be obtained for shapes other than classical ones such as the rectangular cavity shown here.

Finally, Fig. 3 shows calculated results for the probe impedance in a cavity with a slot in one wall. Work is presently under way to obtain experimental confirmation. Note, however, the increase in the real part where the slot is resonant near 250 MHz. In addition to the probe impedance and fields inside the cavity, one could also calculate the aperture distribution.

Conclusions

The work described above depicts the initial step toward ultimately being able to design such antennas via modern computer techniques in electromagnetics. The next step, which is presently underway, is to use a solid surface or patch representation for the cavity-backed slot antenna of arbitrary shape. The completion of this step will permit a substantial and necessary improvement in the computer model. The third step will be to account for a dielectric medium in the cavity of different permittivity than that in the external space.

Acknowledgment

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References

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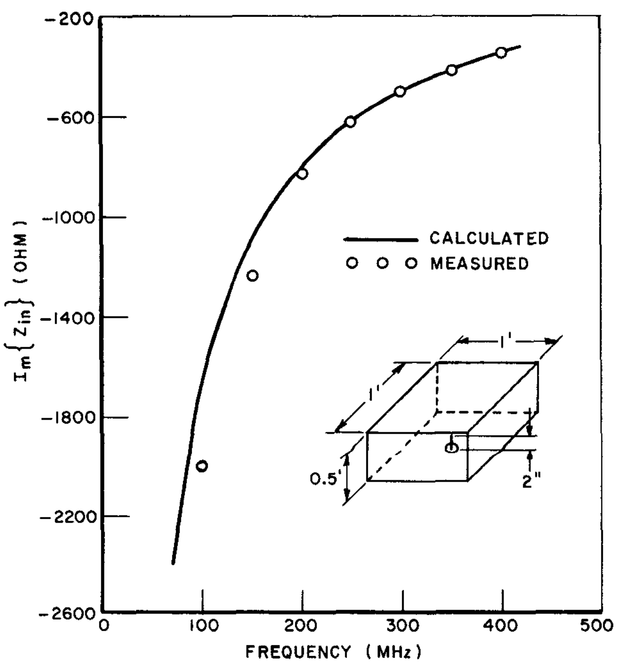

FIG. 1. CALCULATED CAVITY PROBE IMPEDANCE VS EXPERIMENTAL MEASUREMENTS ON SOLID WALL CAVITY (a = .001λ).

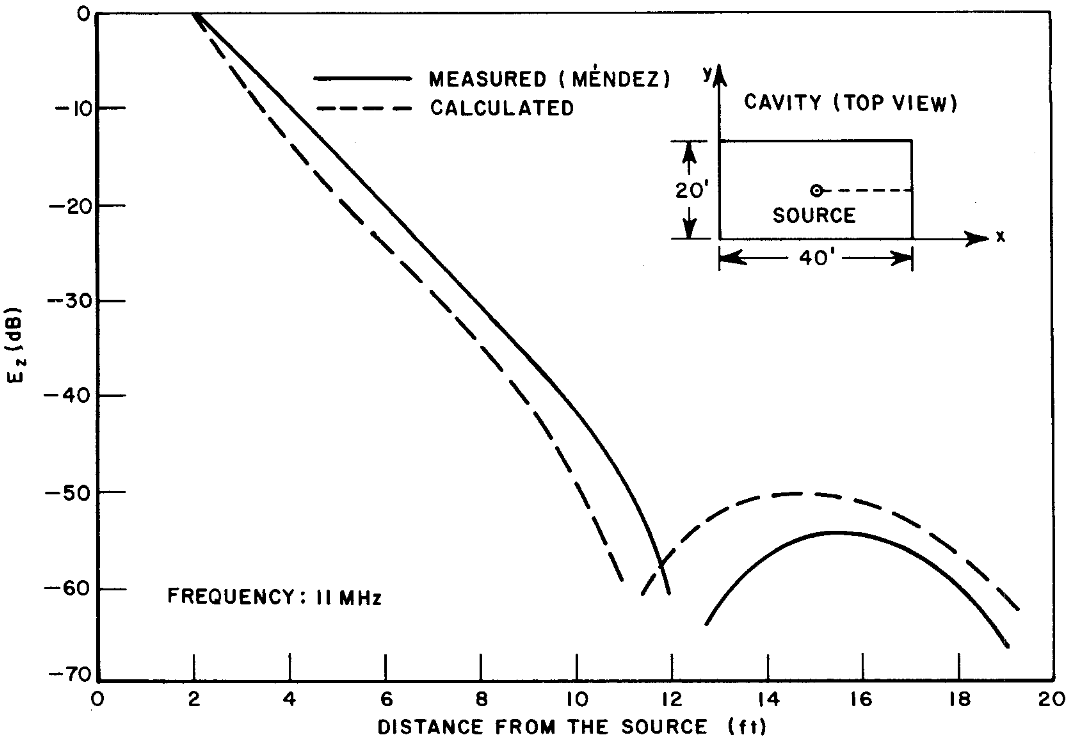

FIG. 2. CALCULATED VS MEASURED (AT y=10', Z=0) Z-COMPONENT OF PROBE EXCITED INTERIOR FIELD IN A 40' x 20' x 10' ROOM.

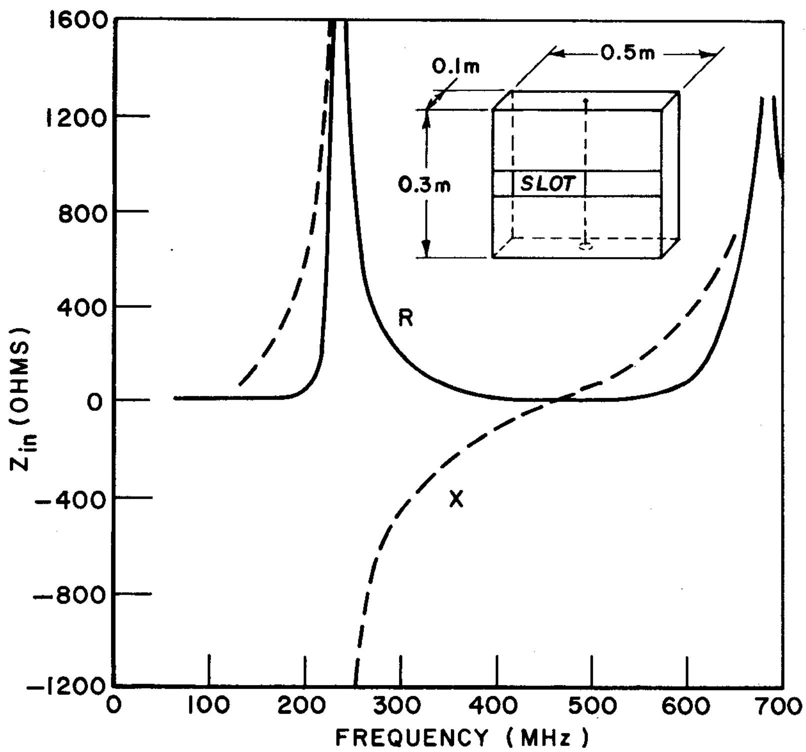

FIG. 3. CALCULATED IMPEDANCE OF A PROBE IN A CAVITY WITH SLOT IN ONE WALL.

NOTES