Comment on "Cerenkov Radiation in Anisotropic Ferrites"[1]

I have read with great interest the above paper since the Applied Physics group here at RCA has been engaged in analysis and experiments in Cerenkov radiation during the last few years. In the interest of historical as well as scientific accuracy, however, I should like to point out that the "problem of simulating an unbounded dielectric" was first solved, though not rigorously, by I. A. Getting,[2] and not by C. E. Enderby, as the article seems to imply.

L. W. Zelby
Consultant
RCA Defense Electronic Products,
Camden, N. J.

Manuscript received January 8, 1964.

[1] F. J. Rosenbaum and P. D. Coleman, IEEE Trans. on Microwave Theory and Techniques, vol. MTT-11, pp. 302–311; September, 1963.

[2] I. A. Getting, *Phys. Rev.*, vol. 71, pp. 123–124; January, 1947.

Measuring the Directivity of a Directional Coupler Using a Sliding Short-Circuit and an Adjustable Sliding Termination

A method for measuring the directivity of directional couplers has been previously described[1] in which one uses an adjustable sliding termination and a sliding short-circuit. One first adjusts the tuner shown in Fig. 1 so as to eliminate multiple reflections in the waveguide in which the sliding terminations are inserted. Then one determines the ratio of two detector outputs, first the average level as the short-circuit slides in the waveguide and second the level obtained when the sliding termination is adjusted for zero reflection. An alternate procedure substitutes for this second level that which is obtained when the sliding termination is first adjusted to produce a detector null and is then slid without further adjustment until the detector output is maximum.

A slight modification of the above method gives some improvement in the technique and simplifies the corrections and estimate of error limits. The modification consists of adjusting the tuner not to eliminate multiple reflections, but to obtain a constant detector level $|b_{3S}|$ as the short-circuit is slid in the uniform waveguide section.

It is known[2] that if the short-circuit has a reflection coefficient magnitude of unity, this adjustment imposes the condition $1/K = -\Gamma_{2i}^*$ on the directional coupler. It follows that the ratio of $|b_{3S}|$ to $|b_{30}|$ expressed in decibels is

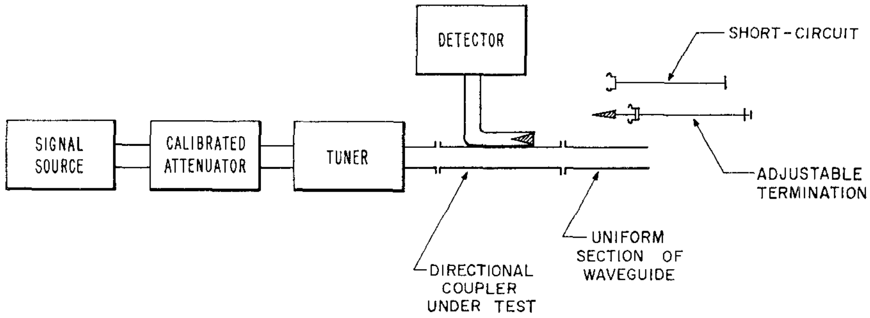

Fig. 1—Simplified diagram of apparatus for directivity measurement.

$$R_1 = 20 \log_{10} |K|. \qquad (1)$$

The detector level $|b_{30}|$ is obtained when the sliding termination is adjusted for zero reflection. The alternate procedure as described above yields a detector level $|b_{3M}|$, and the ratio of $|b_{3S}|$ to $|b_{3M}|$ expressed in decibels can be shown to be

$$R_2 = R_1 - 6.02 \text{ db} + 20 \log_{10}\left(1 + \frac{1}{|K|^2}\right). \qquad (2)$$

In either case, the quantity $|K|$ can be easily obtained and is approximately equal to the directivity ratio of the directional coupler. For coupling looser (more) than 20 db, and a VSWR in the main guide less than 1.15, the directivity will differ from R_1 by less than 0.3 db when the directivity is as low as 10 db and by less than 0.05 db when the directivity is as high as 40 db.

One can obtain somewhat better results by adding a correction to R_1 which depends upon the coupling and is especially worthwhile when the coupling is tighter (less) than 20 db. The correction is given in Fig. 2 and decreases the discrepancies above to 0.2 db and 0.01 db, respectively.

This correction is due to the fact that some of the incident signal is coupled out of the main waveguide and is dissipated in the internal termination, so that it does not reach the short-circuit and is not reflected back to contribute to $|b_{3S}|$.

Suppose that after making the correction, one wishes to estimate the limits of the discrepancy between the corrected figure and the true directivity, due to effects of multiple reflections. This discrepancy can lie between two limits, depending upon the relative phases of the reflections involved. The limits are shown in the graph of Fig. 3 for several typical values of VSWR.

The discrepancy is small when the directivity is high, but becomes quite serious when the directivity (which approximately equals R_1) is low. In most cases the directivity is greater than 15 db and the main waveguide VSWR is less than 1.222, so that the discrepancy is less than 0.15 db.

Errors caused by imperfect adjustments of the tuner and the termination have not been analyzed, but are intuitively felt to be small compared to errors in measuring the ratio of detector levels. One can obtain a feeling for this during the course of the experiments by deliberately changing the tuning adjustments and noting the effect on the measured result.

The method described above is attractive because it avoids awkward manipulations of the directional coupler itself and it is applicable to directional couplers having any combination of rectangular waveguide and coaxial arms; it avoids complicted treatment of the observed data in determining directivity, and it permits accurate measurements.

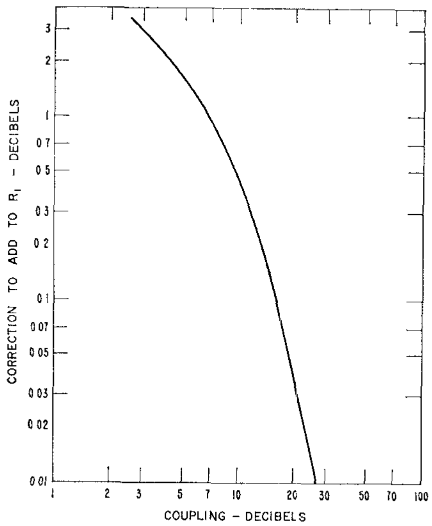

Fig. 2—Correction to $_1R$ due to coupling.

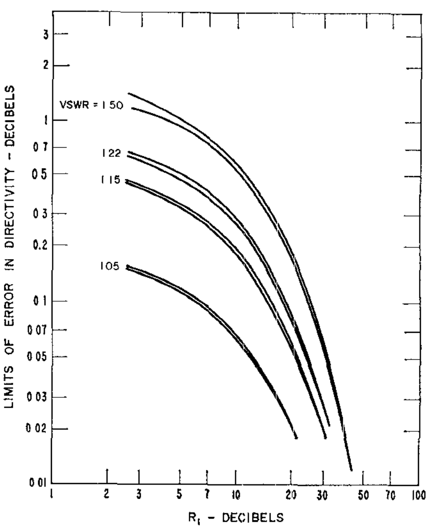

Fig. 3—Limits of error in directivity due to main waveguide VSWR of directional coupler.

R. W. Beatty
Radio Standards Lab.
Nat'l Bur. Standards
Boulder, Colo.

Manuscript received February 13, 1964.

[1] G. E. Schafer and R. W. Beatty, "A method for measuring the directivity of directional couplers," IRE Trans. on Microwave Theory and Techniques, vol. 6, pp. 419–422; October, 1958.

[2] G. F. Engen and R. W. Beatty, "Microwave reflectometer techniques," IRE Trans. on Microwave Theory and Techniques, vol. 7, pp. 351–355. July, 1959.