FREE SPACE MICROWAVE PROPAGATION

1. GENERAL

1.01 This addendum provides information which the transmission characteristics of microwave radio circuits used for television pickup and studio-transmitter links may be computed. It consists essentially of a reprint of an article entitled "Free Space Microwave Propagation" by A. L. Hammerschmidt which was published originally in the March 1948 issue of the RCA Review.

1.02 Sample calculations in the reprint are directly applicable to the TTR-1A and TRR-1A microwave equipment which operates on frequencies in the vicinity of 7000 megacycles per second. The nomographs included as Charts A and B are also applicable to TE microwave equipment which operates on frequencies of 4000 megacycles per second.

1.03 The information in this section provides a means of determining the maximum usable circuit length with any given type of microwave equipment, when a minimum signal-to-noise ratio is specified. Conversely, for any given circuit length the attainable signal-to-noise ratio may be determined. All computations are based on a clear line of sight path for the radio circuit as this is essential for efficient microwave propagation.

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Summary—Nomographic charts have been developed which facilitate the calculation of the performance of microwave relay equipment. One chart shows the relationship of frequency, distance, and path attenuation between isotropic antennas. A second chart shows the relationship between diameter, frequency, and gain of a parabolic reflector antenna with respect to an isotropic antenna. An example demonstrates the application of these charts to a transmission problem, and a table indicating calculated transmission characteristics of a typical microwave television relay equipment for various antenna combinations is included.

INTRODUCTION

EXCELLENT methods of computing the transmission characteristics of microwave relay systems have been covered in previously published papers.[1,2] However, application of these methods to a particular relay circuit is often laborious and time-consuming. This paper describes recently developed nomographic charts which relate the major factors encountered in free-space propagation. Use of these charts greatly simplifies the computations involved in determining the transmission characteristics of a microwave relay system.

NOMOGRAPHIC CHARTS

Two charts are included in this paper. Chart A shows the relationship of frequency, distance, and path attenuation between isotropic (hypothetical omnidirectional) antennas. This chart was developed from the free space formula (Appendix A). The derivation of the formula used to construct the chart is indicated in Appendix B.

Chart B shows the relationship between diameter, frequency, and gain of a parabolic reflector antenna referred to an isotropic antenna. A parabola efficiency of 65 per cent, i.e., the effective area equals 65

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[1] H. T. Friis, "A Note on a Simple Transmission Formula", *Proc. I.R.E.*, Vol. 34, No. 5, pp. 254-255, May, 1946.

[2] C. W. Hansell, "Radio Relay Systems Development by the Radio Corporation of America", *Proc. I.R.E.*, Vol. 33, No. 3, pp. 156-168, March, 1945.