

RECOMMENDATION 525-1

CALCULATION OF FREE-SPACE ATTENUATION

(1978-1982)

The CCIR,

CONSIDERING

that free-space propagation is a fundamental reference for radio-engineering,

UNANIMOUSLY RECOMMENDS

that the methods in Annex I be used for the calculation of attenuation in free-space.

ANNEX I

1. Introduction

As free-space propagation is often used as a reference in other CCIR texts, this Annex lists certain relevant formulae, together with nomograms for rough graphical calculations which may be useful in many cases.

2. Basic formulae for telecommunication links

Free-space propagation may be calculated in two different ways, each of which is adapted to a particular type of service.

2.1 Point-to-area links

If there is a transmitter serving several randomly-distributed receivers (broadcasting, mobile service), the field is calculated at a point located at some appropriate distance from the transmitter, and in a given direction, by the expression:

$$E = \frac{\sqrt{30 p}}{d} \quad (1)$$

in which:

E : is the r.m.s. field strength in volts per metre (Note 1)

p : is the equivalent isotropically radiated power (e.i.r.p.) of the transmitter in the direction of the point in question (Note 2), in watts

d : is the distance from the transmitter to the point in question, in metres.

Expression (1) is often replaced by (2) which uses practical units:

$$E_{mV/m} = 173 \frac{\sqrt{p_{kW}}}{d_{km}} \quad (2)$$

These two relations are shown in Fig. 1.

For antennas operating in free-space conditions the electromotive force may be obtained by multiplying together E and d in expression (1). Its dimension is volts.

Note 1. — If the wave is elliptically polarized and not linear, and if the electric field components along two orthogonal axes are expressed by E_x and E_y , the left-hand term of equation (1) should be replaced by $\sqrt{E_x^2 + E_y^2}$. E_x and E_y can be deduced only if the axial ratio is known. E should be replaced by $E\sqrt{2}$ in the case of circular polarization.

Note 2. — In the case of antennas located at ground level and operating on relatively low frequencies with vertical polarization, radiation is generally considered only in the upper half-space. This should be taken into account in determining the e.i.r.p. (see Recommendation 368).



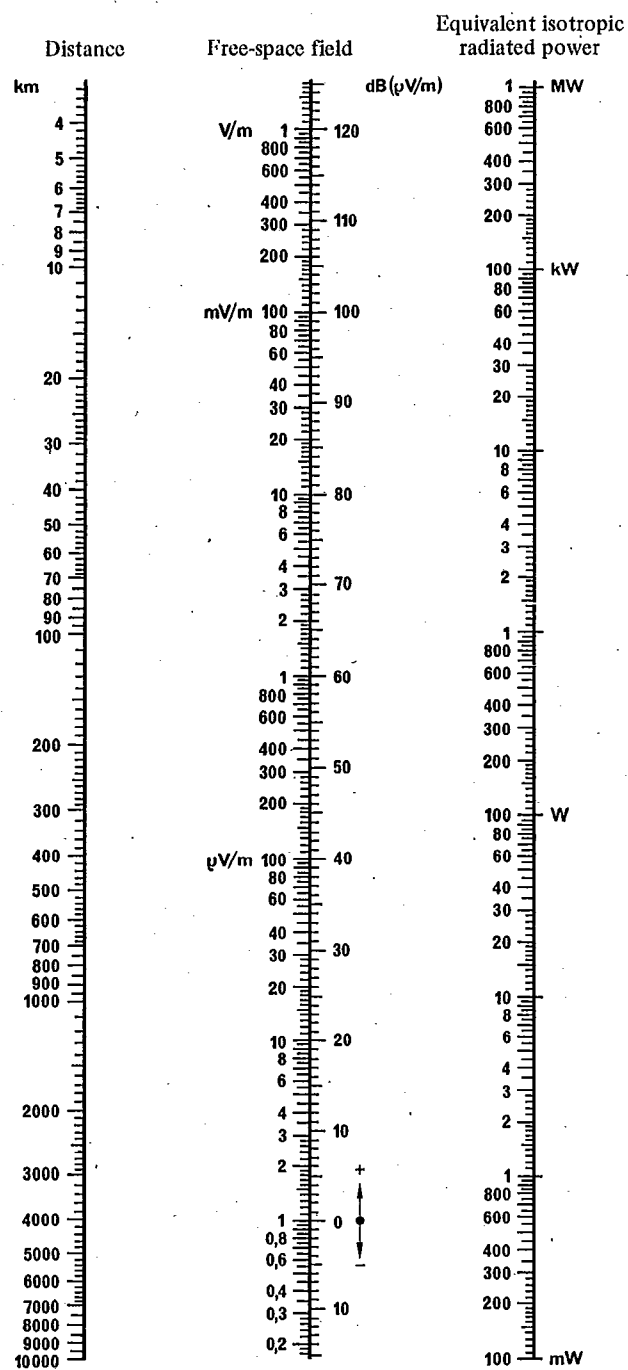


FIGURE 1 – Electro-magnetic field in free space