



GROUNDWAVE FIELD STRENGTH VERSUS DISTANCE

National Association of Broadcasters

This package contains a complete set of all graphs published by the FCC in 73.184. These graphs have been printed using original materials generated by FCC computers. Great care has been taken to assure accuracy of reproduction.

These graphs and graph paper should not be copied. Office copiers introduce geometric distortions which will affect accuracy. Copies for submission to the FCC and station files should only be made after all data have been plotted.

The Field Strength Measurement Form on the next page may be reproduced for use in taking measurements.

Additional sets of graph paper may be purchased from NAB Services. Call 800-368-5644.

GENERAL REQUIREMENTS FOR MEASUREMENTS*

All measurements should be made during the daylight hours in the absence of interference, and special temporary authority may be required prior to the commencement of measurements for a new authorization. For established stations, the FCC Rules permit considerable flexibility in operation during periods of making antenna system field strength measurements.

It is FCC policy that the measurement observations to be recorded and utilized as a basis of analysis of the inverse distance radiation values are those observed with the field strength meter oriented towards the station. The maximum indication can occur when the meter is oriented away from the transmitting source. This phenomenon can be caused by many factors including null depth on the measured radial. These factors vary from local effects surrounding or adjacent to the measuring point, non-uniform conditions inherent in the propagation path and can be affected by the position of the observation point on a rapidly changing portion of the directional pattern.

A record must be kept of the measurement data, including each point number, the field strength observations, dates and times of the measurements, the pattern under investigation, a description of each point location, the name of the individual taking the measurements, the general weather conditions, the field strength instrument utilized and the date of its last calibration. A sample form is provided for tabulating the field measurement data.

Graphical Analysis

The inverse distance field or unattenuated field strength at a reference distance kilometer (1 km) is the field strength predicted at that distance from the transmitting antenna if the earth were to behave as a perfect conductor. As the wave energy travels away from the antenna, the unattenuated field strength reduces by the inverse pro-

portion to the distance from the antenna. For example, if the value of the unattenuated field at 1 km is 100 mV/m, its value at 2 km will be one-half that value or 50 mV/m, and at 10 km, its value will be one-tenth of the 1 km value or 10 mV/m. The effects of attenuation on field strength are shown by families of curves for field strength vs distance for various values of ground conductivity. These graphs are included in Section 73.184 of the FCC Rules. The actual field will be diminished by this inverse distance factor as well as the losses attributable to ground conductivity.

The FCC, in its conversion to the metric system, re-determined the frequency curves. In addition, the FCC used its computer program and determined additional conductivity values for each frequency chart. The dielectric constant for all curves except for sea water, is 15. For sea water the calculations are based upon a dielectric constant of 80.

There are 19 sets of frequency dependent propagation graphs that encompass the frequencies from 540 to 1610 kHz. Curves for each frequency group are drawn on two graphs. One graph shows the uppermost portion with conductivity curves normalized for 100 mV/m/km from one-tenth to 50 km and the bottom portion reflects the conductivity curves for 10 to 5000 km. The second graph is an expanded version of the uppermost portion of the first graph to allow for easier determination of the inverse distance field and conductivity values for measurements less than 50 km from the transmitting antenna.

After the distances from the transmitting antenna to each of the measuring points have been determined and tabulated opposite the observed field strength values, the measured field strength values can be plotted on log-log graph paper. The ordinate (vertical scale) is field strength, expressed in mV/m, and the abscissa (horizontal scale) is distance in kilometers. Data can be plotted on ground-wave field intensity graph paper available through NAB. This paper has the same logarithmic scale as the expanded version of the FCC curves.

Plotting Data

For the logarithmic coordinate system, (log-log graph paper) the inverse distance field strength plots as a straight line. The conductivity curves are drawn for the case of an inverse distance field of 100 mV/m at 1 km, but their use is not limited to that value. If an inverse distance field strength is 200 mV/m (twice the reference value) or 50 mV/m (one-half the reference number) or some other value at 1 km, and if all points on the curve are multiplied by the ratio of the actual inverse distance field strength to 100 mV/m, the effect would be the equivalent of moving the curves by that amount on the logarithmic coordinate paper. This is the basis on which field strength measurements are analyzed. The appropriate conductivity

GROUNDWAVE FIELD STRENGTH VERSUS DISTANCE

values for the frequency involved are made by matching the abscissa of the data with that of the FCC graph and sliding the ordinate information data vertically to obtain the “best fit” of measured field strength values to the conductivity curves. By this method, both the unattenuated field at 1 km and the conductivity values along the radial path can be determined. The use of a light table will assist in aligning and moving the two sheets of paper.

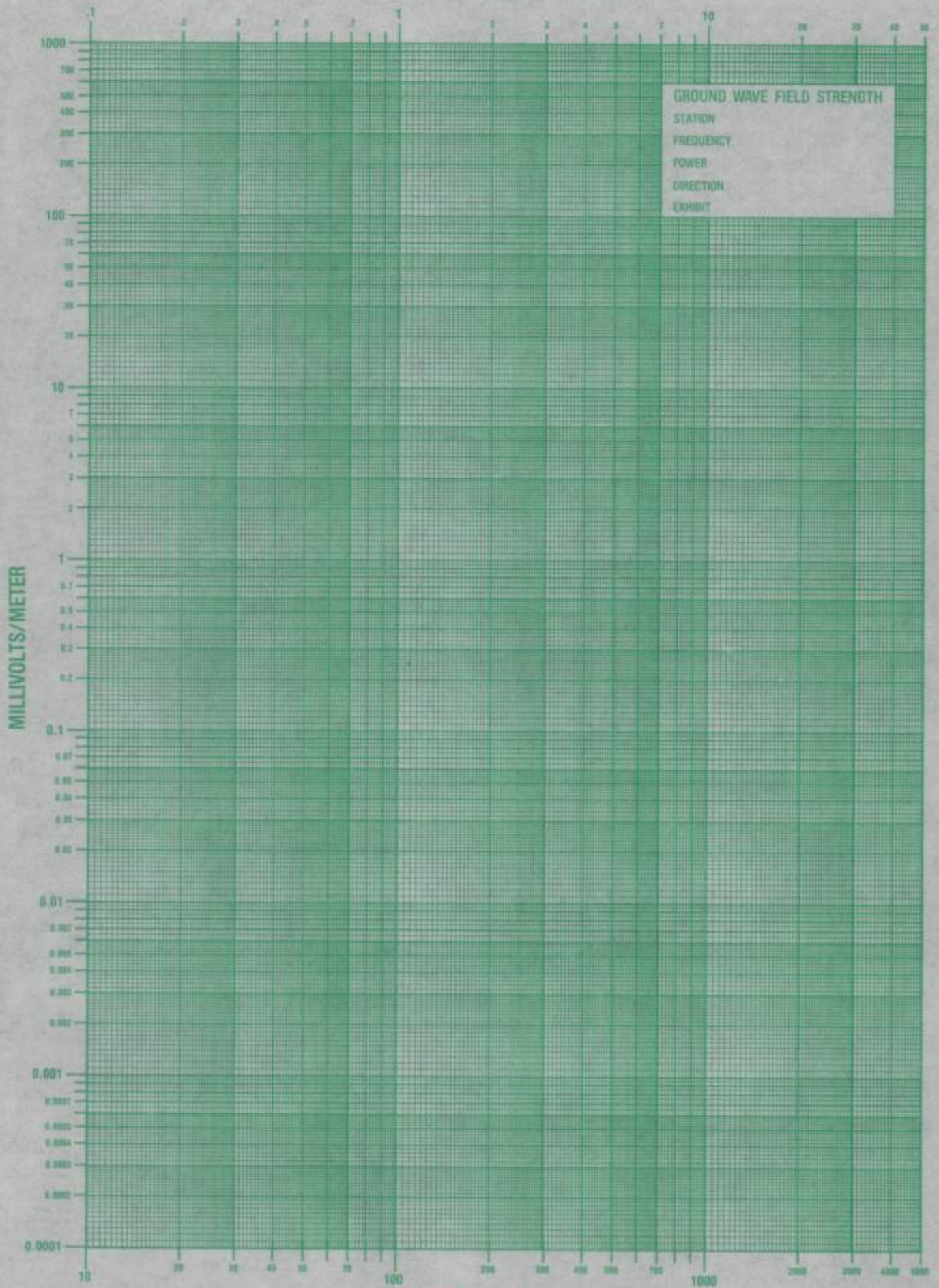
An individual attempting to analyze measurement data for the first time and without the benefit of experienced supervision can find this a frustrating experience. One approach is to take log-log graph paper for the appropriate frequency (either the regular or expanded scale) and plot the measurement point values normalized to 100 mV/km. For example, if the non-directional 0.25 kW operation is expected to possess an RMS field at 1 kW of 91 mV/m (70 degrees [0.194 of a wavelength] electrical height tower with a normal ground system—see Figure 8, Section 73.190 of the FCC Rules), it has a field 91/100 less than the FCC log-log conductivity graph. Therefore, multiply all values (divide all values if the expected field

is greater than 100 mV/m) of the measurement data by the ratio of 100/91 to normalize it to 100 mV/m. Plot the normalized data. The plotted values can be viewed in relation to the conductivity values if the assumption of the inverse distance field is correct. If the normalized data appear to be over the inverse distance line, then the radiation value is higher than assumed and conversely if the normalized data appear normally low, the assumed radiation value selected is too high.

This approach can be useful when the non-directional measurements out to 3 km in the various directions have been taken and a quick evaluation of the conductivity values/radiation efficiency around the site is desired. It also will help to assess whether or not the non-directional radiation pattern is being influenced by other adjacent towers in the directional antenna system.

*From “AM Field Strength Measurements and Proof of Performance” by Donald G. Everist, in the *NAB Engineering Handbook*, 7th Edition, 1985.

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FIELD STRENGTH MEASUREMENTS

FOR _____

PAGE NO: _____

ENGINEER: _____

METER: _____

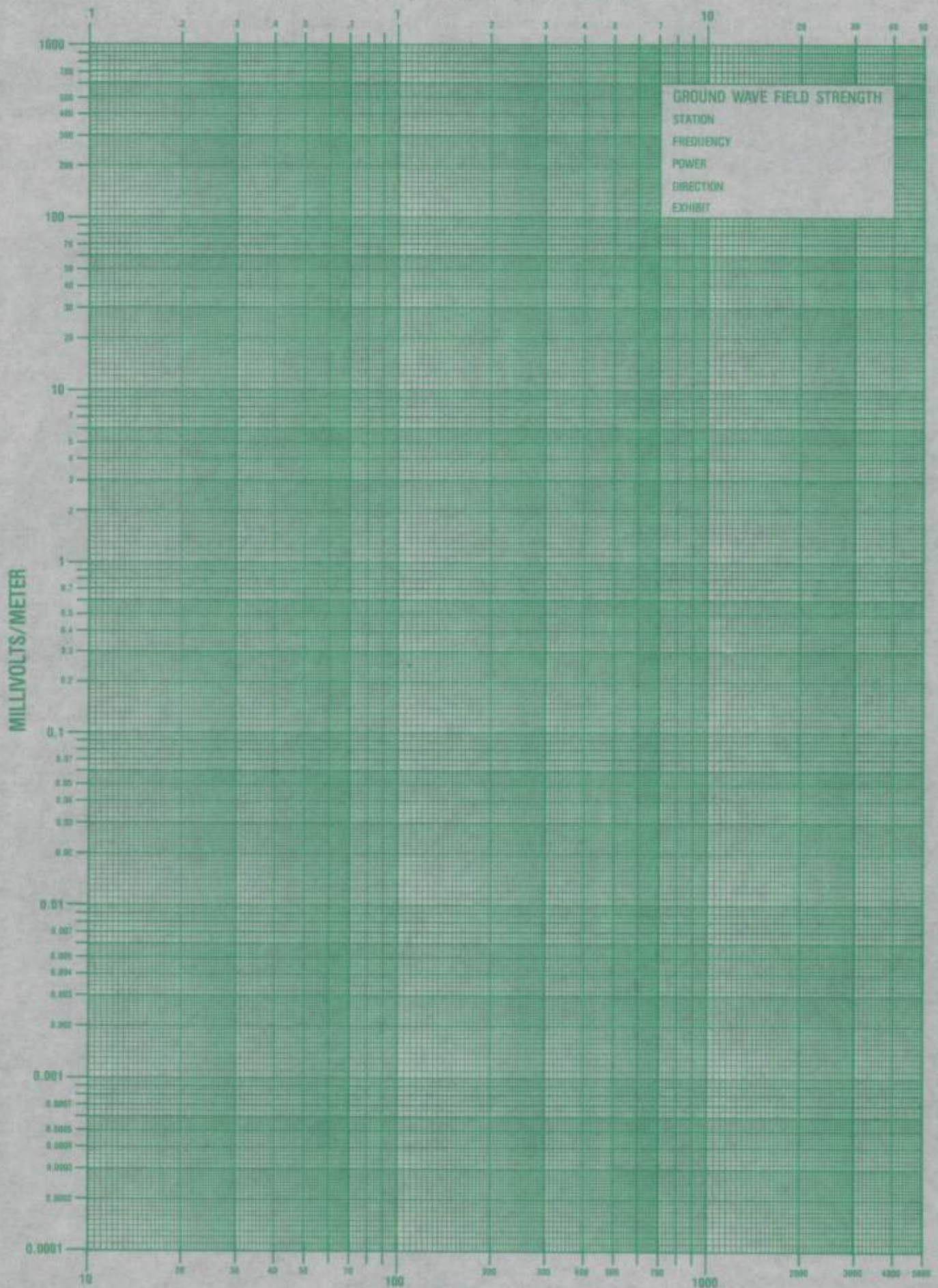
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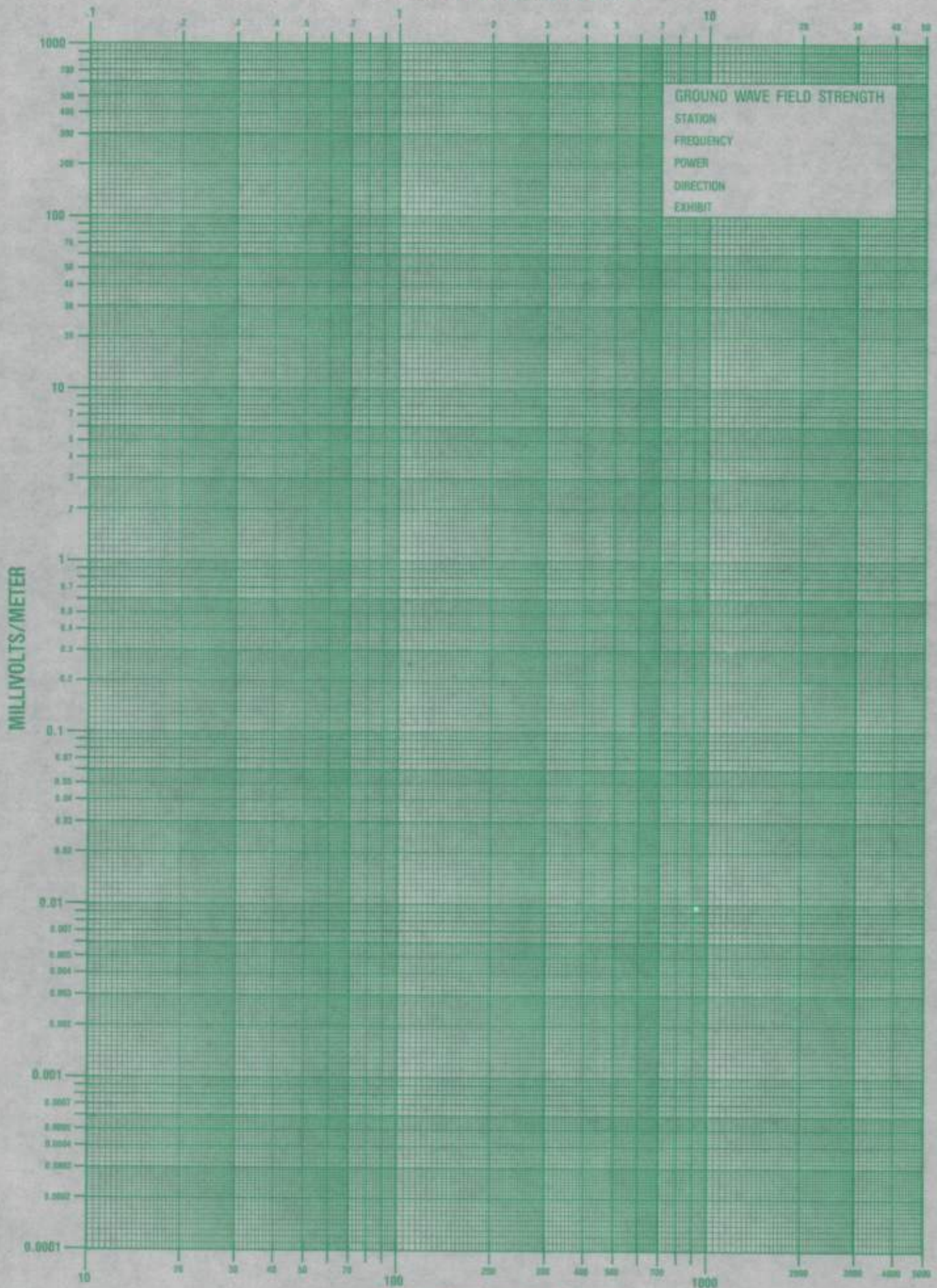
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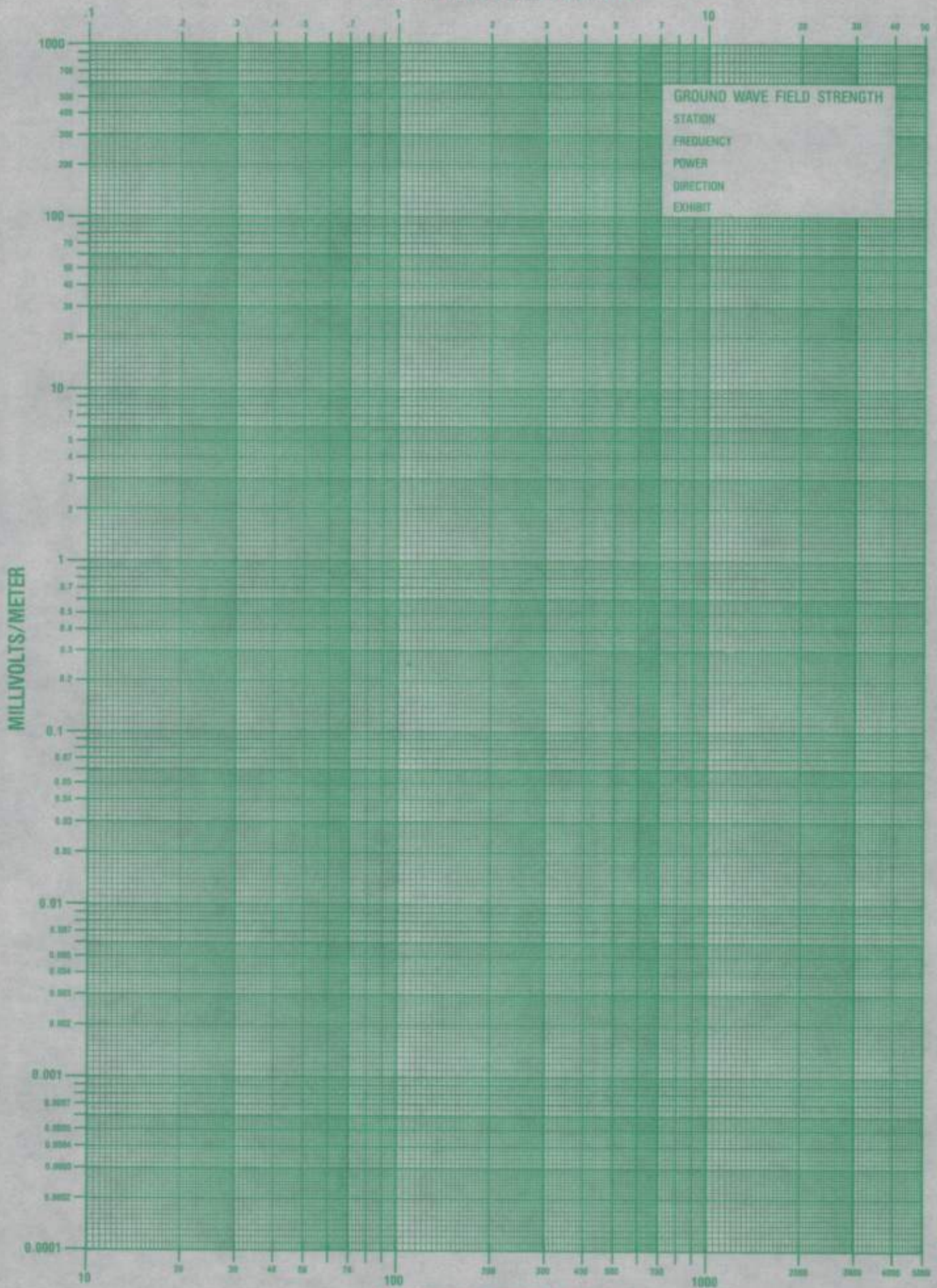
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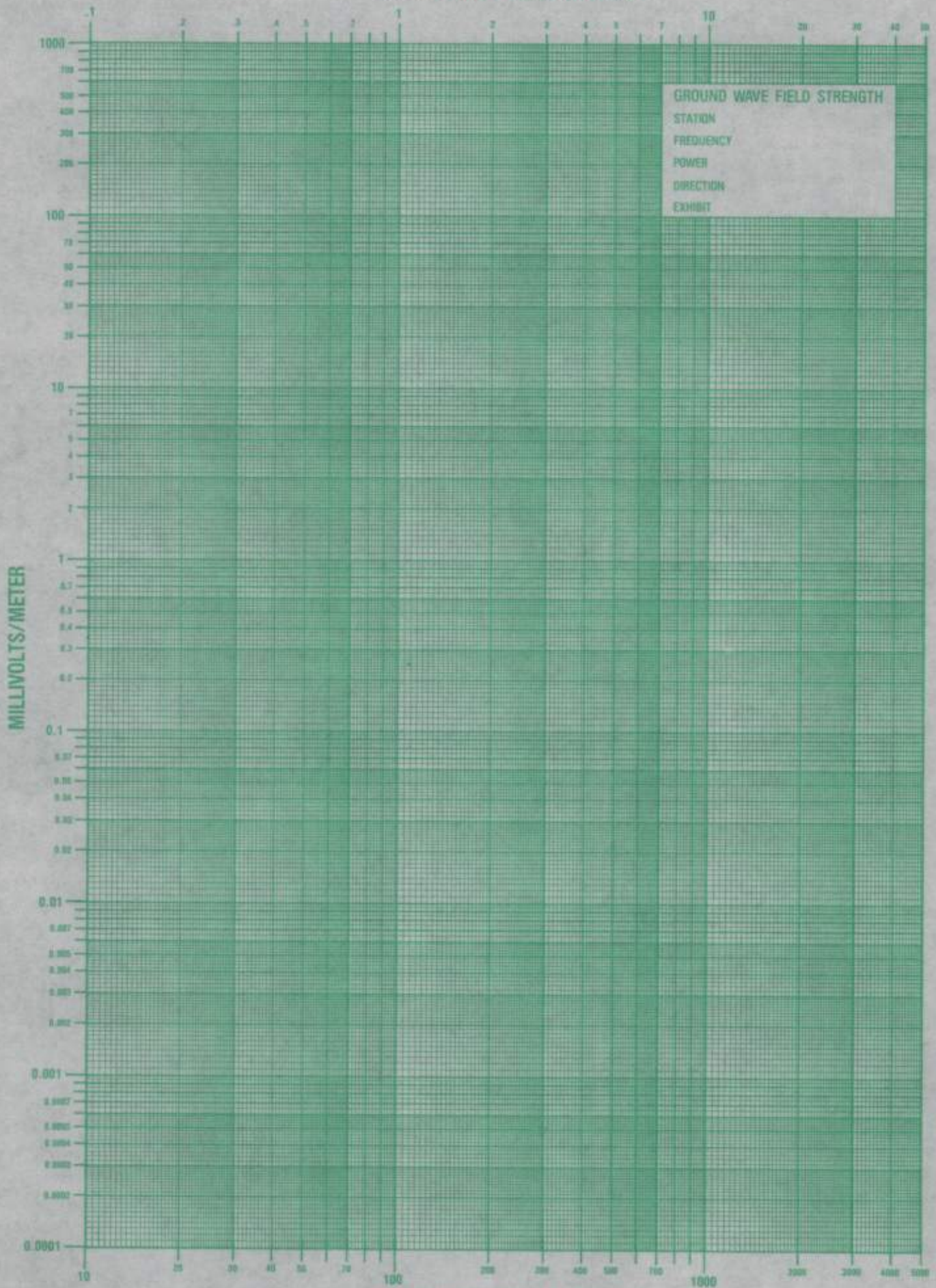
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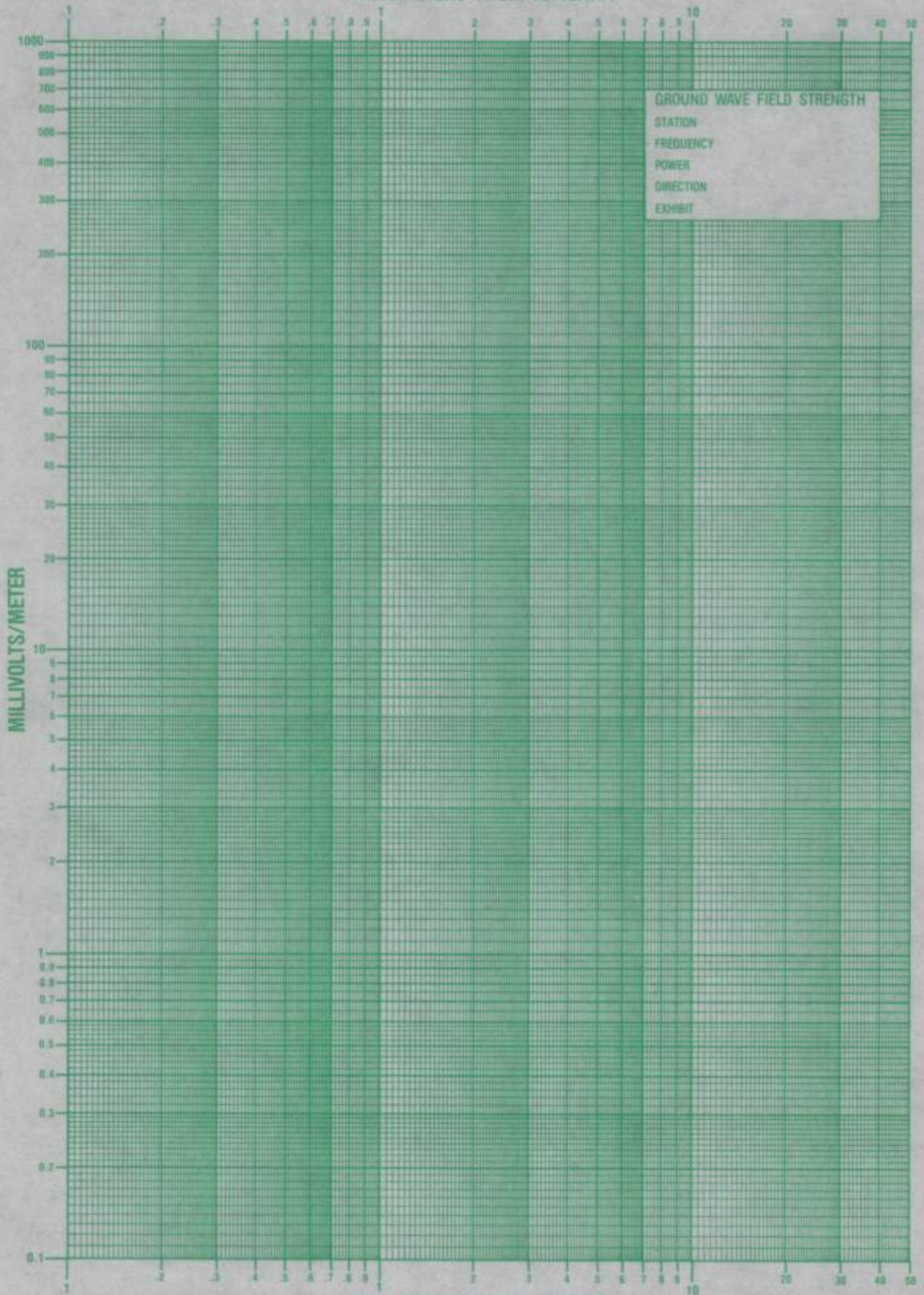
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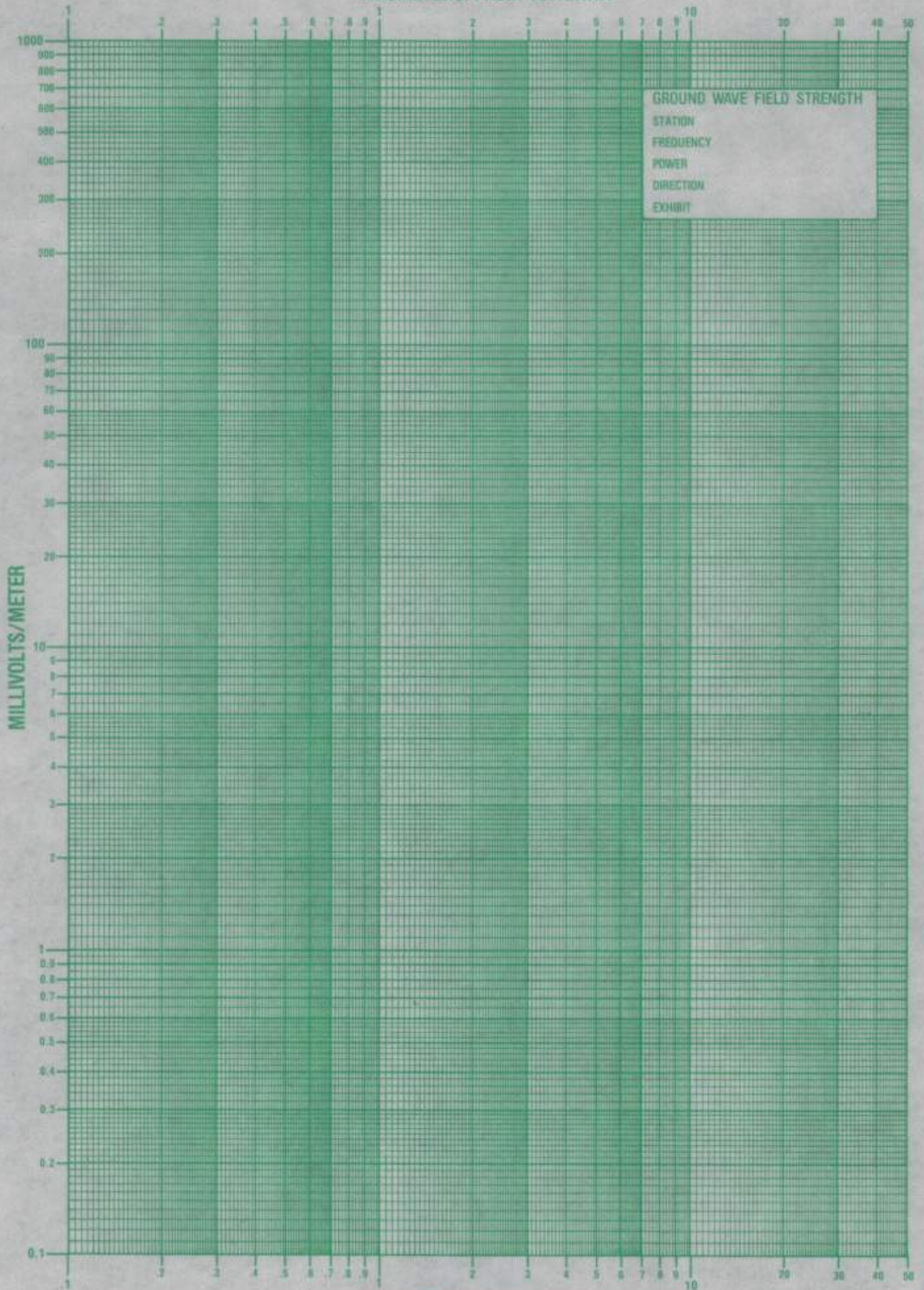
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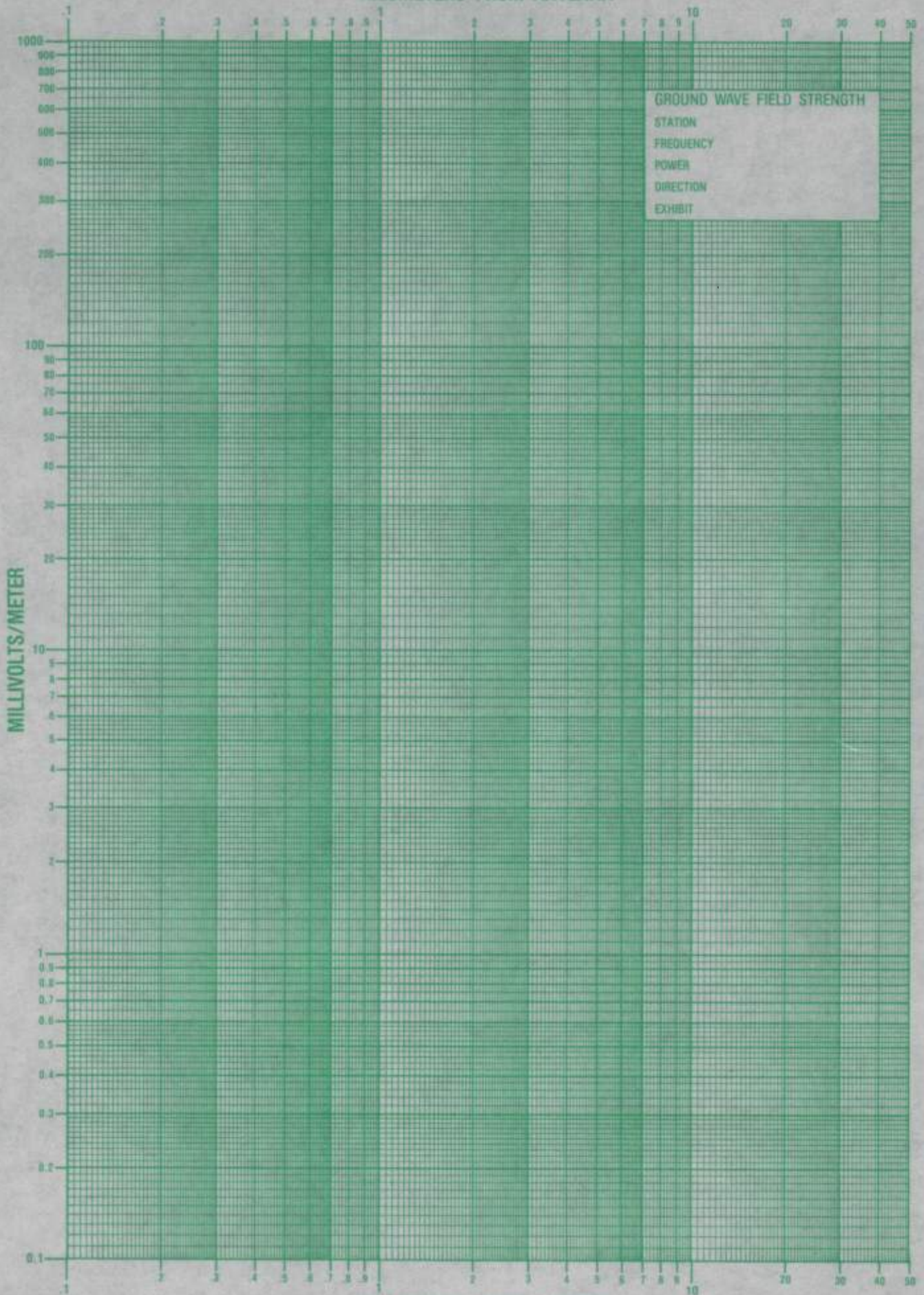
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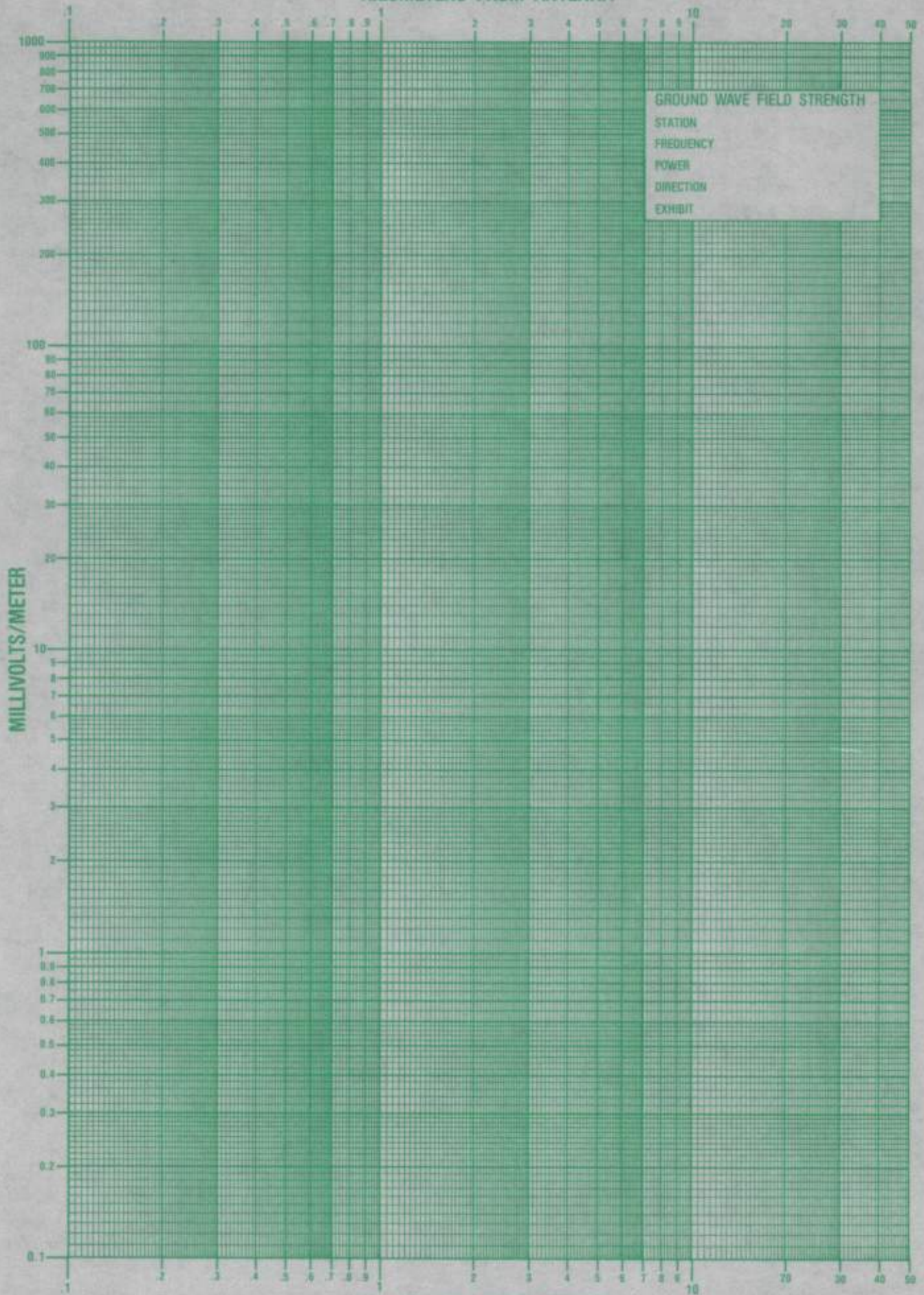
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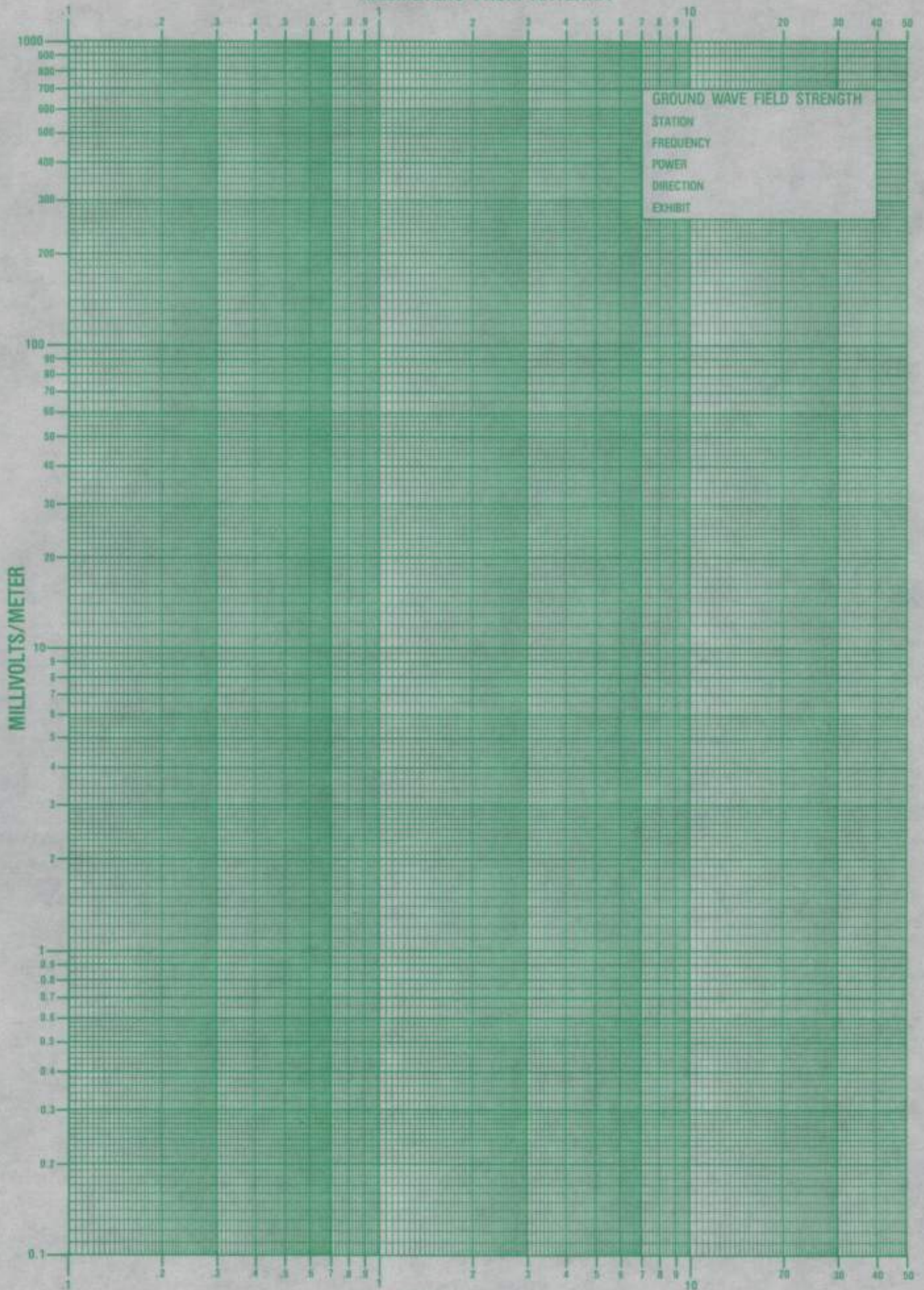
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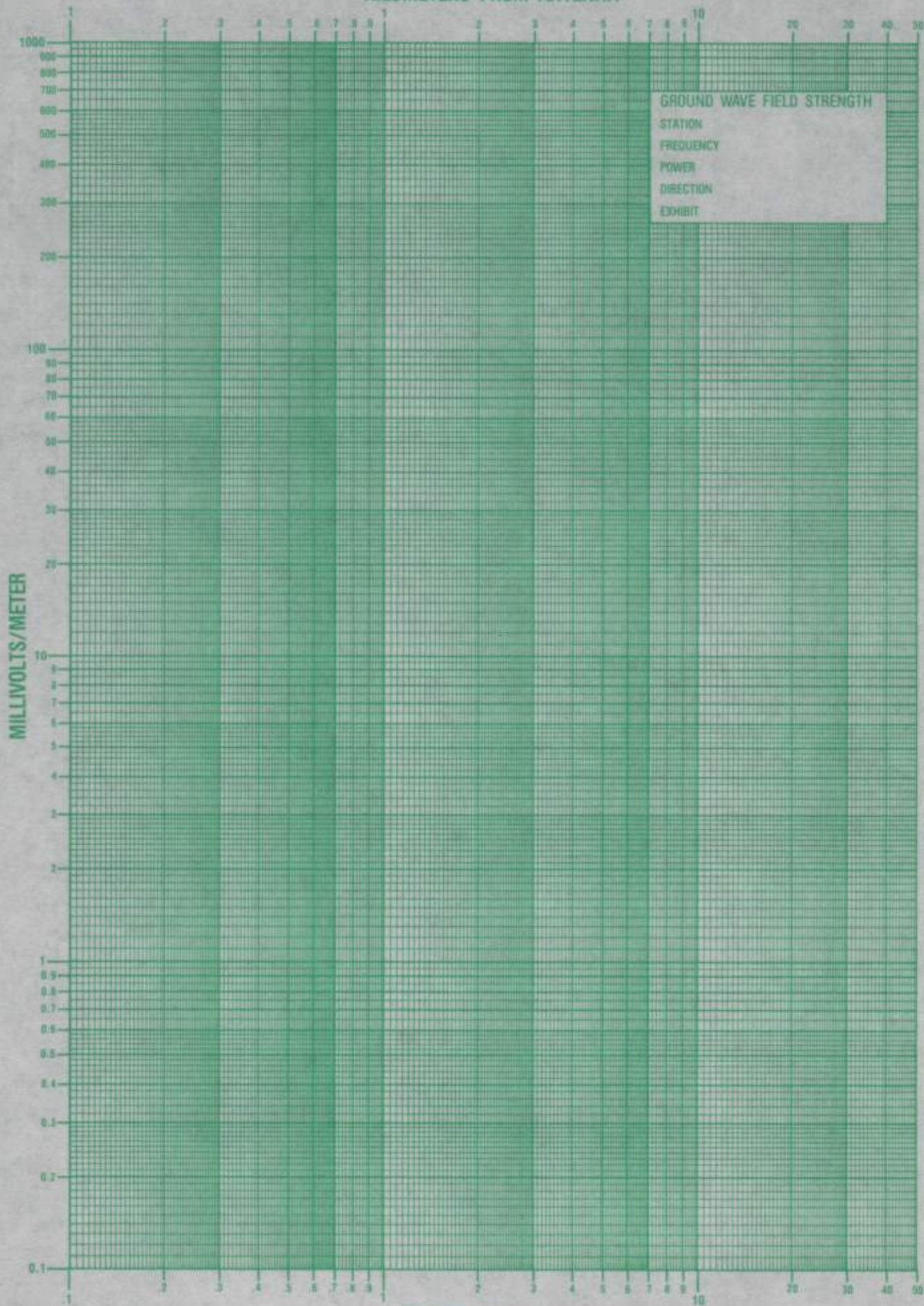
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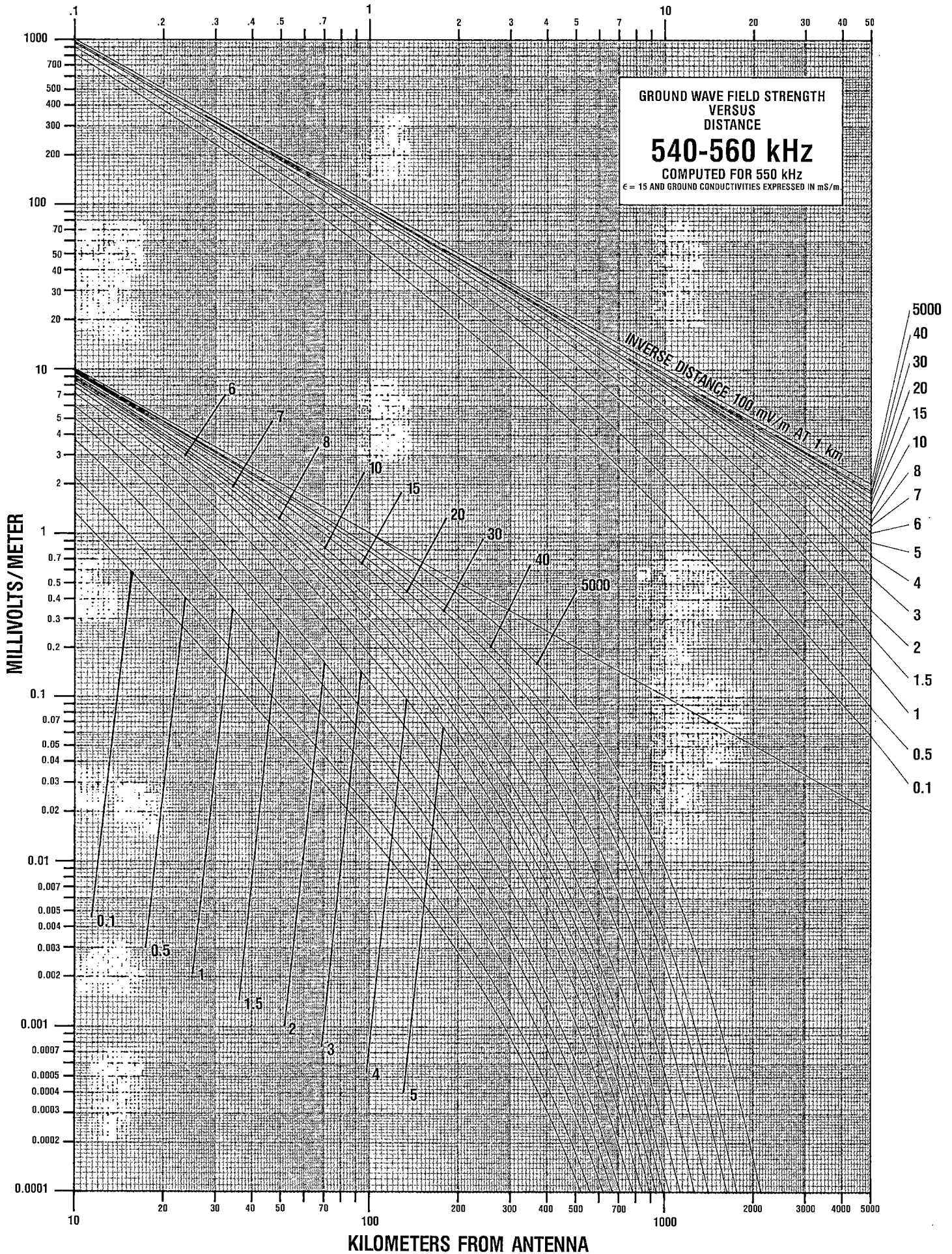
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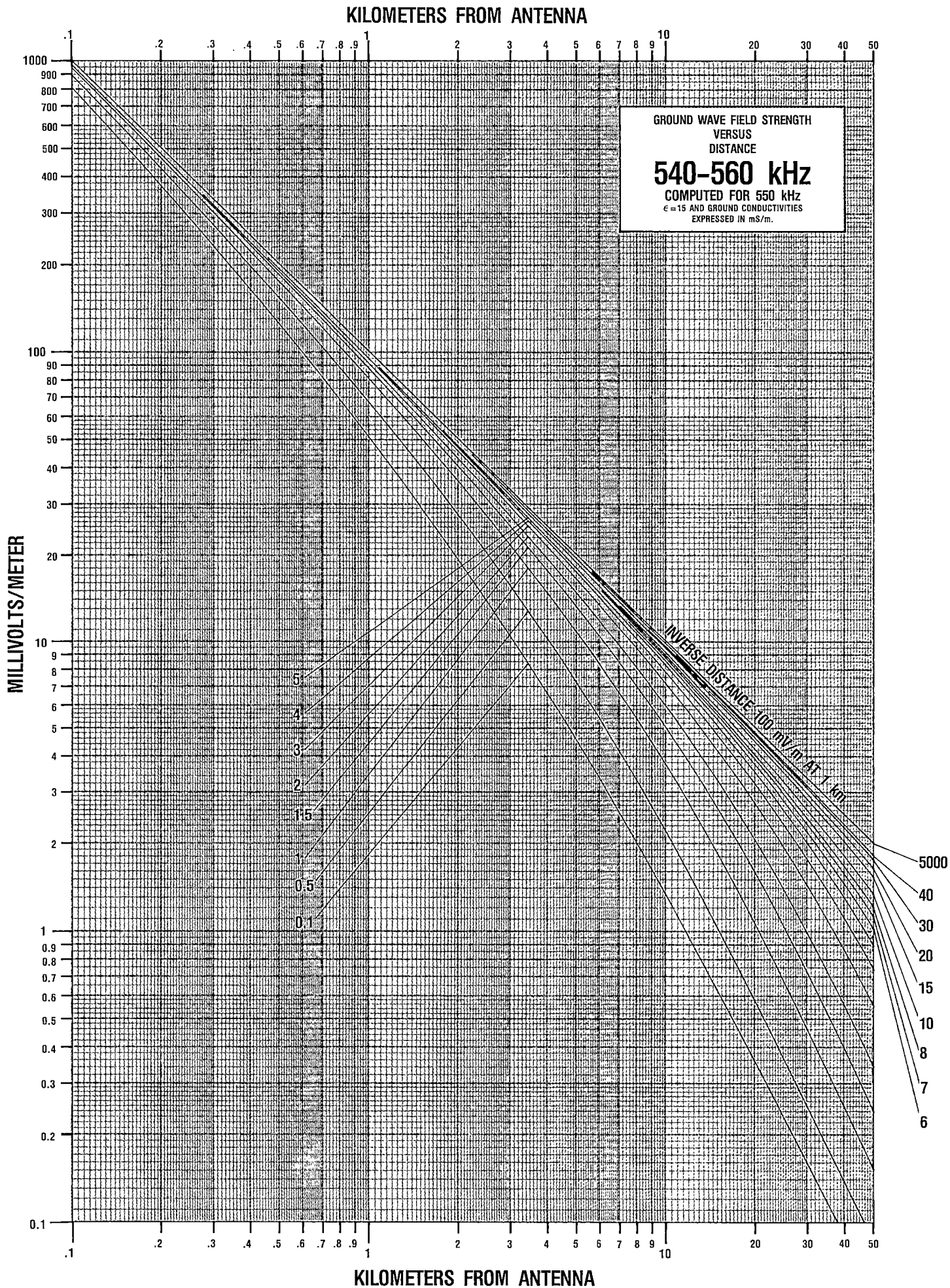
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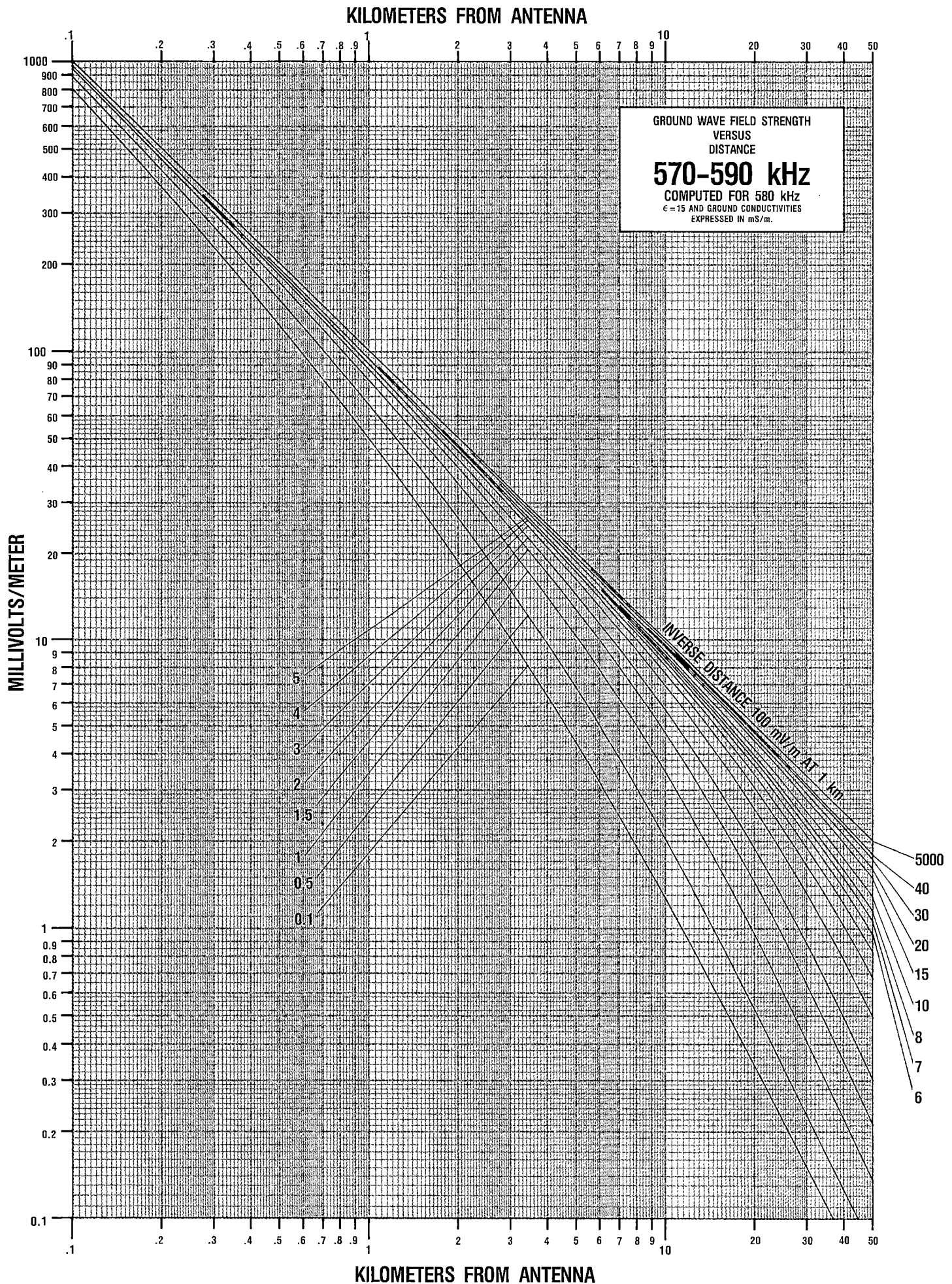
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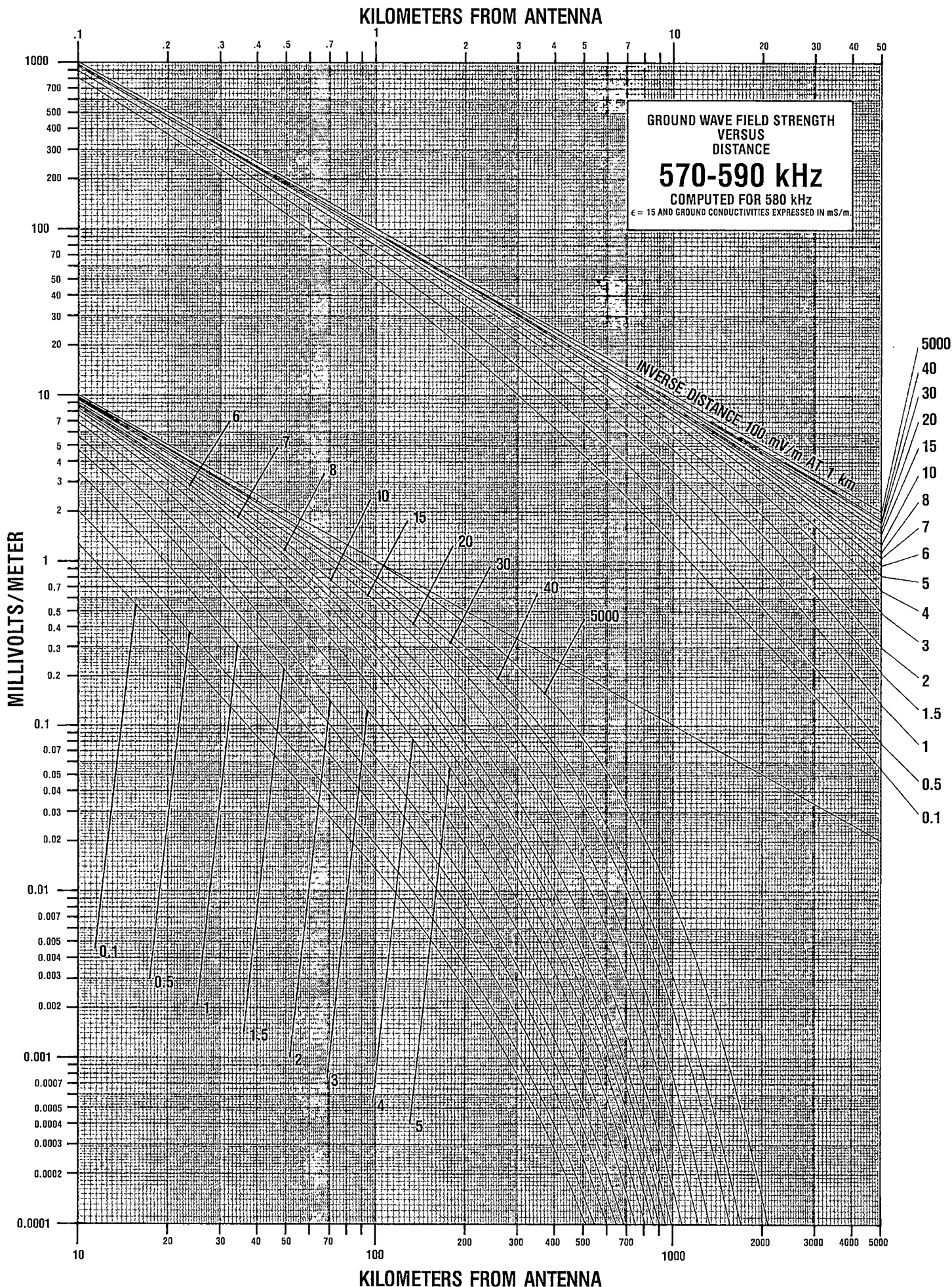
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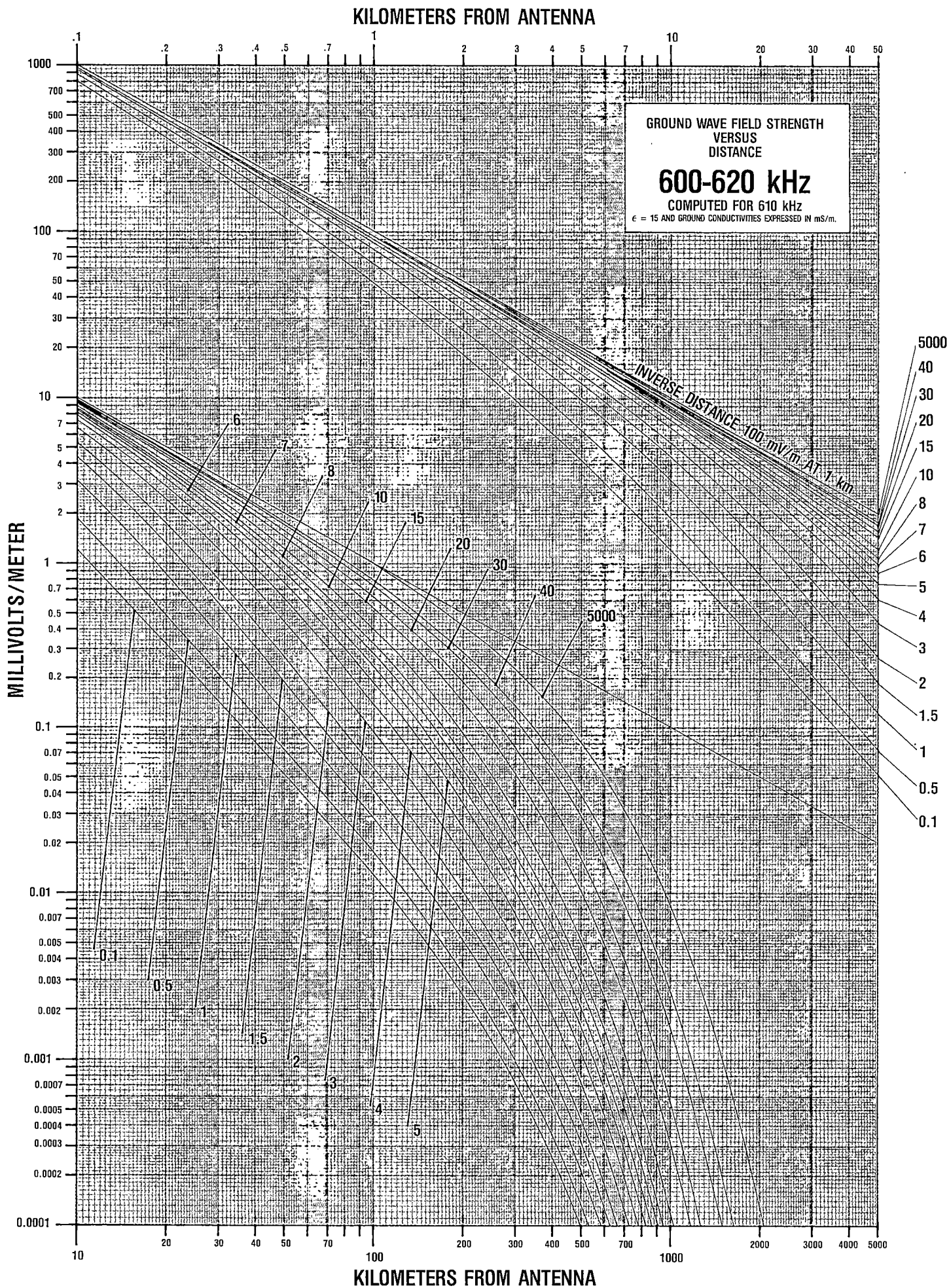
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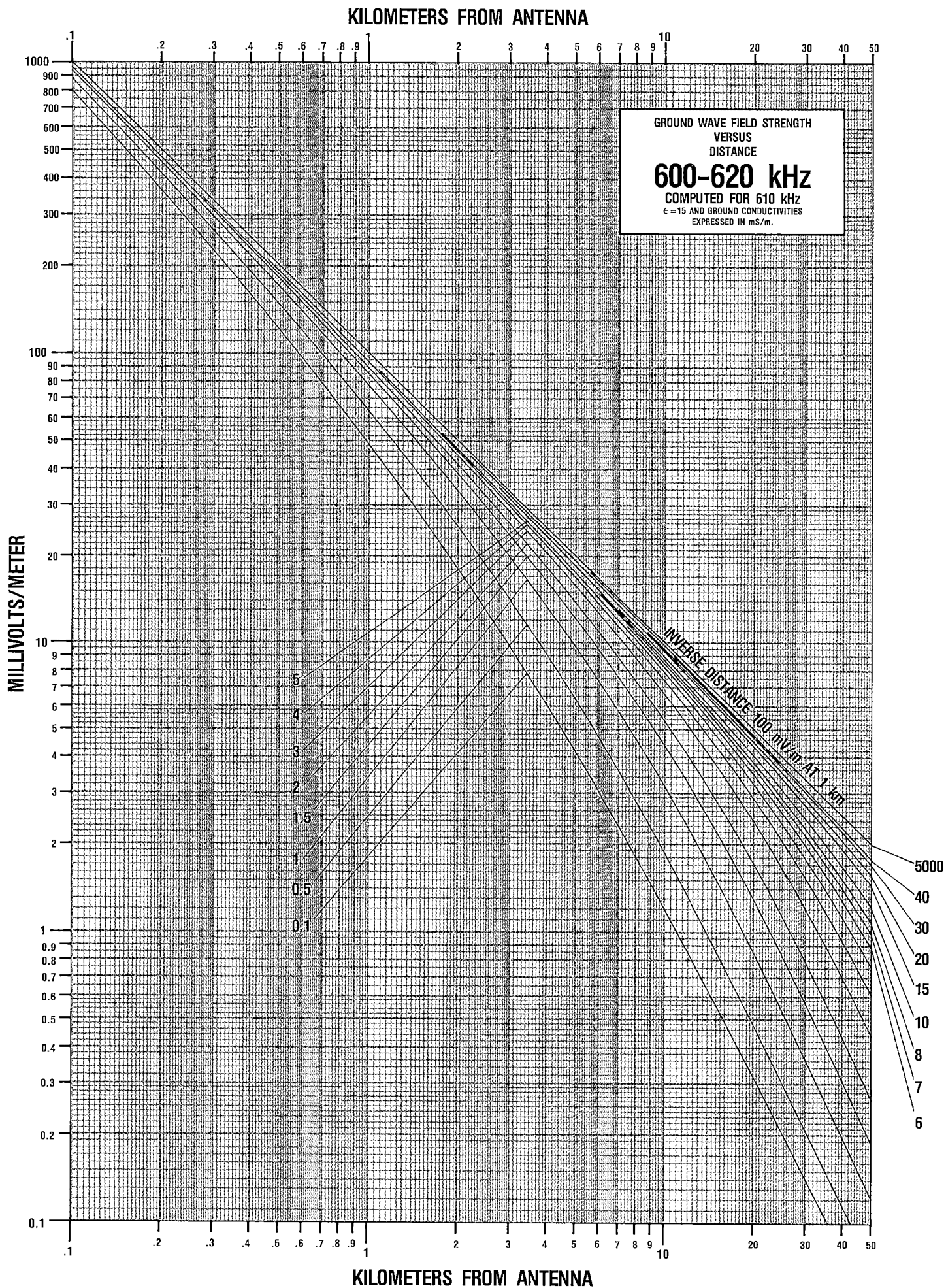
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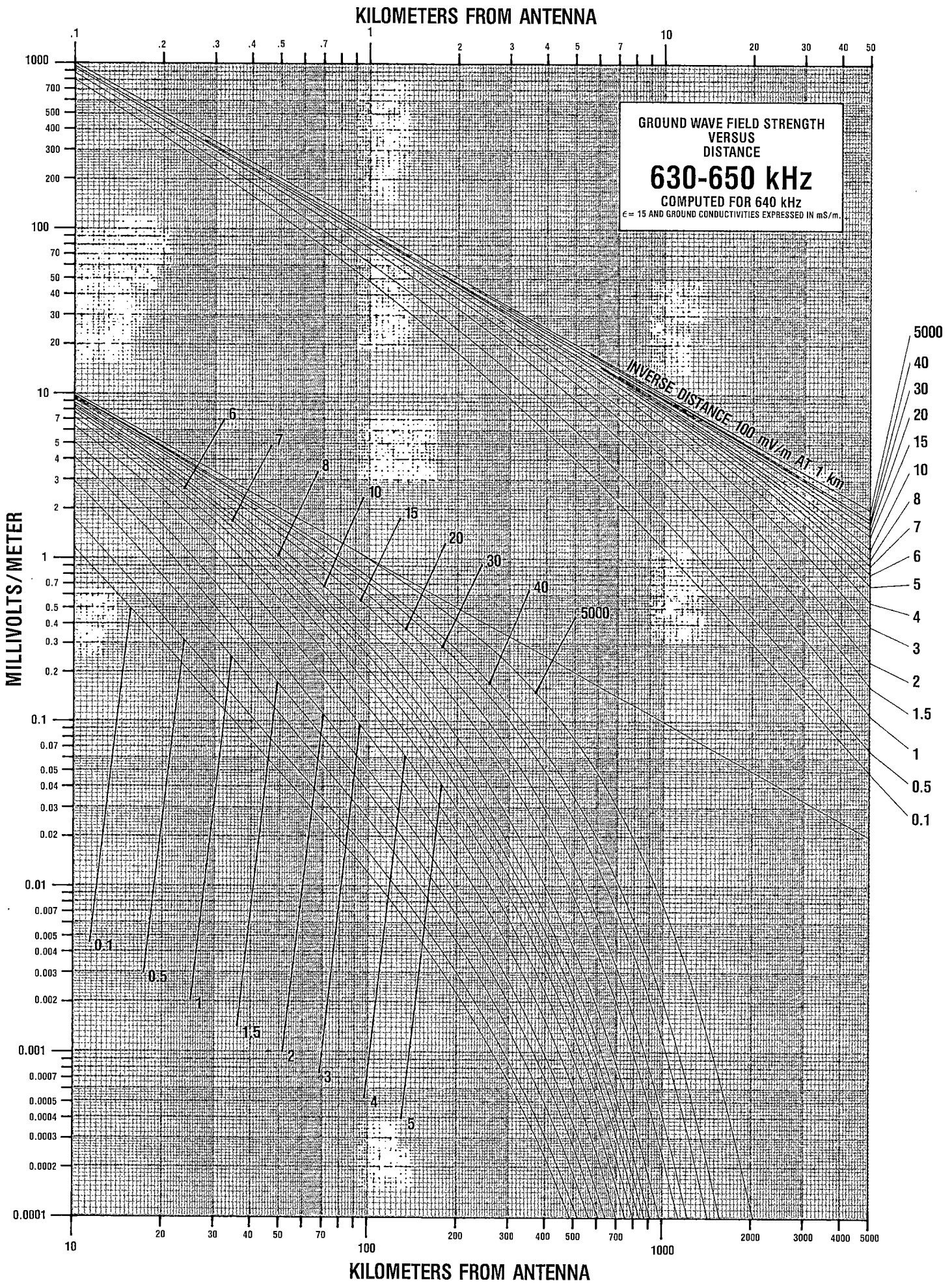
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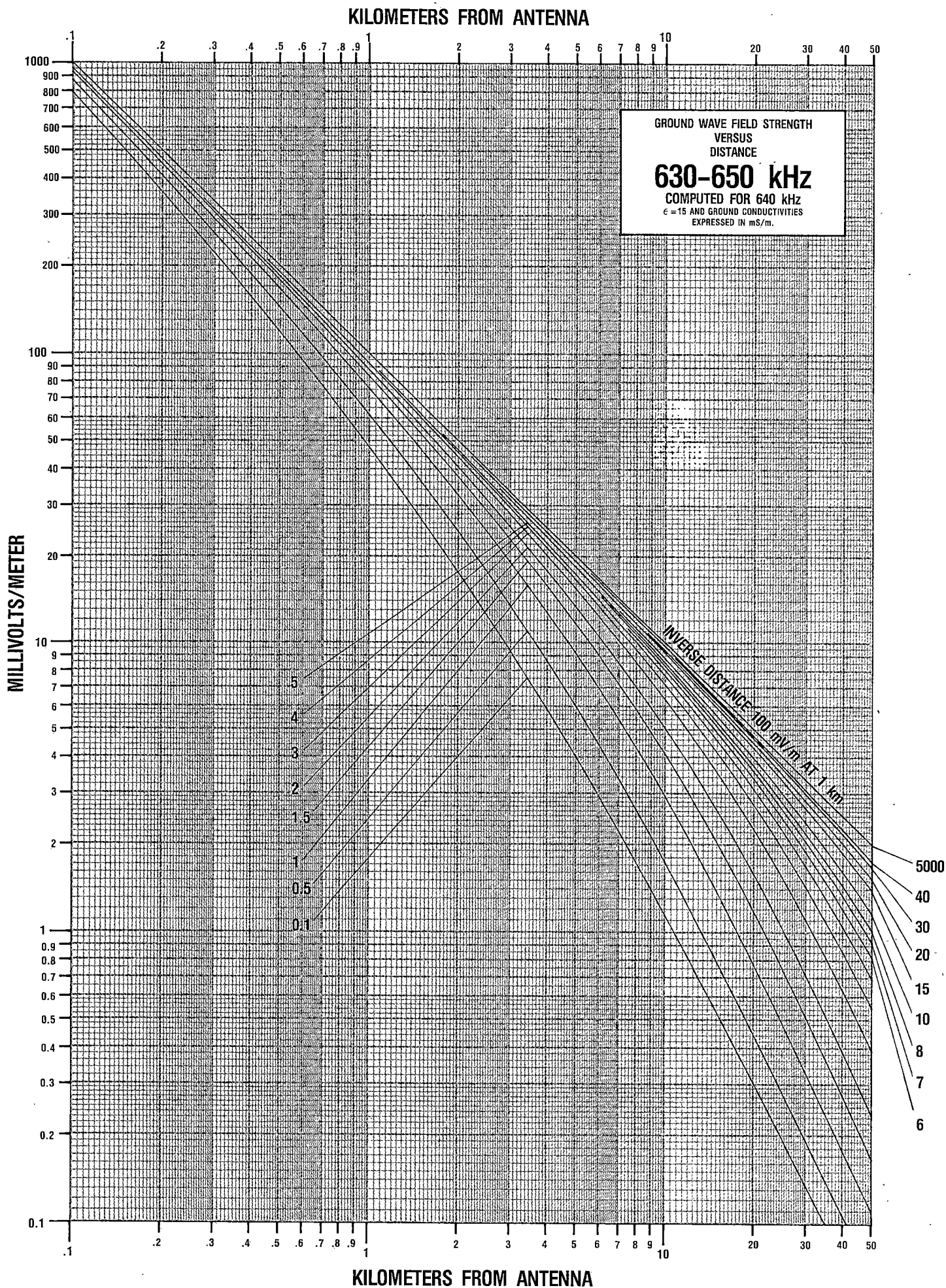
GRAPH 3



GRAPH 3-A

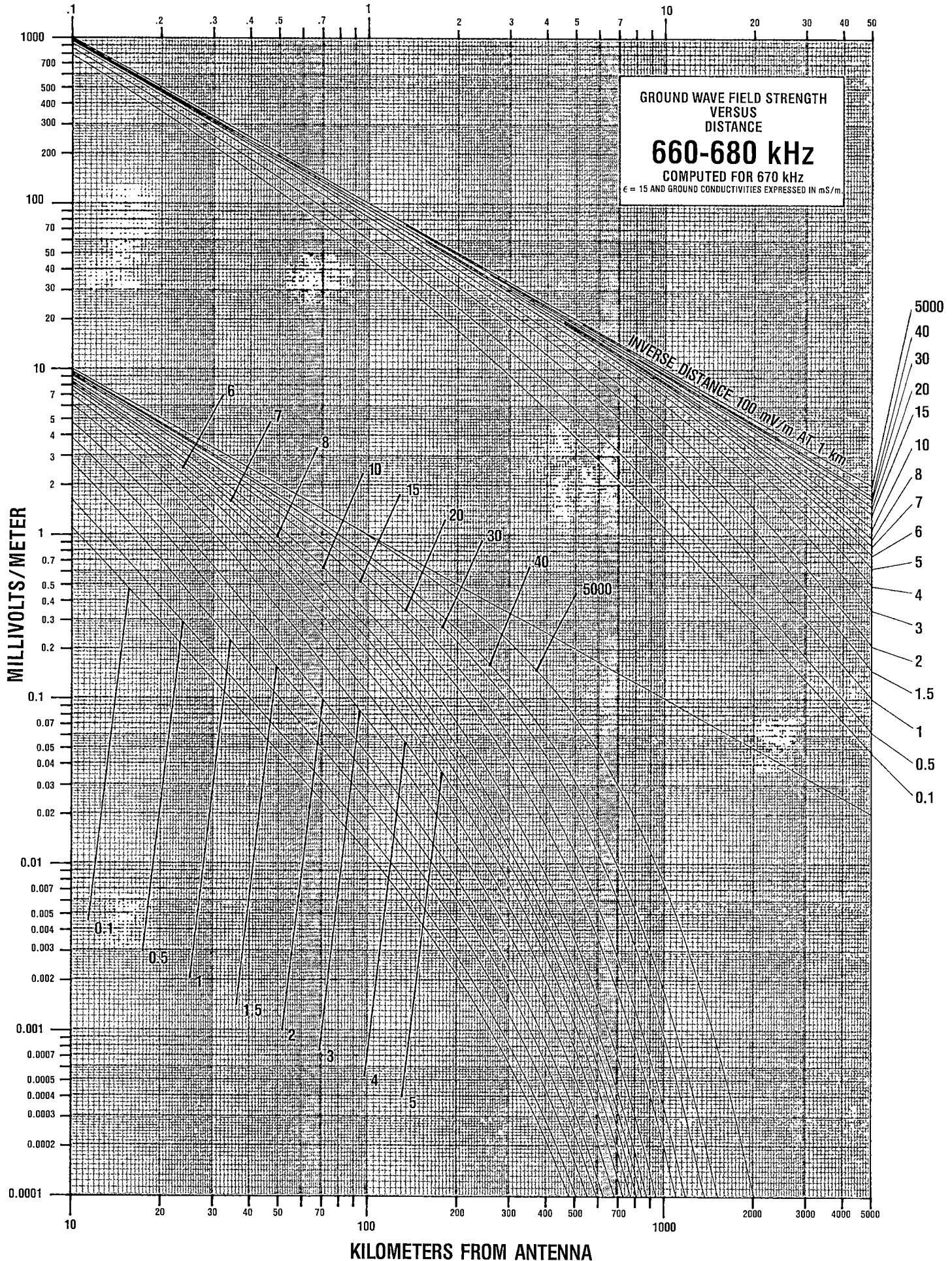


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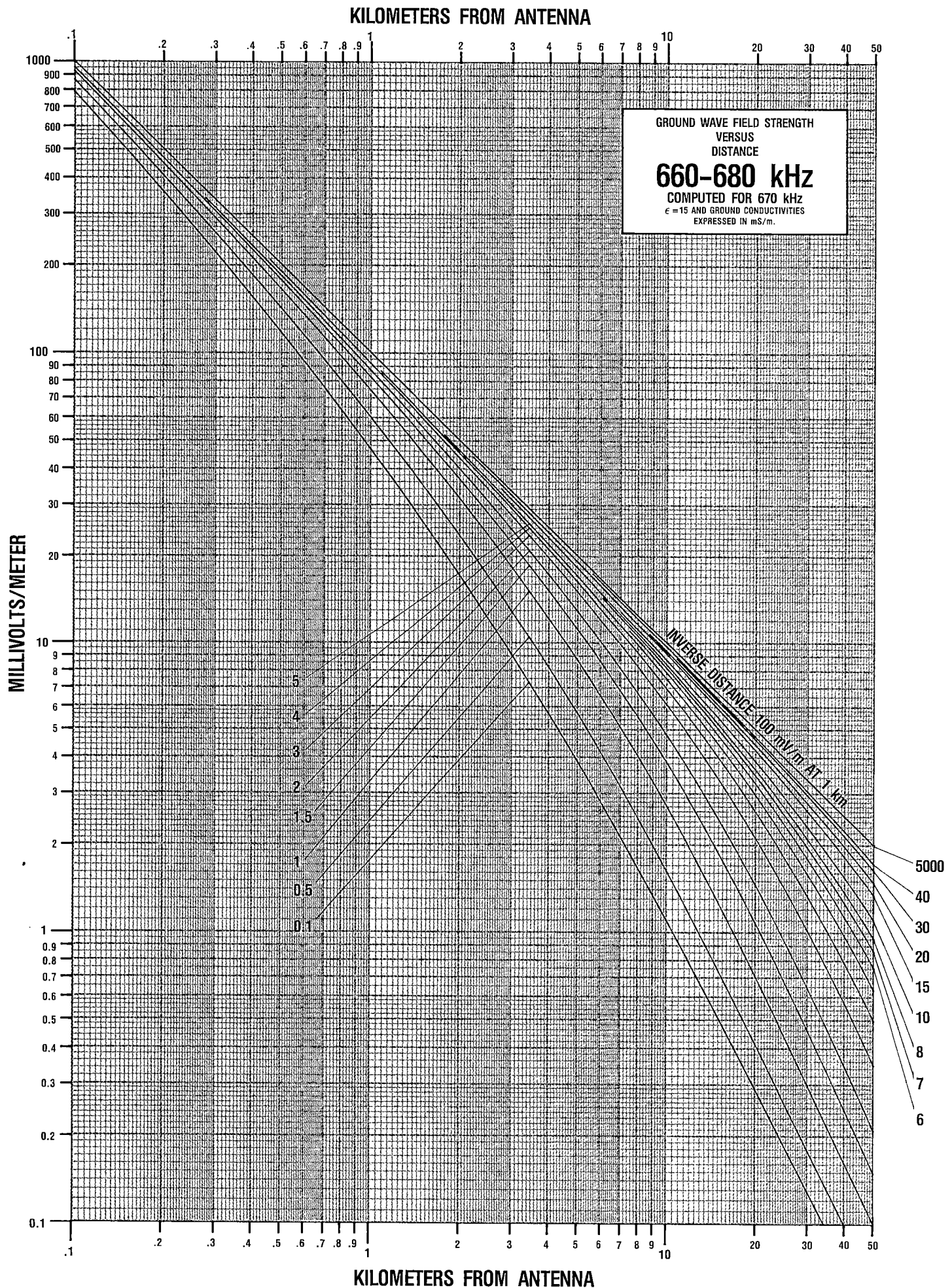


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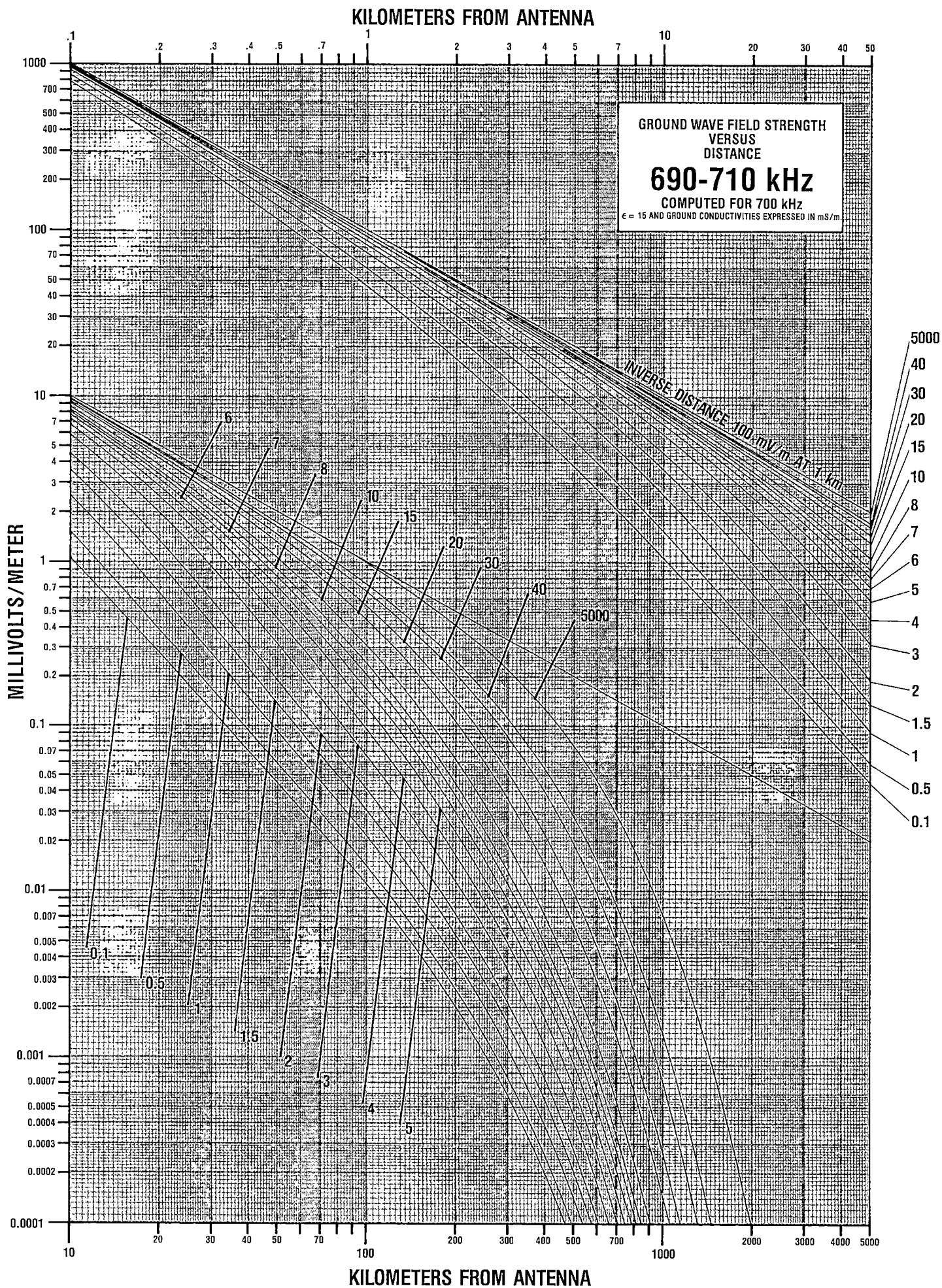
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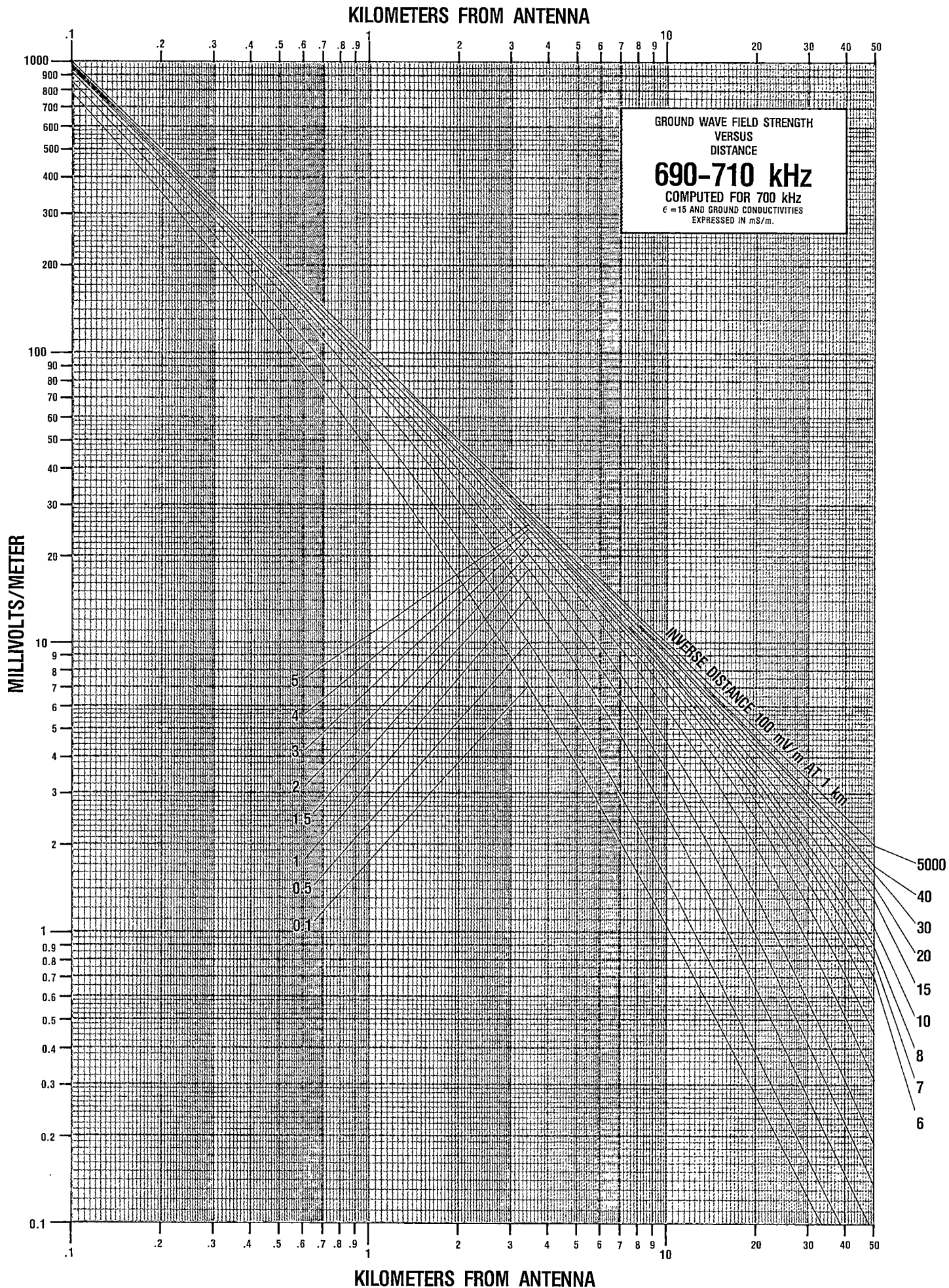
GRAPH 5



GRAPH 5-A

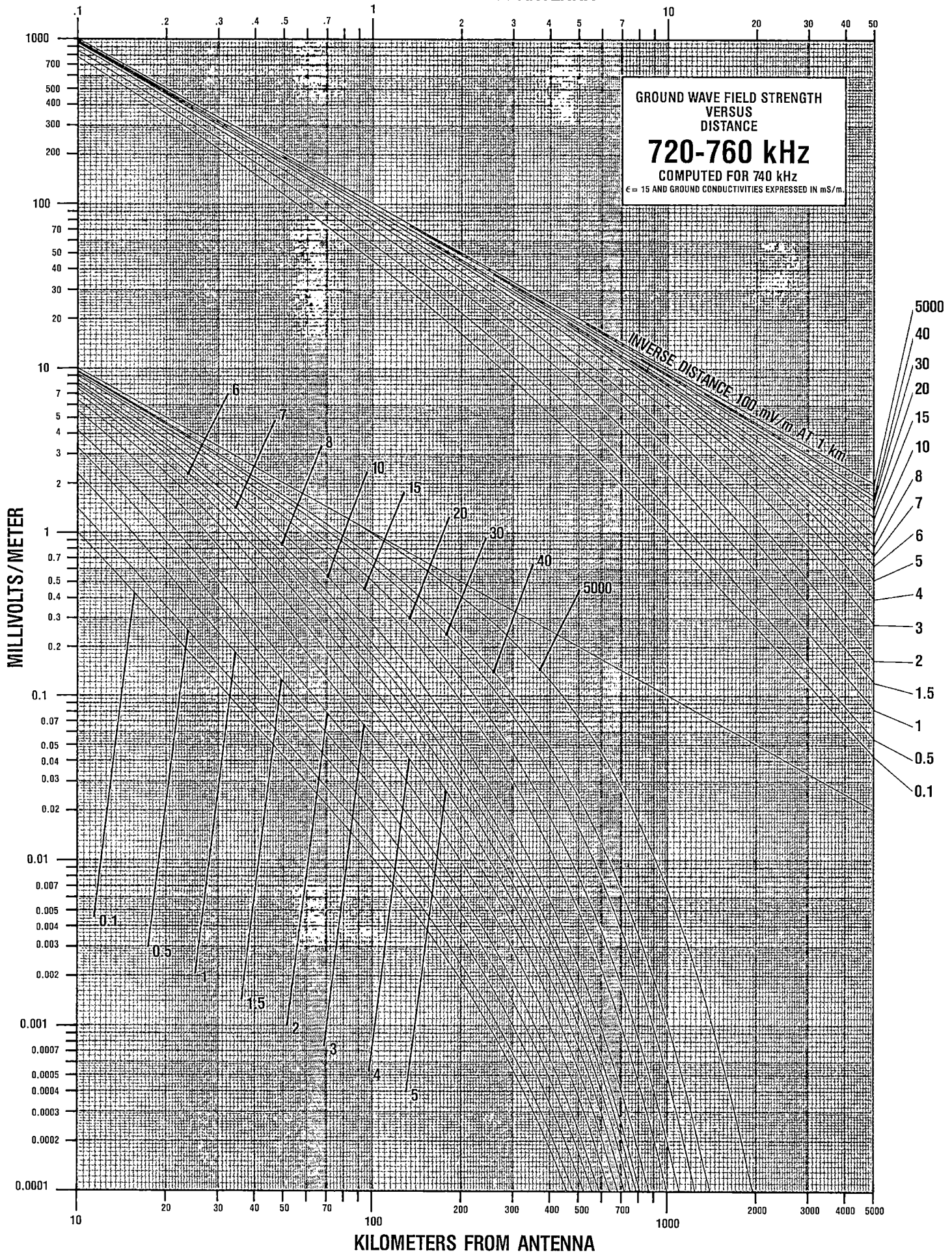


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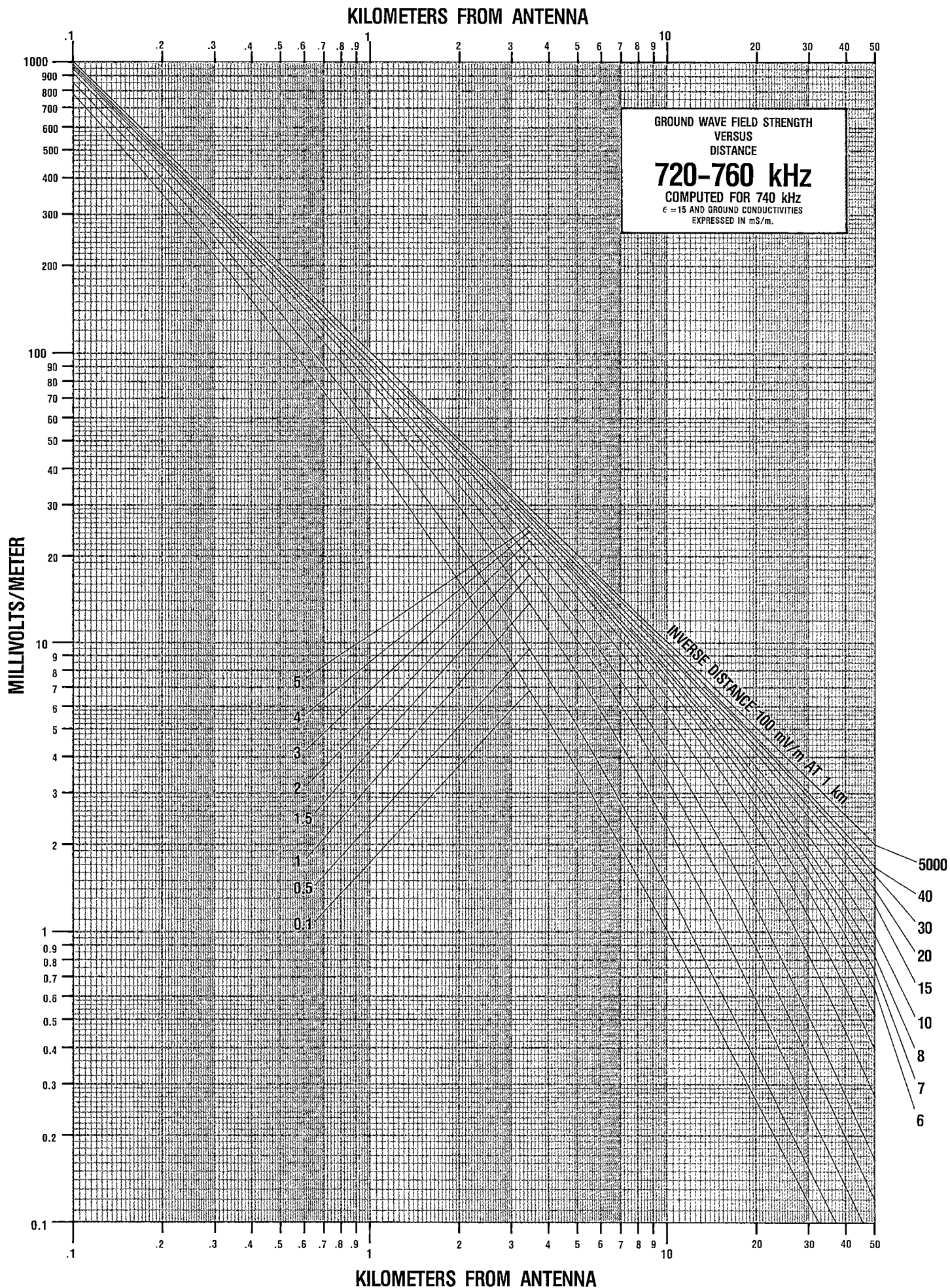
GRAPH 6-A

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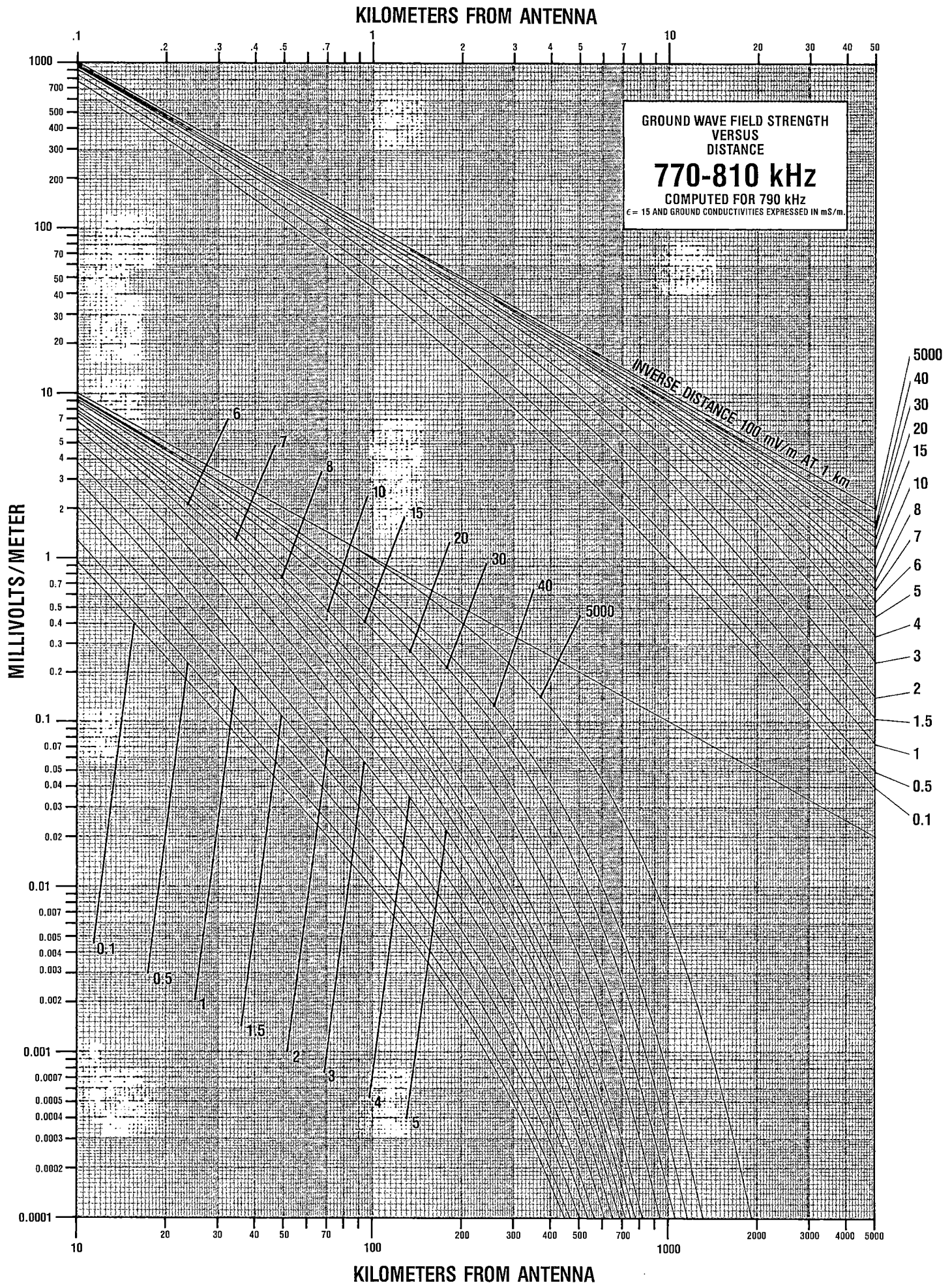


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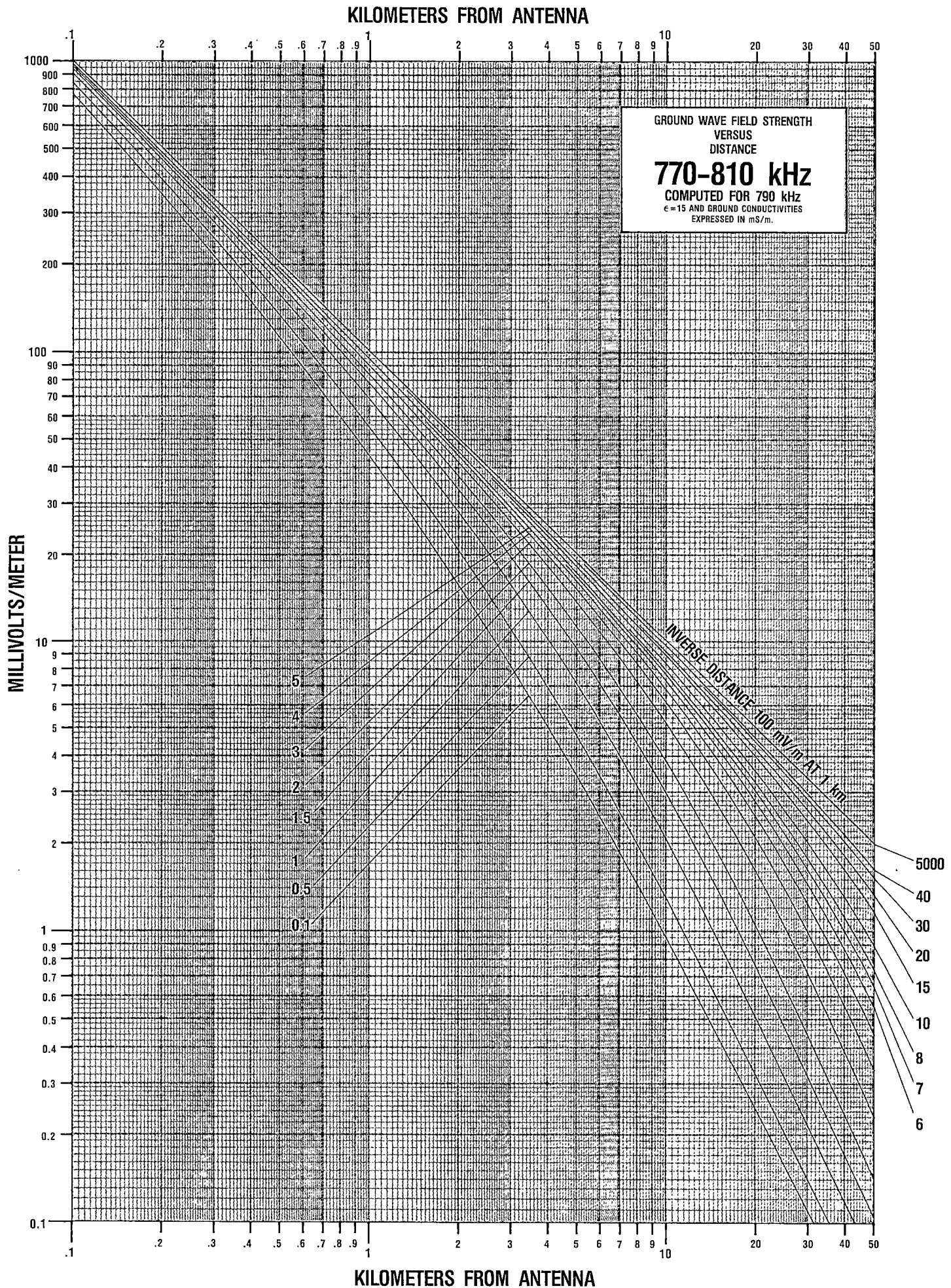
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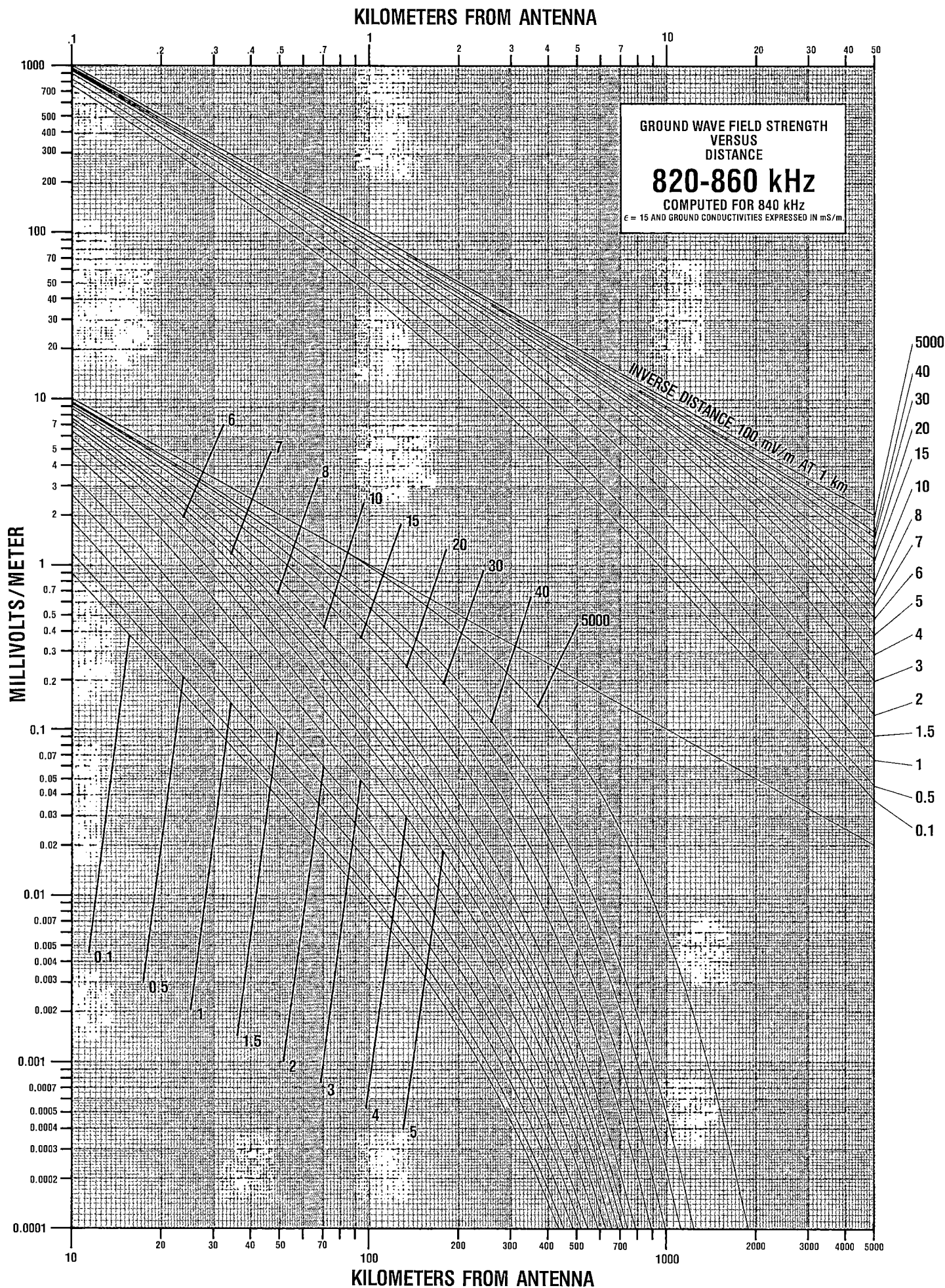
GRAPH 7-A



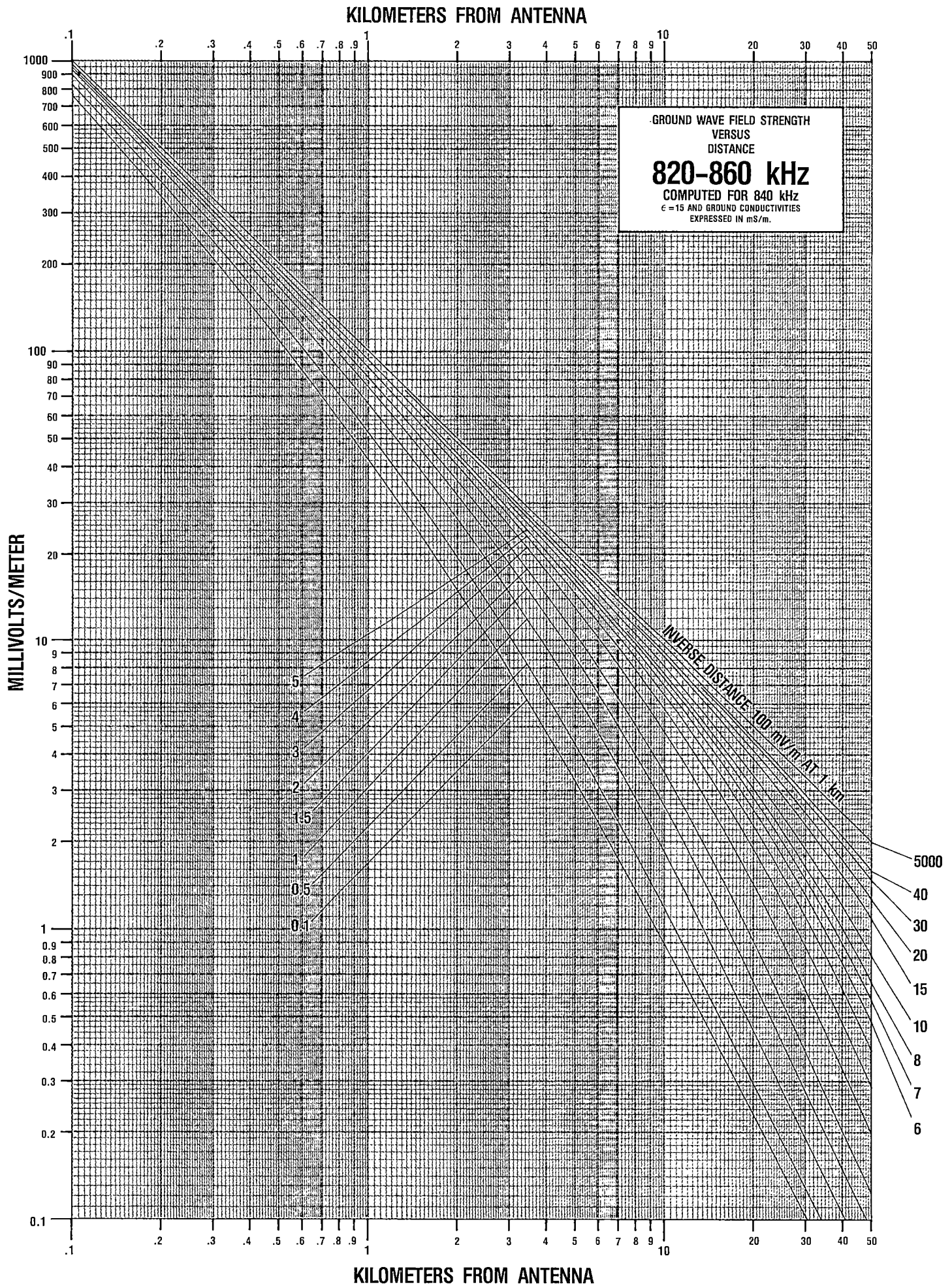
GRAPH 8



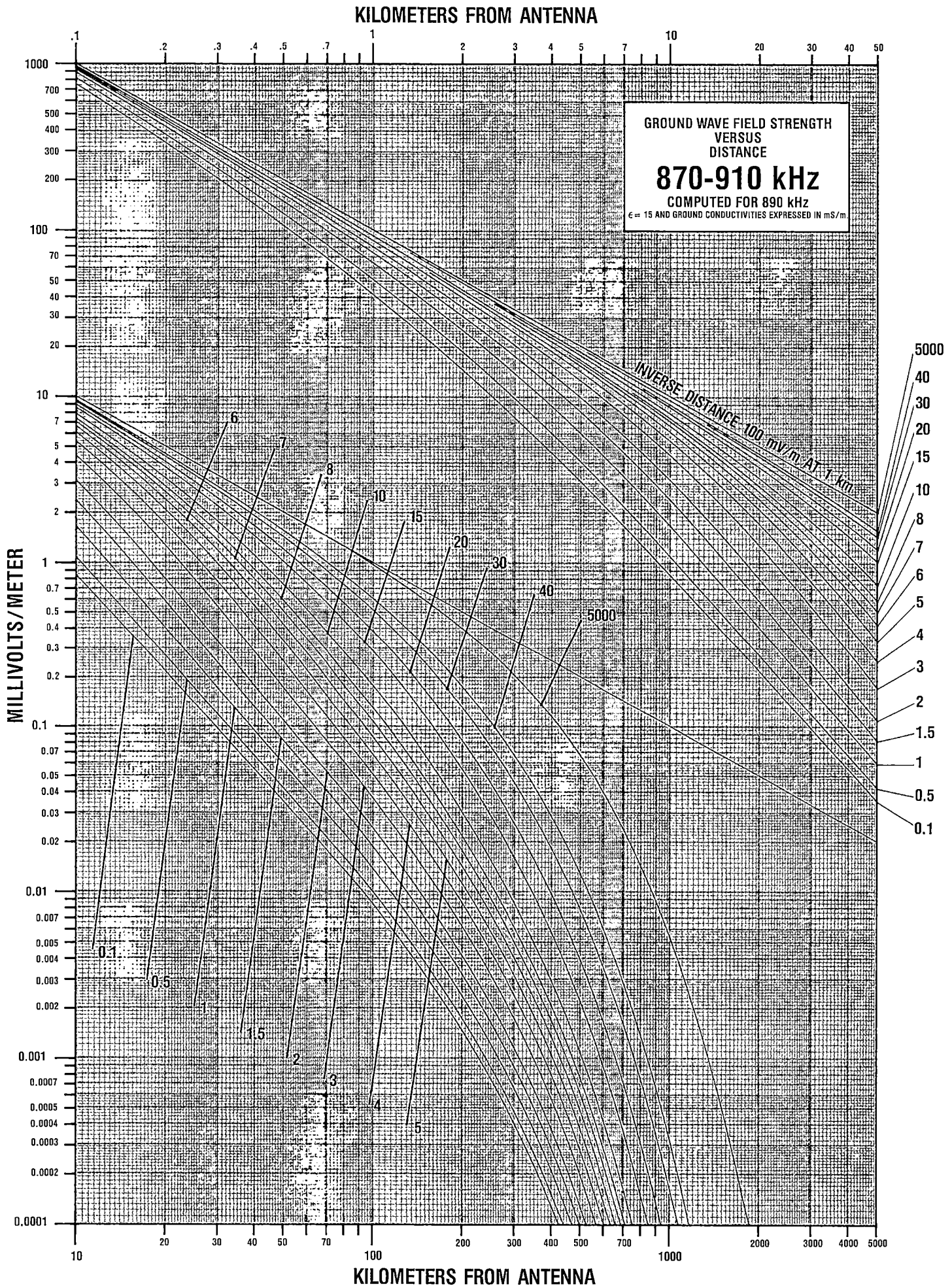
GRAPH 8-A



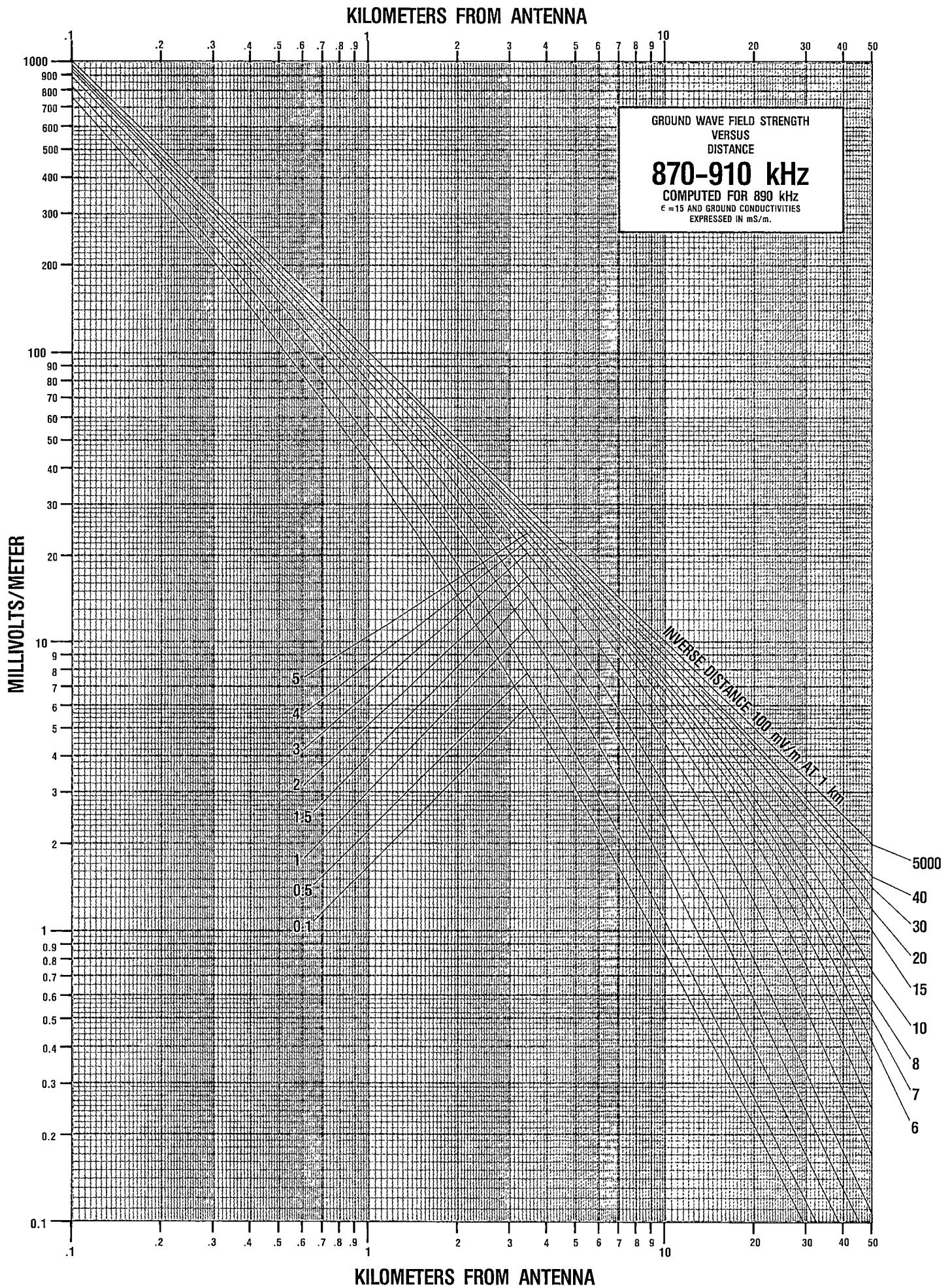
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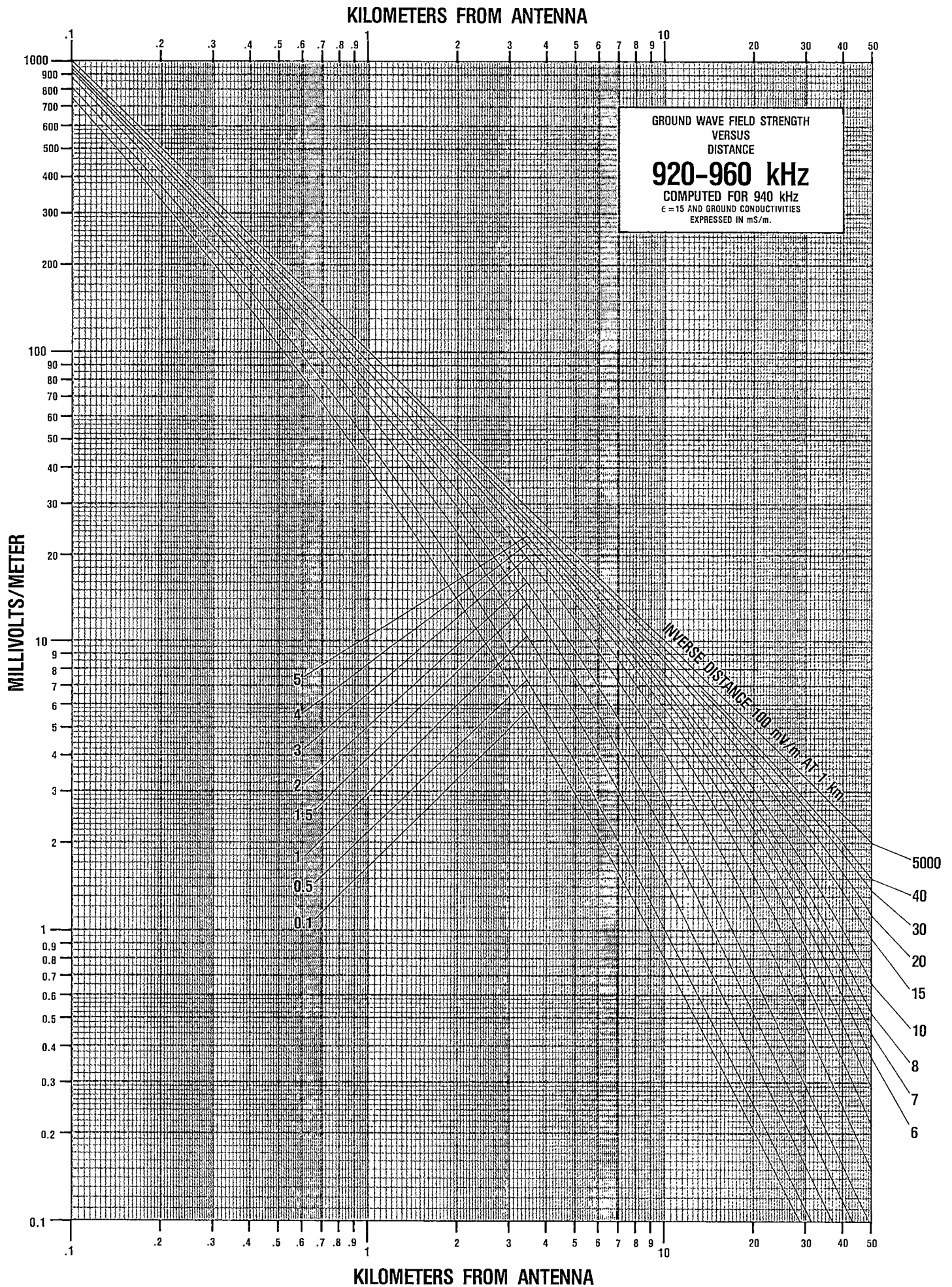


GRAPH 9-A

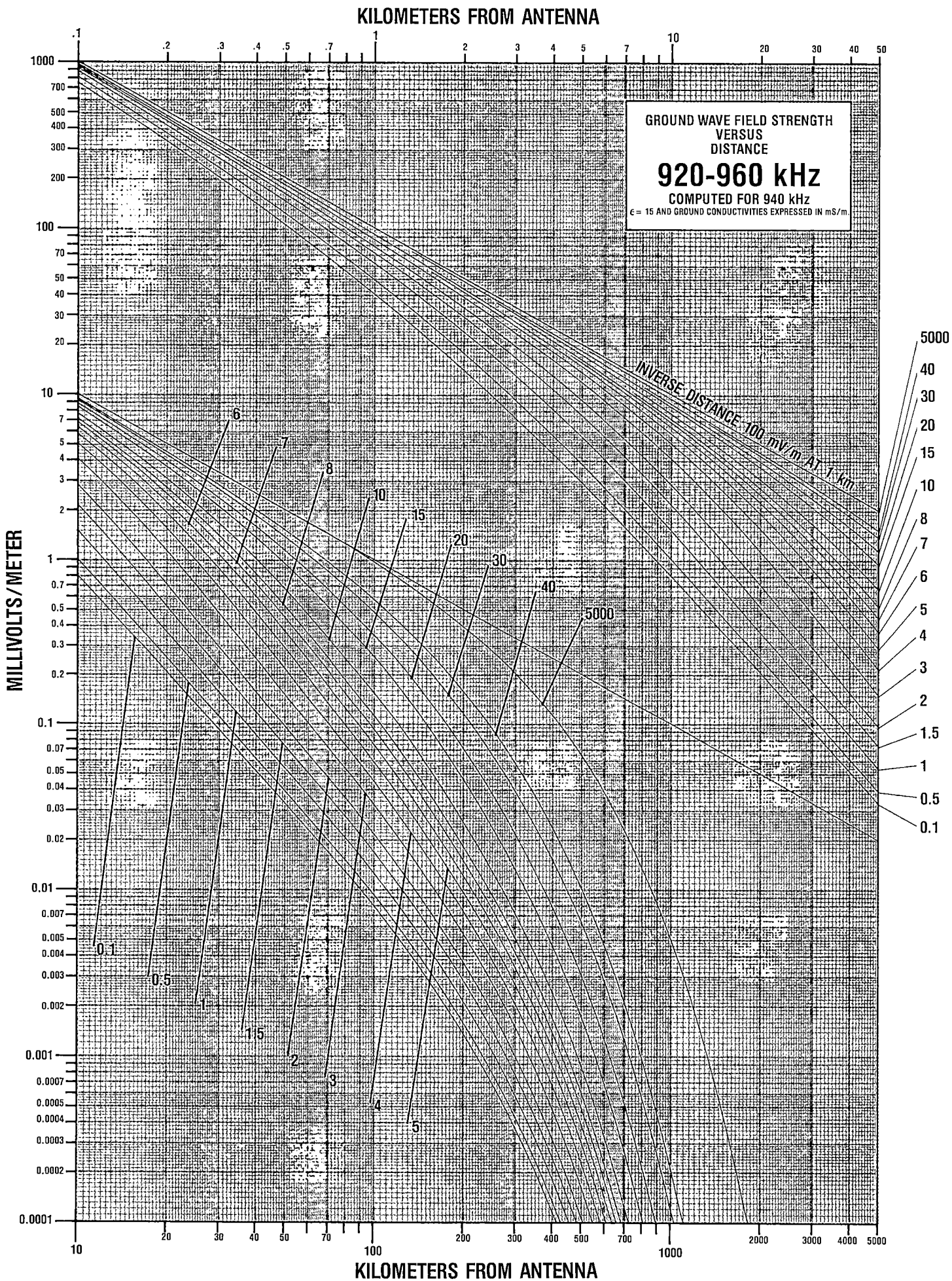


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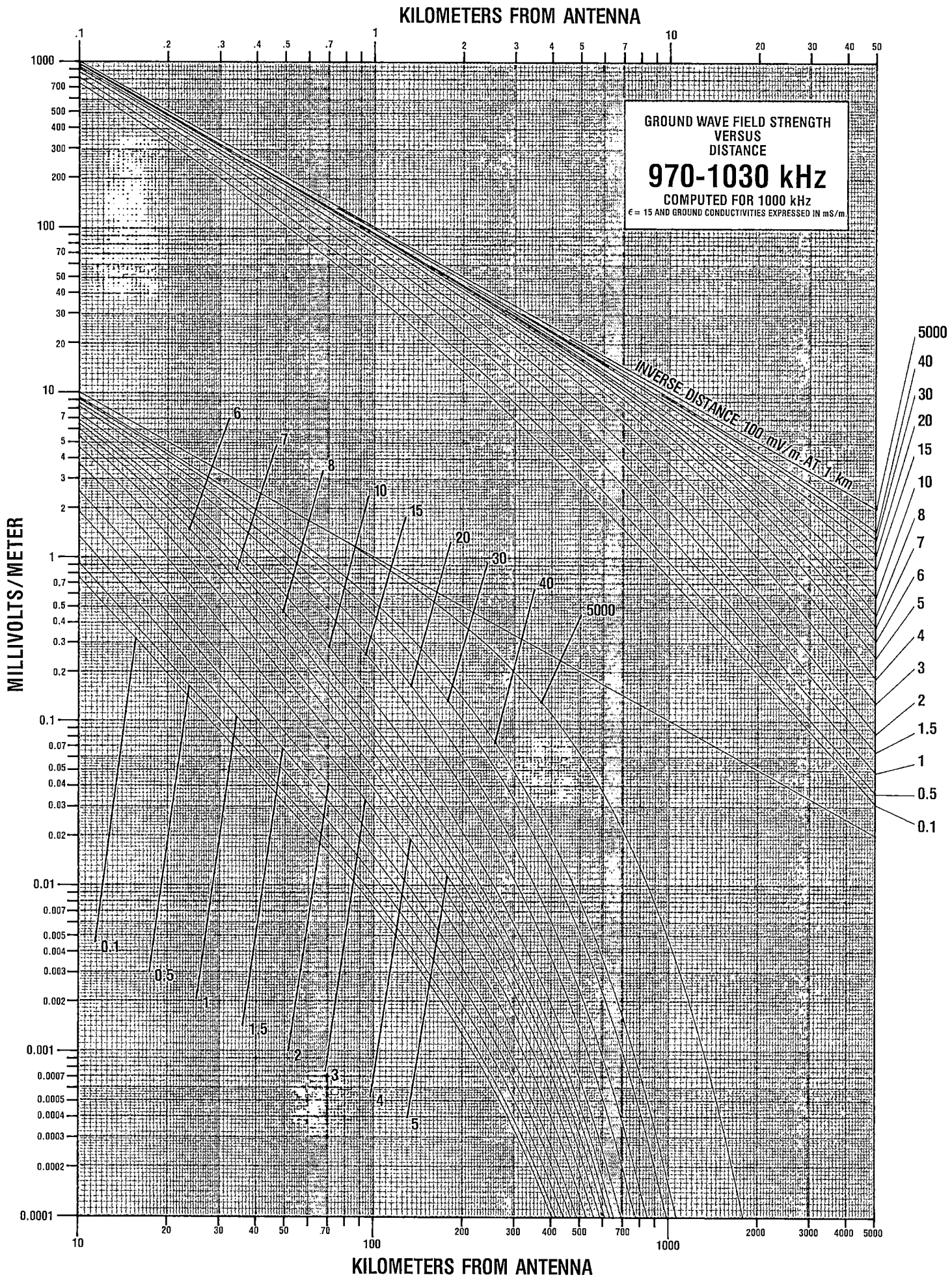




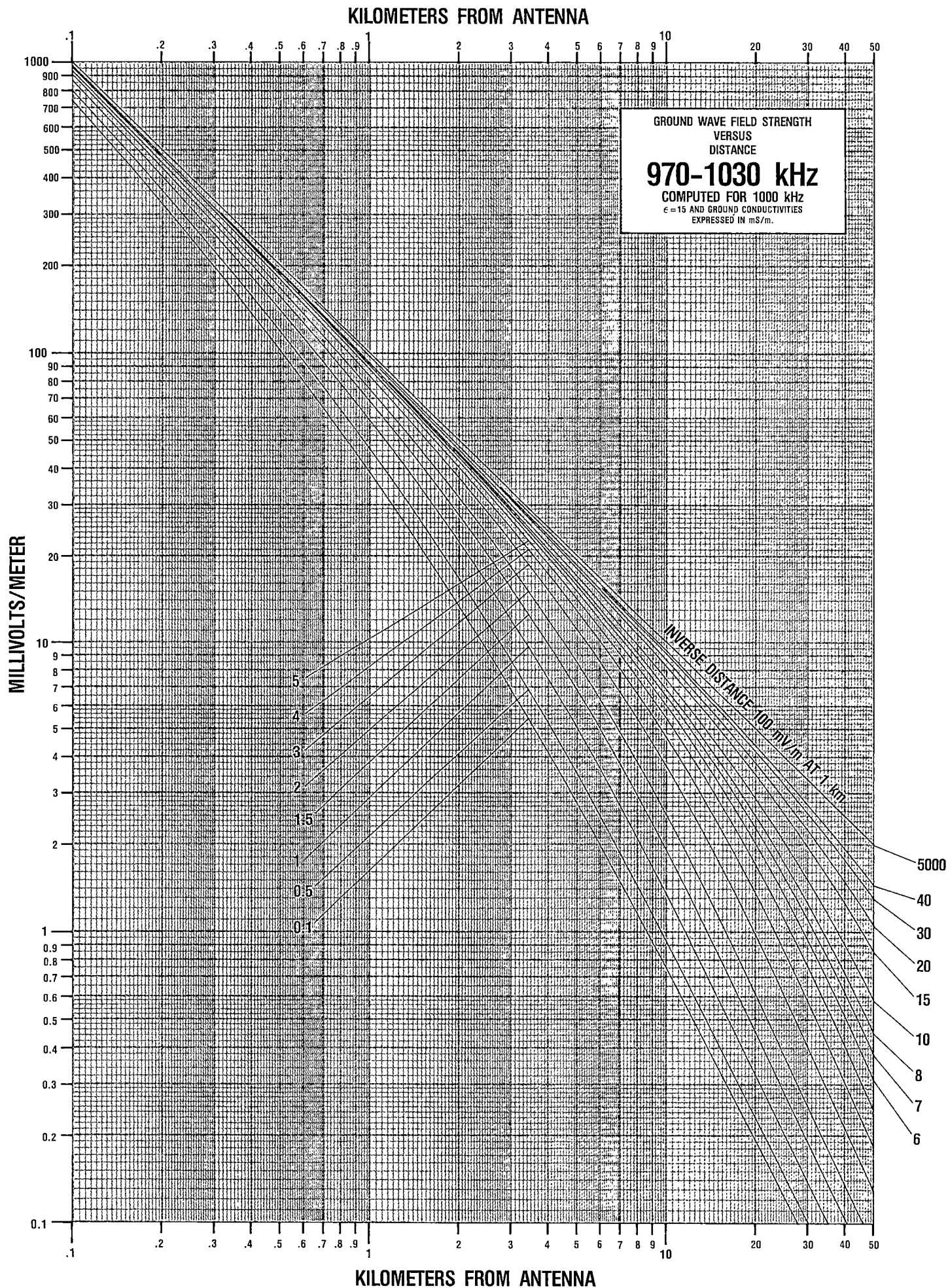
GRAPH 11-A



GRAPH 11

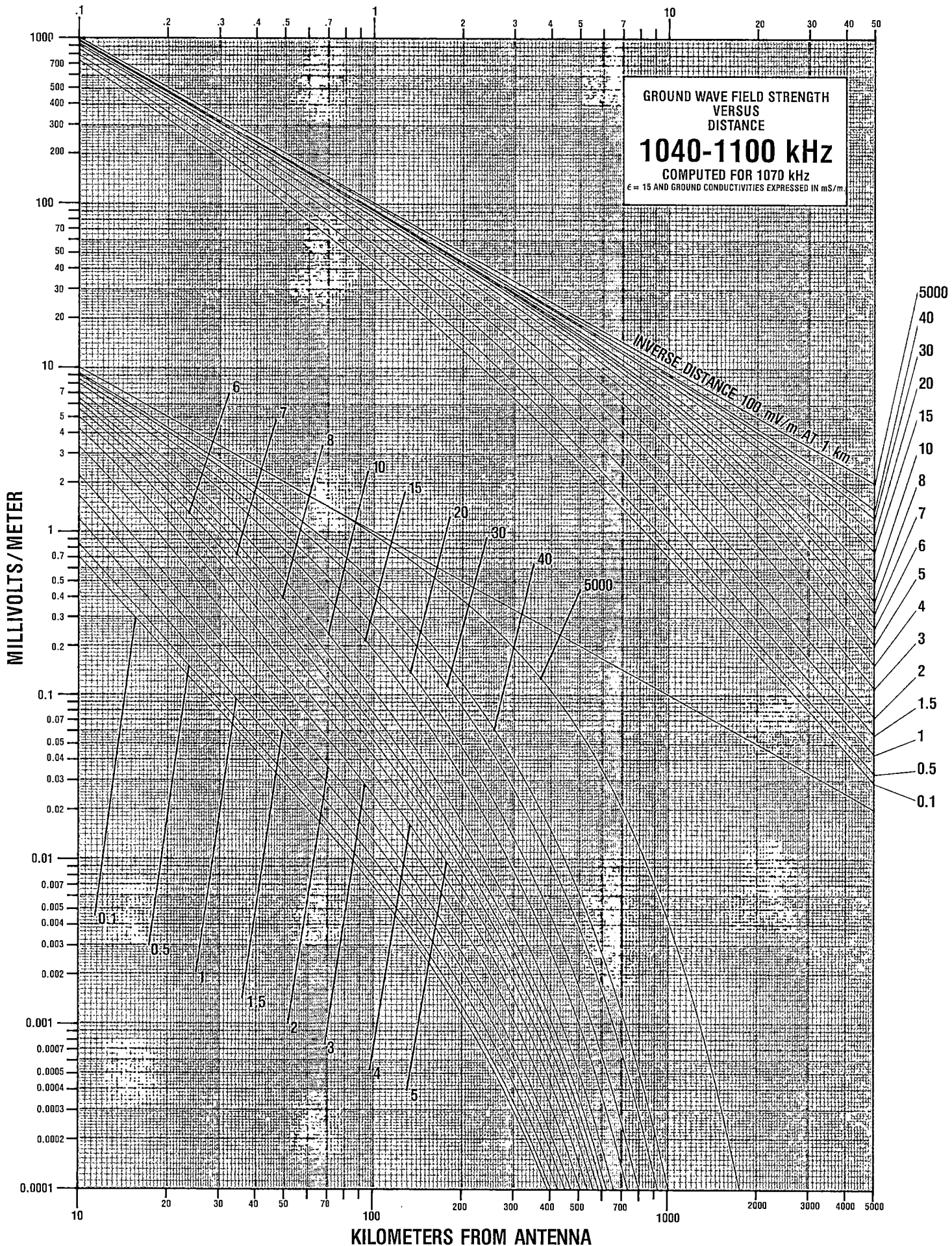


GRAPH 12



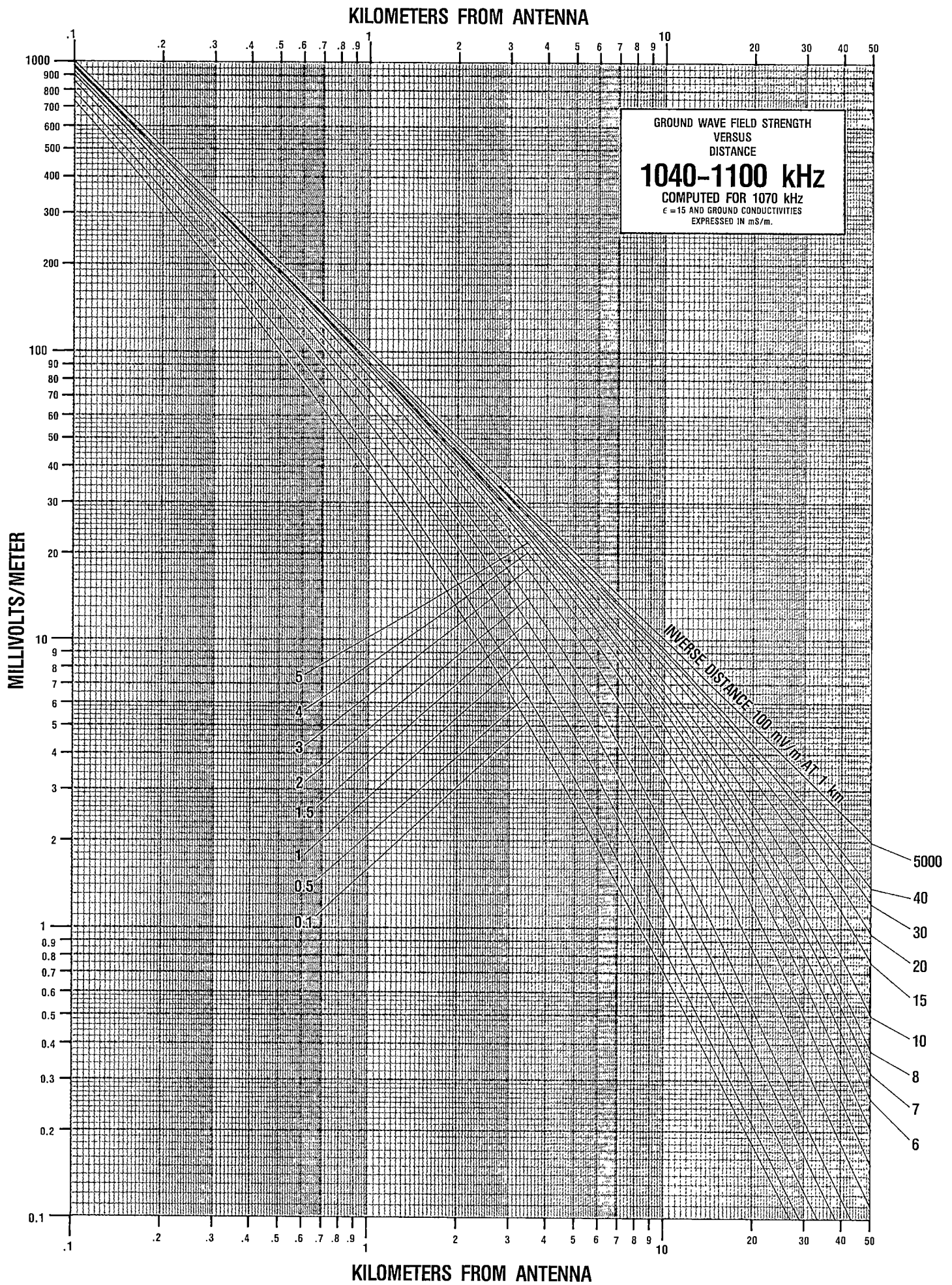
GRAPH 12-A

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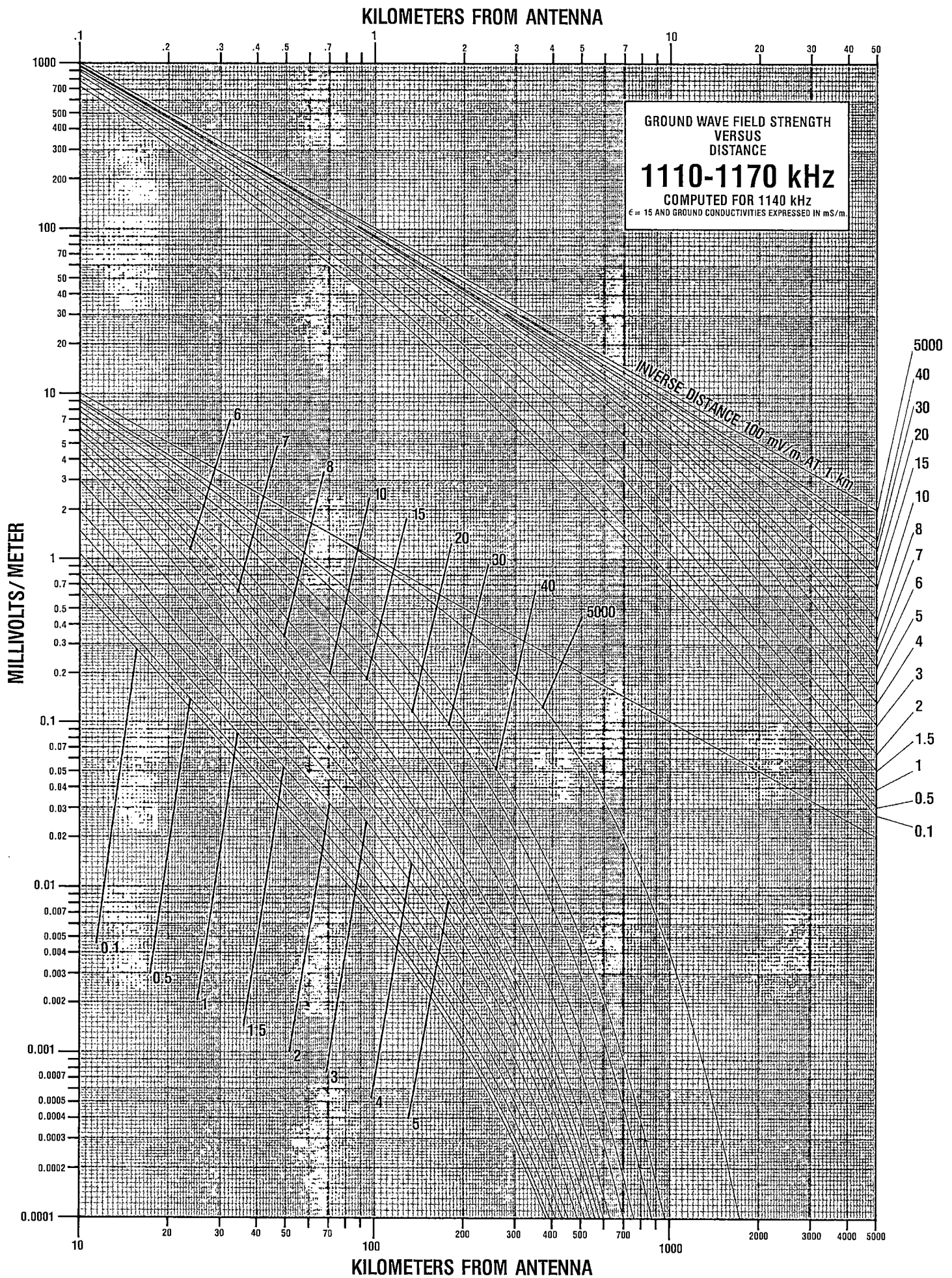


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GRAPH 13

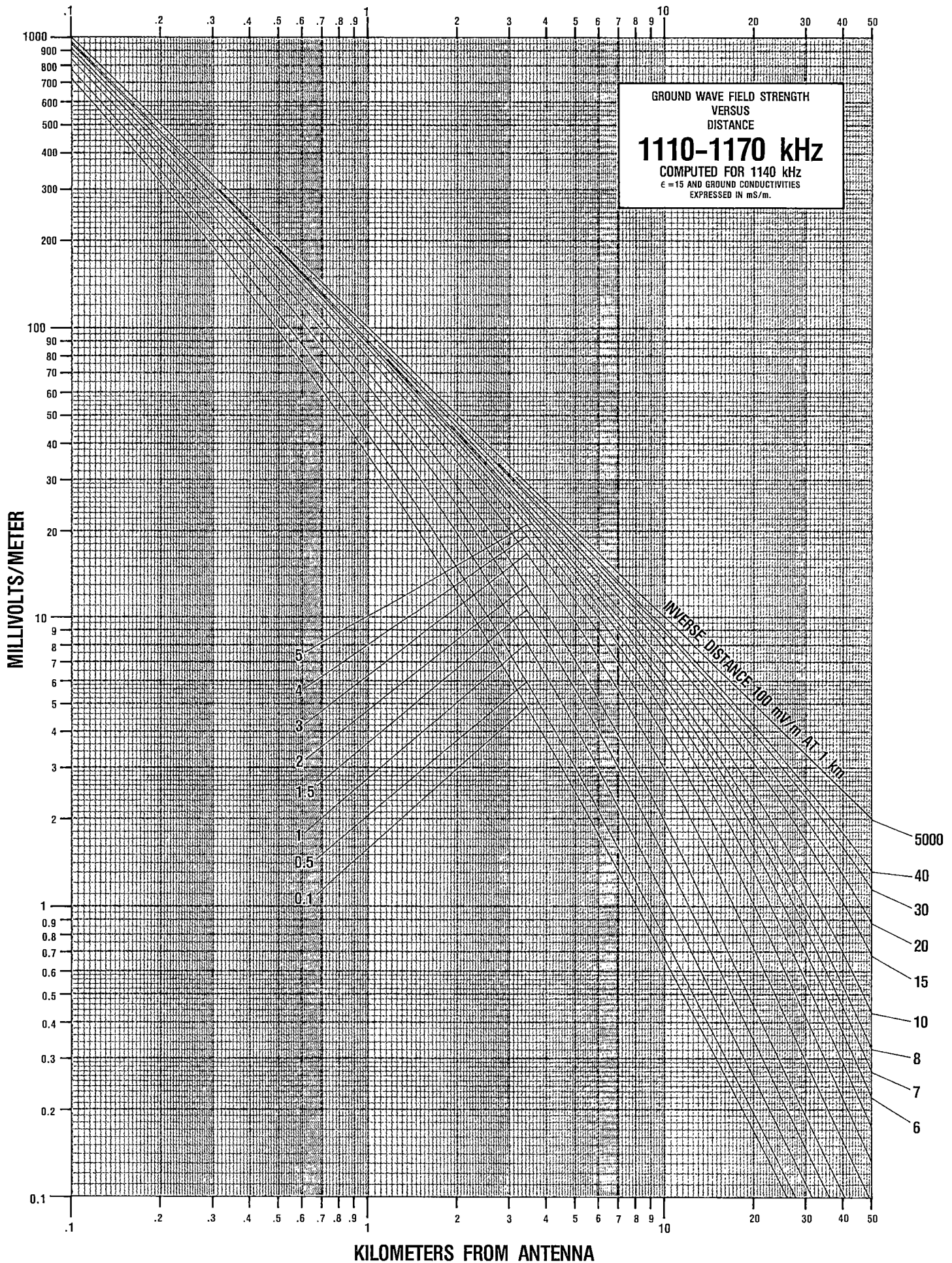


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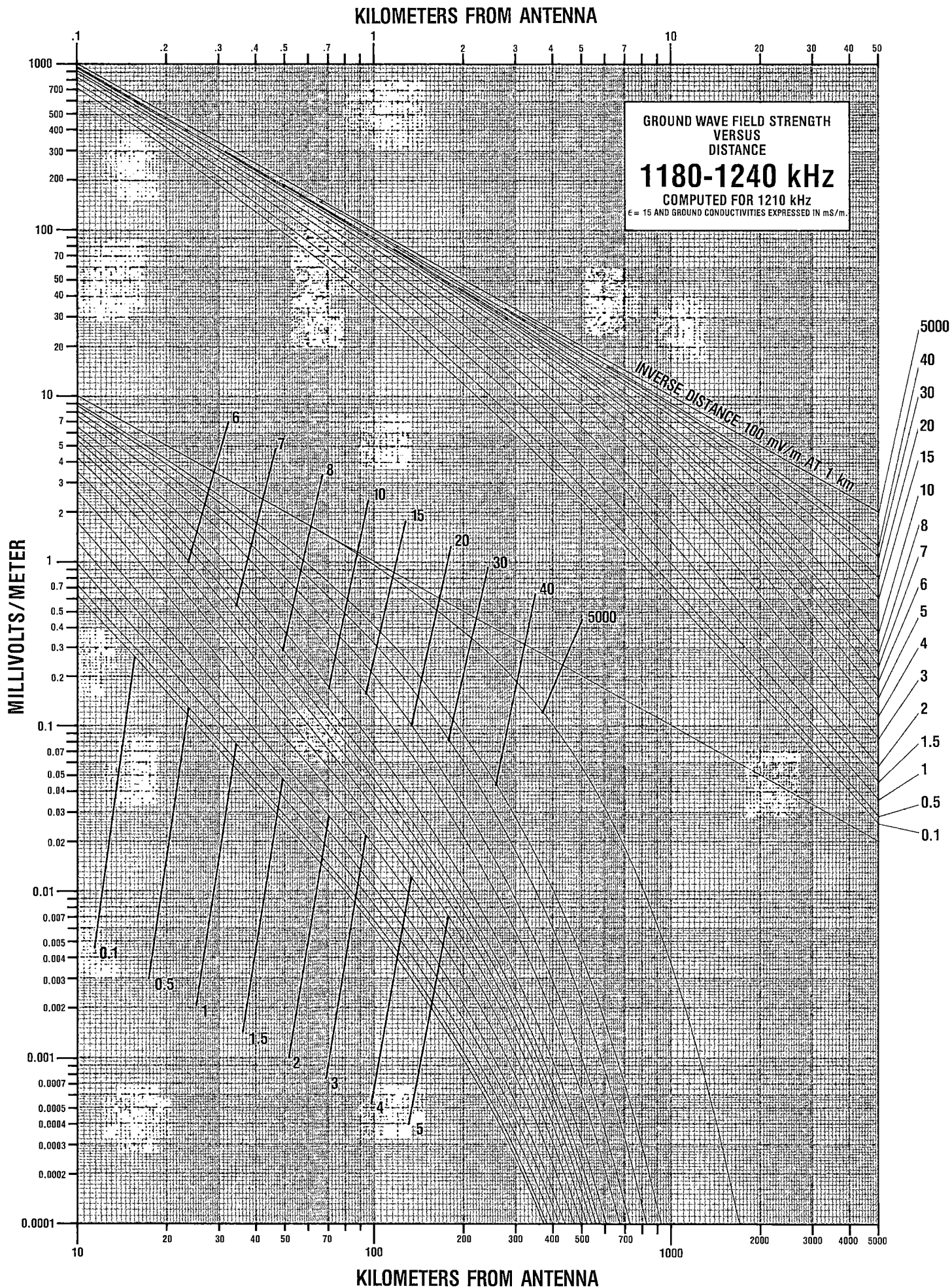


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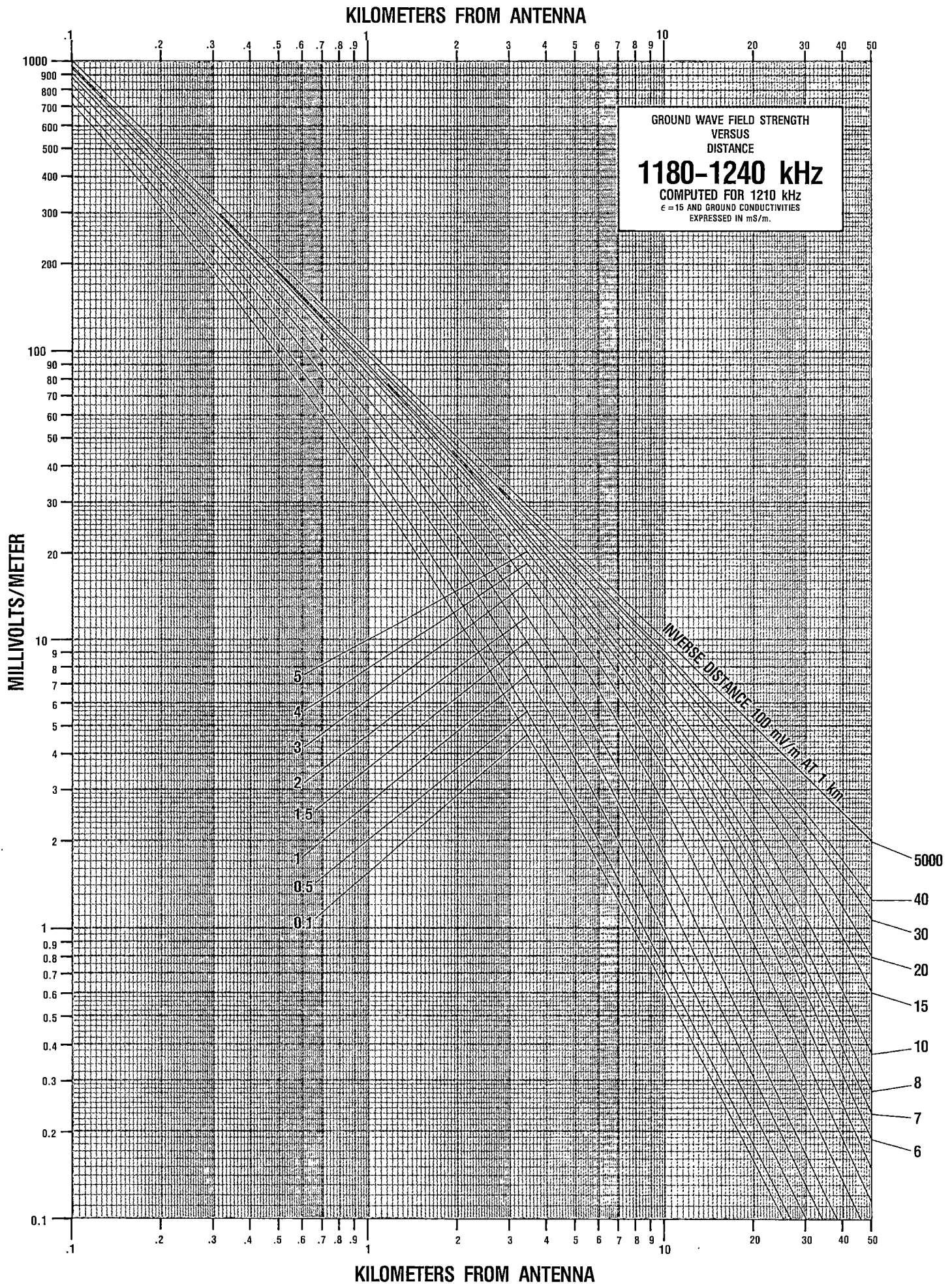
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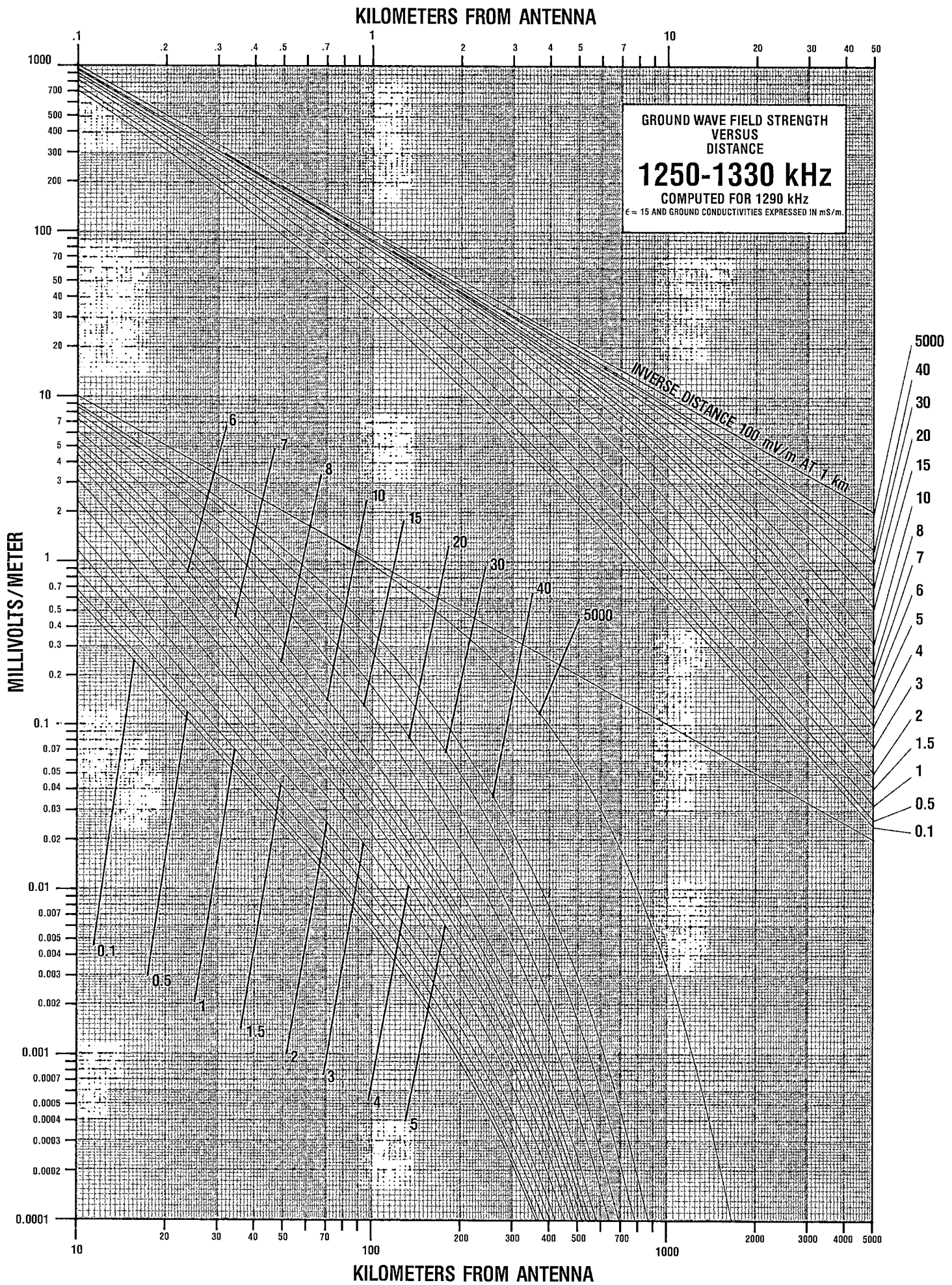
GRAPH 14-A



GRAPH 15

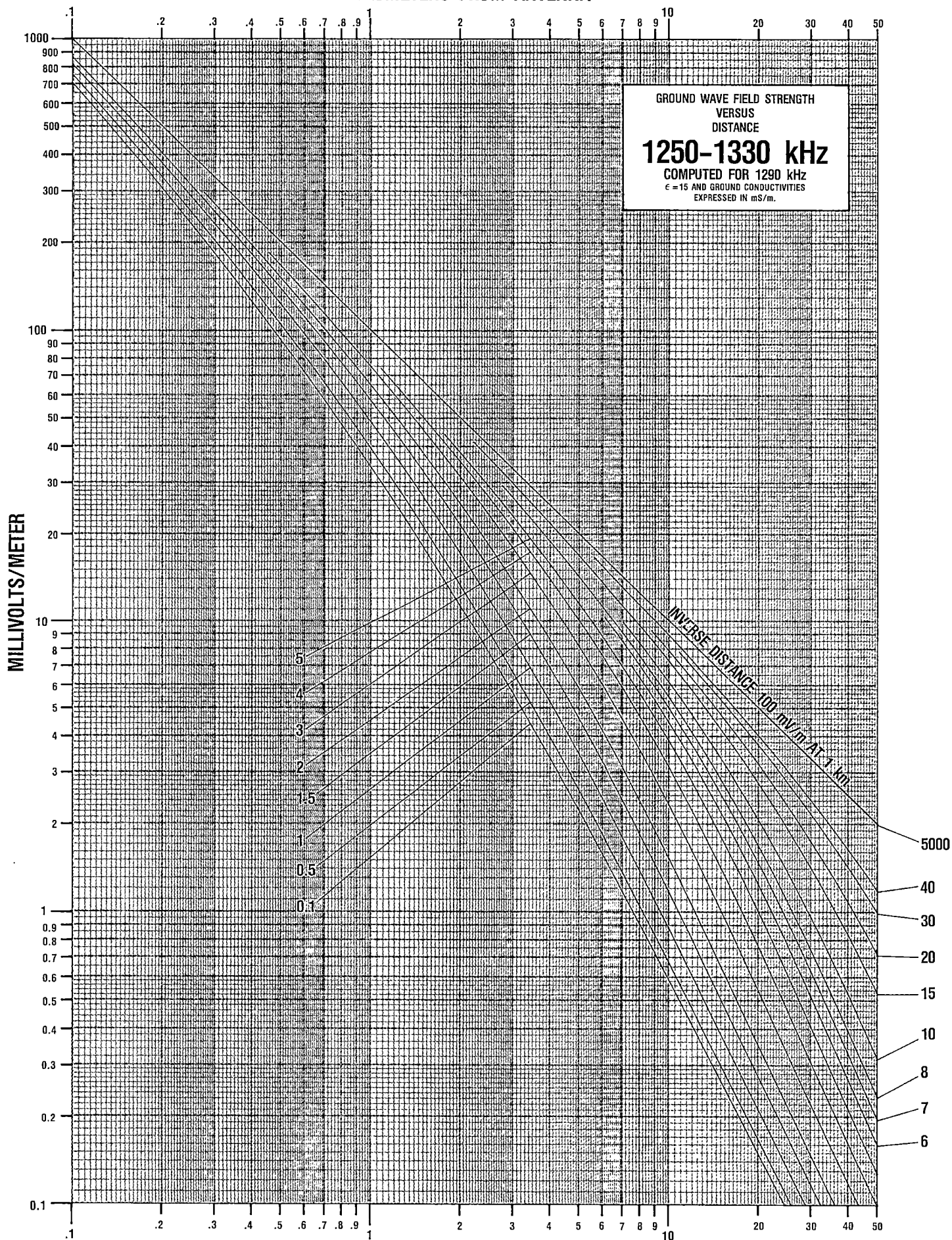


GRAPH 15-A



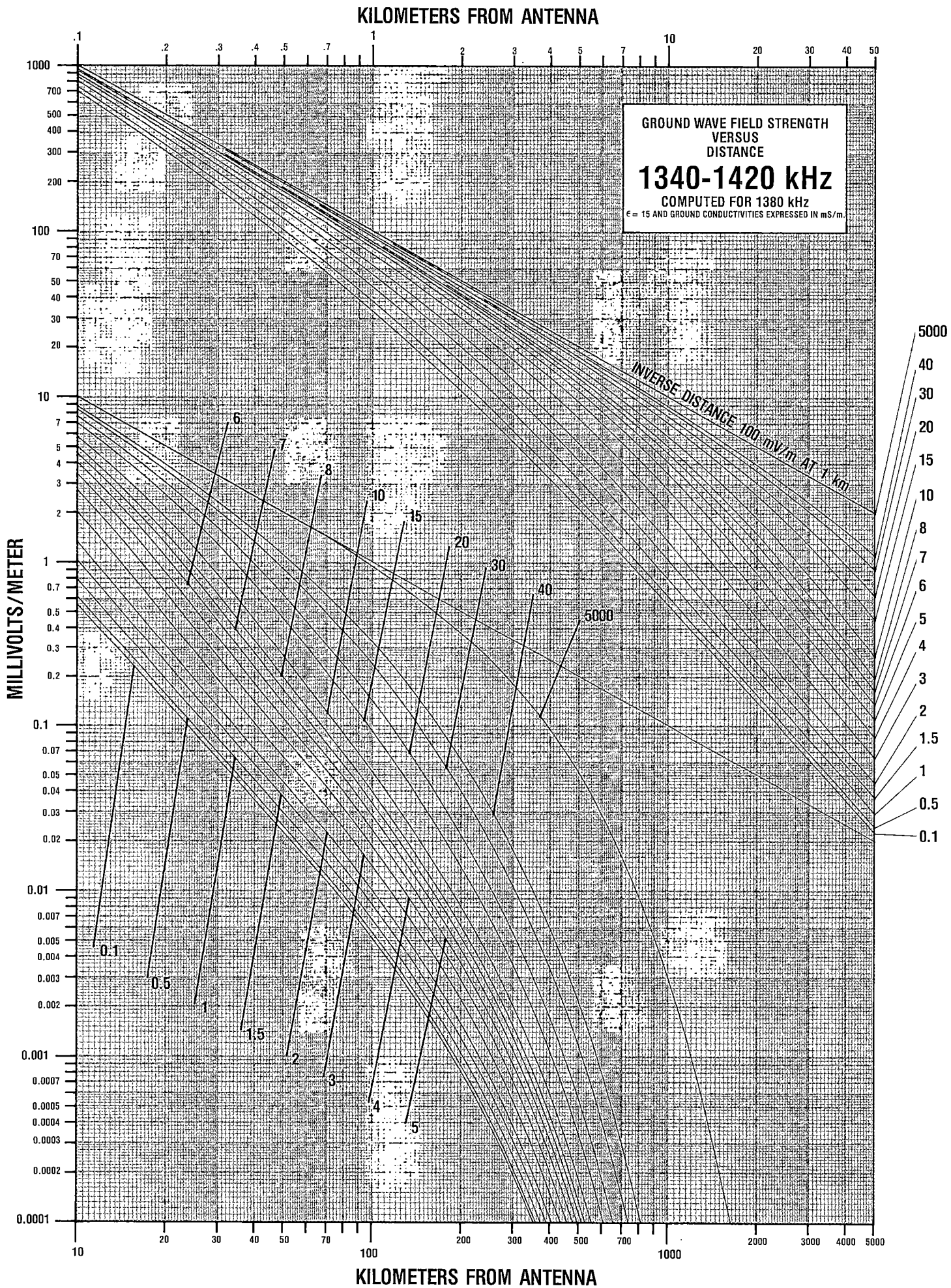
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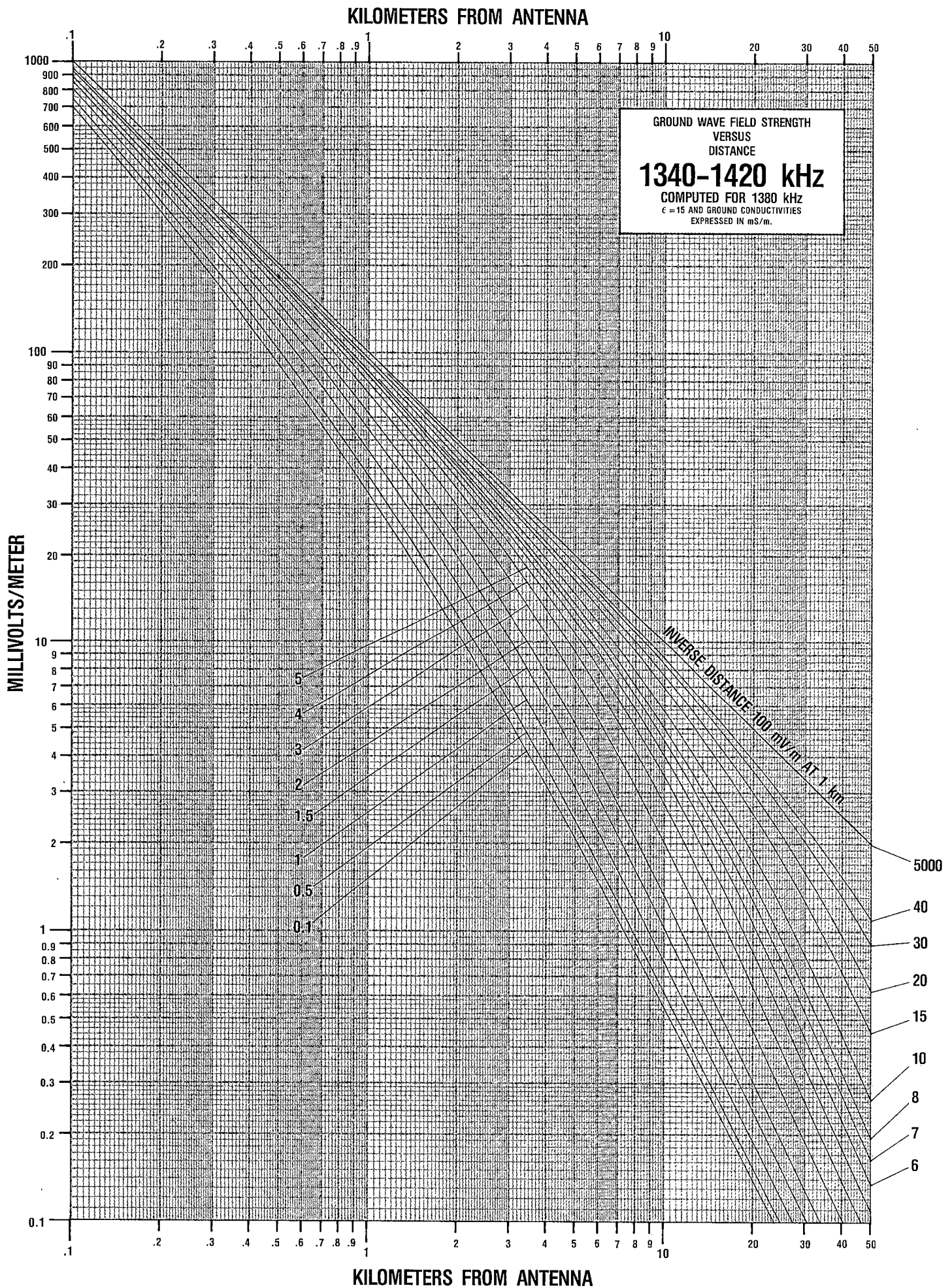


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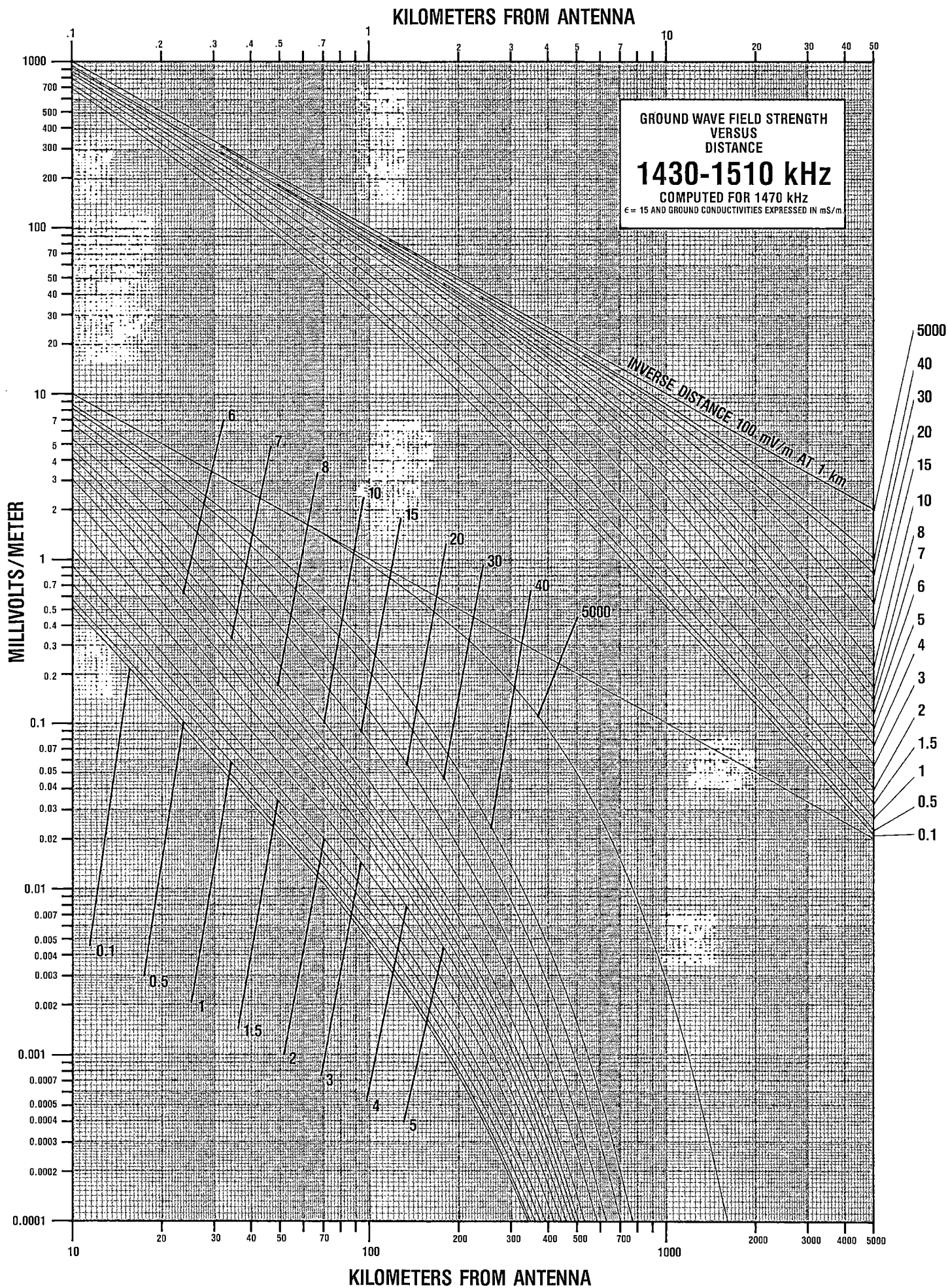
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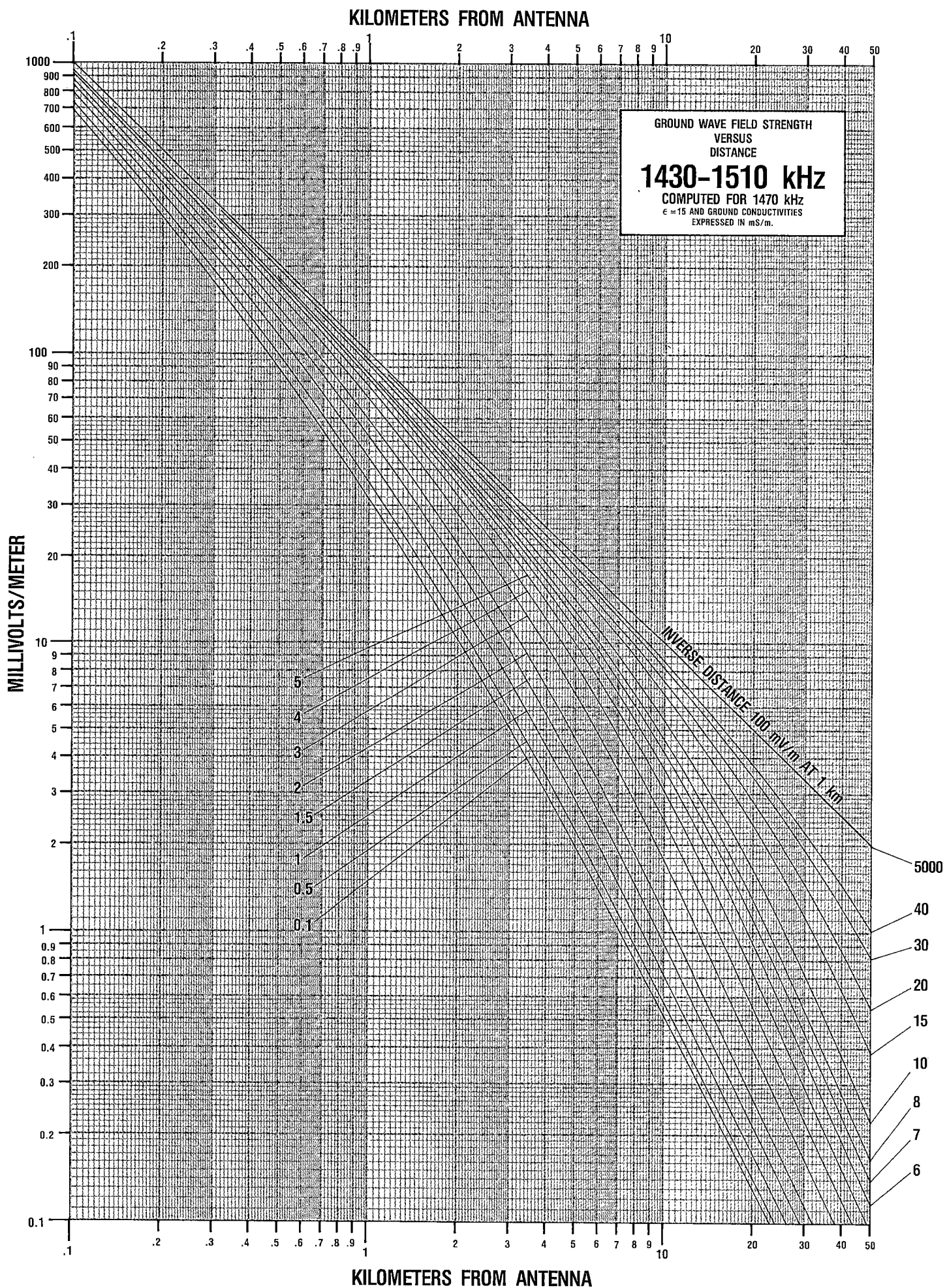
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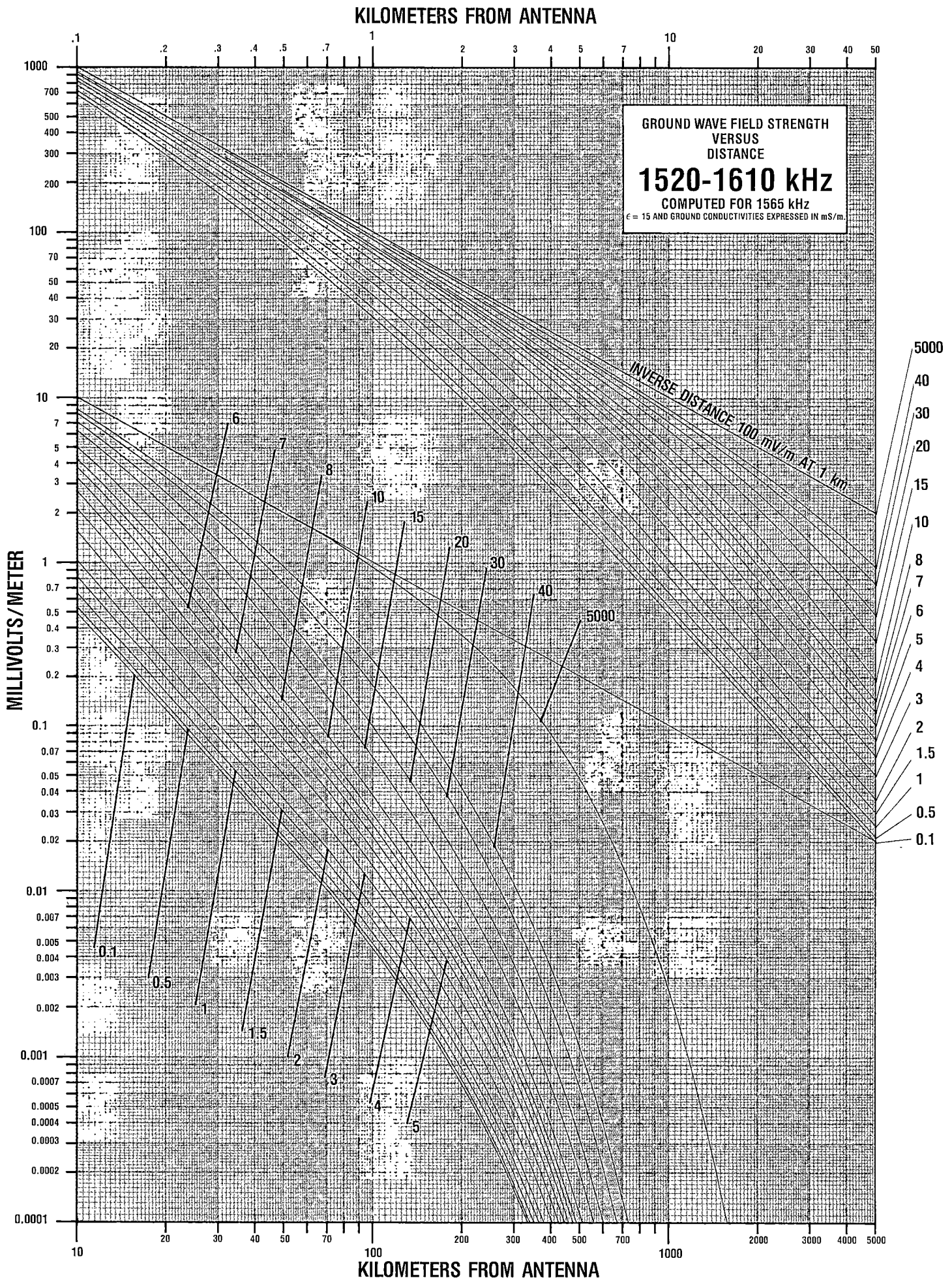
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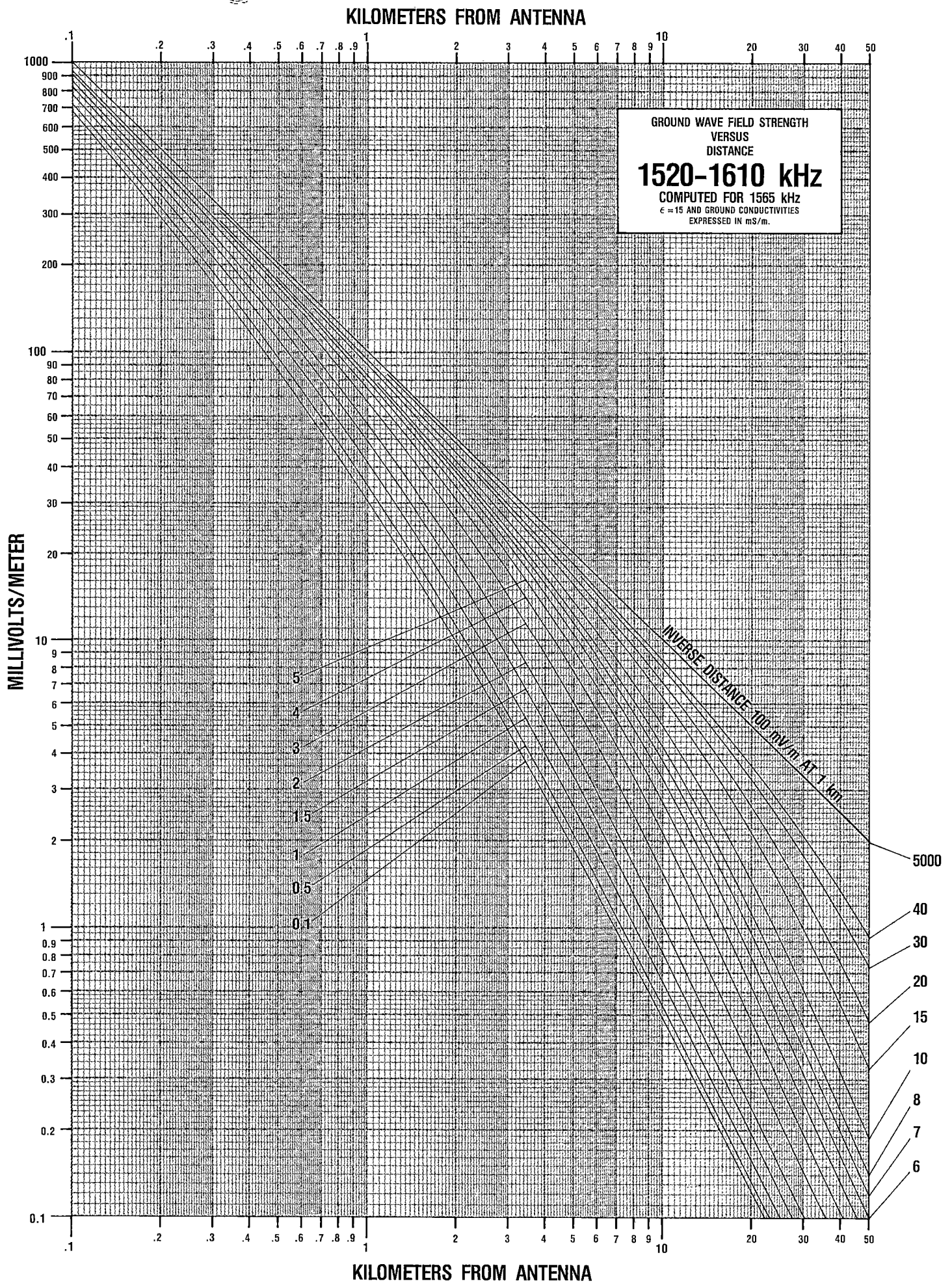
GRAPH 18



GRAPH 18-A



GRAPH 19



GRAPH 19-A