

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

MASTER CURVES OF SCHLUMBERGER SOUNDINGS OVER THREE VERTICAL LAYERS
ARRAY EXPANDED AT RIGHT ANGLES TO STRIKE

by

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MASTER CURVES OF SCHLUMBERGER SOUNDINGS OVER THREE VERTICAL LAYERS: ARRAY EXPANDED AT RIGHT ANGLES TO STRIKE.

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INTRODUCTION

A novel method was developed for the fast computation of resistivity sounding curves over vertical layers (with the electrode array oriented at right angles to the strike of the structure). A computer program for the HP-9845 desk top computer was written (Zohdy, 1980) for the computation and plotting of either single sounding curves or sets of master curves. That program was used for the generation of this album.

Kunetz (1955) computed a few master curves for the symmetric Schlumberger array expanded either at right angles or parallel to an infinitesimally thin dike. The formulation for thick dikes has been expressed in terms of infinite series which are cumbersome to evaluate (Van Nostrand and Cook, 1966). The present method is based on the use of the Laguerre numerical integration formula (Abramowitz and Stegun, 1966). The necessary formulas for the computation of the curves in this album can be found in Zohdy (1980).

Sounding curves obtained with the symmetric Schlumberger array generally are much less distorted by the effects of lateral changes in resistivity than curves obtained with other types of electrode arrays. The computation of this album for only vertical layers should be valuable in recognizing the shape and magnitude of anomalies that are produced by lateral inhomogeneities.

BRIEF ALBUM DESCRIPTION

1. This album is composed of sets of master curves obtained with an idealized Schlumberger electrode array (distance between potential electrodes is infinitesimally small) and the array is assumed to be expanded at right angles to the strike of the three vertical layers (see figure 1).

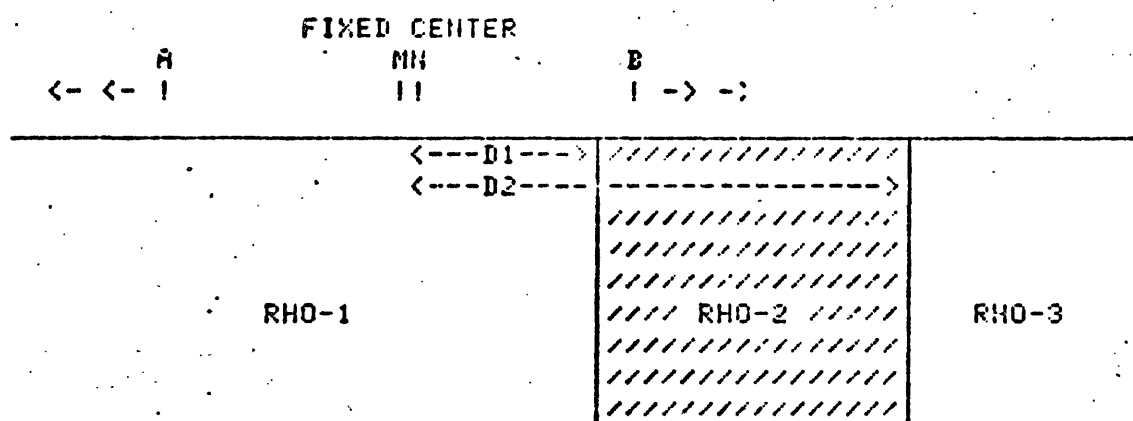
2. Sets of curves are computed with the center of the array located either on medium 1 (left layer with resistivity $RHO-1$) or on medium 2 (middle layer with resistivity $RHO-2$). Sets of curves with the center located on medium 3 (right layer with resistivity $RHO-3$) are the same as those with the center located on medium 1, but with the values of $RHO-1$ and $RHO-3$ exchanged.

3. The sets of curves are arranged in groups of H-type ($RHO-1 > RHO-2 < RHO-3$), A-type ($RHO-1 < RHO-2 < RHO-3$), K-type ($RHO-1 < RHO-2 > RHO-3$), and Q-type ($RHO-1 > RHO-2 > RHO-3$). Furthermore, the sets in which the center is located on medium 1 are designated as H1, A1, K1, or Q1, whereas those in which the center is located on medium 2 are designated as H2, A2, K2, or Q2. The strongest vertical layering effects are observed with geoelectric sections of the K-type.

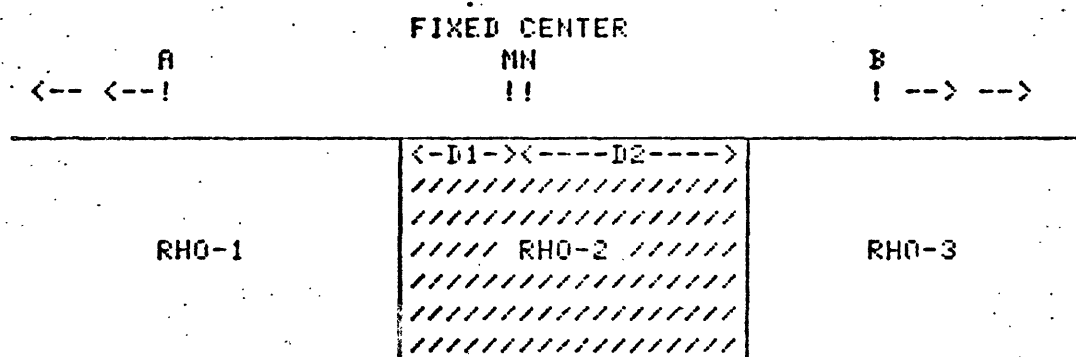
4. For sets of curves in which the center is located on medium 1, the distance D1 is the distance to the nearest contact and D2 is the distance to the farther contact. For sets in which the center is located on medium 2, D1 is the distance to the LEFT contact and D2 is the distance to the RIGHT contact. See figure 1.

5. Each set of curves is labeled at the top with the statement (D1=1, D2 as labeled) which is followed by another statement designating the ratio of the resistivities of the three vertical layers $RHO-1$, $RHO-2$, and $RHO-3$ (from left to right).

6. On each set, a sketch of the dike and the location of the sounding center is shown in the upper right hand corner of the plot.



(a)



(b)

Figure-1 (a) Array center on medium 1, (b) array center on medium 2.
A and B, current electrodes; M and N, potential electrodes;
RHO-1, RHO-2, RHO-3, resistivities of medium 1, 2, 3; D1, D2,
distances from fixed center of array to vertical contacts.

7. Each set is comprised of eight curves for the eight values of $D_2 = 1, 1.5, 2, 4, 8, 20, 40$, and infinity (with $D_1 = 1 = \text{constant}$). For sets in which the sounding center is located on medium 1, this corresponds to dike widths of 0, 0.5, 1, 3, 7, 19, 39, and infinity, respectively. For sets in which the sounding center is located on medium 2, this corresponds to dike widths of 2, 2.5, 3, 5, 9, 21, 41, and infinity, respectively.

8. Resistivity ratios of infinity, 100, 30, 10, 3, 0.3, 0.1, 0.03, and zero are used. The resistivity of the medium on which the sounding center is located is taken as unity.

9. The sets are plotted on a 4x3 cycle logarithmic scale. The length of each log cycle is approximately 4 cm.

10. The album contains 160 sets of curves. The first 81 sets have the sounding center located on medium 1 (group 1). The 79 sets that follow have the sounding center located on medium 2 (group 2). The curve sets in both groups are ordered by type: H, A, K, and then Q.

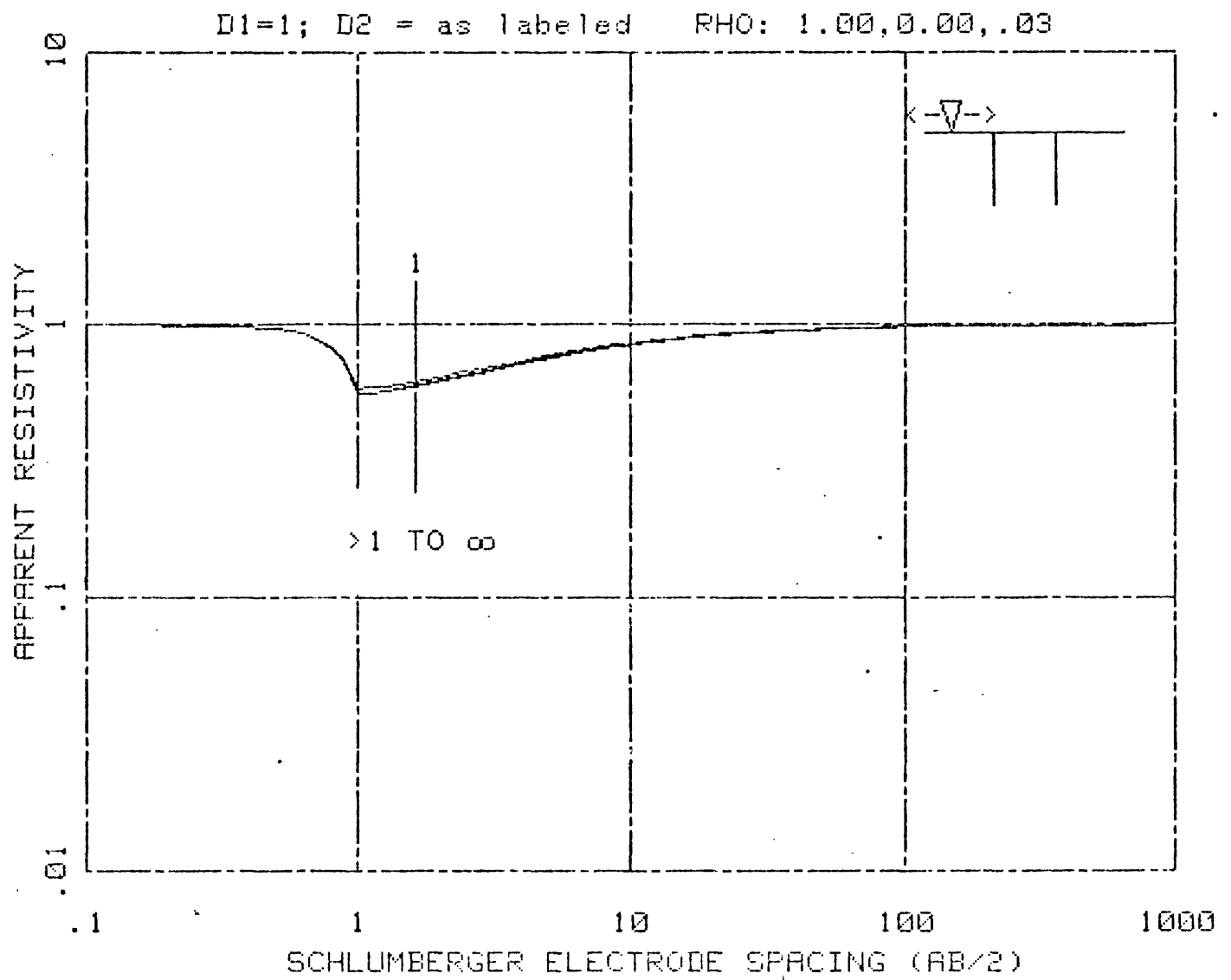
ACKNOWLEDGMENTS

The author wishes to thank Mr. Dean Schoenthaler for his assistance in labeling some of the curve sets in this album.

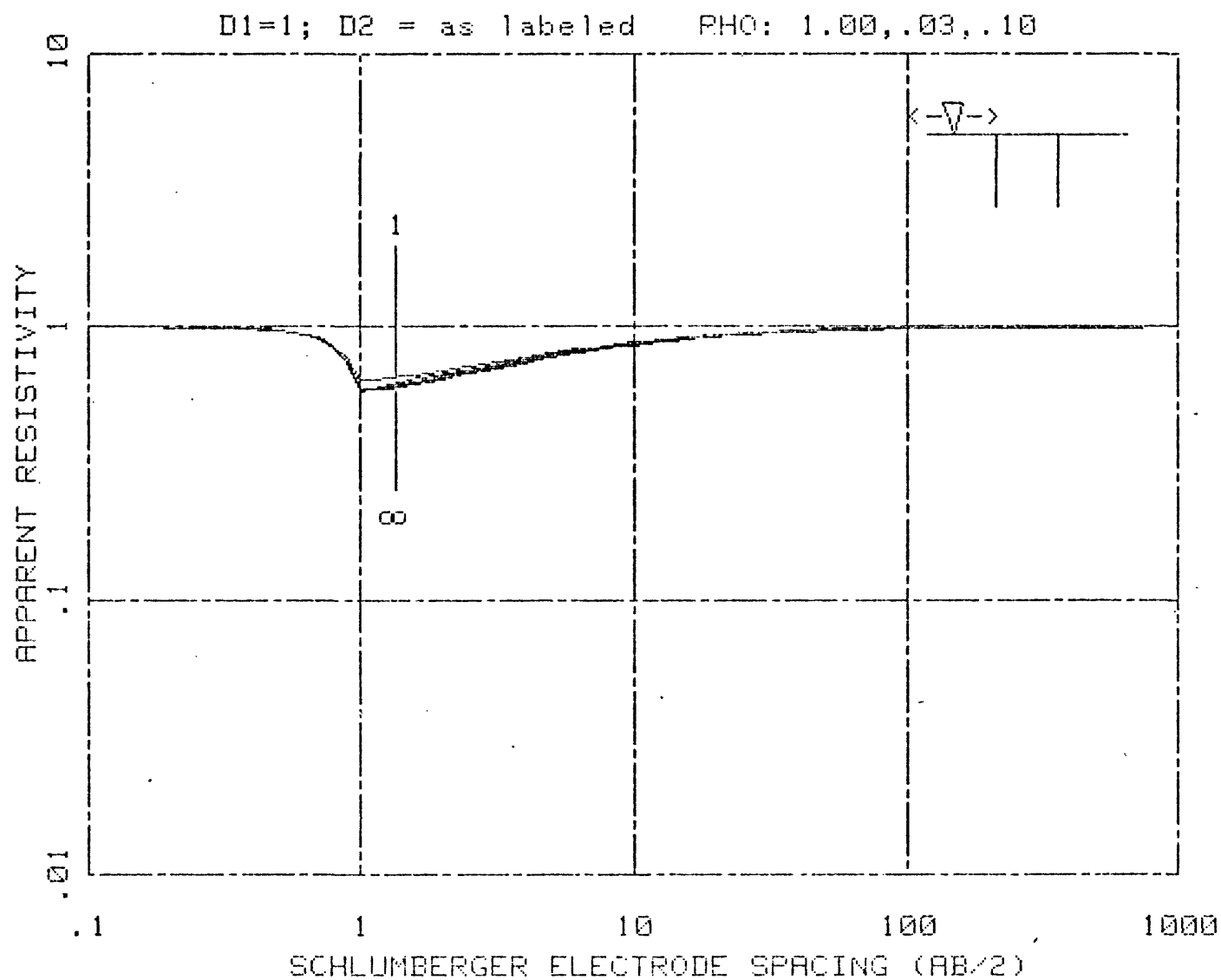
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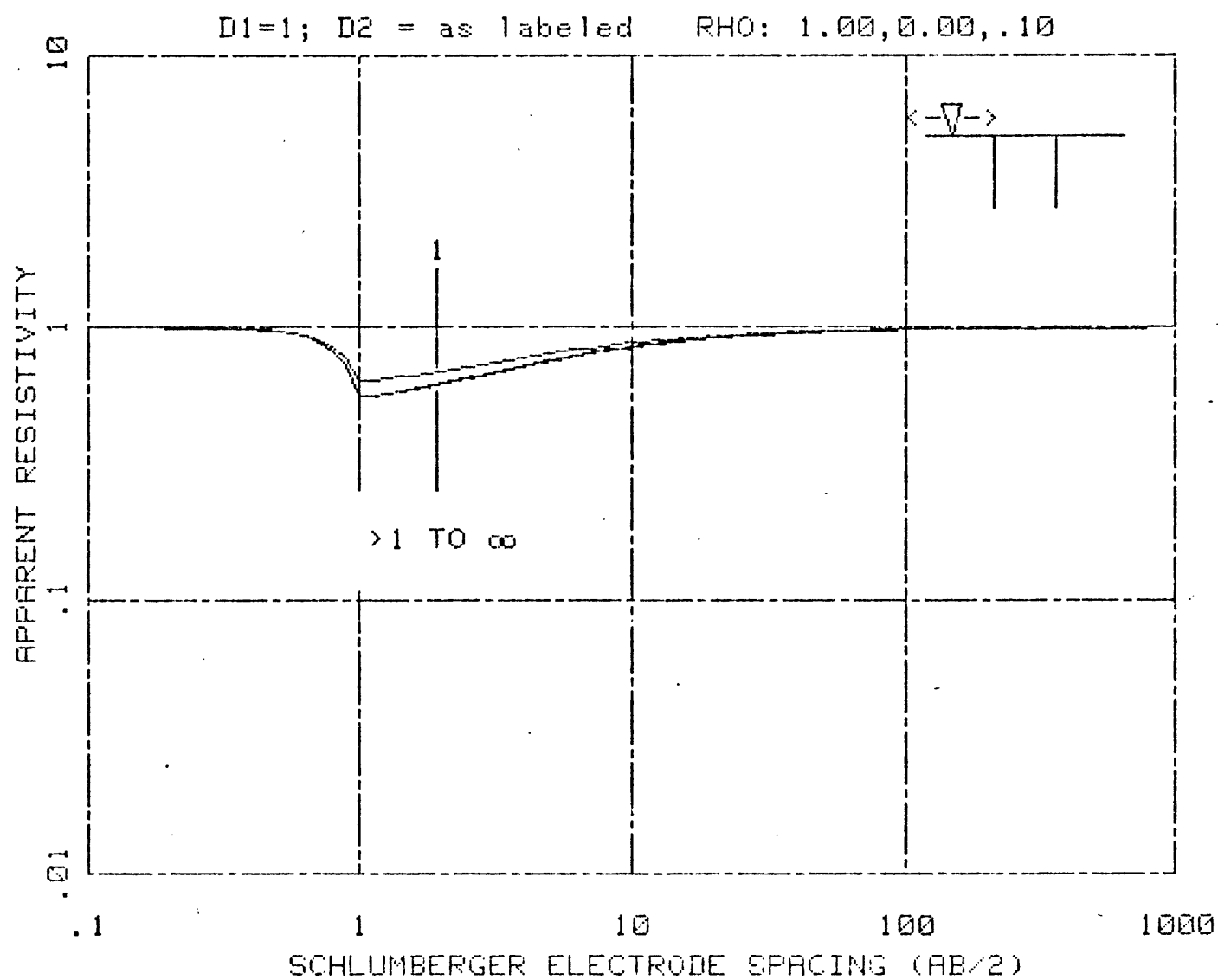
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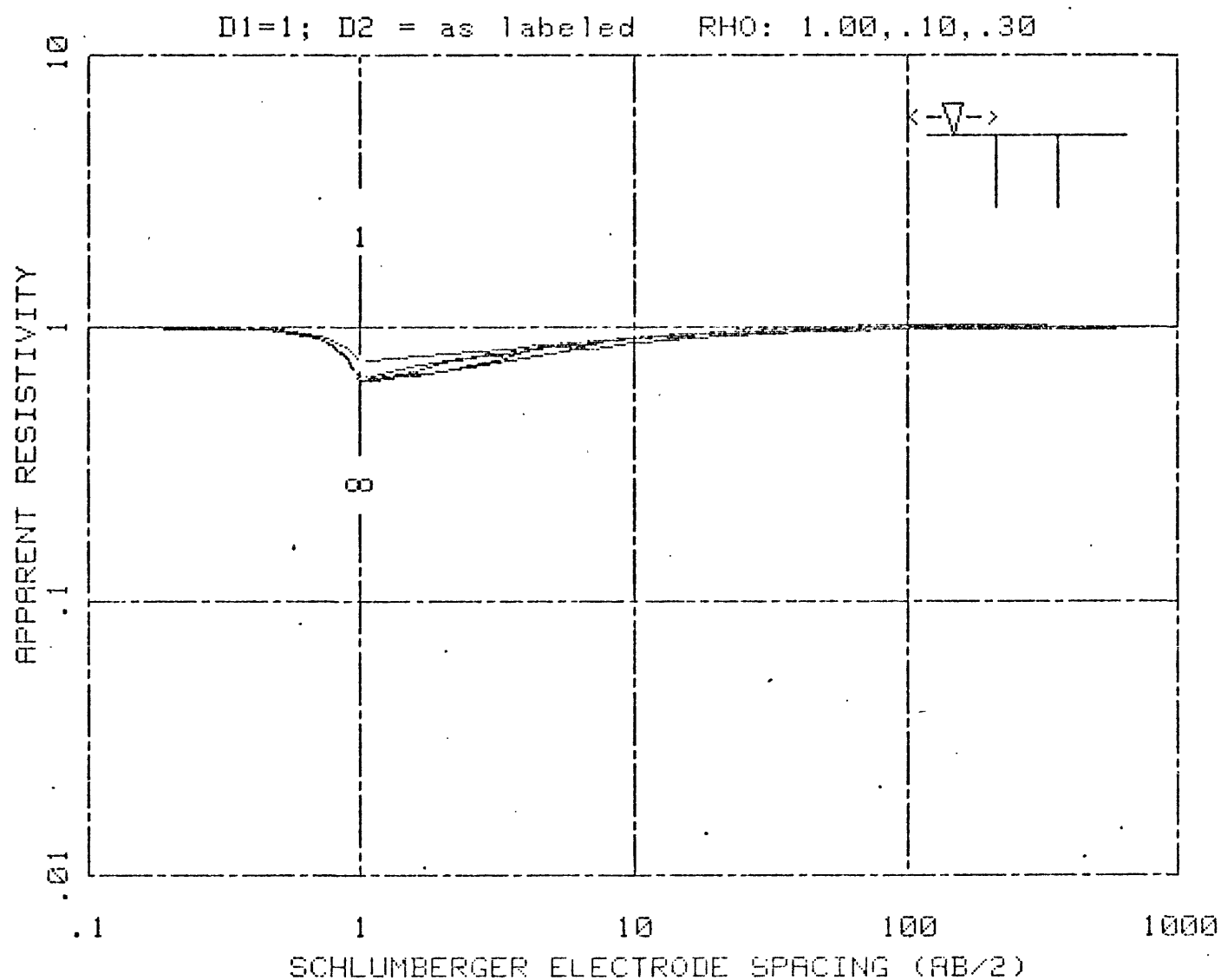
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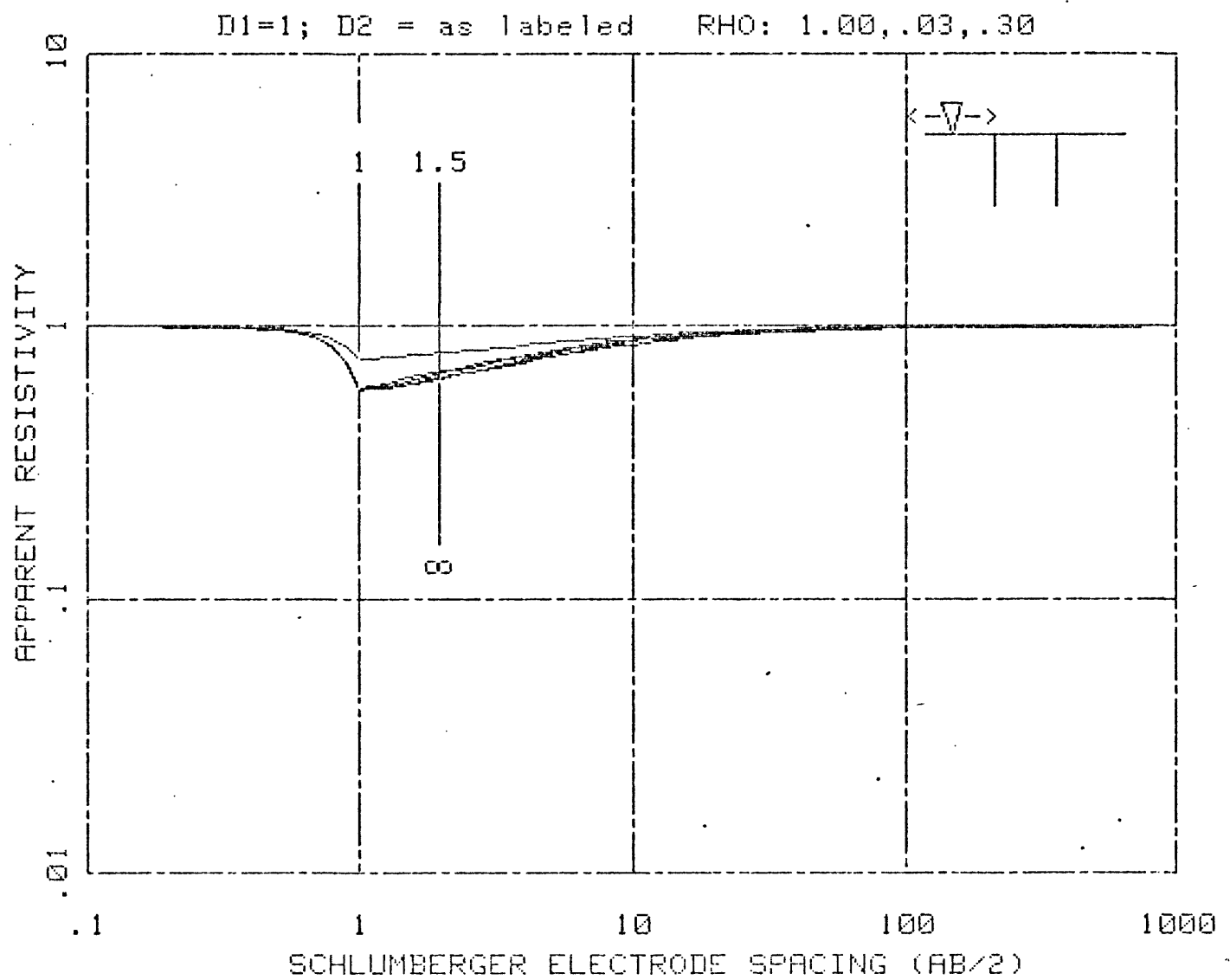
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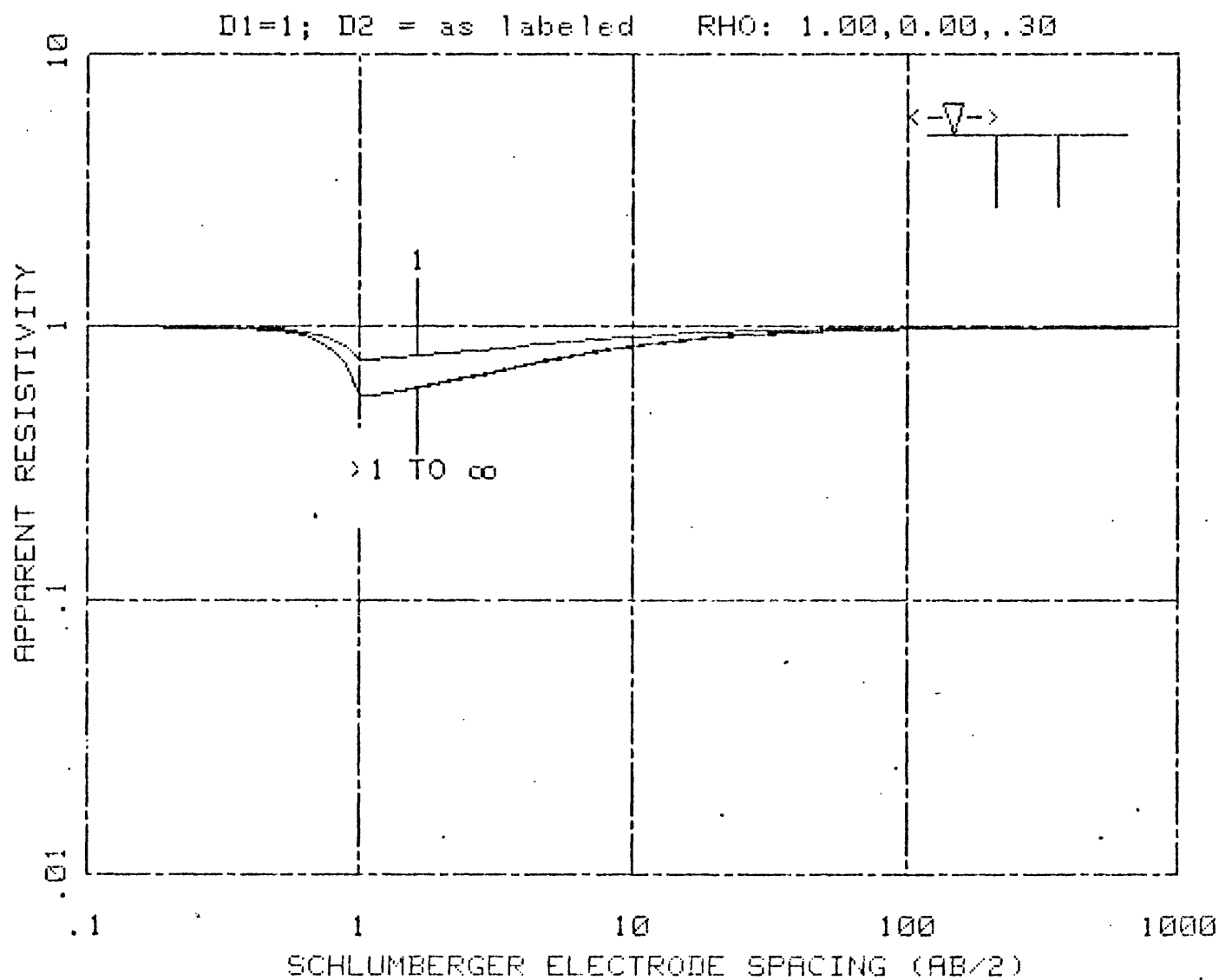
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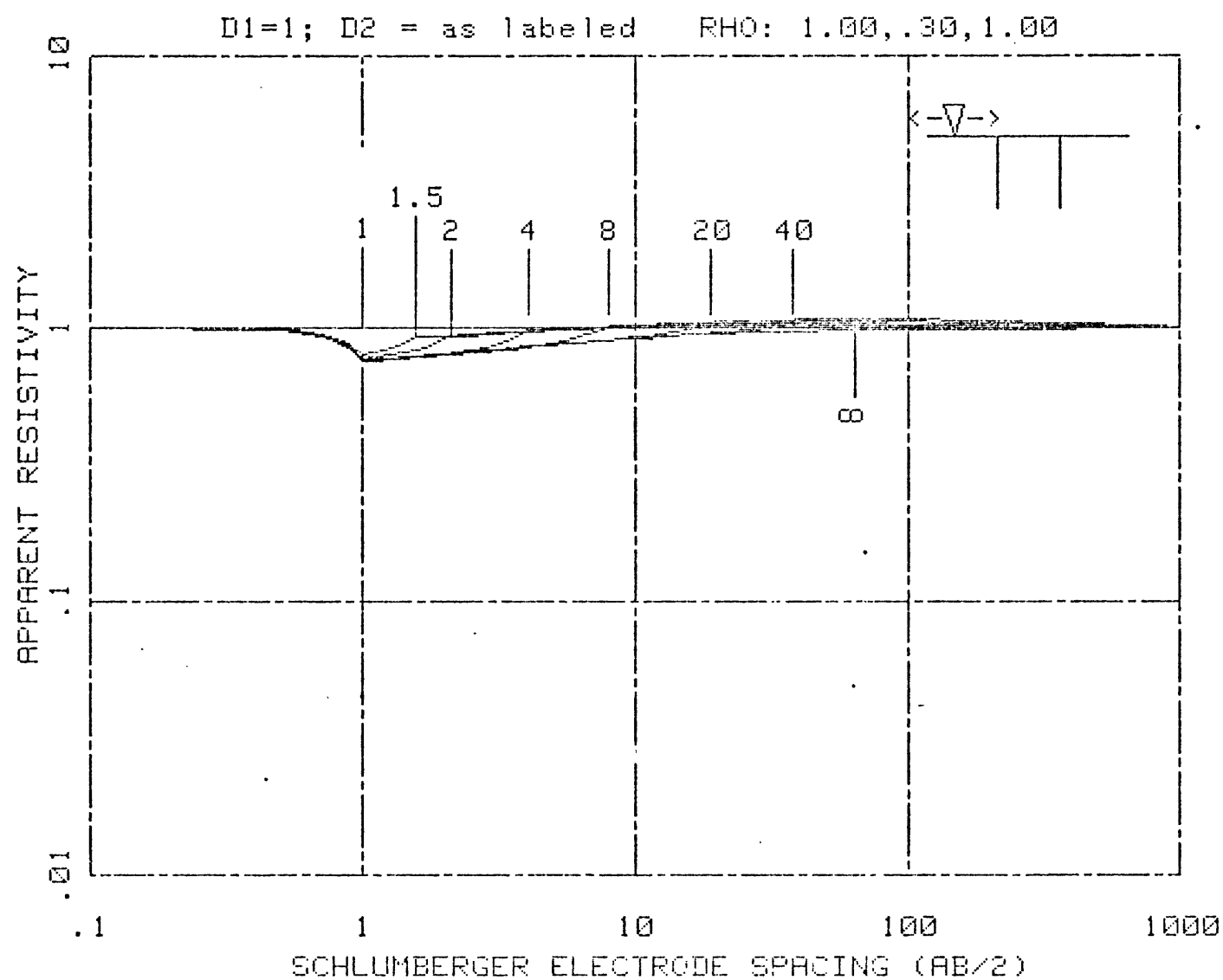
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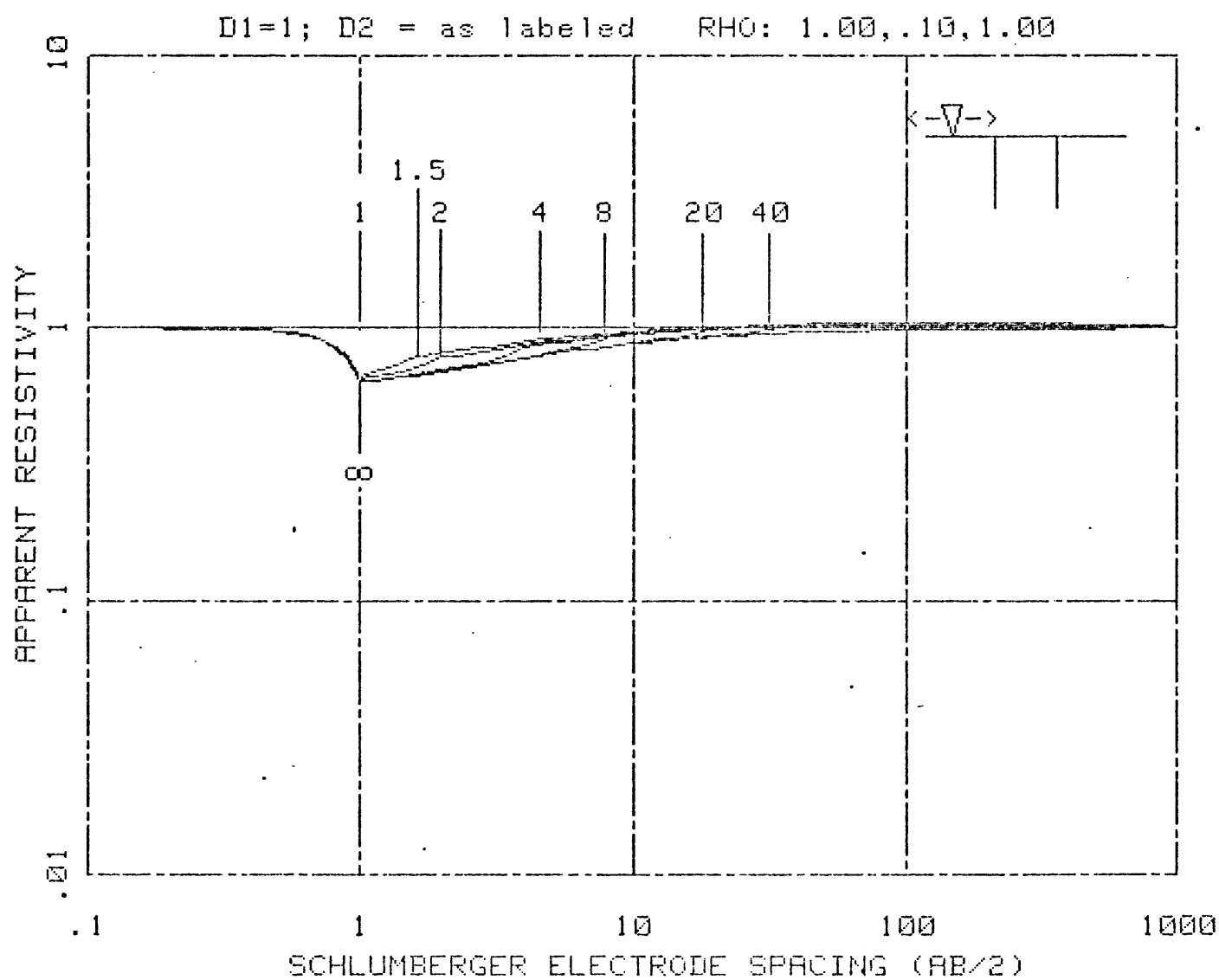
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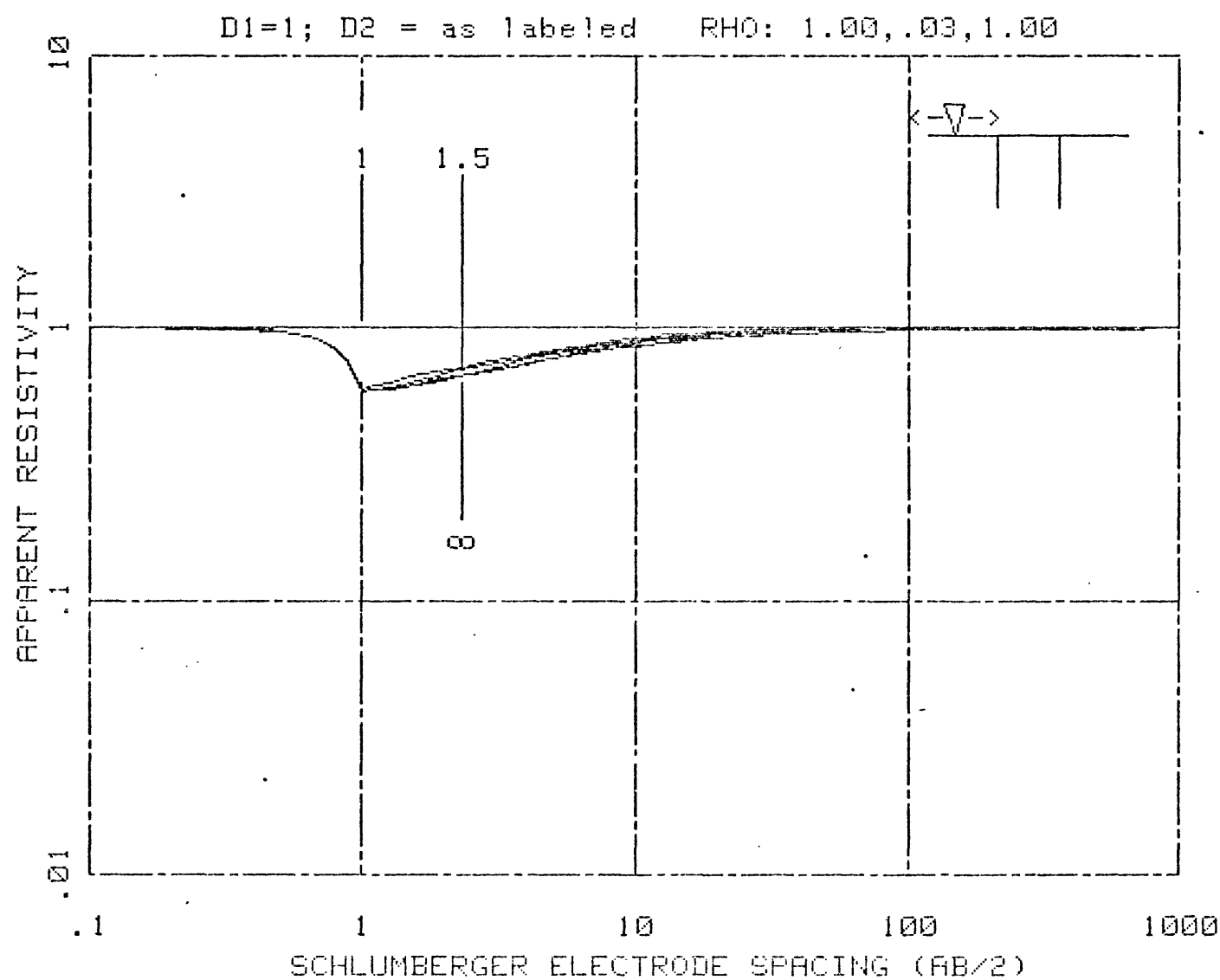
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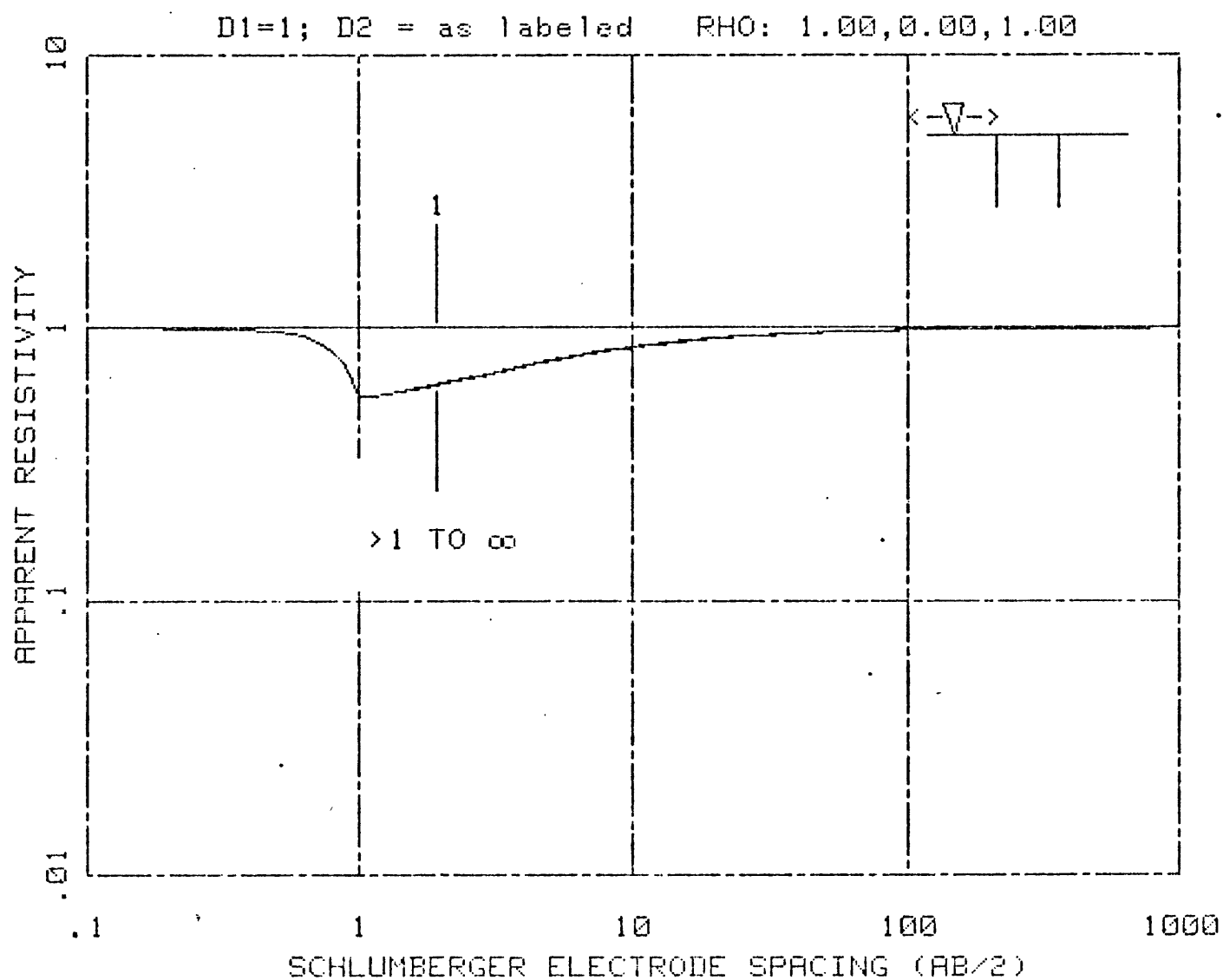
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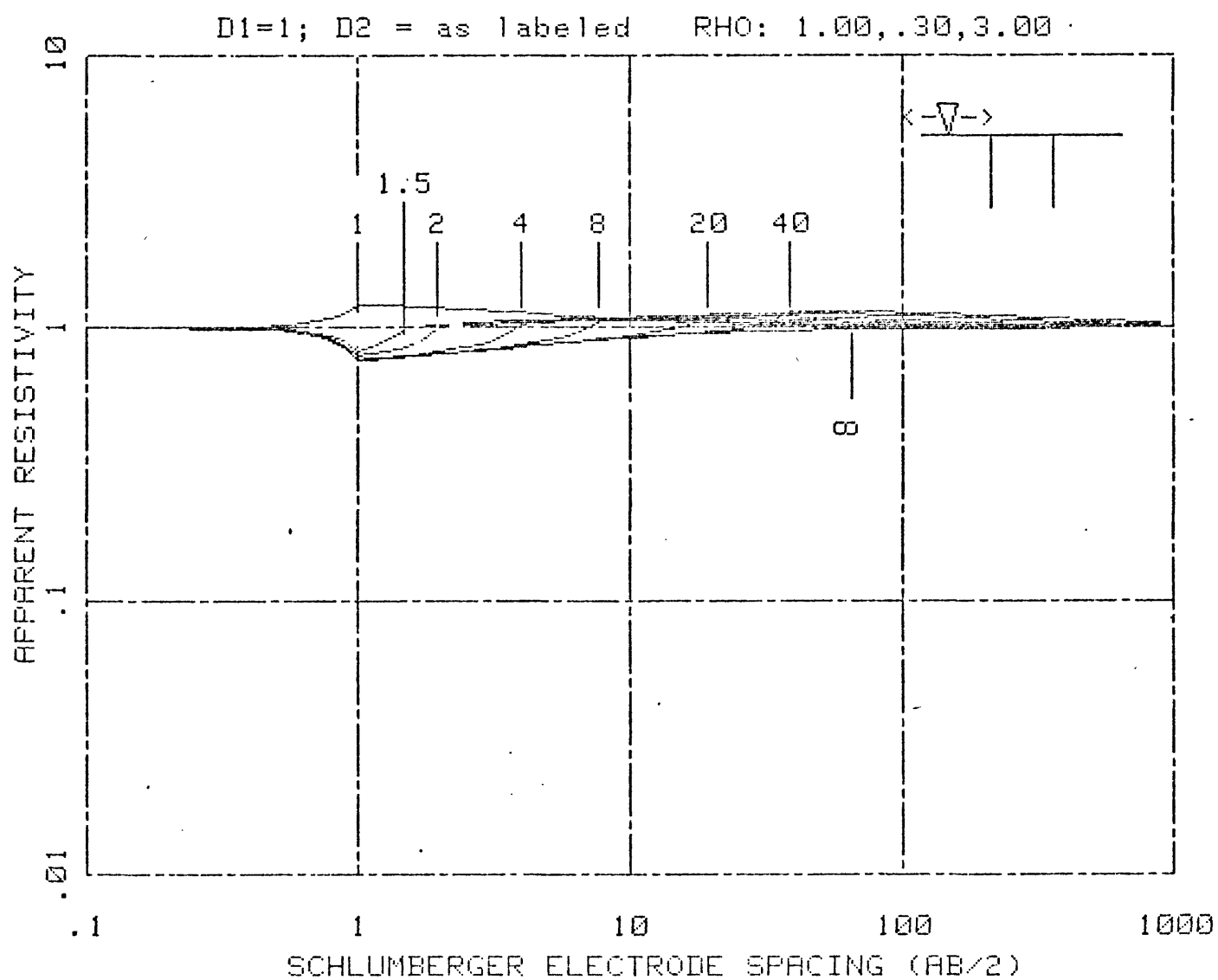
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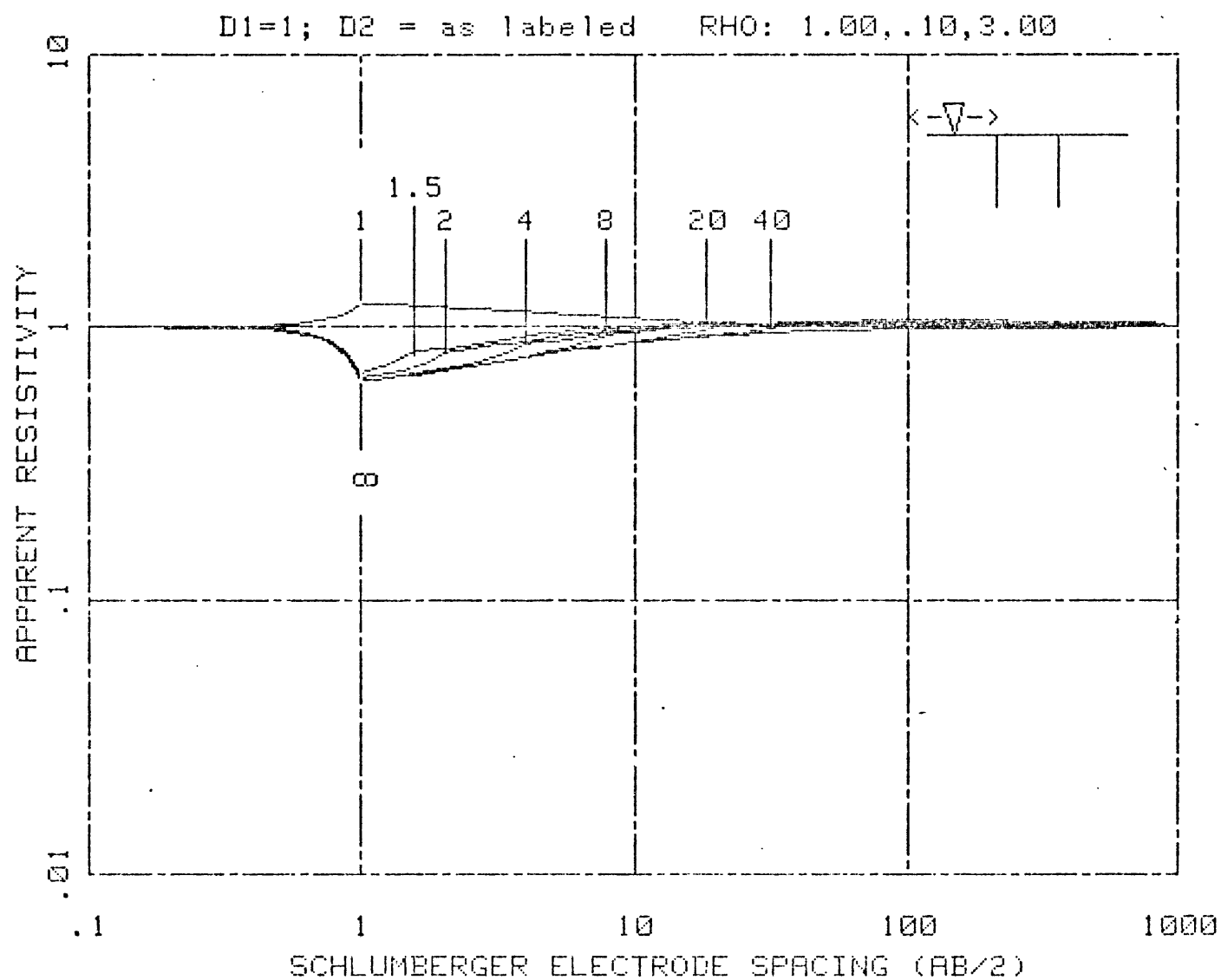
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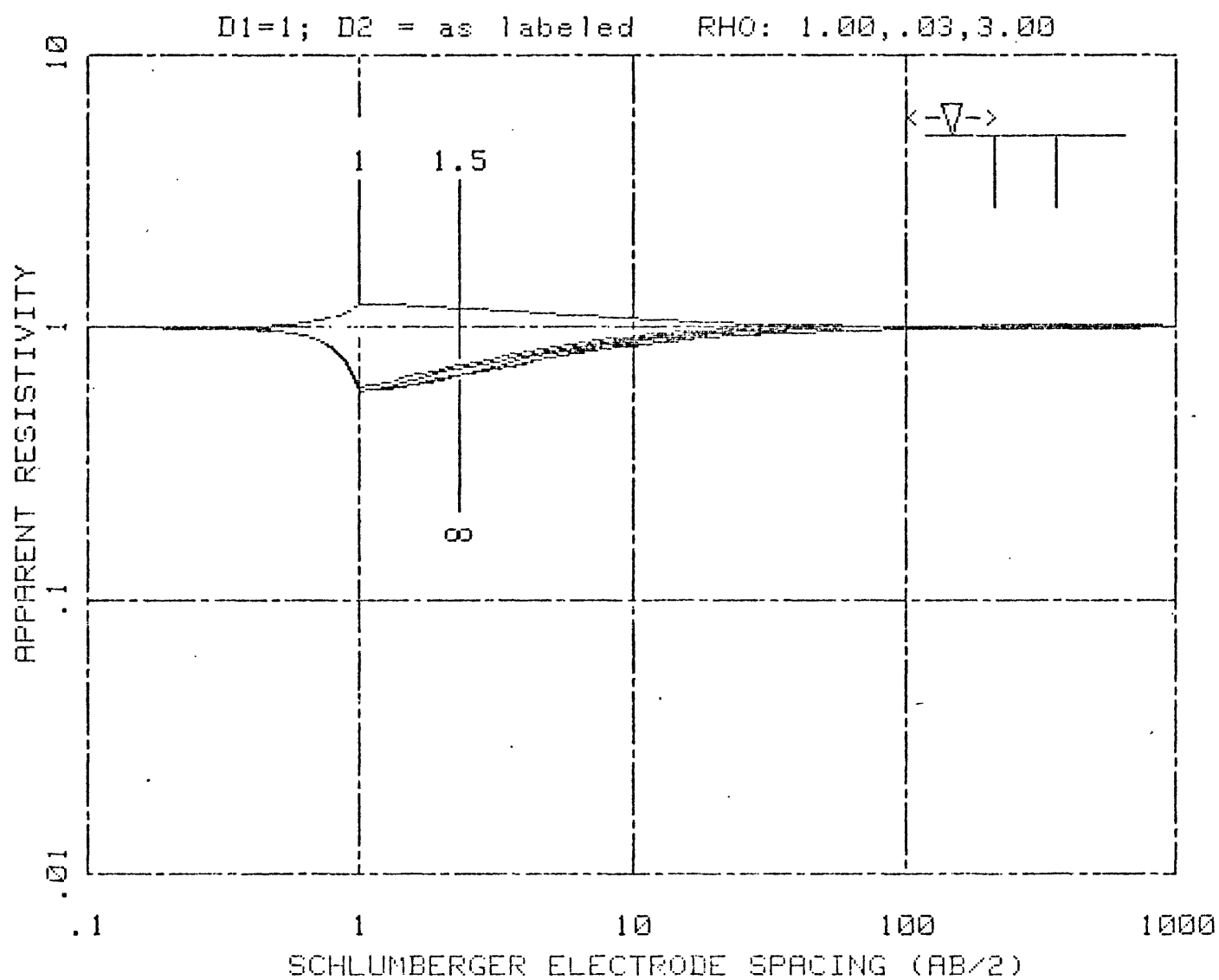
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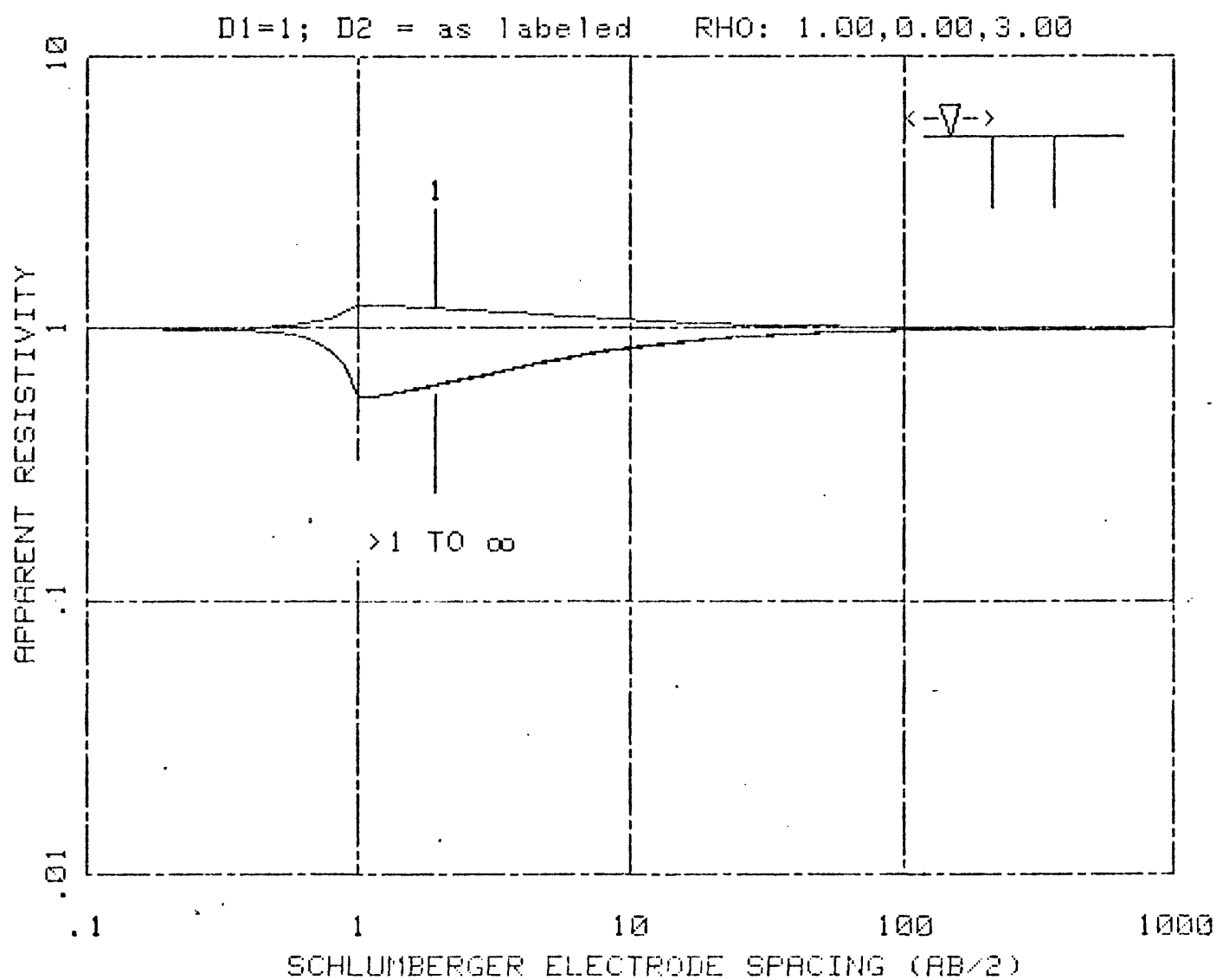
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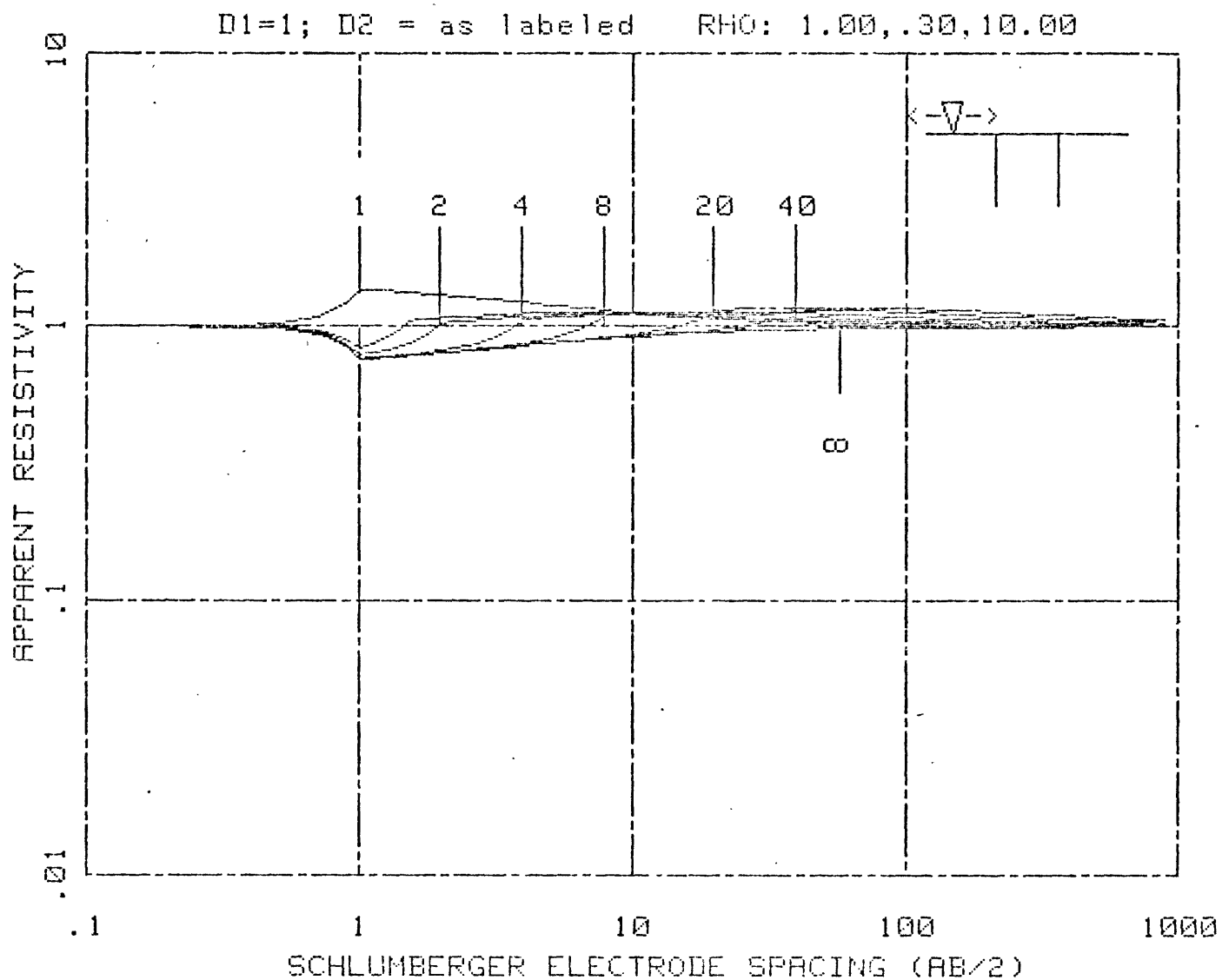
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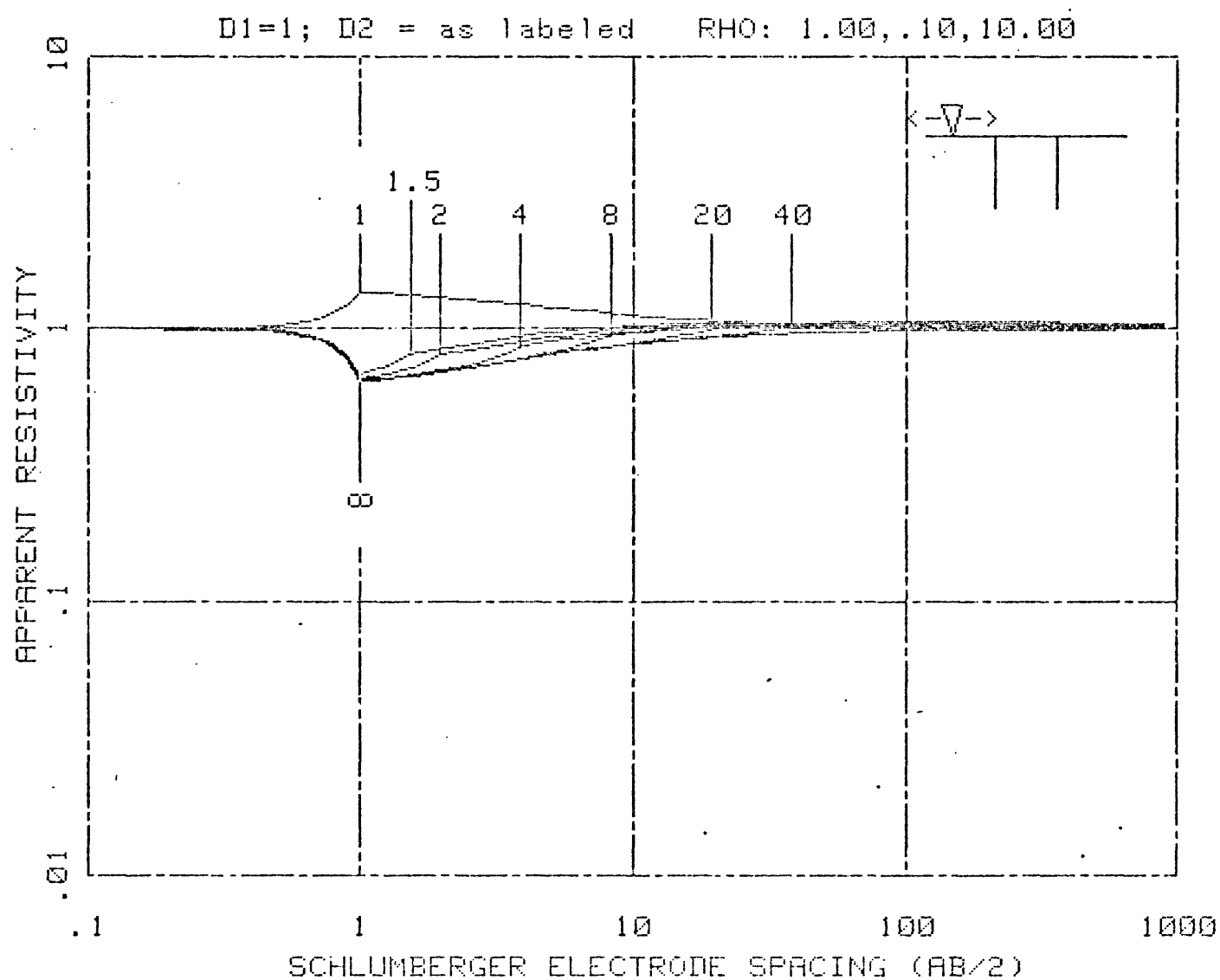
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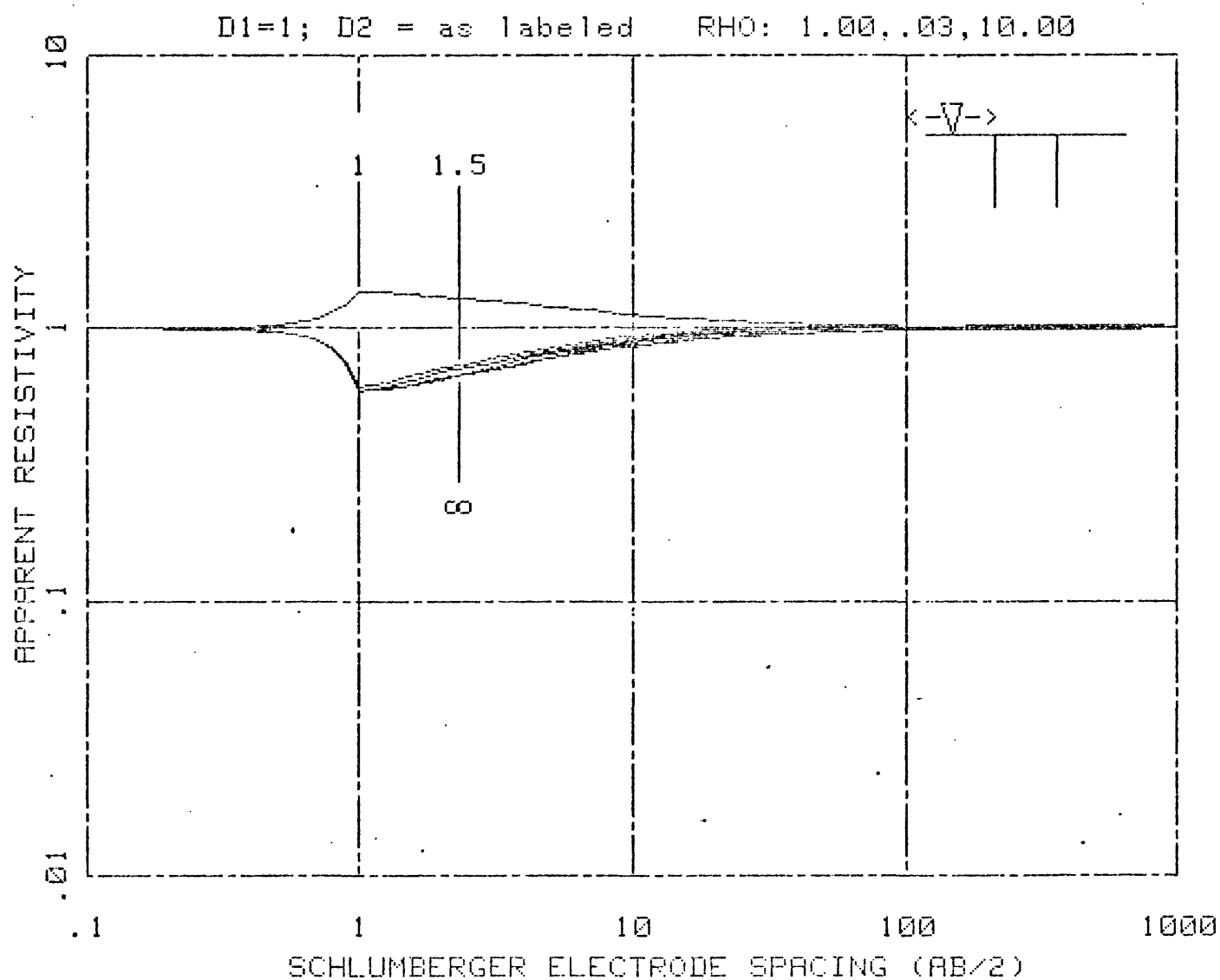
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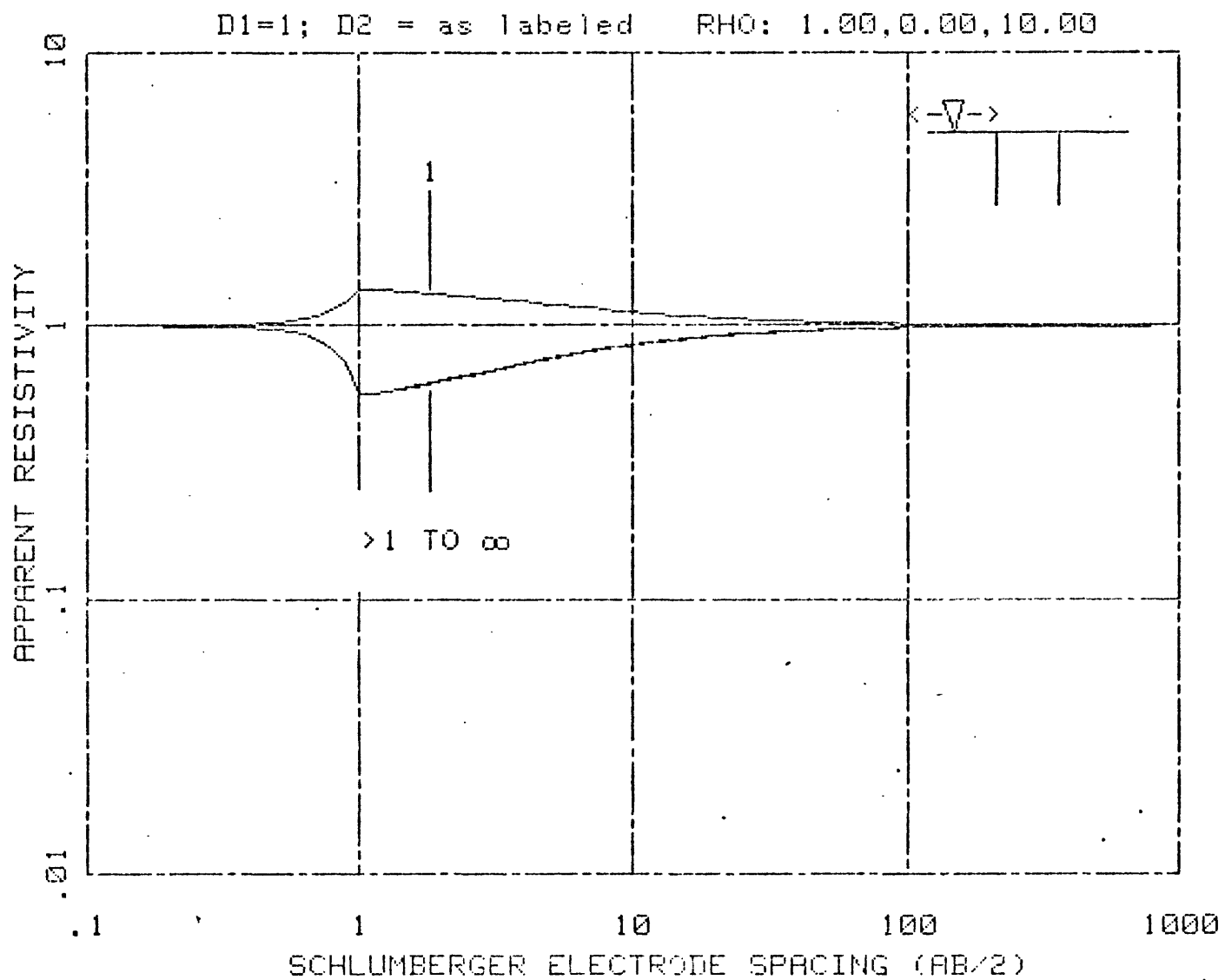
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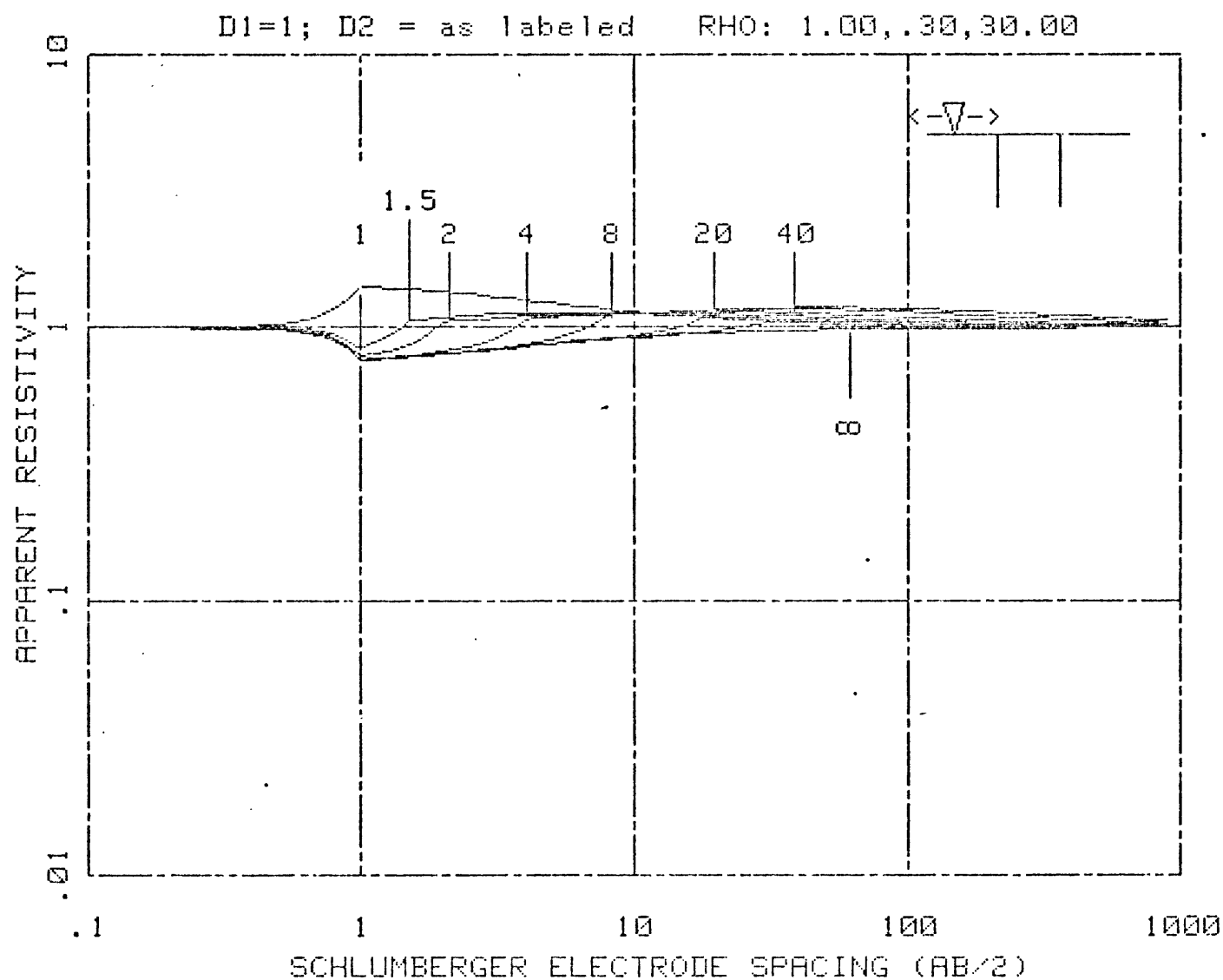
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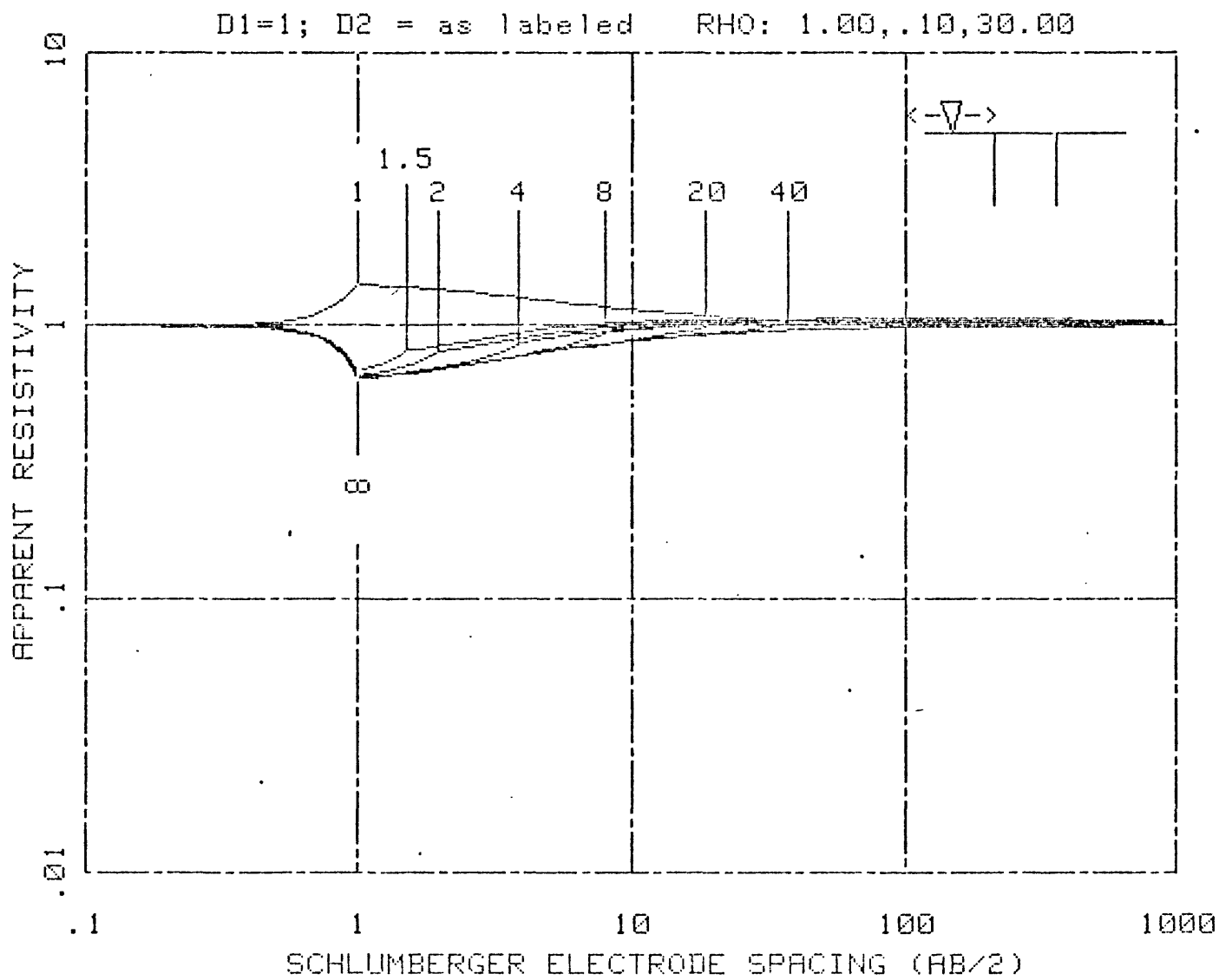
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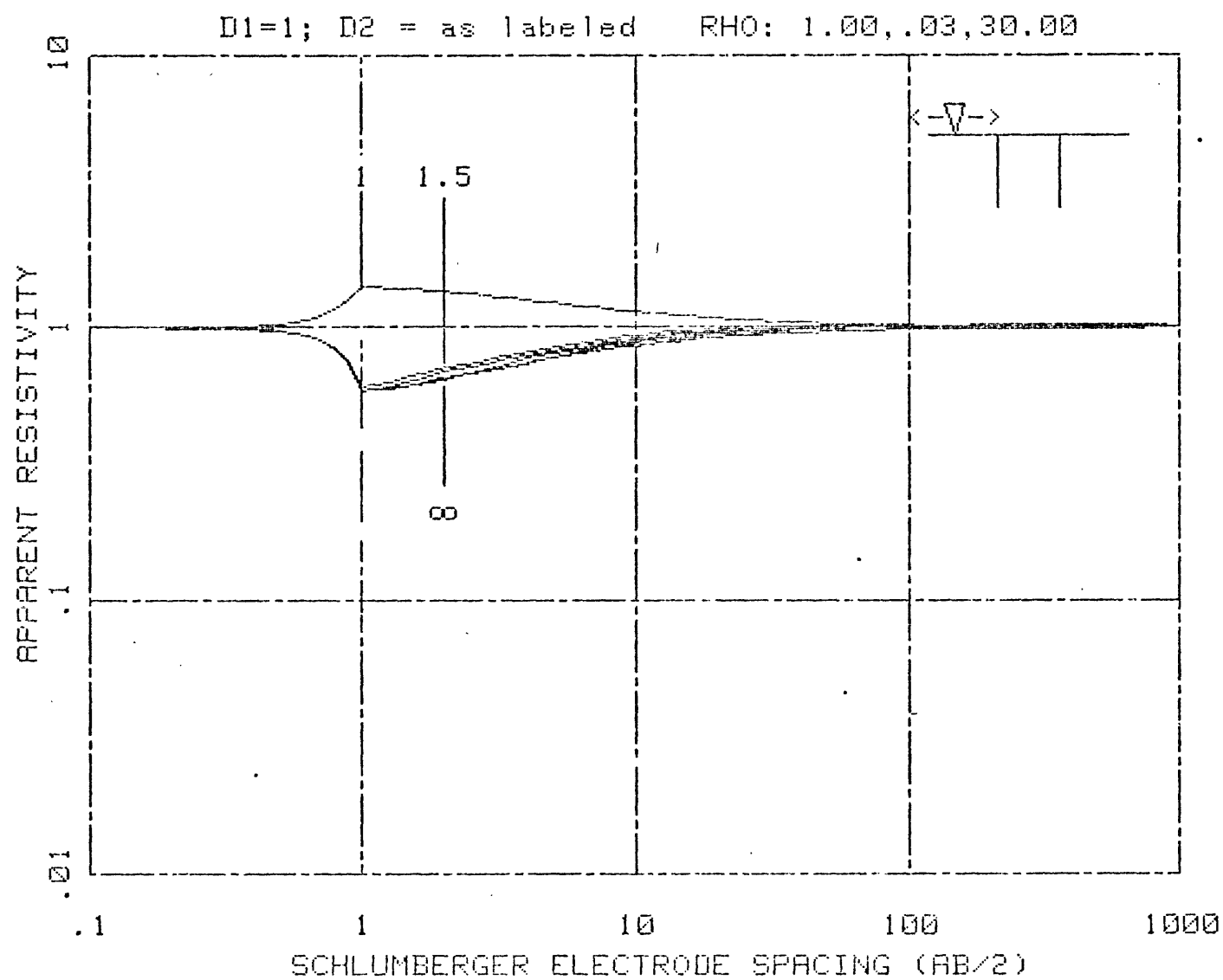
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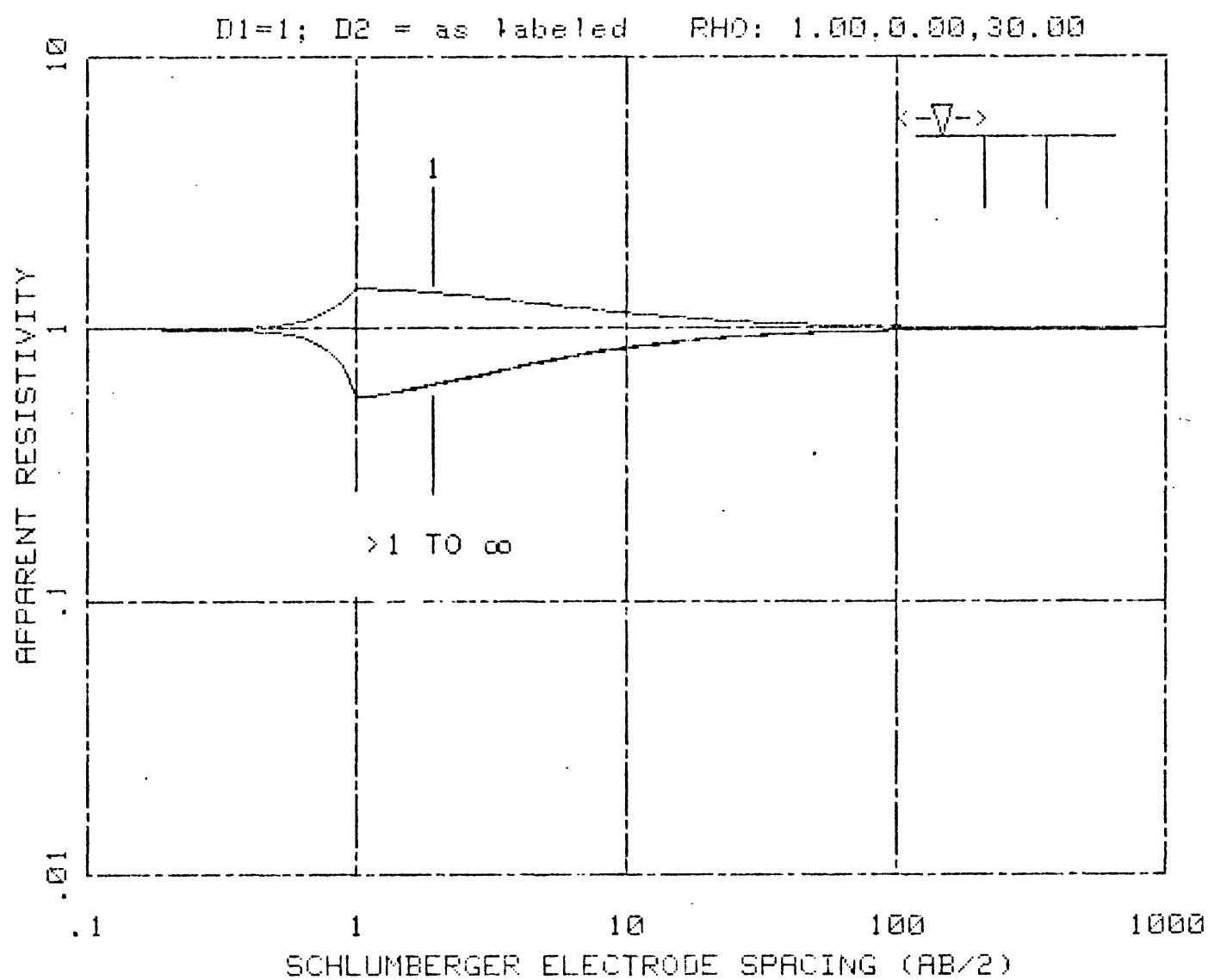
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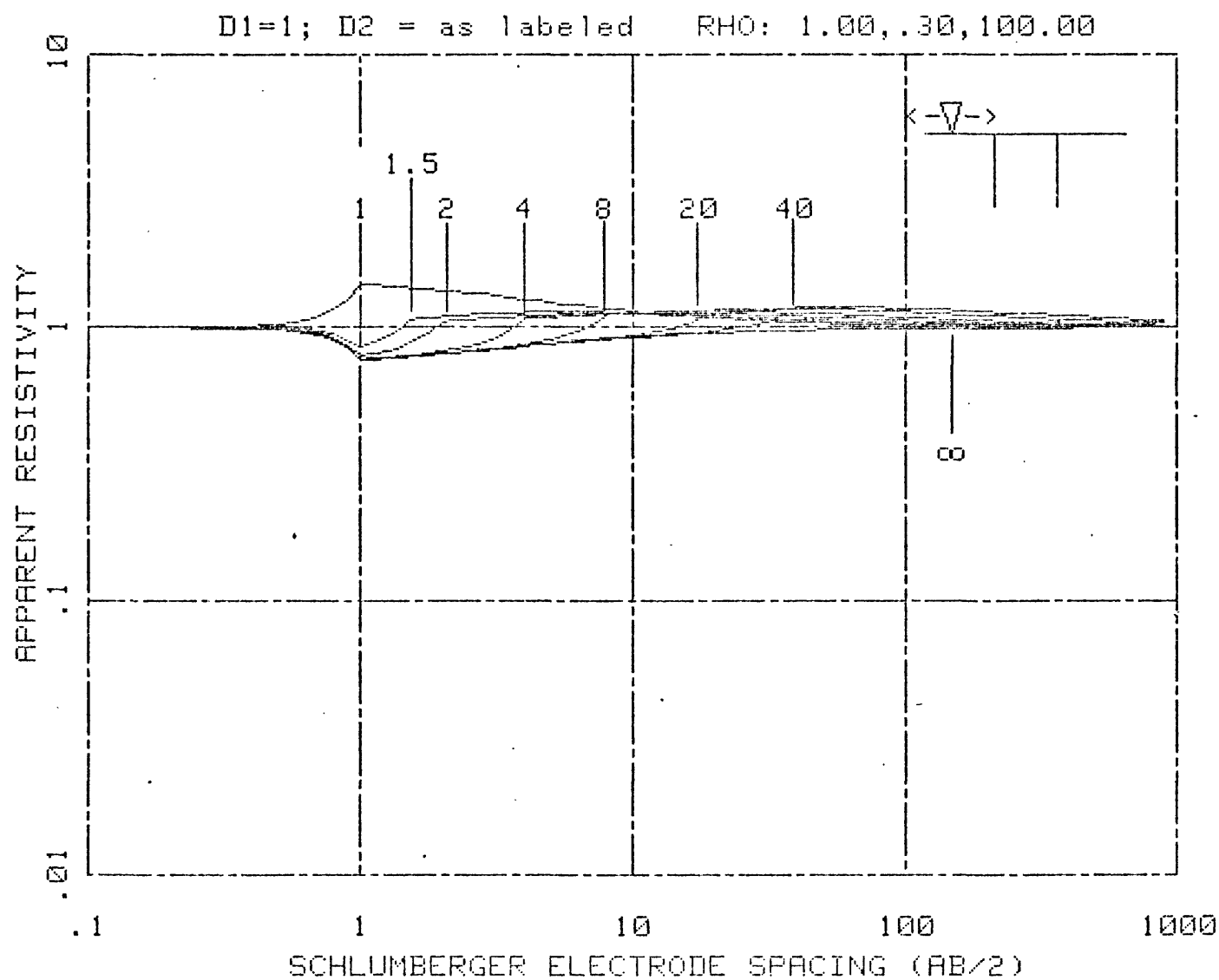
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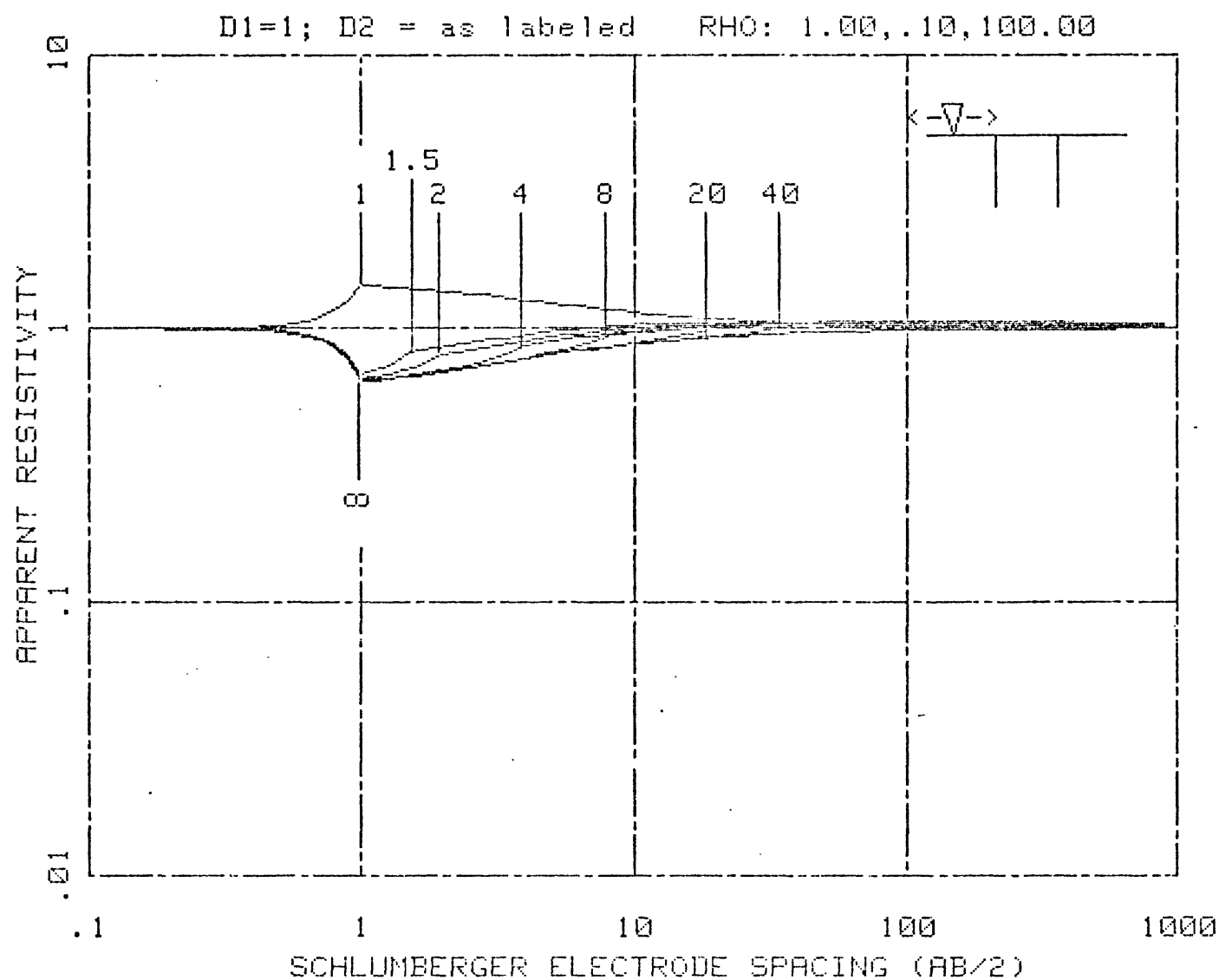
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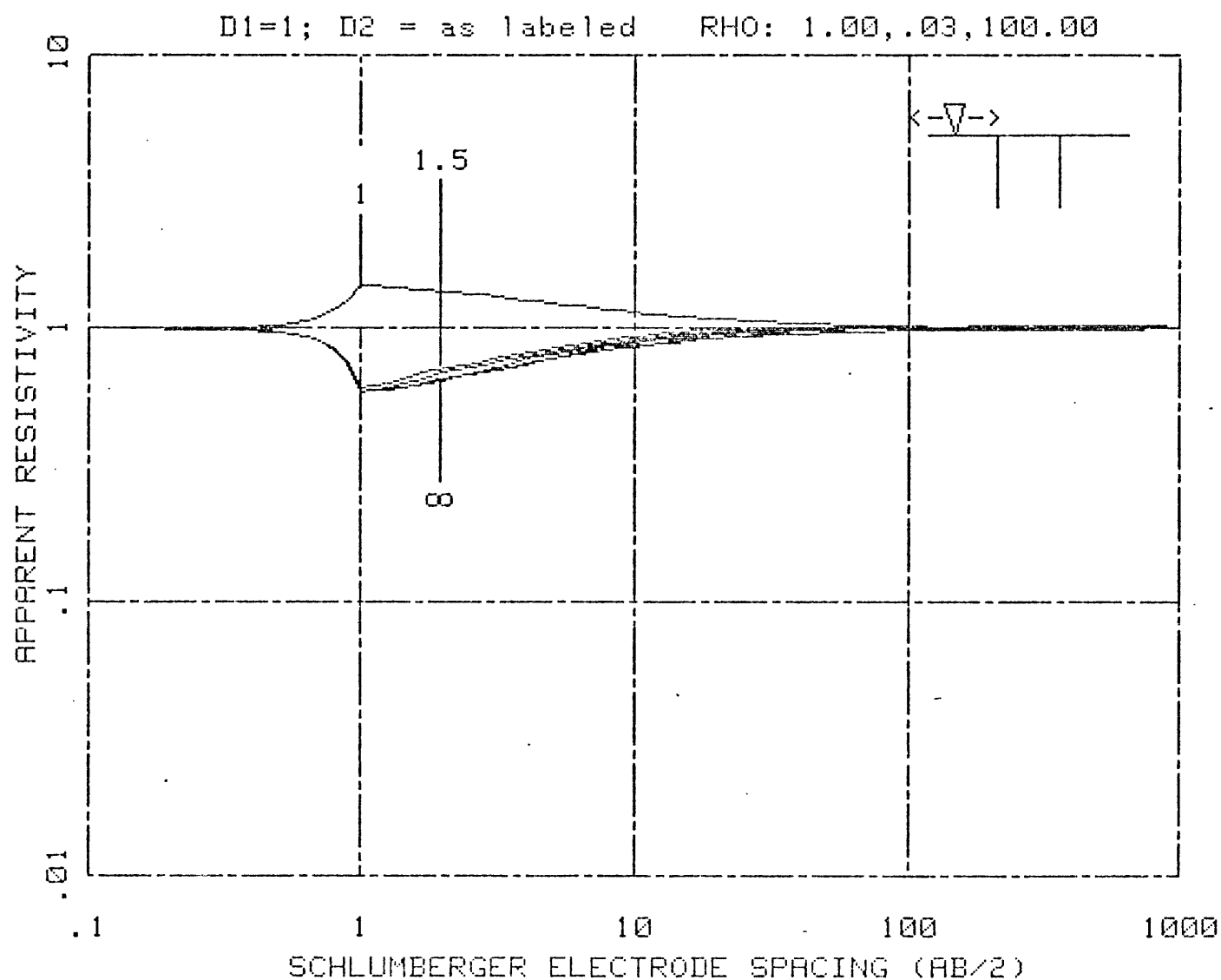
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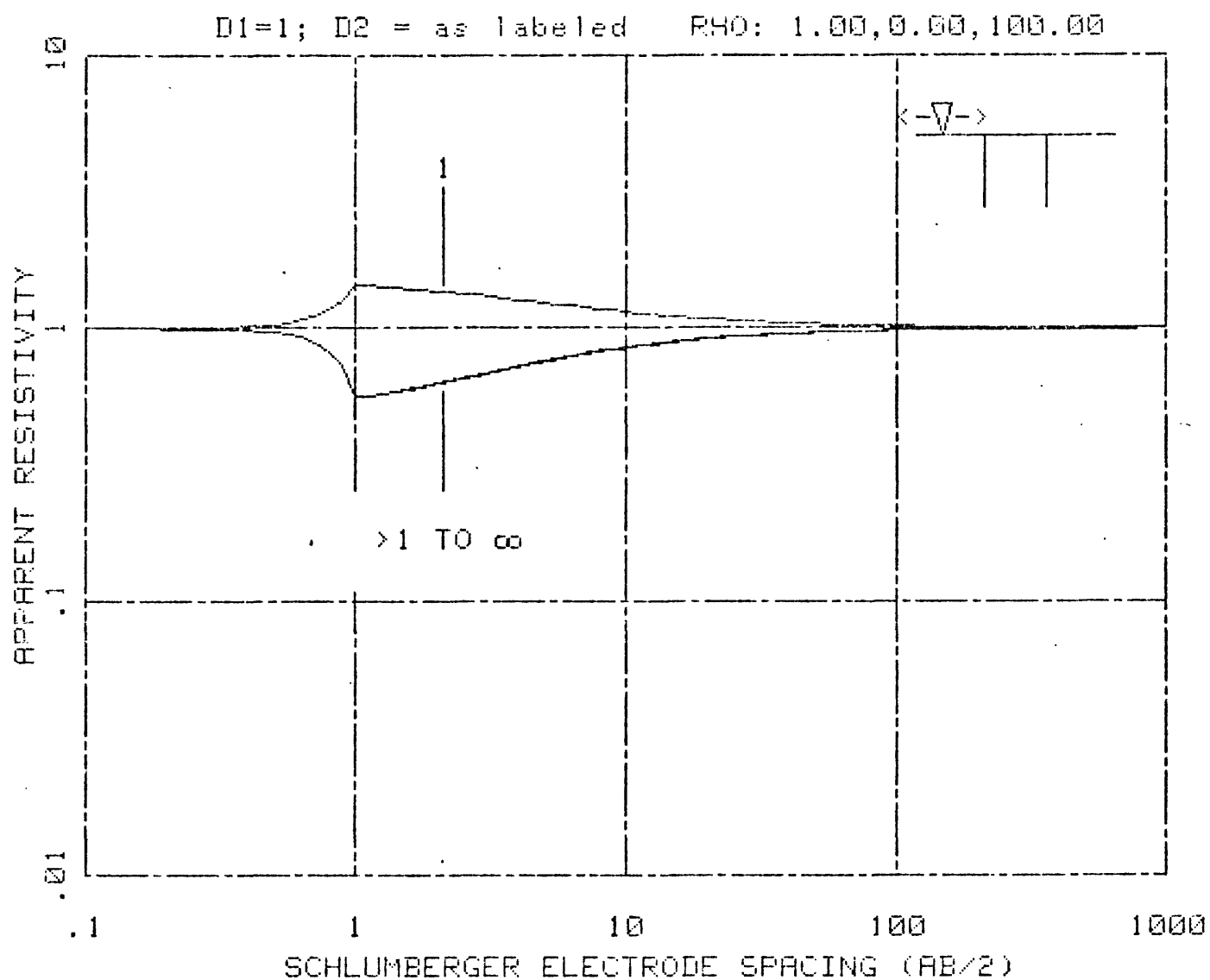
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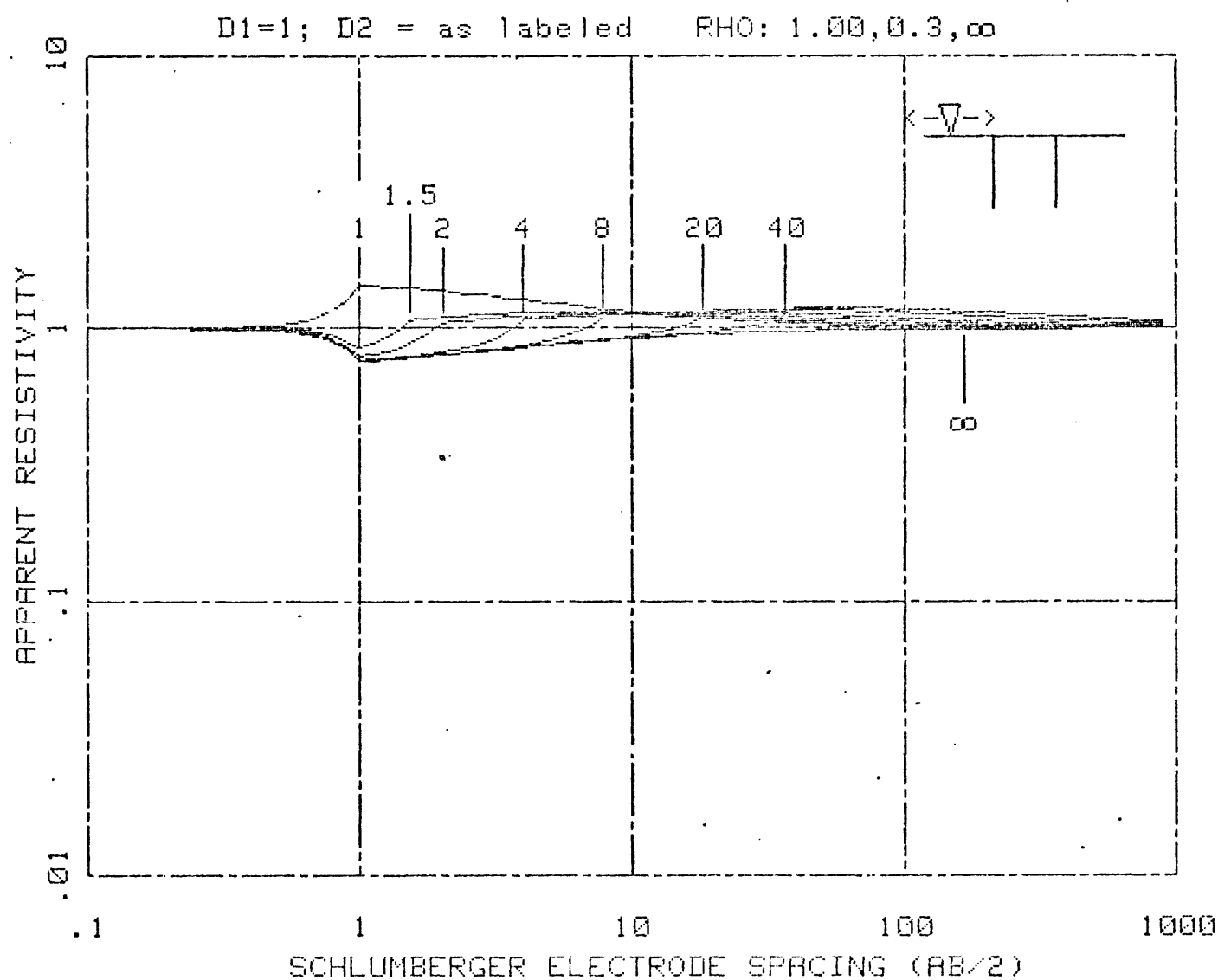
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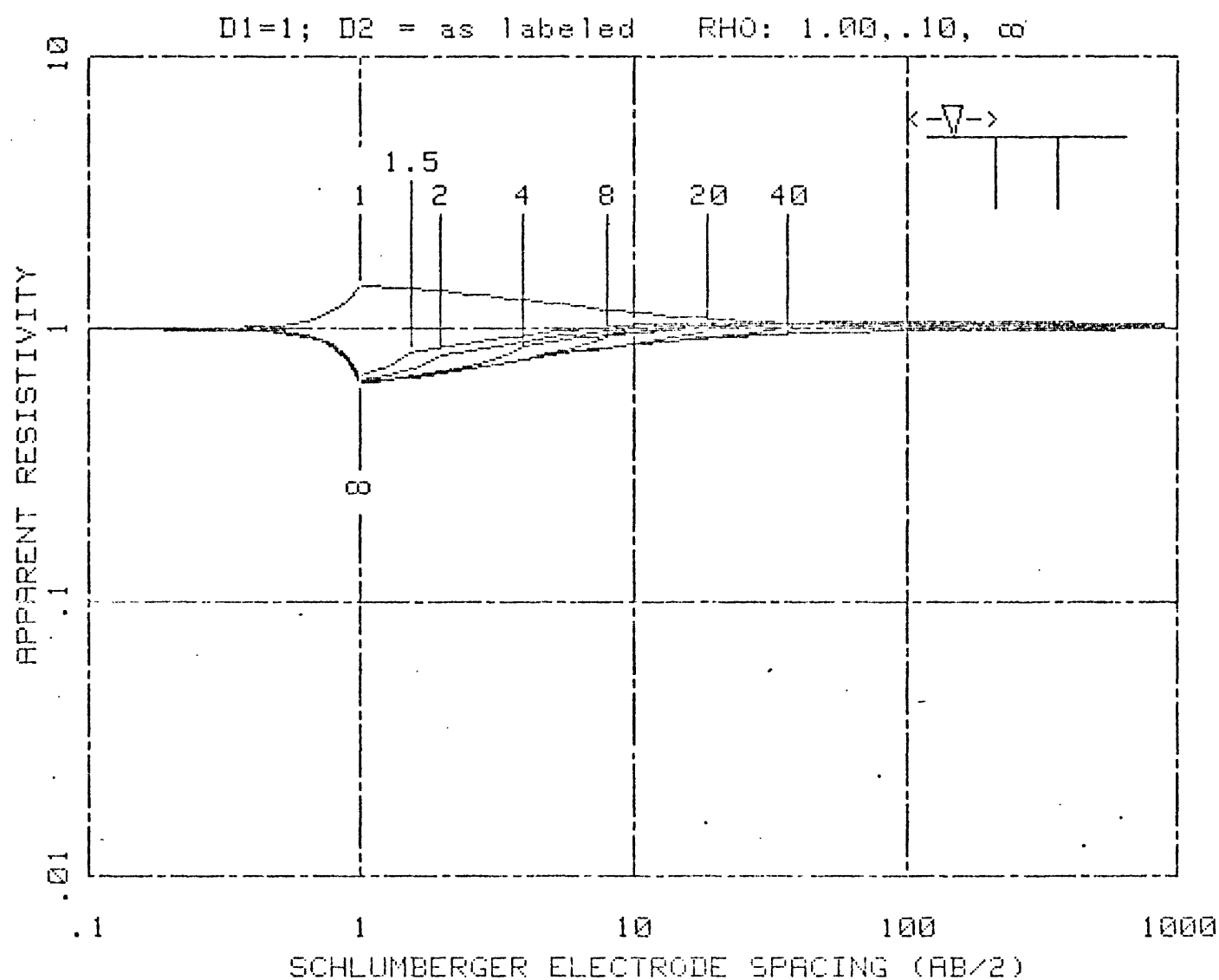
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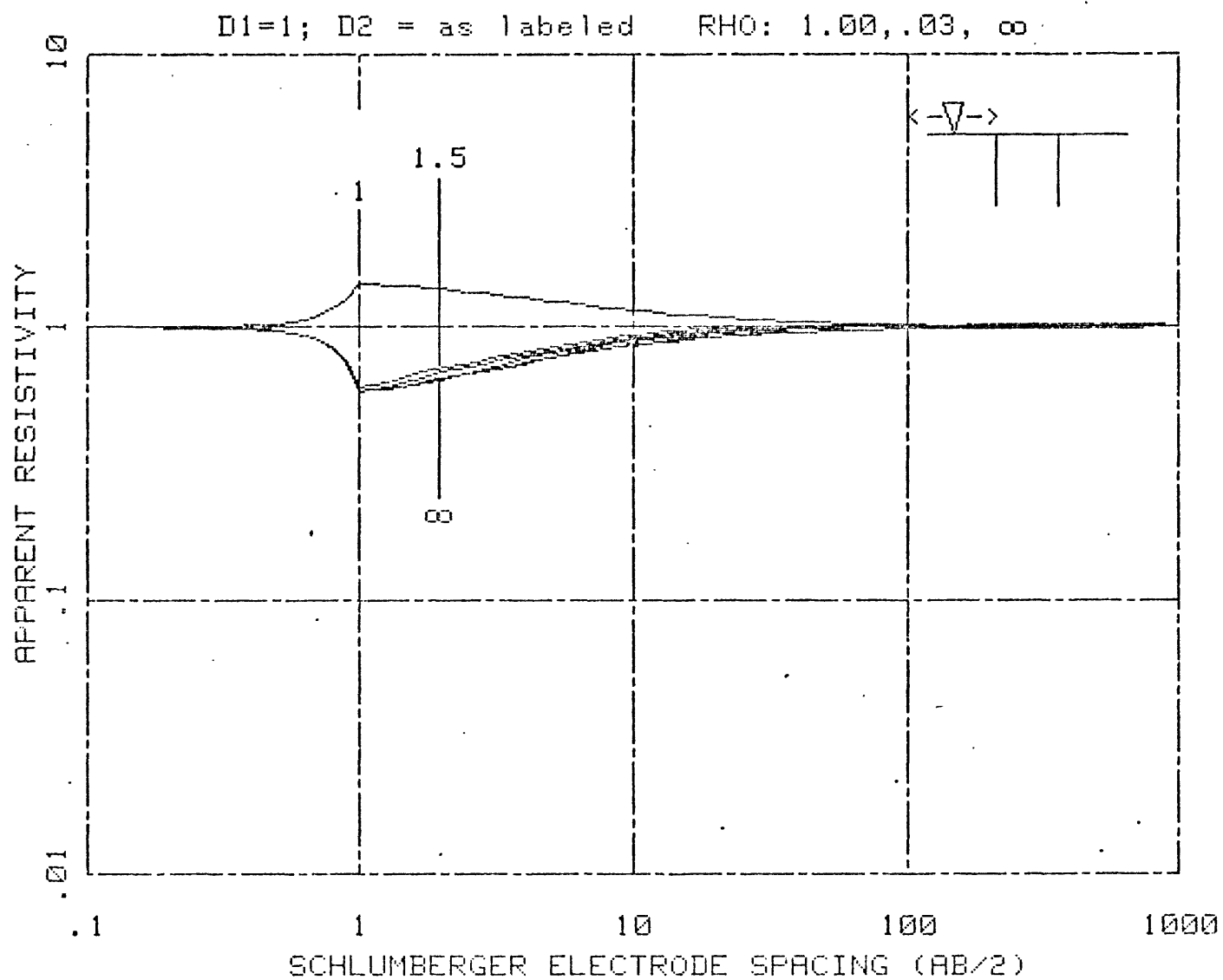
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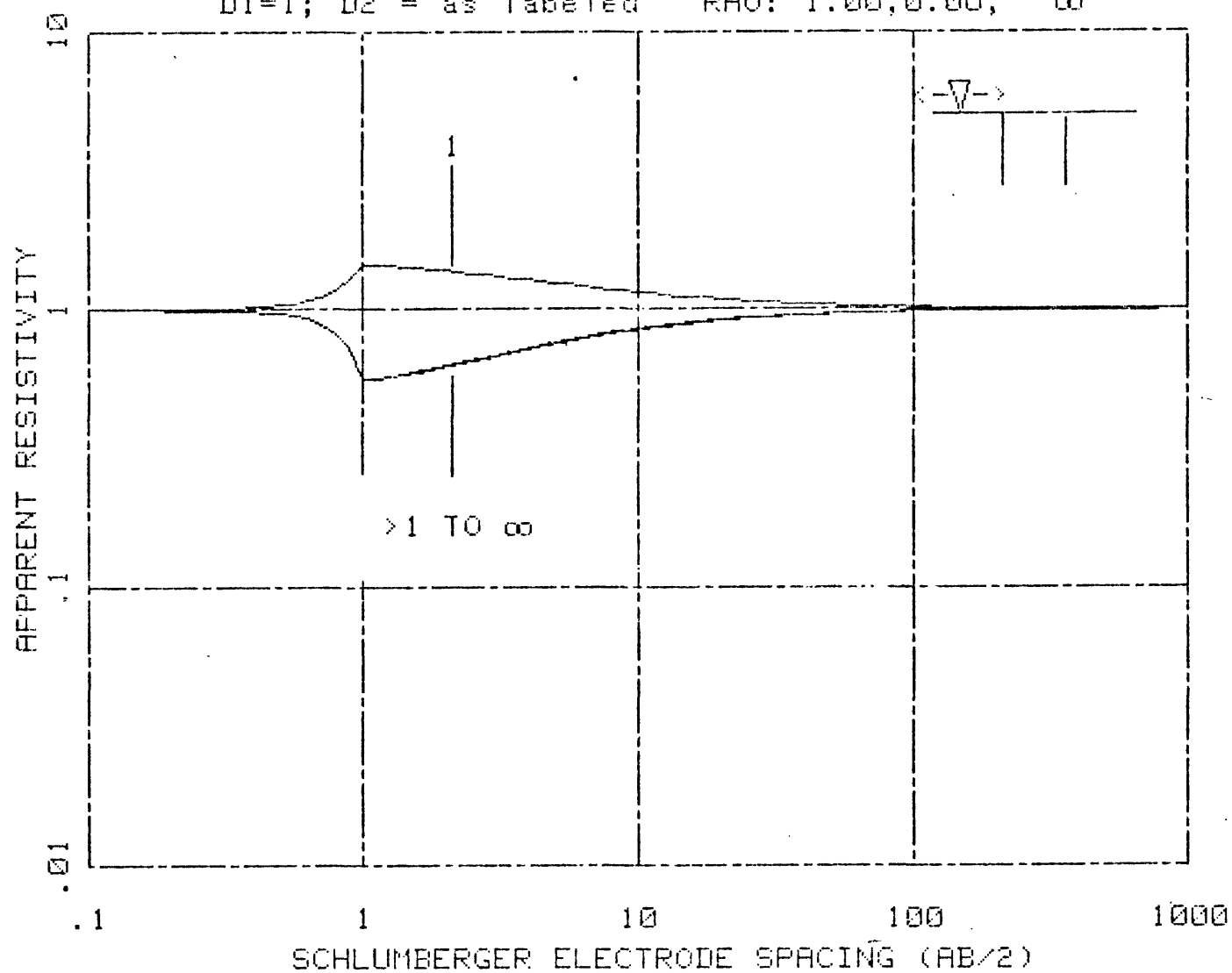
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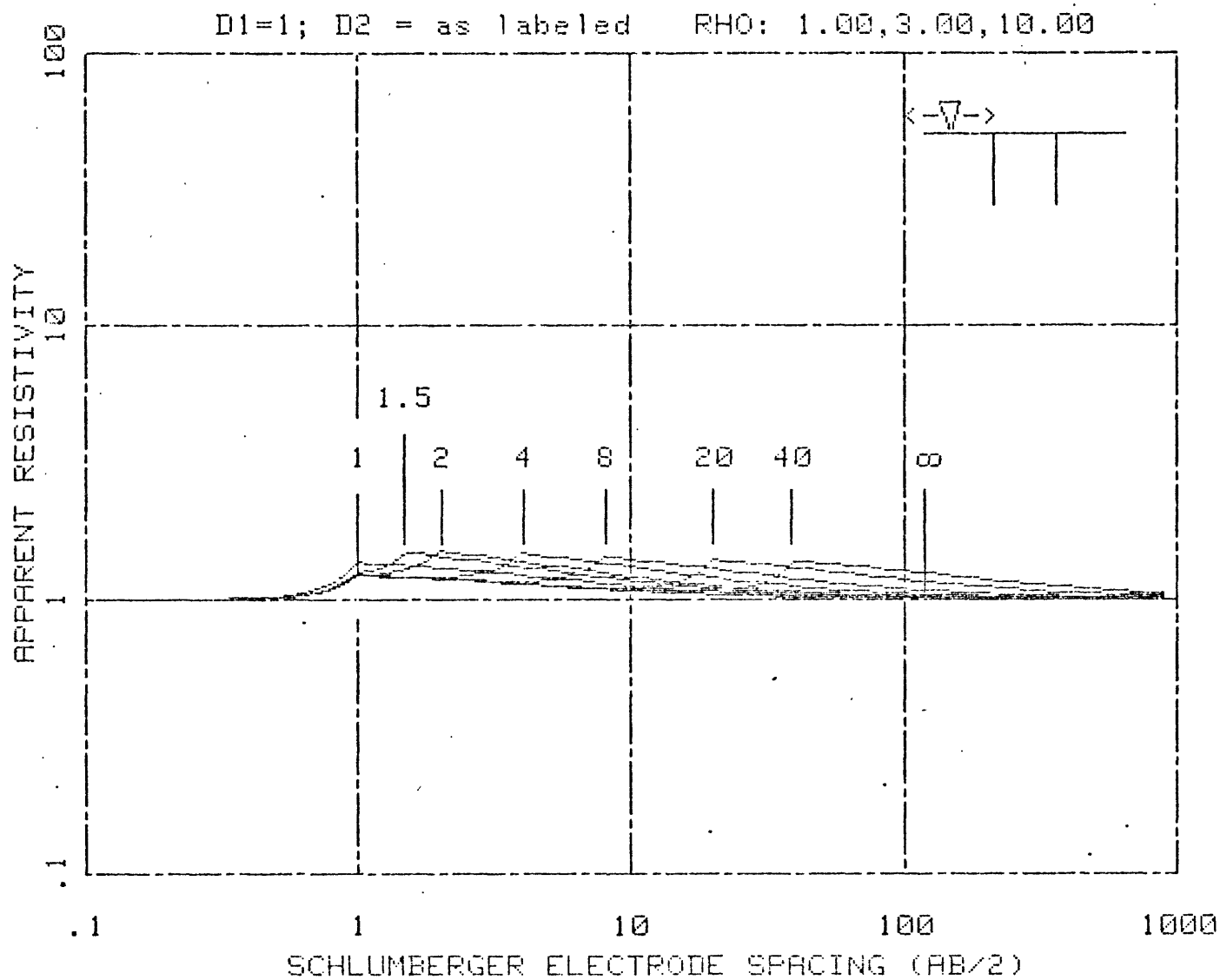
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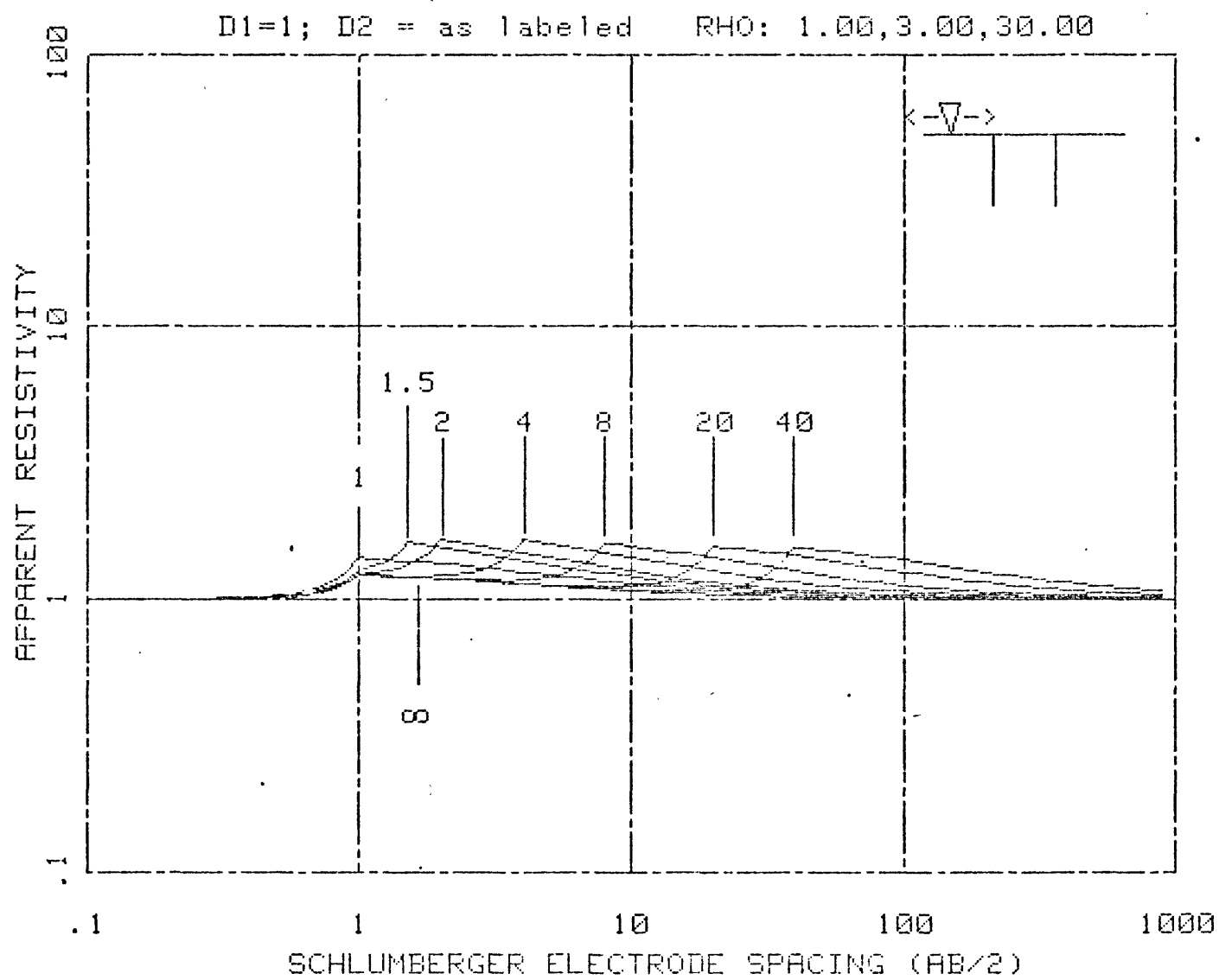
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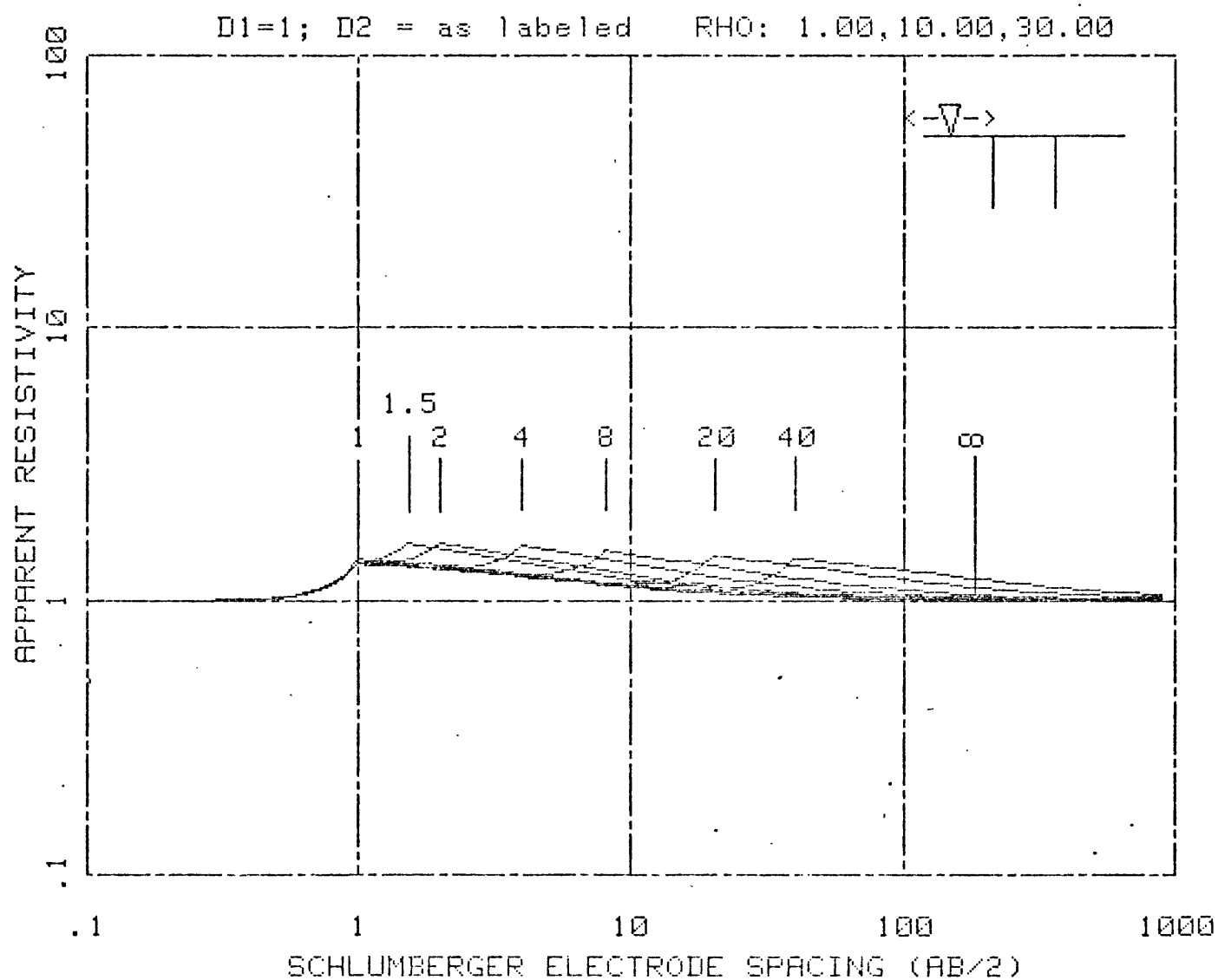
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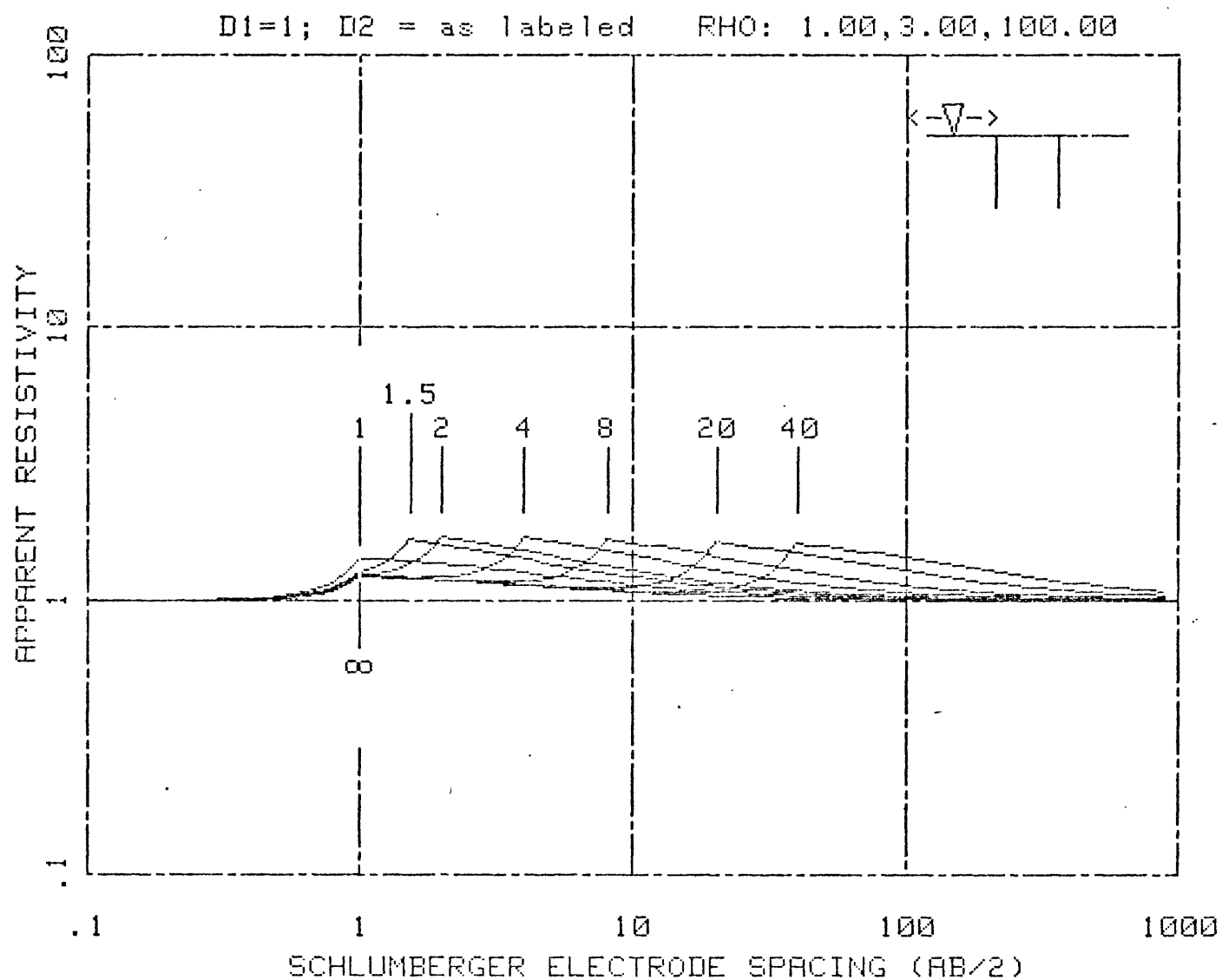
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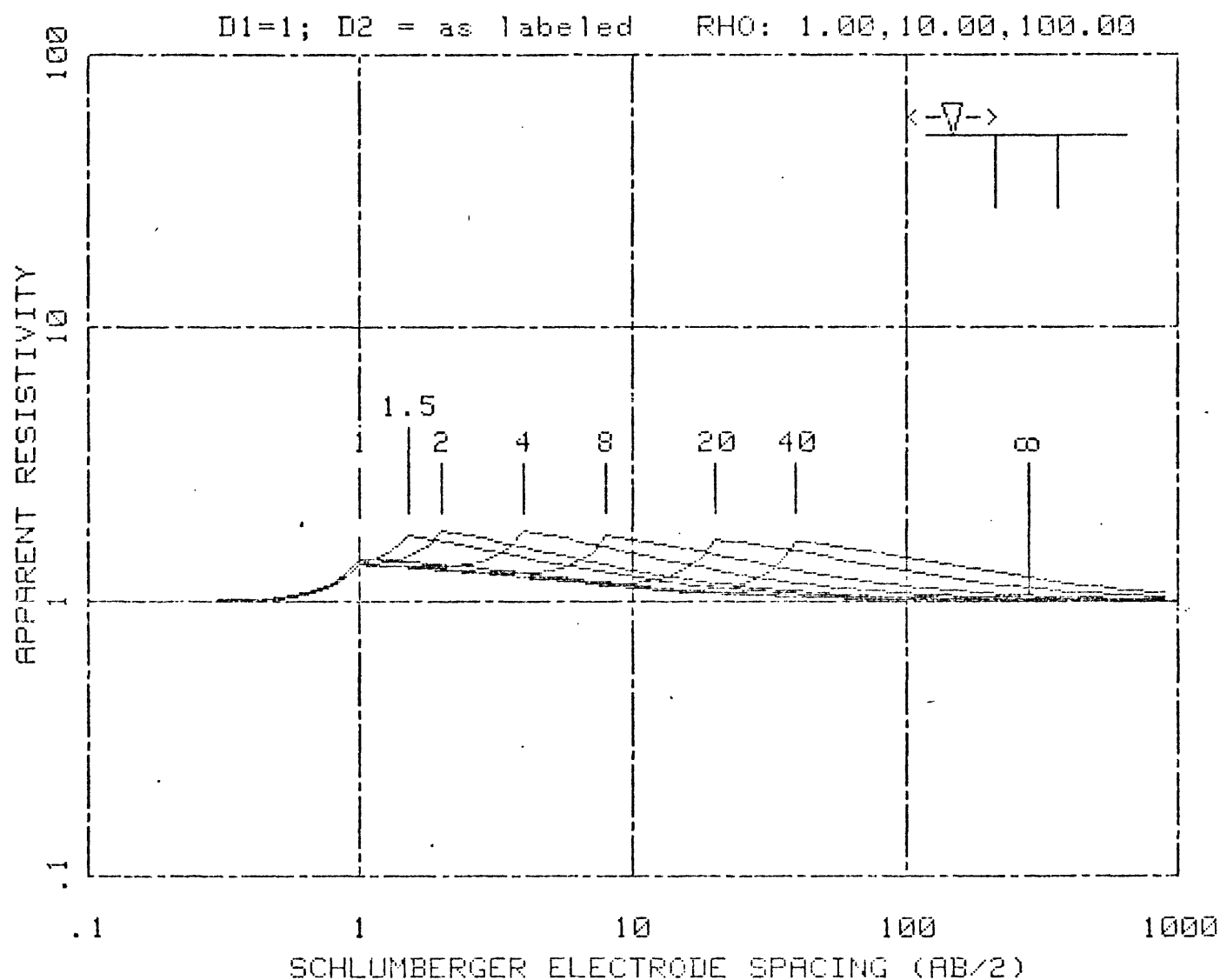
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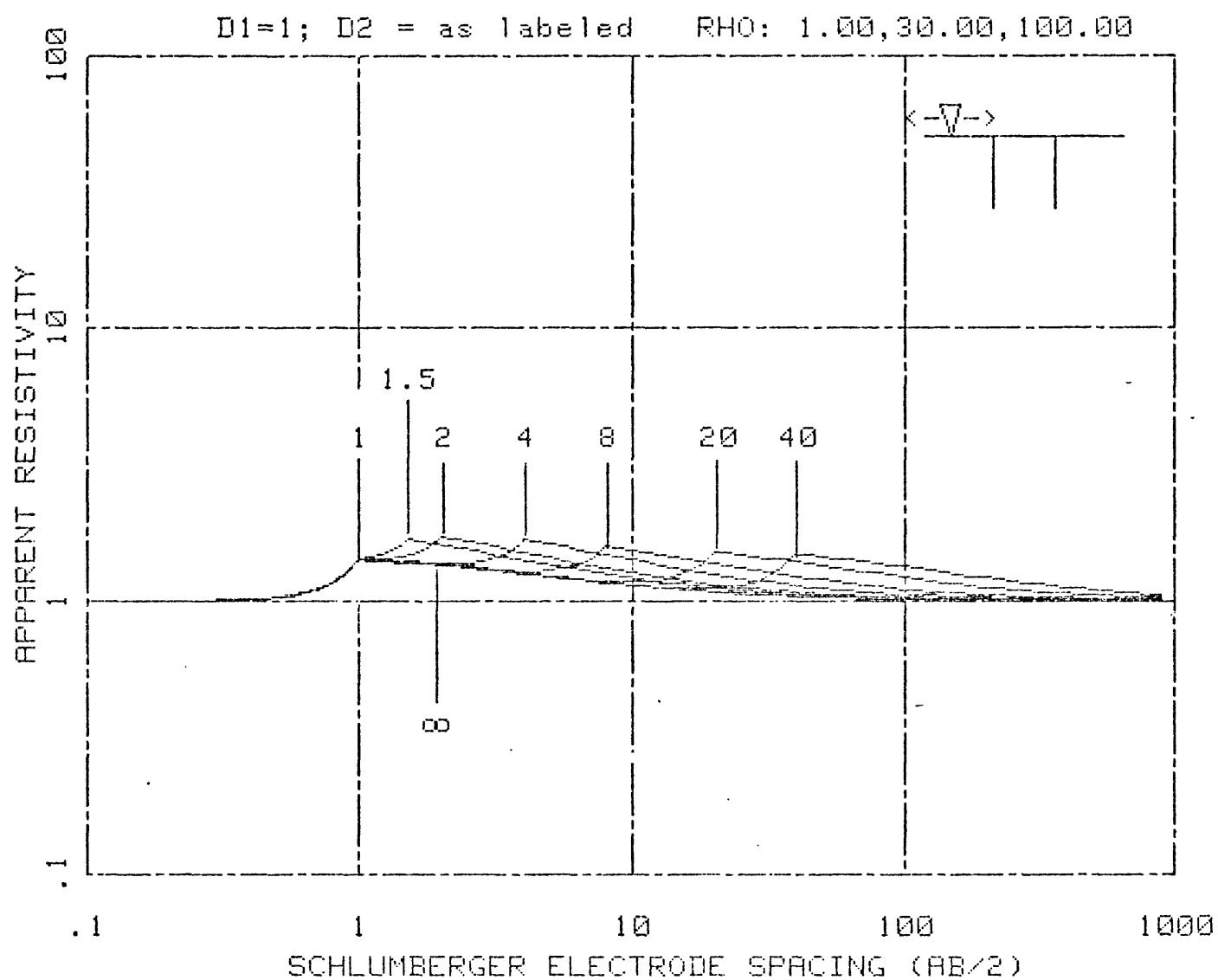
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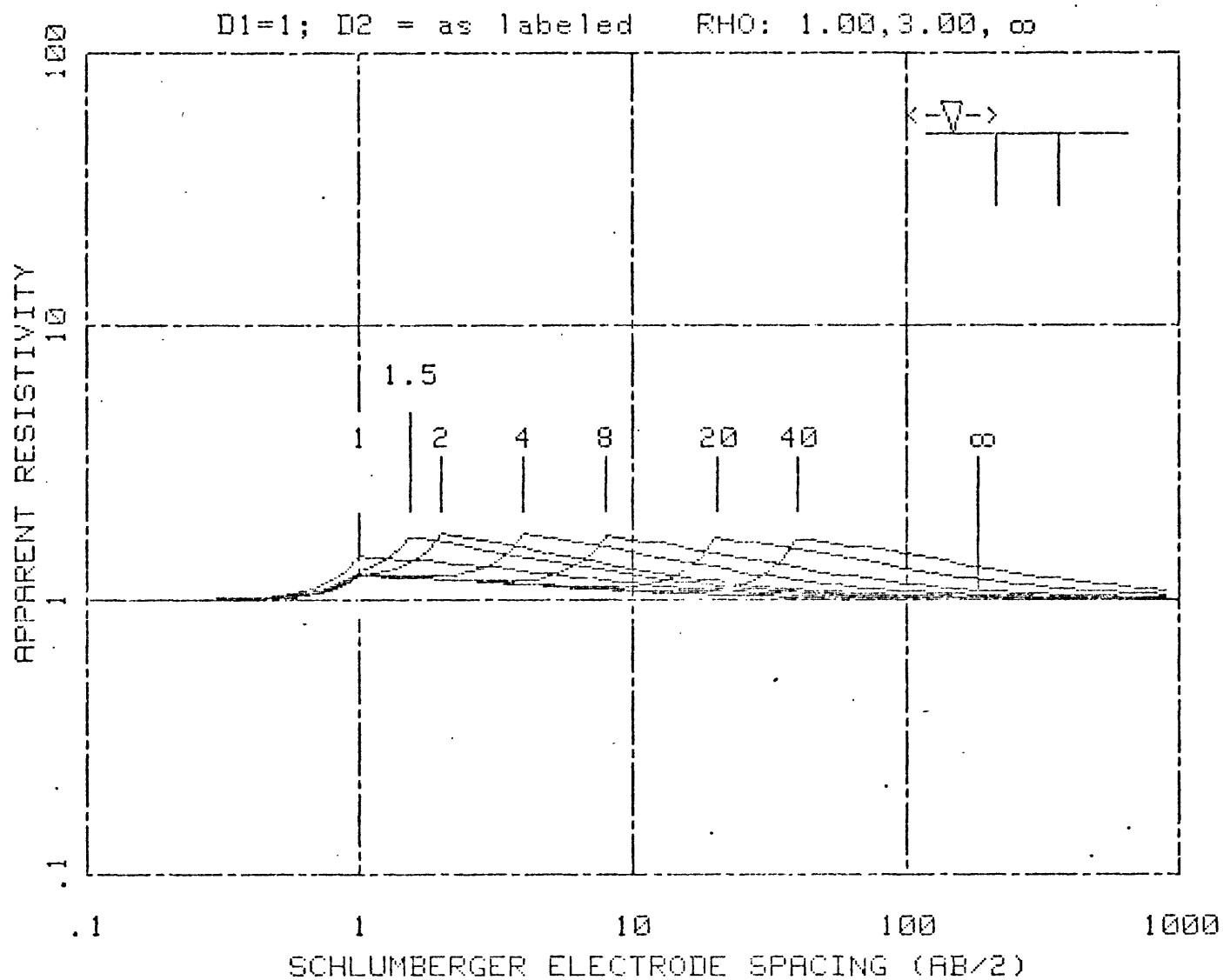
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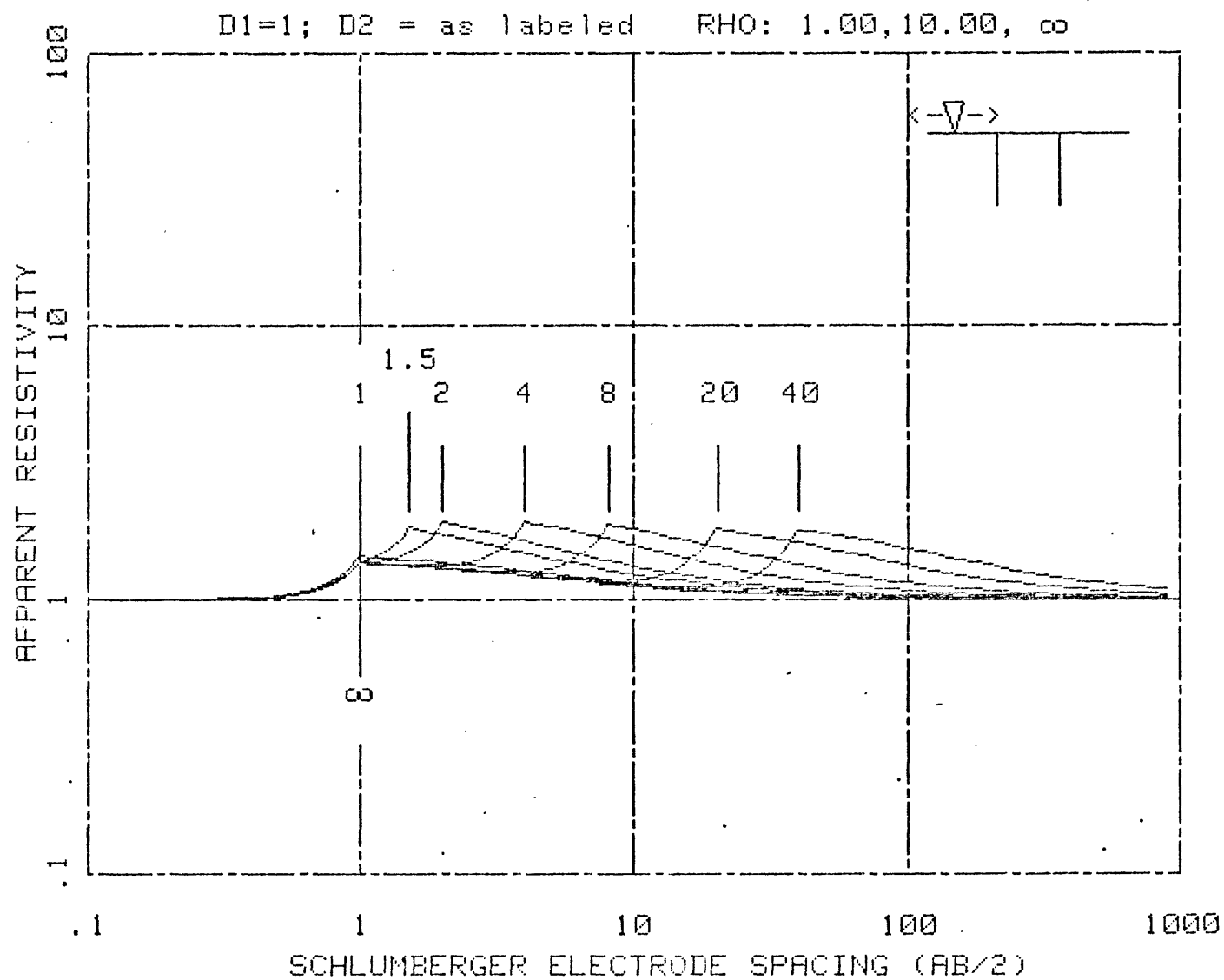
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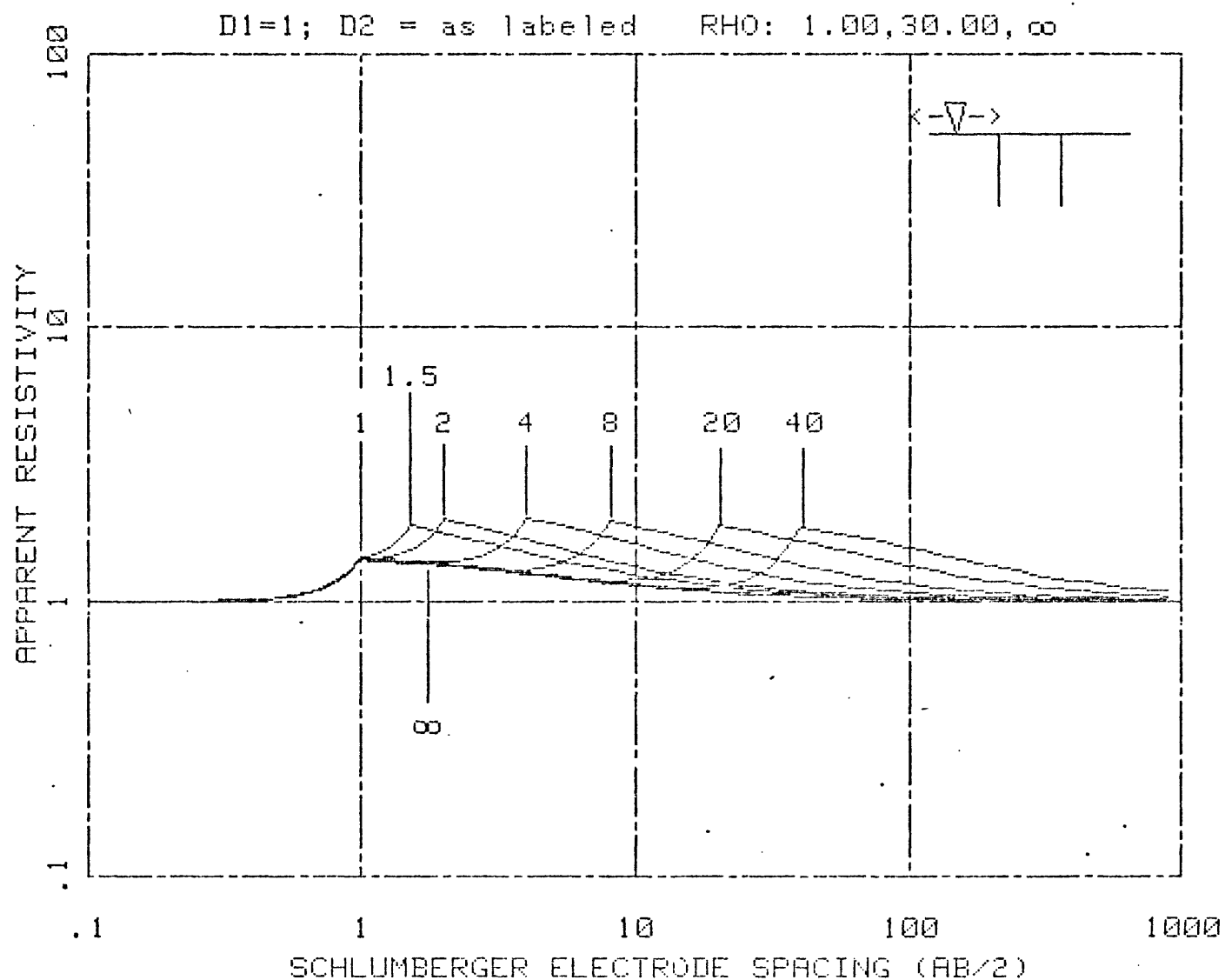
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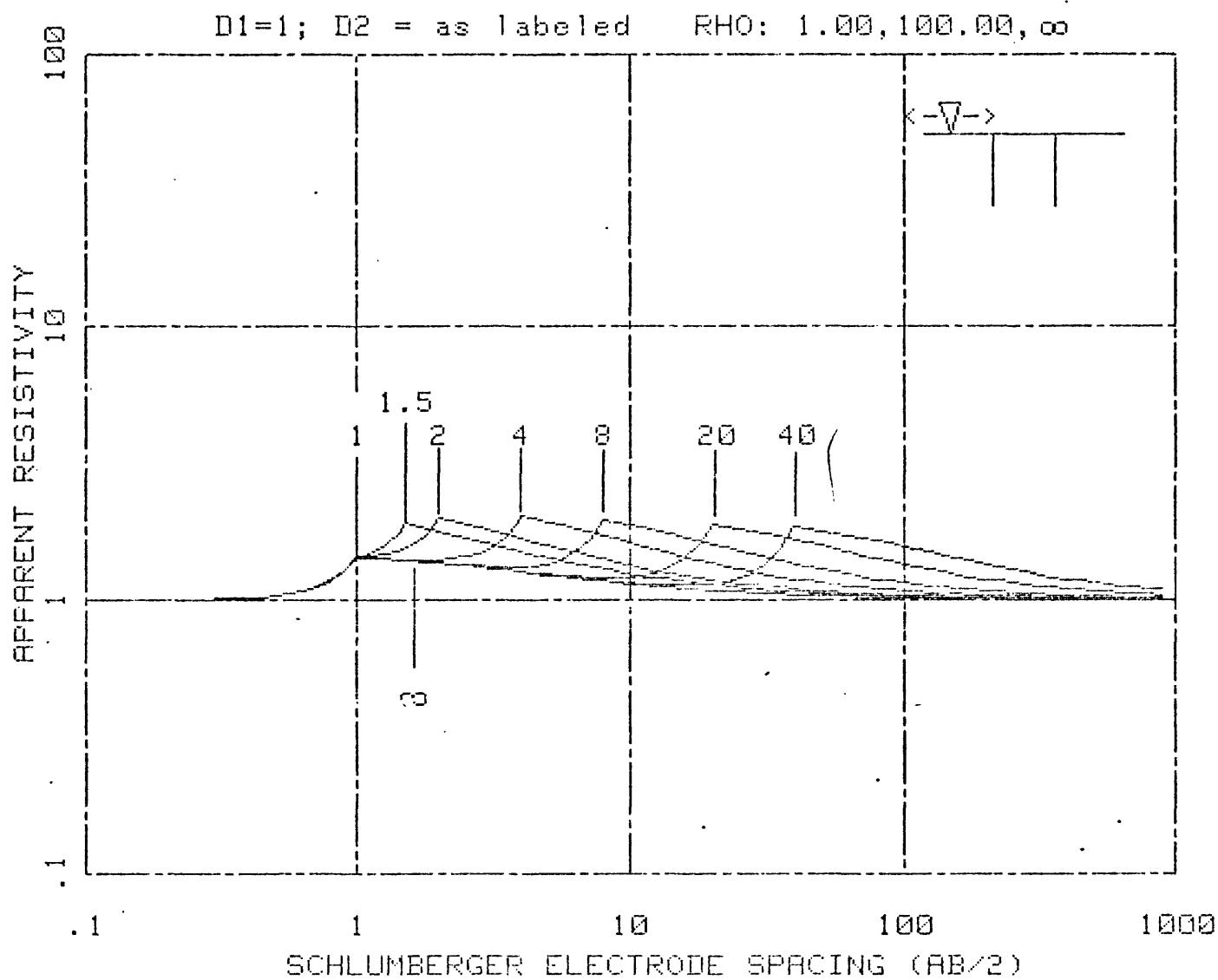
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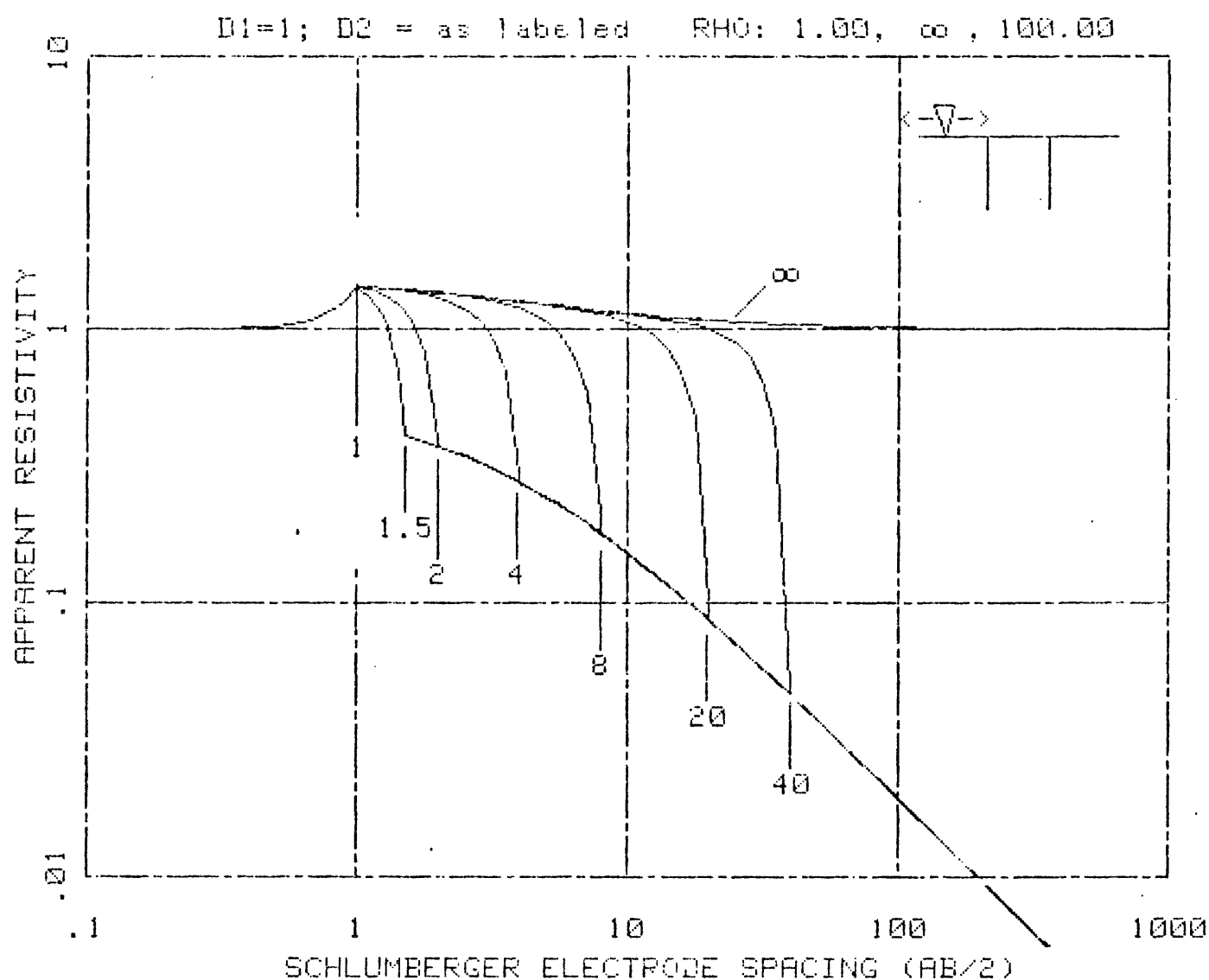
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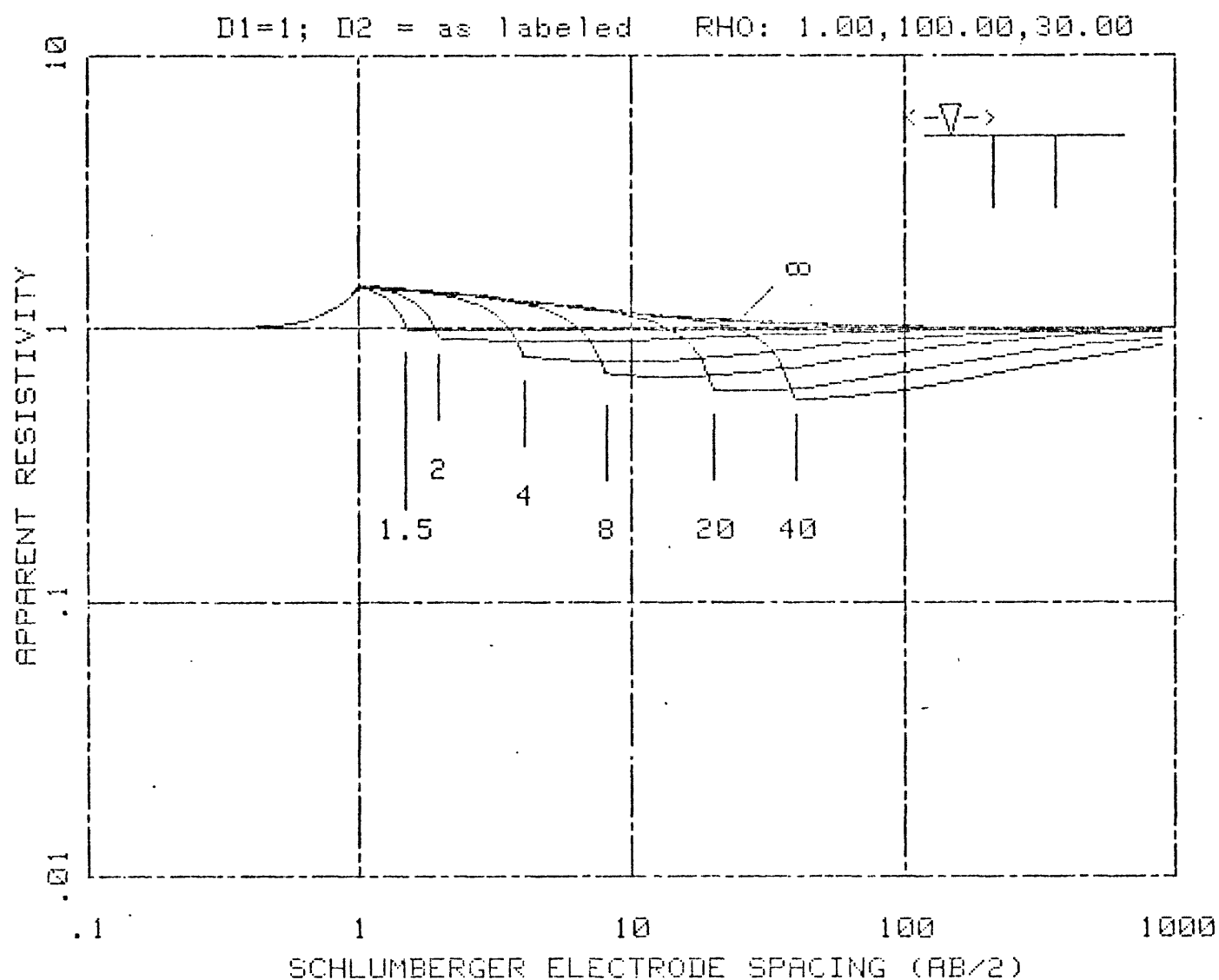
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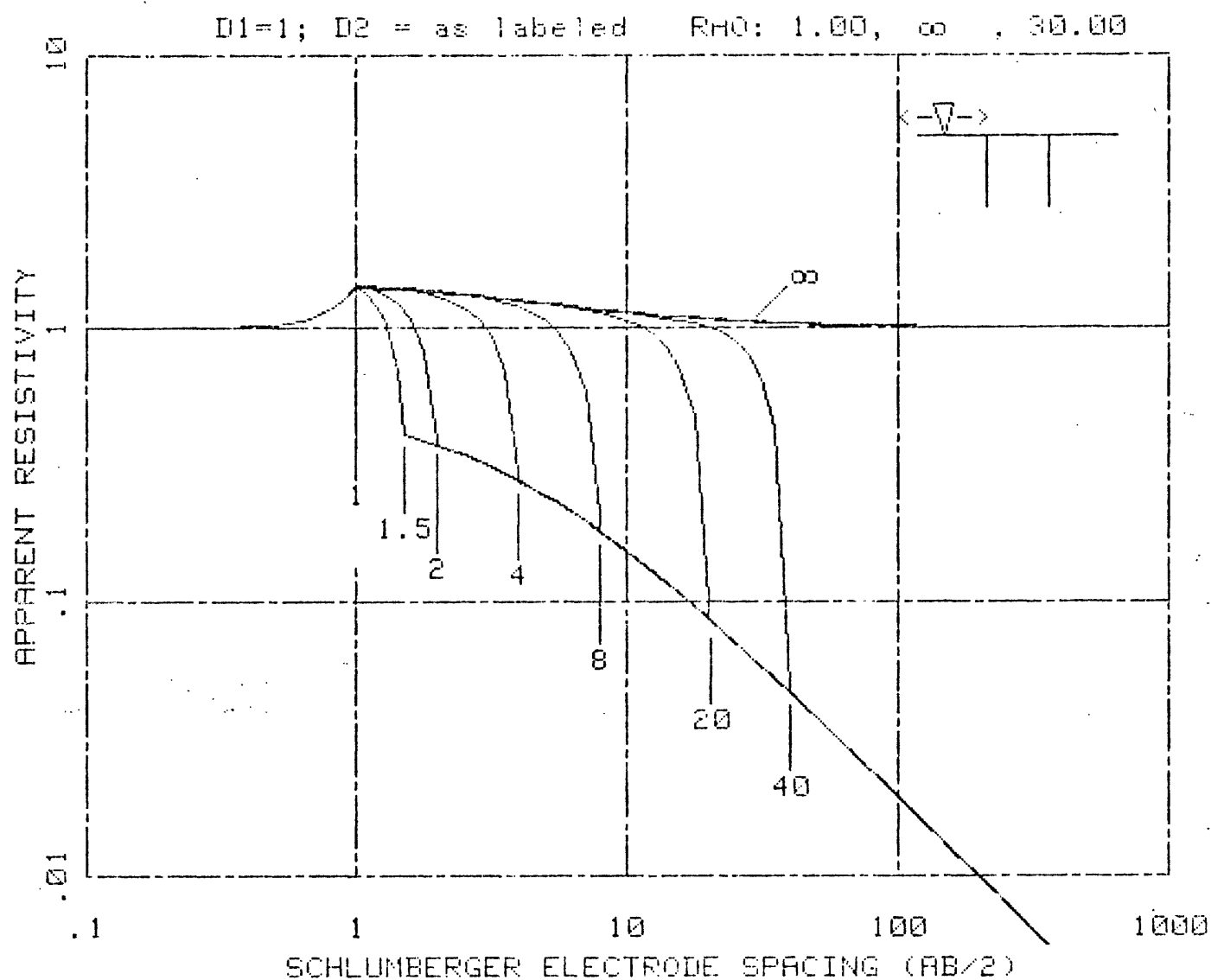
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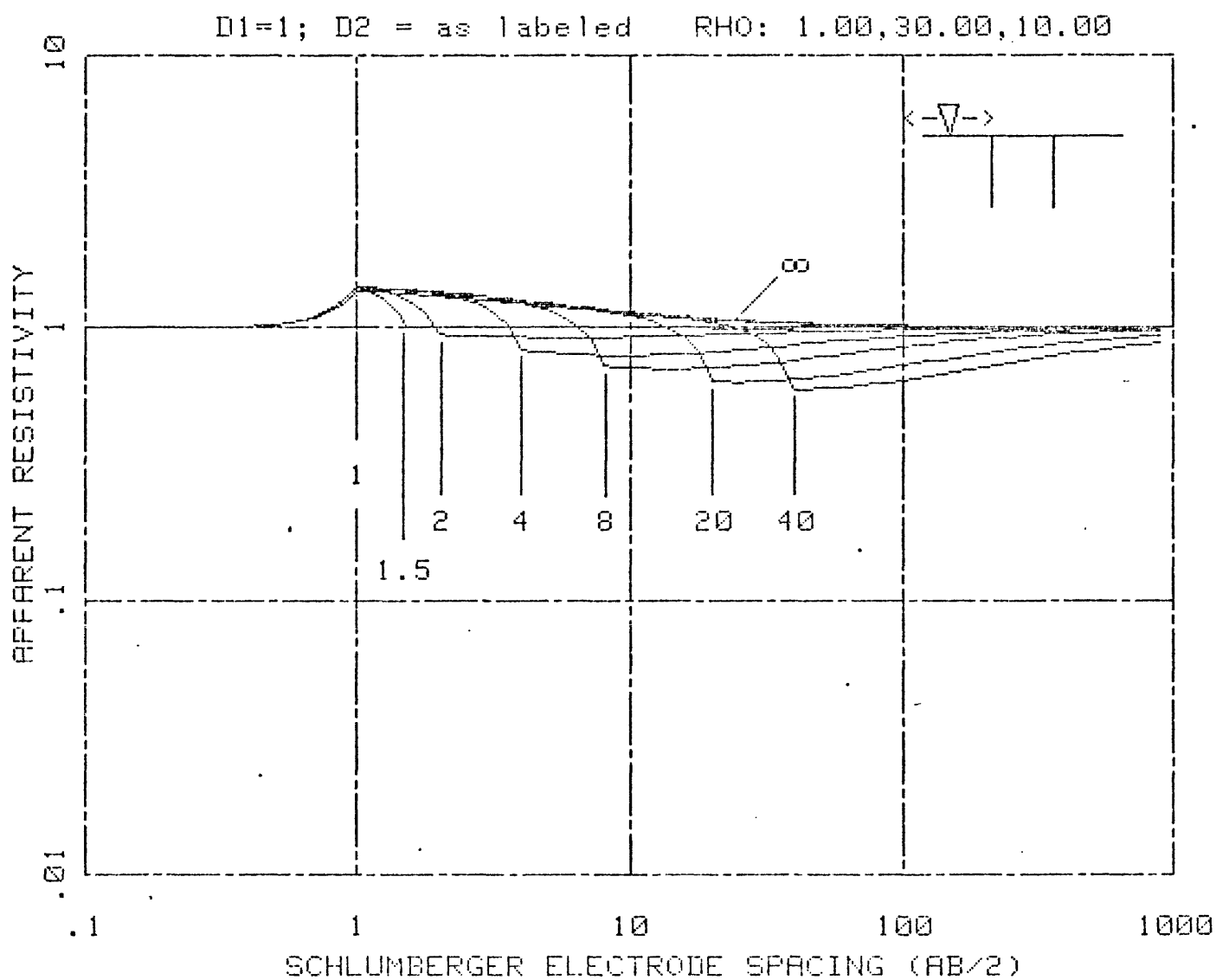
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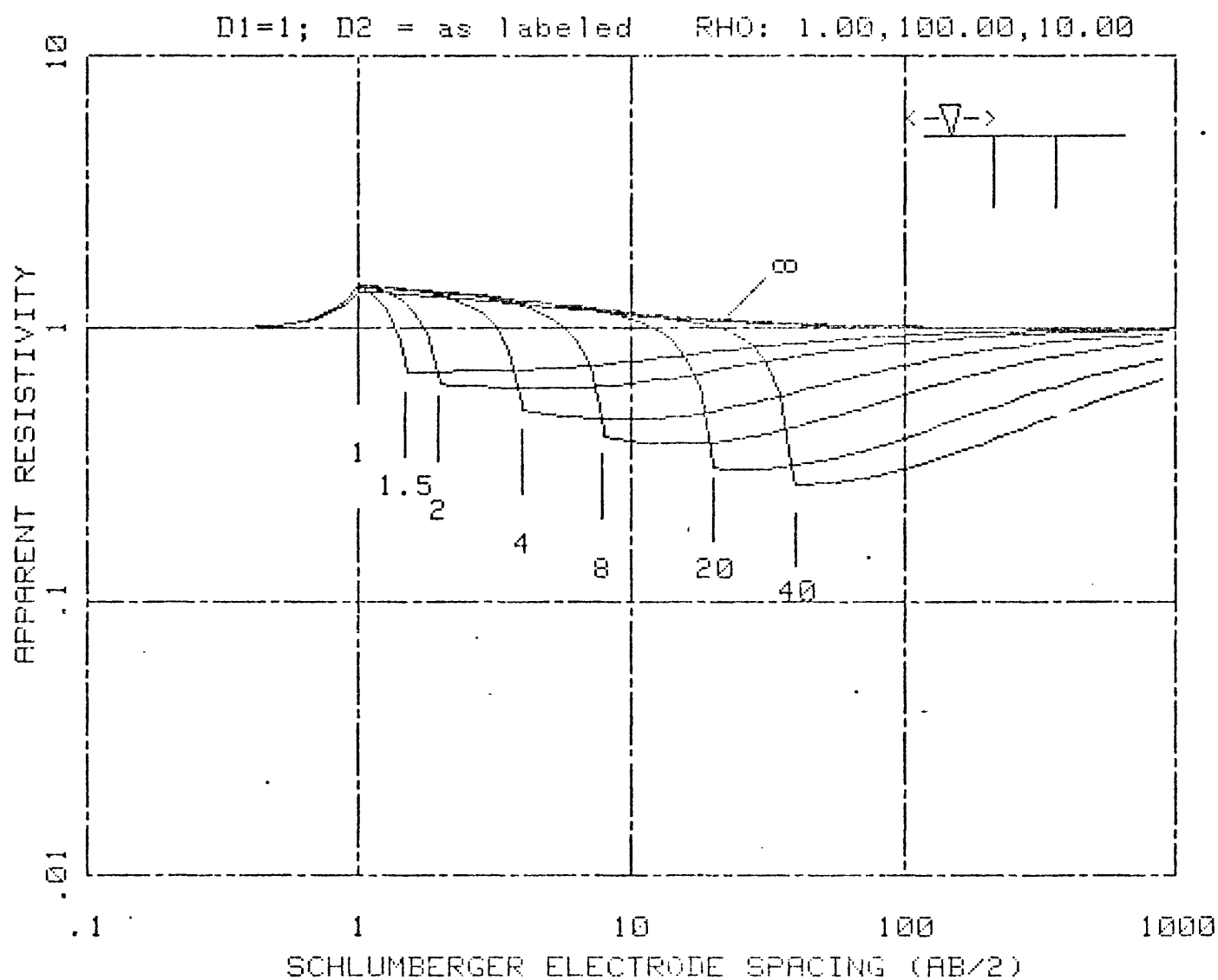
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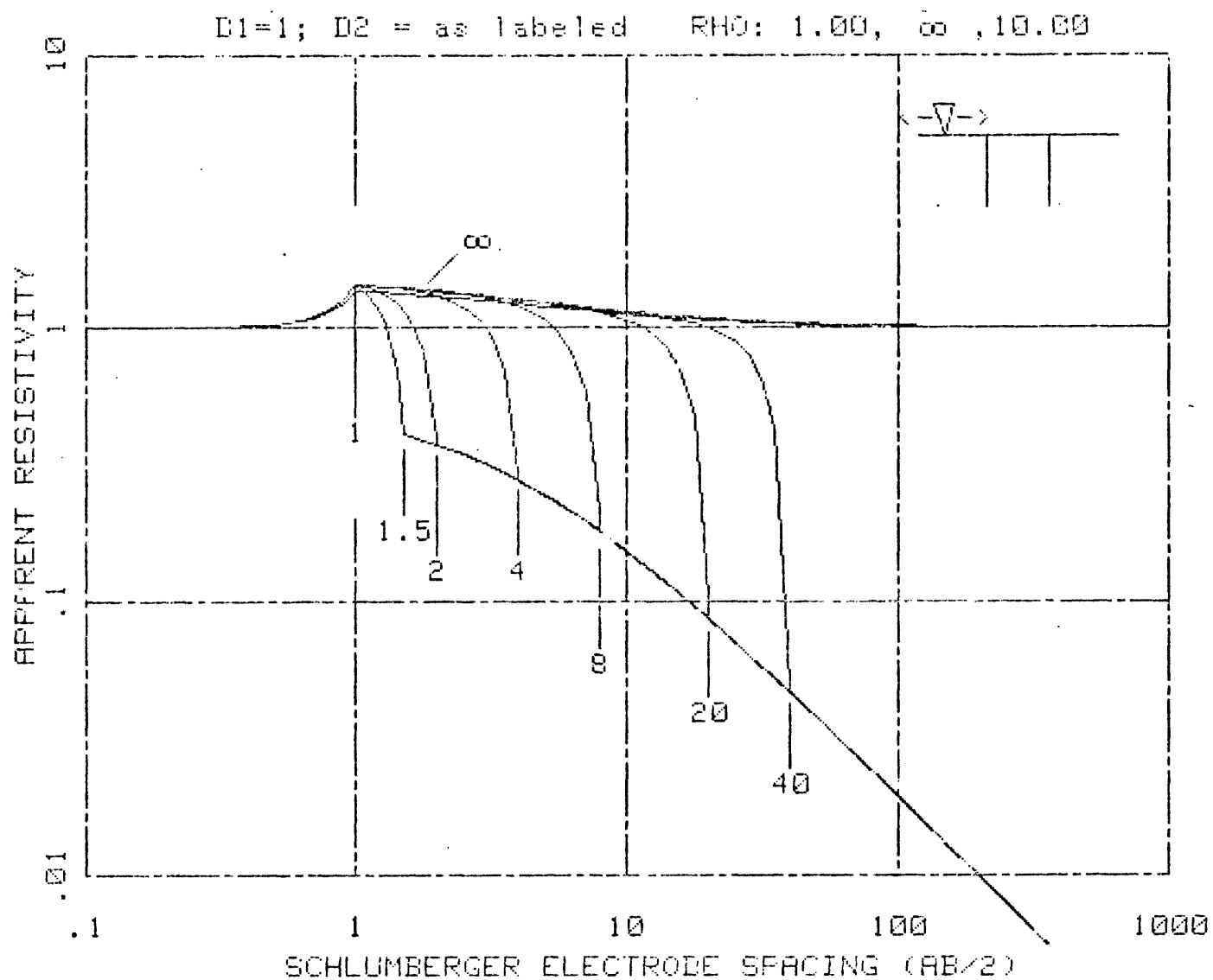
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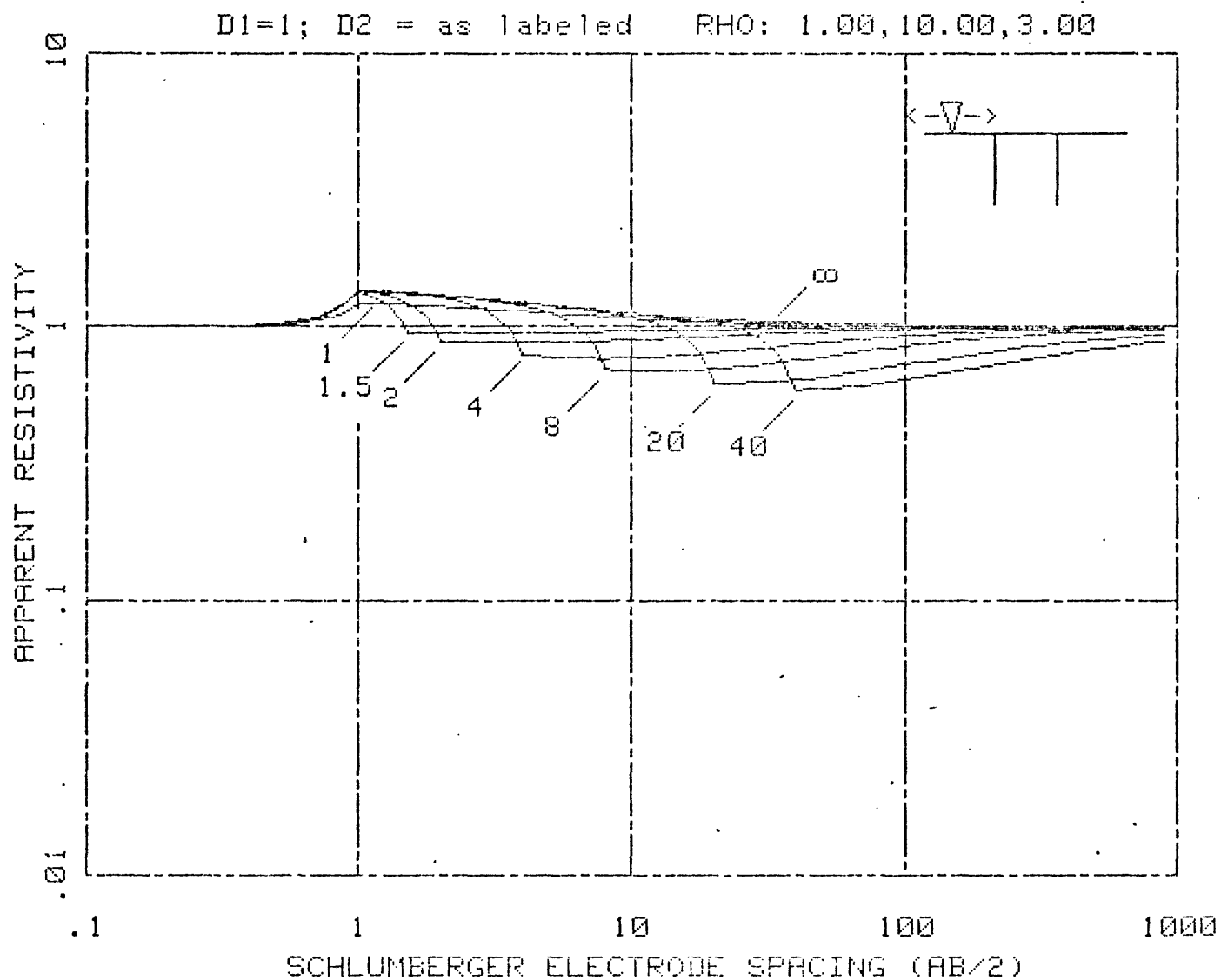
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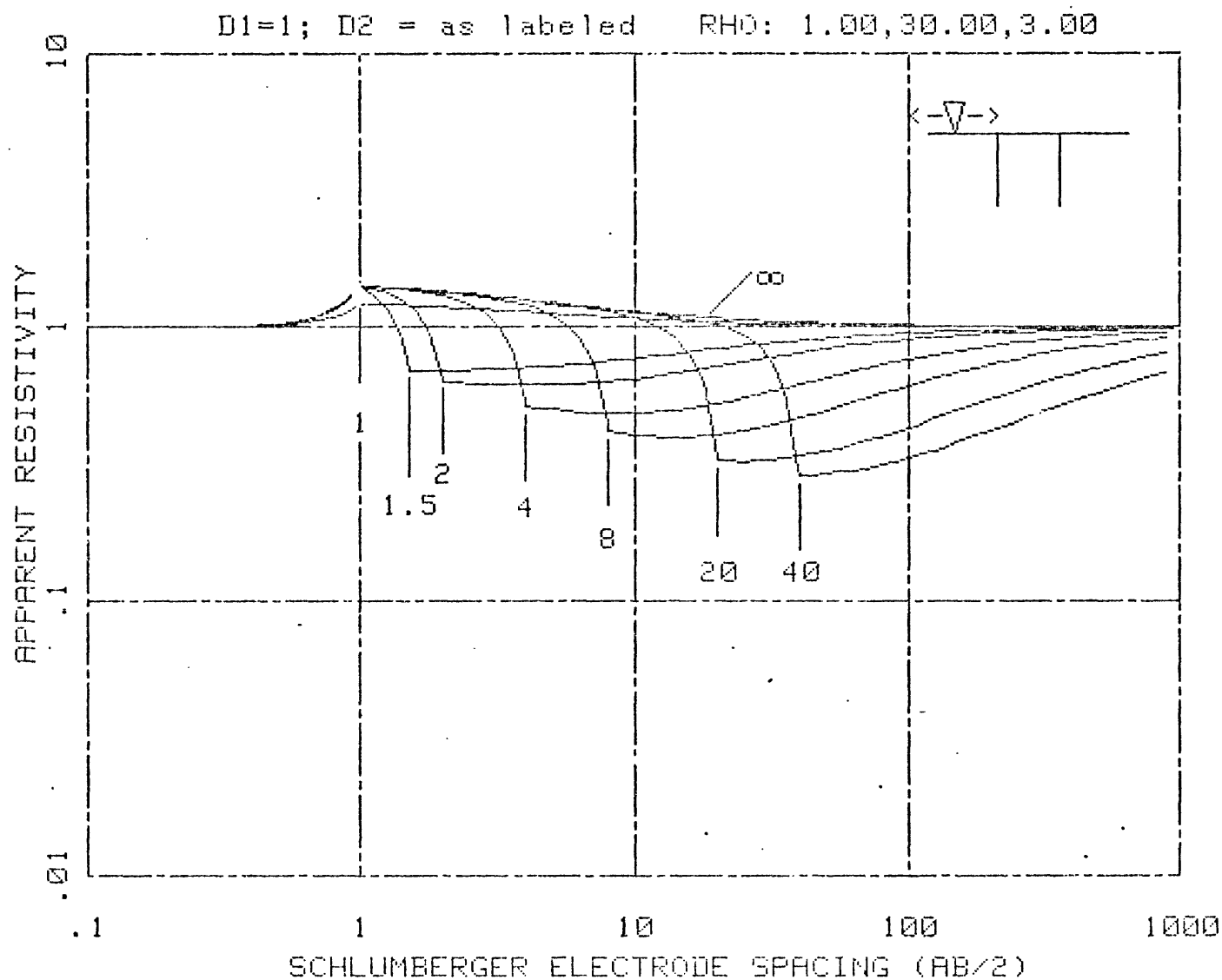
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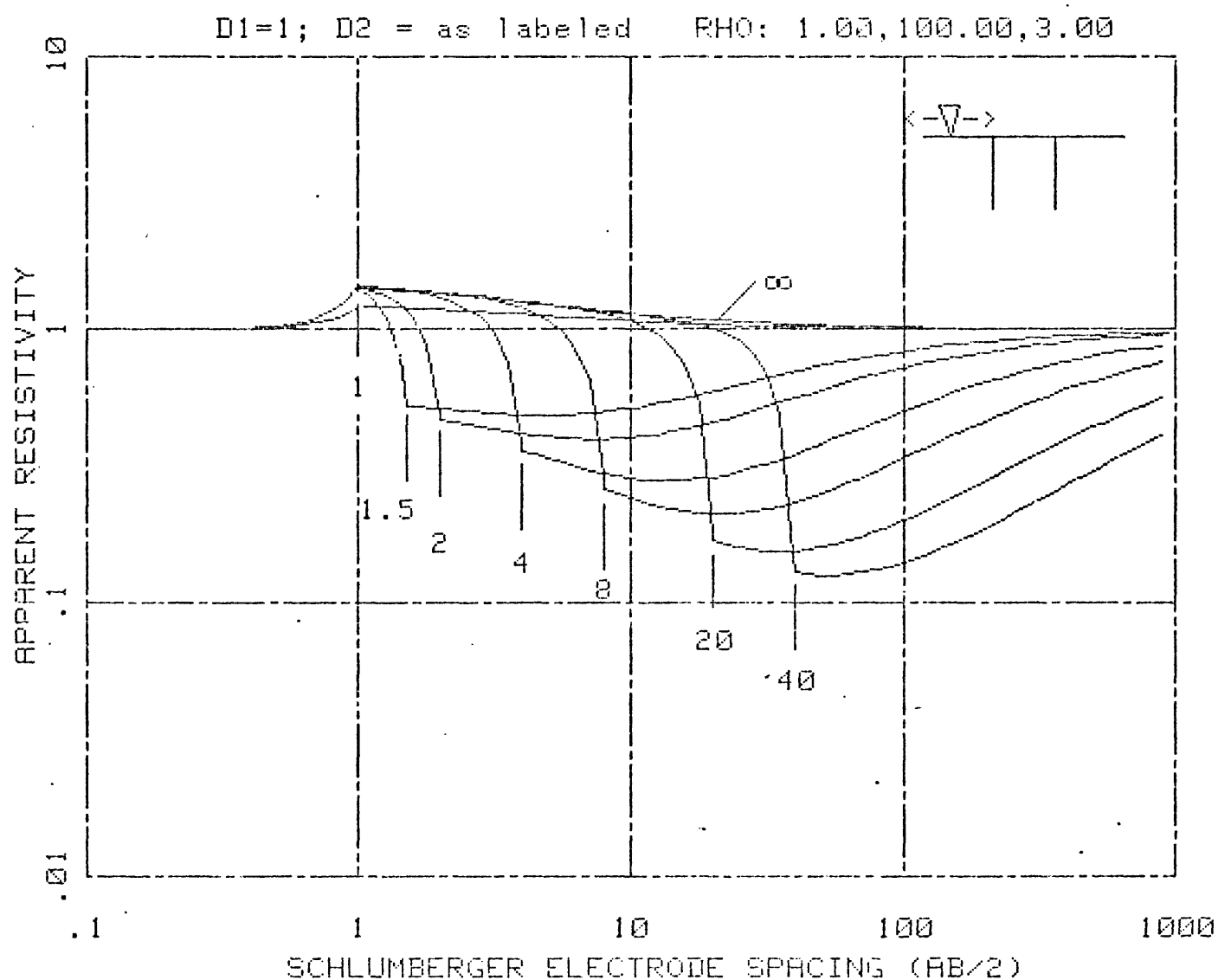
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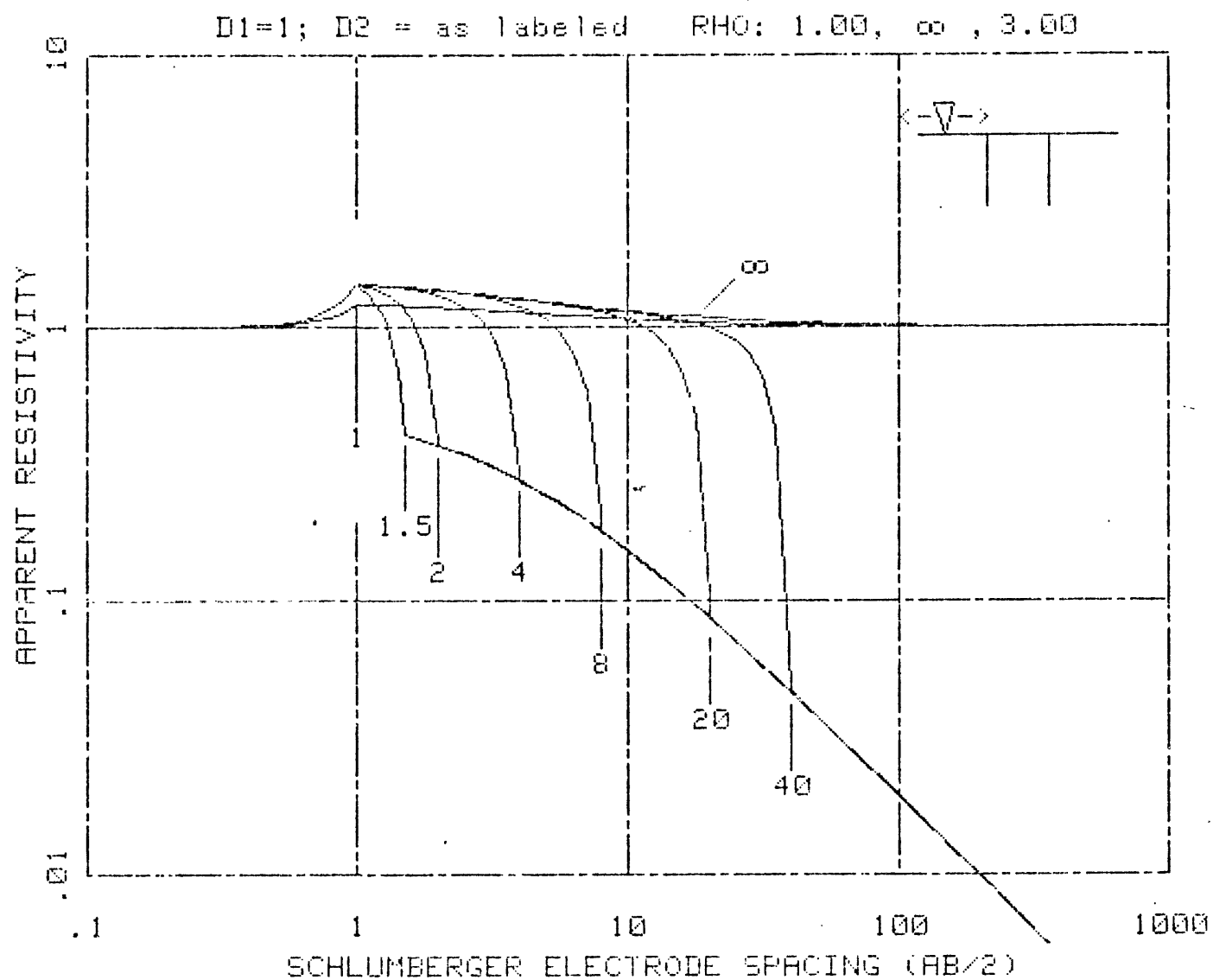
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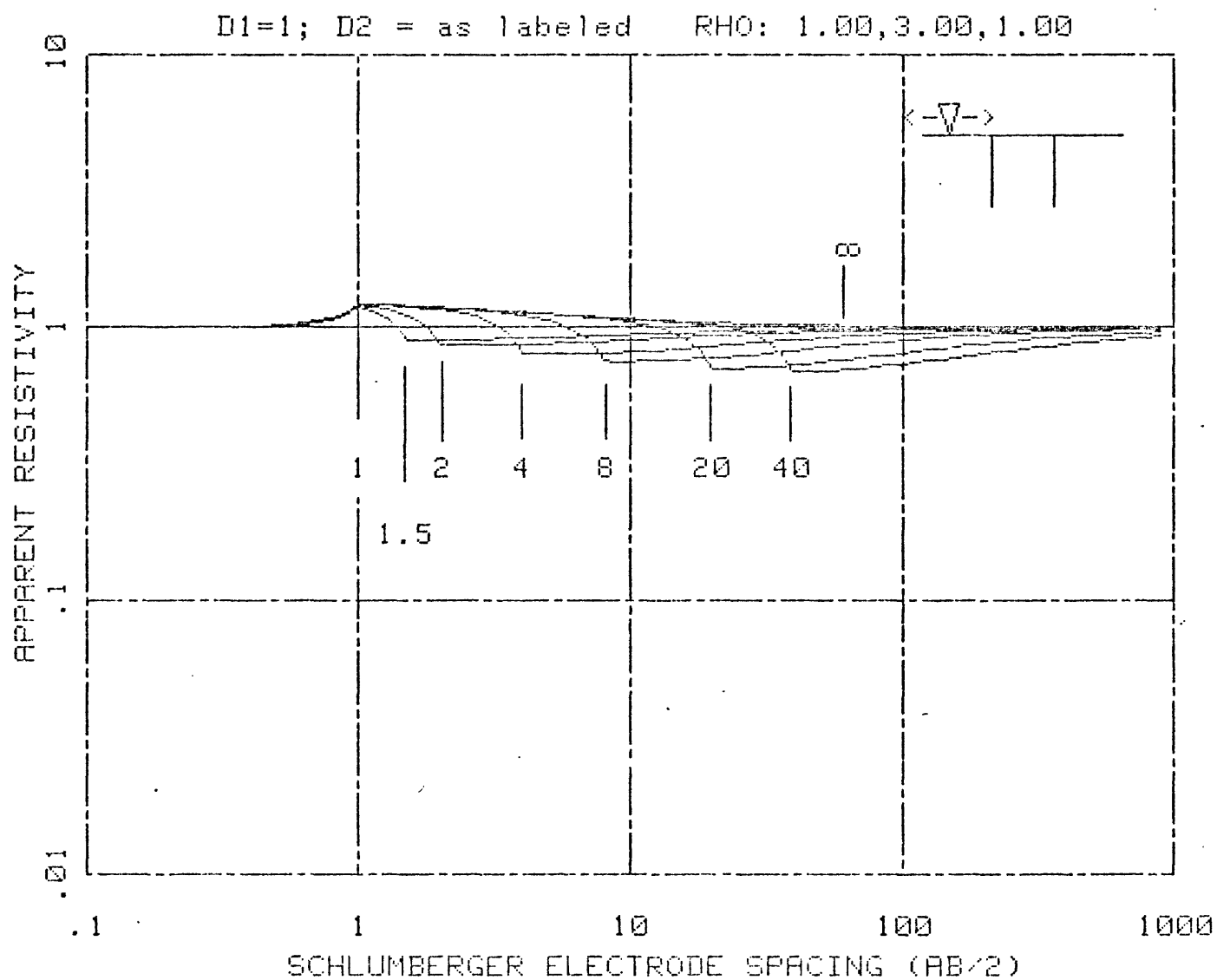
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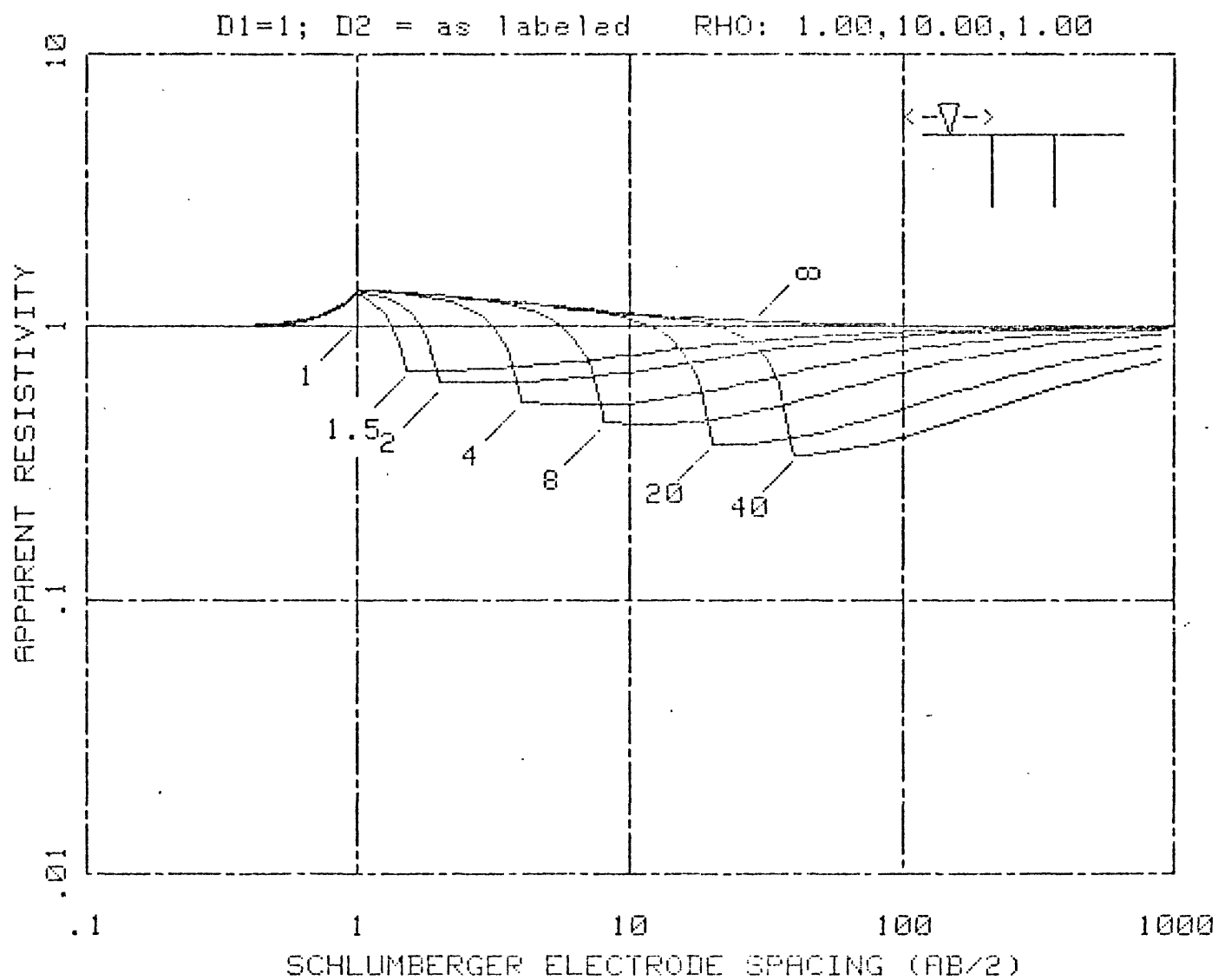
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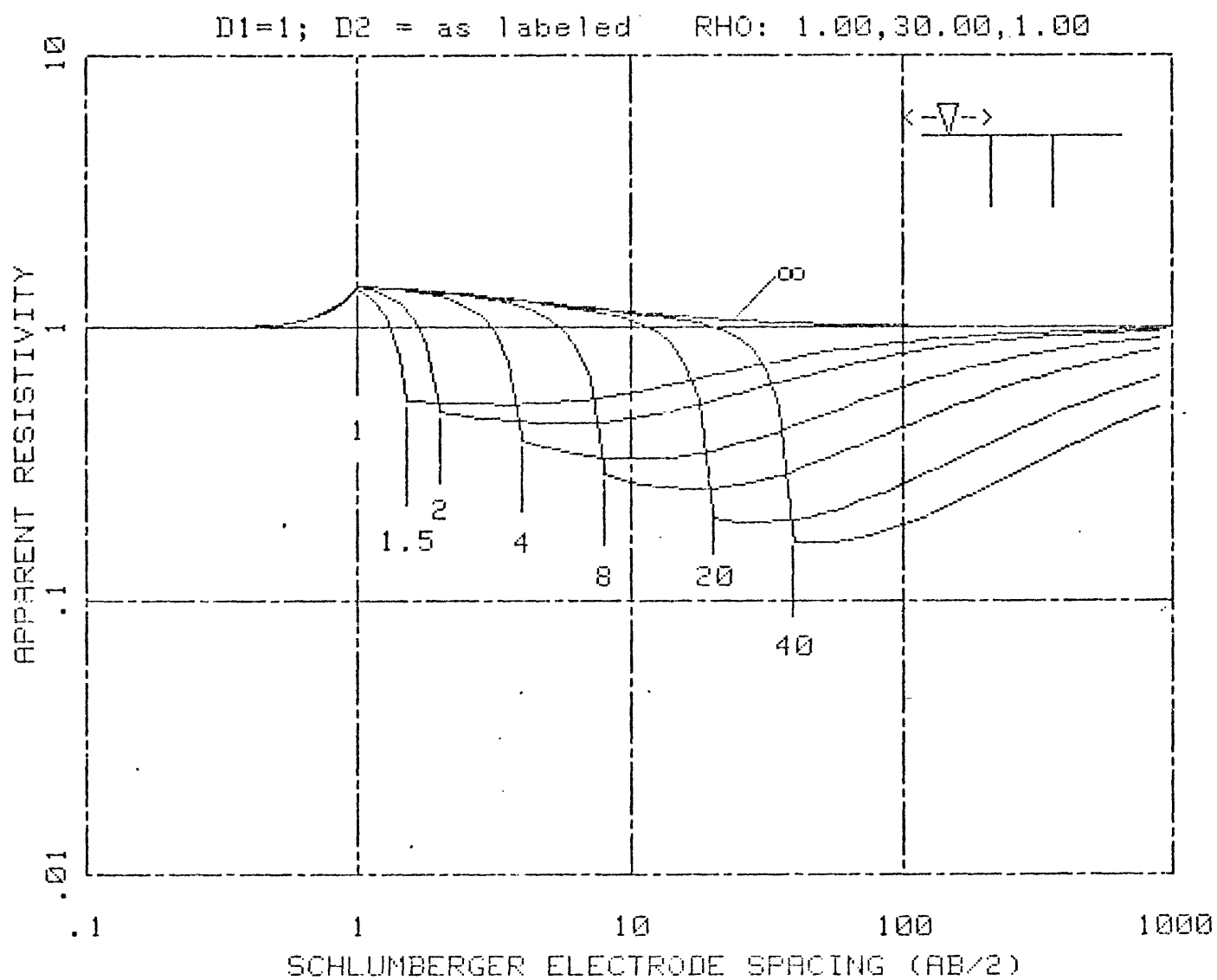
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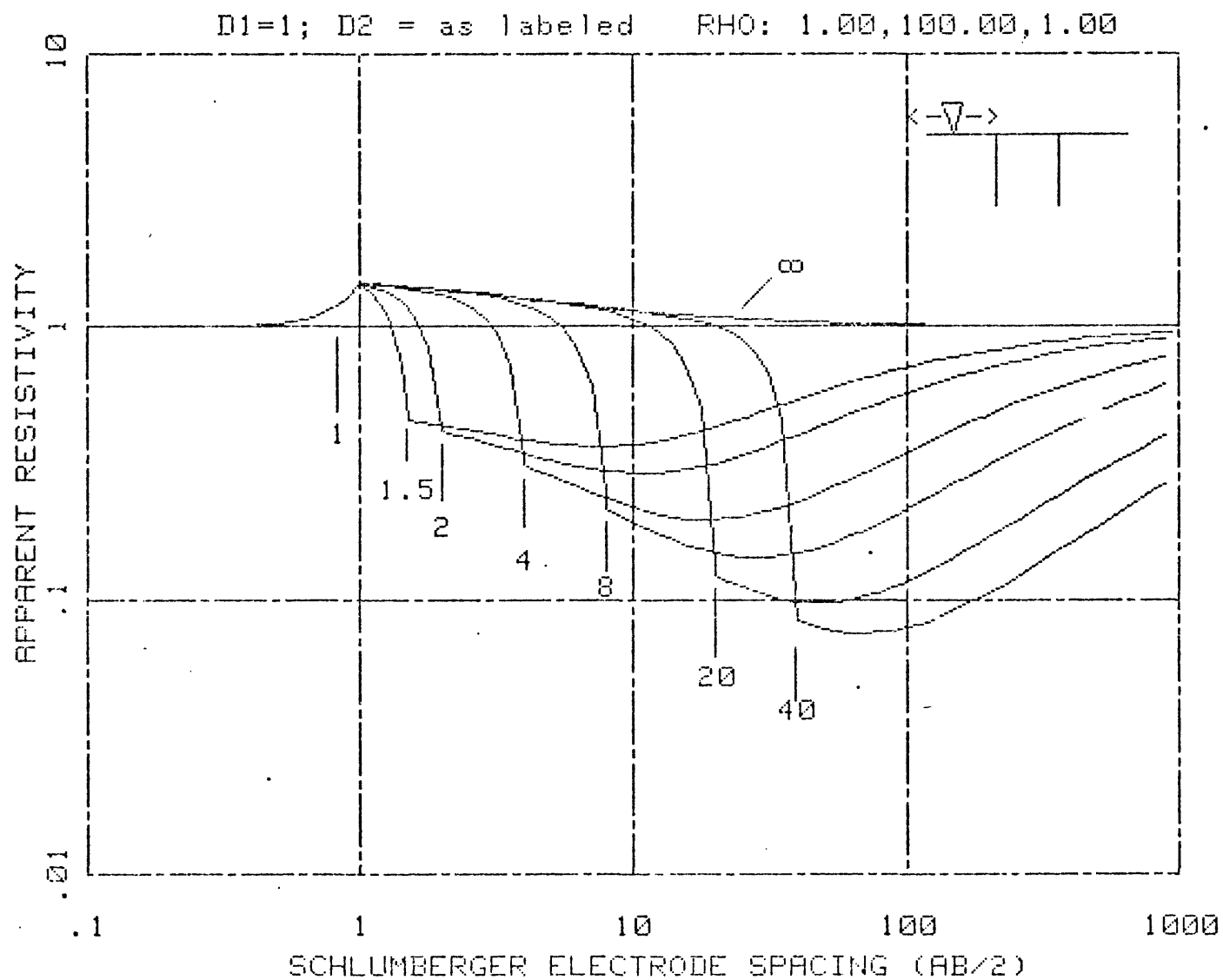
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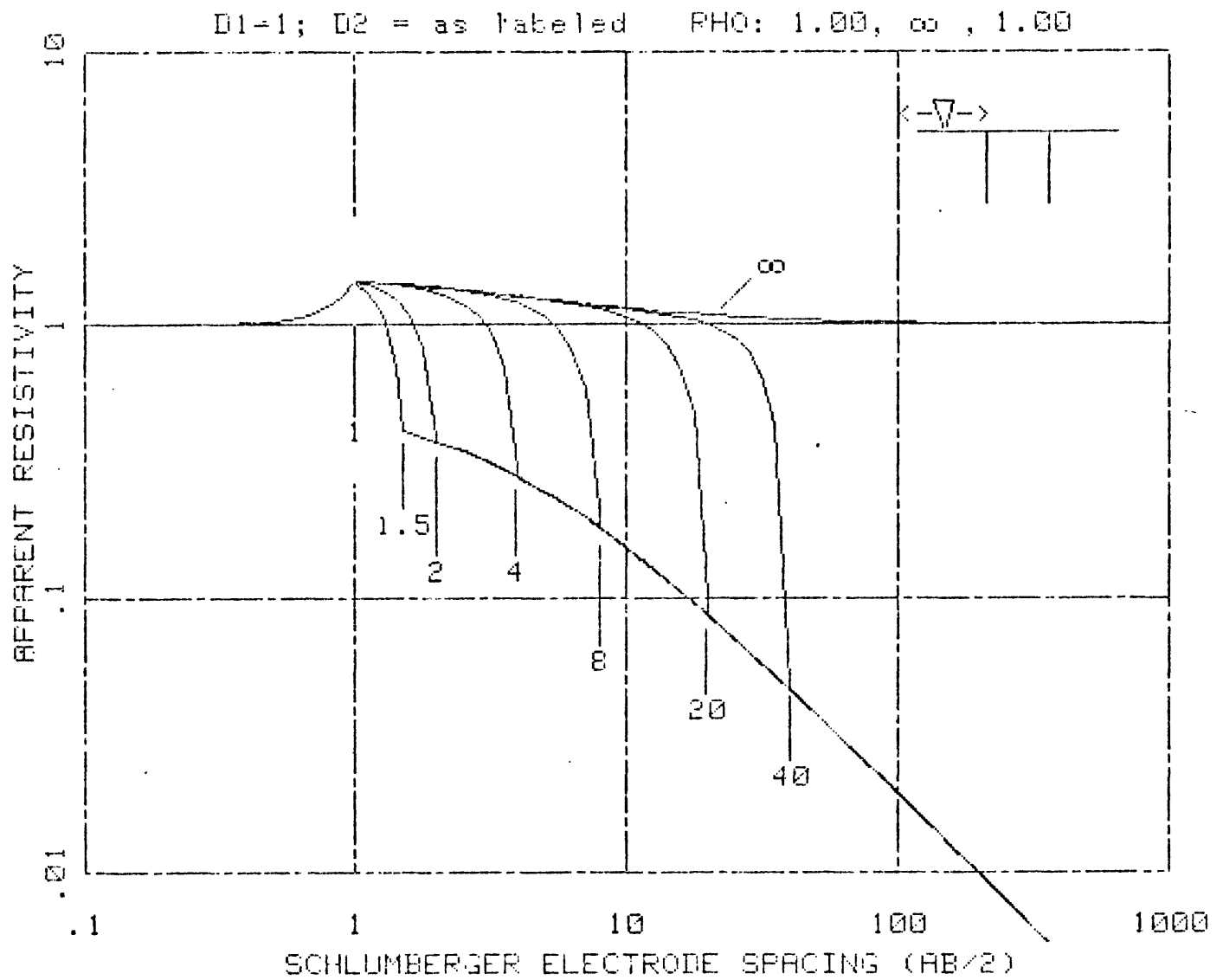
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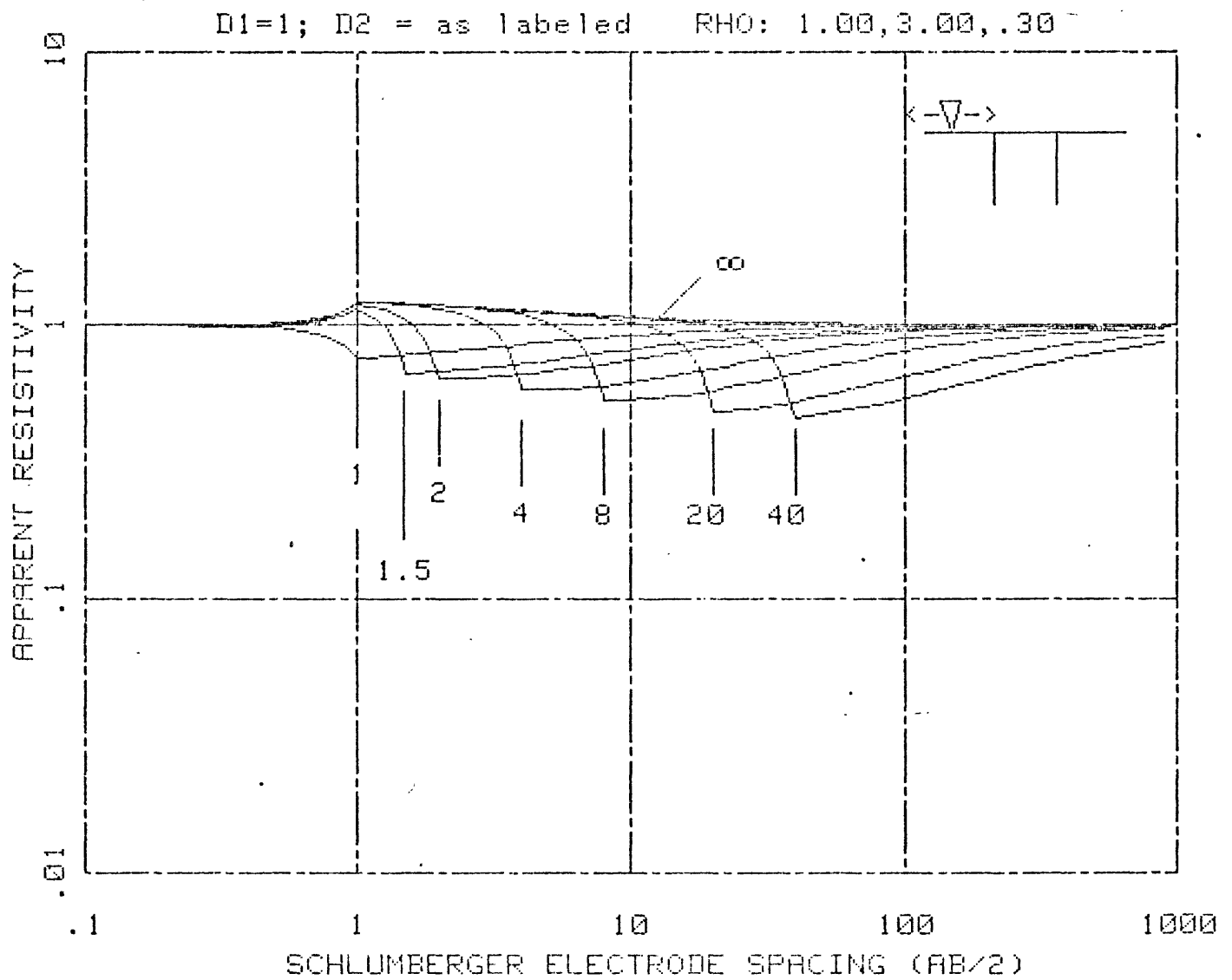
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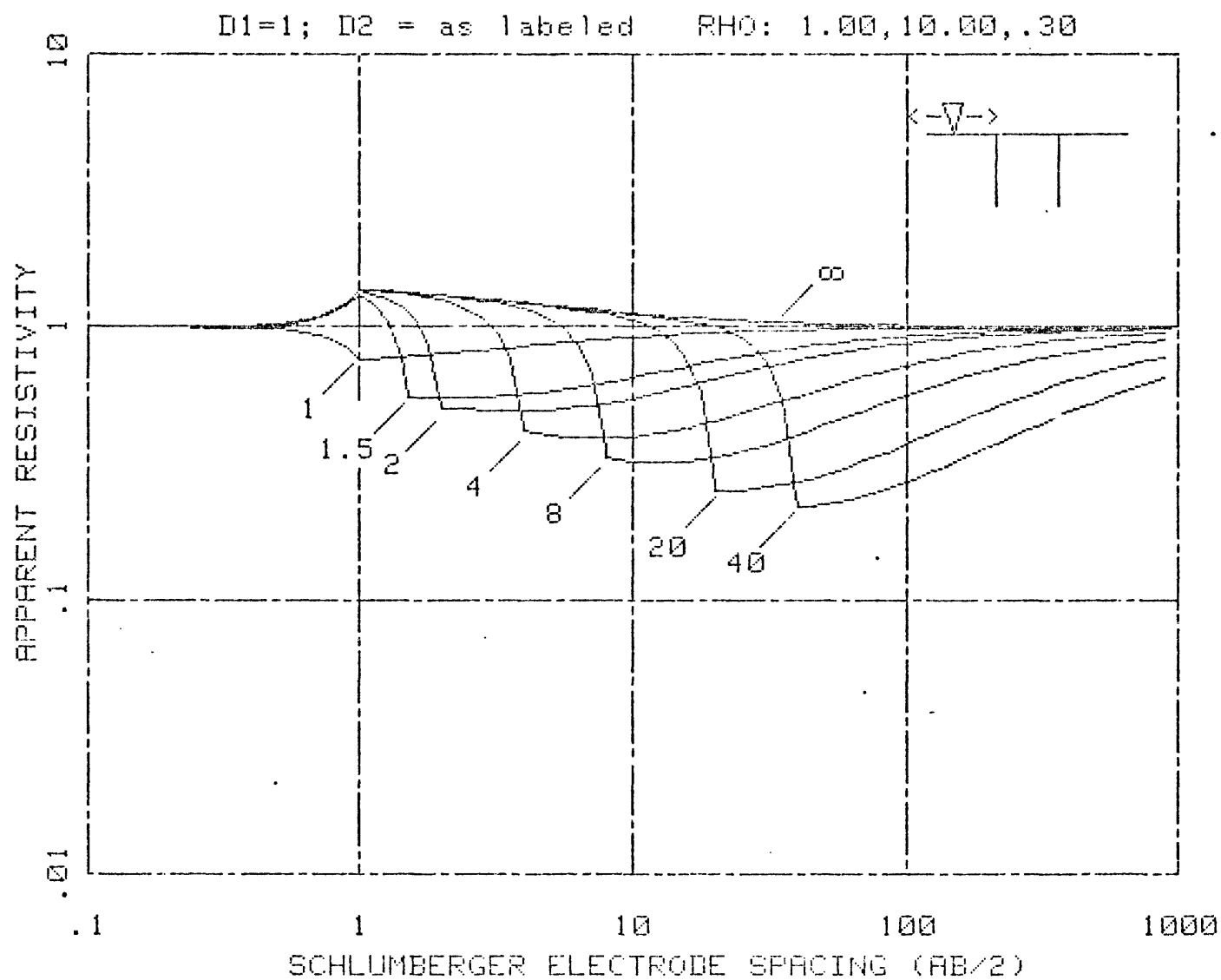
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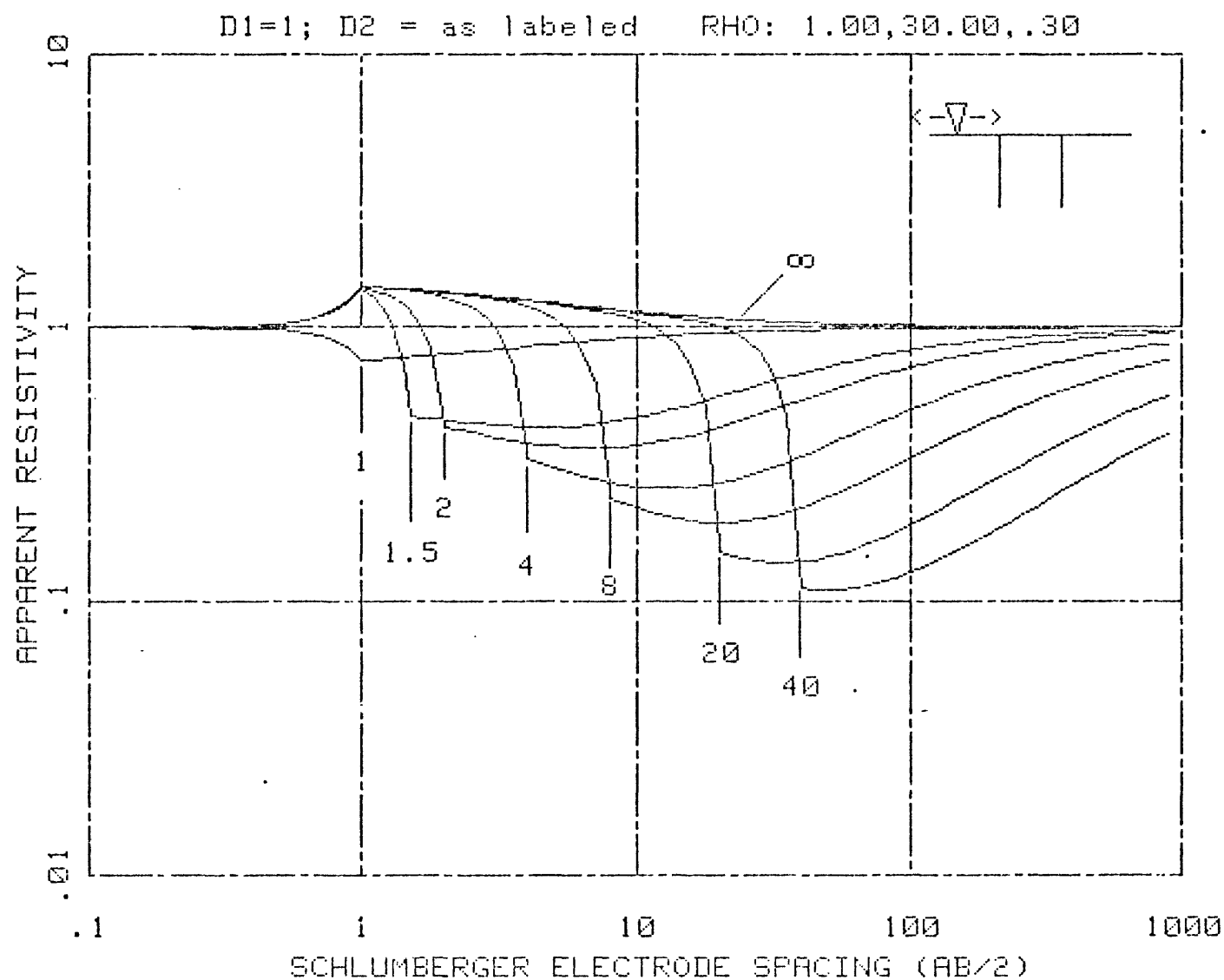
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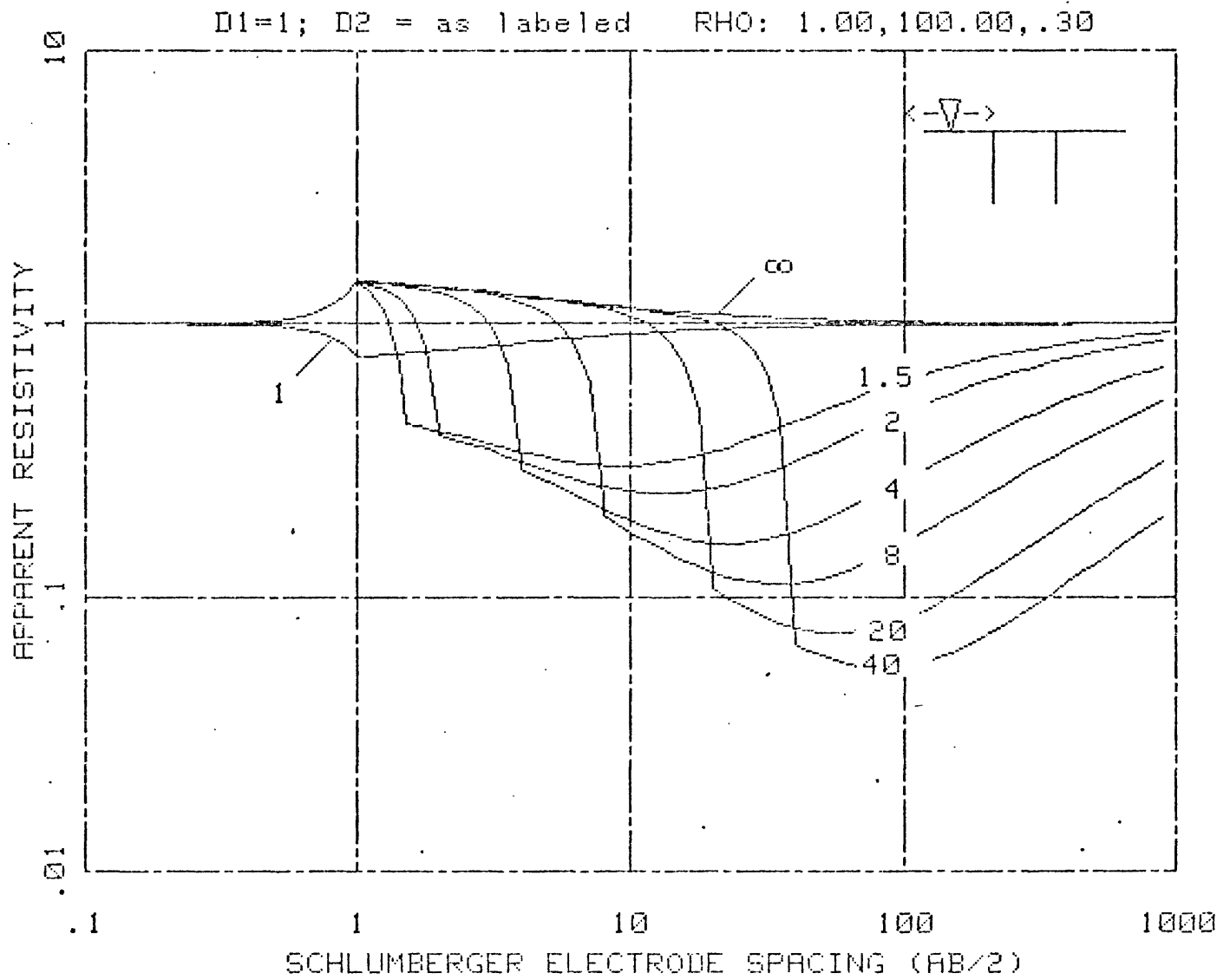
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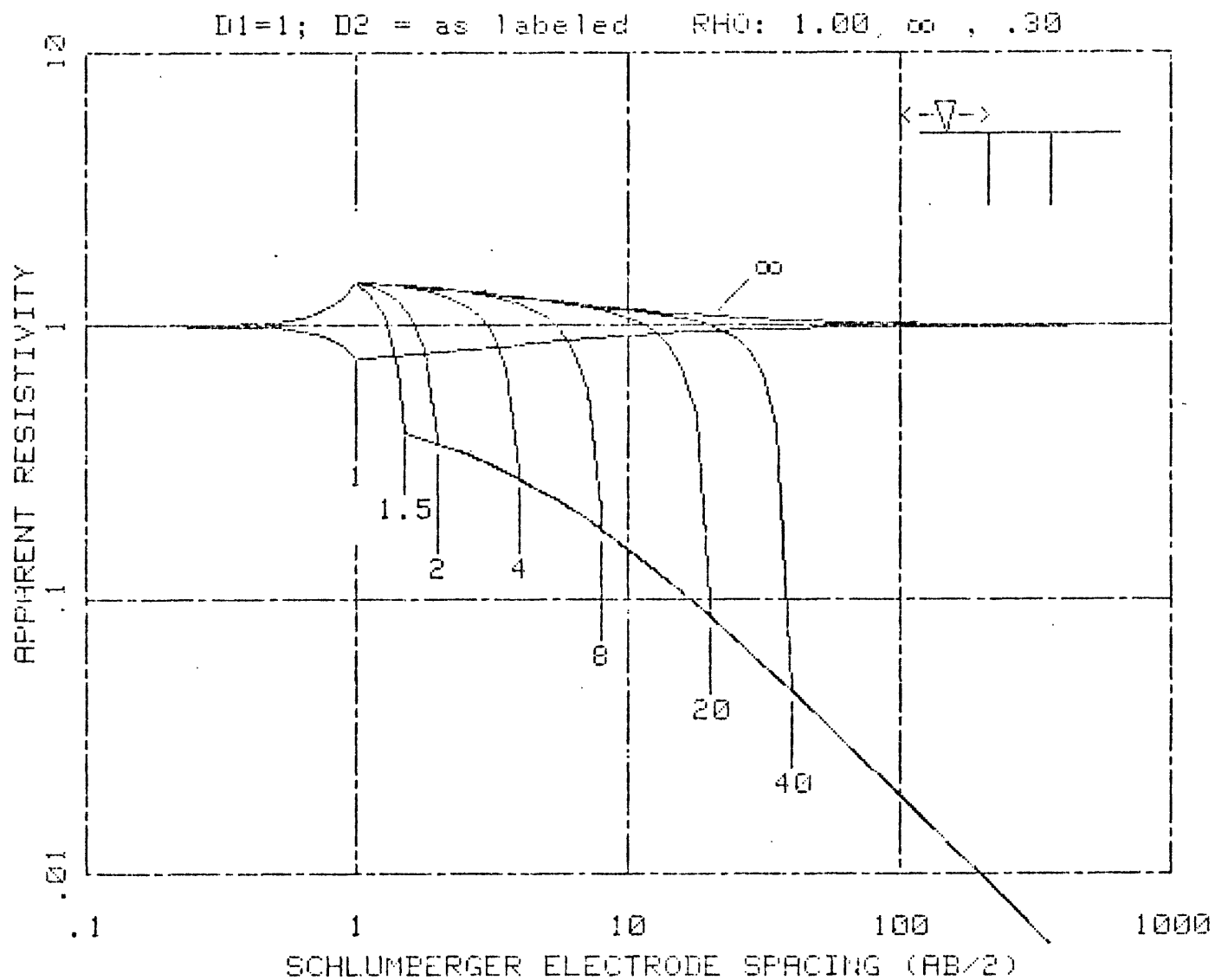
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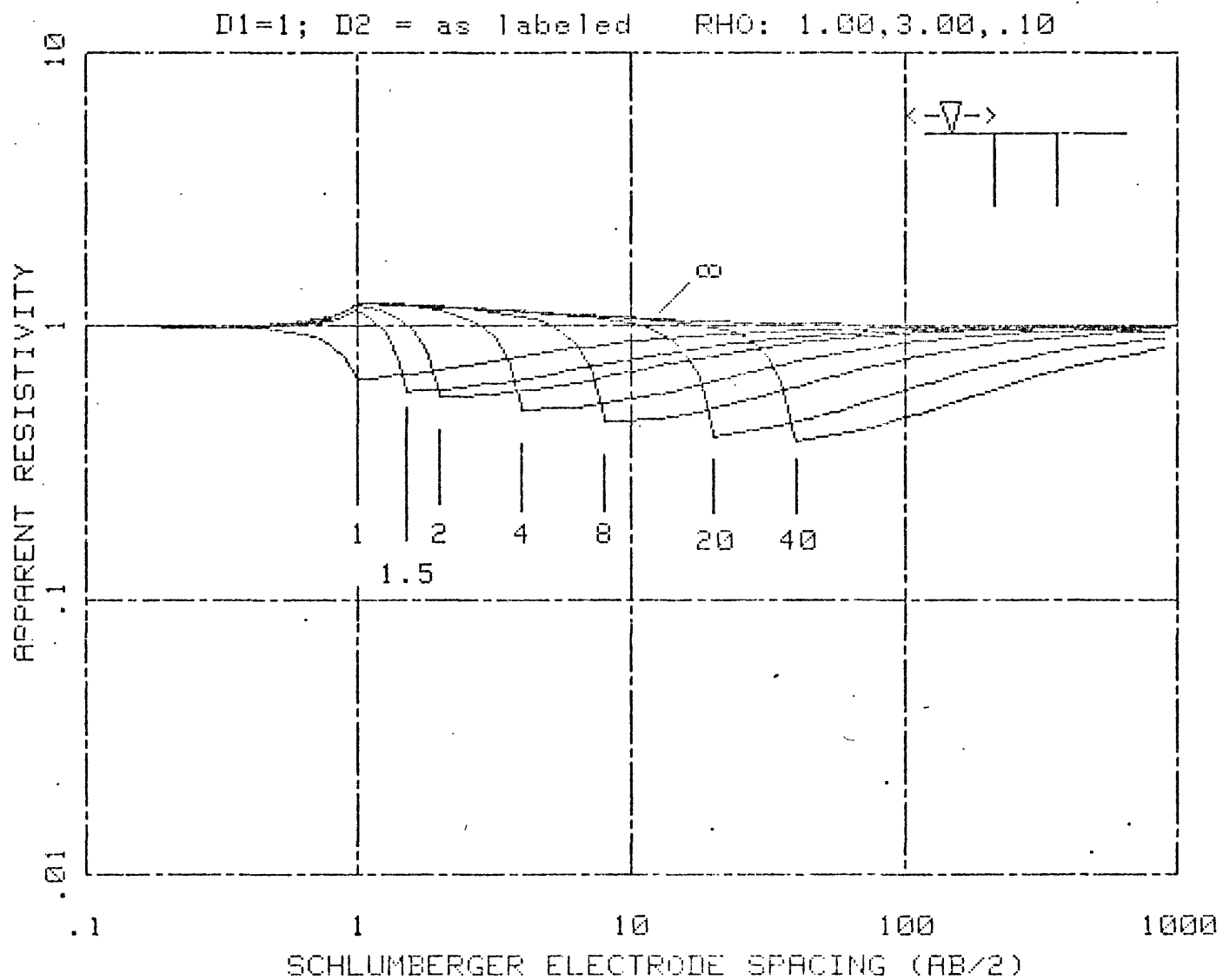
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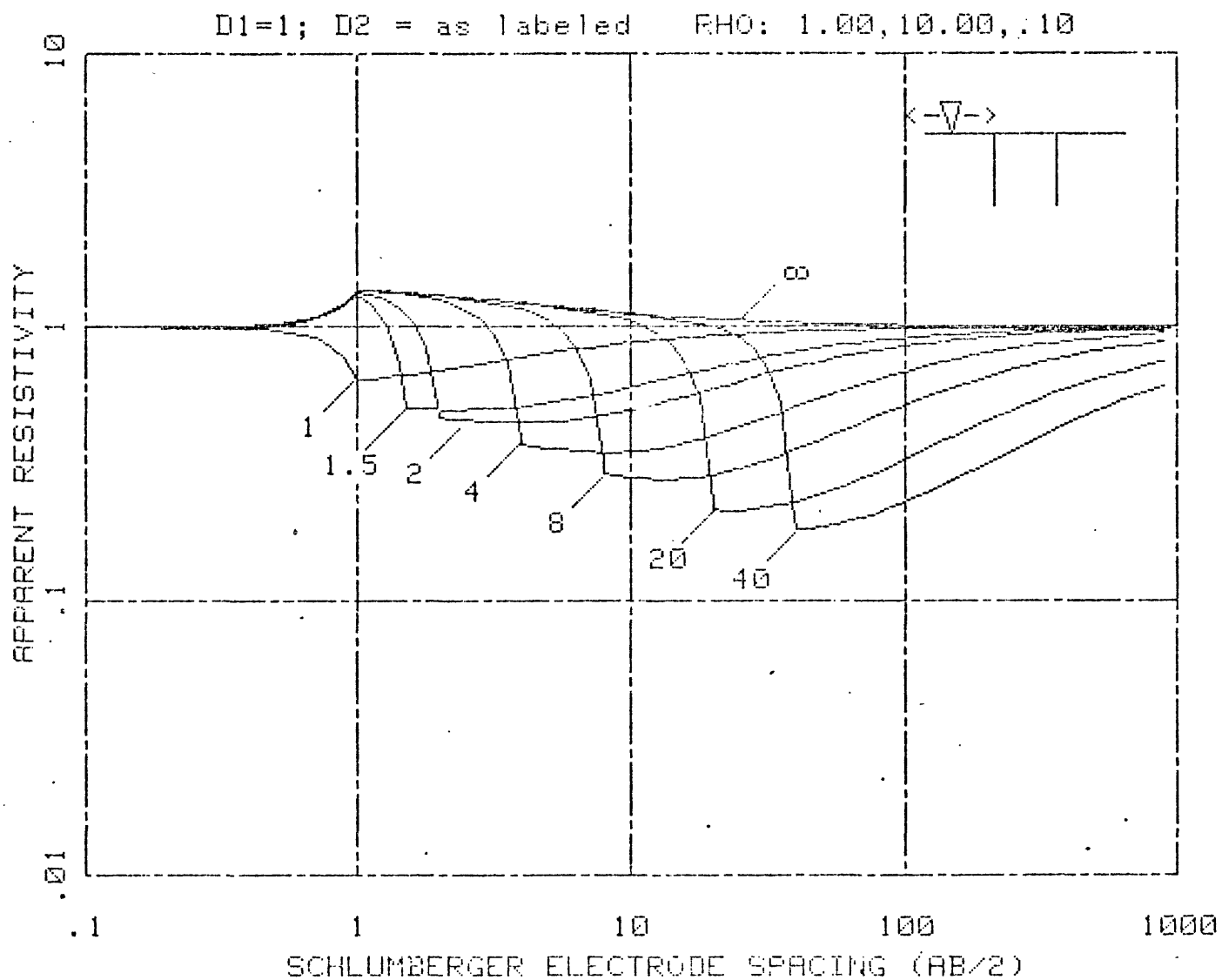
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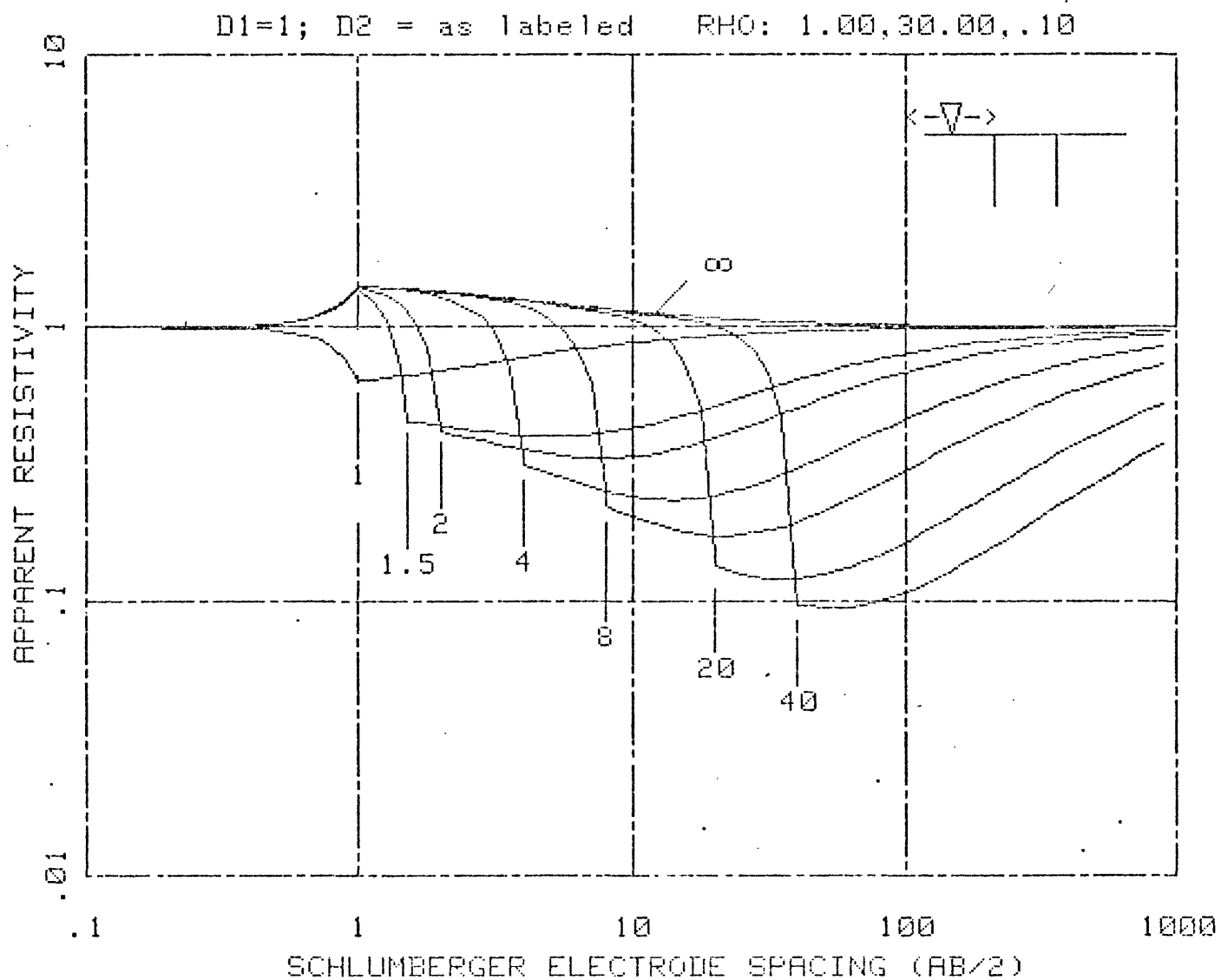
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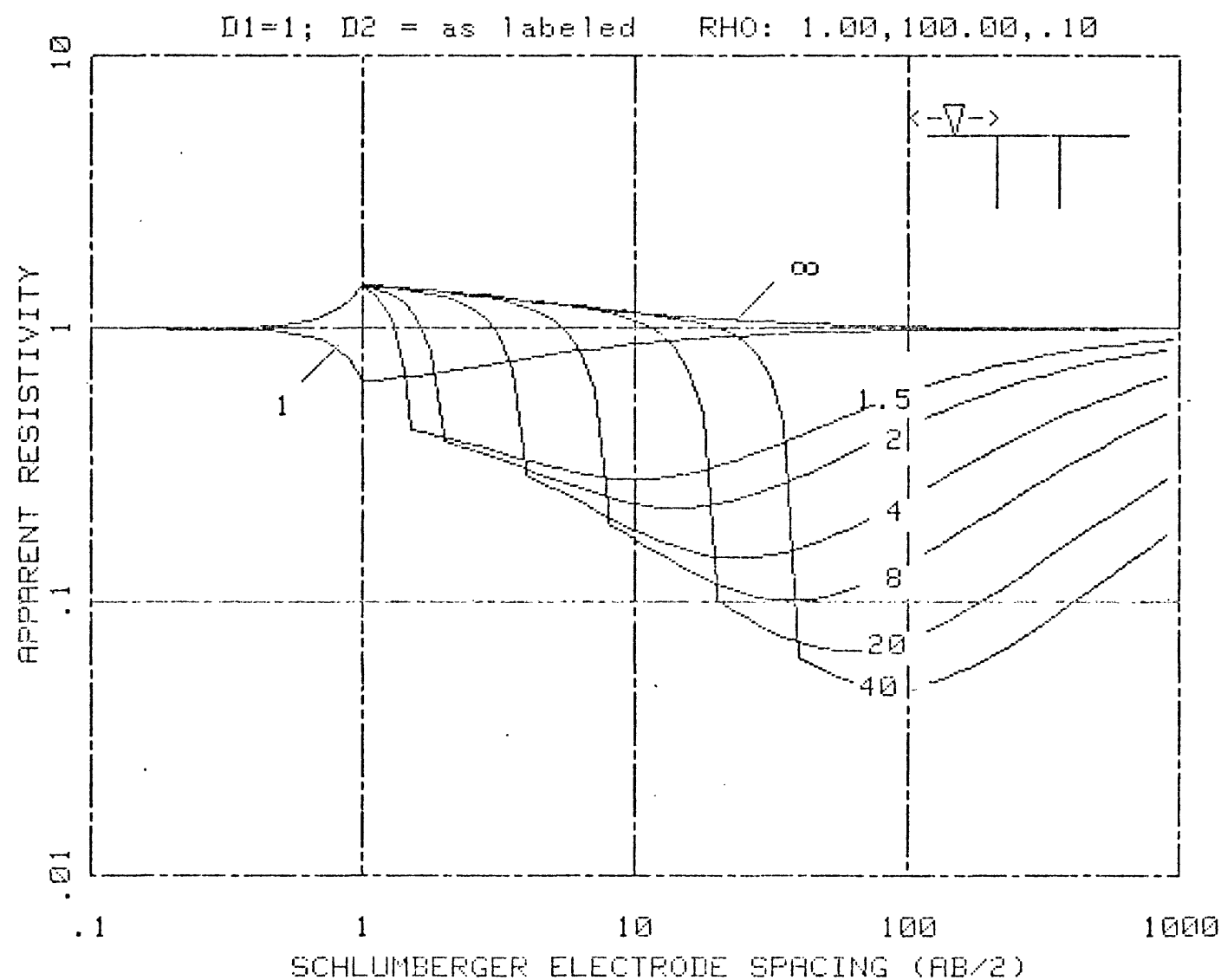
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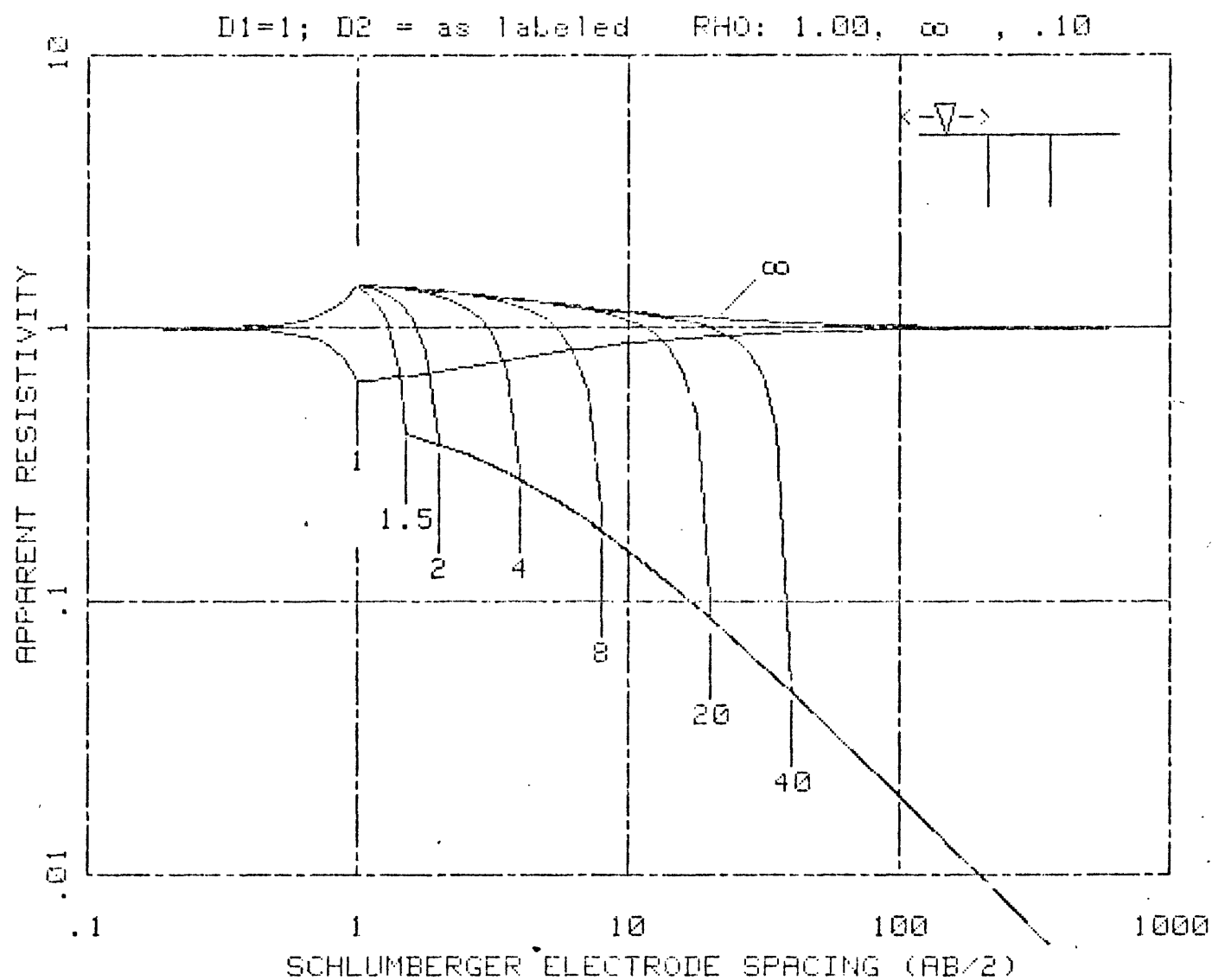
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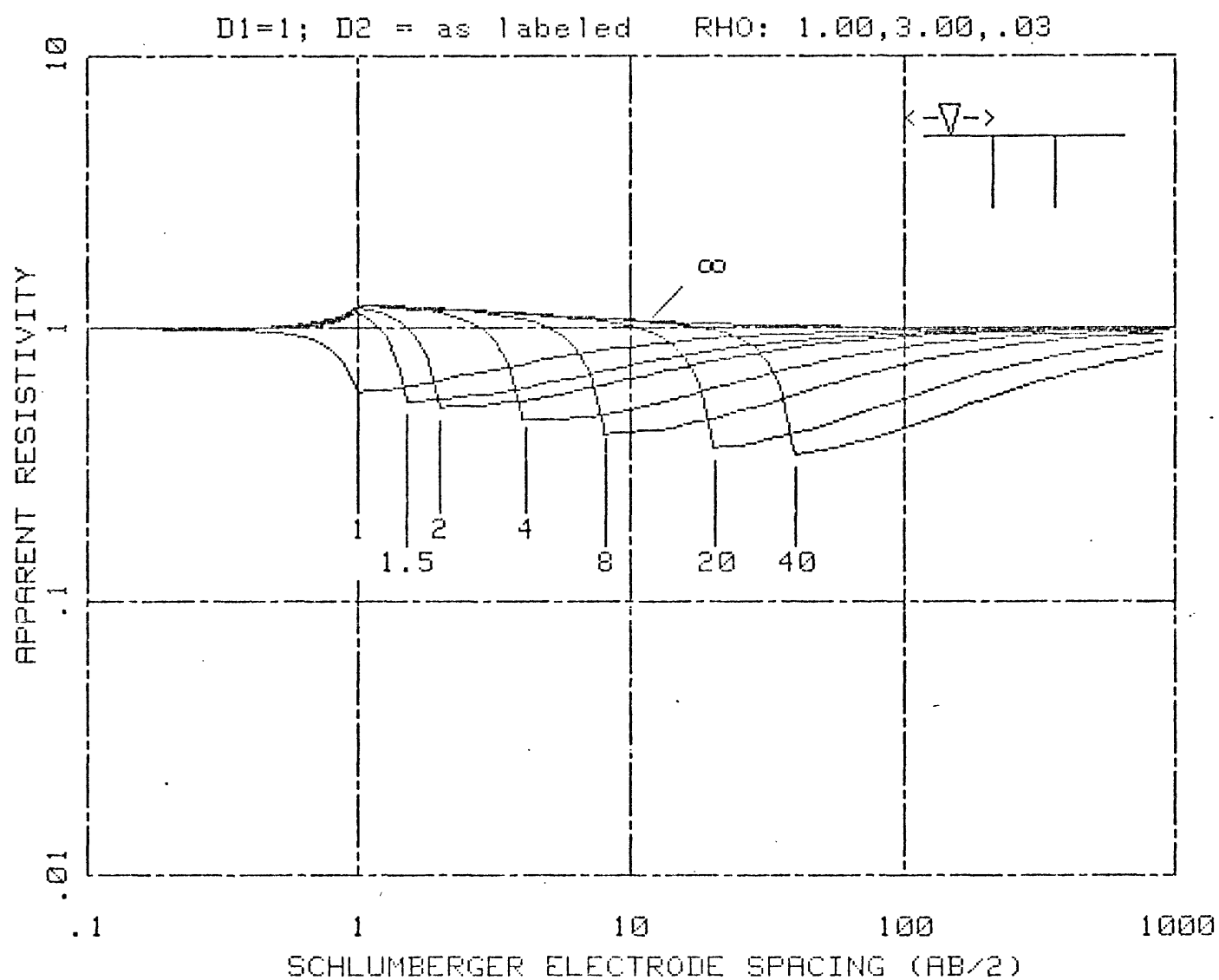
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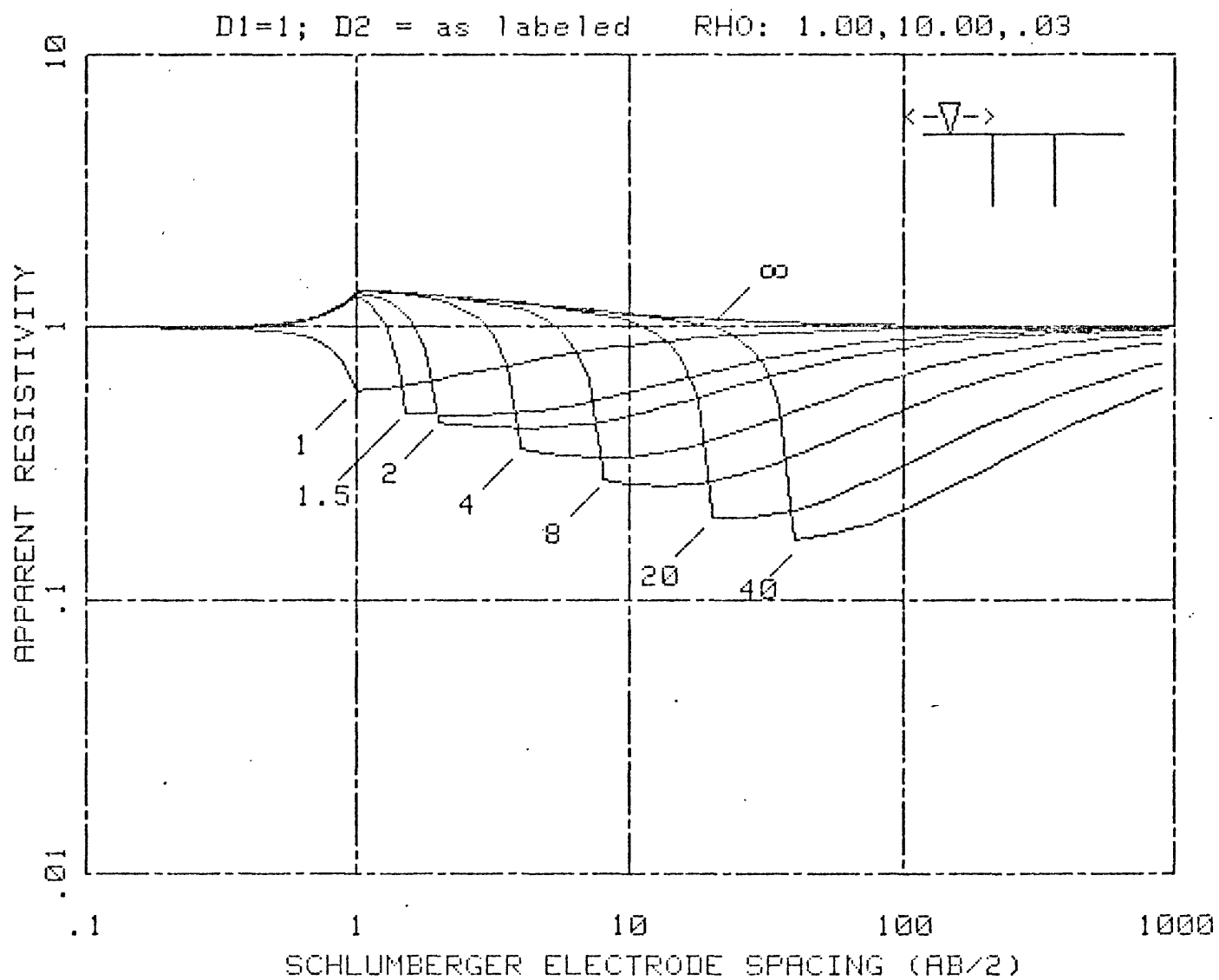
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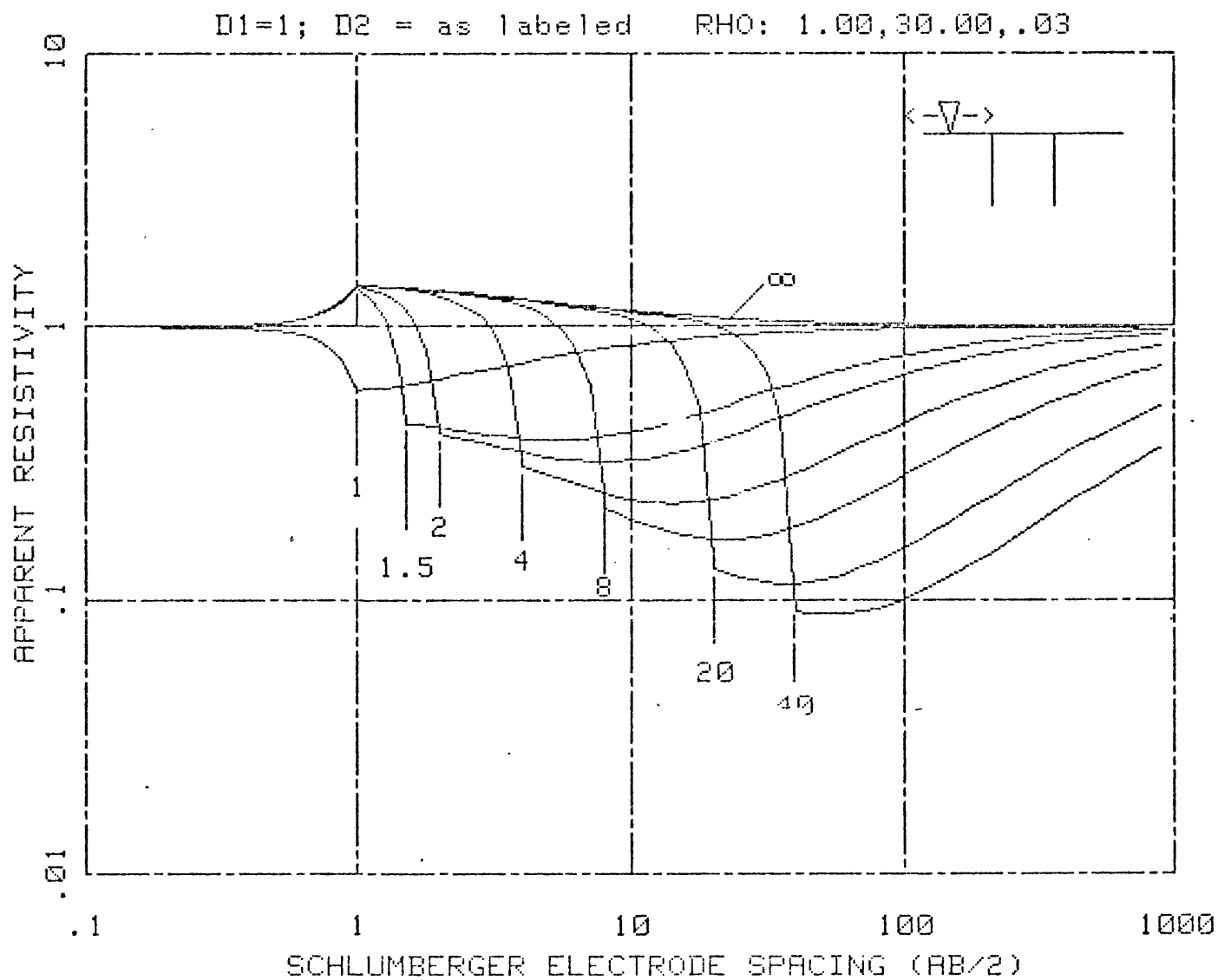
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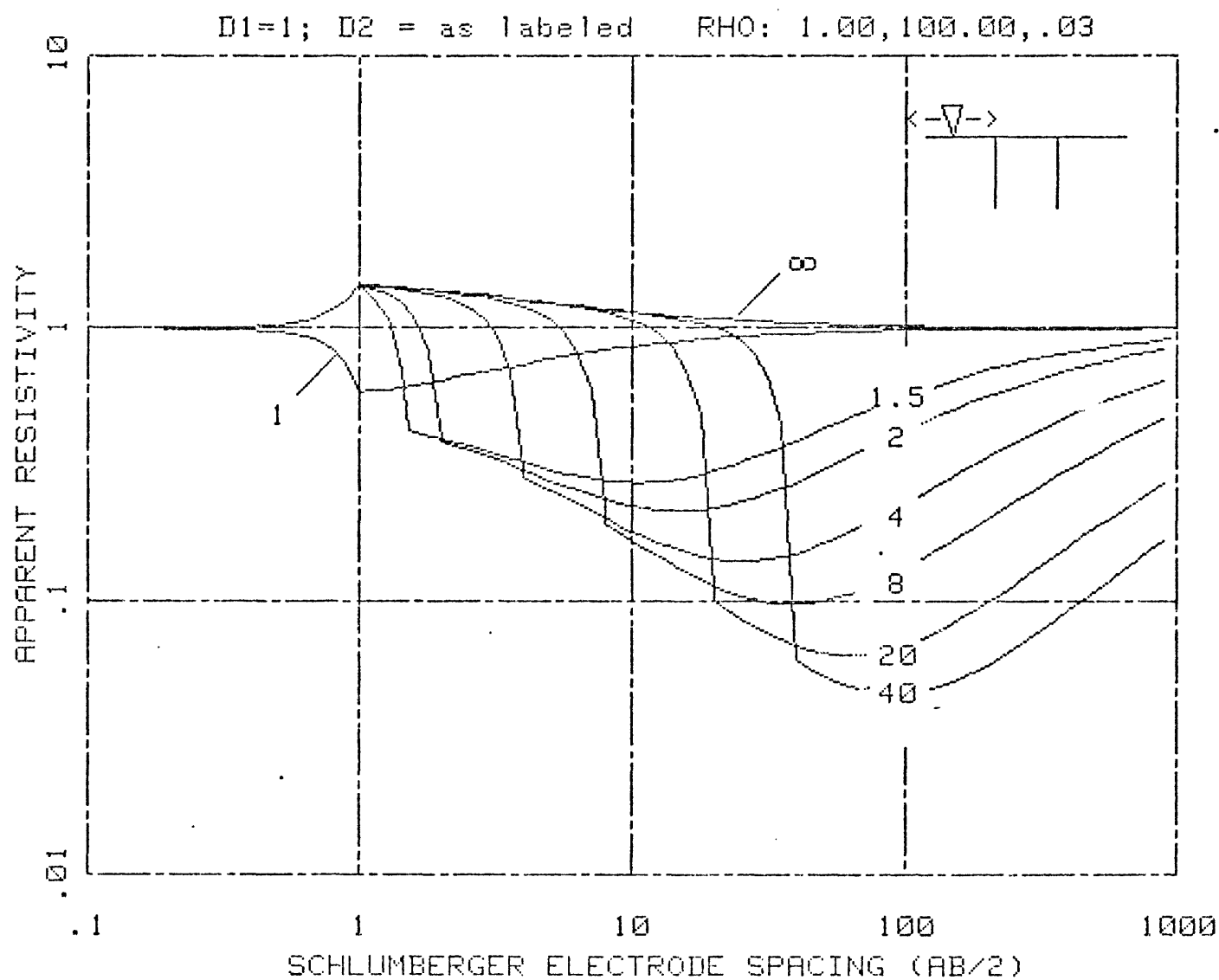
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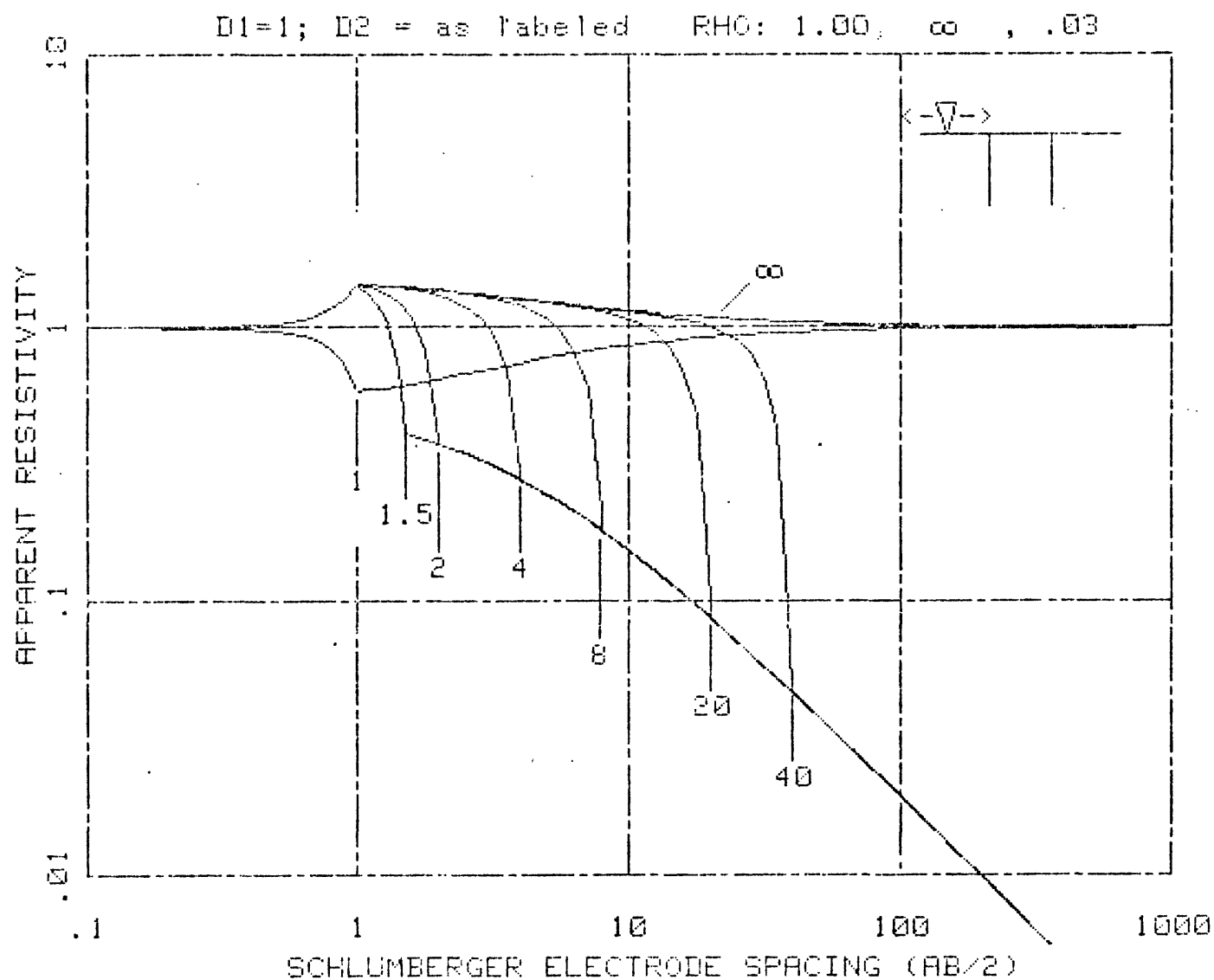
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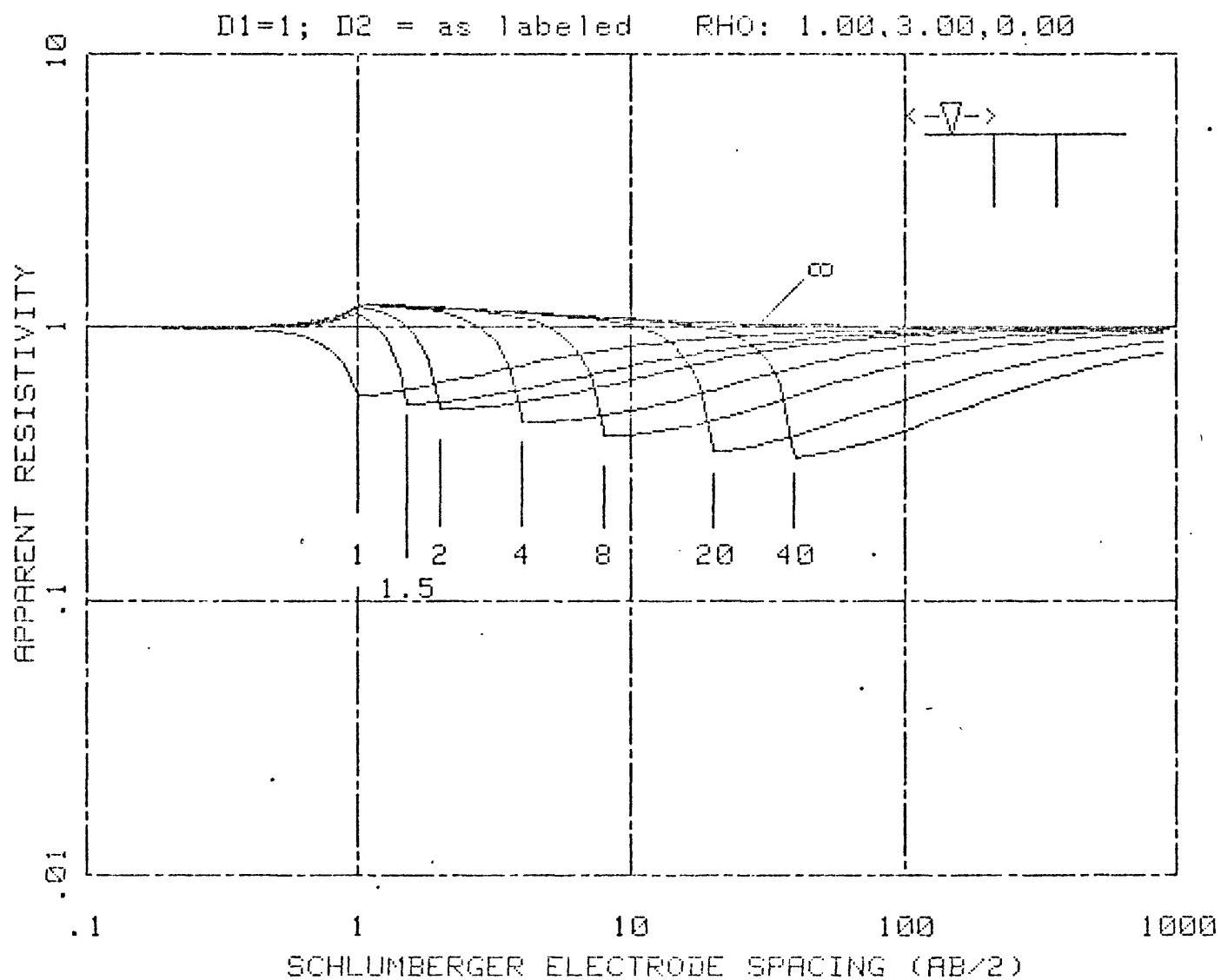
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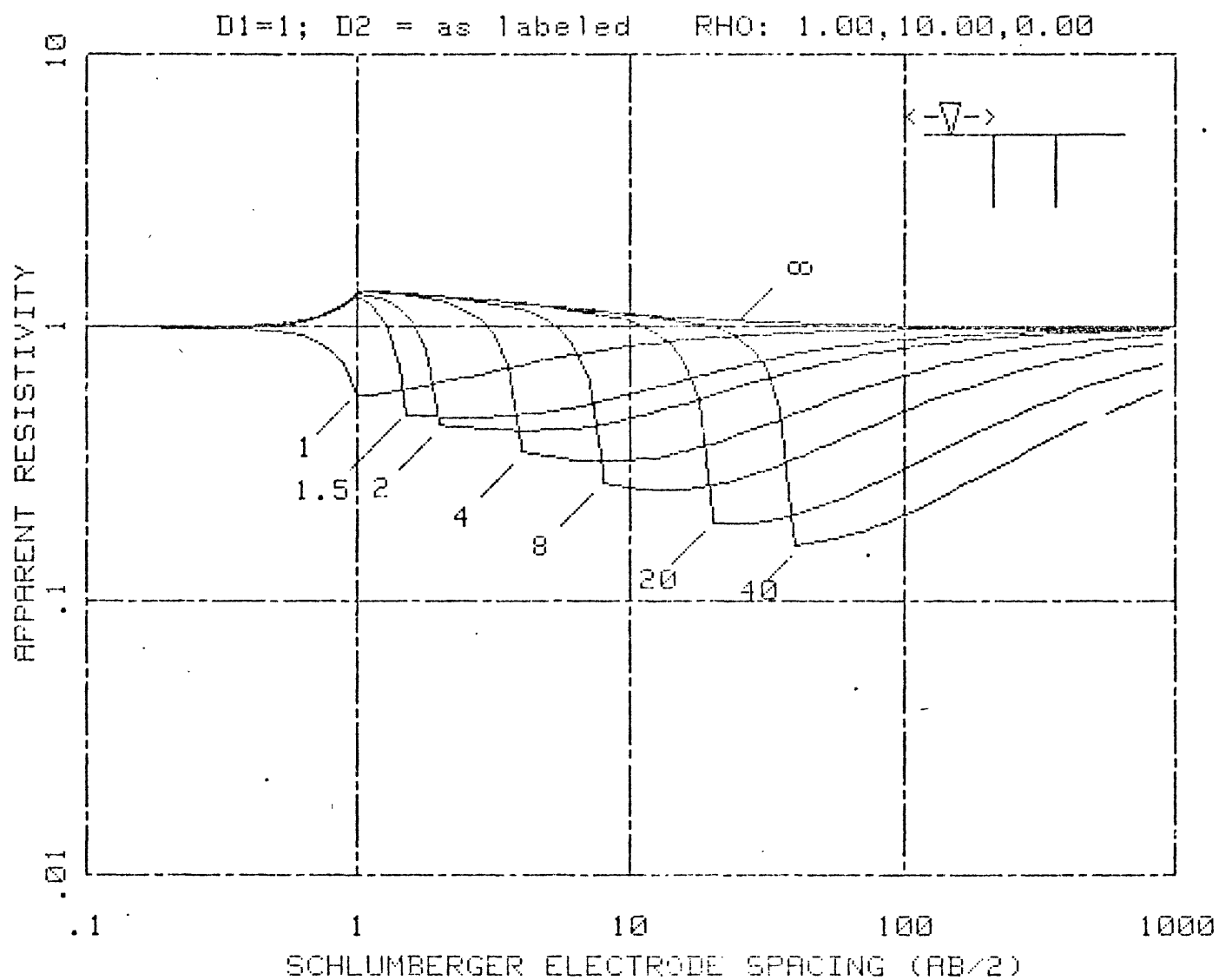
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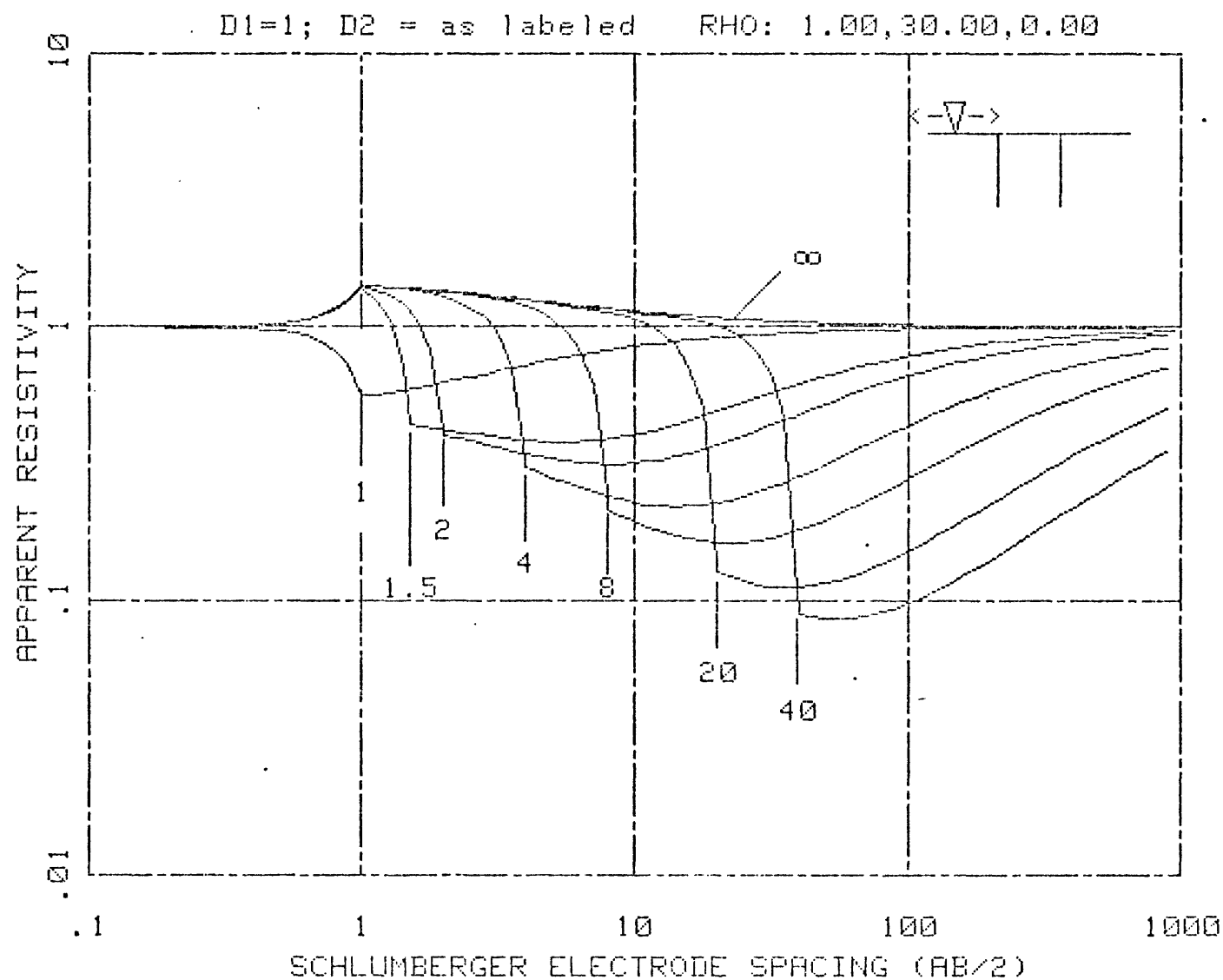
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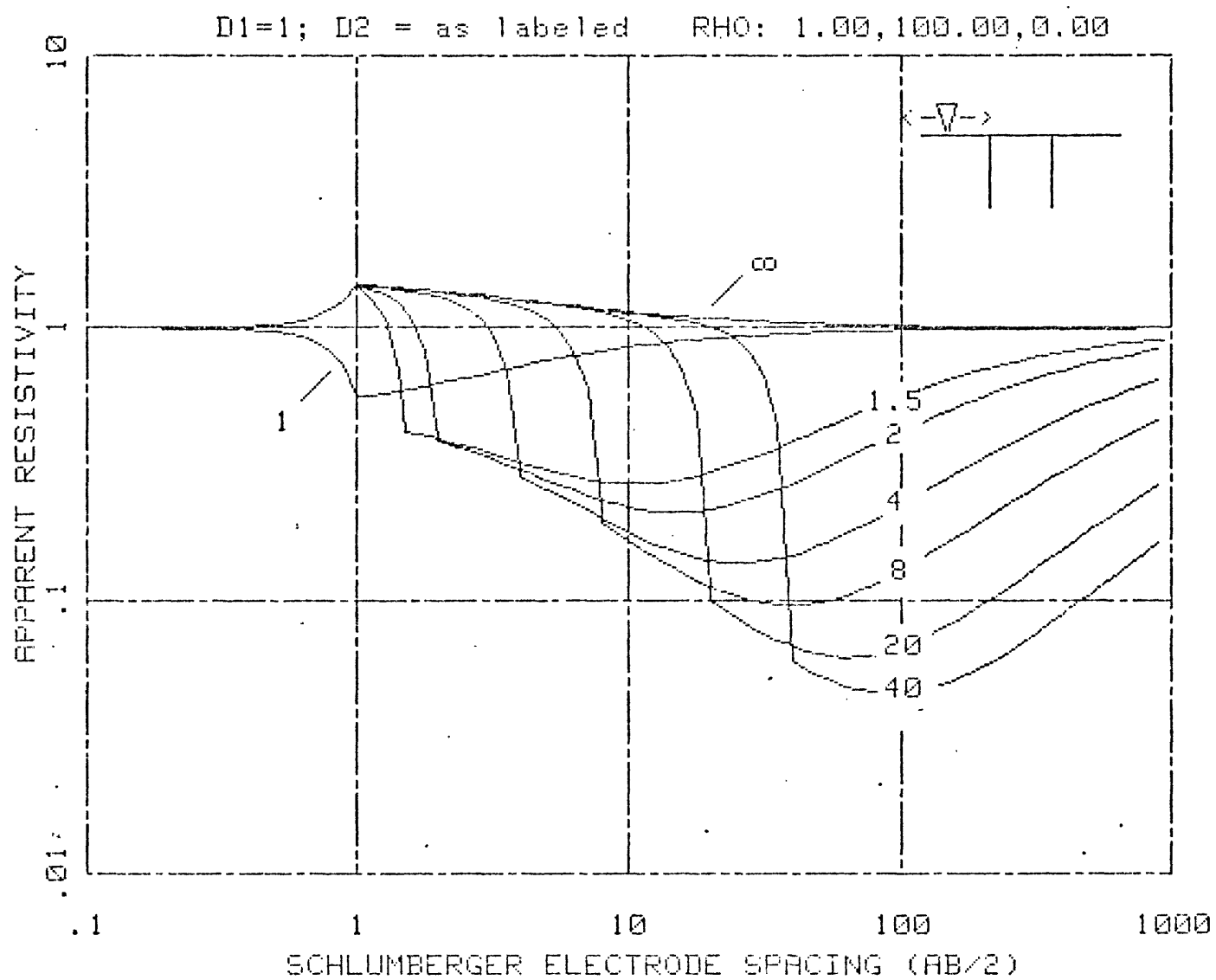
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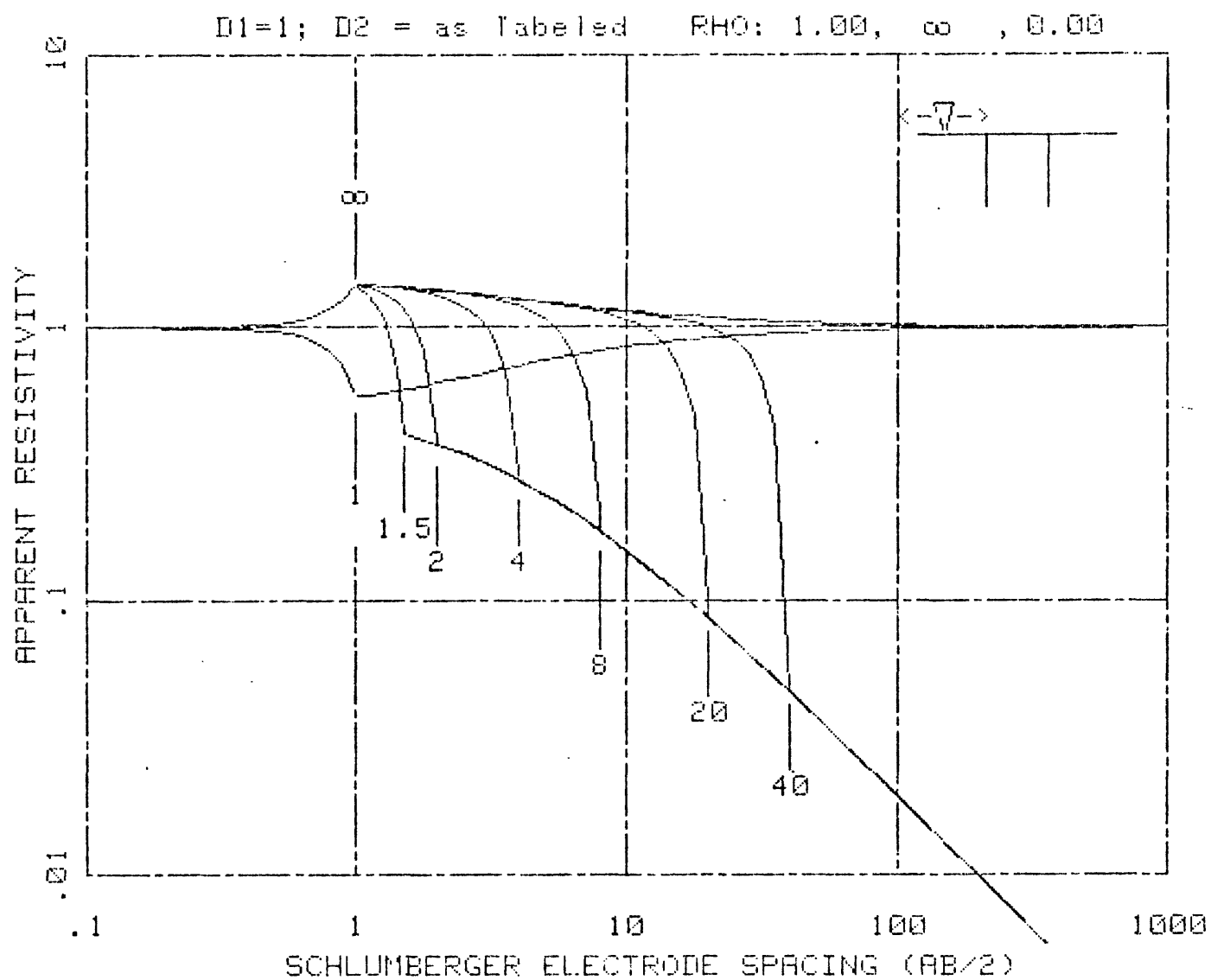
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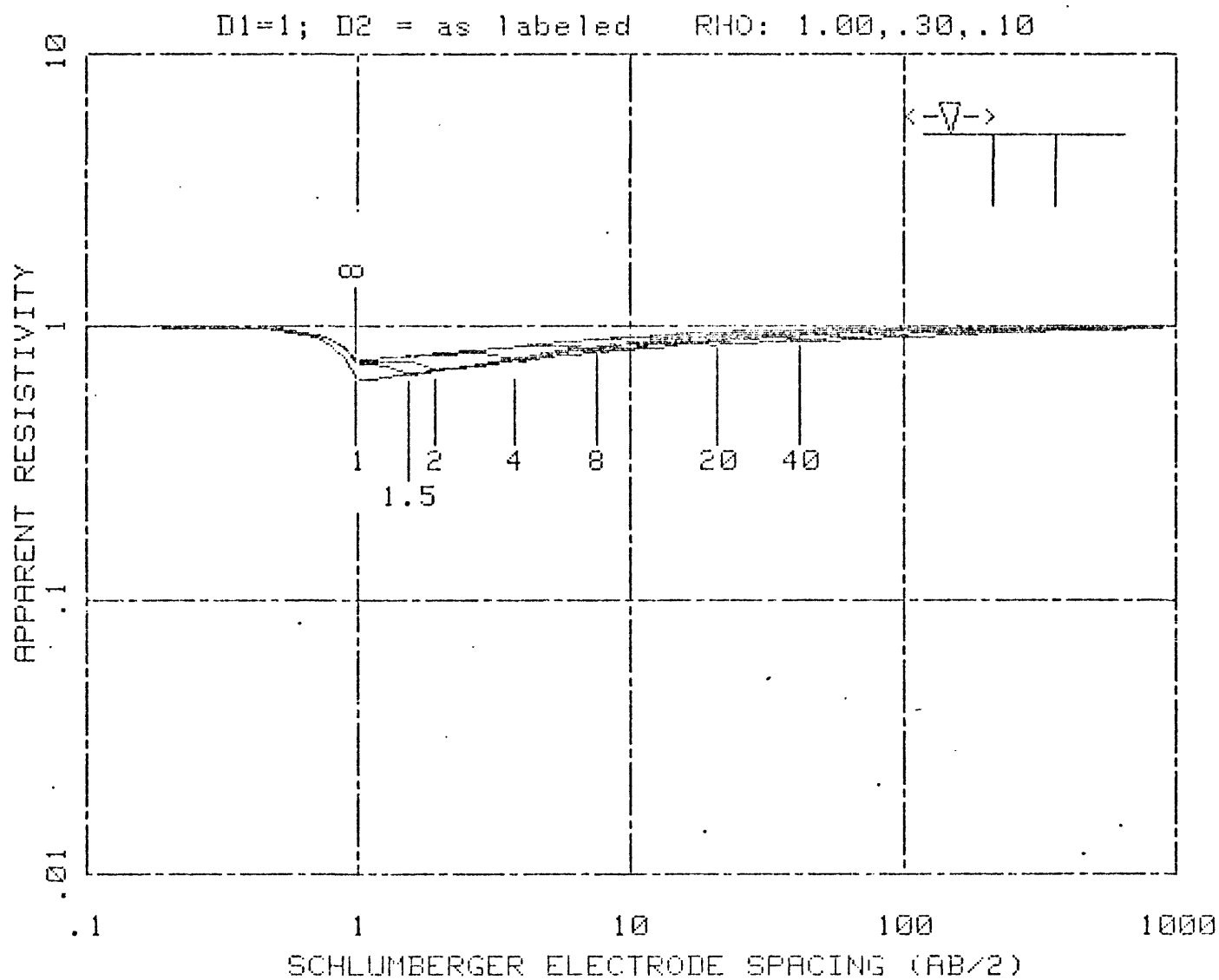
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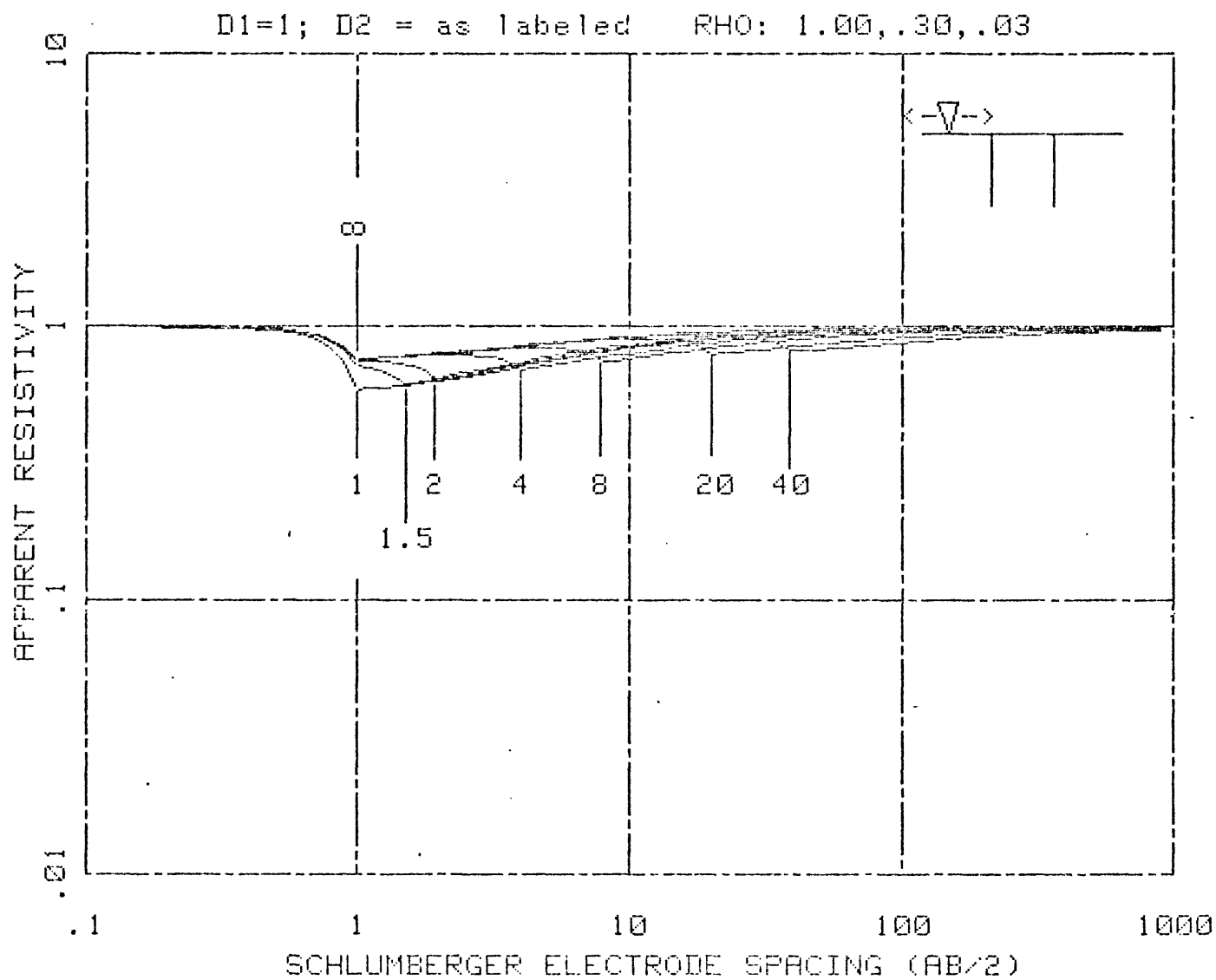
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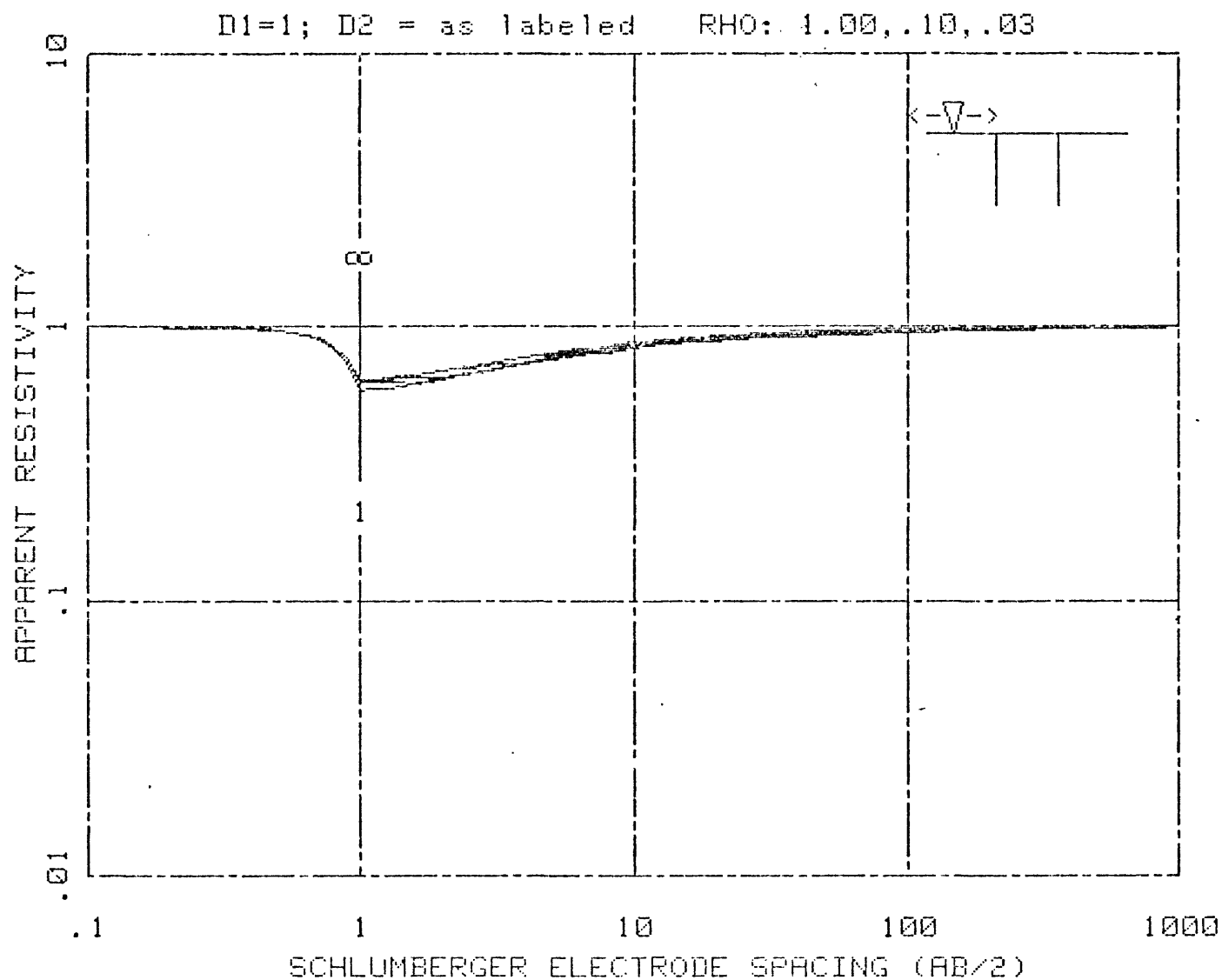
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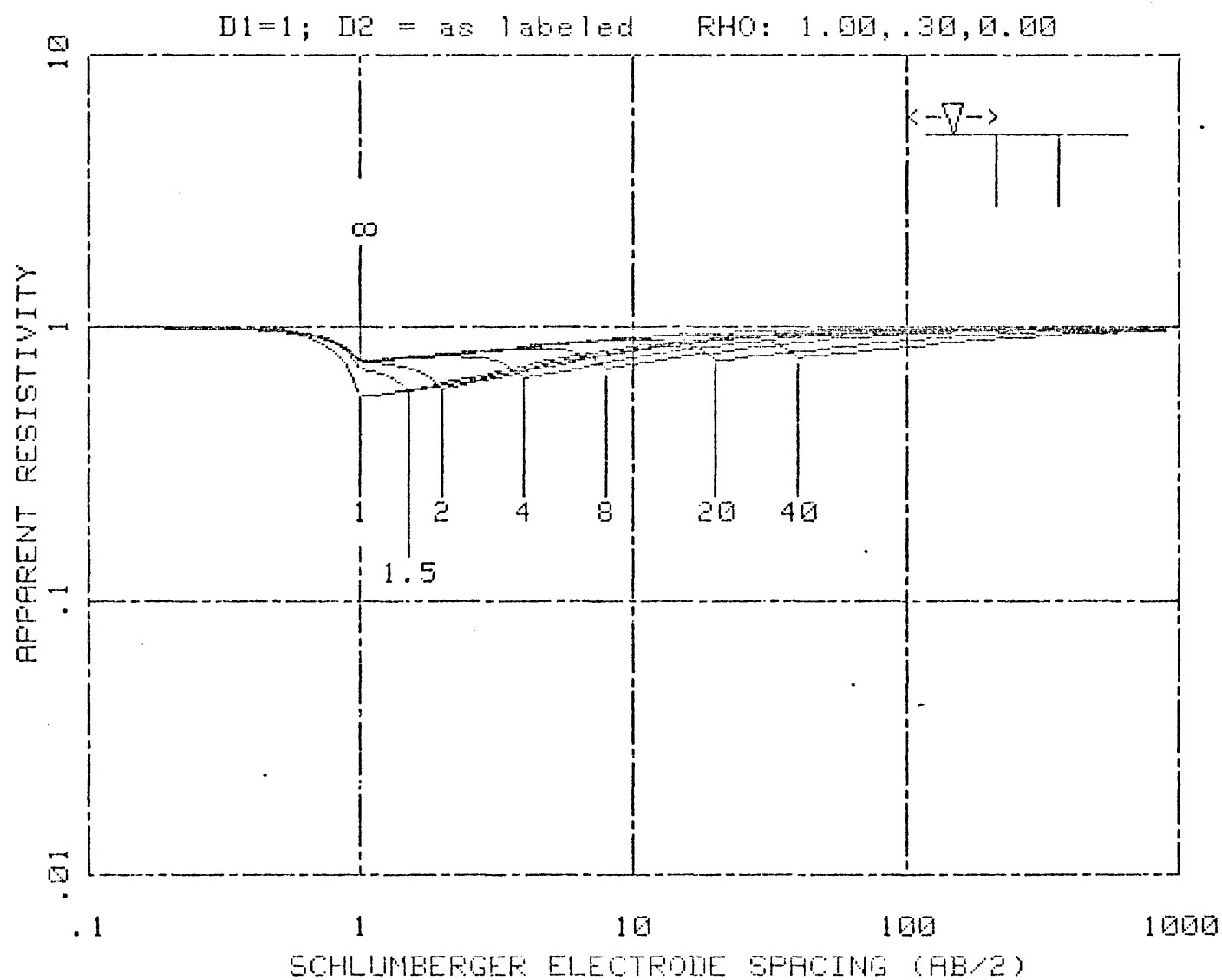
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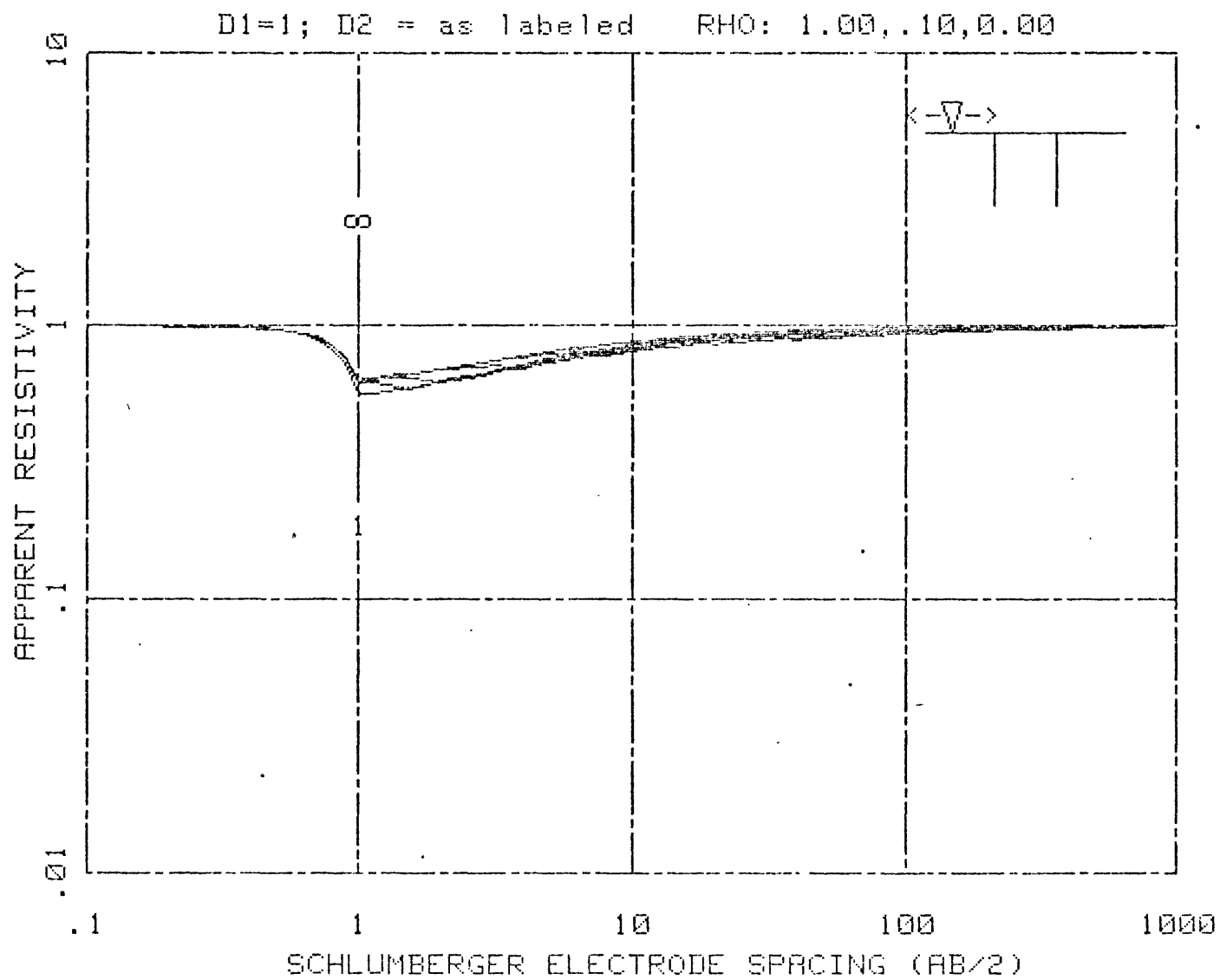
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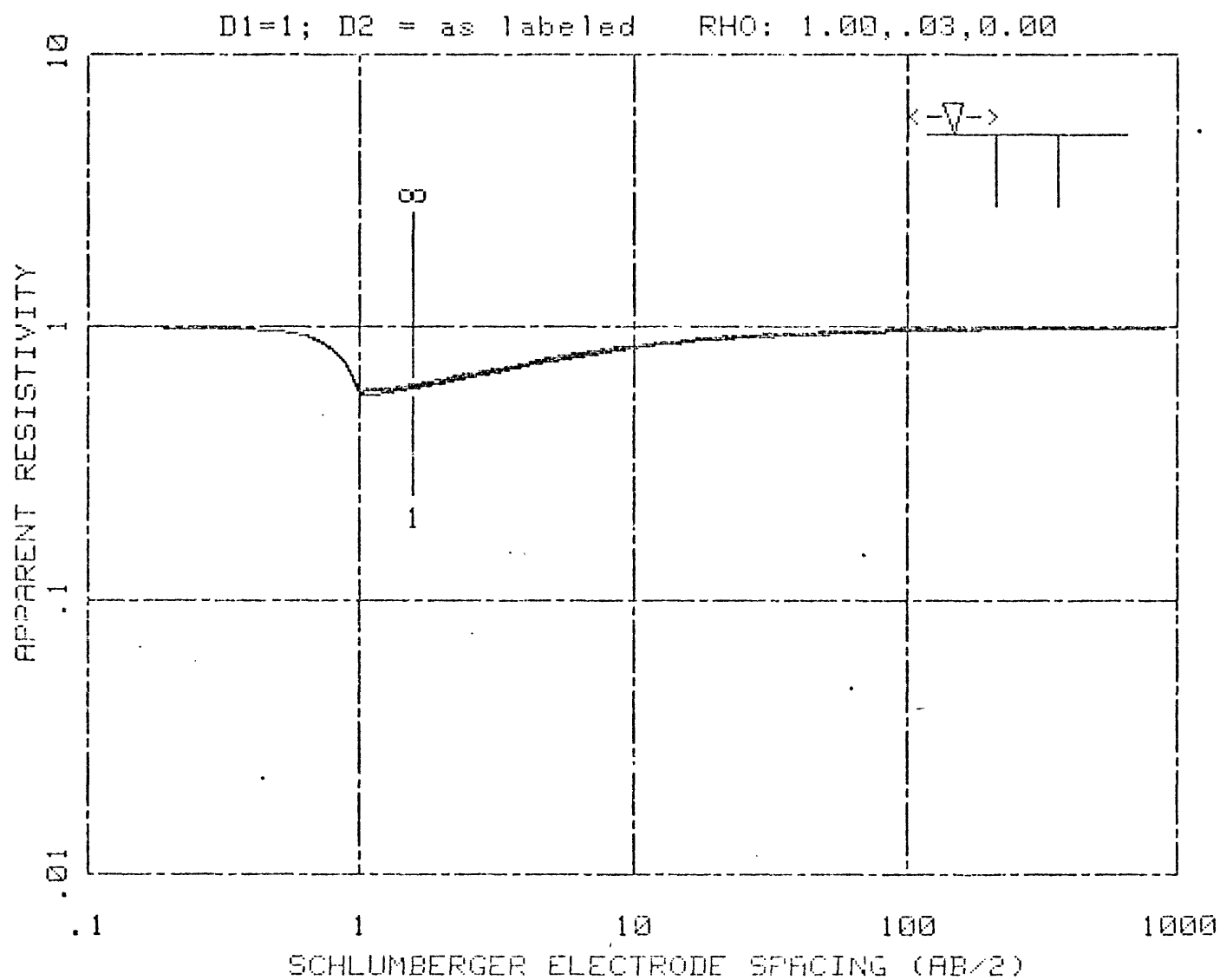
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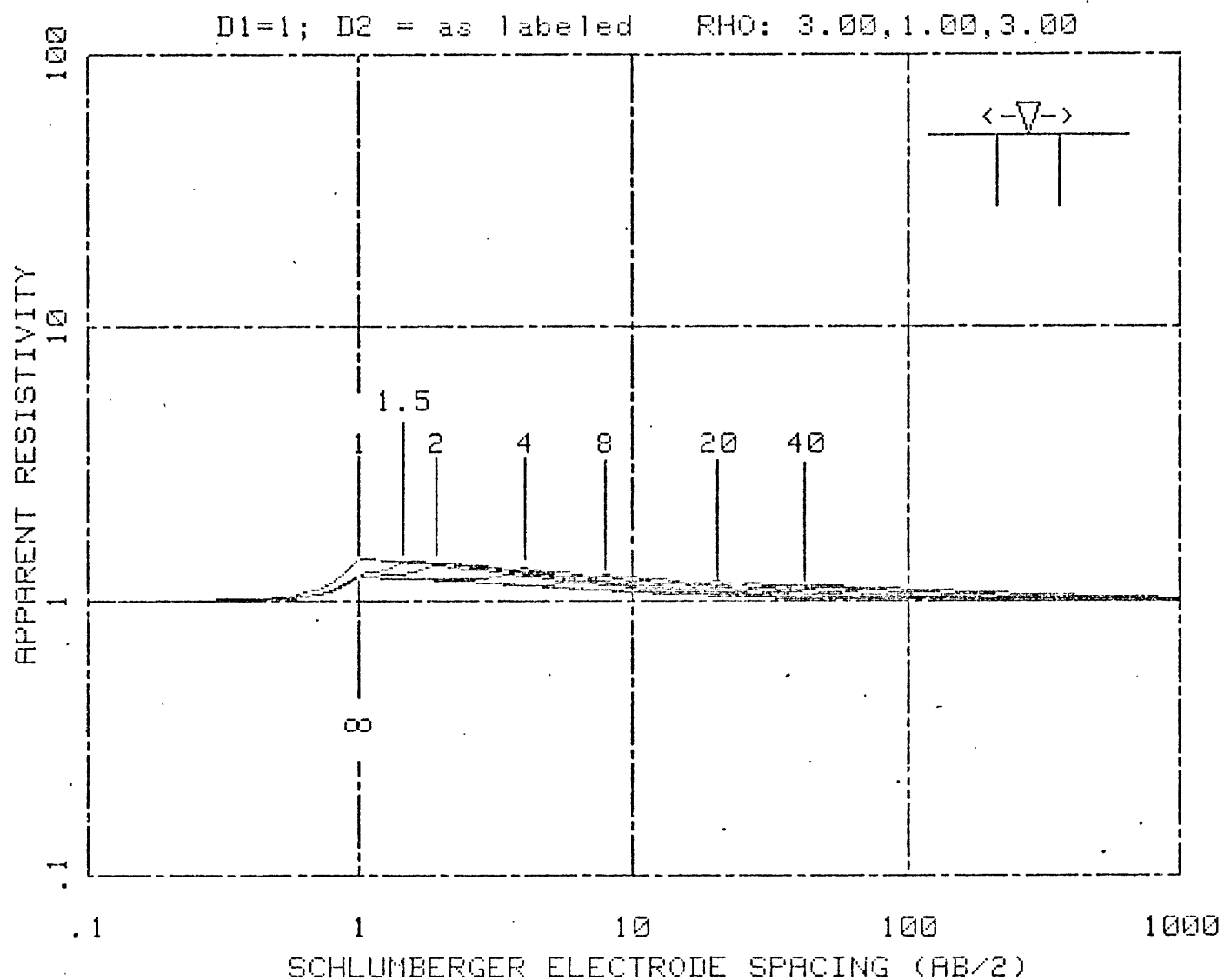
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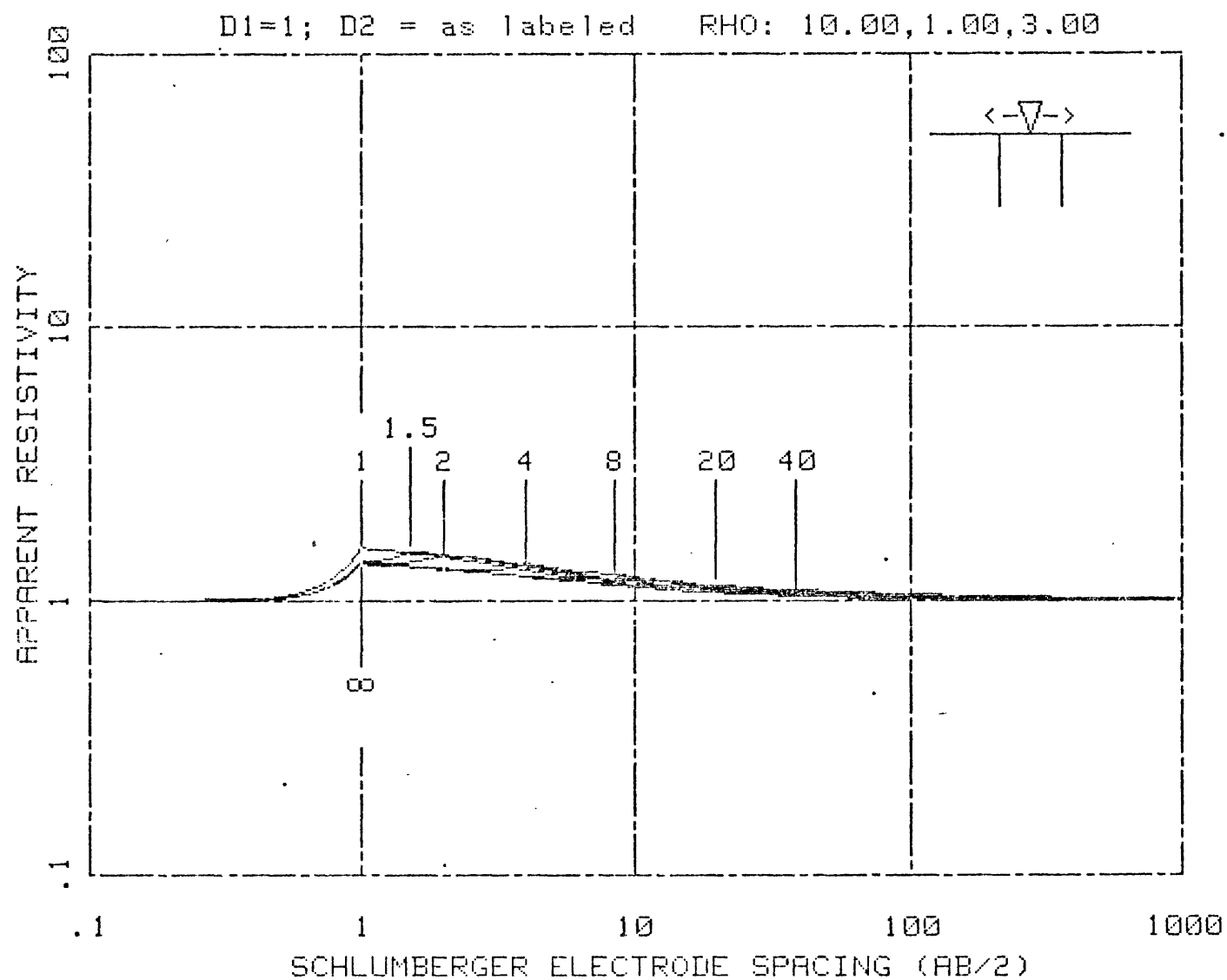
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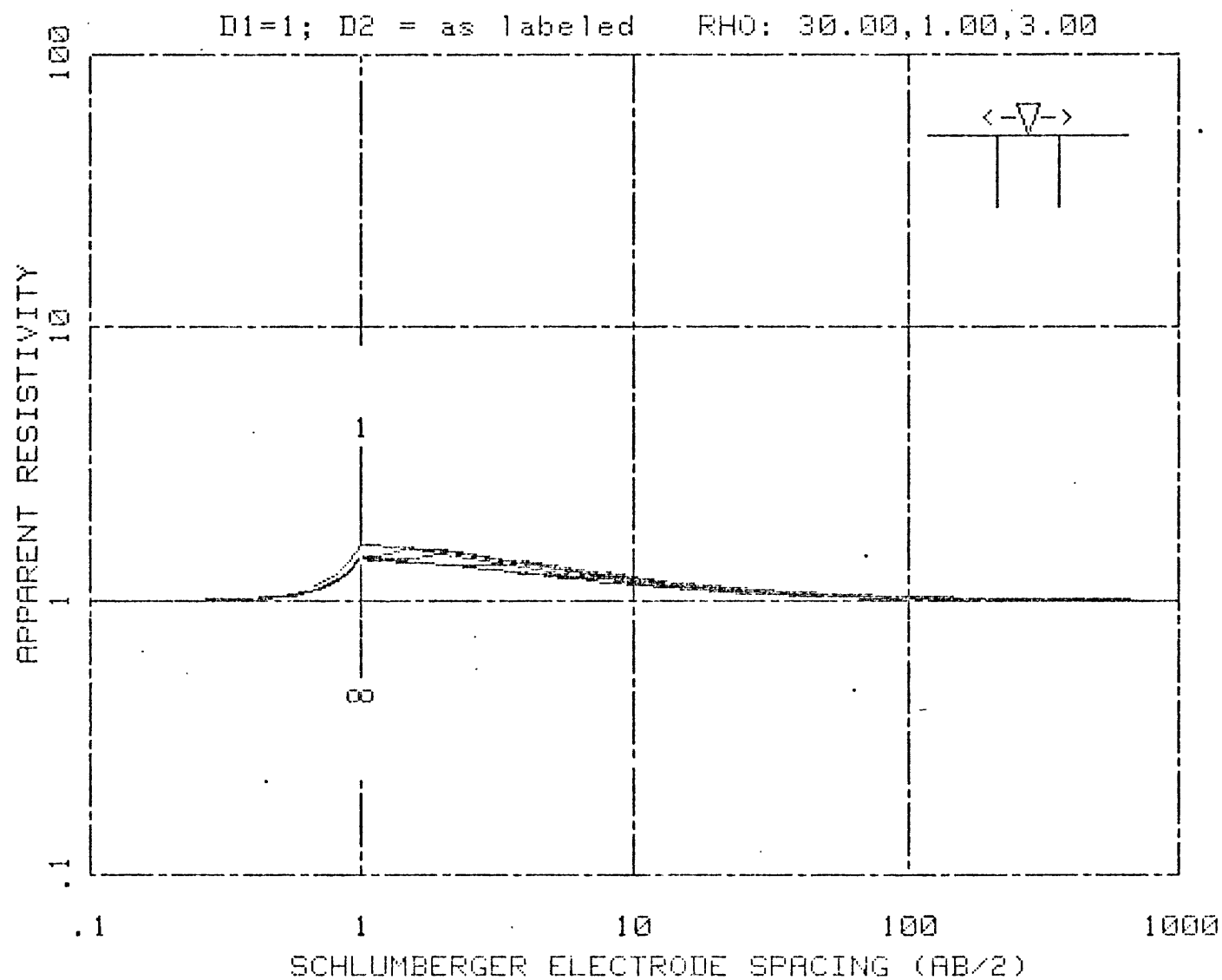
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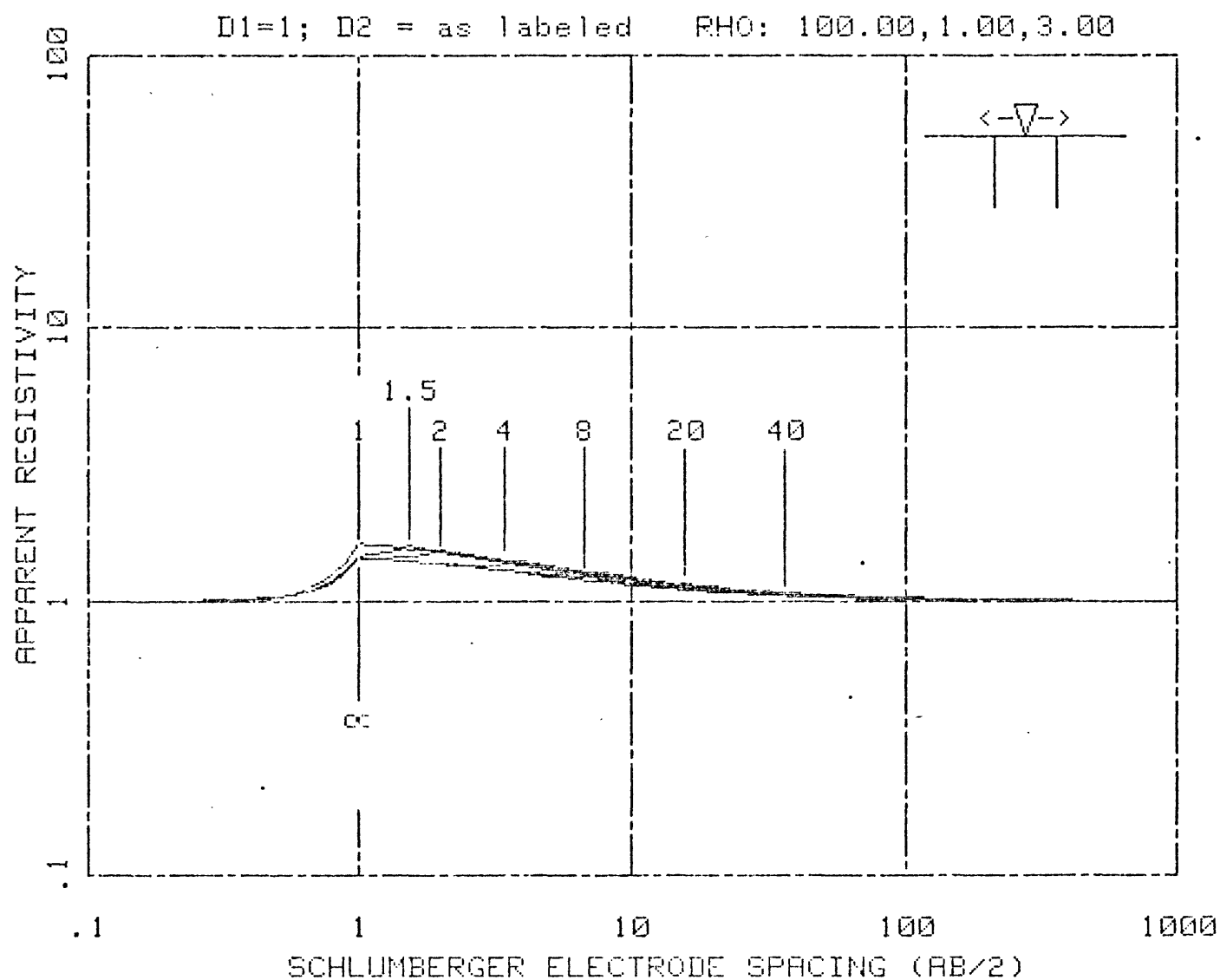
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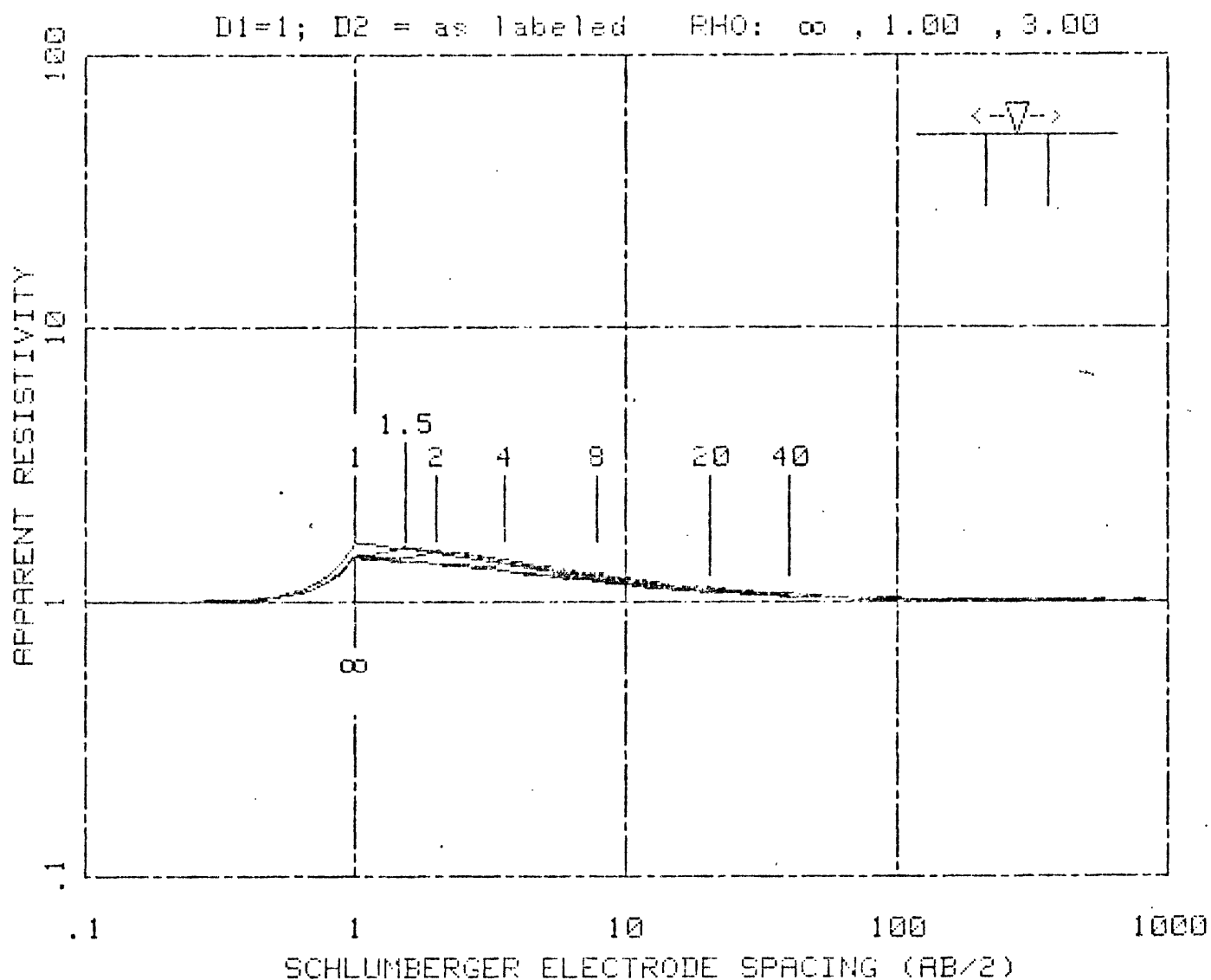
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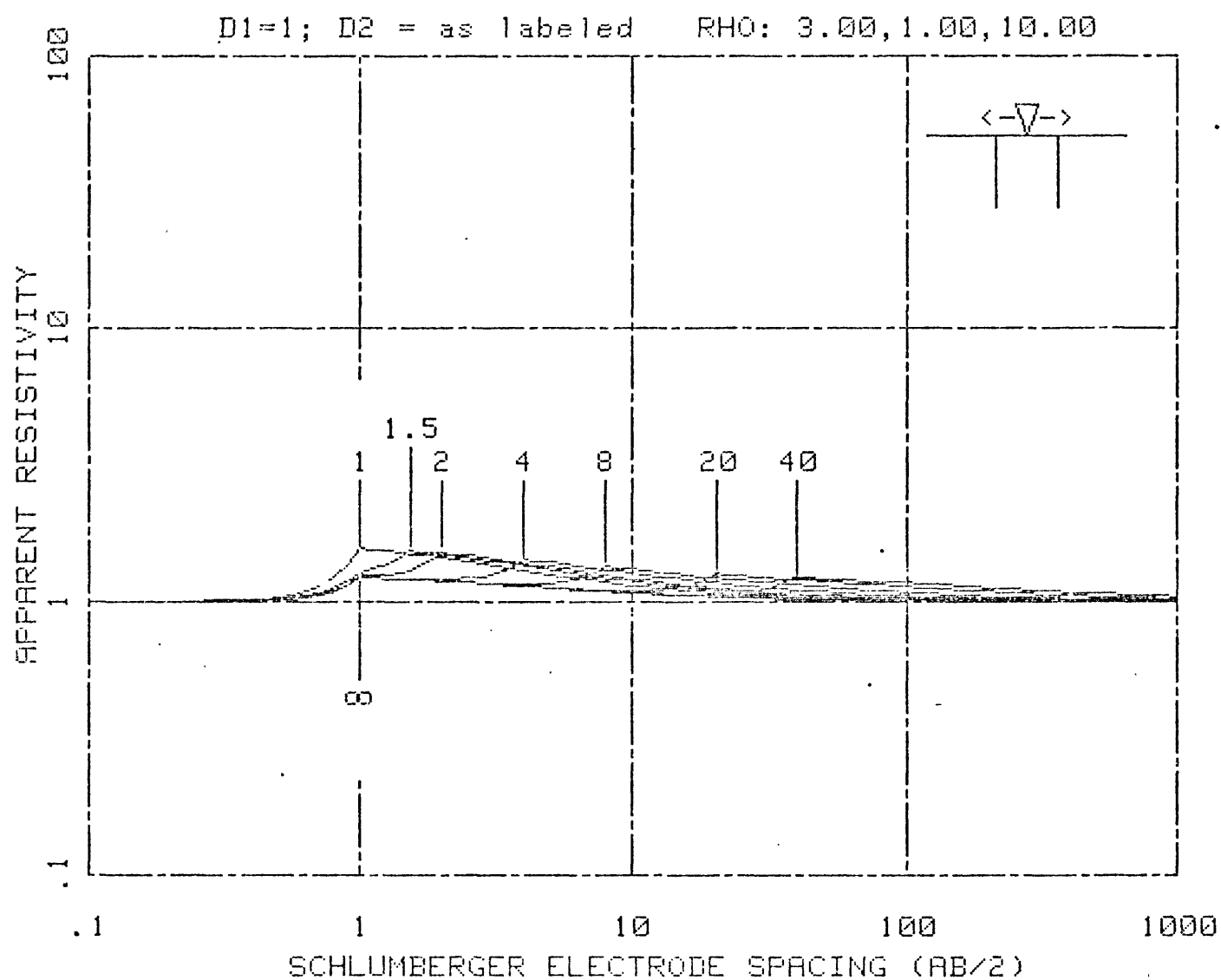
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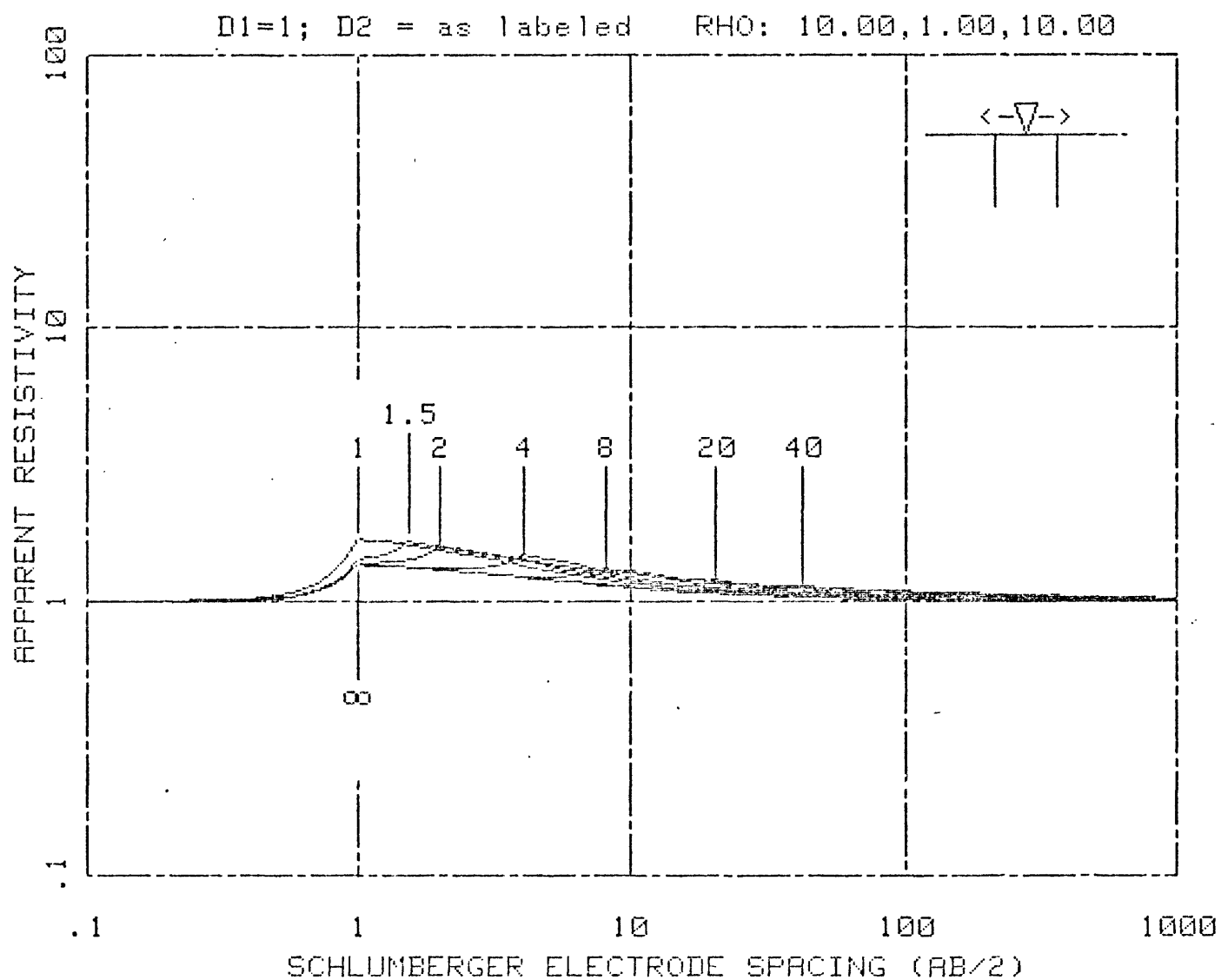
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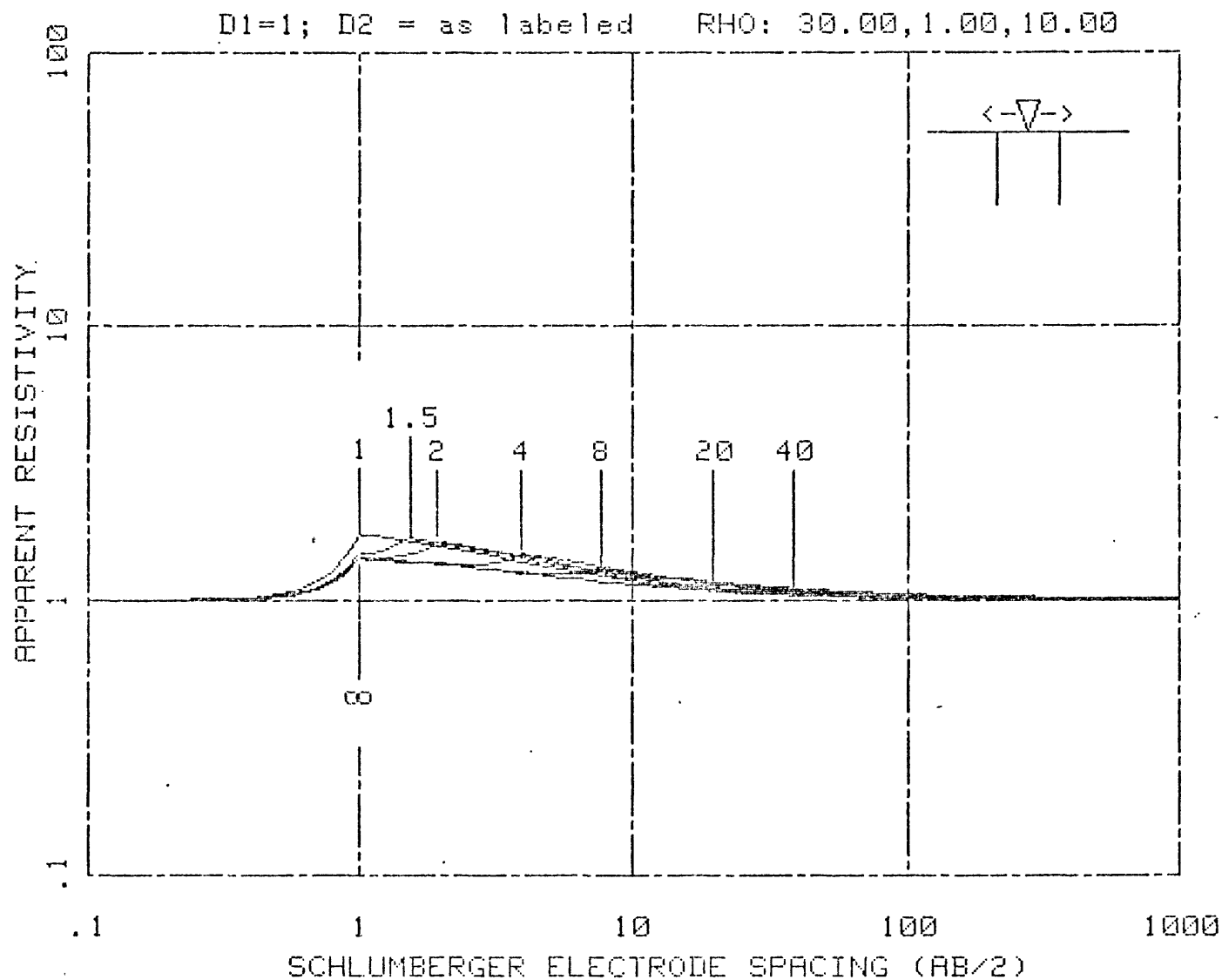
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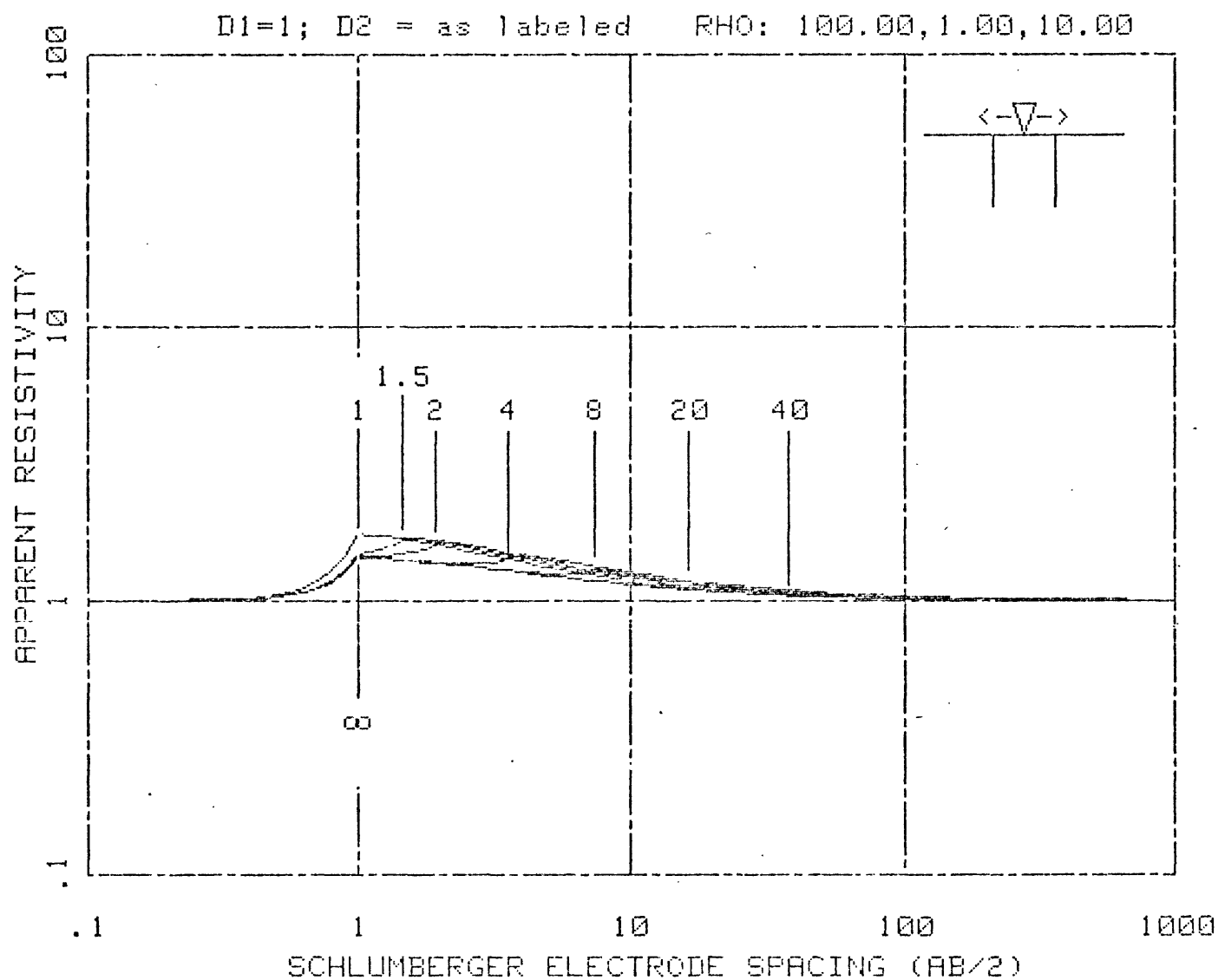
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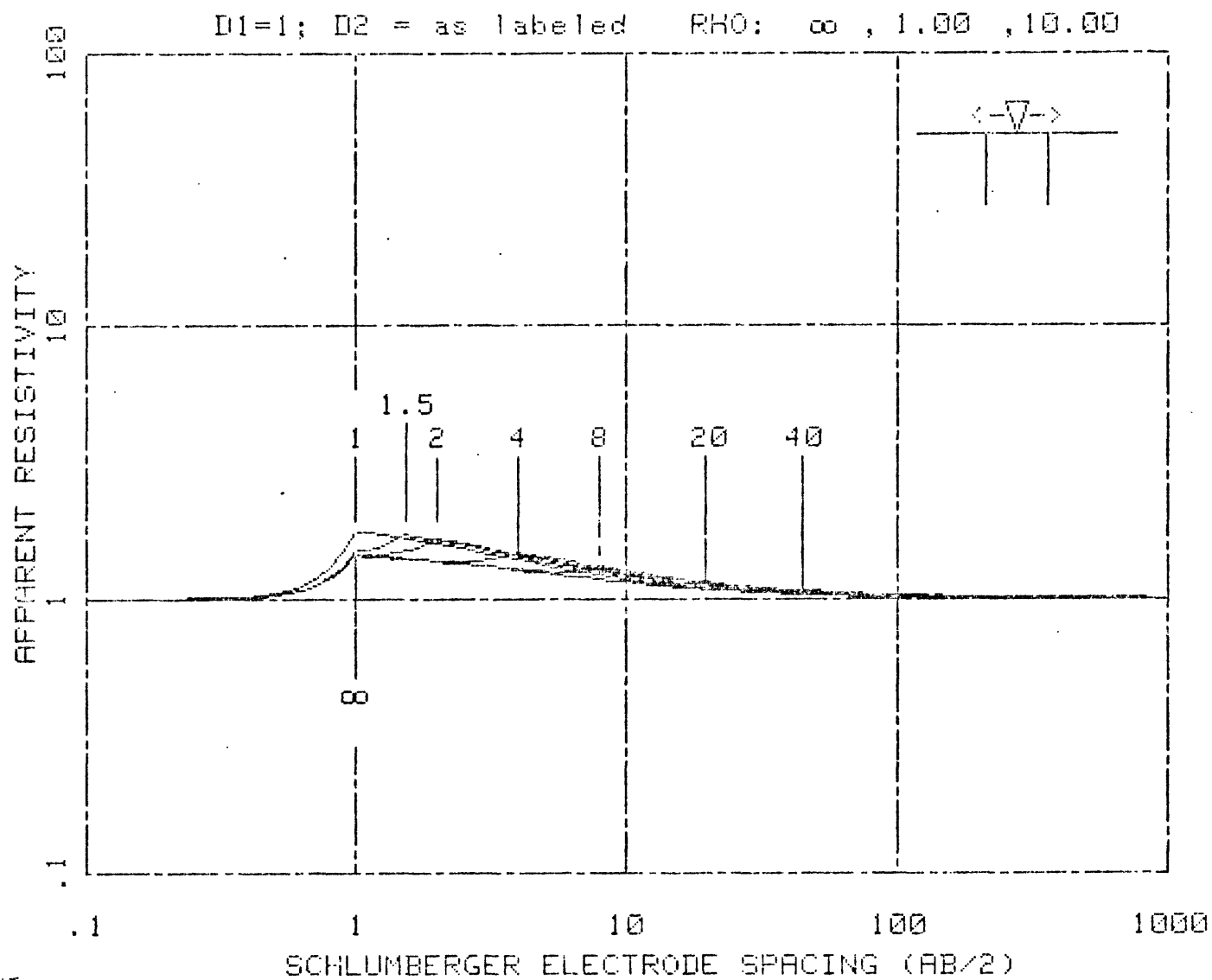
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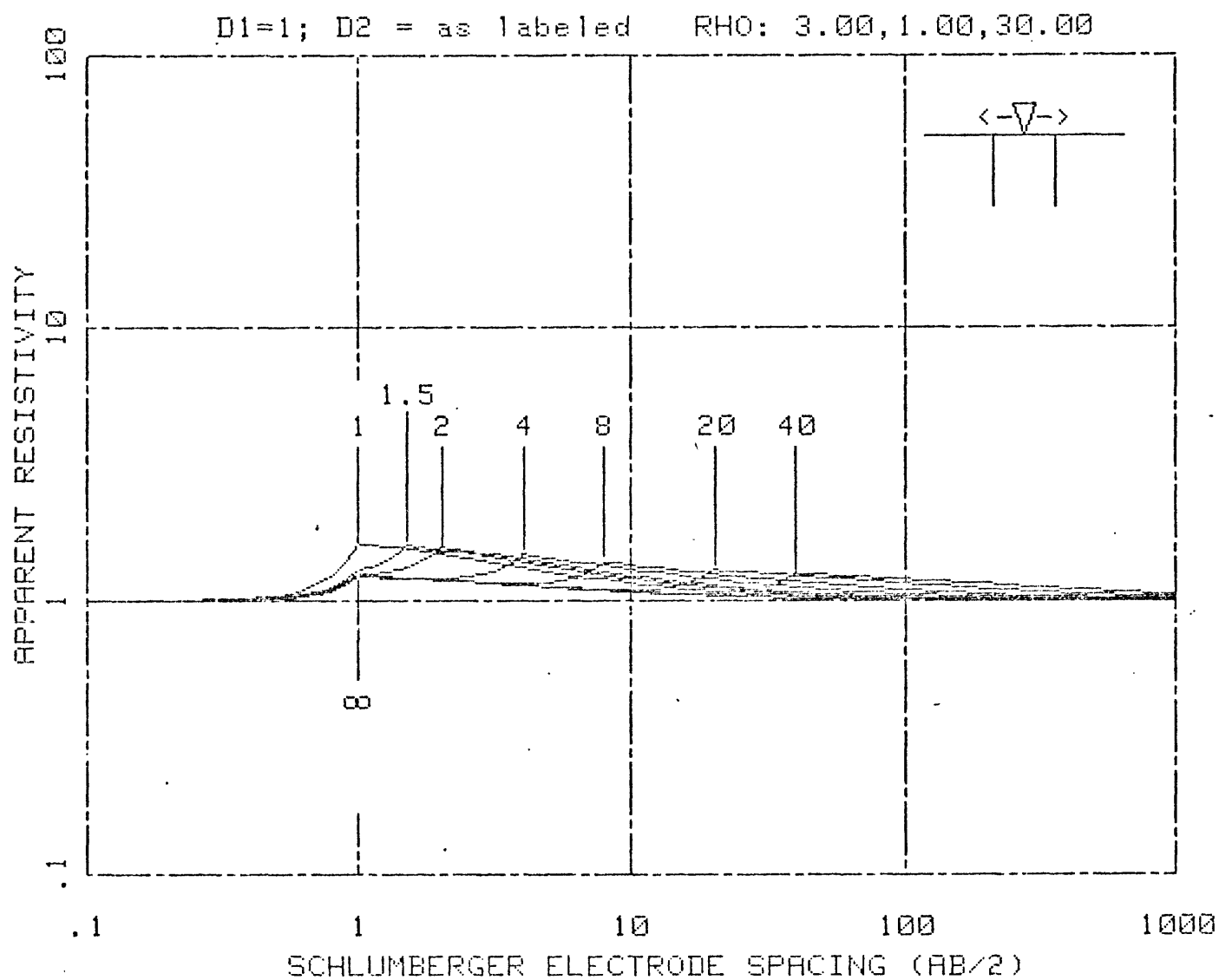
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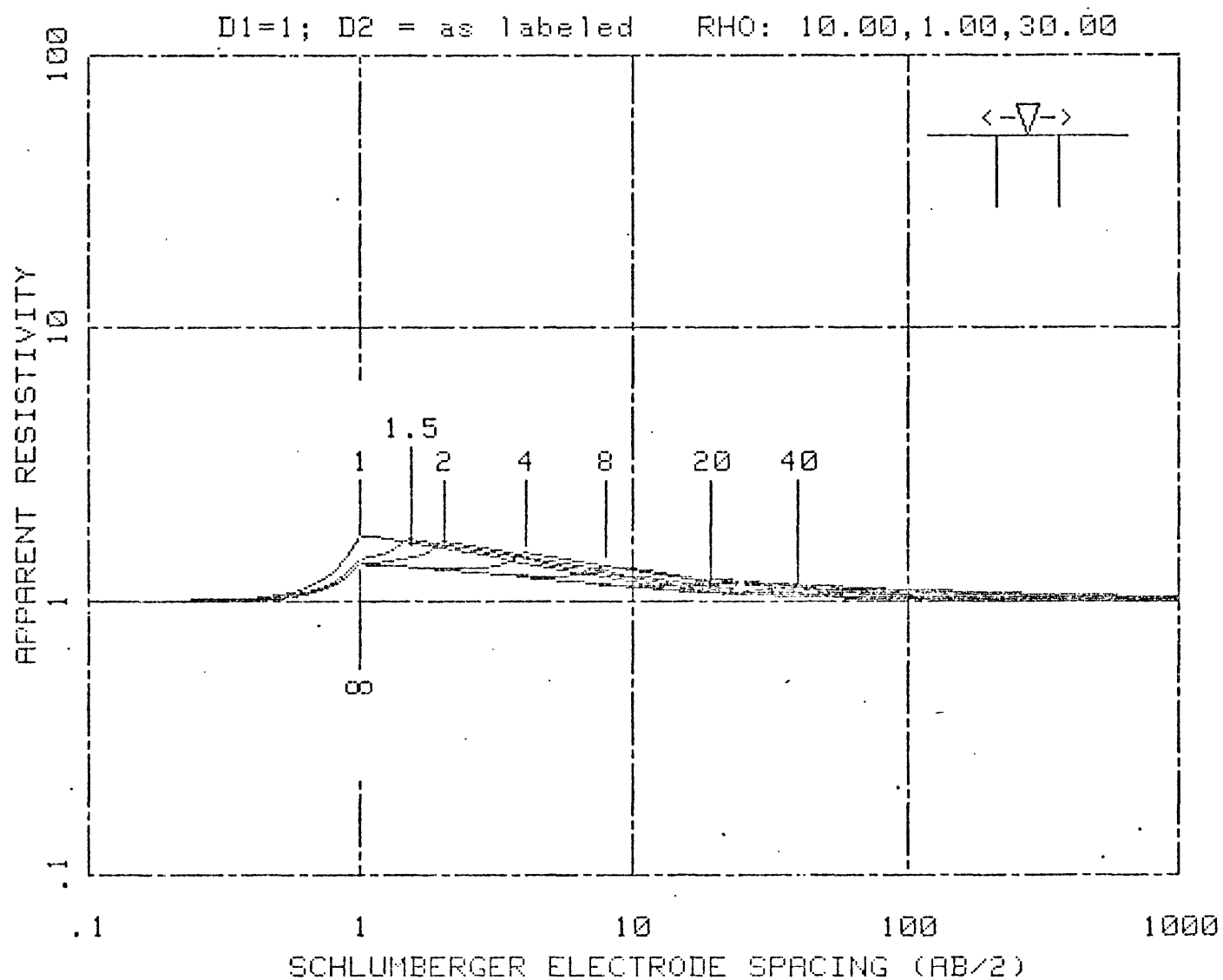
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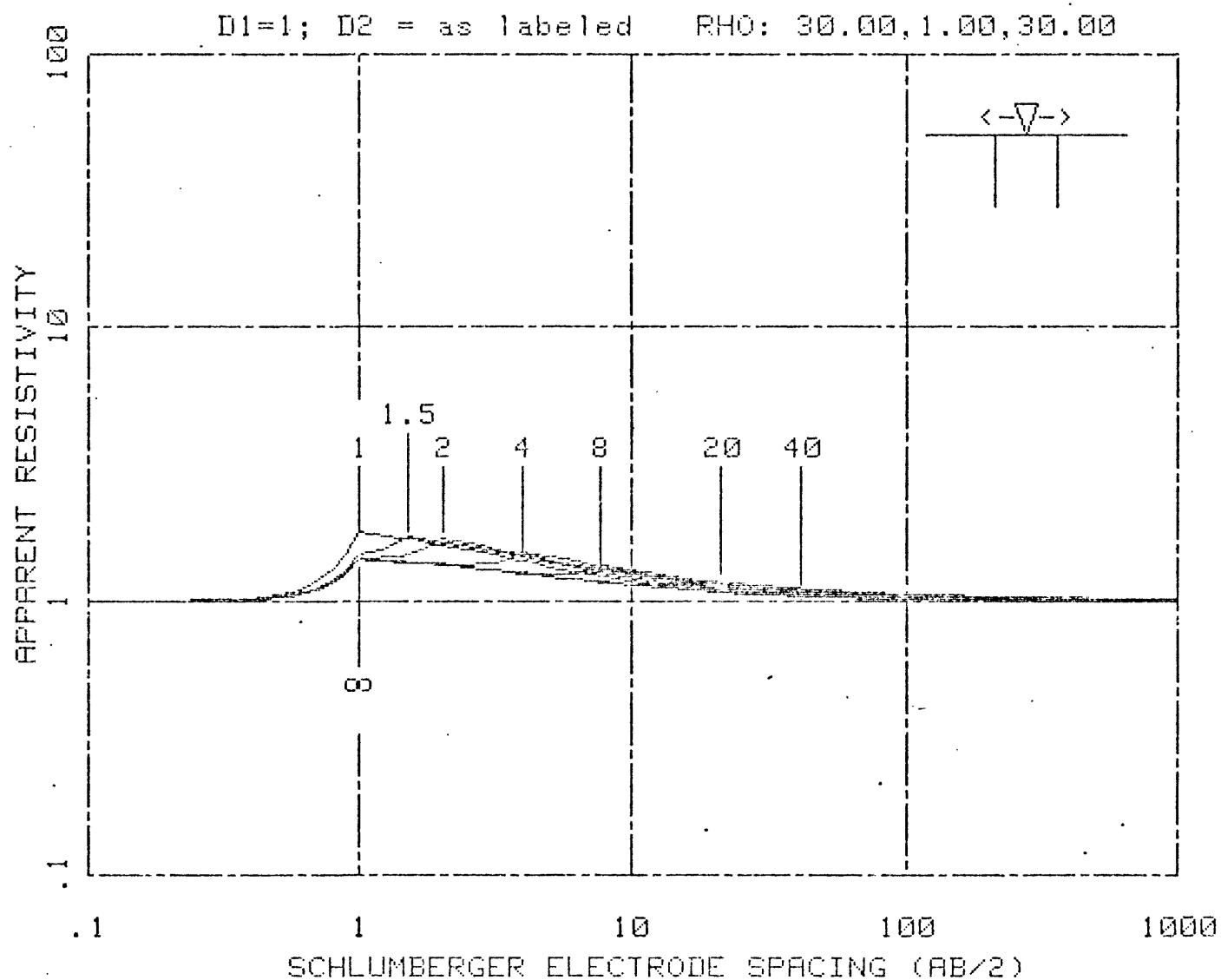
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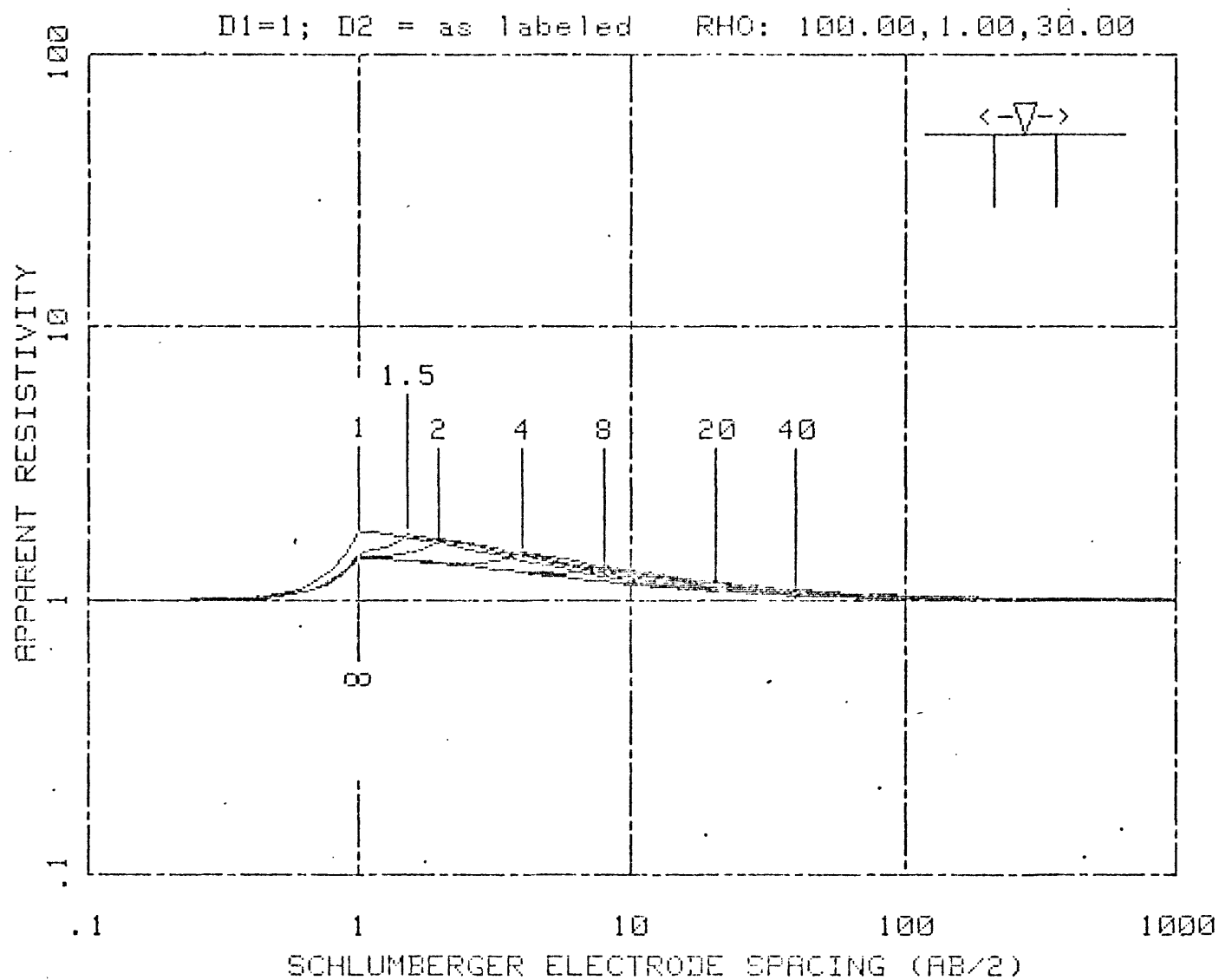
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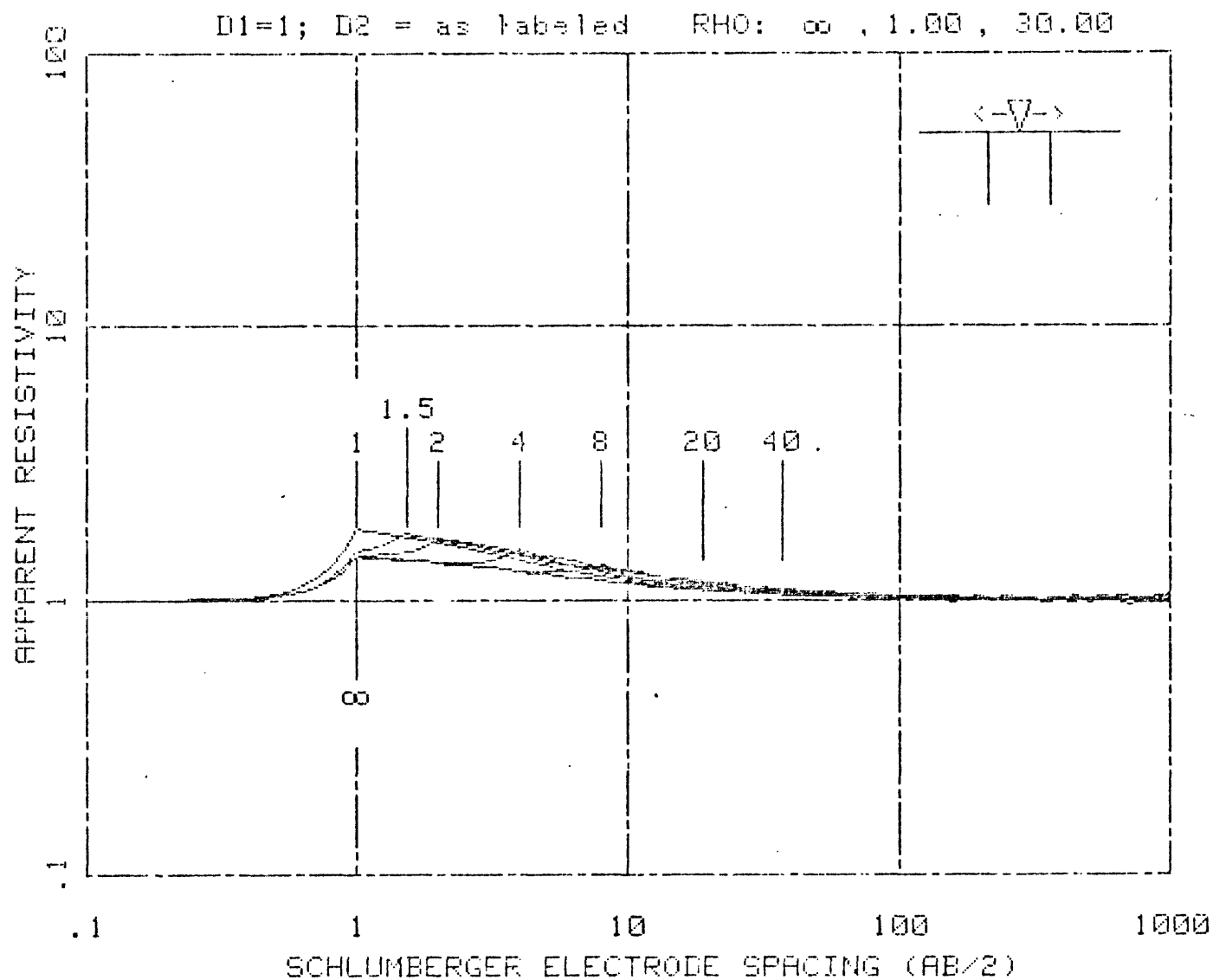
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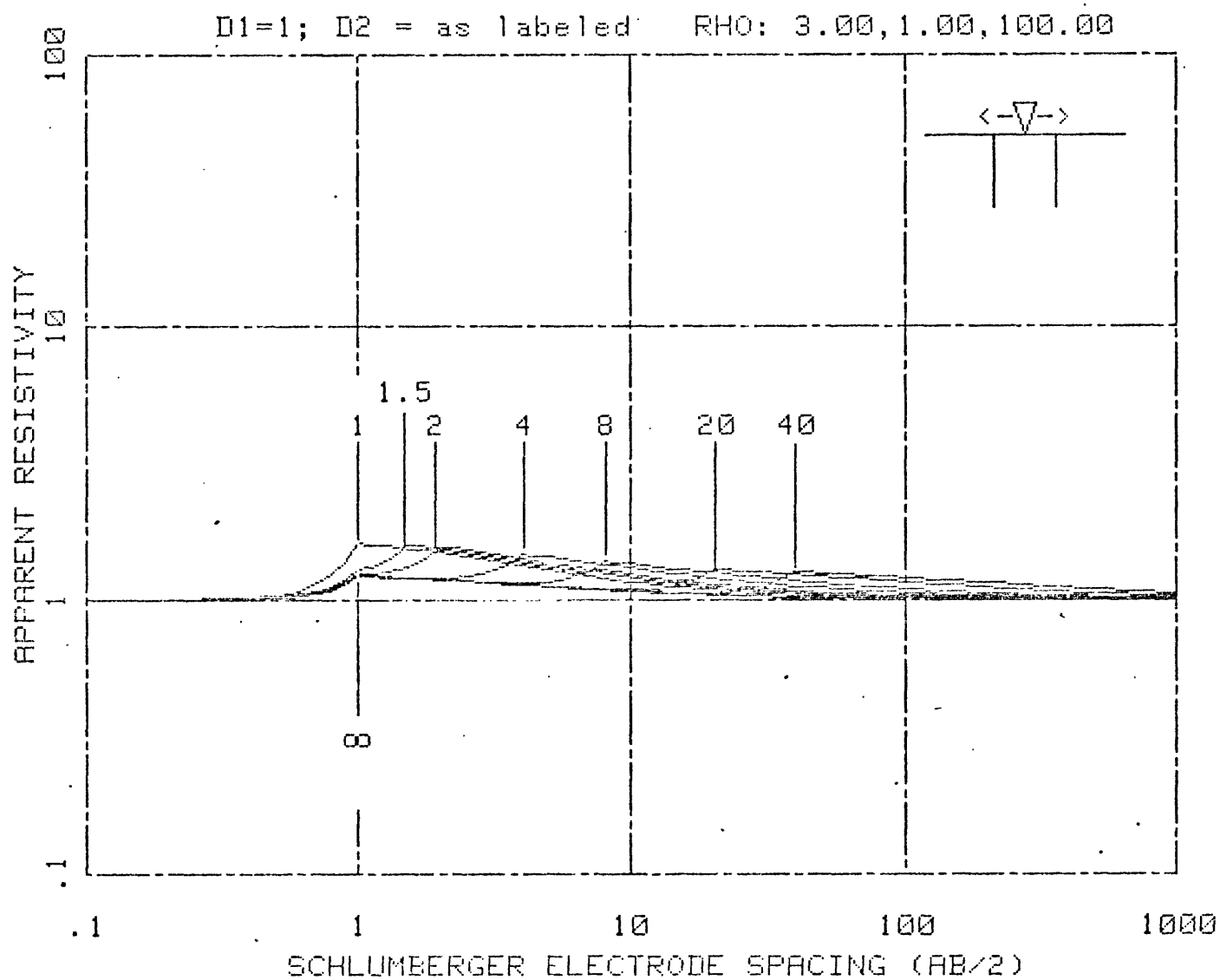
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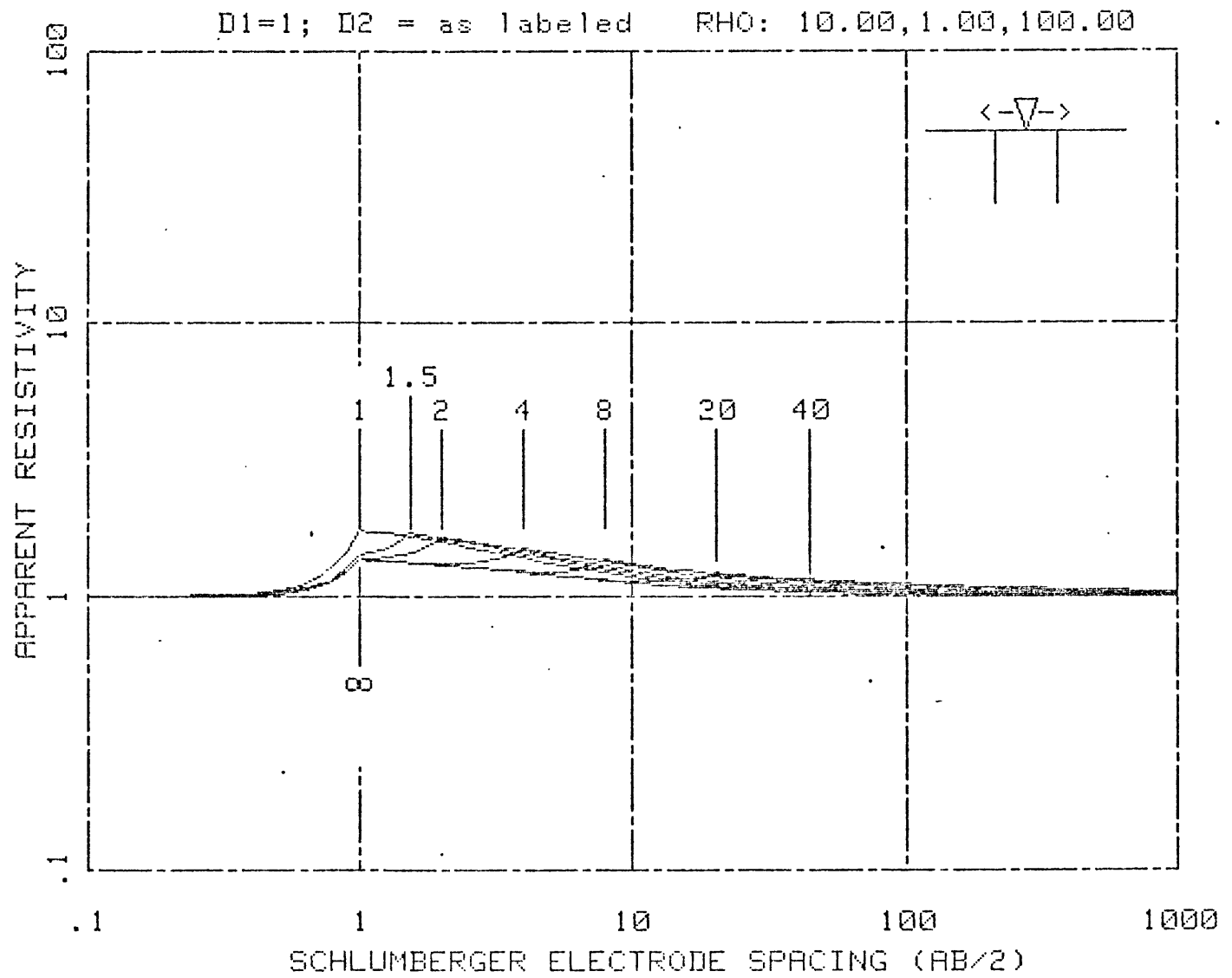
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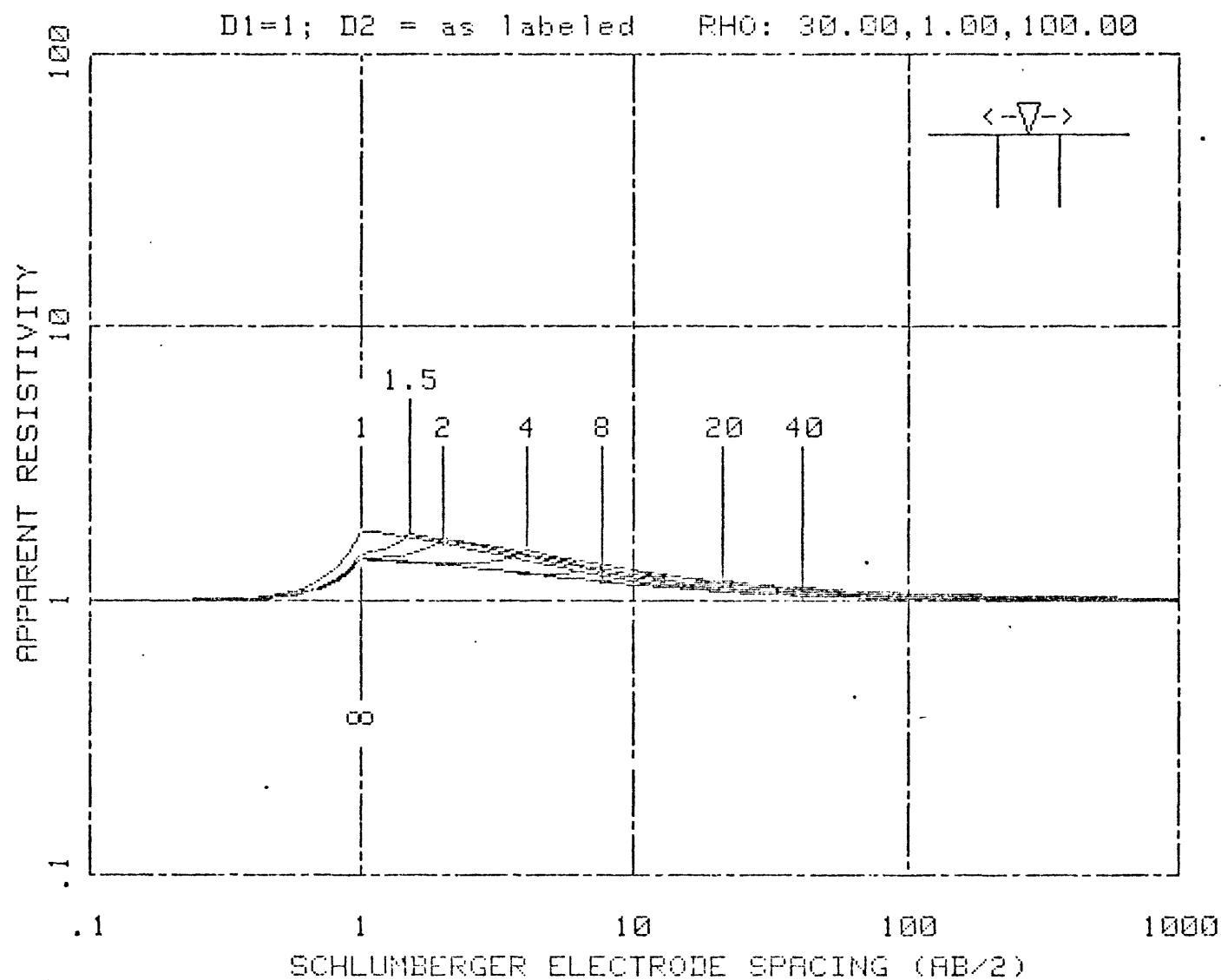
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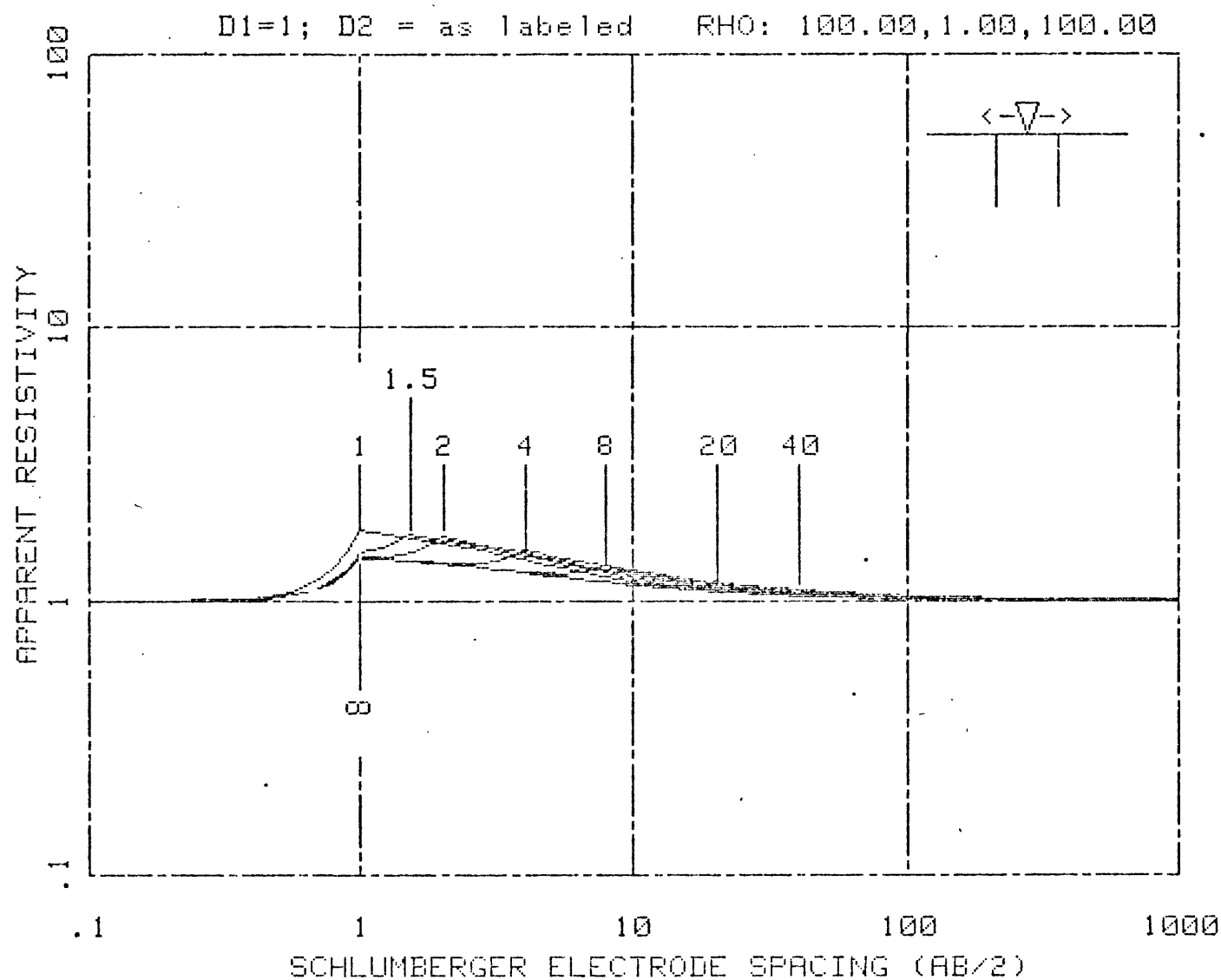
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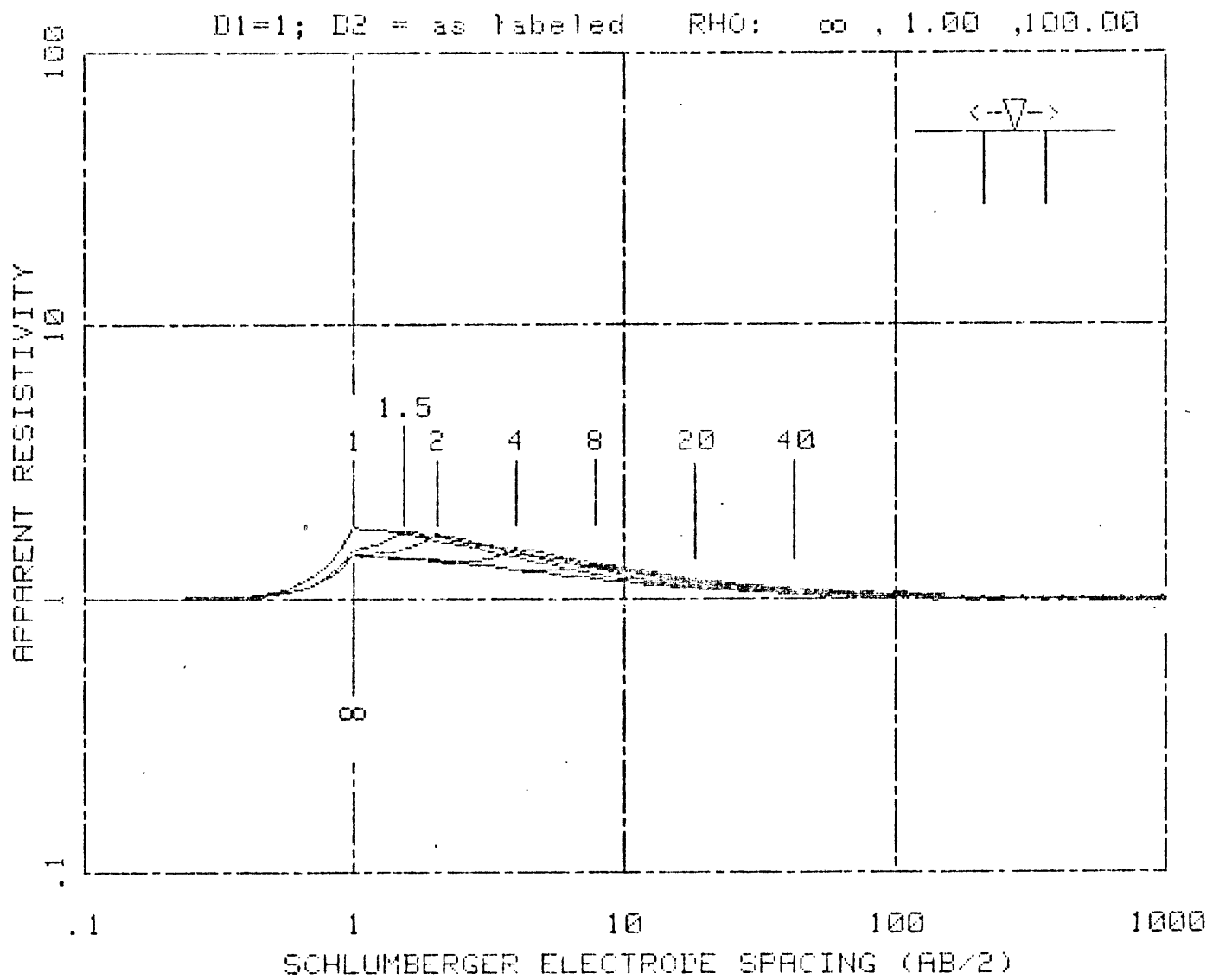
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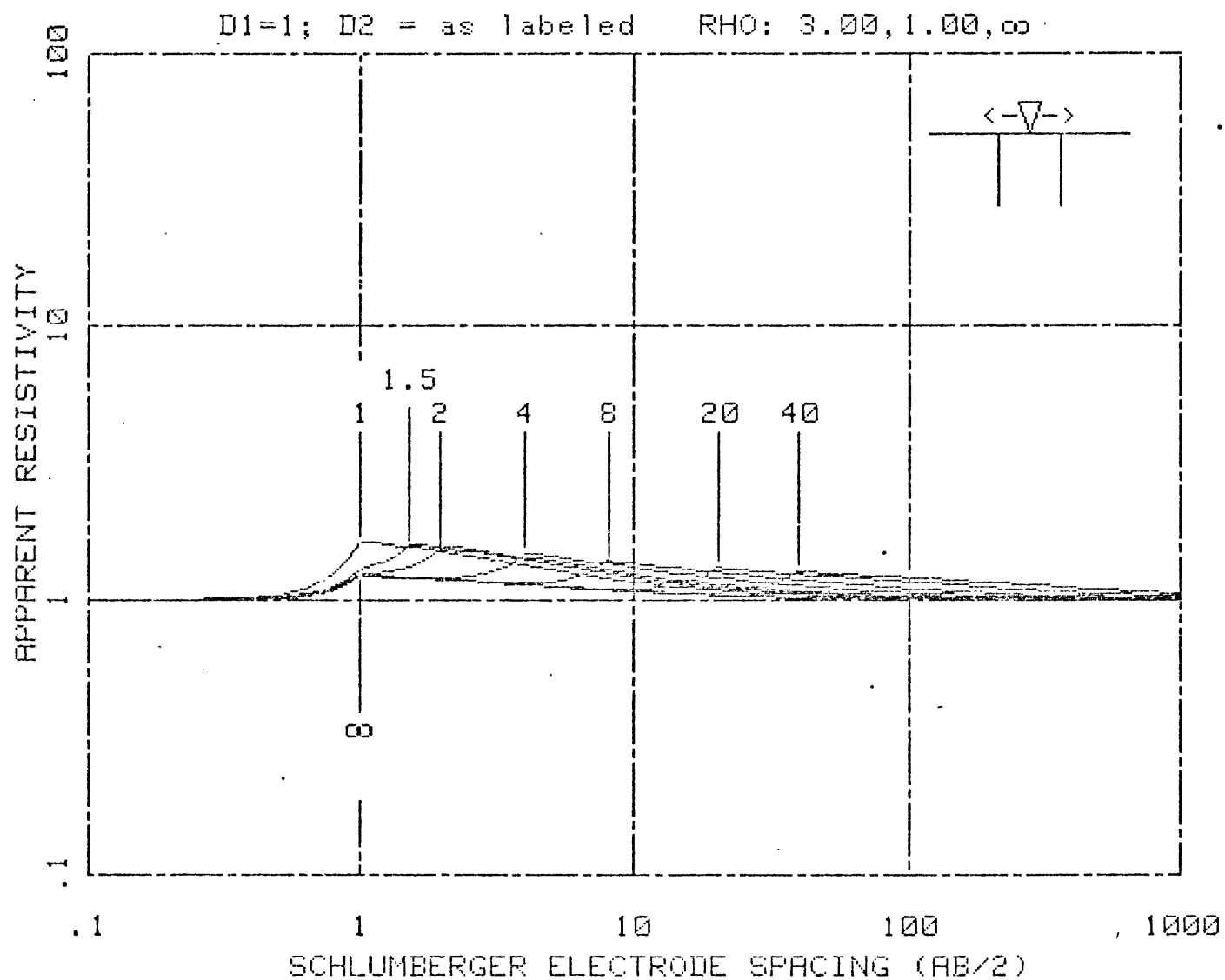
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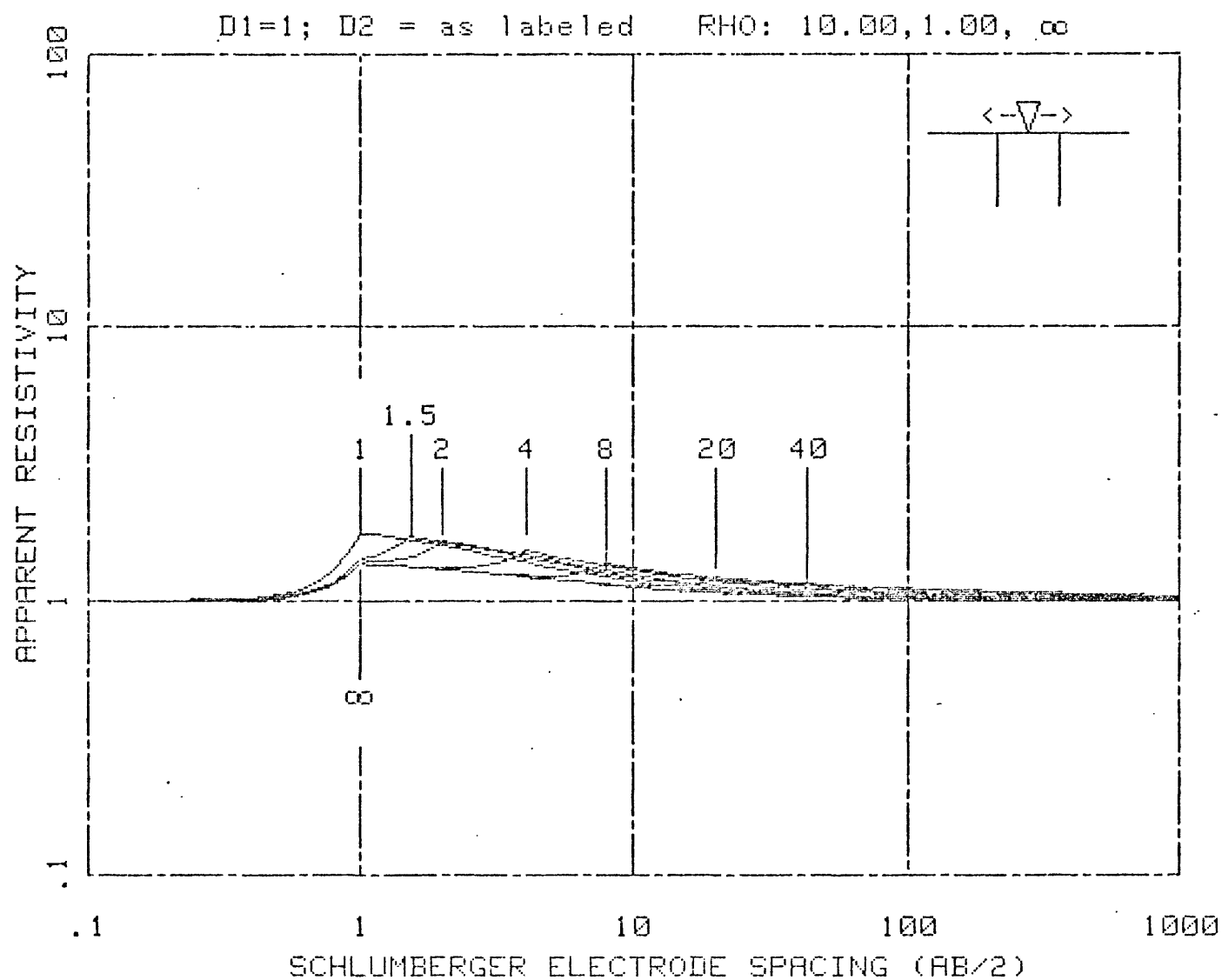
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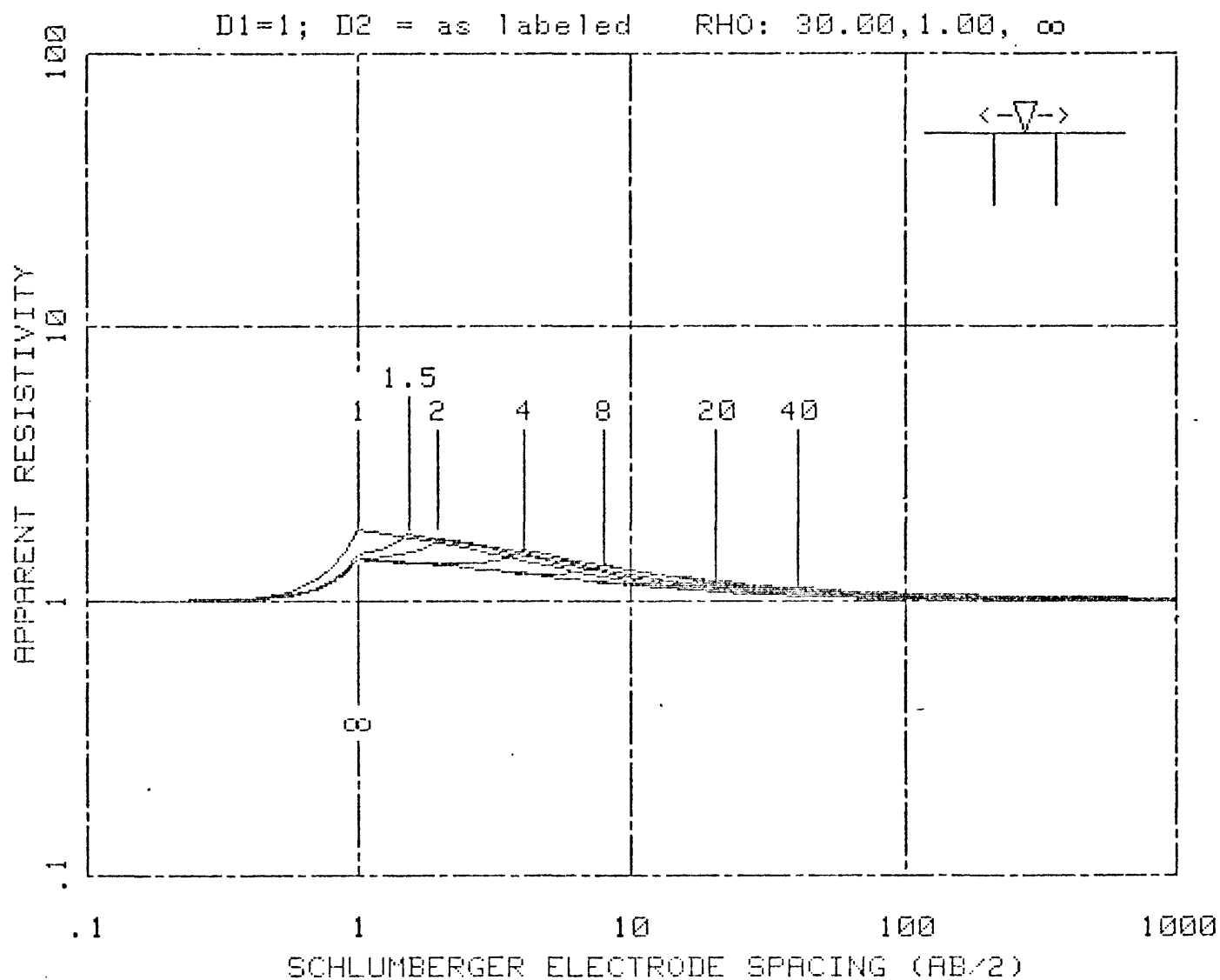
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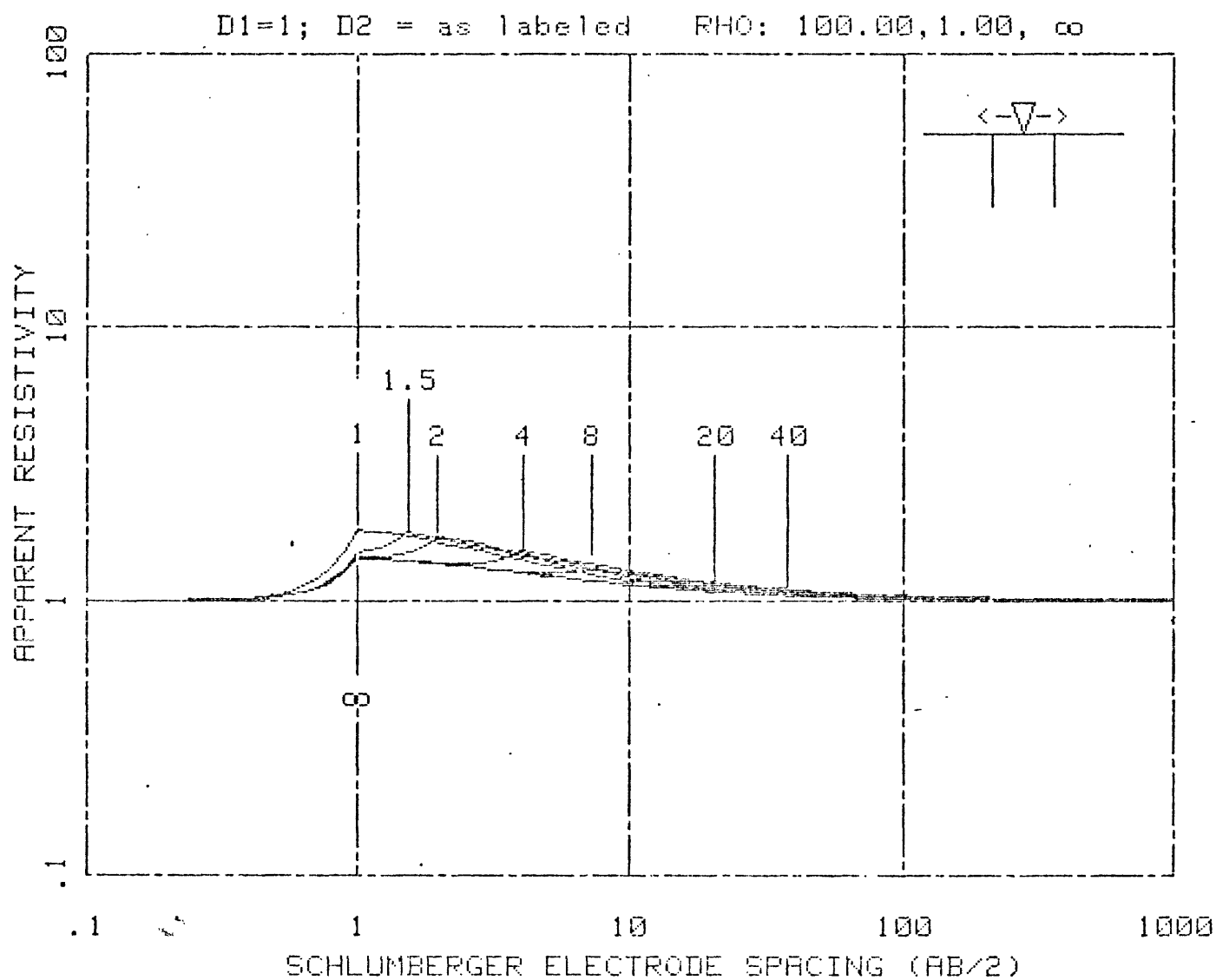
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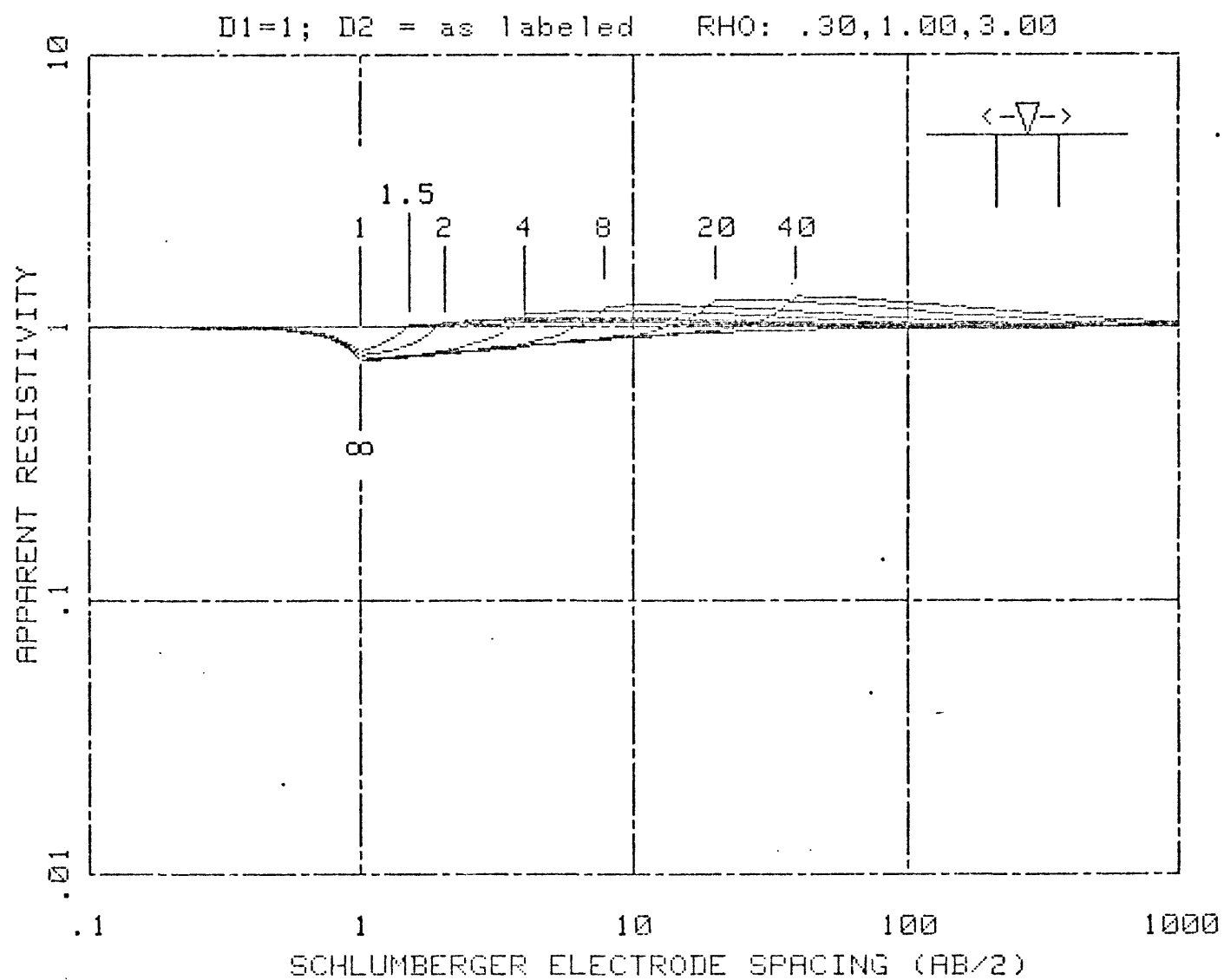
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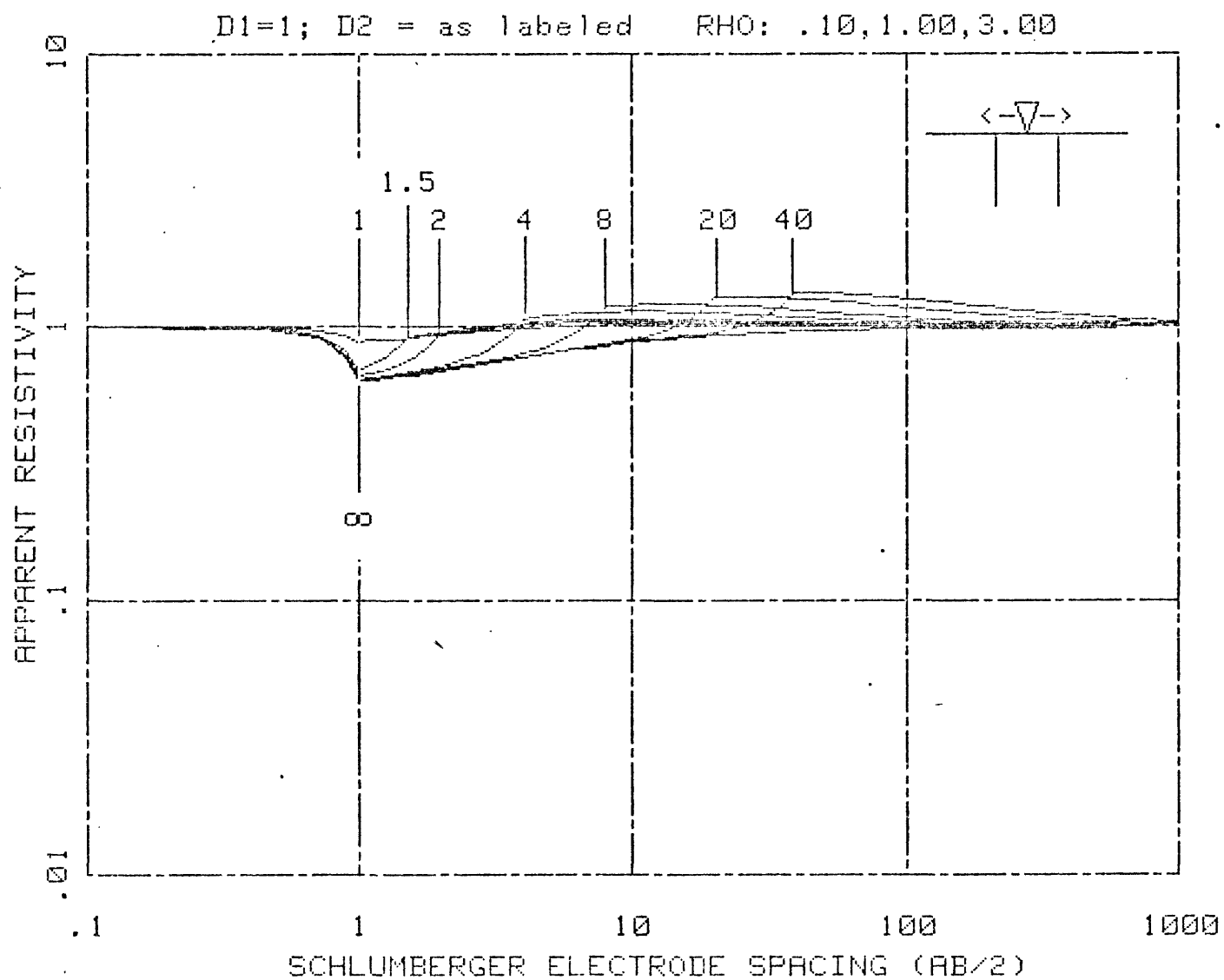
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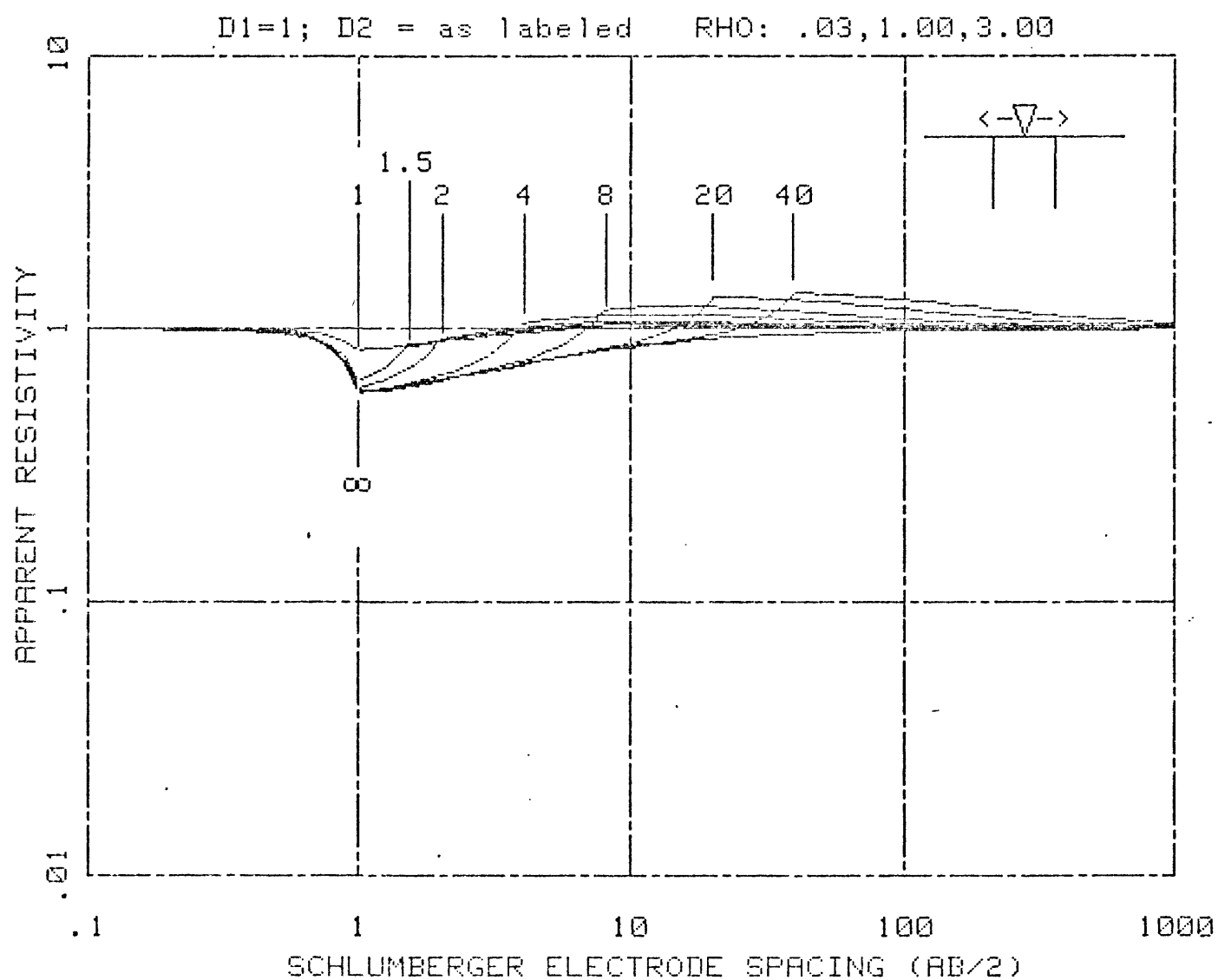
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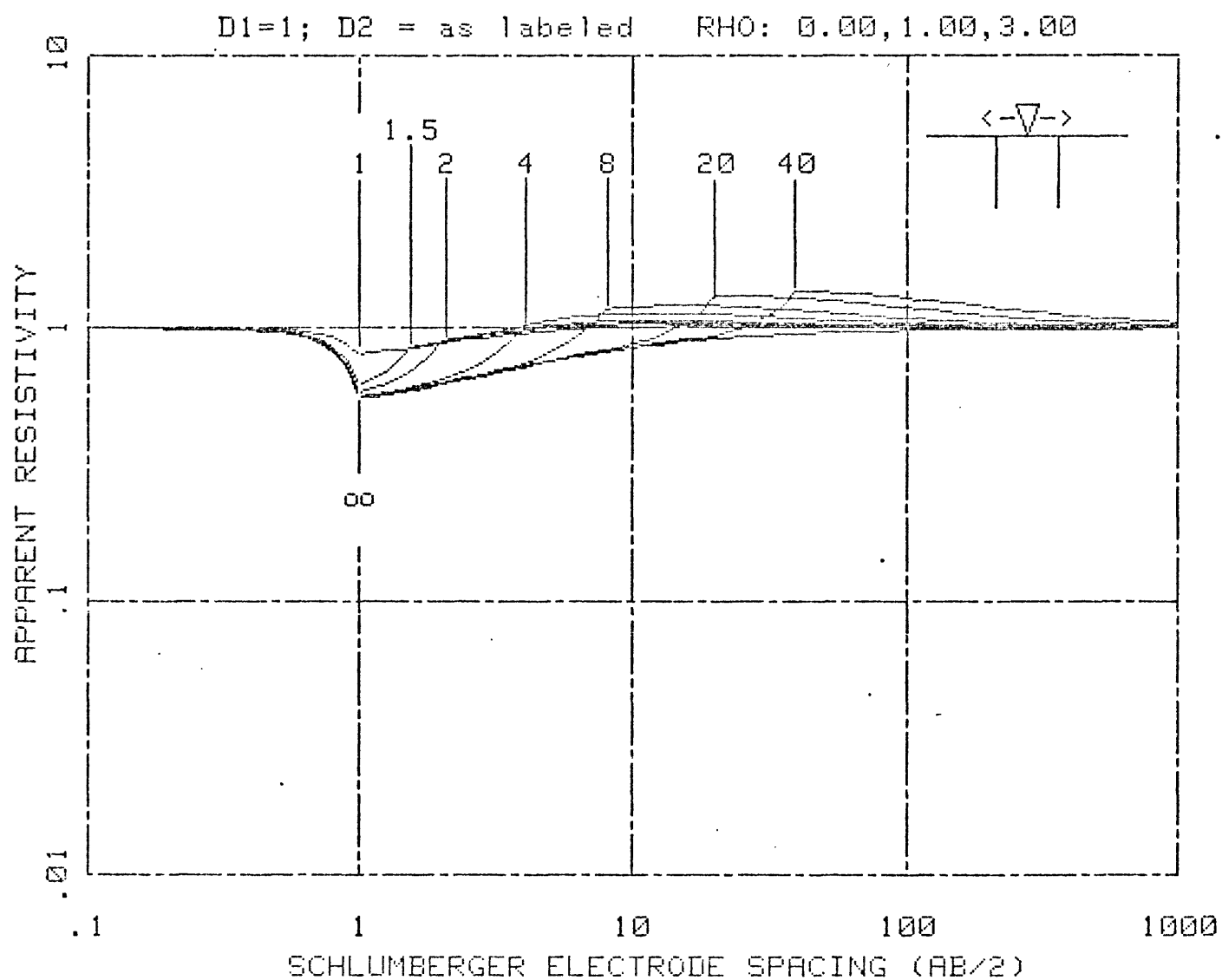
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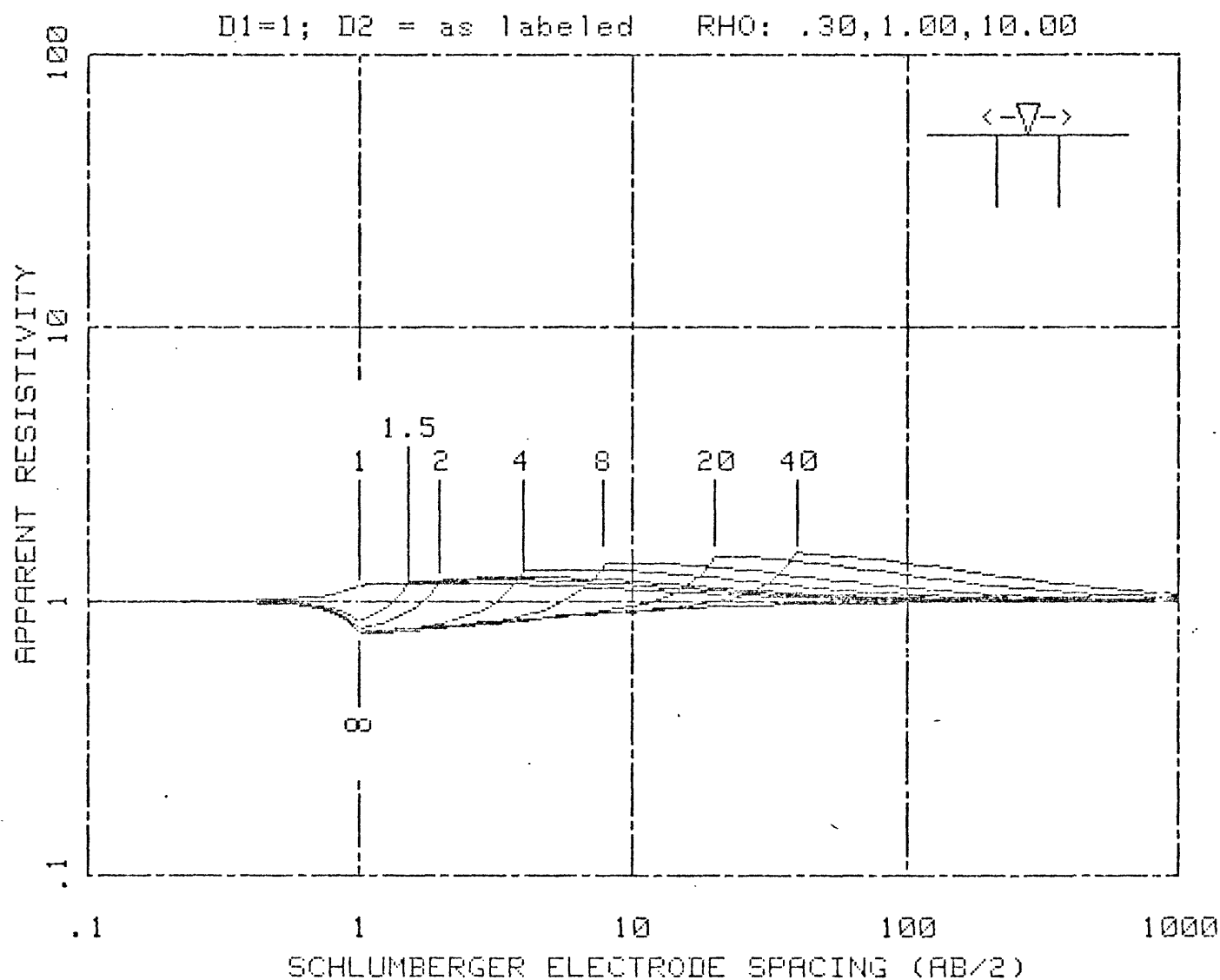
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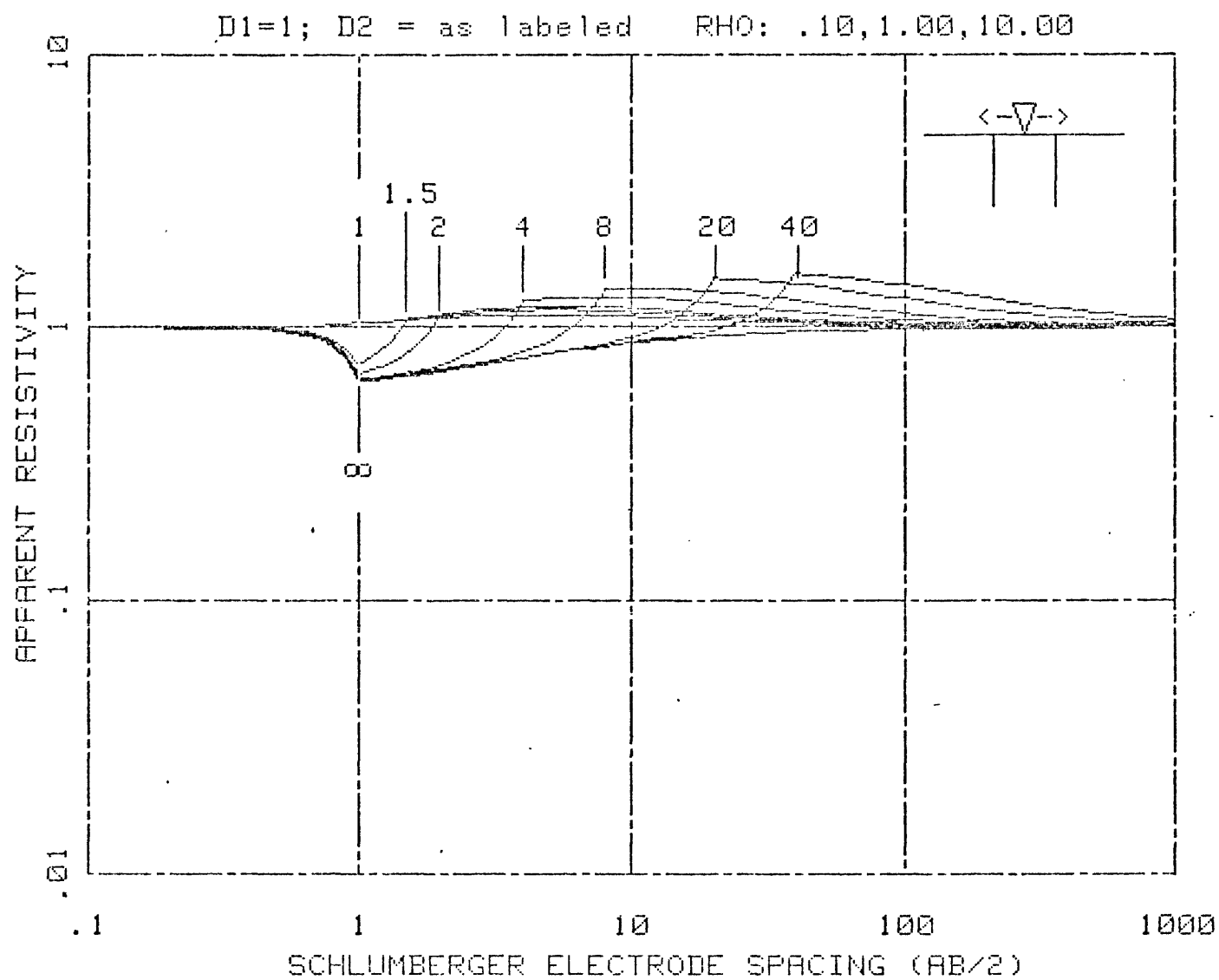
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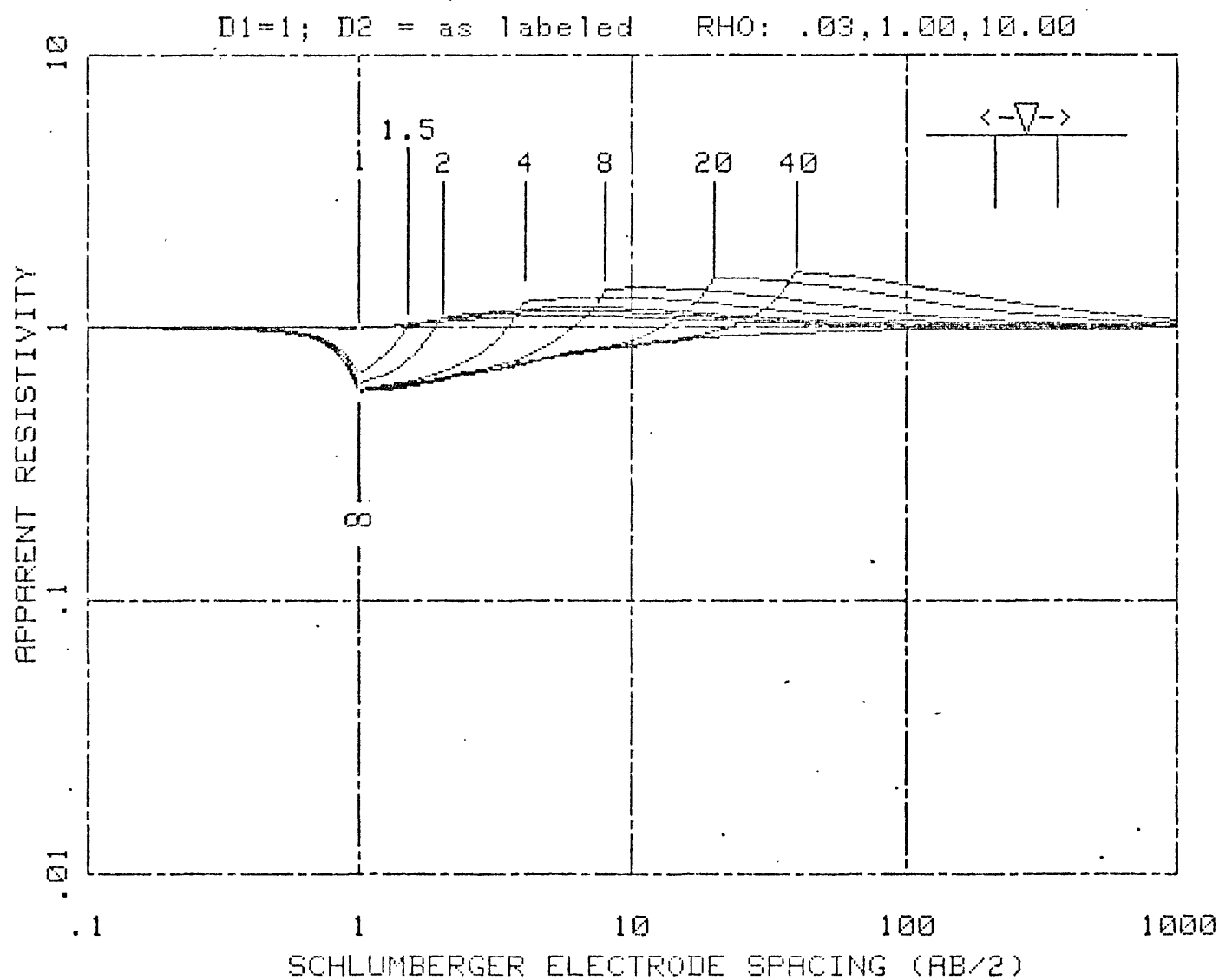


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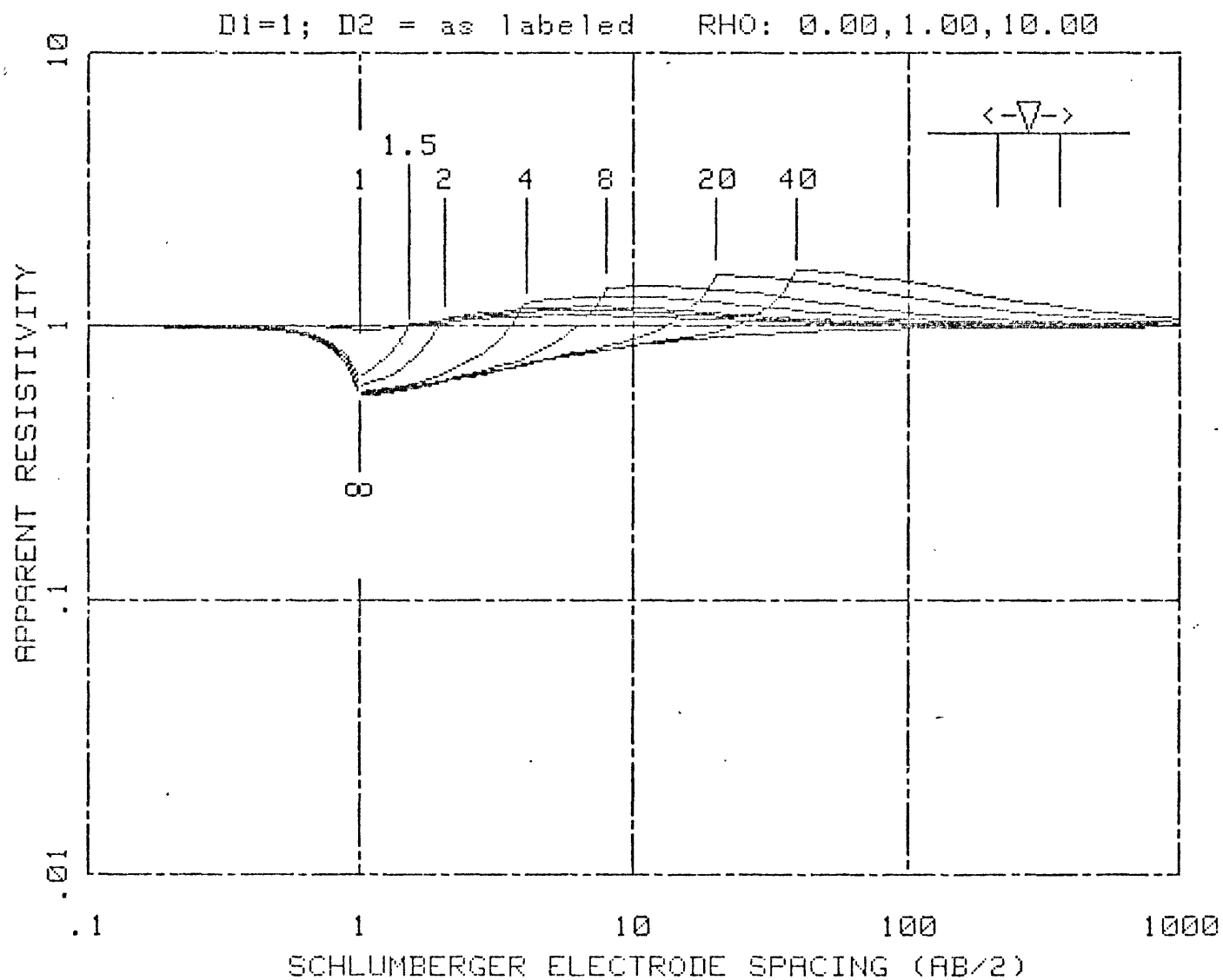


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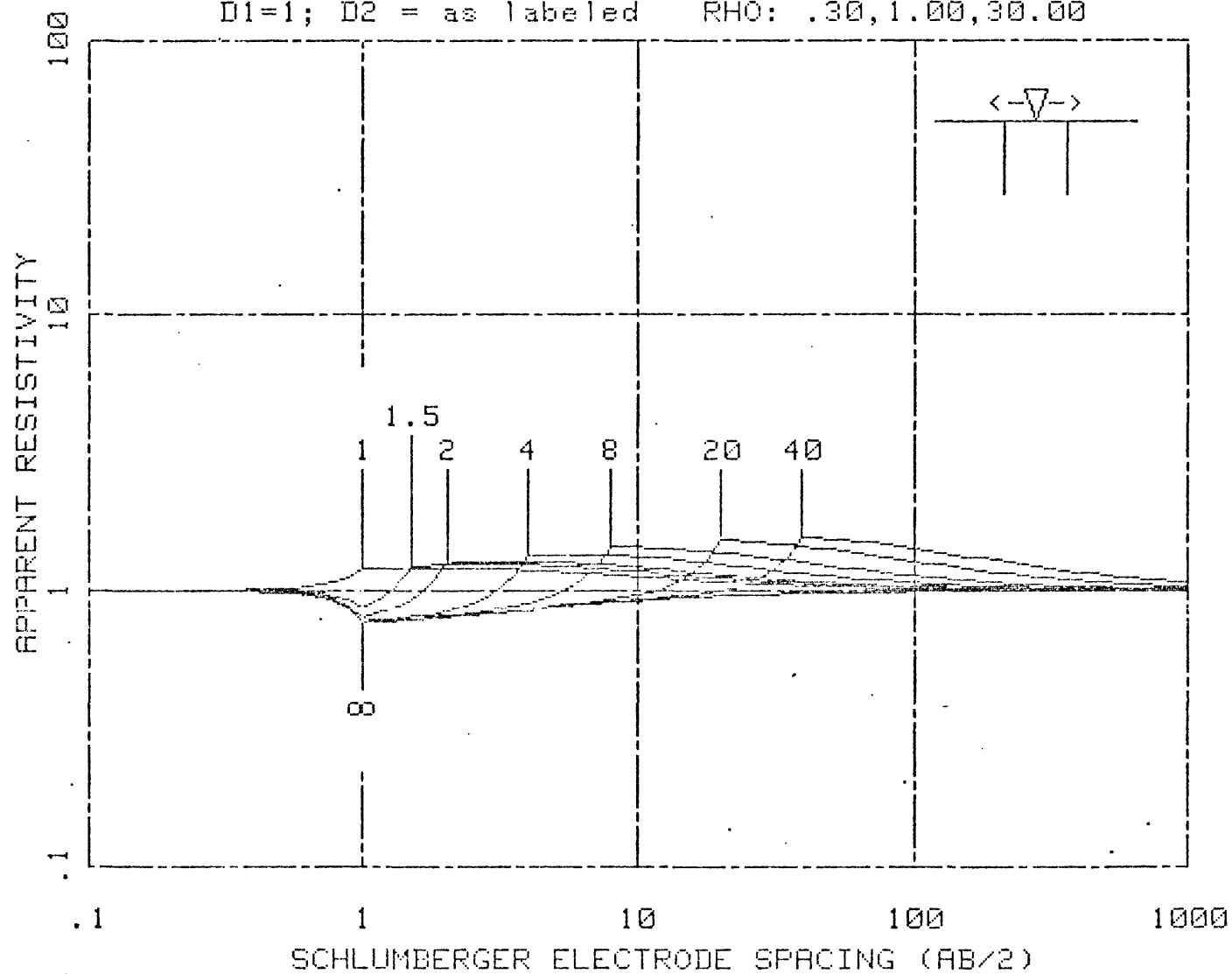


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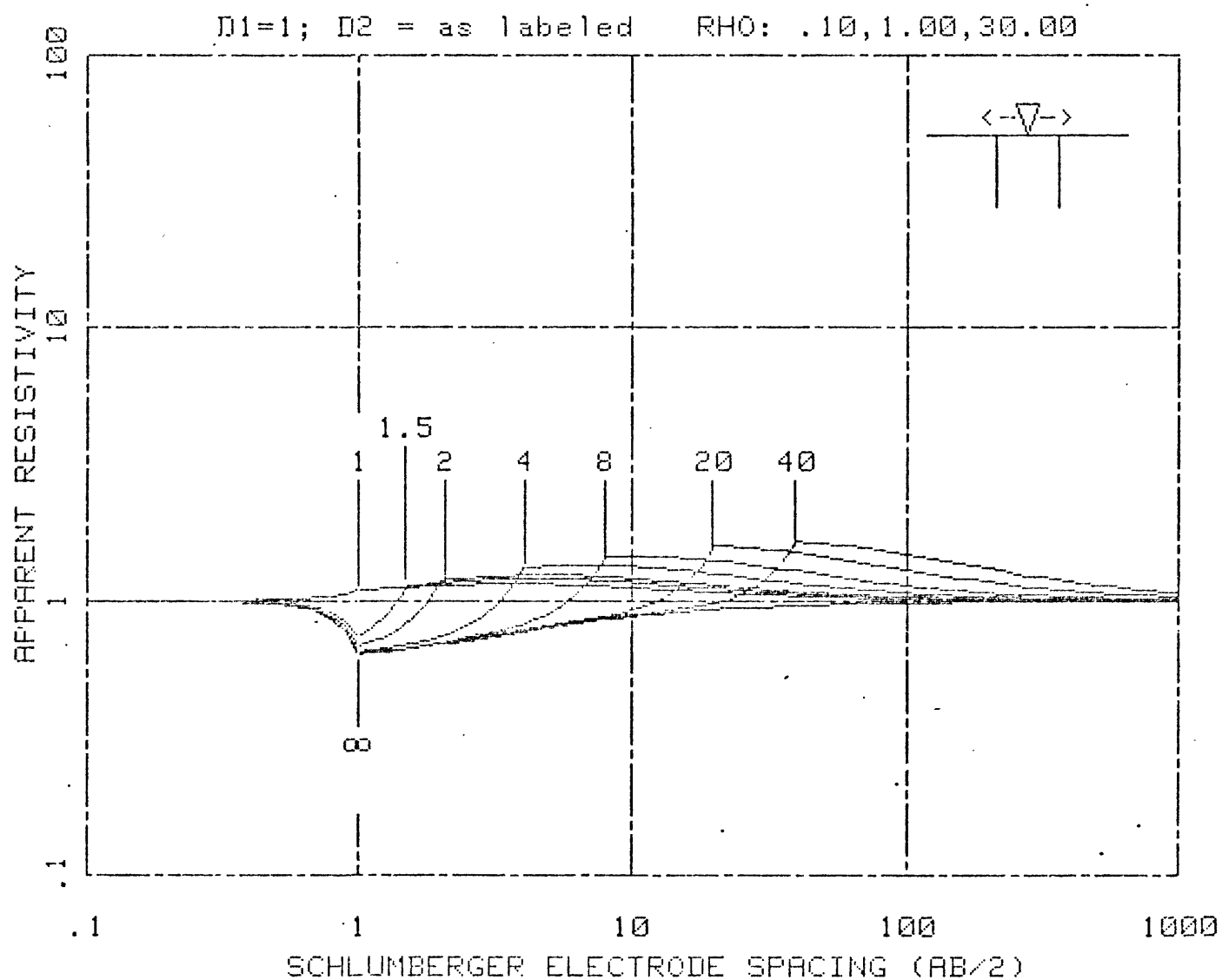


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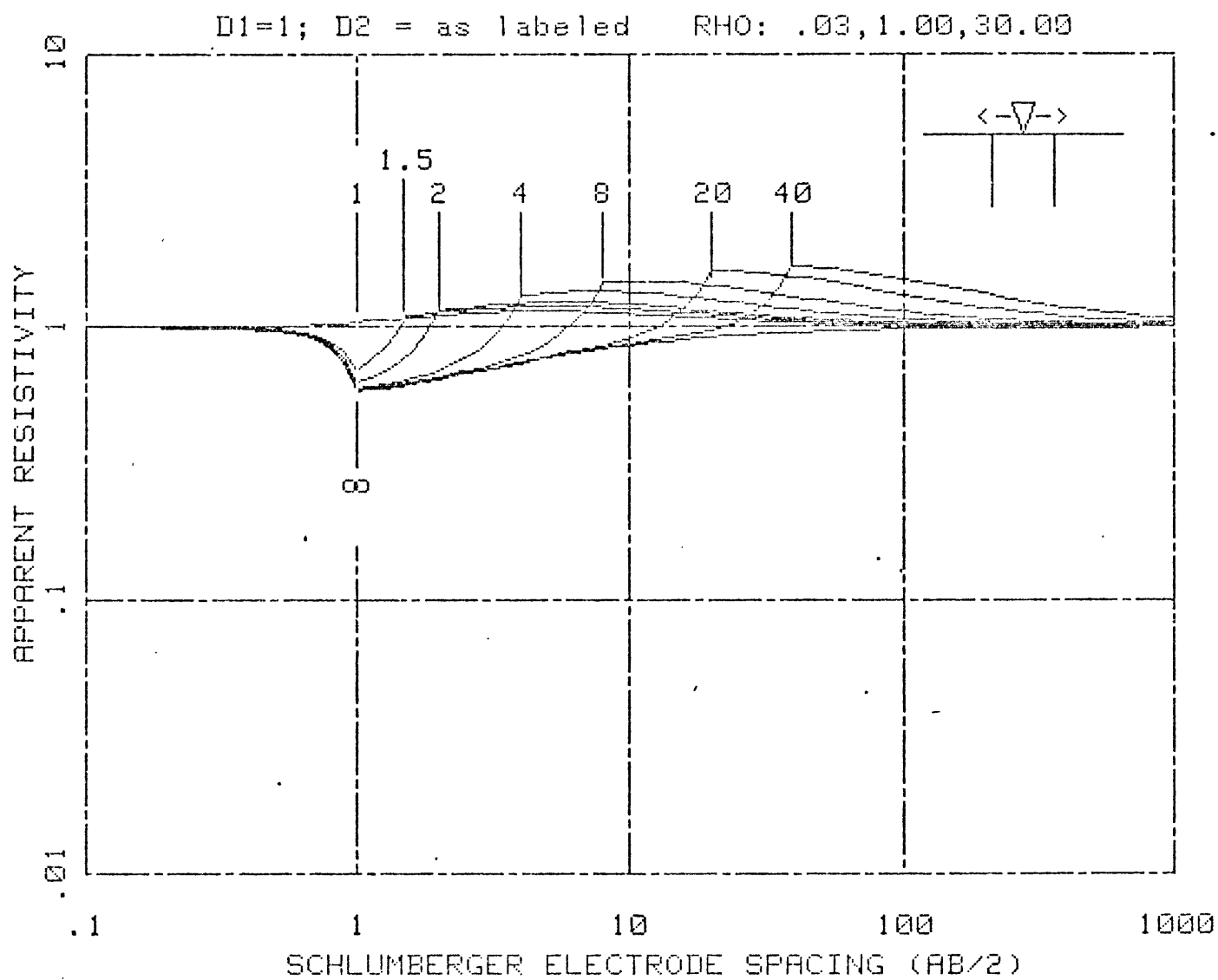
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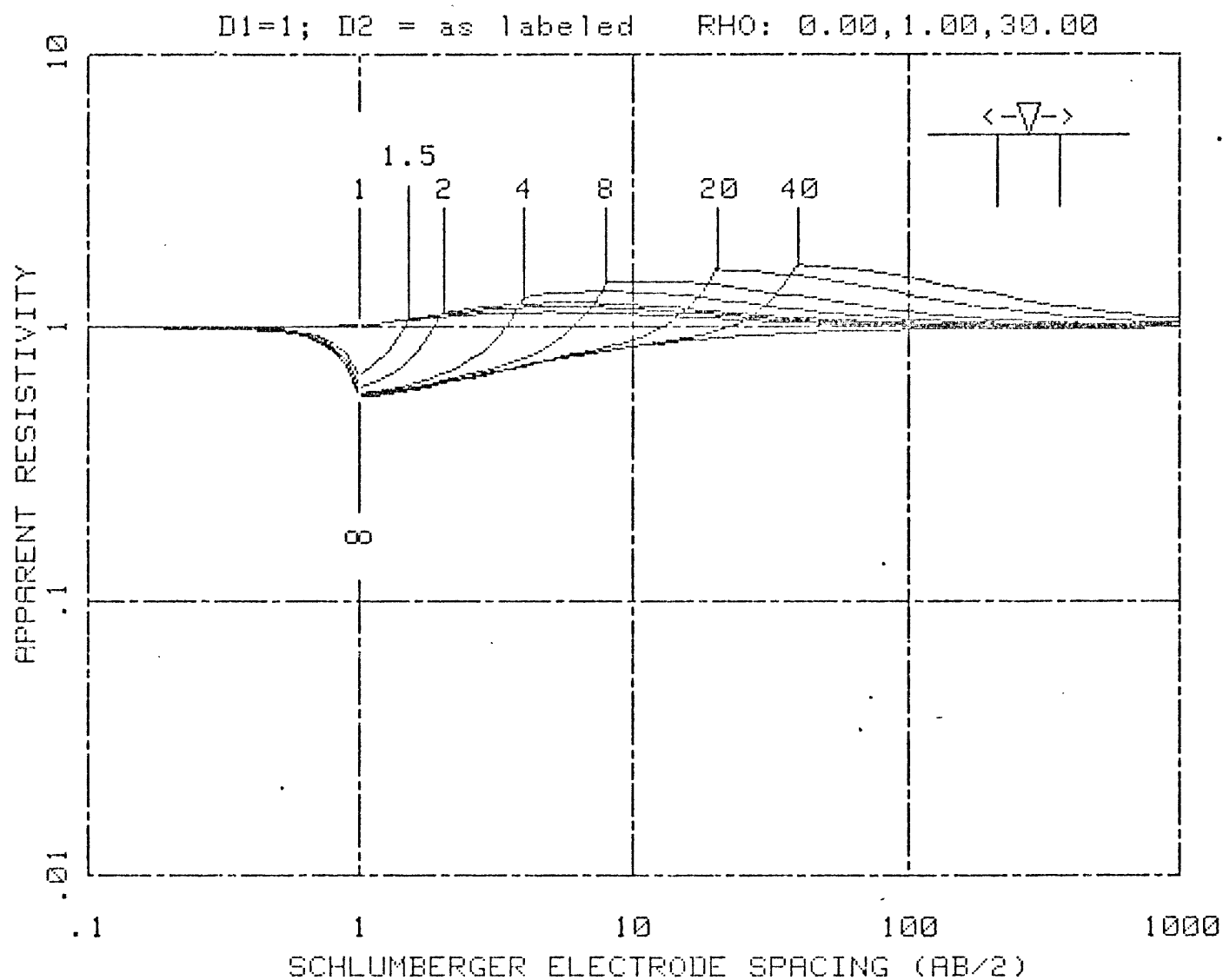
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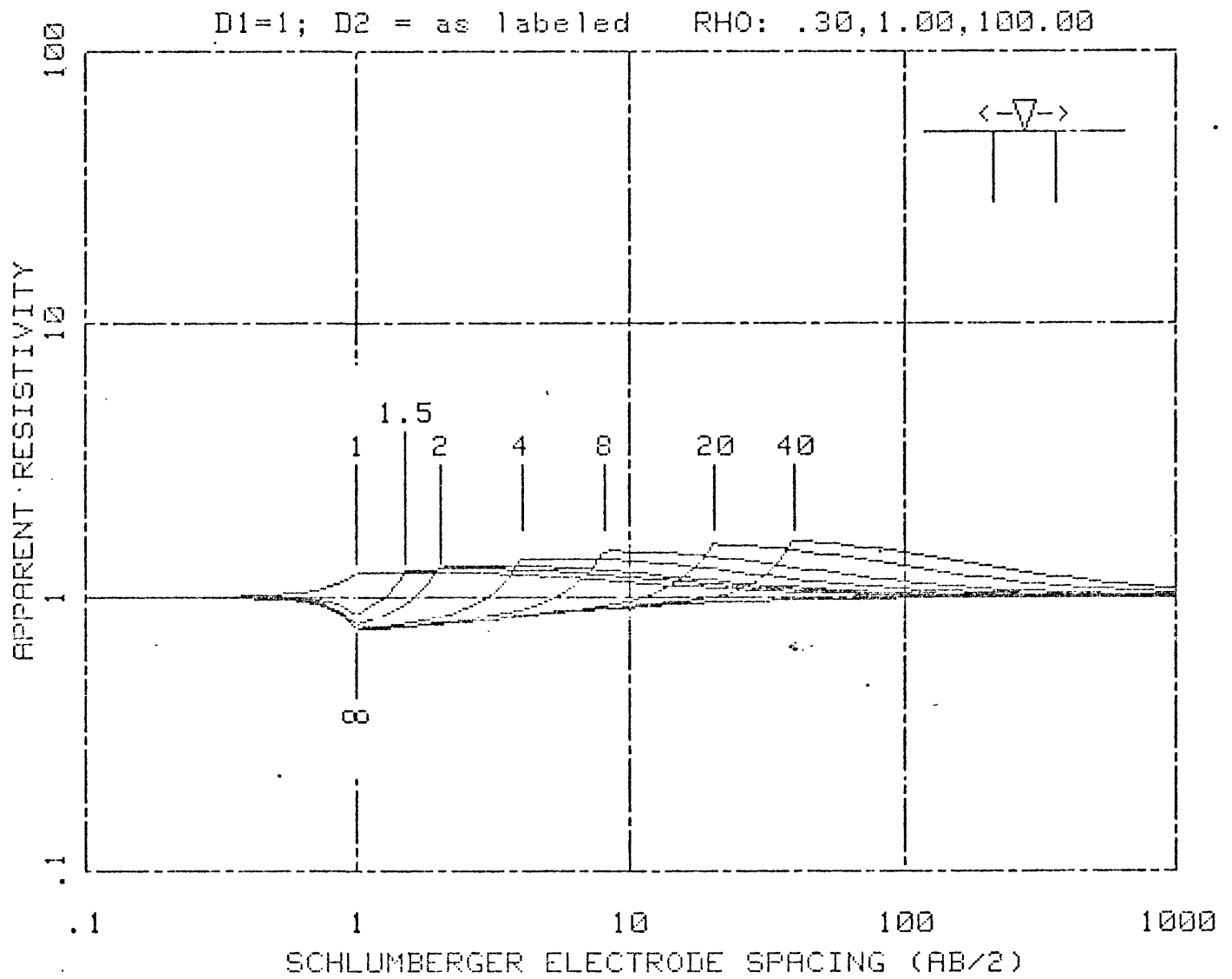
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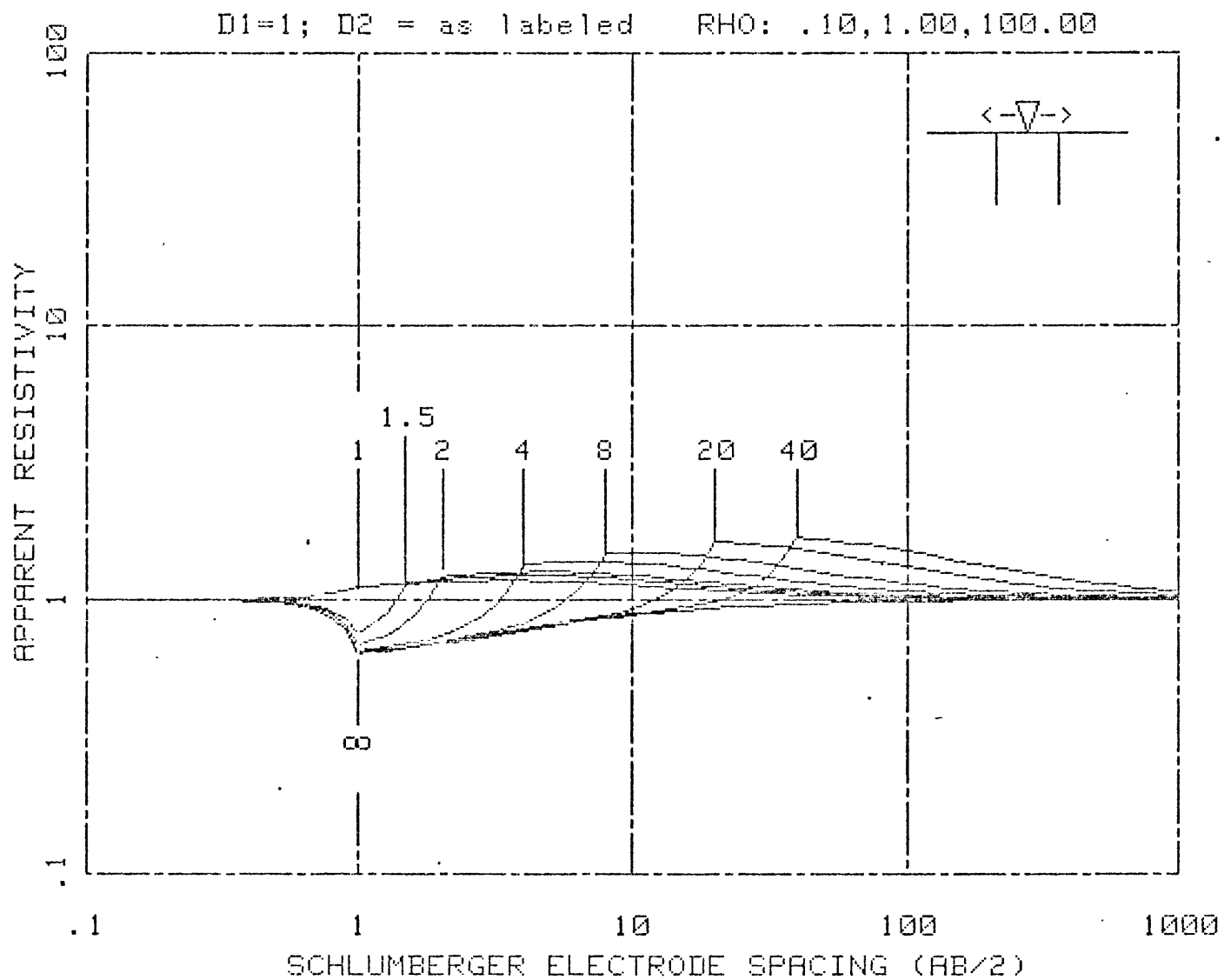
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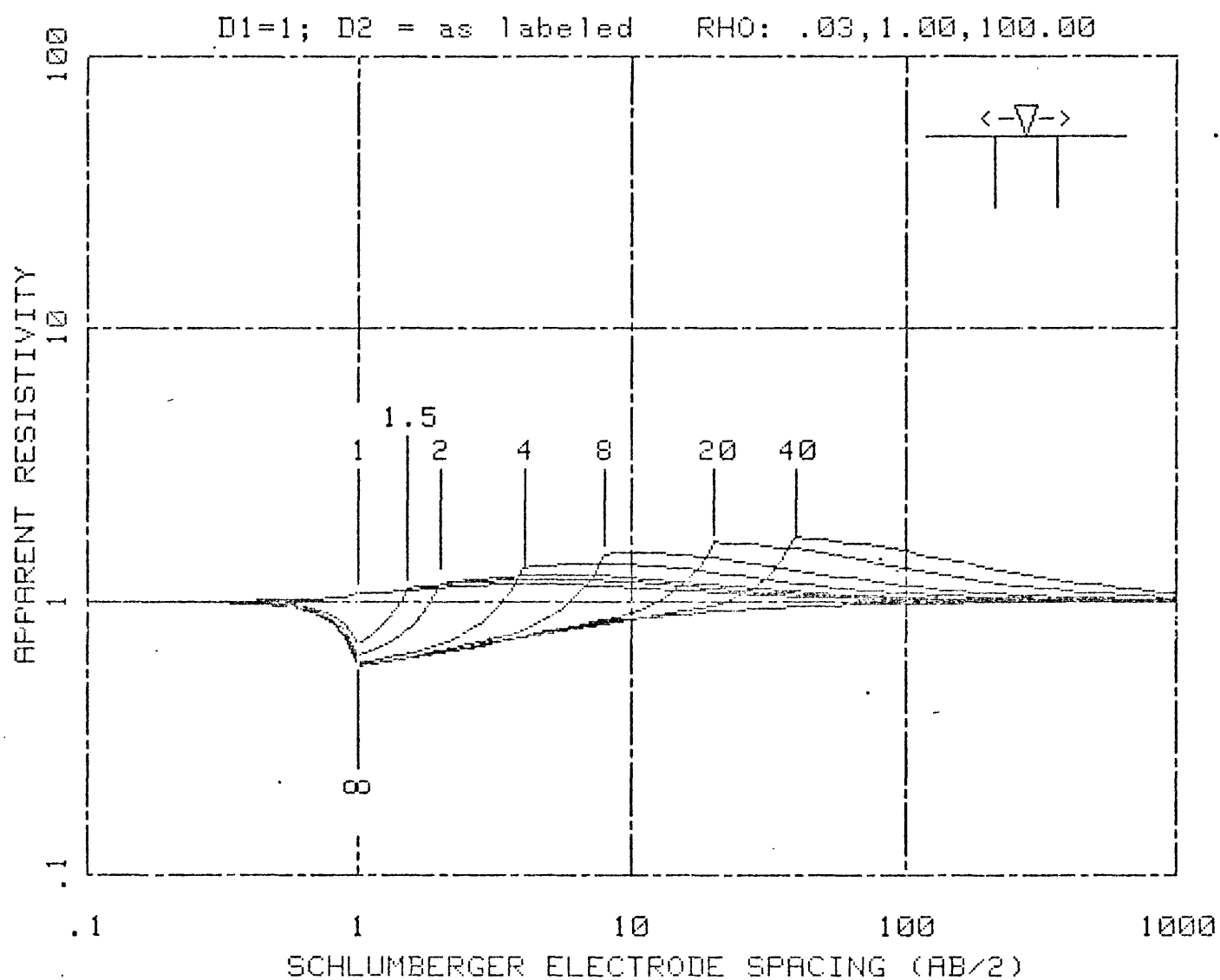
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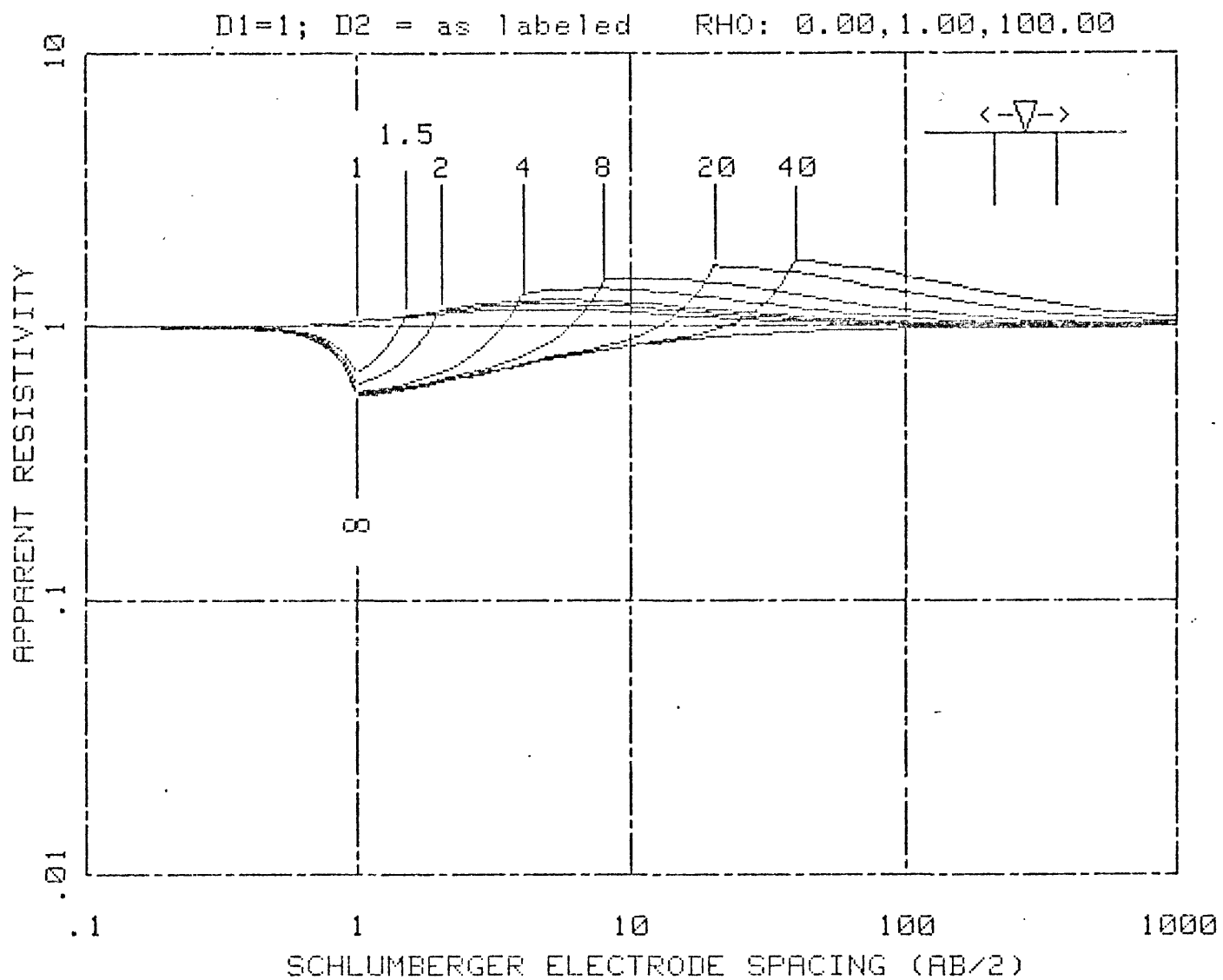
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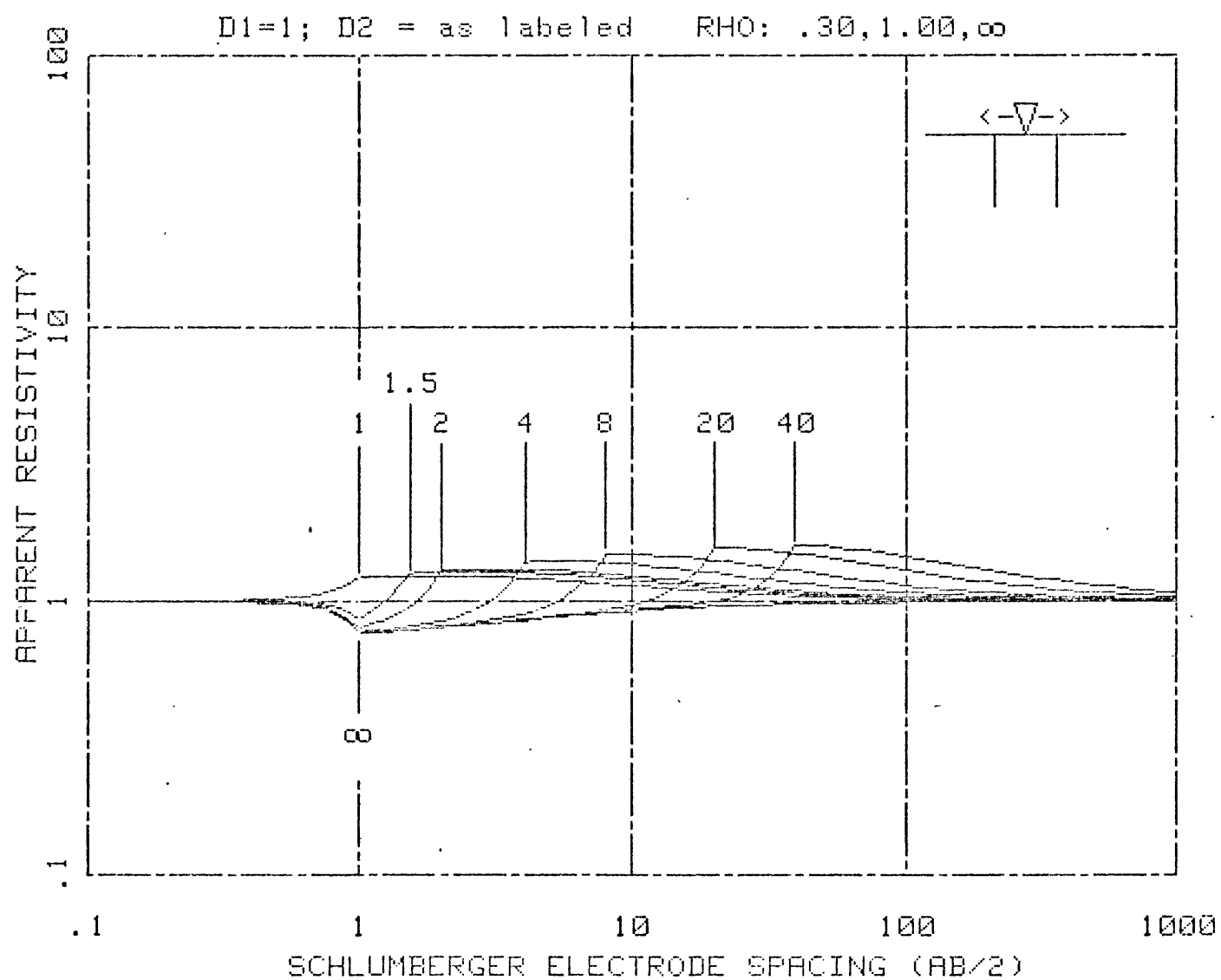
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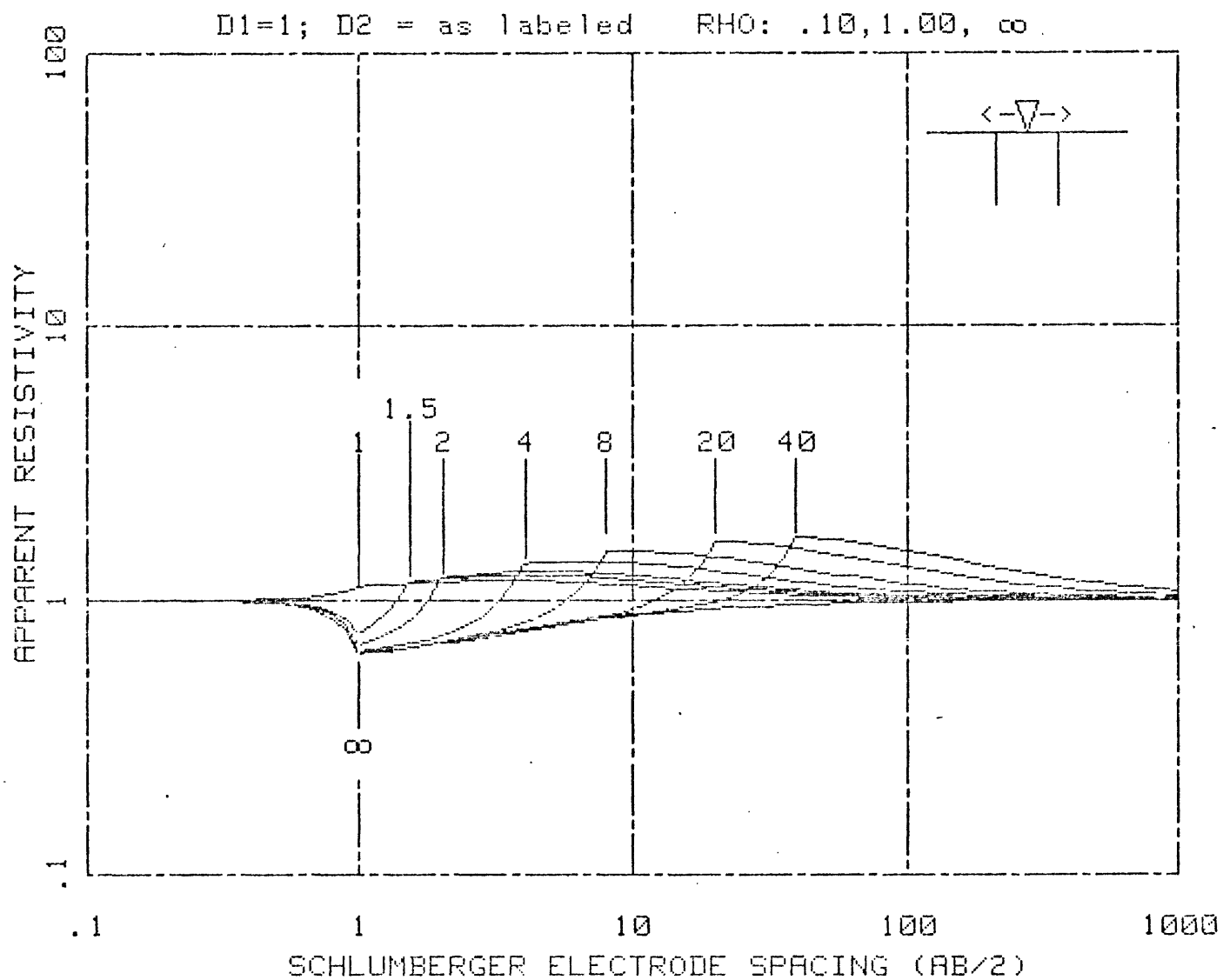
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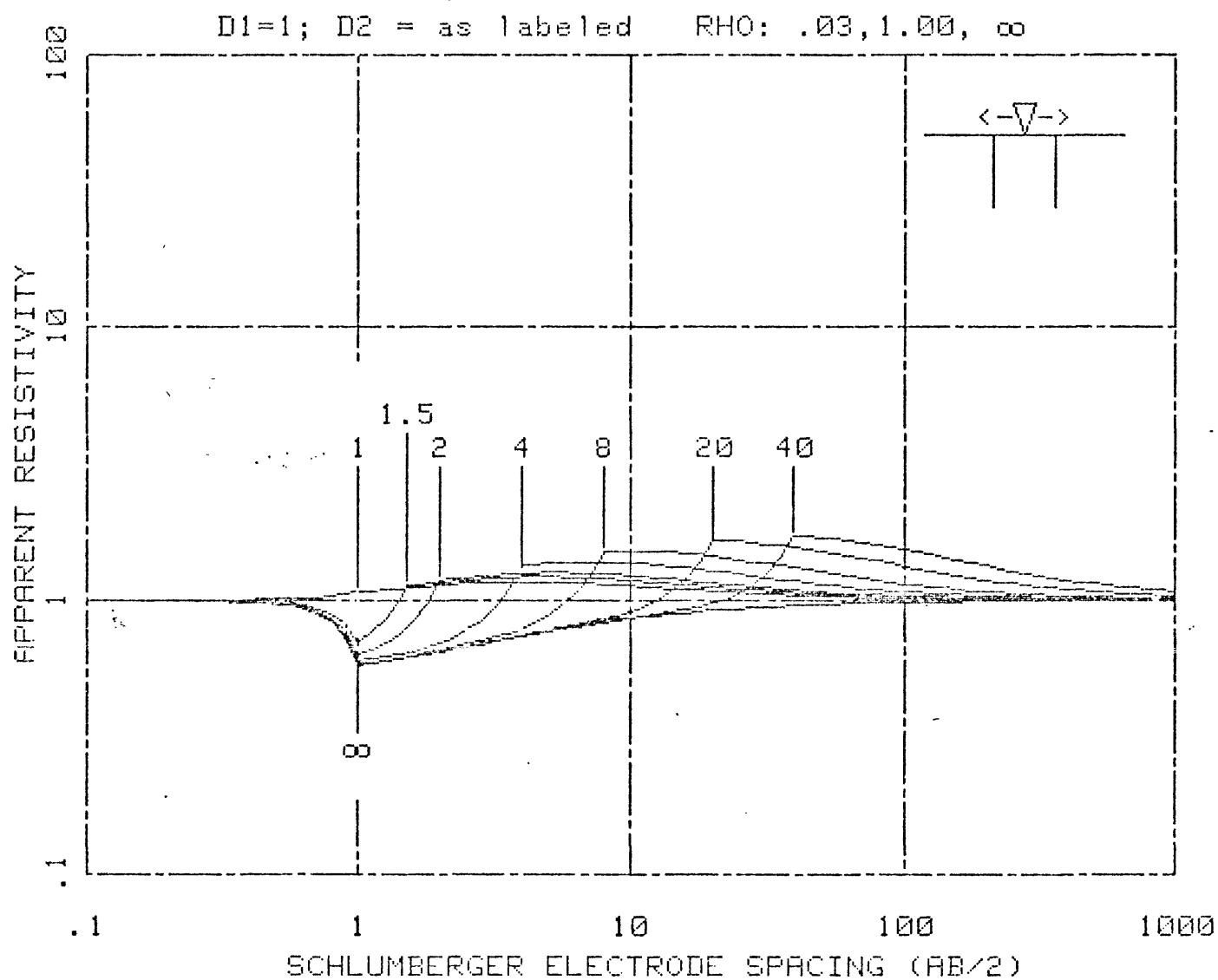


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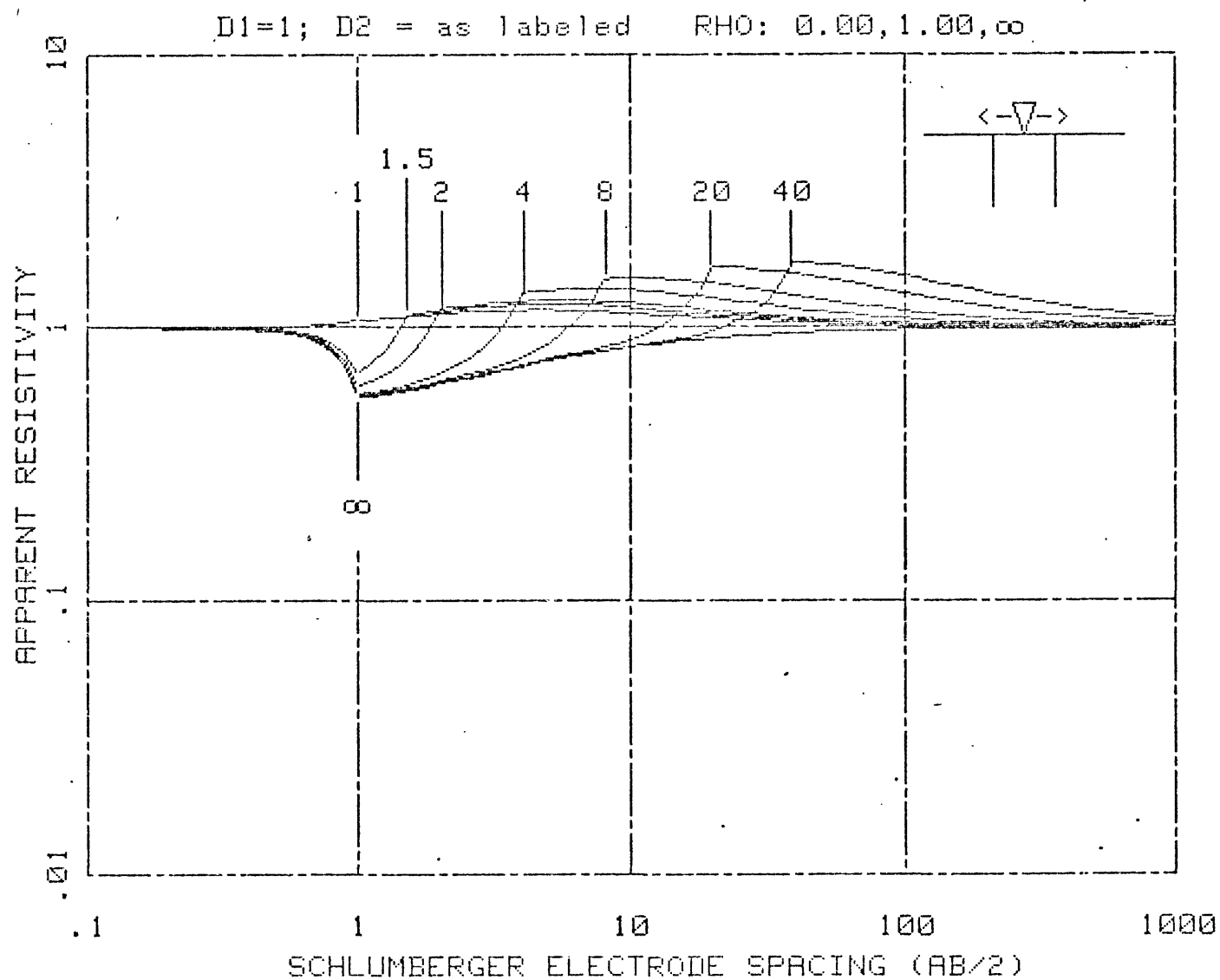


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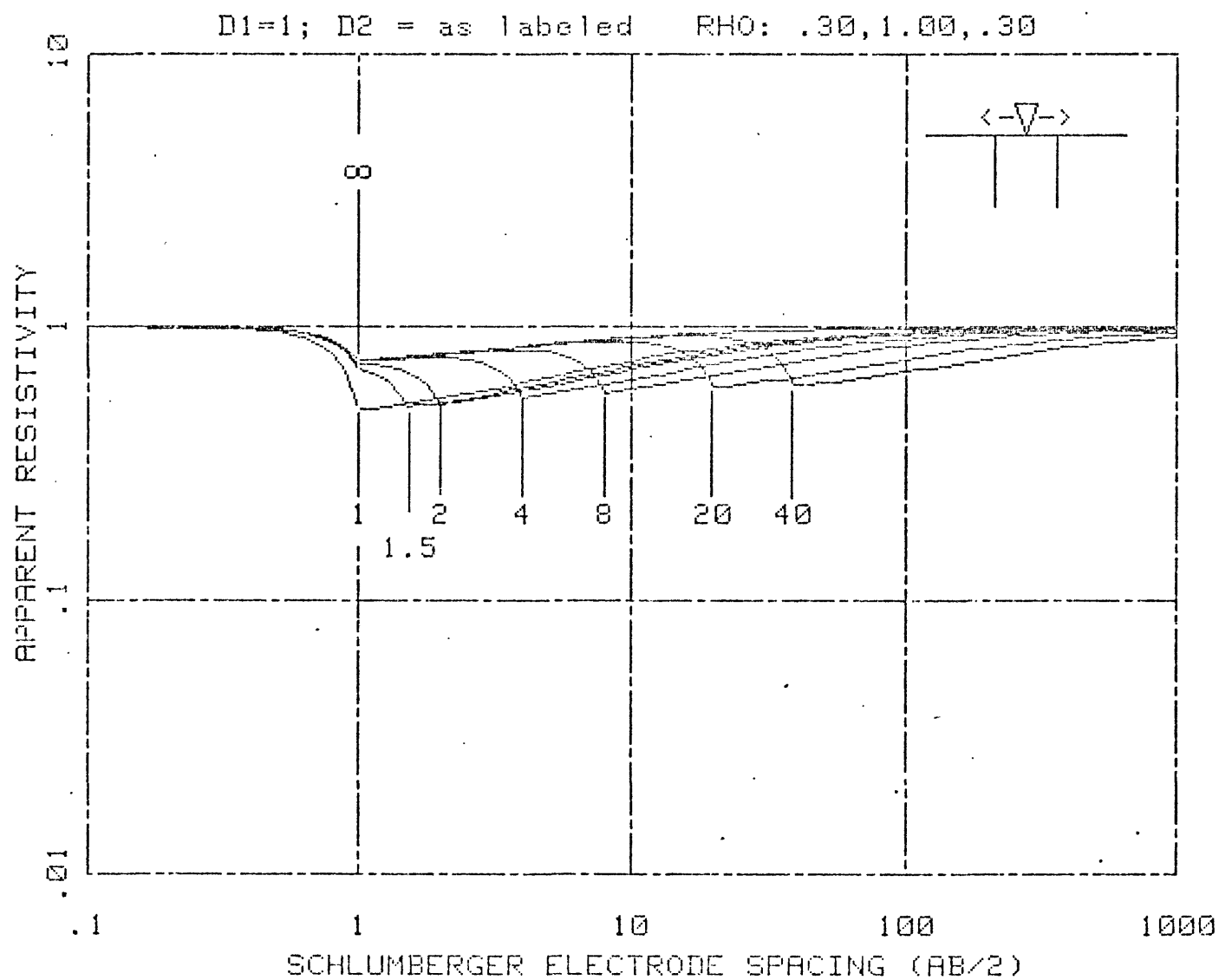




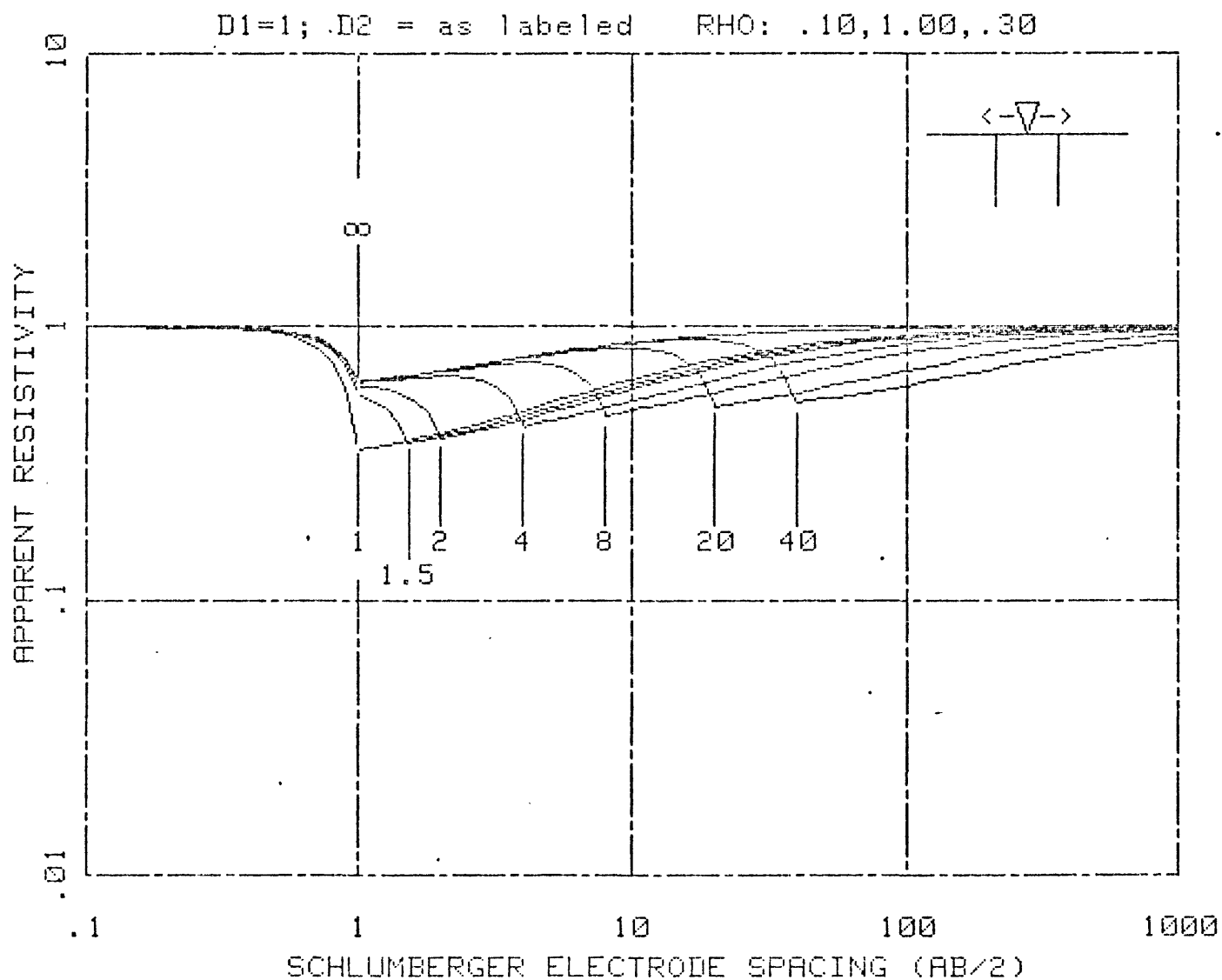
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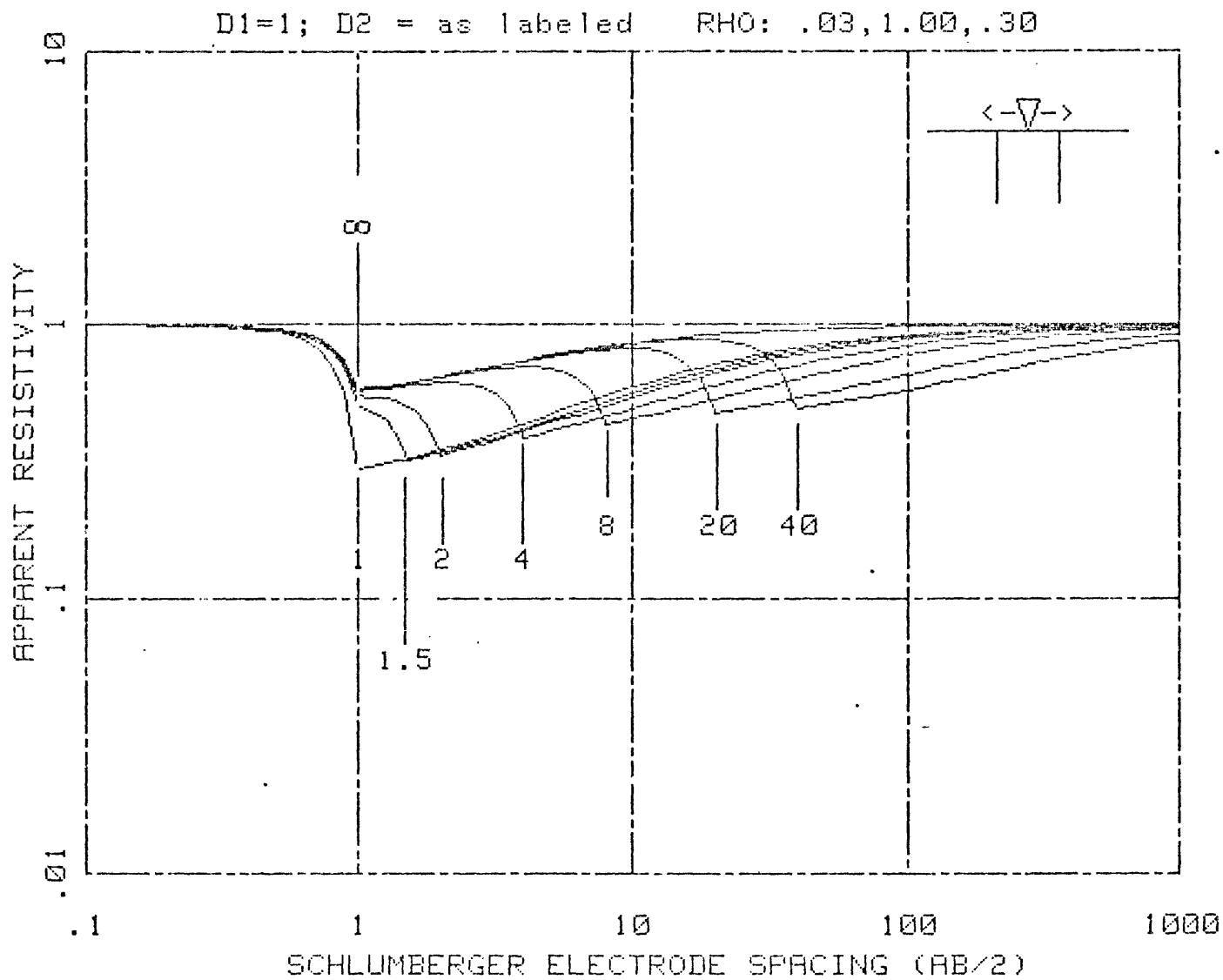
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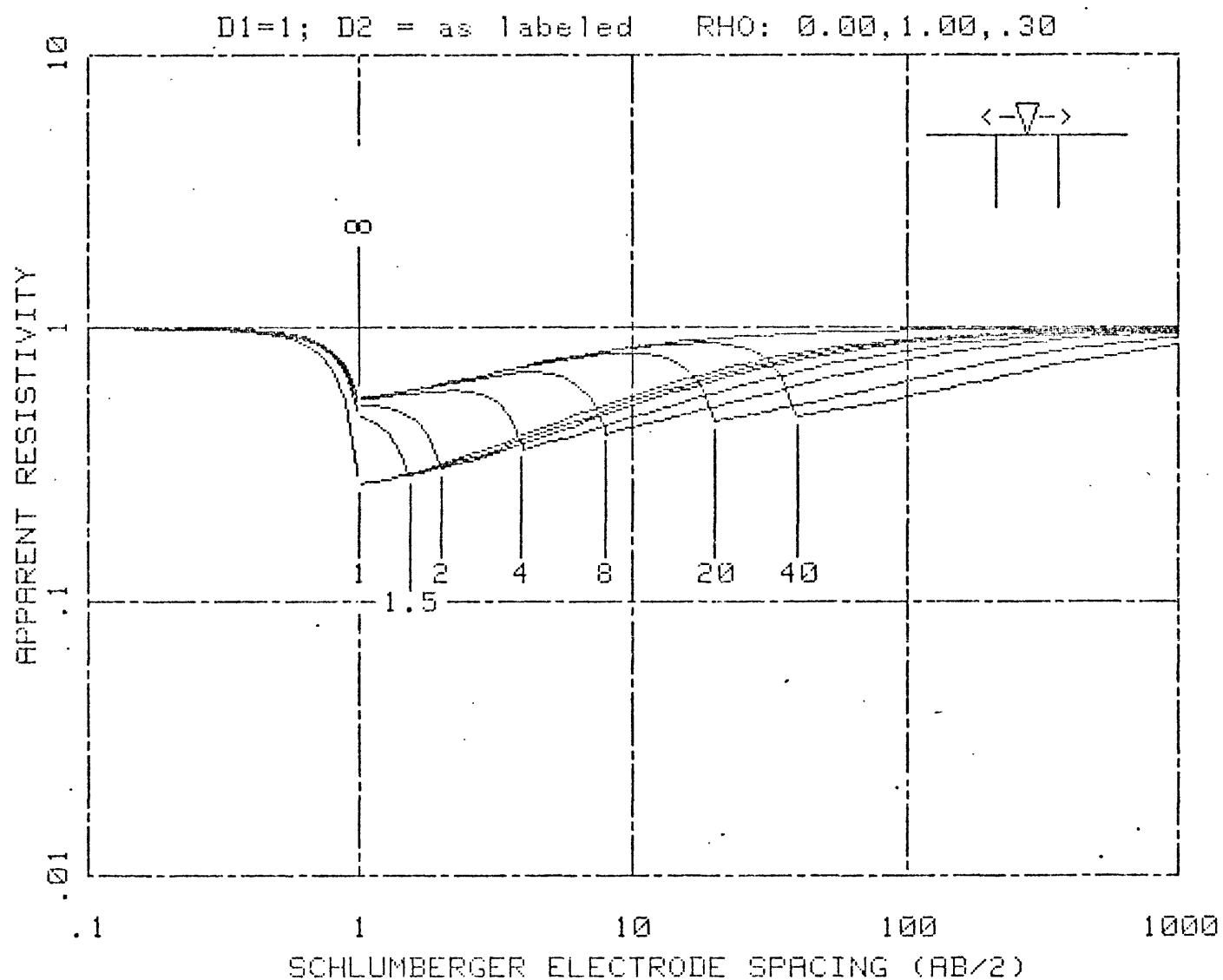
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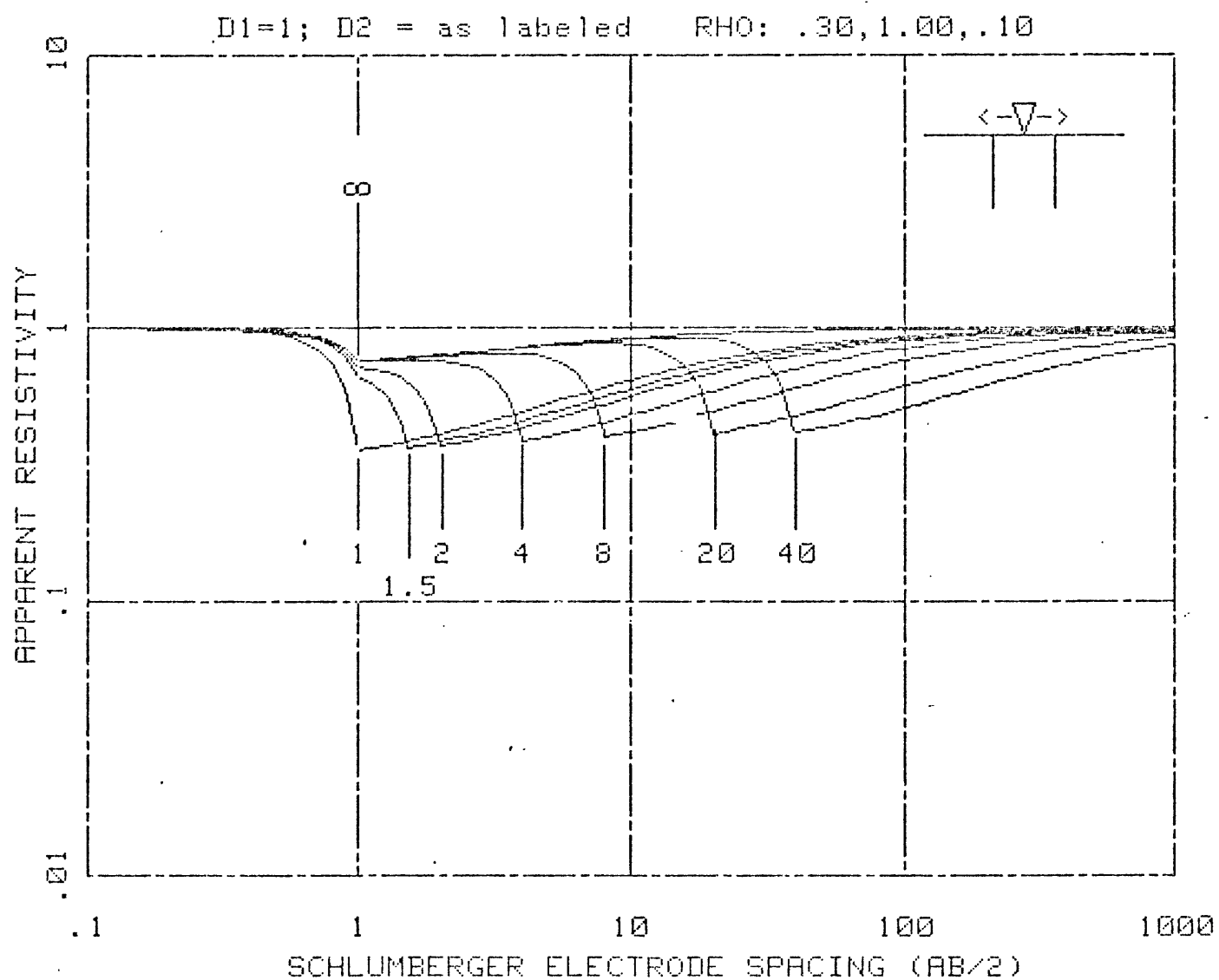
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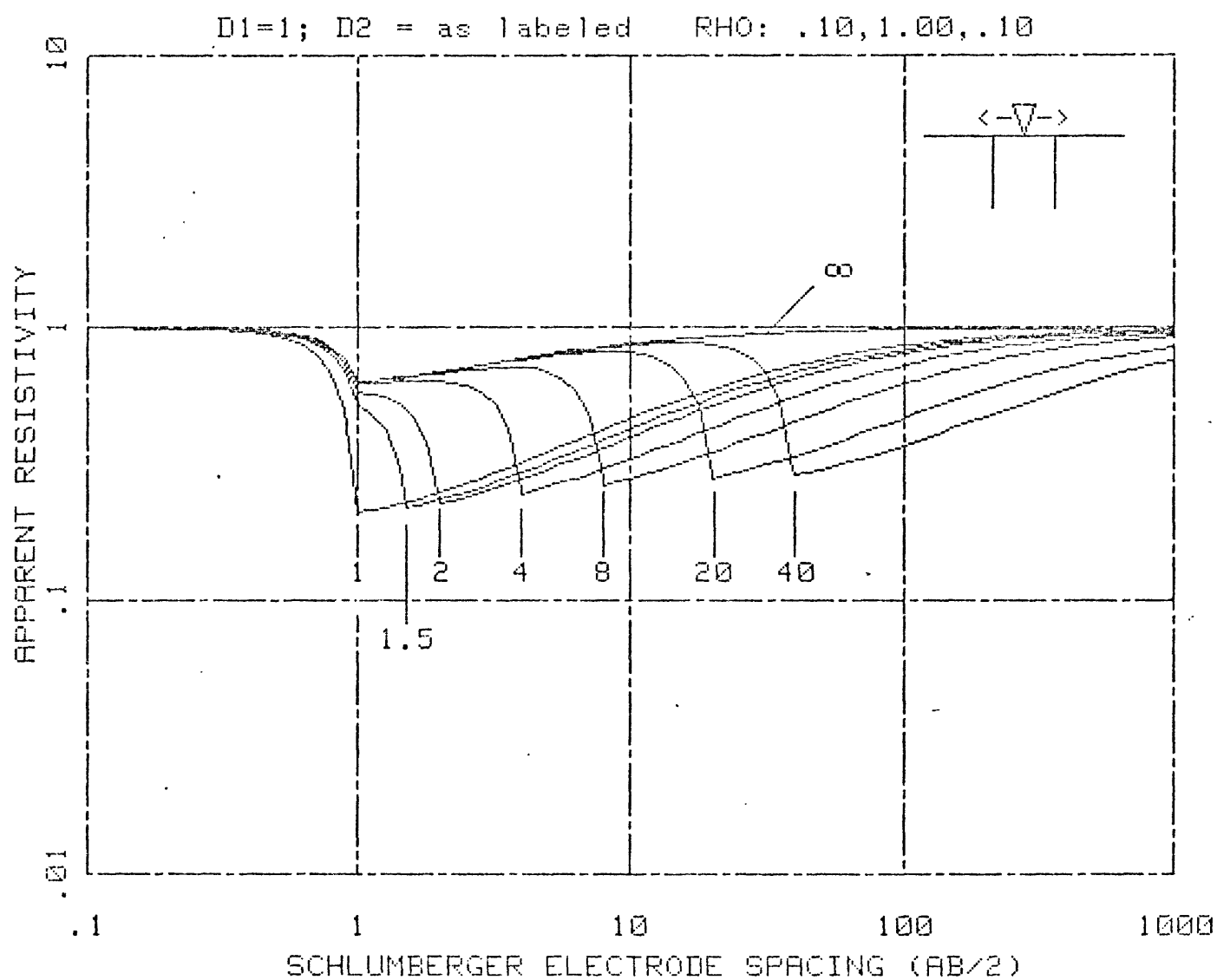
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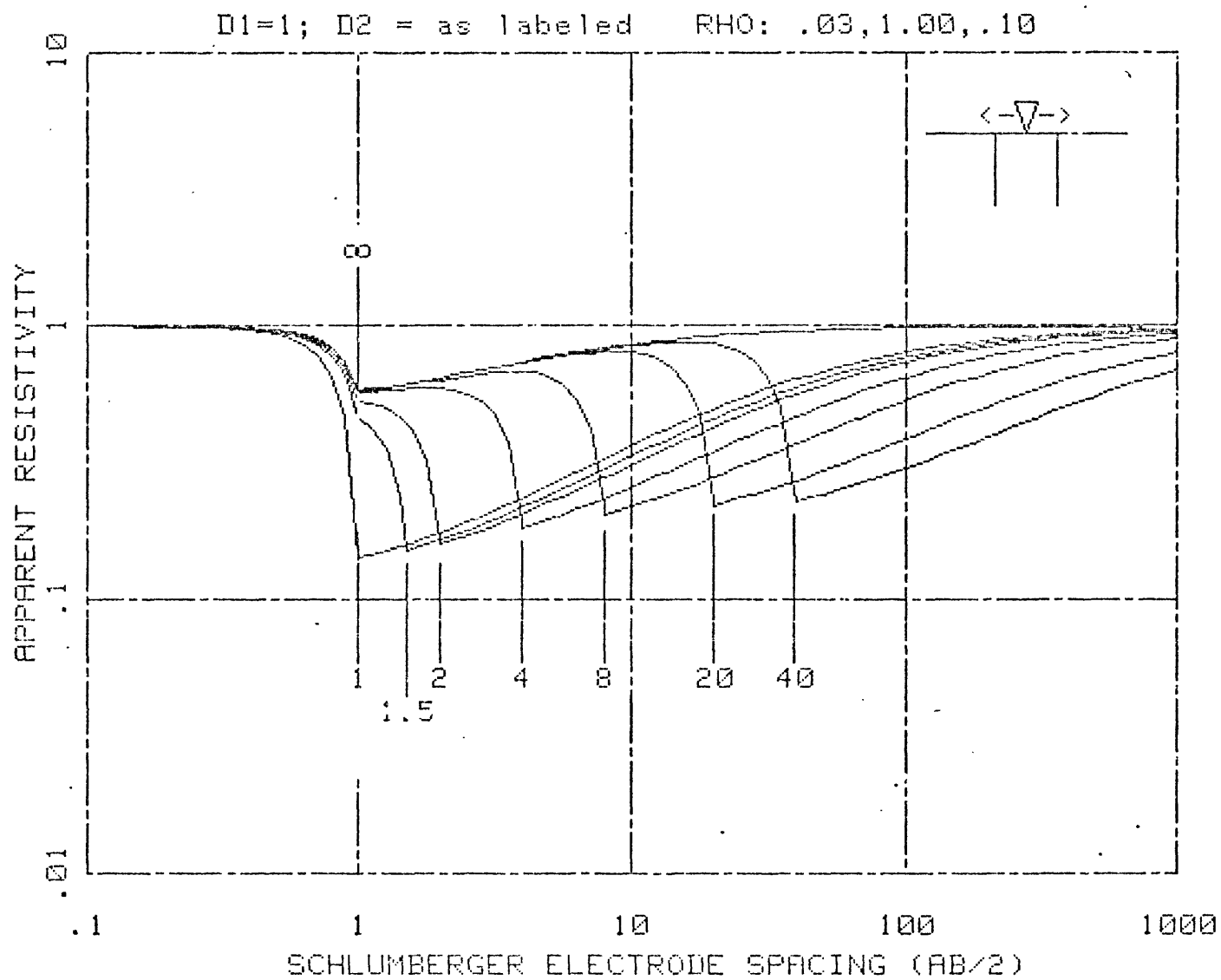
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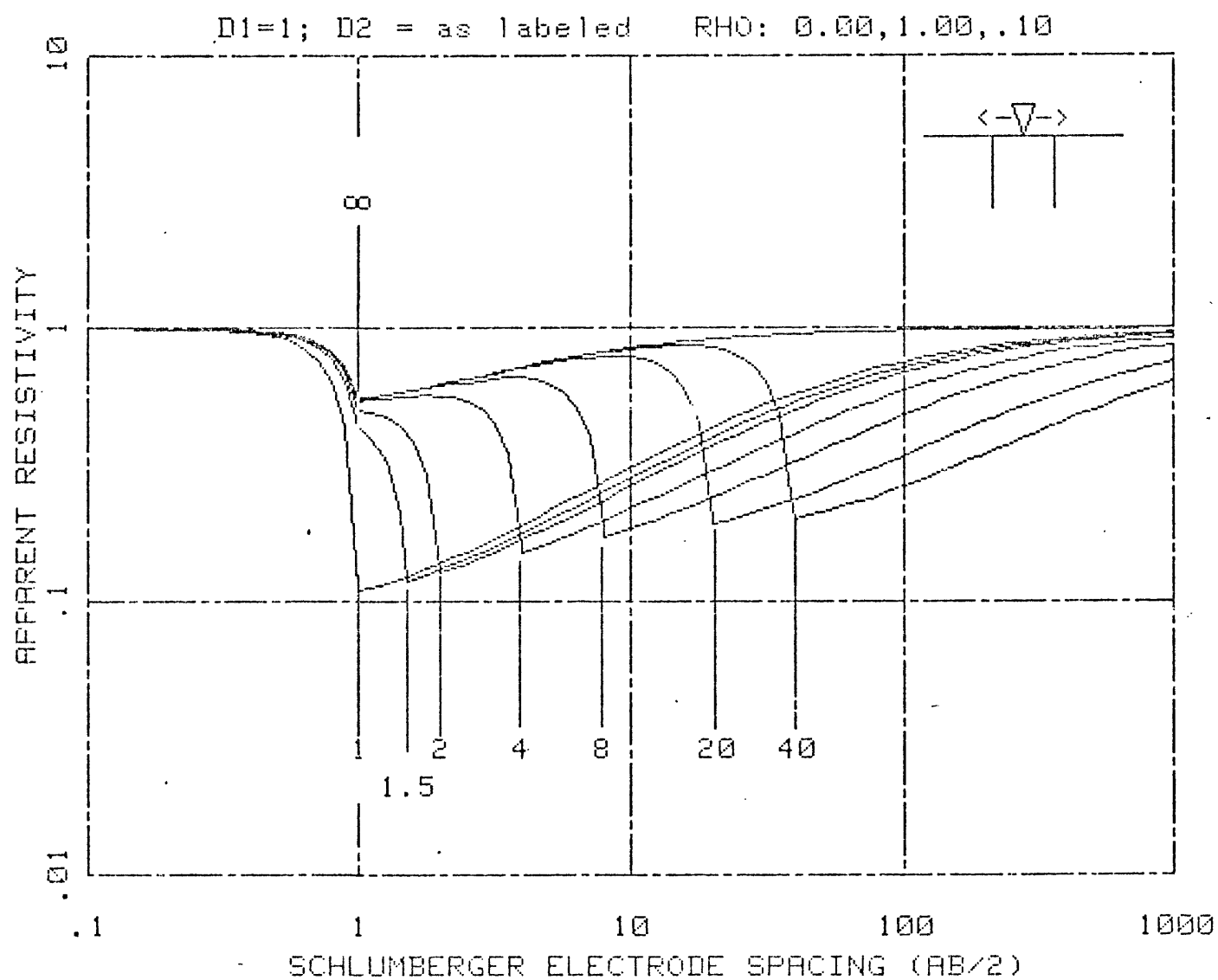
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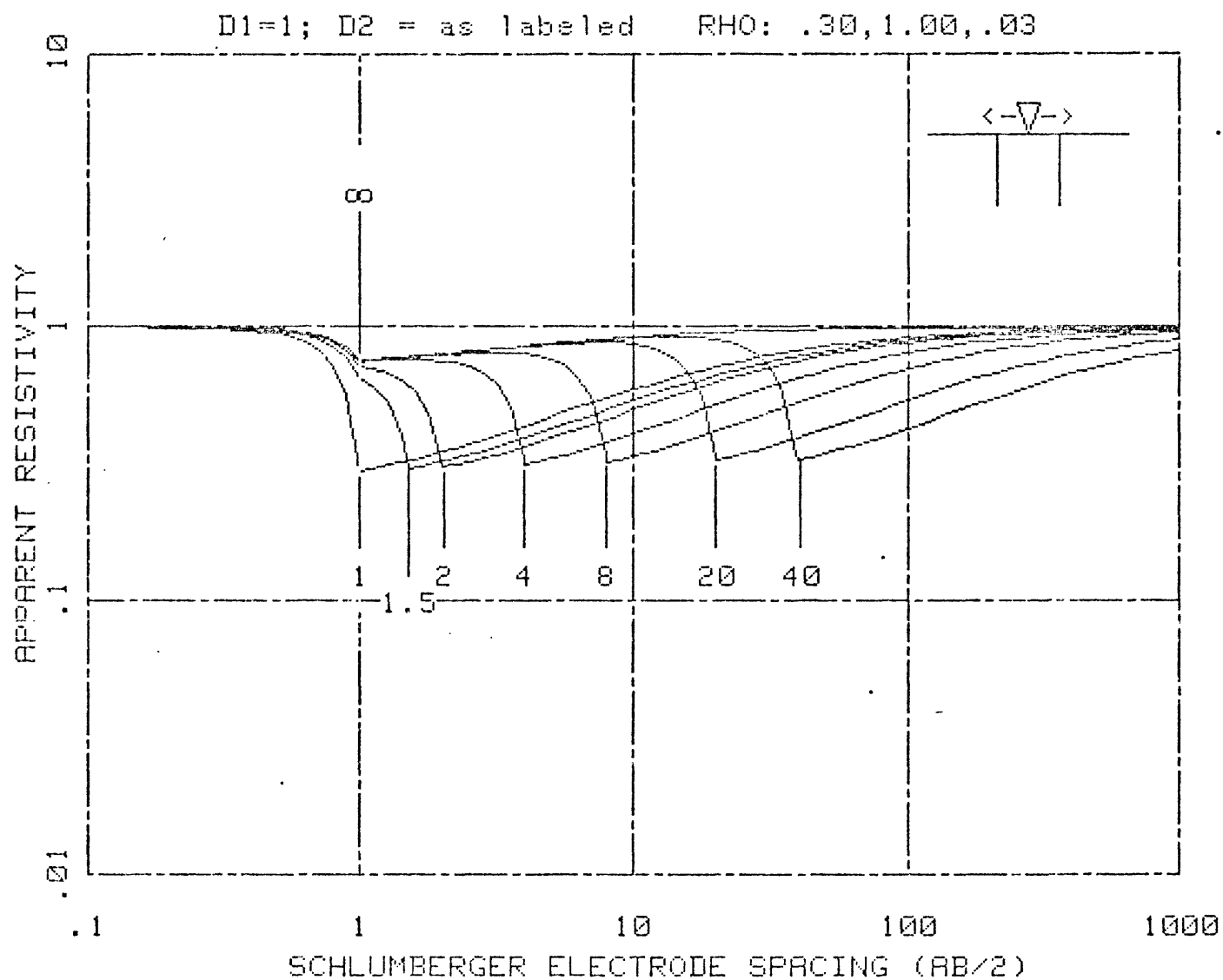
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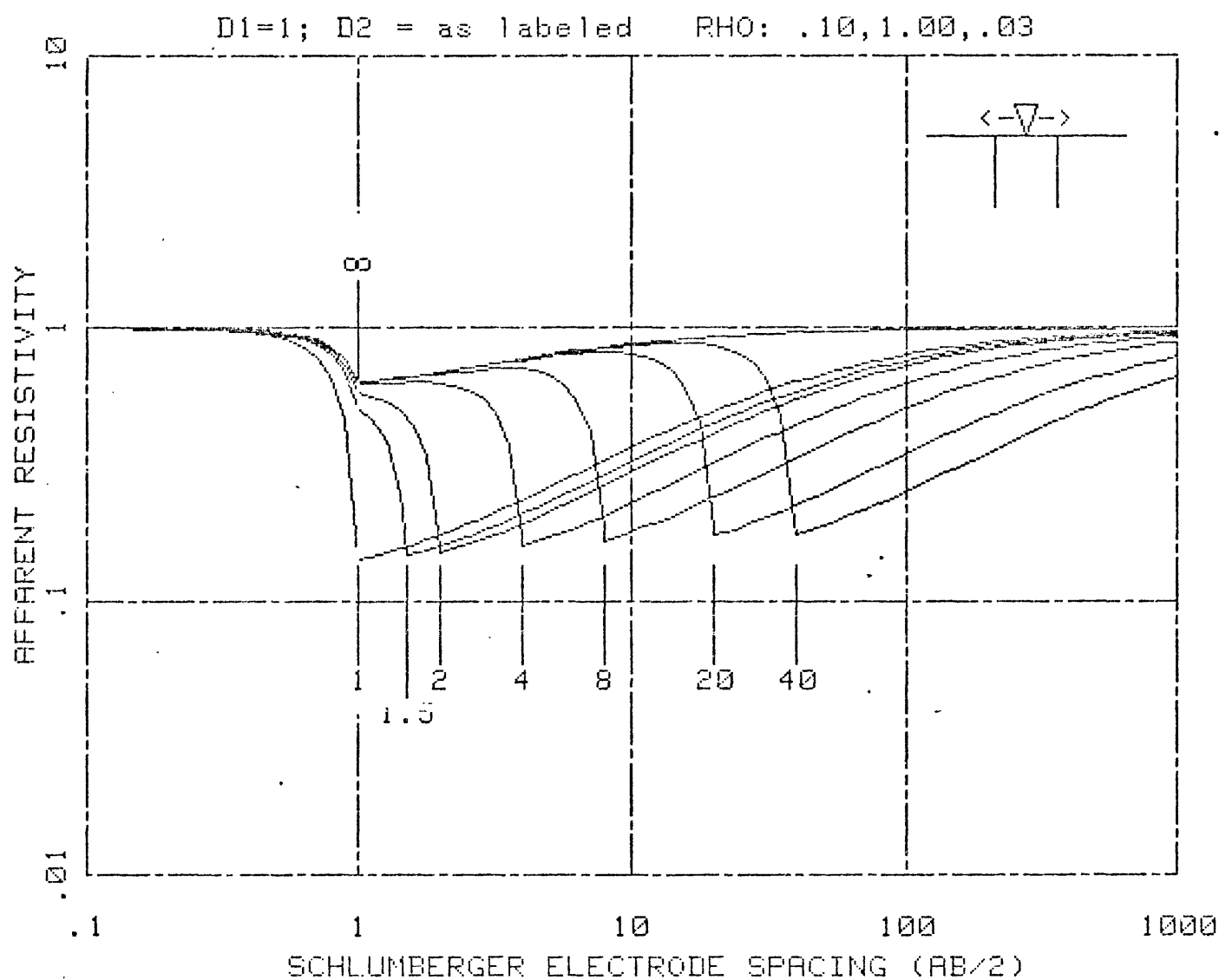
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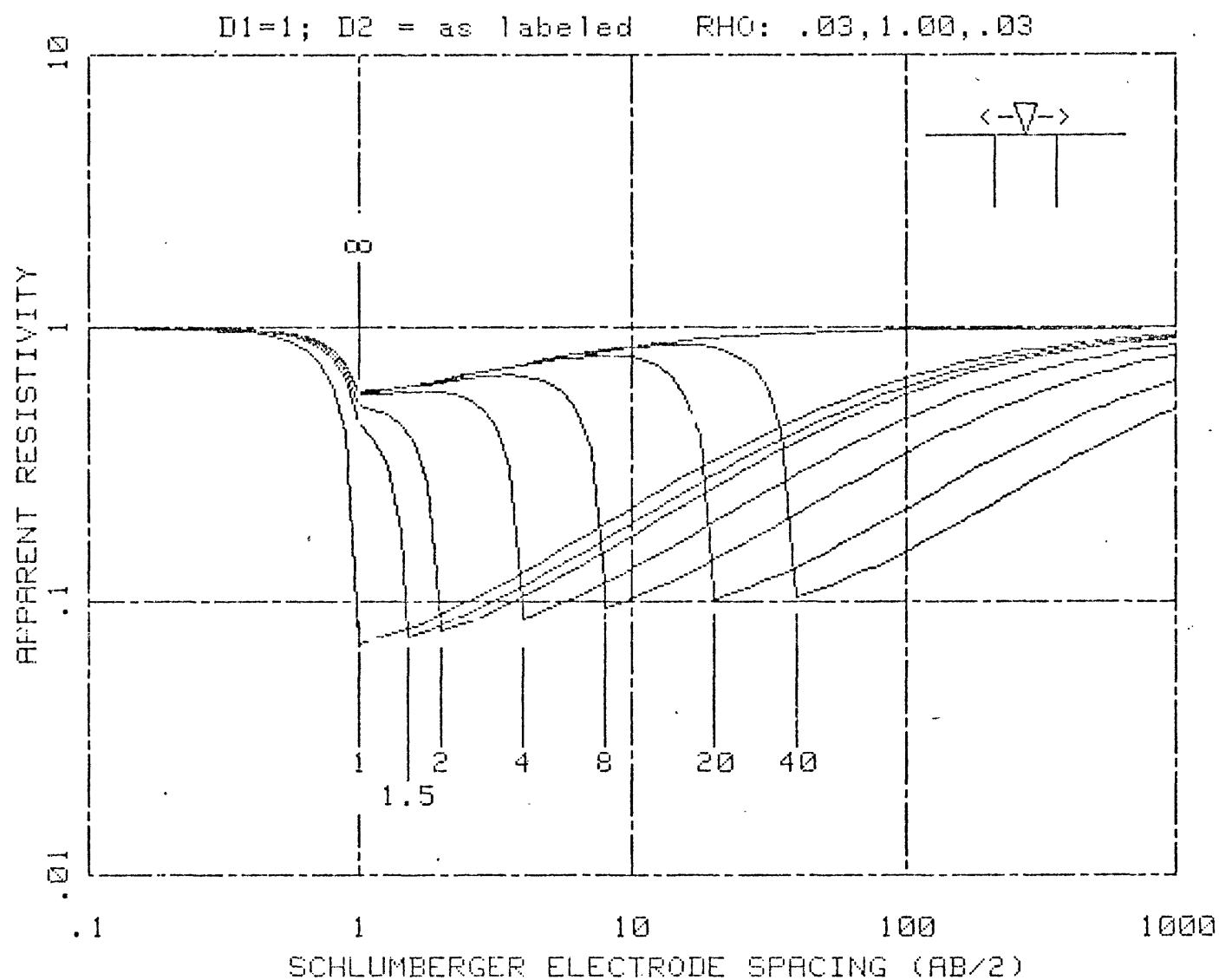
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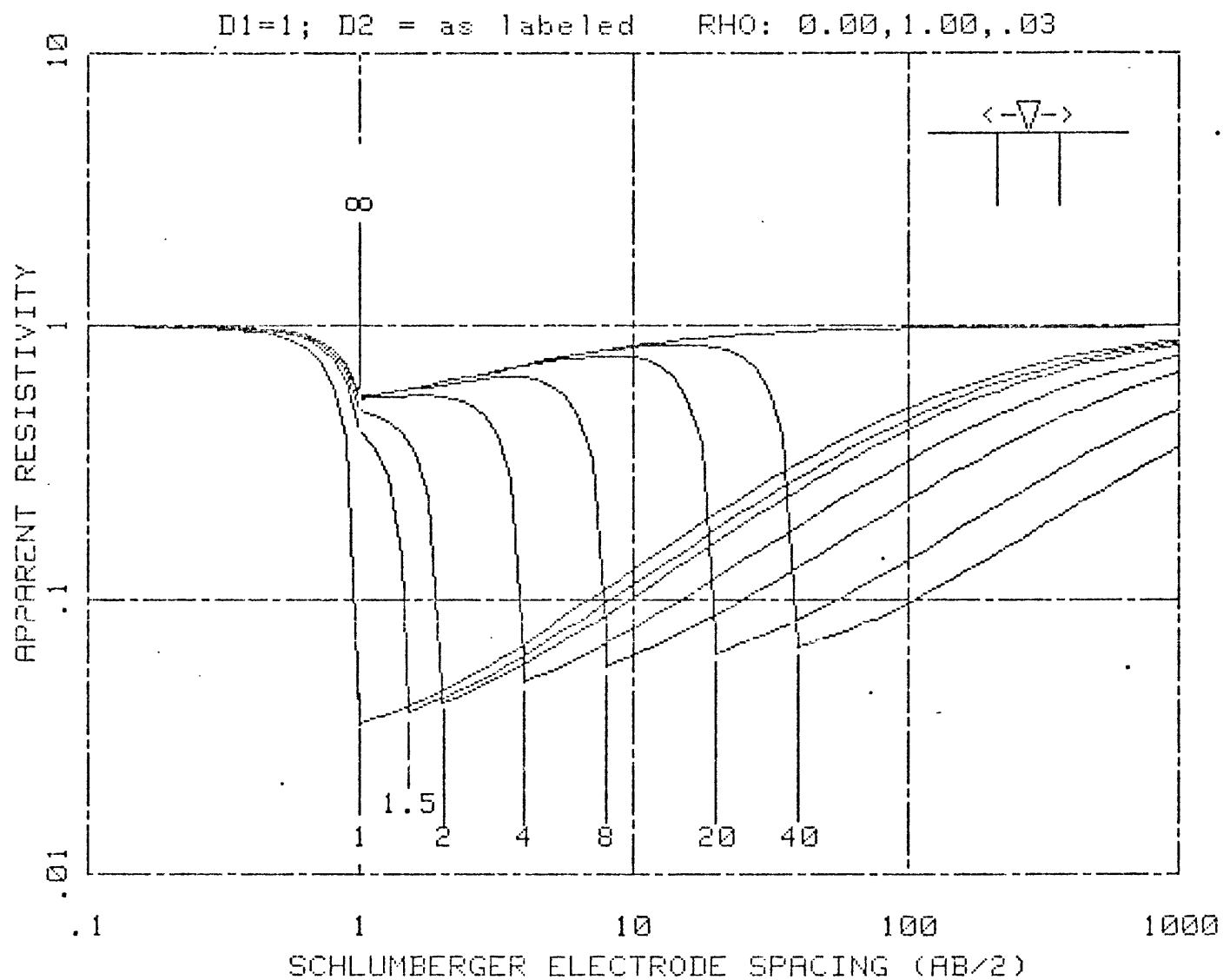
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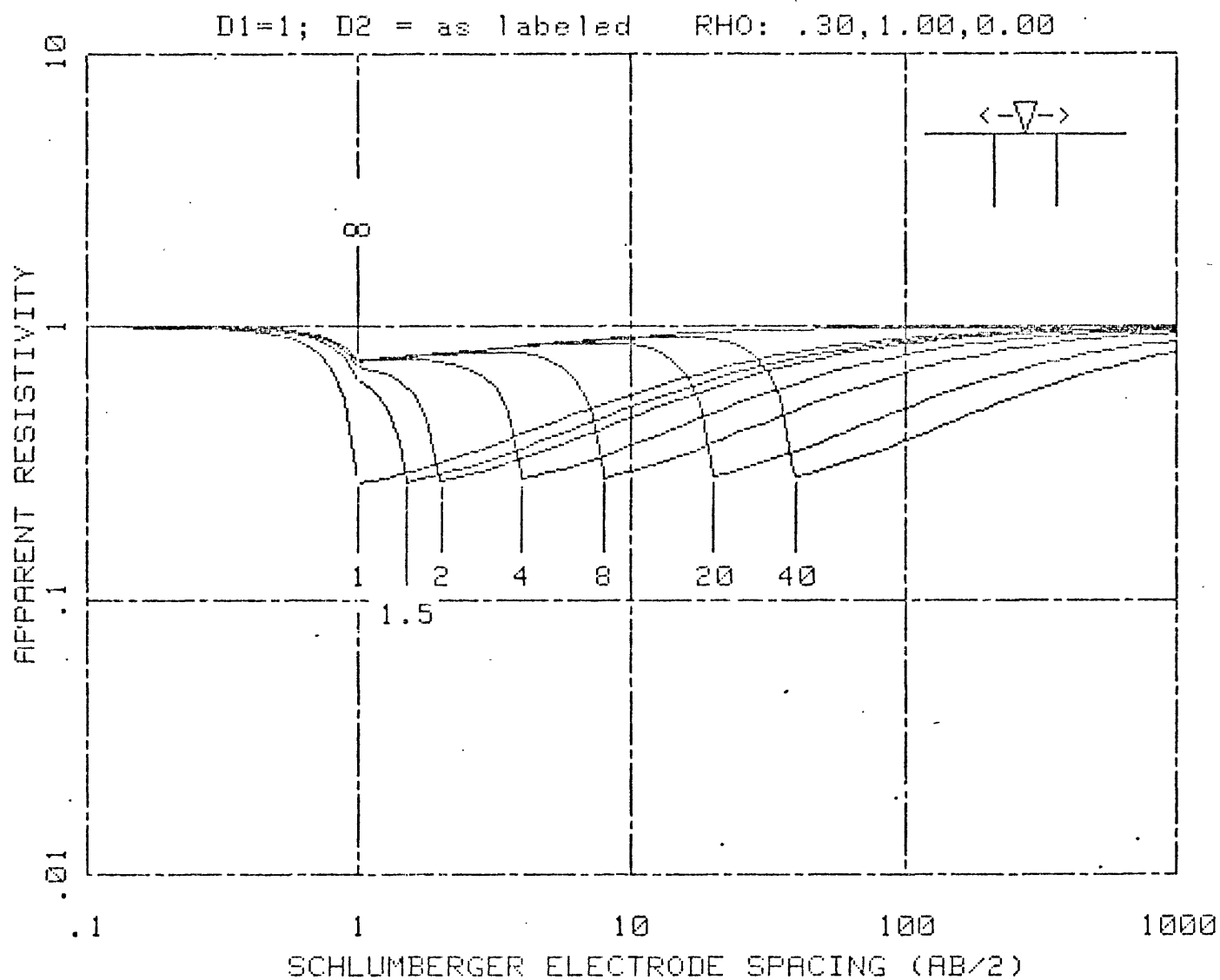
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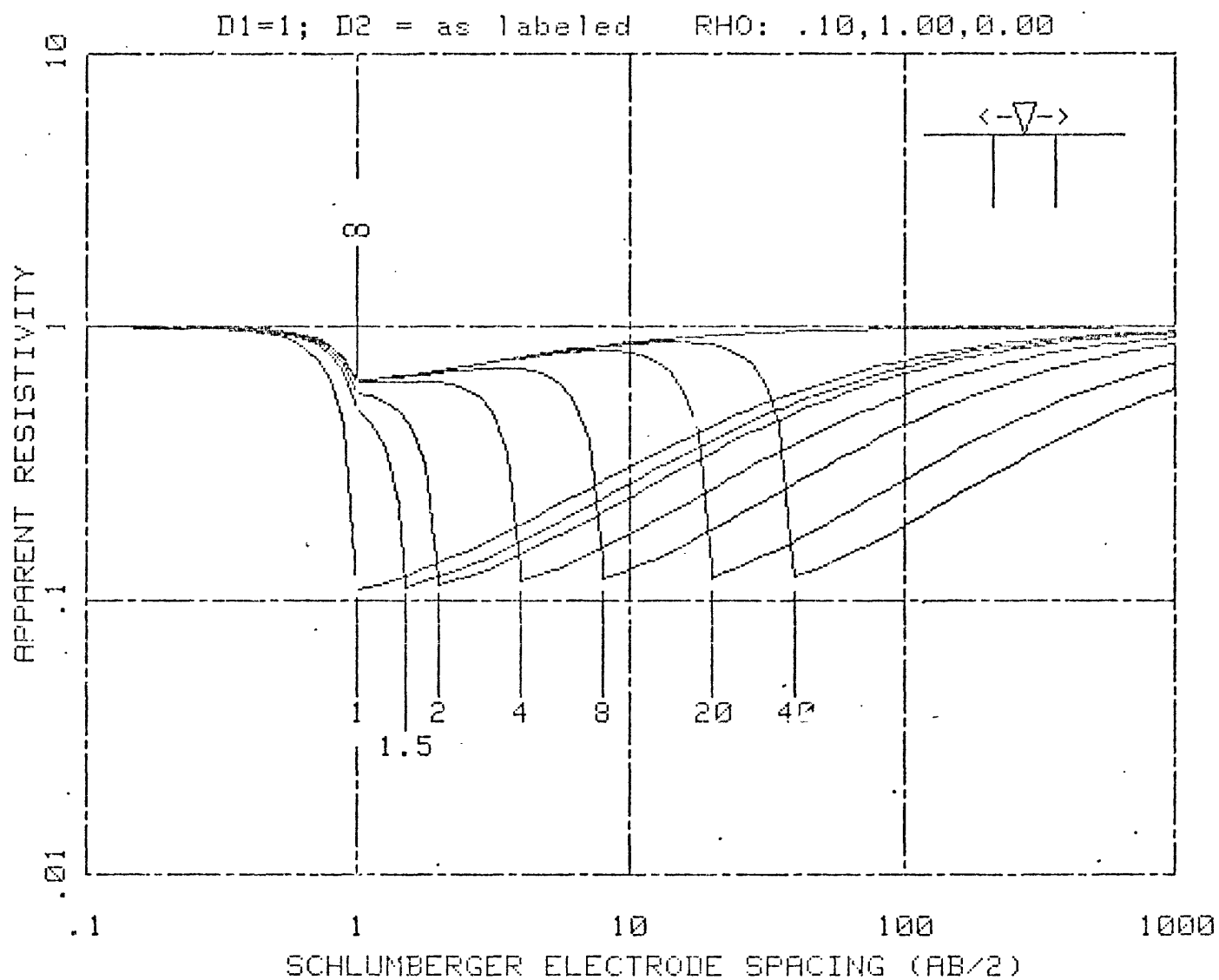
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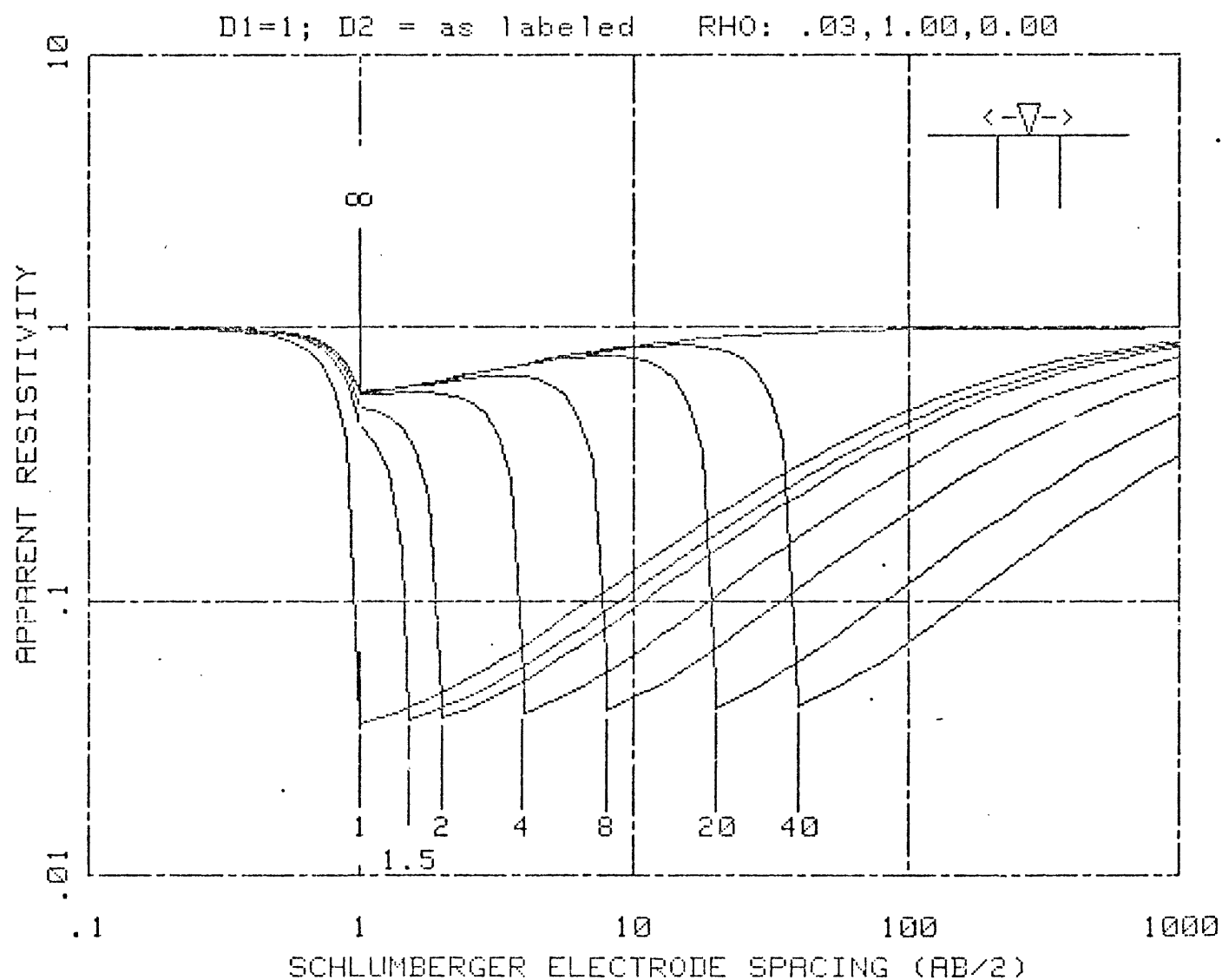
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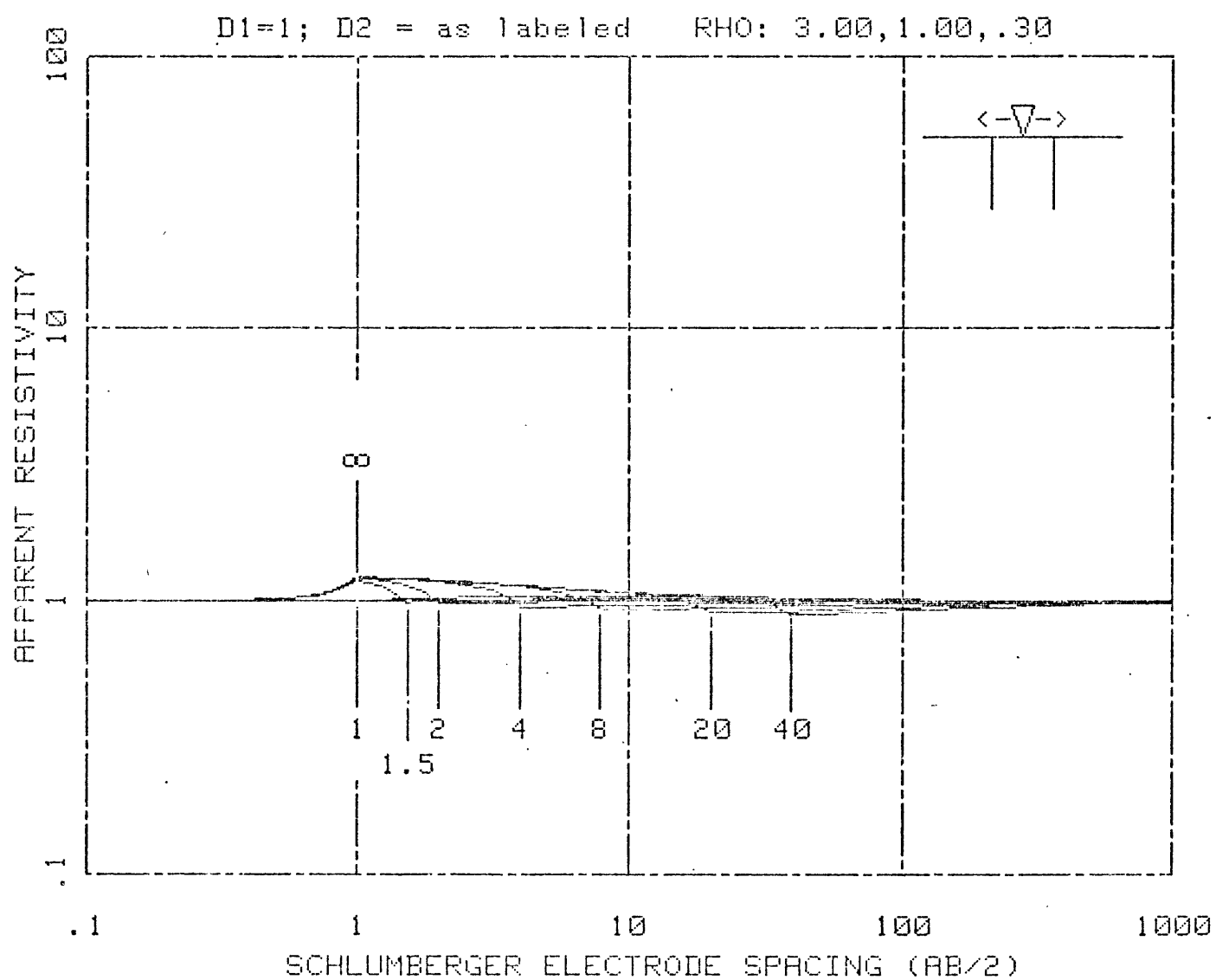
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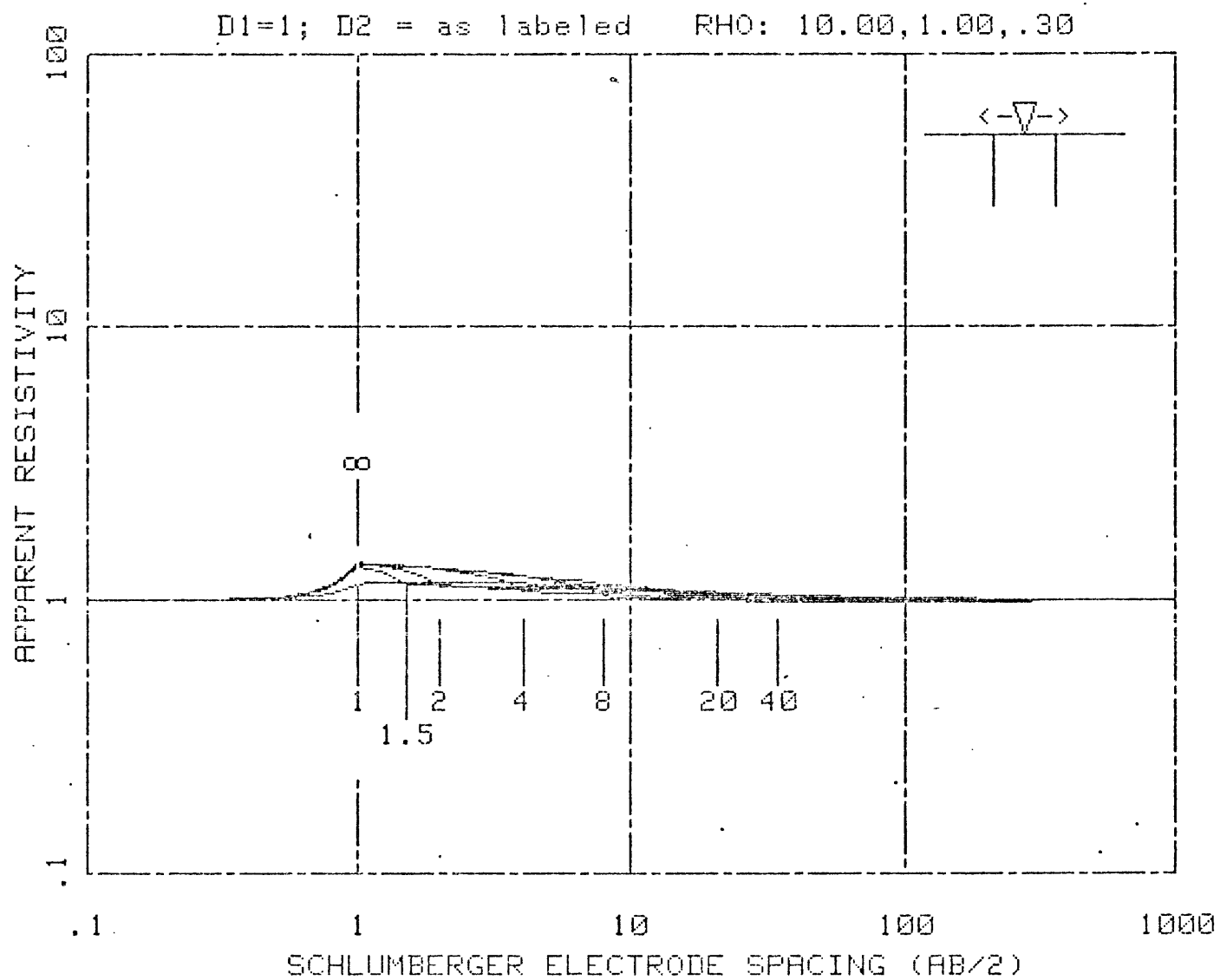
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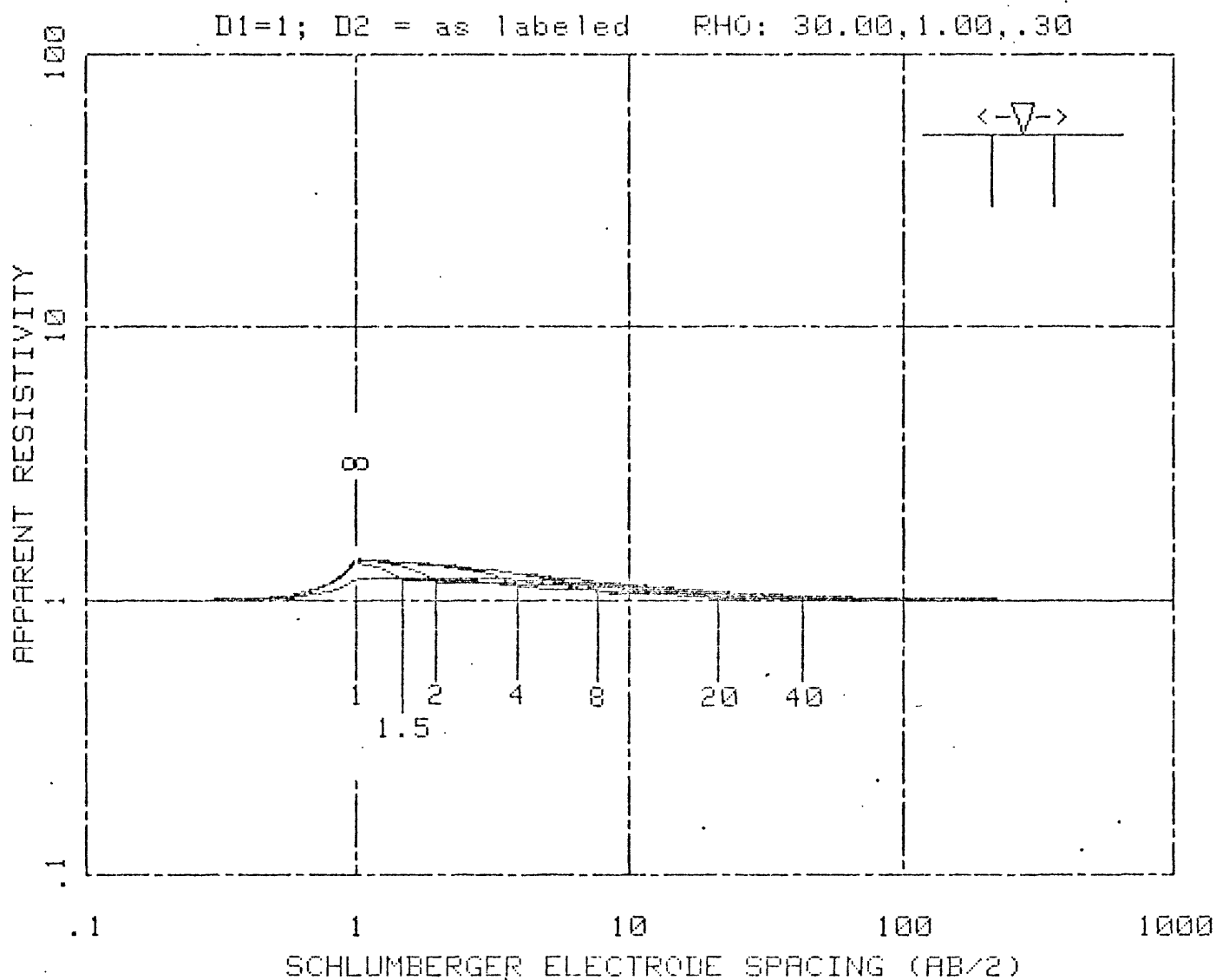
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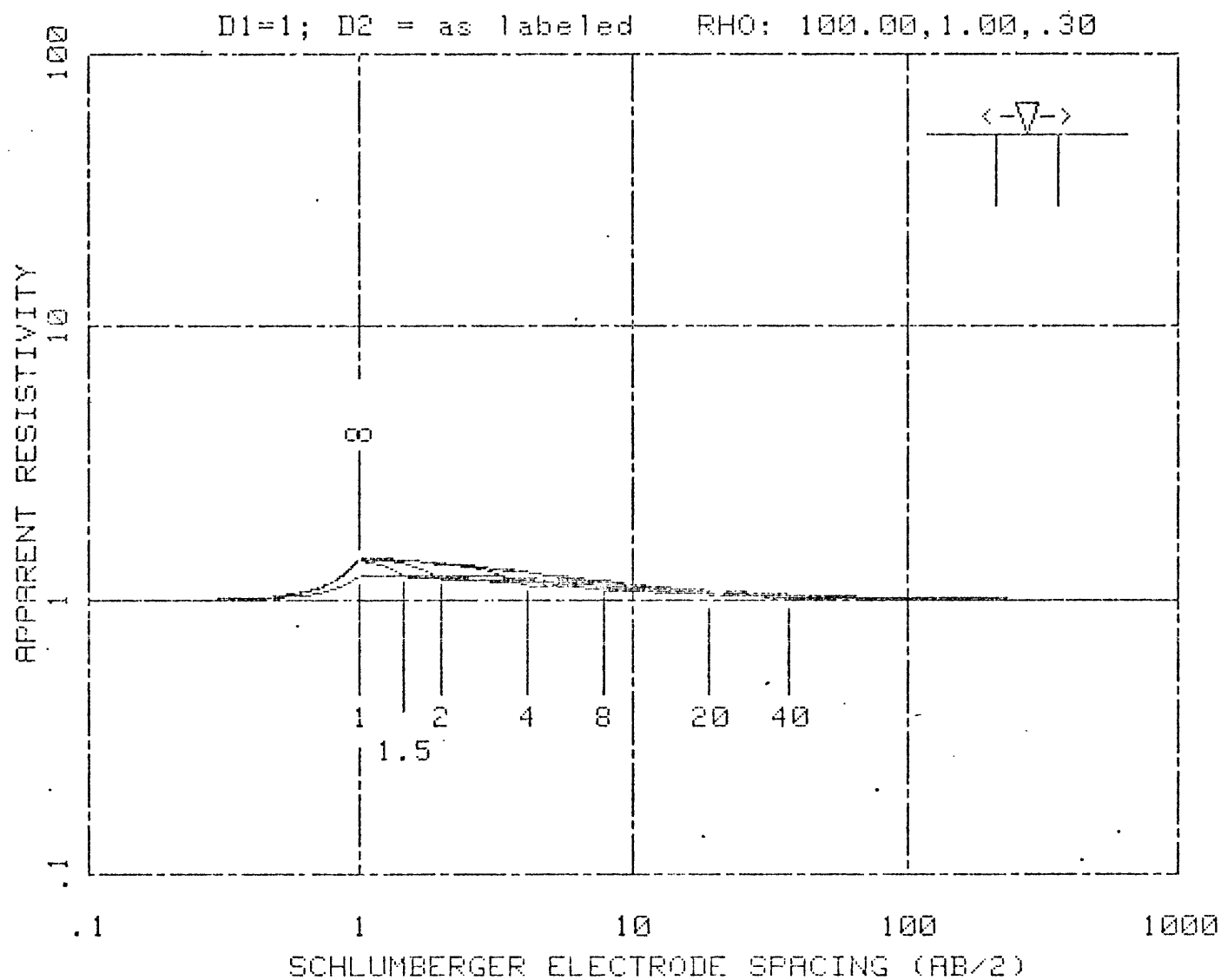
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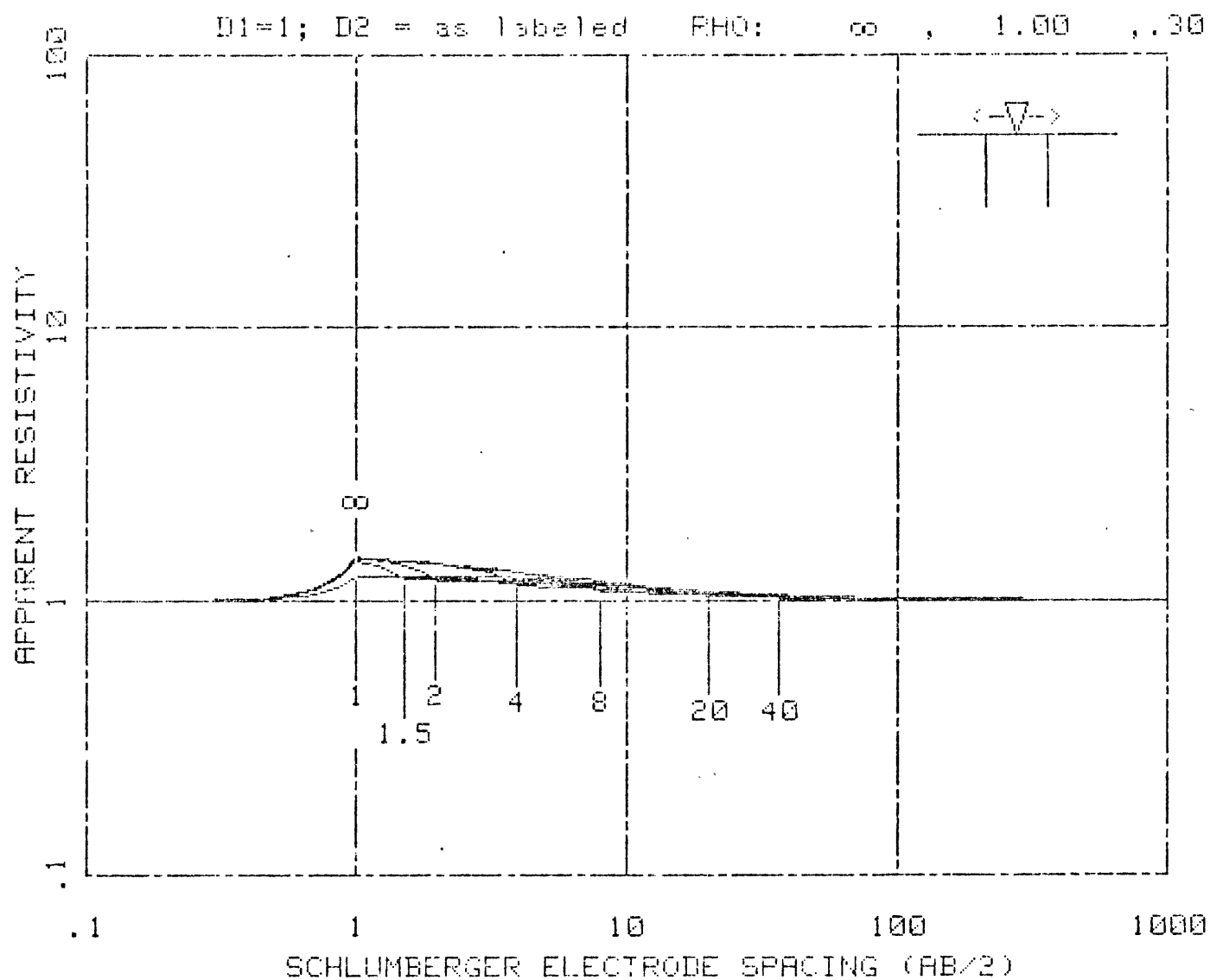
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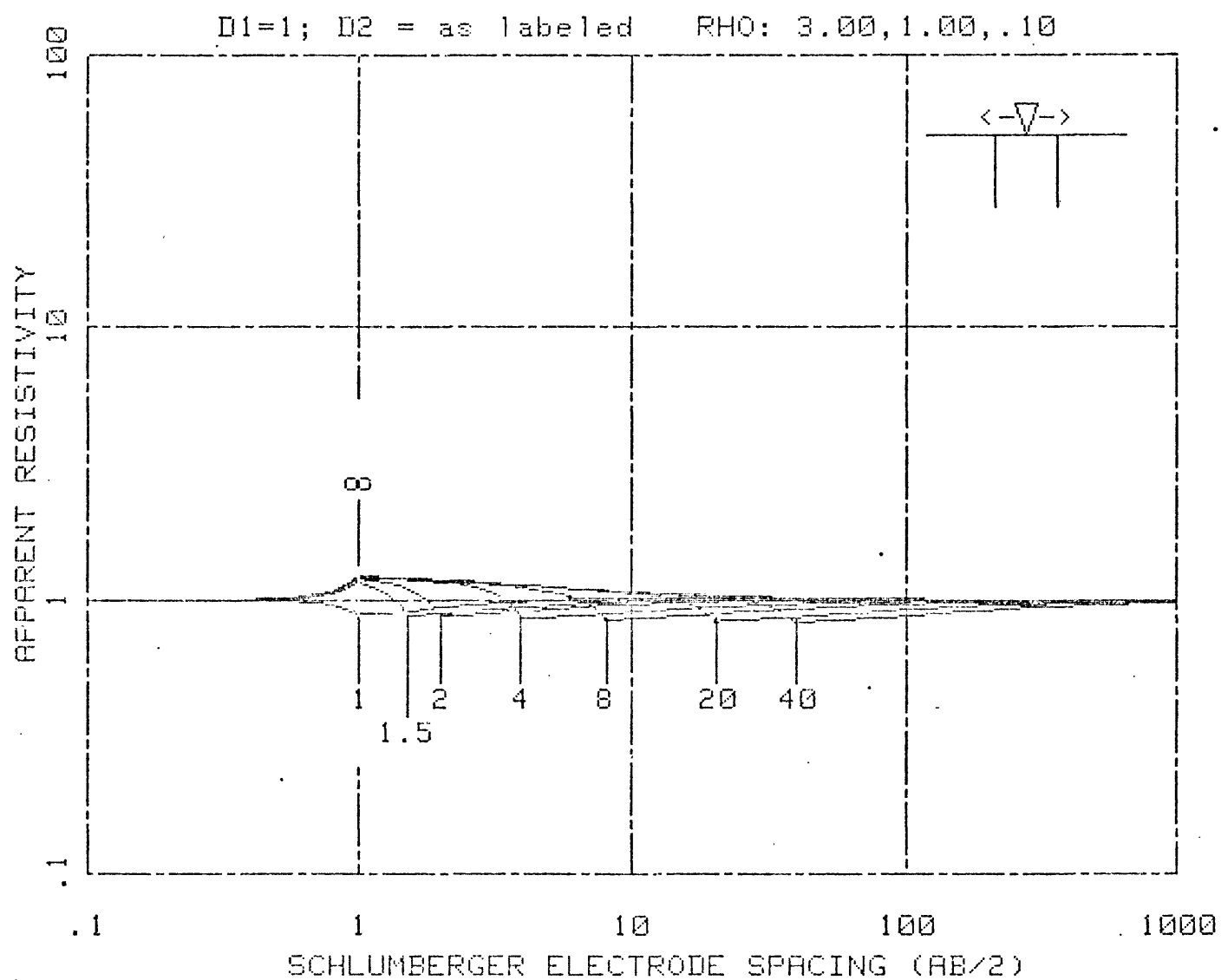
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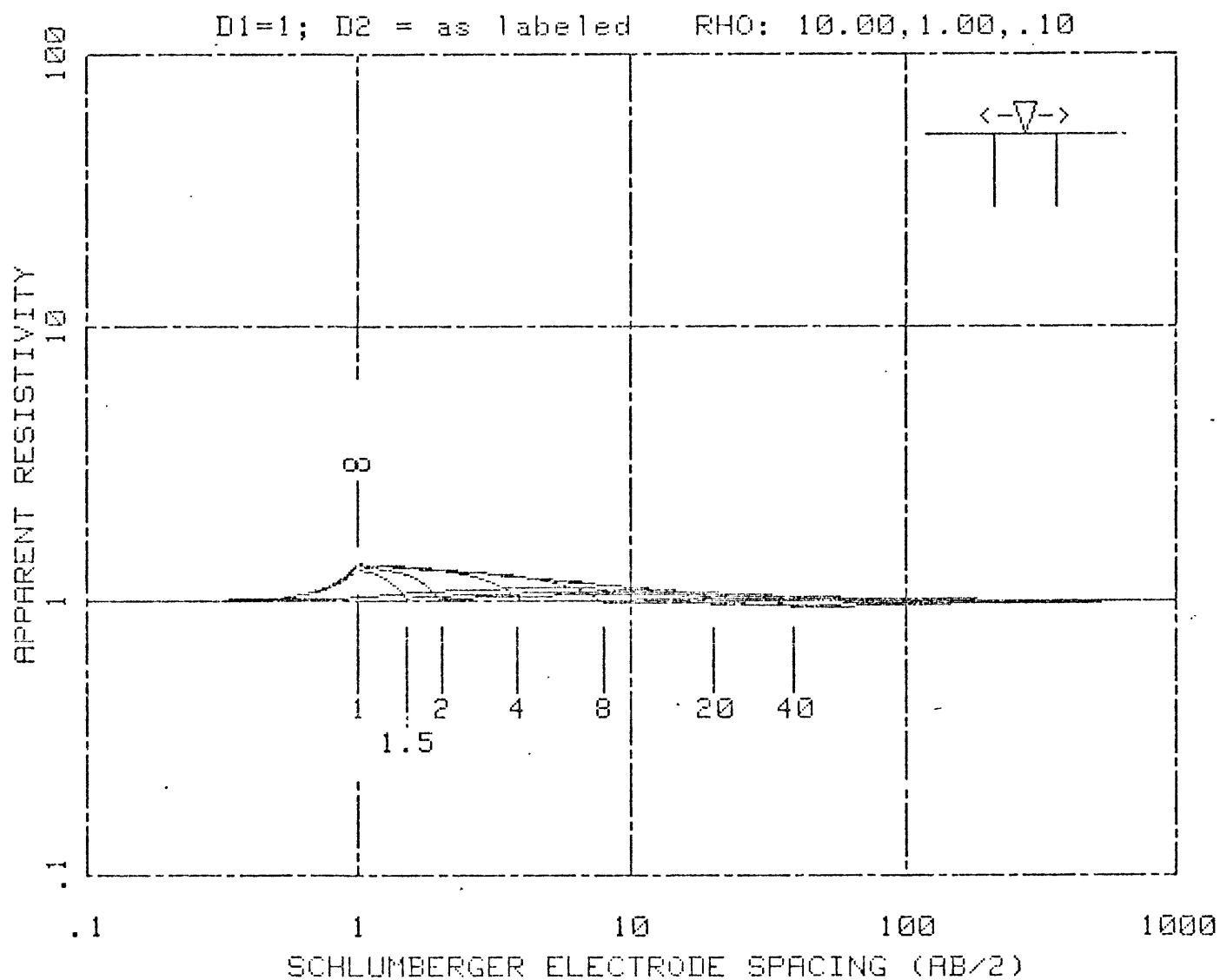
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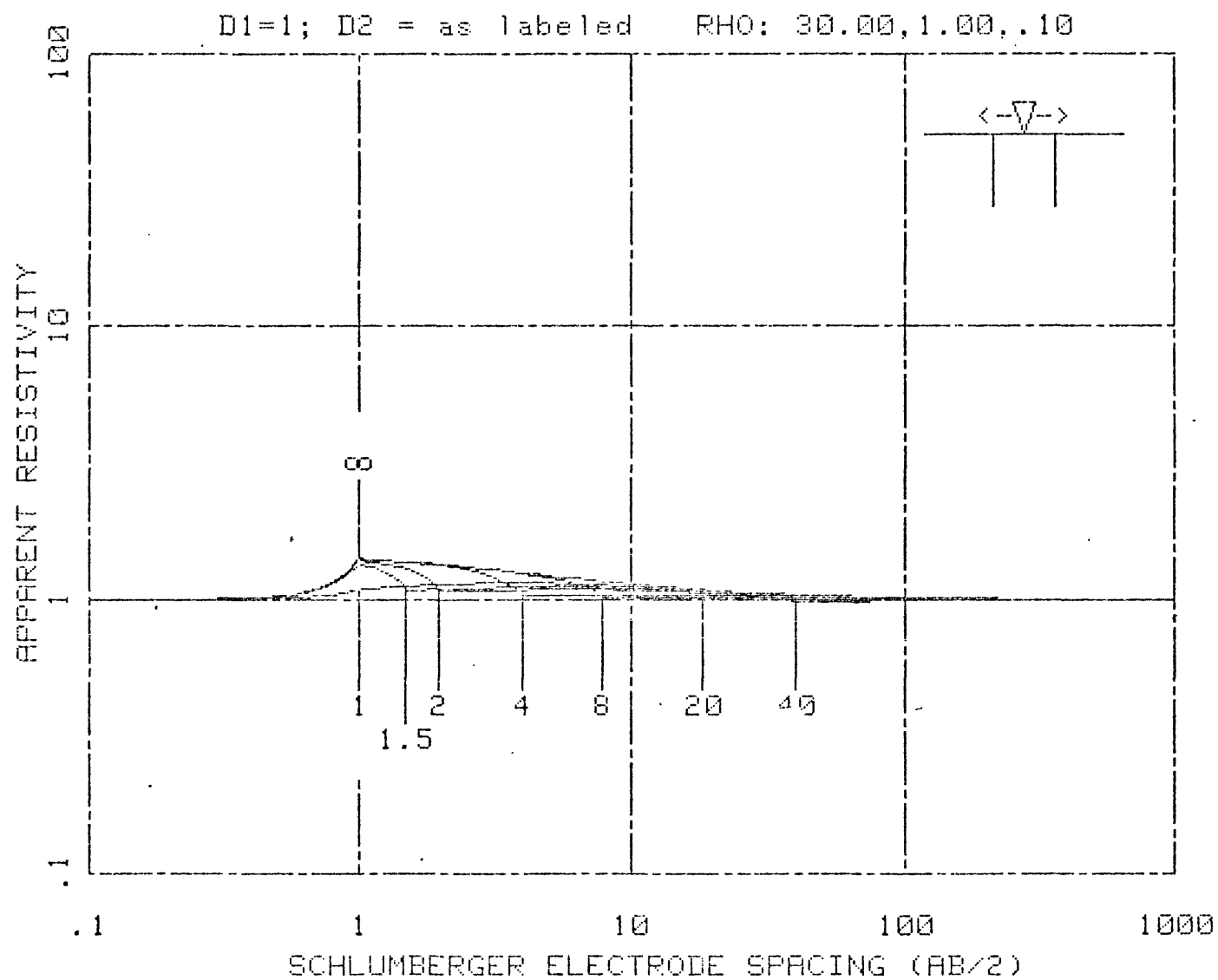
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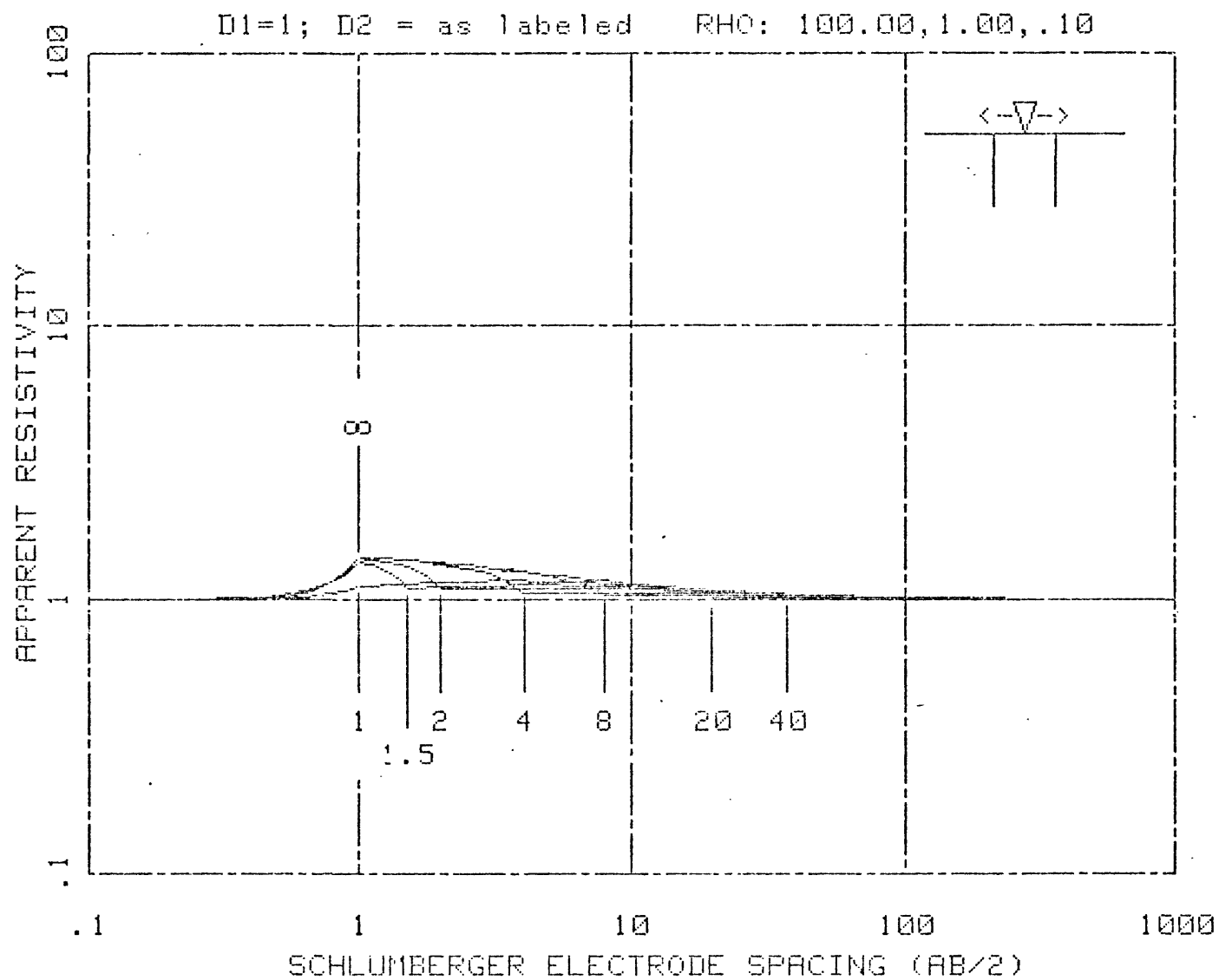
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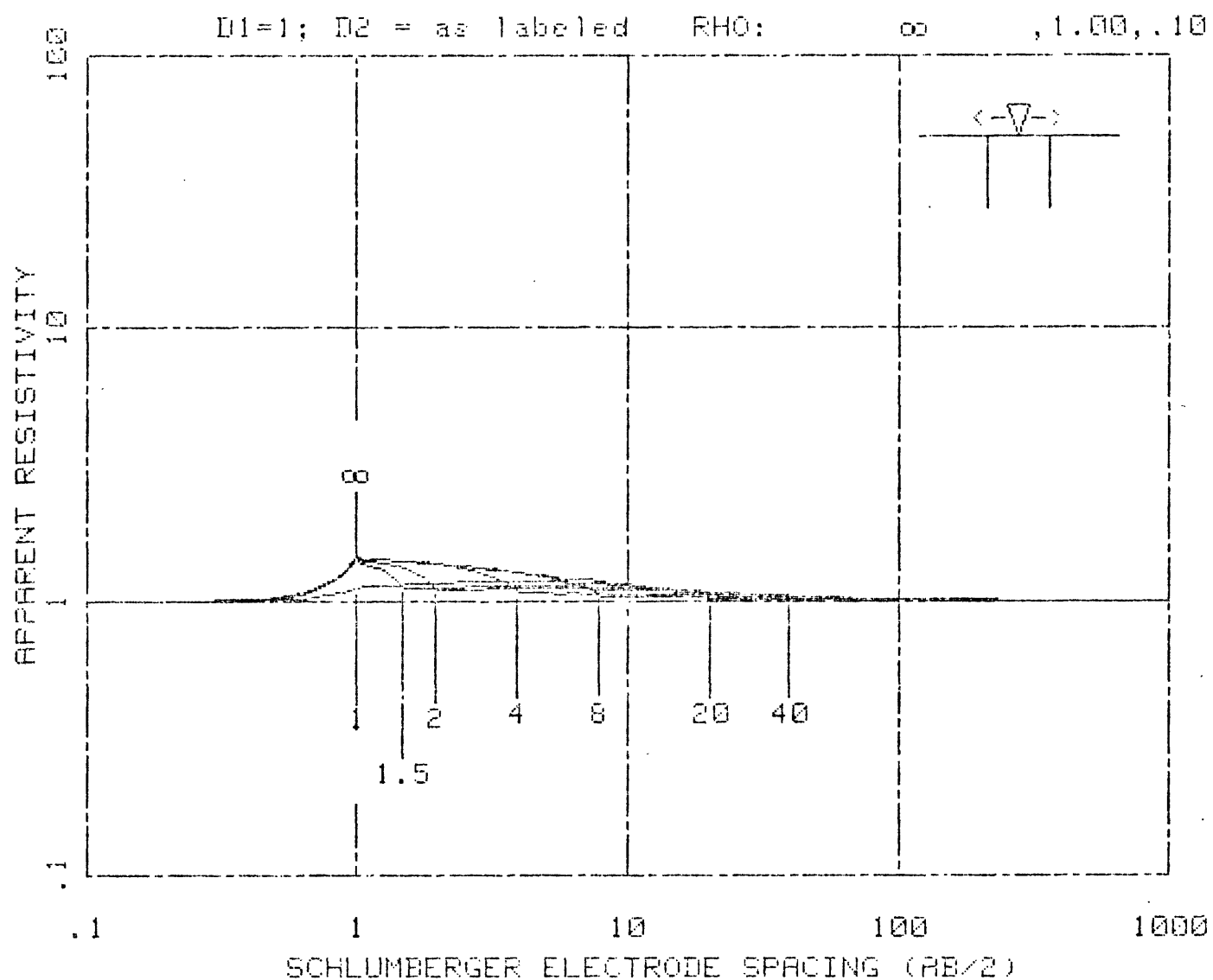
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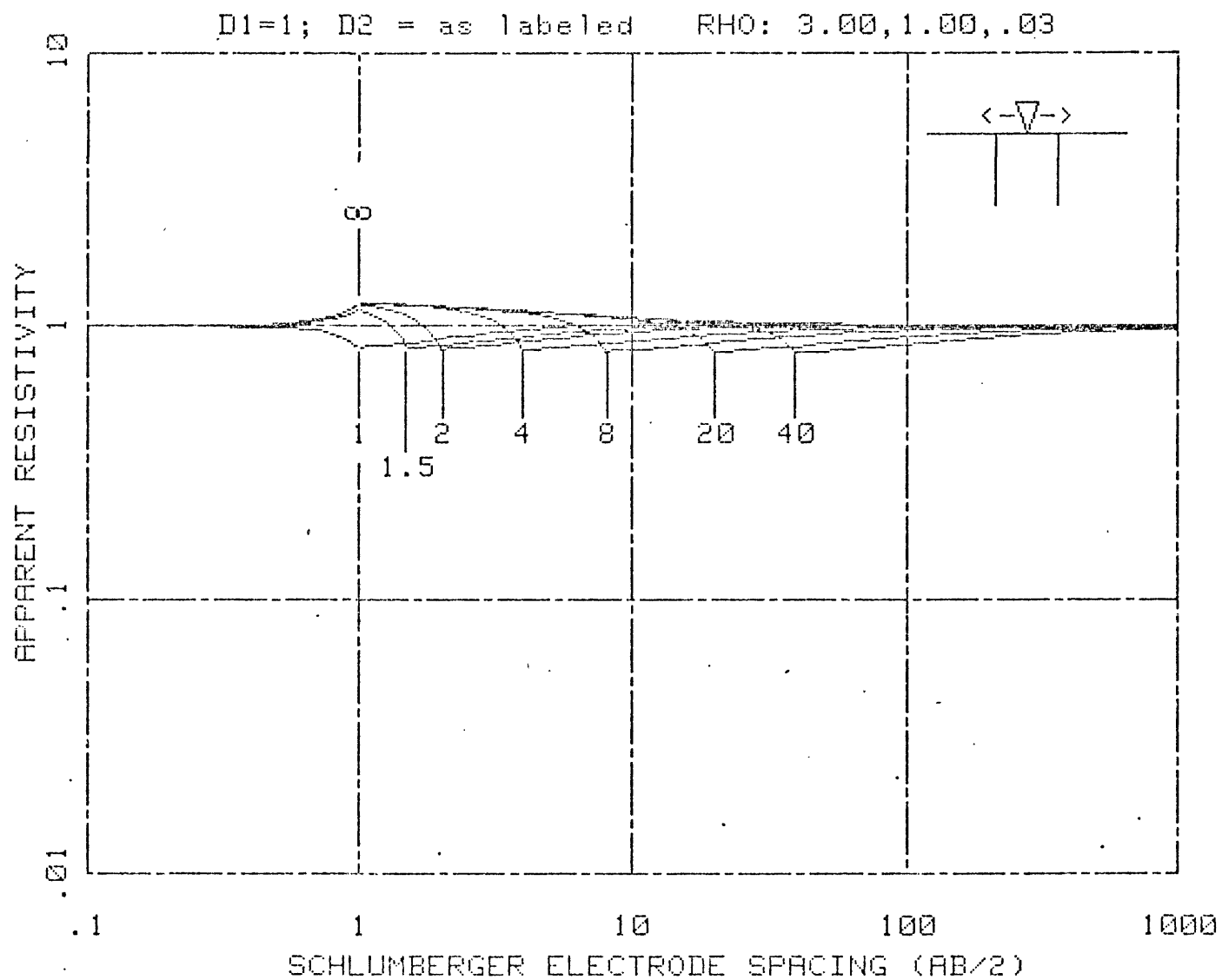
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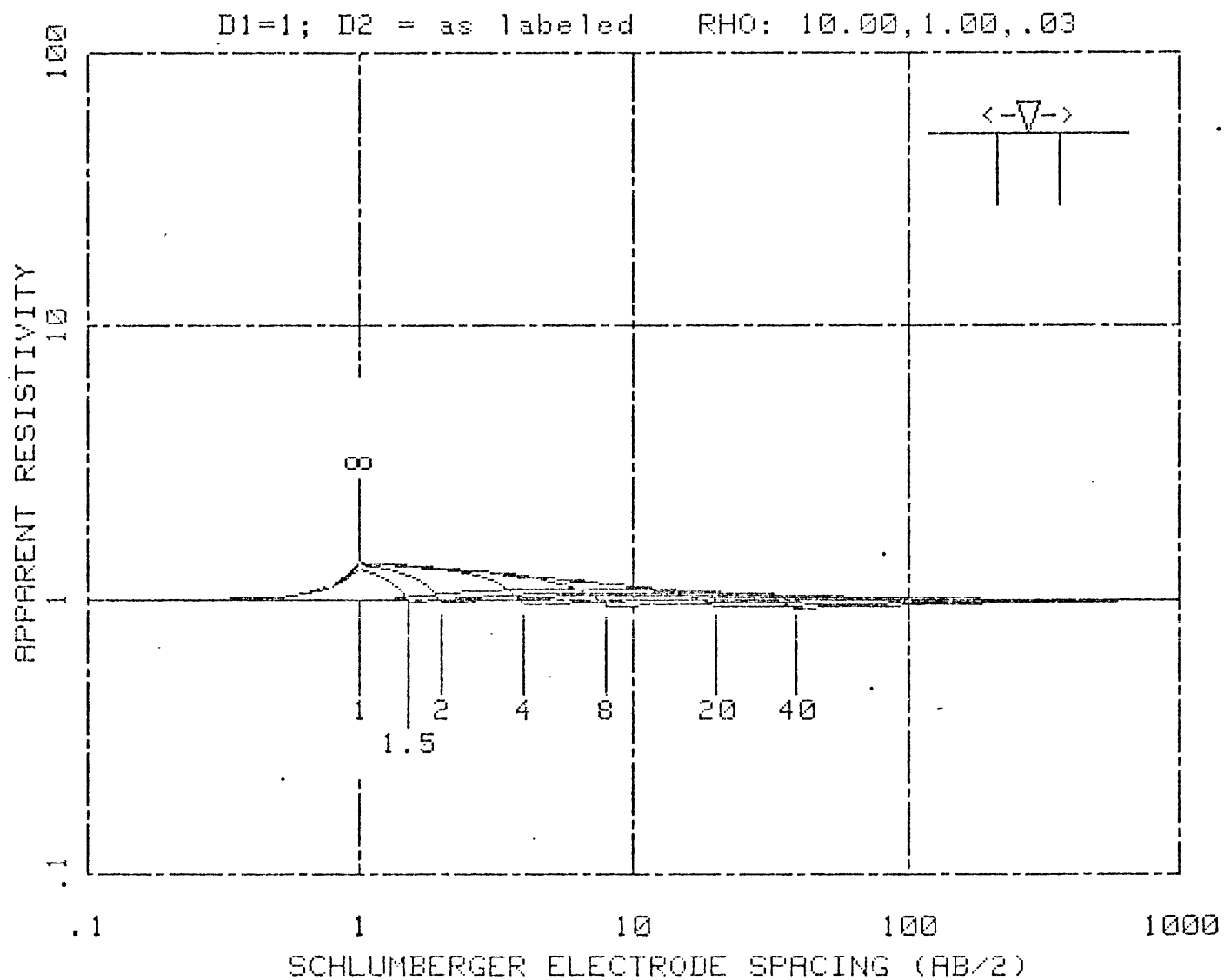
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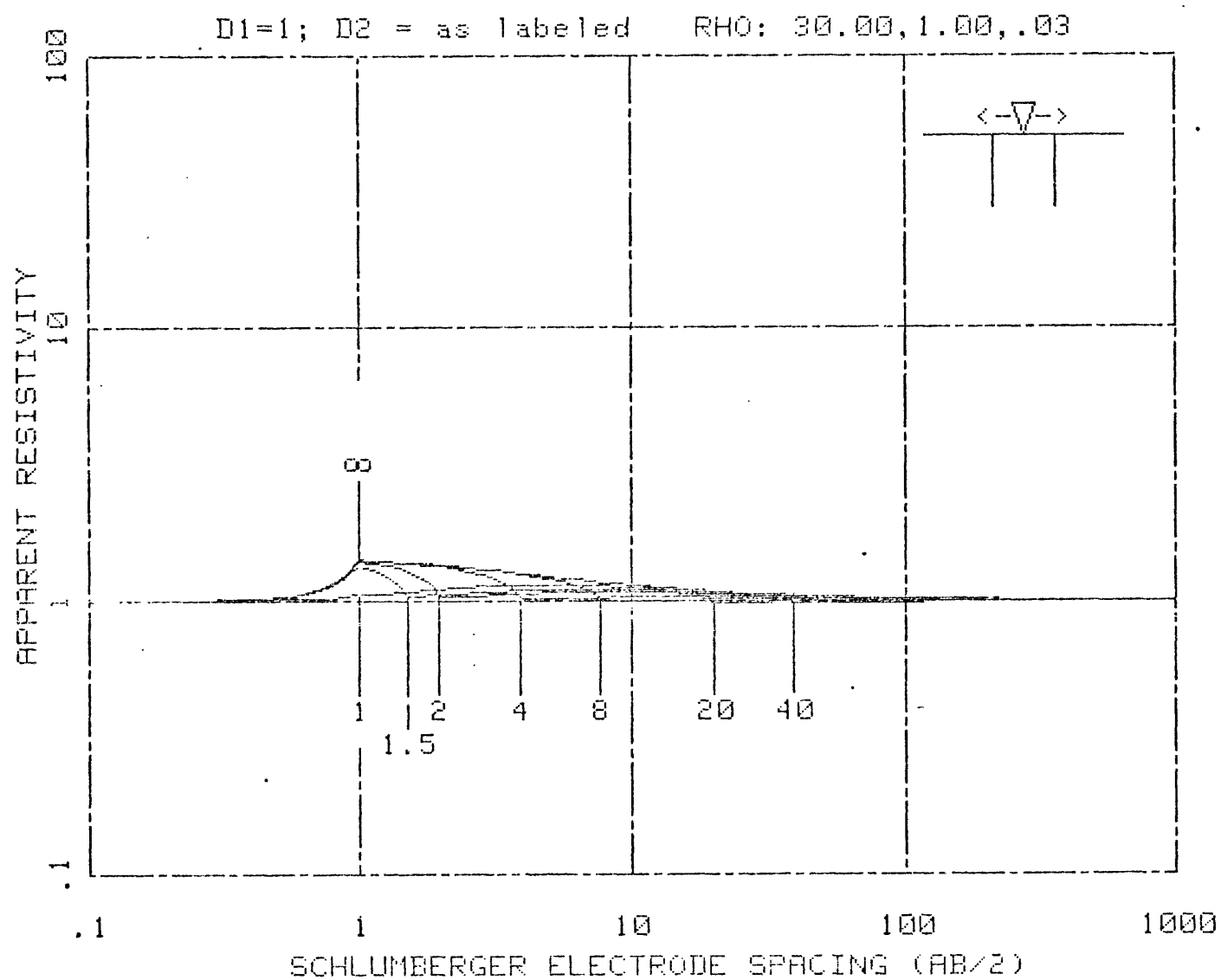
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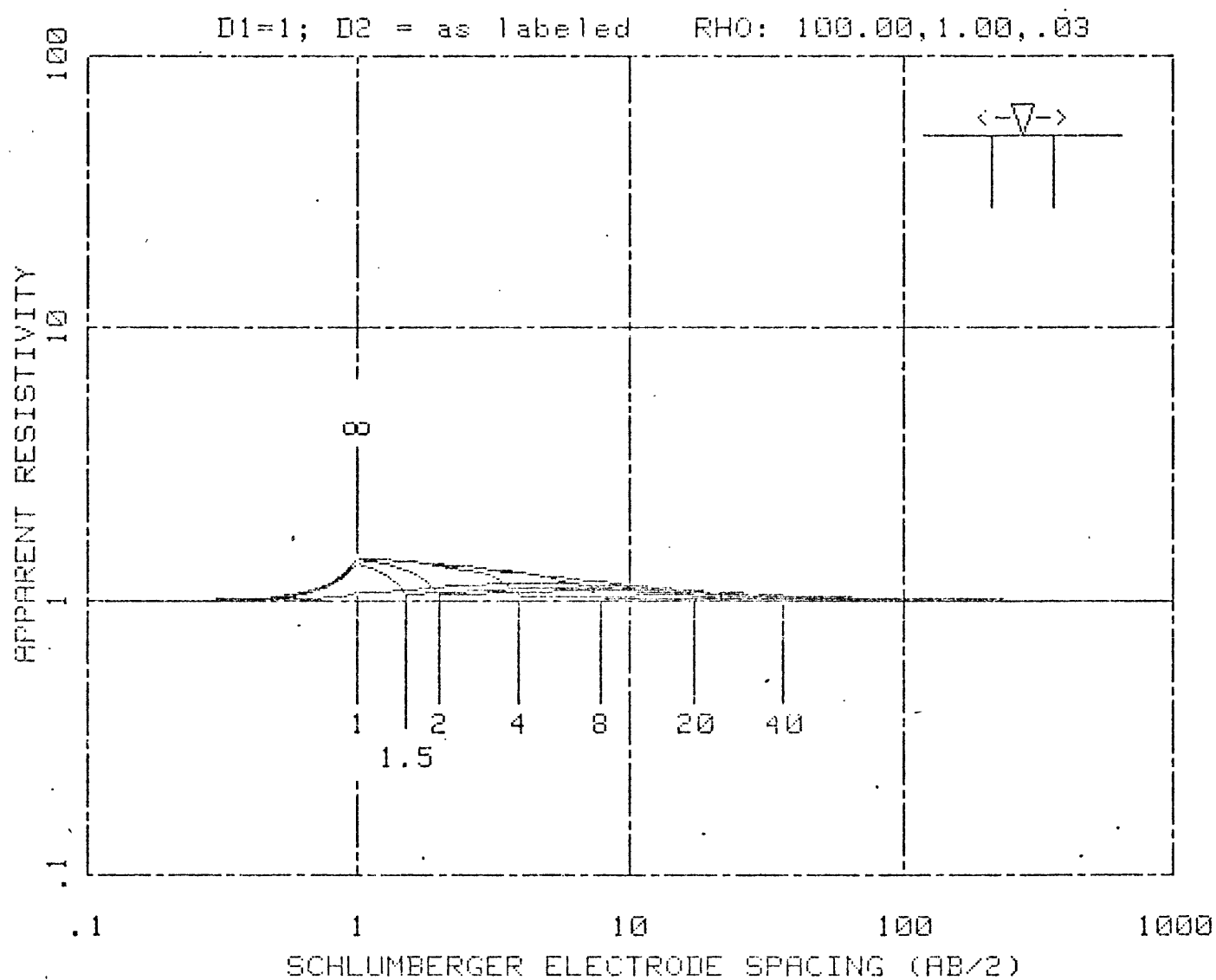
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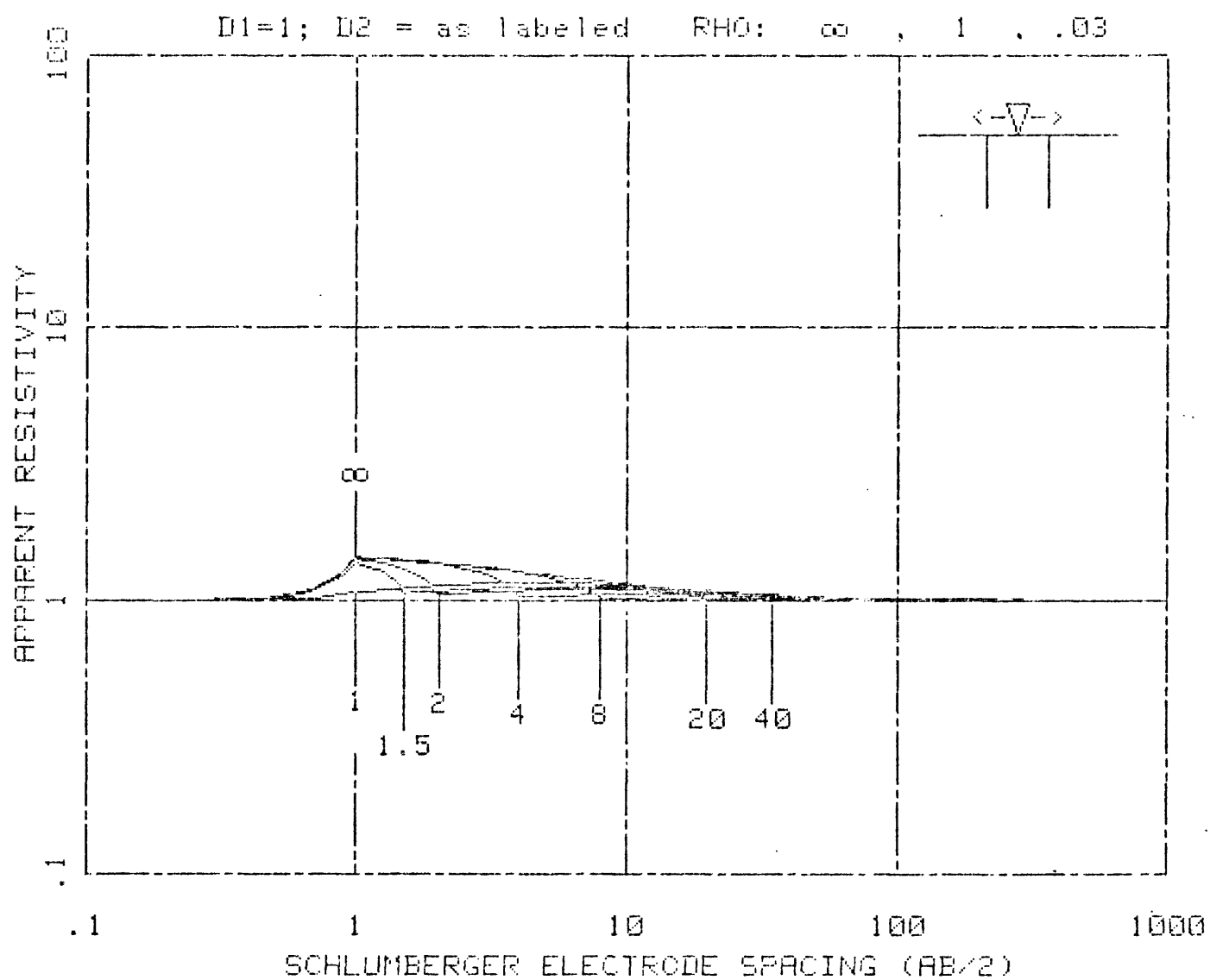
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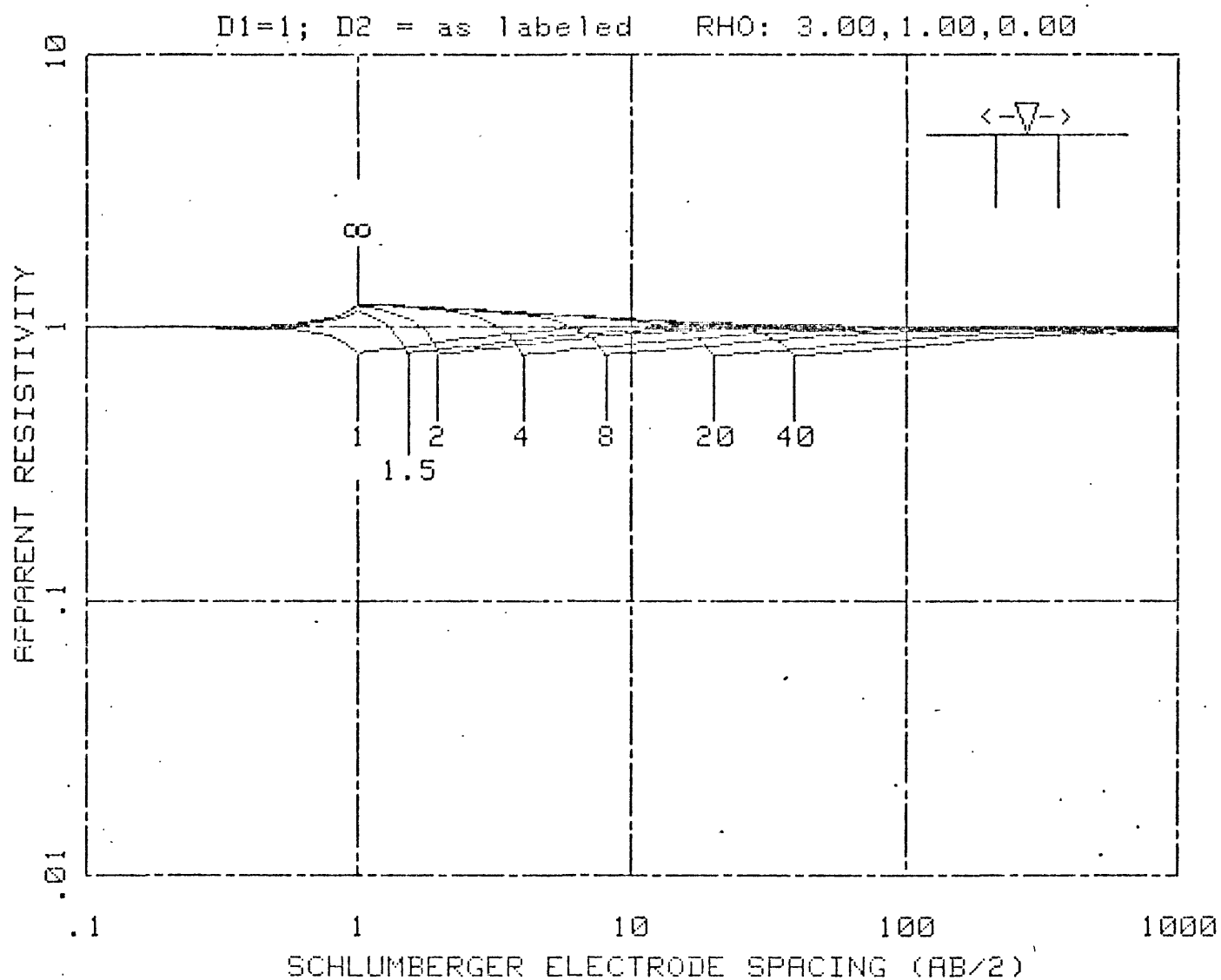
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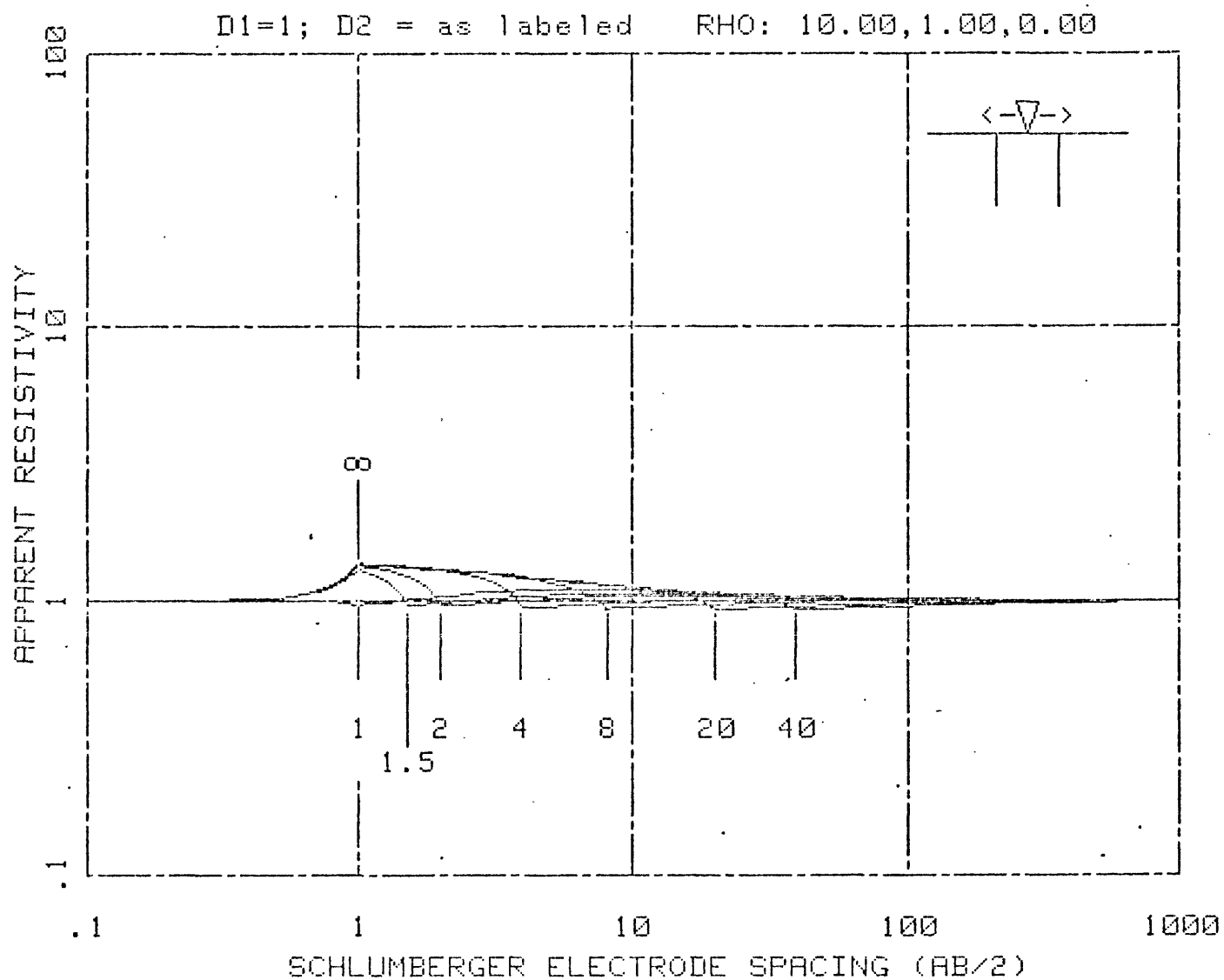
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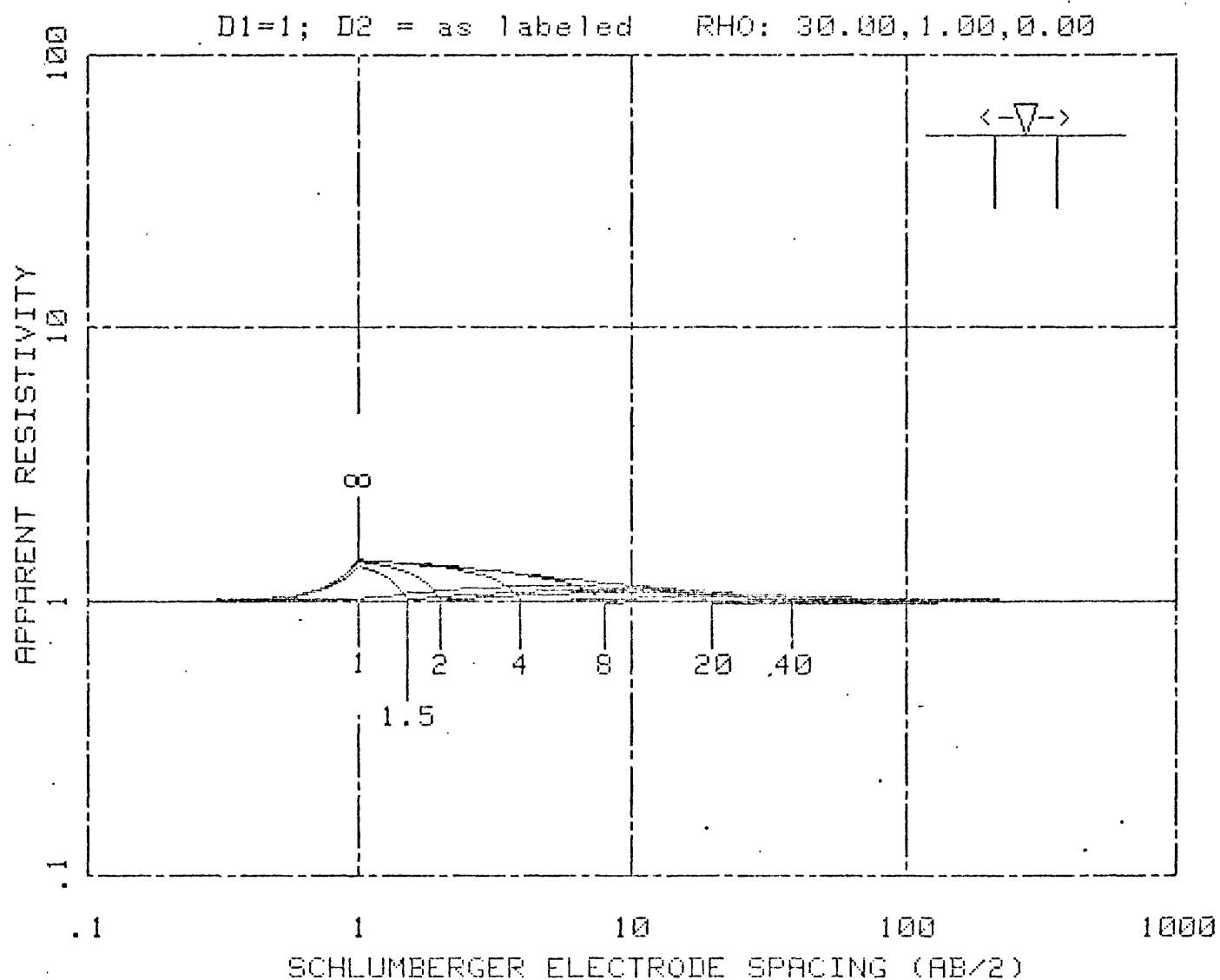
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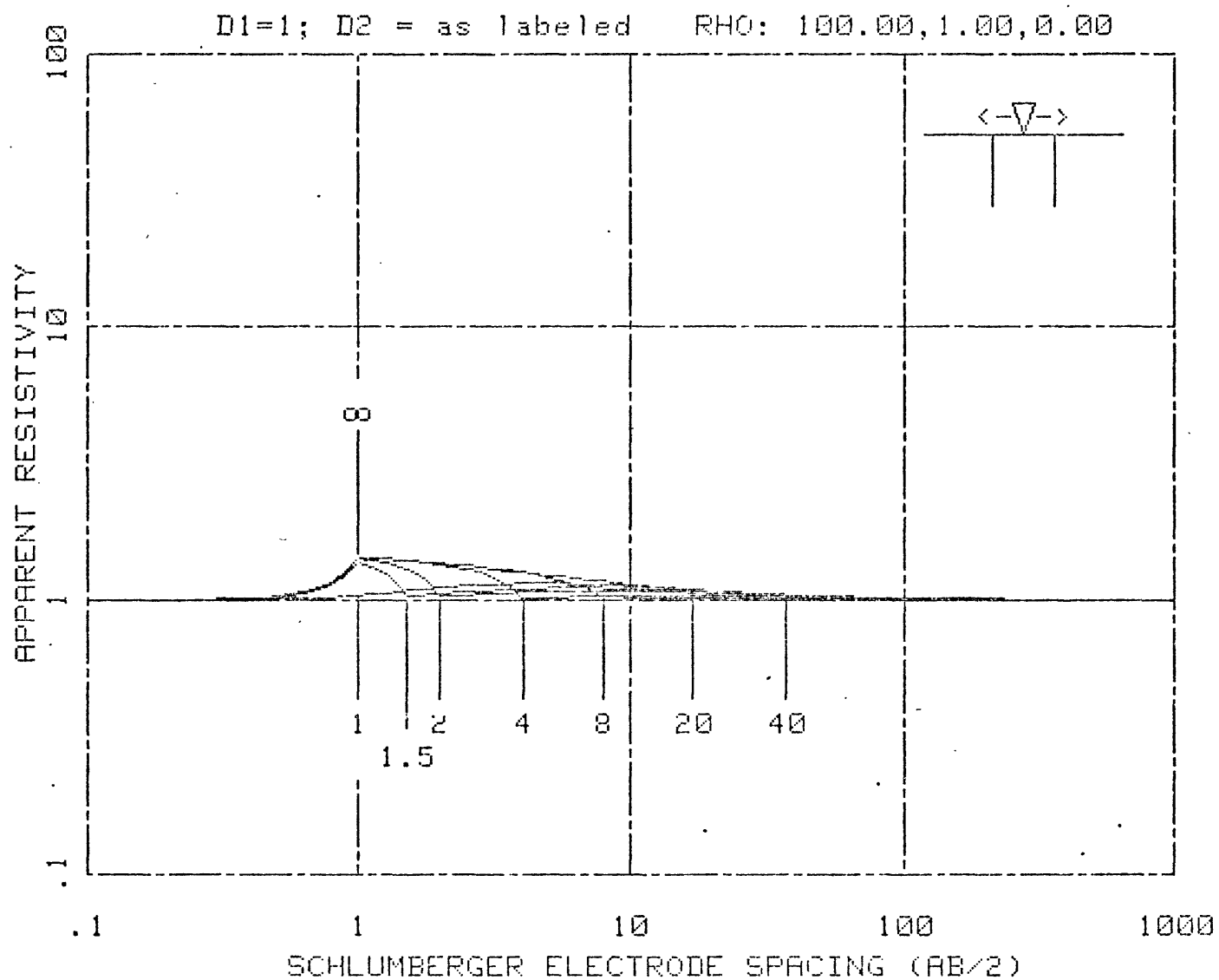
Q2



Q2



Q2



Q2

