GENERAL RADIO COMPANY

engineering department

INSTRUMENT NOTES

IN-111 1967

Measurement of Attenuation and Loss

A slotted line, when used with the width-of-minimum method, is well suited for the measurement of small values of attenuation in two-port devices. For example, the loss of a pair of connectors, or of a short length of transmission line or coaxial cable, can thus be measured with a high degree of accuracy.

Two methods, selected on the basis of the amount of attenuation to be measured, are available.

Attenuation between 0.1 and 6 dB

When the attenuation of the unknown two-port device is above 0.1 dB, the attenuation of the slotted line may usually be neglected and the following direct method is valid.

The procedure is as follows:

a. Attach the micrometer carriage drive to the slotted line in preparation for width-of-minimum measurements.

b. Attach the unknown to the connector end of the slotted line.

c. Short-circuit the output end of the unknown two-port device with a short-circuit termination.

d. Measure the width of the minimum closest to the unknown, and remove the short-circuit termination.

e. Repeat the width-of-minimum measurement with an open-circuit termination.

f. Use figure 1 to determine the reflection coefficients corresponding to the above two measured widths of minima. Call these Γ_{sc} and Γ_{oc}.

g. Calculate the geometric mean of these two reflection coefficients:

$$\Gamma_m = \sqrt{\Gamma_{sc} \times \Gamma_{oc}}\ .$$

The attenuation in decibels of the unknown, A, is given by

$$A = 10 \log_{10} \Gamma_m .$$

Attenuation or Loss below 0.1 dB

When the residual attenuation of the slotted line approaches that of the unknown and cannot be neglected, the substitution method should be used. The attenuation of the measuring equipment is subtracted from the total measured system attenuation. The result is much higher accuracy than that given by the direct method for measurement of small values of attenuation.

The procedure is as follows:

a. Make a preliminary measurement of the loss in the measuring equipment, exclusive of the unknown. Connect all components except the unknown to the slotted line, and short-circuit the output. Measure the width of the *second* accessible minimum from the load, record its position, and call this point P.

b. Replace the short circuit with an open-circuit termination, and measure the widths of the two minima that straddle point P. Average these two widths of minima.

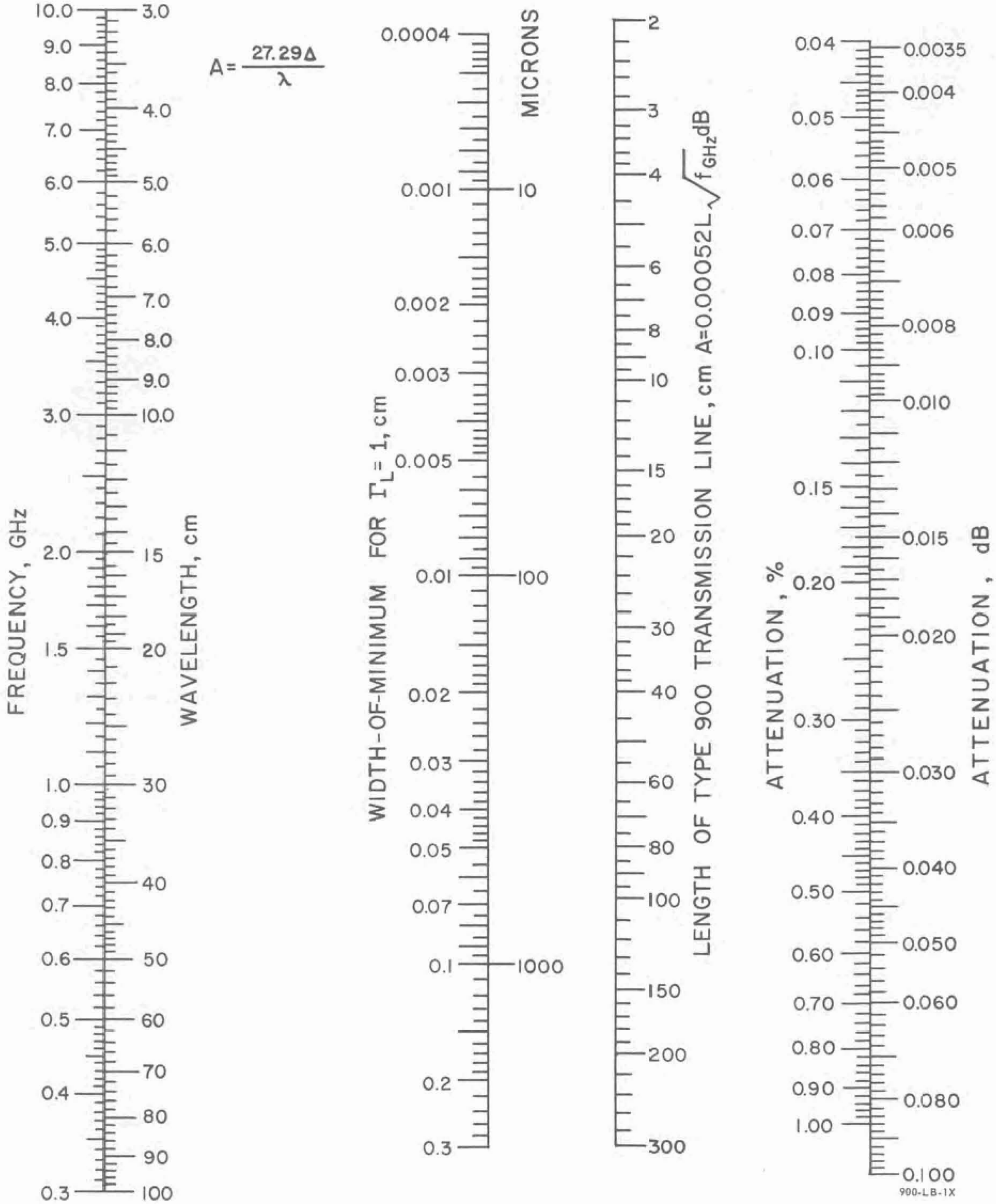

Figure 2. Attenuation nomograph.

the two minima that straddle point Q. Average these two widths of minima.

f. Average the width of minimum from step (d) with that of step (e), and use this value with the attenuation nomograph to determine the total attenuation, A_t, of the unknown plus measuring equipment, i.e., from the output reference plane of the unknown to point Q.

g. Determine a correction for the attenuation between points P and Q. Apply the values for frequency and for the distance in cm between points P and Q (from probe position scale) to the "Length of Type 900 Transmission Line, cm" scale of the attenuation nomograph, to determine the attenuation between the two points. Call this attenuation A_{PQ}, positive if P is to the left of Q and vice versa.

h. Calculate the attenuation of the unknown, A_x, from:

$$A_x = A_t - A_m + A_{PQ}.$$

– John Zorzy