ELECTRICAL CHARACTERISTICS OF EXCHANGE FACILITIES DATA SHEETS GENERAL INFORMATION

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1. GENERAL

1.01 This section describes the contents of data sheets included in the 304 Division of Bell System Practices that cover the electrical characteristics of exchange facilities.

1.02 The issuance of this type of information in the form of individually numbered sections facilitates making new data available and keeping them current. It has the further advantage of concentrating like information together in condensed form.

1.03 The data sheets will not entirely replace such information in other sections of practices where it may be used for illustrative or other purposes in text material.

2. DESCRIPTION AND APPLICATION OF DATA

A. Primary and Secondary Constants of Nonloaded Exchange Facilities

2.01 Primary and secondary constants are given for the various types of nonloaded exchange facilities including open wire and buried distribution wire.

2.02 Primary constants consists of the per mile values of inductance in millihenries, capacitance in microfarads, and for each of 12 frequencies between 50 and 15,000 cycles, the resistance in ohms and the conductance in micromhos.

2.03 Secondary constants consist of values for the same frequencies, of the propagation constant per mile in terms of attenuation and phase shift, and of the characteristic impedance. Attenuation is expressed in nepers and also in db, phase shift in radians. Characteristic impedance is expressed both as resistance and reactance, and as the impedance magnitude and angle.

B. Charts for Determination of Input Impedance of Nonloaded Cable with Any Termination

2.04 The charts in these sections have been designed for determining the resulting impedance at various frequencies when a termination of known impedance components ($r + jx$) is extended by any length of nonloaded cable. The resulting impedance can be computed, but the charts provide a graphic method simple in application and with a considerable saving of time and effort.

2.05 The solid curves are impedance loci and show for each value of terminating impedance the resulting impedance with any length of cable. The dashed curves comprise a length scale which determines the amount of change of impedance along the solid curve for a given length of cable added to (or under certain conditions subtracted from) the terminating impedance. The abscissa and ordinate of the chart are respectively the resistance and reactance (positive or negative) components of impedance. It will be noted that the solid curves are convergent. This means simply that as any terminating impedance is extended by cable the resulting, or input impedance, approaches the characteristic impedance of the cable.

2.06 The following examples illustrate some of the applications of the charts and the manner in which they are applied. Other applications may suggest themselves.

EXAMPLE 1

(a) Assume a termination whose impedance is r = 704 and x = +313 which is to be extended by 12 kft of 19 gauge ENB nonloaded cable.

(b) Assume the problem is to determine the 1000-cycle input impedance of this combination looking inward from the end of the extension.

(c) Refer to the chart in Section 304-017-100, Page 7, for 19 gauge CNB, ENB cable at 1000 cycles. Locate the intersection of r = 704 and x = +313. This point will be found to fall approximately on the dashed curve designated "6 kft" and about midway between two of the solid curves.

(d) Since the length of the nonloaded cable to be added is 12 kft, the new point will fall at 6 + 12 or on the dashed curve designated "18 kft".

(e) From the point determined in (c) move along an interpolated contour between the two solid curves to a point on the 18 kft dashed curve. The values for this point are r = 740 and x = —420 or 740 —j420, which is the desired input impedance. Should the point determined in (c) fall between the dashed curves, interpolation will be necessary to locate the new point.

EXAMPLE 2

It is possible by use of these charts to determine the change from midsection impedance of a loaded cable due to an end section either shorter or longer than a half section.

(a) Assume that it is desired to determine the 1000-cycle impedance looking into a 19 gauge ENB H88 loaded cable with an end section of 1000 feet.

(b) The 1000-cycle midsection impedance of the loaded cable determined from Section 304-141-104 is 1013 — j92.

(c) Locate this impedance on the same chart used in Example 1. It will be found to fall on a solid curve at a point corresponding to 11 kft.

(d) Since the end section is 1000 feet, the difference from midsection length is —2 kft. The length value on the chart will be 11 —2 or 9 kft. The desired impedance is found by moving along an impedance contour from the point determined in (c) to a point corresponding to 9 kft. The impedance at this point is 970 + j120, the desired value.

(e) The impedance for an end section greater than half section may be found by adding the excess length to the midsection impedance in the same manner as in Example 1.

EXAMPLE 3

It is possible also by use of these charts to make the entire impedance computation for a loaded line. This application is particularly valuable where irregularities or spacings other than nominal exist and where unusual or mixed weights of loading are used.

(a) Starting with the terminating impedance add the length of the first loading section as in Example 1. To this impedance add algebraically the impedance of the loading coil. Using this value as a new terminating impedance on the chart add the length of the next section. Proceeding in this manner the impedance at any point on the line may be determined.

C. Secondary Constants and Impedance Charts for Loaded Exchange Cable

2.07 Secondary constants are given in these subdivisions for the various types of exchange cable, both low capacitance and high capacitance, with the commonly used types of exchange loading. These constants are expressed in similar terms as those used for nonloaded facilities and are given for selected frequencies between 50 cycles and nominal cutoff. The nominal cutoff frequency is determined by the formula, $f_c = 1/\pi\sqrt{LC}$.

2.08 The impedance charts have been designed to simplify determination of the impedance of loaded cables with various end sections at various frequencies. The solid lines on the charts are impedance loci for selected frequencies and the dashed curves are end section length loci in tenths of a full section. The abscissa and ordinate are respectively the resistance and reactance (positive or negative) components of impedance. It is not practicable to plot frequencies below 1000 cycles as the areas enclosed within the impedance loci diminish rapidly and becomes unusable. If such impedances are desired they may be determined by means of the nonloaded facility charts and the method described in Example 2 in 2.06.

2.09 The following example illustrates the method of use of the loaded cable impedance charts.

(a) Assume that the impedance is to be determined for a 2400 foot (0.4) end section of 19-gauge ENB H88 loaded cable at a frequency of 2000 cycles.

(b) Select the chart for 19-gauge CNB, ENB H88 loaded cable in Section 304-141-104, Page 2. The required value will be found at the intersection of the dashed curve designated ".4" and the solid curve designated "2000~," i.e., at r= 1170 and x = +100 or 1170 + j100.

(c) For other fractions of a full section length and other frequencies between 1000 and 3000 cycles than those plotted, interpolations may be made. As an aid to interpolation between frequencies, the midsection impedances given in the secondary constants for other frequencies may be spotted along the .5 section dashed curve.