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TELEGRAPHY

TELEGRAPH TRANSMISSION

CALCULATION OF THE DEGREE OF DISTORTION OF A TELEGRAPHIE CIRCUIT IN TERMS OF THE DEGREES OF DISTORTION OF THE COMPONENT LINKS

ITU-T Recommendation R.11

(Previously “CCITT Recommendation”)

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation R.11 was revised by the ITU-T Study Group IX (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Recommendation R.11

CALCULATION OF THE DEGREE OF DISTORTION OF A TELEGRAPH CIRCUIT IN TERMS OF THE DEGREES OF DISTORTION OF THE COMPONENT LINKS

(New Delhi, 1960; amended at Geneva, 1964, 1980, at Melbourne, 1988 and at Helsinki, 1993)

1 In general the isochronous standardized test distortion δ (Definitions 33.07 and 33.12, Recommendation R.140) of a telegraph circuit consisting of a number *n* of links in tandem lies between the arithmetic sum and the square root of the sum of the squares of the degrees of distortion of the individual links,

$$\sum_{i=1}^{n} \delta > \delta > \sqrt{\sum_{i=1}^{n} \delta_i^2},$$

n being the number of links in tandem. The few exceptions to this rule that have been observed related to extremely long circuits (for example, four links, each of approximately 3500 km looped at voice-frequency at the distant end to give the equivalent of four links (each 7000 km go and return) and a total length of approximately 28 000 km on cable and open-wire carrier telephone-type channels).

2 For such purposes as the planning of networks, the degree of distortion of a telegraph circuit consisting of *n* channels or links in tandem in the telex service (where a great number of channels will be interconnected at random) is given fairly approximately by:

$$\delta_{\text{inherent}} = \sum_{n}^{1} + \sqrt{\sum_{1}^{n} (\delta_{\text{bias}})^2 + \sum_{1}^{n} (\delta_{\text{irreg.}})^2}$$

Similarly, for the combination of a transmitter and a telegraph circuit consisting of *n* channels or links in tandem in the telex service, the degree of distortion is given fairly approximately by:

$$\delta_{\text{text}} = \sum_{n,}^{1} \delta_c + \sqrt{\delta_t^2 + \delta_v^2 \sum_{1}^{n} (\delta_{\text{bias}})^2 + \sum_{1}^{n} (\delta_{\text{irreg.}})^2}$$

where

δ_{inherent} is the the probable degree of inherent start-stop distortion on standardized text.

δ_{text} is the the probable degree of gross start-stop distortion in service.

δ_c s the the degree of characteristic start-stop distortion of a single channel or link.

δ_t is the the degree of synchronous start-stop distortion of the transmitter.

δ_v is the the degree of start-stop distortion due solely to the difference between the mean transmitter speed and the standardized speed. (The difference to be considered is equal to six times the mean difference for one element.)

δ_{bias} is the the degree of asymmetrical (bias) distortion of one channel measured using 1:1 or 2:2 signals (either 1:1 or 2:2 signals should be used according to which is normally employed for adjusting the channels).

δ_{irreg} is the the degree of fortuitous distortion of one channel measured using 1:1 or 2:2 signals.

3 The values of distortion (except for δ_c) inserted in the foregoing formulae must have the same probability of being exceeded (*p*). The degree of characteristic distortion δ_c of a channel is fairly constant for each type of voice-frequency channel and can be determined in laboratory tests. Nevertheless, the maximum degree of characteristic distortion is reached for only about 20% of the signals of International Telegraph Alphabet No. 2. Empirical values for δ_c can be obtained with reasonable accuracy by using methods recommended by Recommendation R.4.

4 The probability of exceeding the degrees of distortion $\delta_{inherent}$ and δ_{text} calculated with the aid of the above formulae is 0.2 *p*.

5 The addition of distortion in tandem connected code-independent time-division multiplex systems will differ for non-synchronized and synchronized systems.

In the case of non-synchronized tandem connected systems the arithmetic addition of the maximum distortion of all systems can occur.

NOTE – The probability of occurrence of distortion and the duration of measurement to be assumed will differ in each case and requires further study.

In the case of synchronized systems, the total sampling distortion of all tandem connected systems will by the distortion due to the first system only.