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SERIES R: TELEGRAPH TRANSMISSION

Telegraph distortion

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

Reedition of CCITT Recommendation R.11 published in the Blue Book, Fascicle VII.1 (1988)

NOTES

1 CCITT Recommendation R.11 was published in Fascicle VII.1 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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 and at Melbourne, 1988)

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,

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

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:

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

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:

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

where

δ_{inherent} = the probable degree of inherent start-stop distortion on standardized text,

δ_{text} = the probable degree of gross start-stop distortion in service,

δ_c = the degree of characteristic start-stop distortion of a single channel or link,

δ_t = the degree of synchronous start-stop distortion of the transmitter,

δ_v = 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} = 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),

$\delta_{\text{irreg.}}$ = 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 δ_{inherent} and δ_{text} calculated with the aid of the above formulae is 0.2 *p*.

Note – The laws governing the addition of distortion in tandem connected code-independent time- division multiplex systems, and in particular the duration of measurement to be assumed, are the subject of study.

Pending further study and mores specific advice, arithmetic addition of distortion can be safely assumed for simplicity in all cases. Although pessimistic this will not lead to unnecessarily restrictive planning decisions in those cases where there is a regenerative link in the chain, e.g., Recommendation R.101 TDM or a regenerative SPC exchange. However, where another law is known to apply then the appropriate law of addition can be used.

e.g.:

mcvft	–	see text of Recommendation above
code-independent tdm	–	see note above for non-synchronized tandemed systems
	–	for synchronized tandemed systems the distortion due to the multiplexing process will be that of a single system
code-dependent tdm	–	regenerative

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