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TELEGRAPHY

TELEGRAPH TRANSMISSION

CODE AND SPEED DEPENDENT TDM SYSTEM FOR ANISOCHRONOUS TELEGRAPH AND DATA TRANSMISSION USING BIT INTERLEAVING

ITU-T Recommendation R.101

(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.101 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 Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.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.

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Recommendation R.101**CODE AND SPEED DEPENDENT TDM SYSTEM FOR ANISOCHRONOUS TELEGRAPH AND DATA TRANSMISSION USING BIT INTERLEAVING**

(Geneva, 1976; amended at Geneva, 1980, Malaga-Torremolinos, 1984; Melbourne, 1988 and at Helsinki, 1993)

The CCITT,

considering

- (a) that the economic transmission of large numbers of anisochronous telegraph and data services over a single telephone-type circuit may be achieved by using time-division multiplexing (TDM) techniques;
- (b) that the multiplexing system should be capable of operating as a sub-multiplexer within a higher order TDM hierarchy as well as on an analogue telephone-type circuit in association with standard data modems;
- (c) that the codes and speeds used for anisochronous telegraph and data transmission are well defined, permitting the application of simple code-dependent multiplexing techniques;
- (d) that code-dependent multiplexing provides inherent regeneration of start-stop signals carried by the system;
- (e) that, while it is foreseen that the main application would be for telex traffic, the multiplexing system should be capable of simultaneously transmitting the complete range of standard anisochronous speeds and codes likely to be required by users;
- (f) that the multiplexing system should be capable of accepting for transmission all types of telex signals and of regenerating those signals at the channel outputs within the tolerances specified in the relevant CCITT Recommendations;
- (g) that the multiplexing system should permit the efficient mixing of various combinations of anisochronous speeds, codes and signalling types in the same transmission system;
- (h) that the minimum duration of signal transfer delay through the TDM system could be achieved by the transmission of interleaved elements,

unanimously declares the view

that, where bit-interleaved code and speed dependent TDM systems are used for anisochronous telegraph and data transmission with an aggregate bit rate of 2400 bit/s carried either by an analogue telephone-type circuit or by a higher order TDM, the equipment shall be constructed to comply with the following standard:

1 System capacity

- 1.1** The capacity of the system shall be 46 channels at 50 bauds (7.5 units including a stop element of 1.5 units).
- 1.2** For other modulation rates two alternatives are allowed.
 - 1.2.1 Alternative A**
 - 1.2.1.1** Channels at 75 bauds (7.5 units including a stop element of 1.5 units) shall be accommodated. See 5.5.2 below.
 - 1.2.1.2** Further study is needed to accommodate other modulation rates.

1.2.2 Alternative B

1.2.2.1 The modulation rates and character structures shown in Table 1 shall be accommodated with the capacities indicated for homogeneous configurations.

1.2.2.2 The TDM system shall be capable of multiplexing the eight modulation rates shown in Table 1 simultaneously.

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System capacity (alternative B)

Modulation rate (bauds)	Character structure		Number of channels (homogeneous configuration)
	Character length (units)	Stop element (units)	
50	7.5	1.5	46
75	7.5	1.5	30
100	$\left\{ \begin{array}{l} 7.5 \text{ or} \\ 10 \end{array} \right.$	$\left\{ \begin{array}{l} 1.5 \\ 1 \end{array} \right.$	22
110	11	2	22
134.5	9	1	15
150	10	1	15
200	$\left\{ \begin{array}{l} 7.5 \\ 10 \text{ or} \\ 11 \end{array} \right.$	$\left\{ \begin{array}{l} 1.5 \\ 1 \\ 2 \end{array} \right.$	10
300	$\left\{ \begin{array}{l} 10 \text{ or} \\ 11 \end{array} \right.$	$\left\{ \begin{array}{l} 1 \\ 2 \end{array} \right.$	7

2 Start-stop channel inputs

2.1 The modulation rate tolerance that shall be accepted on continuous incoming 50- and 75-baud start-stop signals with a stop element of 1.4 units shall be at least $\pm 1.4\%$.

2.2 When receiving characters at 50 or 75 bauds having nominally 1.5-unit stop elements, the system shall be capable of transmitting without error, isolated incoming characters that have a one-unit stop element, occurring at a maximum rate of one per second.

2.3 The minimum interval between start elements of undistorted successive continuous characters that may be presented at the channel input when the nominal modulation rate is 50 or 75 bauds shall be $145 \frac{5}{6}$ or $97 \frac{2}{9}$ ms respectively.

2.4 There shall be no restriction on the continuous transmission of all characters specified in clause 1 above (e.g. combination No. 32 of International Telegraph Alphabet No. 2) when they are presented at the maximum permitted rate.

2.5 The effective net margin on all channel inputs when undistorted signals are received from a transmitter having a nominal character length and rate shall be at least 40%.

2.6 At the nominal signalling rate, an input character start element shall be rejected if equal to or less than 0.4 units duration and shall be accepted if equal to or more than 0.6 units duration.

2.7 Elements corresponding to start polarity (at the distant multiplexer output) shall be inserted in the aggregate stream in the case of:

- a) unequipped channels;
- b) equipped but unallocated channels;
- c) open-circuit line condition at the local start-stop channel input.

2.8 The maximum tolerance on modulation rates other than 50 and 75 bauds shall be 1.8%.

3 Start-stop channel outputs

3.1 The maximum degree of gross start-stop distortion shall be 3% for all permitted modulation rates.

3.2 The maximum difference possible between the mean modulation rate of the channel output signals and the nominal modulation rate shall be 0.2%.

3.3 When characters having a nominal 1.5-unit stop element are presented at any input rate within the specified range of this Recommendation, the minimum stop element duration released at the output shall be 1.25 units.

3.4 When characters having a nominal 1- or 2-unit stop element are presented at any input rate within the specified range of this Recommendation, the minimum stop element duration released at the output shall be 0.8 or 1.8 units respectively.

3.5 Channel output shall be controlled as specified below in the event of recognition of any of the following failure conditions:

- a) carrier loss signalled by the modem (OFF condition of received line signal detector – circuit CT109, Recommendation V.24 [1]);
- b) loss of aggregate signal (defined as a period of 280 ms without a transition on the aggregate);
- c) loss of synchronization.

3.6 Within 4 ms of the recognition of the failures described in 3.5, the following shall occur to the channel outputs of the affected TDM:

3.6.1 Leased channels – Two options shall be possible on a per channel basis:

- a) set to steady start polarity;
- b) set to steady stop polarity.

3.6.2 Circuit-switched service – Two options shall be possible on a per channel basis:

- a) steady start polarity at the channel output;
- b) loopback of the channel towards the local end for a period of 5 ± 1 seconds, after which channel outputs shall revert to steady start polarity. Additionally for alternative B, the traffic path shall be maintained towards the distant multiplexer terminal during this loopback interval.

NOTE – The actions taken in case 3.6.2 a) shall ensure that, after recognition of failure, no 50-baud channel used for circuit-switched service shall produce an output pulse of stop polarity of longer than 20 ms or a series of 20-ms pulses of stop polarity. It should be noted that 20-ms pulses can cause difficulty with some switching equipment. The loopback option in 3.6.2 b) is provided in order to avoid clearance of established connections during short breaks and thus avoid excessive recall attempts.

3.7 The affected terminal shall signal its synchronization status to the distant terminal in accordance with 6.3.5 for alternative A and 6.4.2 for alternative B. The distant terminal shall control its channel outputs in accordance with 3.6 above with a delay that shall not exceed 600 ms (measured from the instant of failure), ignoring the propagation time of the bearer circuit. Alternatively, for alternative B, leased channels have the option, at the customer's request, of maintaining the traffic path in the unaffected direction.

NOTE – When leased circuits, particularly simplex ones are set up on the TDM systems by using V.26 or V.27 modem, it is preferable to use the alternative B in this Recommendation.