INTERNATIONAL TELECOMMUNICATION UNION

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OF ITU

DIGITAL SECTIONS AND DIGITAL LINE SYSTEMS

DIGITAL SECTIONS BASED ON THE 2048 kbit/s HIERARCHY

ITU-T Recommendation G.921

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.921 was published in Fascicle III.5 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 G.921

DIGITAL SECTIONS BASED ON THE 2048 kbit/s HIERARCHY

(Malaga-Torremolinos, 1984; amended at Melbourne, 1988)

1 Characteristics of digital sections

1.1 *General features*

1.1.1 *Bit rate*

The digital sections based on the 2048 kbit/s hierarchy should be able to transmit signals at the nominal bit rates with their corresponding tolerances as indicated in Table 1/G.921.

TABLE 1/G.921

Tolerances on transmitted signals

Nominal bit rate (kbit/s)	2048	8448	34 368	139 264
Tolerance (ppm)	50	30	20	15

Note - The 2048 kbit/s digital sections may be operating synchronously or plesiochronously within the same environment.

1.1.2 *Special properties*

The digital sections based on the 2048 kbit/s hierarchy should be bit sequence independent.

1.2 *Characteristics of interfaces*

The digital interfaces should comply with Recommendation G.703.

1.3 *Performance standards*

The performance requirements (e.g. errors, jitter and availability) are specified in terms of a Hypothetical Reference Digital Section (HRDS). Such a model is defined in Recommendation G.801.

1.3.1 *Error performance*

Depending on the various applications in the different parts of a connection as specified in Recommendation G.821, different section quality classes have been defined in Table 2/G.921.

1.3.2 *Jitter*

To ensure that the maximum network limit of jitter (see § 2 of Recommendation G.823) is not exceeded within a digital network it is necessary to control the jitter contributed by transmission systems.

1.3.2.1 *Introduction*

The jitter specifications relate to hypothetical reference digital sections (HRDS) defined in Table 2/G.921.

The limits given below have been derived on the basis that only a few digital sections will be connected in cascade and, moreover, no account has been taken of jitter originating from asynchronous multiplexing equipment. However, in certain real network configurations some Administrations may find it necessary to have more sections in cascade along with many asynchronous digital multiplex. For effective jitter control in these situations it might be necessary to satisfy more demanding limits and/or to use other means of jitter minimization.

All the limits given below for digital sections are to be satisfied for all sections regardless of length and the number of repeaters.

It is important to note that the limits must be met regardless of the transmitted signal. In such circumstances the choice for a test sequence is left to the discretion of national Administrations. The measurement guidelines given in § 4 of Recommendation G.823 should be taken into account.

1.3.2.2 *Lower limit of tolerable input jitter*

The requirements given in Figure 2/G.823 and Table 2/G.823 should be met.

Note - It is recognized that for 2048 kbit/s line sections and under practical conditions of interference the permissible maximum input jitter may have to be reduced in the frequency range f_3 to f_4 (but retaining the existing 20 dB/decade slope below the frequency f_3 which would result in a slightly lower value for frequency f_2). Considering that these sections are used in the lowest levels of the network and that actual 2048 kbit/s sources have very low output jitter in the high frequency range (cf. Recommendations G.732, G.742 and Q.551), the resulting performance will be entirely satisfactory.

1.3.2.3 *Jitter transfer characteristics*

The maximum gain of the jitter transfer function should not exceed the value of 1 dB.

Note 1 - The low frequency limit should be as low as possible taking into account the limitations of measuring equipment. A value in the order of 5 Hz is considered acceptable.

Note 2 - For line sections at 2048 kbit/s complying with the alternative national interface option (Note 2 to Table 2/G.823), a jitter gain of 3 dB is permitted.

TABLE 2/G.921

Digital section quality classifications for error performance

Section quality classification	HRDS length (km) (see Figure 4/G.801) (Note 2)	Allocation (Notes 3, 4)	To be used in circuit classification (see Figure 1/G.821) (Notes 5 and 6)
1	280	0.45 %	High grade
2	280	2 %	Medium grade
3	50	2 %	Medium grade
4	50	5 %	Medium grade

Note 1 - There is no intention to confine any quality classification to any specific bit rate. The possibility of introducing additional options (for instance concerning length) requires further study.

Note 2 - The indicated values of length are those identified in Recommendation G.801. They should be understood to correspond to maximum lengths of real digital sections. If a real digital section is shorter, there will be no reduction of the bit error allocation (i.e. percentage value in the third column). This takes into account that:

- in many line systems (especially on copper wire pairs) most bit errors occur at the ends of the system;

- in the interest of economy, short-haul systems may be designed with greater per-kilometre error ratio than long-haul systems.

If a real digital section is longer (e.g. 450 km), its overall allocation should correspond to that of an integer number of HRDSs (of the same quality classification) the combined lengths of which are at least as long as the real section length (e.g. 2 x 280 km).

Note 3 - The values in this column are percentages of the overall degradation (at 64 kbit/s) specified in Recommendation G.821; i.e. of the 8% errored seconds, of the 10% degraded minutes and of the 0.1% severely errored seconds which are allocated according to the same rules as the two other parameters.

Note 4 - To obtain 64 kbit/s error performance data from error measurement at primary bit rates and above, the method described in Recommendation G.821, Annex D, should be used.

Note 5 - May also be used within a lower grade portion of the connection as defined per Figure 1/G.821.

Note 6 - To take account of adverse propagation conditions on radio systems as detailed in Recommendation G.821, an additional percentage of 0.05% of severely errored seconds has been allocated to a 2500 km radio-relay HRDP for systems operating in the high and medium grade quality part of the HRX. This corresponds for a 280 km section to a value of 0.0055% to be added to section quality classification 1 and 2 allocation when applied to severely errored seconds.

This would result in an additional allowance of 0.025% of severely errored seconds available for the medium grade part of the connection if it is realized entirely with class 1 radio sections. Where the medium grade portion of the network is realized with a mixture of different classifications, part of this additional allowance may be allocated to classes 3 and 4 at the discretion of Administrations.

To be consistent with the statistical assumptions made in G.821 § 3.3 b) regarding the number of radio sections in the HRX, and the occurrence of worst month effects it may be necessary to take into account the probability of worst month effects occurring simultaneously for all radio sections in a connection. A statistical model to be used for network planning and performance evaluation to assess the consistency of a given connection to the overall objective of G.821 is under study.

1.3.2.4 *Output jitter in the absence of input jitter*

The maximum peak-to-peak jitter in the absence of input jitter, for any valid signal condition, should not exceed the limit given in Table 3/G.921.

TABLE 3/G.921

The maximum output jitter in the absence of input jitter for a digital section

(Measurements are made in accordance with the method shown in Figure 1/G.823)

Bit rate (kbit/s)	HRDS length (km)	Maximum output jitter for a digital section		Measurement filter bandwidth		
		Low frequency limit (f_1-f_4) unit interval peak-to-peak	High frequency limit (f_3-f_4) unit interval peak-to-peak	Band-pass filter having a lower cut-off frequency f_1 or f_3 and an upper cut-off frequency f_4		
				f_1	f_3	f_4
2 048	50	0.75	0.2	20 Hz	18 Hz (700 Hz)	100 kHz
8 448	50	0.75	0.2	20 Hz	3 kHz (80 kHz)	400 kHz
34 368	50	0.75	0.15	100 Hz	10 kHz	800 kHz
34 368	280	0.75	0.15	100 Hz	10 kHz	800 kHz
139 264	280	0.75	0.075	200 Hz	10 kHz	3 500 kHz

Note - For interfaces within national networks the frequency values (f_2 and f_3) shown in parenthesis may be used.

1.3.3 *Availability*

Under study.

This performance requirement will be defined taking into account Recommendations G.821, E.800 and CCIR Recommendation 557.

1.4 *Fault conditions and consequent actions*

1.4.1 *Fault conditions*

The digital sections should detect the following fault conditions.

1.4.1.1 *Internal power failure of the line terminal equipment*

Note - Line refers to both cable and radio-relay equipments.

1.4.1.2 *Error ratio > $1 \cdot 10^{-3}$*

The consequent actions should be taken when the bit error ratio is considered to exceed $1 \cdot 10^{-3}$. Some form of persistence check should be employed to establish with appropriate confidence that a fault condition does exist. In any case, the alarm indication should be given with 500 ms of the start of the fault condition; this period includes the detection and any persistence check time.

The alarm indication should be removed once it has been established, with appropriate confidence, that the fault condition has disappeared.

1.4.1.3 *Loss of the signal at the receiving terminal*

Note - The detection of this fault condition is required only when it does not result in an indication "error ratio > $1 \cdot l0^{-3}$".

1.4.1.4 *Loss of alignment when alphabetic line codes or additional frames are used*

Note - The detection of this fault condition is required only when it does not result in an indication "error ratio > $1 \cdot 10^{-3}$".

1.4.1.5 *Loss of incoming interface signal*

1.4.2 *Consequent action*

Further to the detection of a fault condition, appropriate actions should be taken as specified in Table 4/G.921.

TABLE 4/G.921

Fault conditions and consequent actions for digital sections based on the 2048 kbit/s hierarchy

Equipment	Fault conditions	Maintenance alarms		AIS to	
		prompt	deferred (see Note)	Line side	Interface side
Line terminal equipment	Internal power failure	yes		if practicable	if practicable
Line side only	Error ratio > $1 \cdot 10^{-3}$	yes			yes
	Loss of the signal at the receiving terminal	yes			yes
	Loss of alignment when alphabetic line codes or additional frames are used	yes			yes
Interface side only	Loss of incoming signal	yes		yes	

Note - As far as network performance objectives are concerned, criteria to activate deferred maintenance alarm are needed. They should be provided by the systems if possible.

1.4.2.1 Prompt maintenance alarm indication generated to signify that performance is below acceptable standards and maintenance attention is required locally.

Note - The location and provision of any visual and/or audible alarm activated by the alarm indications given in § 1.4.2.1 above, is left to the discretion of each Administration.

1.4.2.2 AIS applied to the line side (see Notes 1 and 2).

1.4.2.3 AIS applied to the interface side.

Note 1 - The equivalent binary content of the alarm indication signal (AIS) is a continuous stream of ones.

Note 2 - The bit rate of this AIS should be within the tolerance limits defined in Table 1/G.921.

Note 3 - In the case of power failure apply AIS only if practicable.

1.4.3 *Time requirements for application of AIS*

In general, the AIS should be transmitted coincident with the detection of the fault conditions given in Table 4/G.921, except for AIS under the fault condition "error ratio > $1 \cdot 10^{-3}$"; in this latter case the time requirements given in § 1.4.1.2 should be respected.

Note - For wholly national digital sections and, with the agreement of the countries involved digital sections which cross international boundaries, an option to delay the transmission of an AIS of up to a few seconds may be needed when the application of an AIS is controlled by means of a G.921 threshold monitoring process based on the severely errored second G.821 parameter. Short downstream alarms in international digital links which are routed via wholly national digital sections may appear during these few seconds.