INTERNATIONAL TELECOMMUNICATION UNION

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GENERAL ASPECTS OF DIGITAL TRANSMISSION SYSTEMS

TERMINAL EQUIPMENTS

DIGITAL MULTIPLEX EQUIPMENT OPERATING AT 139 264 kbit/s AND MULTIPLEXING THREE TRIBUTARIES AT 44 736 kbit/s

ITU-T Recommendation G.755

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.755 was published in Fascicle III.4 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.755

DIGITAL MULTIPLEX EQUIPMENT OPERATING AT 139 264 KBIT/S AND MULTIPLEXING THREE TRIBUTARIES AT 44 736 KBIT/S

(Melbourne, 1988)

1 General

The digital multiplex equipment described in this Recommendation is intended for use between networks using different digital hierarchies as specified in Recommendations G.702 and G.802.

2 Bit rate

The bit rates of the tributary and multiplex signals should be 44 736 kbit/s ± 20 ppm and 139 264 kbit/s ±15 ppm, respectively, as specified in Recommendation G.703.

3 Frame structure

Table 1/G.755 gives the recommended 139 264 kbit/s multiplexing frame structure.

4 Loss and recovery of frame alignment and consequent action

Loss of frame alignment should be assumed to have taken place when four consecutive frame alignment signals have been incorrectly received in their predicted positions.

When frame alignment is assumed to be lost, the frame alignment device should decide that such alignment has effectively been recovered when it detects the presence of three consecutive correct frame alignment signals.

The frame alignment device, having detected the appearance of a single correct frame alignment signal, should begin a new search for the frame alignment signal when it detects the absence of the frame alignment signal in one of the two following frames.

Note - As it is not strictly necessary to specify the detailed frame alignment strategy, any suitable frame alignment strategy may be used provided the performance achieved is at least as efficient in all respects as that obtained by the above frame alignment strategy.

5 Multiplexing and justification methods

Cyclic bit interleaving in the tributary numbering order and positive justification are recommended.

The justification control signal should be distributed and use the C_{ji} -bits (j = 1, 2, 3; i = 1, 2, 3, 4, 5) (see Note 6 to Table 1/G.755).

Positive justification should be indicated by the justification control signal 11111 and no justification by the signal 00000. Majority decision is recommended.

Table 1/G.755 gives the maximum justification rate per tributary and the nominal justification ratio.

6 Jitter

6.1 *Demultiplexer triburaty jitter transfer characteristic*

The demultiplexer 44 736 kbit/s tributary jitter transfer characteristic should meet the gain/frequency limits given in Figure 1/G.755. The equivalent binary content of the test signal used should result in a tributary output signal of 1000.

TABLE 1/G.755

139 264 kbit/s multiplexing frame structure

Nominal tributary bit rate (kbit/s)	44 736
Number of tributaries	3
Frame structure	Bit number
Frame alignment signal (111110100000)	*Set I*
Bits from tributaries	1 to 12
	13 to 159
Justification control bits C_{j1} (Note 1)	*Set II*
Bits from tributaries	1 to 3
	4 to 159
Justification control bits C_{j2} (Note 1)	Set III
Bits from tributaries	1 to 3
	4 to 159
Justification control bits C_{j3} (Note 1)	*Set IV*
	1 to 3
Alarm indication to the remote multiplex equipment (Note 2)	4
Parity bit (Notes 3, 4 and 5)	5
Bits reserved for future use (Note 6)	6 to 9
Bits from tributaries	10 to 159
Justification control bits C_{j4} (Note 1)	*Set V*
	1 to 3
Bits from tributaries	4 to 159
Justification control bits C_{j5} (Note 1)	*Set VI*
	1 to 3
Bits from tributaries available for justification	4 to 6
Bits from tributaries	7 to 159
Frame length	954 bits
Bits per tributary in a frame	307 bits
Maximum justification rate per tributary	146 kbit/s
Nominal justification ratio	0.545

Note 1 - C_{ji} (j = 1, 2, 3; i = 1, 2, 3, 4, 5) indicates the *i*th justification control bit of the *j*th tributary.

Note 2 - See § 10.2.1.

Note 3 - The parity bit = 1 if the number of marks in all tributary bits including the bits in the justifiable time-slots in the preceding frame is odd; the parity bit = 0 if the number of marks in all tributary bits including the bits in the justifiable time-slots in the preceding frame is even.

Note 4 - It is recognized that existing multiplex equipment installed prior to adoption of this Recommendation does not insert the parity bit.

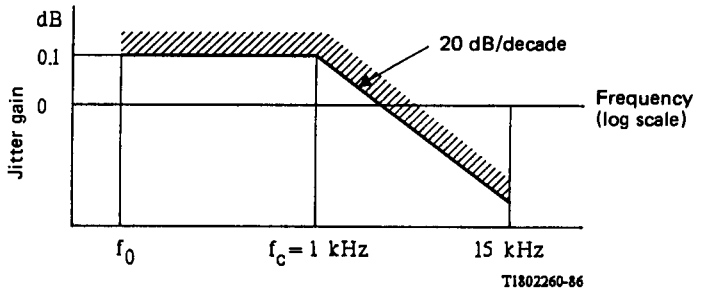
Note 5 - The implementation and the use of this parity bit procedure are for further study.

Note 6 - These bits should be set to 1 when not used.

Note 1 - This characteristic is usually measured between the high speed and low speed interfaces of the demultiplexer and the measurements are taken in unit intervals. It is then necessary to introduce a correction factor to account for the difference in the size of unit intervals.

Note 2 - In addition, the need to specify a muldex jitter transfer characteristic is for further study.

Note 3 - It is recognized that the existing multiplex equipment designed prior to the adoption of this Recommendation might need tributary test signals incorporating the 44 736 kbit/s frame structure defined in Recommendation G.572.



Note - The frequency f_0 should be as low as possible, taking into account the limitations of measuring equipment In any case f_0 should be no greater than 10 Hz. The selective measurement method should be used.

FIGURE 1/G.755

Demultiplexer tributary jitter transfer characteristic

6.2 *Output jitter*

6.2.1 *Tributary output jitter*

With no jitter applied to the input ports of the multiplexer and with the multiplexer directly connected to the demultiplexer, the peak-to-peak jitter at the tributary output port should not exceed 0.3 UI when measured over a one minute interval within the frequency range from f_1 = 10 Hz to f_4 = 400 Hz.

When measured with an instrument incorporating a bandpass filter having a lower cutoff frequency of f_3 = 60 kHz, a roll-off of 20 dB/decade and an upper limit of f_4 = 400 kHz, the peak-to-peak output jitter should not exceed 0.05 UI when it is measured over a one minute interval.

6.2.2 *Multiplexer output jitter*

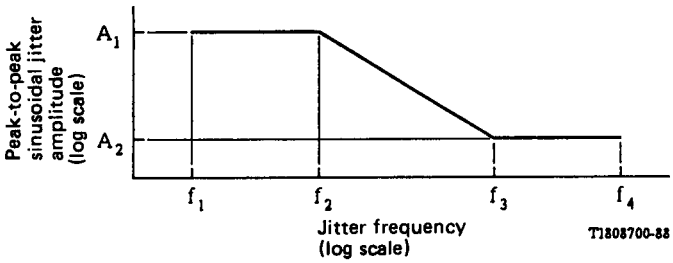
The peak-to-peak jitter at the 139 264 kbit/s output port should not exceed 0.05 UI when it is measured over a one minute interval within the frequency range from 200 Hz to 3500 kHz.

6.3 *Input jitter*

6.3.1 *Tributary input jitter*

The 44 736 kbit/s input port should be capable of accommodating levels of input jitter up to the limits given in Figure 2/G.755.

Note - Current Recommendation G.703 does not refer to the jitter tolerated at the digital distribution frame at 44 736 kbit/s nor at the input port of equipment connected to this distribution frame.



Peak-to-peak sinusoidal jitter amplitude		Frequency			
A_1 (UI)	A_2 (UI)	f_1 (Hz)	f_2 (Hz)	f_3 (kHz)	f_4 (kHz)
5.0	0.1	10	2.3	60	400

FIGURE 2/G.755

Lower limit of maximum tolerable sinusoidal input jitter at 44 736 kbit/s

6.3.2 *Demultiplexer input jitter*

The 139 264 kbit/s input port should be capable of accommodating levels of input jitter up to the limits given in Recommendation G.823.

Note - The jitter accommodation requirement should be met when the jittered input signal is composed of the multiplexed tributary signals having any value of jitter allowed for the 44 736 kbit/s level.

7 Digital interfaces

The digital interfaces at 44 736 kbit/s and 139 264 kbit/s should be in accordance with Recommendation G.703.

8 Timing signal

If it is economically feasible, it may be desirable to be able to derive the multiplexing timing signal from an external source as well as from an internal source.

9 Service digits

Six bits per frame are available for service functions (see Table 1/G.755): bit 4 of Set IV is used to transmit an alarm indication to the remote multiplex equipment when specific fault conditions are detected in the multiplex equipment when specific fault conditions are detected in the multiplex equipment (see § 10 below); bit 5 of Set IV may be used for a parity check; bits 6 to 9 of Set IV are reserved for further use.

10 Fault conditions and consequent actions

10.1 *Fault conditions*

10.1.1 The digital multiplex equipment should detect the following fault conditions:

1) failure of power supply;

2) loss of an incoming 44 736 kbit/s tributary signal at a multiplexer input port;

3) loss of an incoming 139 264 kbit/s multiplex signal at a demultiplexer input port;

Note - The detection of this fault condition is required only when it does not result in an indication of loss of frame alignment.

4) loss of frame alignment signal at a demultiplexer input port;

5) detection of an alarm indication received from the remote multiplex equipment at a demultiplexer input port;

6) detection of alarm indication signal (AIS) at a demultiplexer input port.

Note 1 - The equivalent binary content of the AIS at 139 264 kbit/s should be a continuous stream of binary 1s (marks) as recommended in Recommendation M.20.

Note 2 - The strategy for detecting the presence of the AIS should be such that the AIS is detectable even in the presence of an error ratio of $1 \cdot 10^{-3}$. However, a signal with all bits except the frame alignment signal in the state of 1 should not be mistaken as an AIS.

10.1.2 The need to monitor the degradation of the incoming 139 264 kbit/s signal for the purpose of end-to-end error performance monitoring of the 139 264 kbit/s digital block, as well as the procedure for detecting such degradation are for further study.

10.2 *Consequent actions*

Further to the detection of a fault condition, the appropriate actions should be taken as specified in Table 2/G.755.

Note 1 - The concept and definition of prompt maintenance alarm indication is given in Recommendation M.20.

Note 2 - When the alarm indication signal (AIS) is detected at the input of the demultiplexer, the prompt maintenance alarm indication associated with loss of frame alignment should be inhibited, while the rest of the consequent actions are in accordance with those associated in Table 2/G.755 with the fault condition.

10.2.1 Alarm indication to the remote multiplex equipment should be generated by changing bit 4 of Set IV (see Table 1/G.755) from the state 0 to the state 1.

10.2.2 AIS should be applied to the following as specified in Table 2/G.755:

- all three 44 736 kbit/s tributary outputs from the demultiplexer;
- 139 264 kbit/s output of the multiplexer;
- the time slots of the 139 264 kbit/s signal at the output of the multiplexer, corresponding to the relevant 44 736 kbit/s tributary.

Note - The equivalent binary content of the AIS at 44 736 kbit/s is a signal with a valid frame alignment signal, parity and justification control bits as defined in Table 2/G.752, with the tributary bits being set to a 1010 ... sequence, starting with a binary 1 after each frame alignment, multi-frame alignment and justification control bit, and with all justification control bits being set to binary 0.

TABLE 2/G.755
Fault conditions and consequent actions

Equipment part	Fault condition (see § 10.1)	Consequent actions (see §10.2)				
		Prompt maintenance alarm indication generated	Alarm indication to the remote multiplex equipment generated	AIS applied		
				To all the tributaries	To the composite signal	To the relevant time slots of the composite signal
Multiplexer and demultiplexer	Failure of power supply	Yes		Yes, if practicable	Yes, if practicable	
Multiplexer only	Loss of incoming signal on a tributary	Yes				Yes
Demultiplexer only	Loss of incoming signal at 139 264 kbit/s	Yes	Yes	Yes		
	Loss of frame alignment	Yes	Yes	Yes		
	Alarm indication received from the remote multiplex equipment					

Note - A *Yes* in the table signifies that a certain action should be taken as a consequence of the relevant fault condition. An *open space* in the table signifies that the relevant action should *not* be taken as a consequence of the relevant fault condition, if this condition is the only one present. If more than one fault condition is simultaneously present the relevant action should be taken if, for at least one of the conditions, a *Yes* is defined in relation to this action.