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TERMINAL EQUIPMENTS

CHARACTERISTICS OF PRIMARY PCM MULTIPLEX EQUIPMENT OPERATING AT 2048 kbit/s

ITU-T Recommendation G.732

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.732 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.732

CHARACTERISTICS OF PRIMARY PCM MULTIPLEX EQUIPMENT OPERATING AT 2048 kbit/s

(Geneva, 1972; further amended)

1 General characteristics

1.1 *Fundamental characteristics*

The encoding law used is the A-law as specified in Recommendation G.711. The sampling rate, load capacity and the code are also specified in that Recommendation.

The number of quantized values is 256.

Note - The inversion of bits 2, 4, 6, and 8 is covered by the encoding law and is applicable only to voice-channel time slots.

1.2 *Bit rate*

The nominal bit rate is 2048 kbit/s. The tolerance on this rate is ± 50 parts per million (ppm).

1.3 *Timing signal*

It should be possible to derive the transmitting timing signal of a PCM multiplex equipment from an internal source, from the incoming digital signal and also from an external source.

Note - Further study is required on the effect of jitter of the incoming signal on the timing signal, and on the measures to be taken in case of loss of the incoming signal or the external source.

2 Frame structure

Refer to §§ 3.3.1 and 3.3.2 of Recommendation G.704 for frame structure and use of derived channel time slots.

Note - If channel time slot 16 which is assigned to signalling as covered in § 5 below is not needed for signalling it may be used for purposes other than a voice channel encoded within the PCM multiplex equipment.

3 Loss and recovery of frame alignment

The strategy for the loss and recovery of frame alignment should be according to Recommendation G.706, § 4.1.

4 Fault conditions and consequent actions

4.1 *Fault conditions*

The PCM multiplex equipment should detect the following fault conditions:

4.1.1 Failure of power supply.

4.1.2 Failure of codec (except when using single-channel codecs).

As a minimum requirement this fault condition should be recognized when, for at least one signal level in the range -21 to -6 dBm0, the signal-to-quantizing noise ratio performance of the local codec is 18 dB or more below the level recommended in Recommendation G.712.

4.1.3 Loss of incoming signal at the 64 kbit/s input port (time slot 16).

Note 1 - The detection of this fault condition is not mandatory when channel associated signalling is used and the signalling multiplex is situated within a few metres of the PCM multiplex equipment.

Note 2 - The detection of this fault condition is not mandatory when contradirectional interfaces are used.

4.1.4 Loss of the incoming signal at 2048 kbit/s.

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

4.1.5 Loss of frame alignment.

4.1.6 Excessive bit error ratio detected by monitoring the frame alignment signal.

4.1.6.1 With a random bit error ratio of $\leq 10^{-4}$, the probability of activating the indication of fault condition within a few seconds should be less than 10^{-6}.

With a random bit error ratio of $\geq 10^{-3}$, the probability of activating the indication of fault condition within a few seconds should be higher than 0.95.

4.1.6.2 With a random bit error ratio of $\geq 10^{-3}$, the probability of deactivating the indication of fault condition within a few seconds should be almost 0.

With a random bit error ratio of $\leq 10^{-4}$, the probability of deactivating the indication of fault condition within a few seconds should be higher than 0.95.

Note - The activating and the deactivating period specified as "a few seconds" is intended to be in the order of 4 to 5 seconds.

4.1.7 Alarm indication received from the remote PCM multiplex equipment (see § 4.2.3 below).

4.2 *Consequent actions*

Further to the detection of a fault condition, appropriate actions should be taken as specified in Table 1/G.732. The consequent actions are as follows:

4.2.1 Service alarm indication generated to signify that the service provided by the PCM multiplex is no longer available. This indication should be forwarded at least to the switching and/or signalling multiplex equipment depending upon the arrangements provided. The indication should be given as soon as possible and not later than 2 ms after detection of the relevant fault condition.

This specification, taking into account the specification given in § 3 above, is equivalent to recommending that the average time to detect a loss of frame alignment and to give the relevant indication should not be greater than 3 ms.

When using common-channel signalling, the indication should be forwarded to the switching equipment by means of a separate interface on the PCM multiplex equipment.

4.2.2 Prompt maintenance alarm indication generated to signify that performance is below acceptable standards and maintenance attention is required locally. When the Alarm Indication Signal (AIS) (see General Notes below to § 4.2) is detected, the prompt maintenance alarm indication associated with loss of frame alignment (see § 4.1.5 above) and excessive error ratio (see § 4.1.6 above) should be inhibited, while the rest of the consequent actions are in accordance with those associated in Table 1/G.732 with the two fault conditions.

Note - The location and provision of any visual and/or audible alarm activated by the alarm indications given in §§ 4.2.1 and 4.2.2 above, is left to the discretion of each Administration.

4.2.3 Alarm indication to the remote end, transmitted by changing bit 3 of channel time-slot 0 from the state 0 to the state 1 in those frames not containing the frame alignment signal. This should be effected as soon as possible.

4.2.4 Transmission suppressed at the analogue outputs.

4.2.5 AIS applied to time-slot 16 64 kbit/s output (see General Notes below to § 4.2). This action should be taken as soon as possible and not later than 2 ms after the detection of the fault condition.

4.2.6 AIS applied to time slot 16 of the output 2048 kbit/s composite signal (if supervision of the incoming 64 kbit/s signal is provided).

General Notes to § 4.2

Note 1 - The equivalent binary content of the AIS is a continuous stream of binary 1s. 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 in the 1 state, should not be mistaken as an AIS.

Note 2 - All timing requirements quoted apply equally to restoration, subsequent to the fault condition clearing.

5 Signalling

5.1 *Signalling arrangement*

Refer to § 3.3.3 of Recommendation G.704. Channel time slot 16 may be used to provide an interface at 64 kbit/s which shall be suitable for use with either common channel or channel associated signalling.

TABLE 1/G.732

Fault conditions and consequent actions for the PCM multiplex equipment

Equipment part	Fault conditions (see § 4.1)	Consequent actions (see § 4.2)					
		Service alarm indication generated	Prompt maintenance alarm indication generated	Alarm indication to the remote end transmitted	Transmission suppressed at the analogue outputs	AIS applied to 64 kbit/s output (time slot 16)	AIS applied to time slot 16 of the 2048 kbit/s composite signal
Multiplexer and demulti-plexer	Failure of power supply	Yes	Yes	Yes (if practicable)	Yes (if practicable)	Yes (if practicable)	Yes (if practicable)
	Failure of codec	Yes	Yes	Yes	Yes		
Multiplexer only	Loss of incoming signal at 64 kbit/s input time slot 16 (see Notes under § 4.1.3)		Yes				Yes
Demulti-plexer only	Loss of incoming signal at 2048 kbit/s	Yes	Yes	Yes	Yes	Yes	
	Loss of frame alignment	Yes	Yes	Yes	Yes	Yes	
	Error ratio 10^{-3} on the frame alignment signal	Yes	Yes	Yes	Yes	Yes	
	Alarm indication received from the remote end (bit 3 of time slot 0)	Yes					

Note - A *Yes* in the table signifies that an 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.

5.2 *Loss and recovery of multiframe alignment in case of channel associated signalling*

Multiframe alignment should be assumed to have been lost when two consecutive multiframe alignment signals have been received with an error.

Multiframe alignment should be assumed to have been recovered as soon as the first correct multiframe alignment signal is detected.

Note - To avoid a condition of spurious multiframe alignment, the following procedure may be used in addition to the above:

- Multiframe alignment should be assumed to have been lost when, for a period of one or two multiframes, all the bits in time slot 16 are in state 0.
- Multiframe alignment should be assumed to have been recovered only when at least one bit in state 1 is present in the time slot 16 preceding the multiframe alignment signal first detected.

5.3 *Fault conditions and consequent actions in case of channel associated signalling*

5.3.1 *Fault conditions*

The signalling multiplex equipment should detect the following fault conditions:

5.3.1.1 Failure of power supply.

5.3.1.2 Loss of 64 kbit/s incoming signal at the input of the signalling demultiplexer.

Note 1 - The detection of this fault condition is not mandatory when the signalling multiplex equipment is situated within a few metres of the PCM multiplex equipment or when this fault condition results in an indication of loss of multiframe alignment.

Note 2 - Where separate circuits are used for the digital signal and the timing signal then loss of either or both should constitute loss of the incoming signal.

5.3.1.3 Loss of multiframe alignment.

5.3.1.4 Alarm indication received from the remote signalling multiplex equipment (see § 5.3.2.3 below).

5.3.1.5 Receipt of the service alarm indication from the PCM multiplex equipment (see § 4.2.1 above).

5.3.2 *Consequent actions*

Further to the detection of a fault condition appropriate actions should be taken as specified in Table 2/G.732. The consequent actions are as follows:

5.3.2.1 Service alarm indication to be forwarded to the switching equipment depending upon the switching and signalling arrangements provided.

5.3.2.2 Prompt maintenance alarm indication generated to signify that performance is below acceptable standards and maintenance attention is required locally. If provision is made for detecting the AIS, then on the reception of the AIS, the prompt maintenance alarm indication should be inhibited in the case of loss of multiframe (see § 5.3.1.3 above).

Note - The location and provision of any visual and or audible alarms activated by the alarm indications given in §§ 5.3.2.1 and 5.3.2.2 above is left to the discretion of each Administration.

5.3.2.3 Alarm indication to the remote signalling multiplex equipment, generated by changing from the state 0 to the state 1 bit 6 of channel time slot 16 of frame 0 of the multiframe (see Table 7/G.704); this should be effected as soon as possible.

5.3.2.4 Application of the condition corresponding to state 1 on the line to all receive signalling channels. This condition should be forwarded as soon as possible and not later than 3 ms after the detection of the fault condition.

Note - All timing requirements quoted apply equally to restoration, subsequent to the fault condition clearing.

6 Interfaces

The analogue interfaces should be in accordance with Recommendations G.712, G.713, G.714 and G.715. The digital interfaces at 2048 kbit/s should be in accordance with Recommendation G.703. The digital interfaces at 64 kbit/s should be of either the codirectional or the contradirectional type specified in Recommendation G.703. The specifications for 64 kbit/s interfaces are not mandatory for channel associated signalling. The interface for external synchronization of the transmitting timing signal should be in accordance with Recommendation G.703.

TABLE 2/G.732

Fault conditions and consequent actions for channel-associated signalling multiplex equipment

Equipment part	Fault conditions(see § 5.3.1)	Consequent actions (see § 5.3.2)			
		Service alarm indication generated	Prompt maintenance alarm indication generated	Alarm indication to the remote end transmitted	Application of state, equivalent to state 1, on line to all receive signalling channels
Multiplexer and demultiplexer	Failure of power supply	Yes	Yes	Yes (if practicable)	Yes (if practicable)
Demulti-plexer only	Loss of incoming signal	Yes	Yes	Yes	Yes
	Loss of multiframe alignment	Yes	Yes	Yes	Yes
	Alarm indication received from the remote signalling multiplex equipment	Yes			Yes
	Receipt of the service alarm indication from PCM mux	Yes			Yes

Note - A *Yes* in the table signifies that an 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.

7 Jitter

7.1 *Jitter at 2048 kbit/s output*

In the case where the transmitting timing signal is derived from an internal oscillator, the peak-to-peak jitter at the 2048 kbit/s output should not exceed 0.05 UI when it is measured within the frequency range from f_1 = 20 Hz to f_4 = 100 kHz.

7.2 *Jitter at 64 kbit/s output (for interfaces according to Rec. G.703)*

7.2.1 In the case where the incoming 2048 kbit/s signal has no jitter, the peak-to-peak jitter at the 64 kbit/s output should not exceed 0.025 UI when it is measured within the frequency range from f_1 = 20 Hz to f_4 = 10 kHz. The equivalent binary content of the test signal applied to the 2048 kbit/s input shall be a pseudo-random bit sequence of length 2^{15} - 1 as specified in Recommendation O.151.

Note - In order to carry out this measurement without invoking AIS at the 64 kbit/s output, it will normally be necessary to include a frame alignment signal in the test signal.

7.2.2 The jitter transfer function between the 2048 kbit/s input and the 64 kbit/s output should not exceed -29.6 dB when measured over the frequency range f_0 to 10 kHz. The frequency f_0 should be less than 20 Hz and as low as possible (e.g. 10 Hz), taking into account the limitations of measuring equipment.

Note 1 - The 2048 kbit/s test signal shall be modulated by sinusoidal jitter. The equivalent binary content of the test signal shall be 1000.

Note 2 - In order to carry out this measurement without invoking AIS at the 64 kbit/s output, it will normally be necessary to include a frame alignment signal in the test signal.

Note 3 - The jitter reduction of 1/32 due to demultiplexing is equivalent to -30.1 dB.