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TERMINAL EQUIPMENTS

SECOND ORDER PCM MULTIPLEX EQUIPMENT OPERATING AT 8448 kbit/s

Recommendation G.744

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.744 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.

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SECOND ORDER PCM MULTIPLEX EQUIPMENT OPERATING AT 8448 kbit/s

(Geneva, 1976; amended at Geneva, 1980 and at Melbourne, 1988)

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 8448 kbit/s. The tolerance on this rate is ± 30 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 §§ 3.4.1 and 3.4.2 of Recommendation G.704 for frame structure and use of derived channel time slots.

3 Loss and recovery of frame alignment

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 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.

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 slots 67 to 70)*

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 8448 kbit/s.

Note 1 - The detection of this fault condition is required only when it does not result in an indication of loss of frame 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.

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 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 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 of $\geq 10^{-4}$**,** 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 end (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.744. 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 or a loss of the incoming 8448-kbit/s signal 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 Note 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 rate (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.744 with the two fault conditions.

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

4.2.3 Alarm indication to the remote end generated by changing bit 7 of channel time slot 66 from the state 0 to the state 1. This should be effected as soon as possible.

4.2.4 Transmission suppressed at the analogue outputs.

4.2.5 AIS applied to time slots 67 to 70 of the 64 kbit/s outputs when not used for speech (see General Note 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 slots 67 to 70 of the output 8448 kbit/s composite signal when these are not used for speech (if supervision of incoming 64 kbit/s signal is provided).

General Note to § 4.2 - 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 $1 \cdot 10^{-3}$. However, a signal with all bits except the frame alignment in the 1s state, should not be mistaken for an AIS.

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

TABLE 1/G.744

Fault conditions and consequent actions for the PCM multiplex equipment

Equipment part	Fault condition (see § 4.1)	Consequent actions (see § 4.2)					
		Service alarm indication generated	Prompt maintenance alarm indication generated	Alarm indication to the remote end generated	Trans-mission suppressed at the analogue outputs	AIS applied to 64-kbit/s outputs (time slots 67 to 70)	AIS applied to time slots 67 to 70 of the 8448 kbit/s composite signal
Multiplexer and demultiplexer	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 inputs time slots 67 to 70 (see notes under § 4.1.3)		Yes				Yes
Demultiplexer only	Loss of incoming signal at 8448 kbit/s	Yes	Yes	Yes	Yes	Yes	
	Loss of frame alignment	Yes	Yes	Yes	Yes	Yes	
	Error rate 1 in 10^{-3} for the alignment signal	Yes	Yes	Yes	Yes	Yes	
	Alarm indication received from the remote end (bit 7 of time slot 66)	Yes					

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.

5 Signalling

5.1 *Signalling arrangement*

Refer to § 3.4.3 of Recommendation G.704. Channel time-slots 67 to 70 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 or other services as required.

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

For multiframe alignment each 64 kbit/s channel should be treated separately. For each channel, 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 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 the relevant channel time slots 67, 68, 69 or 70 are at the state 0.
- Multiframe alignment should be assumed to have been recovered, only when at least one bit in the state 1 is present in the relevant time slots 67, 68, 69 or 70 preceding the multiframe alignment signal first detected.

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

The fault conditions and consequent actions for each 64 kbit/s signalling channel and for each signalling multiplex equipment are the same as recommended in Recommendation G.732, § 5.3.

6 Interfaces

The analogue interfaces should be in accordance with Recommendations G.712, G.713 and G.714. The digital interfaces at 8448 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.

7 Jitter

7.1 *Multiplex signal output jitter at 8448 kbit/s output*

In the case where the transmitting timing signal is derived from an internal oscillator, the peak-to-peak jitter at the 8448 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 = 400 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 8448 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 8448 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 8448 kbit/s input and the 64 kbit/s output is under study.