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TERMINAL EQUIPMENTS

CHARACTERISTICS OF A 64 kbit/s CROSS-CONNECT EQUIPMENT WITH 2048 kbit/s ACCESS PORTS

Recommendation G.796

Geneva, 1992

FOREWORD

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CCITT NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized private operating agency.

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Recommendation G.796

CHARACTERISTICS OF A 64 kbit/s CROSS-CONNECT EQUIPMENT WITH 2048 kbit/s ACCESS PORTS

(1992)

Scope

This Recommendation gives the characteristics of a synchronous cross-connect equipment to be used in a synchronized digital network and which cross-connects time slots at 64 kbit/s or $n \times 64$ kbit/s from/to any 2048 kbit/s access port.

1 General characteristics

1.1 *Capacity*

This parameter depends mainly on the network architecture. It can change with time. Increasing an equipment should not disturb the existing data traffic.

1.2 *Access ports*

Access ports of a cross-connect equipment are input and output ports used to terminate 2048 kbit/s signals transporting synchronous 64 kbit/s and $n \times 64$ kbit/s signals to be cross-connected (see § 3).

1.3 *Timing signal*

1.3.1 *Control of timing signal*

It should be possible to derive the internal timing signal from the following:

a) one from a number of external source(s) at 2048 kHz;

b) one from a number of 2048 kbit/s signal(s);

c) from an internal oscillator.

The frequency accuracy of signals in items a) and b) above will normally be $\pm 1 \times 10^{-11}$. To take into account possible frequency deviations on these signals occurring due to failure in the synchronous network, the design of timing derivation circuits should assume a frequency accuracy of ± 1 ppm.

Note – The provision of timing signal outputs available for the purpose of synchronizing other equipments, is an option that might be required depending upon national synchronization arrangements.

1.3.2 *Timing performance*

The timing performance of the internal clock should comply with Recommendation G.812. In the holdover mode, the local clock requirements of § 2.2.3 of Recommendation G.812 should be met.

Note – For other timing performance options, refer to § 6.3 below.

1.4 *Blocking factor*

For the mandatory functions in § 2.1 below, the blocking factor should be zero for cross-connect equipment of size up to 256 access ports of 2048 kbit/s; a zero blocking factor for the case of greater than 256 access ports is desirable. For the optional functions in § 2.2, the blocking factor should be as low as possible; the maximum value is under study.

See Notes in §§ 2.1 and 2.2 below.

2 Functions

2.1 *Mandatory functions*

a) Cross-connection of 64 kbit/s and $n \times 64$ kbit/s signals, according to the TS order given in §§ 5.2 of Recommendation G.704 and 2.2.3 of Recommendation G.735, bidirectional. The equipment shall maintain octet sequence integrity of the signals being cross-connected;

Note 1 – The need to deal with $n \times 64$ kbit/s signals according to § 5.2 of Recommendation G.704 and 6×64 kbit/s (384 kbit/s) signals according to § 2.2.3 of Recommendation G.735, should be taken into account in the design of the equipment architecture to minimize any impact on delay and blocking factor.

Note 2 – For some $n \times 64$ kbit/s applications it is necessary to maintain octet sequence integrity within the same frame.

b) Management; These should include control functions and provision of maintenance information.

2.2 *Optional functions*

a) Cross-connection of 64 kbit/s and $n \times 64$ kbit/s signals, unidirectional. The equipment shall maintain octet sequence integrity of the signals being cross-connected;

Note – For some applications it is necessary to maintain octet sequence integrity within the same frame.

b) Cross-connection of channel associated signalling bits, a, b, c, d, in time slot 16 corresponding to the 64 kbit/s time slot cross-connection. The equipment shall maintain a, b, c, d bits integrity;

c) Distribution of 64 and $n \times 64$ kbit/s signals on a broadcast basis;

d) Cross-connection of $n \times 64$ kbit/s signals which are not according to the time slot order given in §§ 5.2 of Recommendation G.704 or 2.2.3 of Recommendation G.735 or those where the formats differ between input and output ports, bidirectional and unidirectional. The equipment shall maintain octet sequence integrity of the signals being cross-connected;

Note 1 – The need to deal with $n \times 64$ kbit/s signals with different formats should be taken into account in the design of the equipment architecture to minimize any impact on delay and blocking factor.

Note 2 – For some applications it is necessary to maintain octet sequence integrity within the same frame.

e) The following optional functions are under study:

- cross-connection of sub 64 kbit/s channels;
- cross-connection of 64 and $n \times 64$ kbit/s signals on a point-to-multipoint basis.

3 Interfaces

3.1 *2048 kbit/s interfaces*

3.1.1 *Physical interface*

According to § 6 of Recommendation G.703.

3.1.2 *Frame structure*

Refer to §§ 2.3 of Recommendation G.704 and 5 of Recommendation G.704 for basic frame structure and for characteristics of frame structure carrying channels at various bit rates in 2048 kbit/s. Bit 1 of the frame should be used in accordance with § 2.2.3 of Recommendation G.704, i.e. for a CRC check bit procedure. Refer to § 2.2.3 of Recommendation G.735 for time slot order of 384 kbit/s sound programme signals contained in a 2048 kbit/s frame.

Depending on the application, some 2048 kbit/s access frames could contain channel associated or common channel signalling.

3.2 *Synchronization interface at 2048 kHz*

The physical and electrical characteristics of the synchronization interface shall be according to § 10 of Recommendation G.703.

3.3 *Interface with TMN*

Under study.

3.4 *Local operator interface*

According to Recommendation M.3010, F interface.

4 Frame alignment and CRC procedures

An illustration of the procedure is given in Figure 2/G.706.

4.1 *Loss of frame alignment*

Refer to § 4.1.1 of Recommendation G.706.

4.2 *Recovery of frame alignment*

Refer to § 4.1.2 of Recommendation G.706.

4.3 *CRC multiframe alignment in time slot 0*

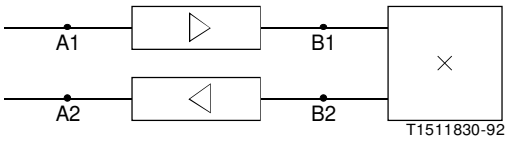
Refer to § 4.2 of Recommendation G.706.

4.4 *CRC bit monitoring*

Refer to § 4.3 of Recommendation G.706.

5 Defect or failure conditions and performance monitoring

Figure 1/G.796 gives the location and definition of the reference points used in the specification of defect or failure conditions, performance monitoring and consequent actions.



A1 reference point	G.704 frame logical signal at receiver part of 2048 kbit/s access port.
A2 reference point	G.704 frame logical signal at transmitter part of 2048 kbit/s access port.
B1 reference point	64 kbit/s data channels derived from signals at A1 reference point before cross-connexion.
B2 reference point	64 kbit/s data channels derived from signals at B1 reference point after cross-connection.

▷ Receiver part of a 2048 kbit/s access port excluding the adaptation of the G.703 signal to the G.704 frame logical signal.

◁ Transmitter part of a 2048 kbit/s access port excluding the adaptation of the G.704 frame logical signal to the G.703 signal.

× Cross connection function.

Note – A1 and A2 (respectively B1 and B2) are related to the same 2048 kbit/s access port.

FIGURE 1/G.796
Reference model for a cross-connect

5.1 *Defect or failure conditions at the A1 reference point and consequent actions at the B1 and A2 reference points*

5.1.1 *Defect or failure conditions*

The equipment should detect the following conditions:

5.1.1.1 *Failure of power supply*

5.1.1.2 *Loss of incoming signals at 2048 kbit/s*

A loss of signal (LOS) defect condition is determined by the absence of signal transitions of either positive or negative polarity over a period of 255 contiguous pulse positions, starting with the last receipt of a pulse.

A LOS defect condition is deemed to be terminated on the detection of an average pulse density of at least 12.5% over a period of 255 contiguous pulse positions starting with the receipt of a pulse.

Note 1 – The detection of this defect is required only when it does not result in an indication of loss of frame alignment.

5.1.1.3 *Loss of frame alignment*

Refer to § 4.1 above.

5.1.1.4 *Loss of multiframe alignment*

Refer to § 5.2 of Recommendation G.732.

The detection of this defect is required when channel associated signalling is used.

5.1.1.5 *Error ratio 1×10^{-3}*

Refer to § 4.1.5 of Recommendation G.736.

Note – The detection of this defect is optional. When required, it could be determined by counting either the number of errored frame alignment words or the number of errored bits in frame alignment words or by using the CRC4 procedure.

5.1.1.6 *Reception of AIS*

An AIS defect condition is determined when the incoming signal has less than two ZEROs in each of two consecutive diframe periods (512 bits per diframe).

The defect is cleared if each of two consecutive frame periods contains three or more ZEROs or FAS has been found.

5.1.1.7 *Defect indication from a remote equipment*

This is detected on bit 3 TS0 NFAS.

5.1.1.8 *Reception of AIS in time slot 16*

Refer to § 4.2.4 of Recommendation G.736 and § 3.2.2 of Recommendation O.162.

5.1.1.9 *Other defect or failure conditions*

E.g. frame slips: under study.

5.1.2 *Consequent actions*

Further to the detection of a defect or a failure condition, appropriate consequent actions should be taken as specified in Table 1/G.796. The consequent actions should be taken rapidly as indicated below:

– the application of AIS at B1 reference point should be taken within 3 ms of the detection of the relevant defect or failure condition;

– the maximum period between the detection of a defect or a failure condition and the transmission of a defect indication at the A2 reference point is a national requirement; a figure of the order of 100 ms is suggested;

– the maximum period between the detection of a defect or a failure condition and the generation of any failure information is dependent on the maintenance strategy for the equipment (see § 7).

TABLE 1/G.796

Defect or failure condition and consequent action for 2048 kbit/s access ports

Defect or failure condition at the A1 reference point	Consequent actions			
	Failure information generated (Note 1)	Defect indication to remote end A2 reference point	AIS applied at B1 reference point	
			Data TS	TS16 bits (Note 2)
Failure of power supply		Yes (if practicable)		
Loss of incoming signal		Yes bit 3 TS0 NFAS	Yes	Yes
Loss of frame alignment		Yes bit 3 TS0 NFAS	Yes	Yes
Error ratio 1×10^{-3} (Note 5)		Yes bit 3 TS0 NFAS	Yes (Note 3)	Yes (Note 3)
Defect indication received from remote end bit 3 TS0 NFAS		No	No	No
AIS received		Yes (Note 4)	Yes	Yes
Loss of multiframe alignment		Yes bit 6 TS16 FR0	No	Yes
Defect indication received from remote end bit 6 TS16 FR0		No	No	No
AIS received in TS16		Yes bit 6 TS16 FR0	No	Yes

Note 1 – For any particular failure condition, an action is initiated:

– at the level of the equipment (e.g. bell, lamp, printer); or

– at the level of the management of the equipment, refer to § 7 below.

Individually, it is possible to classify failure information as one of the following:

– not applicable;

– maintenance event information (MEI);

– deferred maintenance alarm (DMA);

– prompt maintenance alarm (PMA).

Note 2 – Applicable if TS16 is used for channel associated signalling or channel associated supervision/maintenance. AIS is applied to the relevant a, b, c, d bits.

Note 3 – According to national requirements.

Note 4 – In order to enable appropriate actions at the remote end, the indication of reception of AIS should not be transmitted on bit 3 of TS0 NFAS. Transmission of this information is under study.

Note 5 – The detection of this defect condition is optional.

5.2 *Defect or failure conditions and consequent actions for the core of the equipment*

5.2.1 *Defect or failure conditions*

The equipment should detect the following conditions:

5.2.1.1 *Failure of a connection*

A connection inside the equipment should be deemed to have failed when the 64 and $n \times 64$ kbit/s path between the A1 and A2 reference points of the relevant ports is not available for a period of time greater than 1 second.

5.2.1.2 *Loss of synchronization signal(s)*

The equipment is timed on its own internal oscillator when that is not the normal mode of operation.

5.2.1.3 *Other defect or failure conditions*

For further study.

5.2.2 *Consequent actions*

Further to the detection of a defect or a failure condition, appropriate consequent actions should be taken as specified in Table 2/G.796. The consequent actions should be taken as soon as possible:

– the application of AIS at relevant B2 reference points (or B1 or A2) should be taken within 3 ms of the detection of the defect or failure condition when this action is practicable;

– the maximum period between the detection of a defect or a failure condition and the transmission of defect indications to the remote end is a national requirement; a figure of the order of 100 ms is suggested;

– the maximum period between the detection of a defect or failure condition and the generation of any failure information is dependent on the maintenance strategy for the equipment. It is covered in § 7 below specifying the management aspects of cross-connect equipment.

TABLE 2/G.796

Defect or failure condition and consequent action for the core of the equipment

Defect or failure	Consequent actions			
	Failure information generated (Note 1)	Defect indication to remote end A2 reference point	AIS applied at A2 or B1 or B2 reference pointt	
			Data TS	TS16 bits (Note 2)
Failure of a connection		No	Yes (if practicable)	
Loss of synchronization signal		Yes (Note 3)	No	No

Note 1 – See Note 1 of Table 1/G.796.

Note 2 – See Note 2 of Table 1/G.796.

Note 3 – This action should be taken at the level of all A2 reference points. In order to enable appropriate actions at the remote ends, the indication of loss of synchronization signal(s) should not be transmitted on bit 3 of TS0 NFAS. Transmission of this information is under study.

5.3 *Performance monitoring*

The following performance indications can be derived from error event and other fault conditions:

– unavailable time;

– degraded performance;

– unacceptable performance.

The strategy to determine these quality performance parameters are described in Recommendations M.20 and M.550. More details are given in § 7 below specifying management aspects of cross-connect equipment.

6 Performance

6.1 *Jitter*

6.1.1 *Jitter at 2048 kbit/s output*

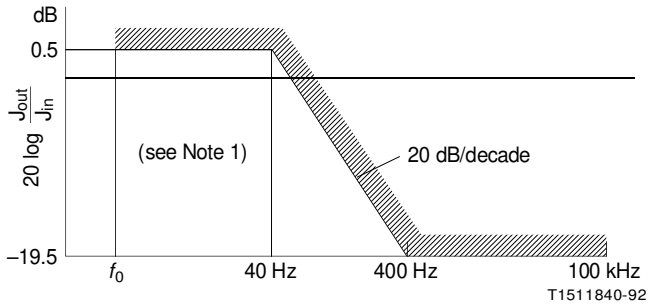
When the timing source is jitter free, the peak-to-peak jitter at any 2048 kbit/s output should not exceed 0.05 UI when it is measured in the range from f_1 = 20 Hz to f_4 = 100 kHz.

6.1.2 *Jitter tolerance at 2048 kbit/s input*

The tolerance to jitter of any 2048 kbit/s input should be according to § 3 of Recommendation G.823.

6.1.3 *Jitter transfer function*

The jitter transfer function between the input used for synchronization purposes and any 2048 kbit/s output should not exceed the gain/frequency limits given in Figure 2/G.796. The input signal shall be modulated with sinusoidal jitter.



Jout Out signal jitter
Jin In signal jitter

Note 1 – 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 2 – To achieve accurate measurements, the use of a selective method is recommended with a bandwidth sufficiently small referred to the relevant measurement frequency but not wider than 40 Hz.

FIGURE 2/G.796
Jitter transfer

6.2 *Transfer delay*

6.2.1 *64 and n × 64 kbit/s signals*

The transfer delay of 64 and $n \times 64$ kbit/s signals through a cross-connect equipment should be as small as possible taking account of buffer sizes. The delay should not exceed 600 µs.

6.2.2 *Channel associated signalling data in time slot 16*

The transfer delay of channel associated signalling data in time slot 16 should not exceed 7 ms.

6.3 *Slips*

6.3.1 *Operation without loss of synchronization*

Two situations need to be considered:

i) the timing signal and the relevant input signal are timed from the same G.811 1×10^{-11} clock: no slips should occur assuming adequate wander buffers are provided;

ii) the timing signal and the relevant input signal are timed from separate G.811 clocks: in this plesiochronous mode of operation, the rate of controlled slips should be in accordance with Recommendation G.822.

6.3.2 *Operation in case of loss of synchronization*

6.3.2.1 *Normal performance*

The timing signal and the relevant input signal are independently timed as a result of loss of all synchronization signals: the rate of controlled slips should be limited to that caused by internal clock frequency changes in the holdover mode. Refer to § 1.3.2 above.

6.3.2.2 *More stringent performance*

For the situation presented in § 6.3.2.1 above, the rate of controlled slips should be limited to that caused by internal clock frequency changes in the holdover mode assuming that the transit clock requirements of § 2.2.3 of Recommendation G.812 are met.

6.3.2.3 *Less stringent performance*

For the situation presented in § 6.3.2.1 above, depending on the way the cross-connect equipment is synchronized, one of the following situations apply:

– for the first 24 hours, no more than 10 controlled slips per hour (cross-connect equipment with only one external synchronization signal);

– for the first 24 hours, no more than 300 controlled slips per hour (cross-connect equipment with several independent external synchronization signals).

6.4 *Error performance*

The design objective long term error performance for a single pass through the equipment of a 64 kbit/s connection from/to reference points A_1/A_2 is:

– no SES;

– better than 99.995% EFS (assuming Poisson distribution of errors).

7 Management

For further study.

8 Abbreviations

AIS Alarm indication signal

CAS Channel associated signalling

CRC Cyclic redundancy check

CRC4 Cyclic redundancy check 4 (applicable to 2048 kbit/s G.704 frame)

DMA Deferred maintenance alarm

EFS Error free second

FAS	Frame alignment signal
FR0	Frame 0 (of a CAS signalling multiframe for a 2048 kbit/s G.704 frame)
LOS	Loss of signal
MEI	Maintenance event information
NFAS	Non-frame alignment signal
PMA	Prompt maintenance alarm
ppm	part per million
SES	Severely errored second
TMN	Telecommunications management network
TS	Time slot
TS0	Time slot 0 (of a 2048 kbit/s G.704 frame)
TS16	Time slot 16 (of a 2048 kbit/s G.704 frame)
UI	Unit interval