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ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16

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Foreword

This second edition European Telecommunication Standard (ETS) has been produced by the Transmission and Multiplexing (TM) Technical Committee of the European Telecommunications Standards Institute (ETSI).

This ETS has been produced in order to meet the requirements of network operators and equipment manufacturers for the deployment and design of synchronous cross connect equipment to be used in synchronous digital leased line networks.

This ETS consists of 2 parts as follows:

Part 1: "Core functions and characteristics".

Part 2: "Management" (DE/TM-01014-3).

NOTE: Part 2 of this ETS (ETS 300 010-2) is under development within ETSI TC-TM.

The corresponding ETS for equipment for cross connection of sub-rate signals is under development.

Proposed transposition dates	
Date of latest announcement of this ETS (doa):	31 August 1995
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1 Scope

This European Telecommunication Standard (ETS) describes requirements of cross connect equipment for use in synchronous digital leased line networks. It covers equipment having 2 048 kbit/s access ports and is limited to the basic functions, external characteristics and performance of the equipment. Requirements for the management of the equipment are to be covered in ETS 300 010-2 which should be used in conjunction with this part of the ETS.

NOTE: ETS 300 010-2 is under development within ETSI TC-TM.

Some network operators may have additional requirements and these are provided in normative annexes A to C.

2 Normative references

This ETS incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1] CCITT Recommendation G.703 (1991): "Physical/electrical characteristics of hierarchical digital interfaces".

[2] CCITT Recommendation G.704 (1988): "Synchronous frame structures used at primary and secondary hierarchical levels".

[3] CCITT Recommendation G.706 (1991): "Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in CCITT Recommendation G.704".

[4] CCITT Recommendation G.732 (1991): "Characteristics of primary PCM multiplex equipment operating at 2 048 kbit/s".

[5] CCITT Recommendation G.735 (1988): "Characteristics of primary PCM multiplex equipment operating at 2 048 kbit/s and offering synchronous digital access at 384 and/or 64 kbit/s".

[6] CCITT Recommendation G.736 (1988): "Characteristics of a synchronous digital multiplex equipment operating at 2 048 kbit/s".

[7] CCITT Recommendation G.773 (1988): "Protocol suites for Q interface for management of transmission systems".

[8] CCITT Recommendation G.811 (1988): "Timing requirements at the outputs of primary reference clocks suitable for plesiochronous operation of international digital links".

[9] CCITT Recommendation G.812 (1988): "Timing requirements at the outputs of slave clocks suitable for plesiochronous operation of international digital links".

[10] CCITT Recommendation G.822 (1988): "Controlled slip rate objectives on an international digital connection".

[11] CCITT Recommendation G.823 (1988): "The control of jitter and wander within digital networks which are based on the 2 048 kbit/s hierarchy".

[12] CCITT Recommendation M.20 (1988): "Maintenance philosophy for telecommunication networks".

[13] CCITT Recommendation M.2100 (1992): "Performance limits for bringing into service and maintenance of digital paths, sections and line sections".

[14] CCITT Recommendation M.3010 (1988): "Principles for a telecommunication management network".

[15] CCITT Recommendation O.162: "Specifications for an instrument to monitor the frame alignment signal of frame structures (frame alignment signal monitor)".

[16] CEPT Recommendation T/TR 02-02, edition 3 (1987): "Rack/telecommunication centre power supply interfaces".

NOTE: This CEPT Recommendation is to be replaced by prETS 300 132 ("Equipment Engineering (EE); Power supply interface at the input to the telecommunications equipments (DE/EE-2001)") when available.

3 Definitions

For the purposes of this ETS, the following definitions apply.

synchronous cross connect equipment: A device which accepts a number of signals comprising synchronously multiplexed lower bit rate signals and cross connects the constituent lower bit rate signals.

blocking factor: The existence of cross connections in a cross connect equipment can block the establishing of any new cross connection. The blocking factor is the probability that a new cross connection cannot be made, expressed as a decimal fraction of 1.

synchronization signal: A clock control signal obtained from a synchronization network.

access port: Access ports of a cross connect equipment are input and output ports used to terminate 2 048 kbit/s signals transporting synchronous 64 and n x 64 kbit/s signals to be cross connected.

cross connection capacity: This comprises the maximum number of equivalent channels at 64 kbit/s which can be cross connected as equivalent to a 64 kbit/s channel.

NOTE: Cross connection of Time Slot 0 (TS 0) (or bits 1 to 8) or Time Slot 16 (TS 16) information according to CCITT Recommendation G.704 [2] should be considered as equivalent to a 64 kbit/s channel.

4 Symbols and abbreviations

For the purposes of this ETS, the following symbols and abbreviations apply.

AIS	Alarm Indication Signal
CRC	Cyclic Redundancy Check
CRC 4	Cyclic Redundancy Check procedure relating to the 2 048 kbit/s basic frame structure according to CCITT Recommendation G.704 [2]
EFS	Error Free Second
FAS	Frame Alignment Signal
fr0	frame 0
LOS	Loss Of incoming 2 048 kbit/s Signal
SES	Severely Errored Second
TMN	Telecommunication Management Network
TS	Time Slot
TS 0	Time Slot 0
TS 16	Time Slot 16
TS 0 NFAS	Time Slot 0 without Frame Alignment Signal

5 Network reference configuration

Figure 1 gives typical representation of the cross connect equipment in its network environment.

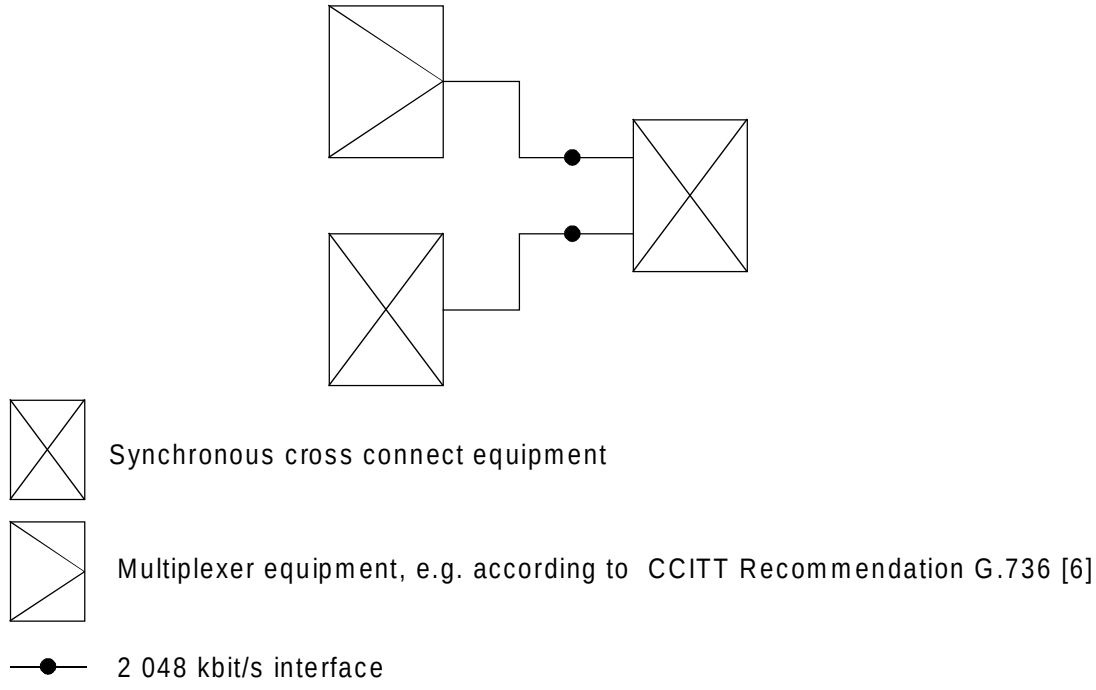


Figure 1: Network reference configuration

6 Reference model

Figure 2 provides a reference model for the equipment, including the location of reference points.

Definitions of functional blocks are given below:

physical interface (PI): This function terminates and generates the signals at an access port. This function also detects the Loss Of incoming 2 048 kbit/s Signal (LOS) condition, the line code violations as appropriate.

plesiochronous path termination (PPT): This function terminates and generates a logical signal at 2 048 kbit/s at an access port. This function provides frame generation and recovery and detection of defect or failure conditions on the 2 048 kbit/s logical signal.

cross connection function (XC): This function allows the cross connection of 64 and n x 64 kbit/s (n ranging from 1 to 32) signals from J1 reference point of an access port i to J2 reference point of an other access port j and from J1 reference point of this access port j to J2 reference point of access port i (see Note 4 under Figure 2 for the meaning of J1 and J2 reference points).

channel associated signalling cross connection function (CASXC): If channel associated signalling is used then this function provides the cross connection of the a, b, c and d signalling information from L1 to L2 reference points in correspondence with the related 64 or n x 64 kbit/s cross connection from J1 reference point of an access port i to J2 reference point of an other access port j and from J1 reference point of this access port j to J2 reference point of access port i assuming that access ports i and j are carrying signals containing channel associated signalling (see Note 5 under Figure 2 for the meaning of L1 and L2 reference points).

special function (SF): Example of optional special function are analogue multipoint conference bridge, data multipoint bridge, broadcasting, digital low bit rate transcoding for voice channel.

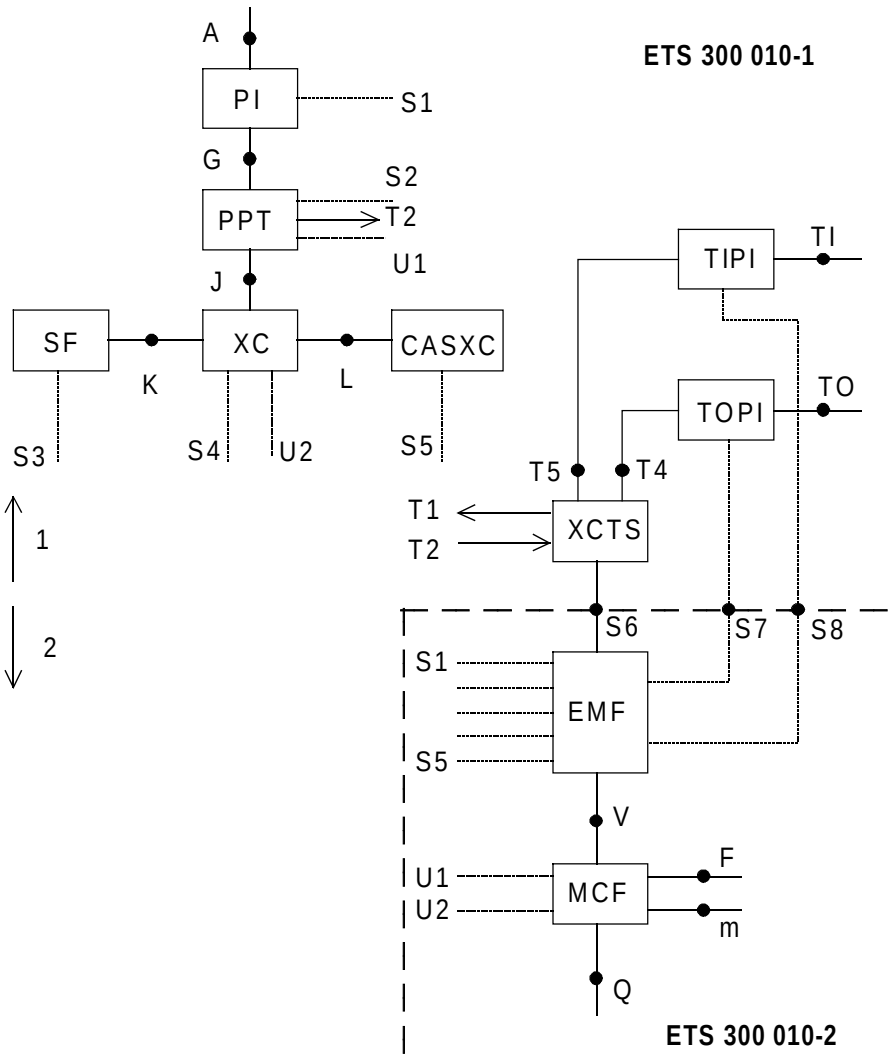
timing input physical interface (TIPI): This function terminates an external 2 048 kHz synchronization signal.

timing output physical interface (TOPI): This function generates an external 2 048 kHz signal.

cross connect timing source (XCTS): This function provides all internal timing signals necessary for the cross connect equipment.

equipment management function (EMF): This function is connected to all the other functional blocks and provides for a local user or the Telecommunication Management Network (TMN) a mean to perform all the management functions of the cross connect equipment.

message communication function (MCF): This function terminates and generates the cross connect management control channel(s). The control channel may as well be a Q interface. The function is also able to inter work as a relay function between the local workstation connected via a F interface and the TMN. It also provides local access to internal management functions via a m interface which is not subject to standardization.



NOTE 1: T1 is distributed to all the others functional blocks.

NOTE 2: Not all functional blocks are always required.

NOTE 3: Not all the necessary functions are shown; e.g. internal code conversion or line protection.

NOTE 4: Reference points A to J can each be divided into two reference points (e.g. A1 and A2) which relate to the J to A (direction 2 on the figure) and A to J (direction 1 on the figure) directions respectively.

NOTE 5: In the same way, reference points K and L can each be divided into two reference points (K1, K2 and L1, L2 respectively).

NOTE 6: The functional reference model and the defined reference points are only for the purpose of describing the functions of the cross connect equipment and are not intended to represent actual implementations. References to signalling bits or information, 64 kbit/s time slots or frame structures at internal reference points J, K and L refer only to the logical processing/mapping of the information content as observed from the external interfaces and do not impose a physical constraint within the equipment.

Figure 2: Functional model of the cross connect equipment

7 General characteristics

7.1 Size

This parameter depends mainly on network growth and can therefore change with time. It shall be possible to increase the size of an equipment without disturbing the existing traffic.

7.2 Timing signal

7.2.1 Control of timing signal

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

a) one of a number of external source(s) at 2 048 kHz according to subclause 9.2;

b) one of a number of 2 048 kbit/s signal(s) according to subclause 9.1;

c) an internal oscillator.

On fault condition on the active synchronization signal it shall be possible to program a fall-back strategy up to three steps; see subclause 11.2.1.2.

Complementary information corresponding to management aspects of the equipment will be provided in ETS 300 010-2 (currently under development).

The frequency accuracy of signals in a) and b) should 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 part per million.

The requirements for the 2 048 kbit/s physical interface according to subclause 9.1.1 are not affected.

7.2.2 Timing performance

The timing performance of the internal clock shall comply with CCITT Recommendation G.812 [9]. In the holdover mode, the local clock requirements of CCITT Recommendation G.812 [9], § 2.2.2 shall be met.

NOTE: For other timing performance options, refer to annex C.

8 Functions

The cross connect equipment shall perform the functions given in subclauses 8.1 and 8.2.

8.1 Cross connection

Cross connection of 64 and n x 64 kbit/s signals, bidirectional.

The n x 64 kbit/s signals shall be according to CCITT Recommendation G.704 [2], § 5.2. 6 x 64 kbit/s (384 kbit/s) signals according to CCITT Recommendation G.735 [5], § 2.2.3 should be taken into account in the design of the equipment. The equipment shall maintain octet sequence integrity of the signals being cross connected.

NOTE 1: For some n x 64 kbit/s applications it may be necessary to maintain octet sequence integrity within each frame.

NOTE 2: Refer to annex B for other n x 64 kbit/s Time Slot (TS) allocations.

8.2 Management

This includes control functions and provision of maintenance information and will be detailed in ETS 300 010-2 (currently under development).

9 Interfaces

9.1 2 048 kbit/s interface

9.1.1 Physical interface

The 2 048 kbit/s physical interface shall be according to section 6 of CCITT Recommendation G.703 [1].

9.1.2 Frame structure

The details of frame structure carrying channels at various bit rates in 2 048 kbit/s shall be according to CCITT Recommendation G.704 [2], § 2.3 and § 5. Bit 1 of the frame shall be used in accordance with CCITT Recommendation G.704 [2], § 2.3.3, i.e. for a Cyclic Redundancy Check (CRC) procedure. However, CCITT Recommendation G.735 [5], § 2.2.3 for TS allocation of 384 kbit/s sound programme signals contained in a 2 048 kbit/s frame should be taken into account.

NOTE: Refer to annex B for other n x 64 kbit/s TS allocation.

9.2 Synchronization interface at 2 048 kHz

The physical and electrical characteristics of the synchronization interface shall be according to section 10 of CCITT Recommendation G.703 [1].

9.3 Interface with the TMN

The interface with the TMN shall be the Q interface according to CCITT Recommendation G.773 [7].

9.4 User interface

The user interface shall be the F interface according to CCITT Recommendation M.3010 [14].

9.5 Power supply interface

The power supply interface shall be the A interface according to CEPT Recommendation T/TR 02-02 [16] (see note to clause 2).

10 Frame alignment and CRC procedure

An illustration of the procedure is given in figure 2 of CCITT Recommendation G.706 [3].

10.1 Loss of frame alignment

The strategy for loss of frame alignment shall be according to CCITT Recommendation G.706 [3], § 4.1.1.

10.2 Recovery of frame alignment

The strategy for recovery of frame alignment shall be according to CCITT Recommendation G.706 [3], § 4.1.2.

10.3 CRC multiframe alignment in TS 0

CRC multiframe alignment in TS 0 shall comply with CCITT Recommendation G.706 [3], § 4.2.

10.4 CRC bit monitoring

The CRC bit monitoring shall be performed according to CCITT Recommendation G.706 [3], § 4.3.

11 Defect or failure conditions and performance monitoring

11.1 Defect or failure conditions at the G2 (or A2) reference point and consequent actions at the J2 (or G2) and G1 (or A1) reference points

11.1.1 Defect or failure condition

The equipment shall detect the conditions given in subclauses 11.1.1.1 to 11.1.1.6.

11.1.1.1 Failure of power supply

See table 1.

11.1.1.2 Loss of incoming signal at 2 048 kbit/s

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

11.1.1.3 Loss of frame alignment

The strategy for loss of frame alignment shall be according to CCITT Recommendation G.706 [3], § 4.1.1.

11.1.1.4 Error ratio $1:10^{-3}$

The detection of this defect shall comply with CCITT Recommendation G.736 [6], § 4.1.5.

The detection of this defect is optional. When required, it can be determined by counting either the number of errored frame alignment signals or the number of errored bits in frame alignment signals or by using the CRC procedure relating to the 2 048 kbit/s basic frame structure according to CCITT Recommendation G.704 [2] (CRC 4). ETS 300 010-2 (currently under development) will cover the details of this.

11.1.1.5 Reception of Alarm Indication Signal (AIS)

The detection of AIS shall comply with CCITT Recommendation G.736 [6], § 4.2.4, and CCITT Recommendation O.162 [15], § 3.3.2.

11.1.1.6 Defect indication from a remote equipment

See table 1.

11.1.2 Consequent actions

Following to the detection of a defect or a failure condition, appropriate actions shall be taken as specified in table 1. These actions should be taken as soon as possible:

- AIS at J2 reference point should be applied 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 defect indication at the A1 reference point shall be of the order of 100 ms;

- the maximum period between the detection of a defect or a failure condition and the generation of any failure information is dependant on the maintenance strategy for the equipment. This will be covered in ETS 300 010-2 (currently under development).

However, in case of the fault condition error ratio 1.10^{-3} provision shall be made for some form of persistence check (e.g. 2 or 3 times the integration time) with appropriate confidence that a fault condition does exist (see CCITT Recommendation G.736 [6], § 4.1.5.1 and § 4.1.5.2).

Table 1: Defect or failure conditions and consequent actions for a 2 048 kbit/s access port

Defect or failure condition at G2 (or A2) reference point	Consequent actions		
	Failure information generated (note 1)	Defect indication to remote end at A1 reference point	AIS applied to data TS at J2 reference point
Failure of power supply			Yes if practicable
Loss of incoming signal		Yes, bit 3 TS 0 NFAS	Yes
Loss of frame alignment		Yes, bit 3 TS 0 NFAS	Yes
Error ratio 1.10^{-3} (note 4)		Yes, bit 3 TS 0 NFAS	Yes (note 2)
Defect indication received from remote end, bit 3 TS 0 NFAS		No	No
AIS received		Yes (note 3) (note 5)	Yes

NOTE 1: Consequent actions related to the generation of failure information will be specified in ETS 300 010-2 (currently under development). These actions could be taken at the level of the equipment (e.g. bell, lamp, etc.) or at the level of the management of the equipment.
NOTE 2: Provision shall be made for disabling this action.
NOTE 3: In order to enable appropriate actions at the remote end, the indication of reception of AIS may be transmitted in addition to any other defect information to the remote end. The use of the 4 kbit/s data link on Sa4 in TS 0 NFAS or the use of a free Sa bit of TS 0 NFAS is suggested for this application.
NOTE 4: The detection of this defect condition is optional.
NOTE 5: This consequent action is optional.

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

11.2.1 Defect or failure conditions

The equipment shall detect the conditions given in subclauses 11.2.1.1 and 11.2.1.2.

11.2.1.1 Failure of a connection

A connection inside the equipment shall be deemed to have failed when the 64 or n x 64 kbit/s path between the A2 and A1 reference points of the relevant ports is not available for a period of more than 1 s.

11.2.1.2 Loss of synchronization signal(s)

The equipment is timed by its own internal oscillator in the case where this is not the normal mode of operation. In the case of loss of active synchronization reference, the equipment shall switch over to another reference according to the programmed fall-back strategy. In the case of selecting the internal oscillator (case c) of subclause 7.2.1) the equipment shall enter into the holdover mode.

11.2.2 Consequent actions

Following the detection of a defect or a failure condition, appropriate consequent actions shall be taken as specified in table 2. These actions shall be taken as soon as possible:

- the application of AIS at relevant J1 reference points (or J2 or A1) should be taken within 3 ms of the detection of the failure condition;

- the maximum period between the detection of a defect or failure condition and the transmission of a defect indication at the A1 reference point should be in the order of 100 ms;

- 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. ETS 300 010-2 (currently under development) will specify the management aspects of cross connect equipment.

Table 2: Defect or failure conditions and consequent actions for the core of the equipment

Defect or failure condition	Consequent actions		
	Failure information generated (note 1)	Defect indication to remote end at A1 reference point	AIS applied to data TS at J1 reference point (or J2 or A1)
Failure of a connection		No	Yes (if practicable)
Loss of synchronization signal(s)		Yes, (note 2)	No

NOTE 1: Consequent actions related to the generation of failure information will be specified in ETS 300 010-2 (currently under development). These actions could be taken at the level of the equipment (e.g. bell, lamp, etc.) or at the level of the management of the equipment.

NOTE 2: This action should be taken at the level of all A1 reference points. In order to enable appropriate actions at the remote ends the indication of loss of synchronization signal(s) may be transmitted. The use of the 4 kbit/s data link on Sa4 in TS 0 NFAS or the use of a free Sa bit of TS 0 NFAS is suggested for this application.

11.3 Performance monitoring

The following performance indications can be derived from error events or other defects:

- unavailable time;

- degraded performance;

- unacceptable performance.

The strategy to determine these quality performance parameters is described in CCITT Recommendation M.20 [12] and CCITT Recommendation M.2100 [13]. See also ETS 300 010-2 (currently under development) for the specification of management aspects of cross connect equipment.

12 Performance

12.1 Blocking factor

The blocking factor shall be zero for cross connect equipment of size up to at least 256 x 2 048 kbit/s access ports.

12.2 Jitter

12.2.1 Jitter at 2 048 kbit/s output

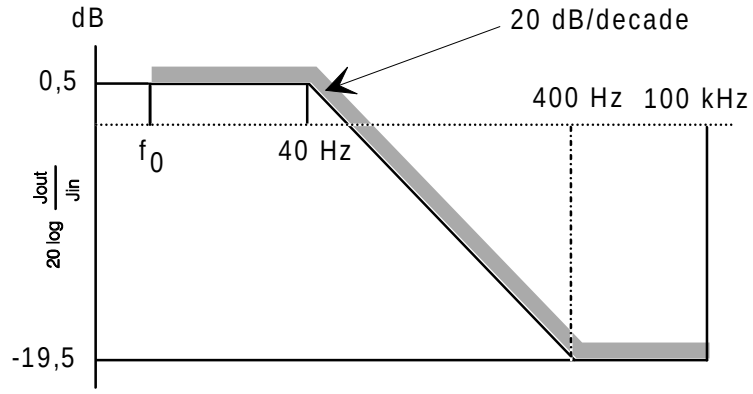
When the timing source is jitter free, the peak-to-peak jitter at any 2 048 kbit/s output shall not exceed 0,05 Unit Interval when it is measured in the range from f1 = 20 Hz to f4 = 100 kHz (refer to figure 2 of CCITT Recommendation G.823 [11]).

12.2.2 Jitter tolerance at 2 048 kbit/s input

The tolerance to jitter of any 2 048 kbit/s input port shall be according CCITT Recommendation G.823 [11], § 3.

12.2.3 Jitter transfer function

The jitter transfer function between the input used for synchronization purposes and any 2 048 kbit/s output shall not exceed the gain/frequency limits given in figure 3. The input signal shall be modulated with sinusoidal 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 limitation 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 3: Limits for jitter transfer function

12.3 Transfer delay

The transfer delay of 64 and n x 64 kbit/s signals through a cross connect equipment should be as small as possible taking account of buffer sizes. The delay shall not exceed 650 µs between the connectors of the corresponding access ports. For a temporary period this limit may be exceeded for existing equipment.

12.4 Slips

Three situations should be considered:

a) in normal operation the timing signal and the relevant input signal are timed from the same CCITT Recommendation G.811 [8] 1×10^{-11} clock. No slip should occur, assuming adequate wander buffers are provided;

b) the timing signal and the relevant input signal are timed from separate CCITT Recommendation G.811 [8] clocks. In this plesiochronous mode of operation, the rate of controlled slips should be in accordance with CCITT Recommendation G.822 [10], § 2.3;

c) the timing signal and the relevant input signal are independently timed as the result of loss of all synchronization signals. The rate of controlled slips shall be limited to that caused by internal clock frequency changes in the holdover mode. Refer to subclause 7.2.2.

NOTE: For other slip rate options in the holdover mode refer to annex C.

12.5 Error characteristics of the equipment

The design objective long term error performance for a single pass through the equipment of a 64 kbit/s connection from/to reference points A1 and A2 shall be:

- no Severely Errored Second (SES);

- better than 99,995 % Error Free Second (EFS).

Annex A (normative): Additional requirements for cross connection of channel associated signalling bits in TS 16

This annex describes the additional requirements for cross connect equipment when some 2 048 kbit/s access frames contain channel associated signalling according to CCITT Recommendation G.704 [2].

Where references are made to the relevant clauses and subclauses of this ETS, the corresponding clauses or subclauses are given in parentheses after the title.

A.1 Network reference configuration (clause 5)

Figure A.1 gives typical representation of the cross connect equipment in its network environment.

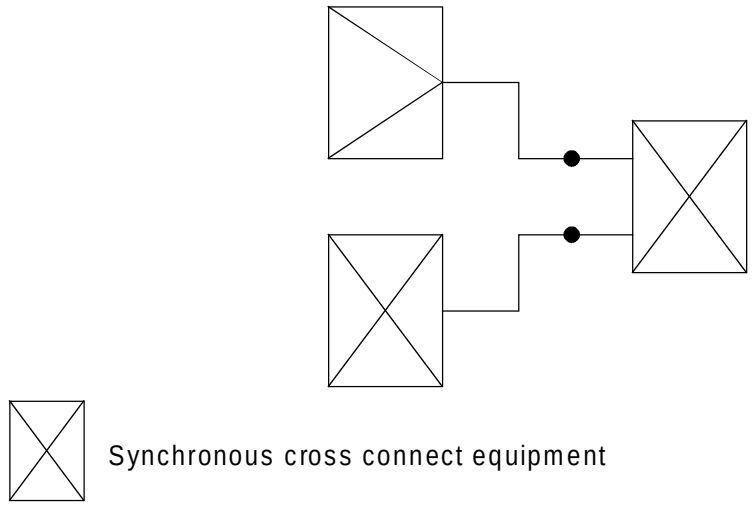


Figure A.1: Network reference configuration

A.2 Cross connection (subclause 8.1)

Cross connection of 64 and n x 64 kbit/s signals, bidirectional. The n x 64 kbit/s signals shall be according to CCITT Recommendation G.704 [2], § 5.2. 6 x 64 kbit/s (384 kbit/s) signals according to CCITT Recommendation G.735 [5], § 2.2.3, should be taken into account in the design of the equipment. The equipment shall maintain octet sequence integrity of the signals being cross connected.

For access ports carrying 2 048 kbit/s frames which contain channel associated signalling, the equipment shall cross connect signalling bits a, b, c, d in TS 16 corresponding to 64 kbit/s TS cross connection. The equipment shall maintain a, b, c, d bit sequence integrity.

NOTE 1: For some n x 64 kbit/s applications it may be necessary to maintain octet sequence integrity within each frame.

NOTE 2: Refer to annex B for other n x 64 kbit/s TS allocation.

A.3 Frame structure (subclause 9.1.2)

The details of frame structure carrying channels at various bit rates in 2 048 kbit/s shall be according to CCITT Recommendation G.704 [2], § 2.3 and § 5. Bit 1 of the frame shall be used in accordance with CCITT Recommendation G.704 [2], § 2.3.3, i.e. for a CRC check bit procedure. However, CCITT Recommendation G.735 [5], § 2.2.3 for TS allocation of 384 kbit/s sound programme signals contained in a 2 048 kbit/s frame should be taken into account. Some 2 048 kbit/s access frames contain channel associated signalling.

NOTE: Refer to annex B for other n x 64 kbit/s TS allocation.

A.4 Defect or failure conditions and performance monitoring (clause 11)

A.4.1 Defect or failure conditions (subclause 11.1.1)

The equipment shall detect the additional conditions given in the following subclauses.

A.4.1.1 Loss of multiframe alignment

The detection of this defect shall comply with CCITT Recommendation G.732 [4], § 5.2.

A.4.1.2 Reception of AIS in TS 16

The equivalent binary content of the AIS is a continuous stream of binary 1's. 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 1.10^{-3}. However, a signal with all bits except the multiframe alignment in the 1 state, should not be mistaken as an AIS.

A.4.1.3 Defect indication in TS 16 from a remote equipment

The defect indication in TS 16 from a remote equipment corresponds to the loss of multiframe alignment in this remote equipment and is transmitted on bit 6 of TS 16 of frame 0 according to CCITT Recommendation G.732 [4], § 5.3.2.3.

A.4.2 Consequent actions (subclause 11.1.2)

Table 1 of subclause 11.1.2 is replaced by table A.1.

Table A.1: Defect or failure conditions and consequent actions for 2 048 kbit/s access port

Defect or failure condition at G2 (or A2) reference point	Consequent actions			
	Failure information generated (note 1)	Defect indication to remote end at A1 reference point	AIS applied to data TS at J2 reference point	
			Data TS	TS 16 bits
Failure of power supply		Yes if practicable		
Loss of incoming signal		Yes, bit 3 TS 0 NFAS	Yes	Yes
Loss of frame alignment		Yes, bit 3 TS 0 NFAS	Yes	Yes
Error ratio 1.10^{-3} (note 4)		Yes, bit 3 TS 0 NFAS	Yes (note 2)	Yes (note 2)
Defect indication received from remote end, bit 3 TS 0 NFAS		No	No	No
AIS received		Yes (note 3)	Yes	Yes
Loss of multiframe alignment		Yes bit 6 TS 16 frame 0 (fr0)	No	Yes
Defect indication received from remote end, bit 6 TS 16 fr0		No	No	No
AIS received in TS 16		Yes bit 6 TS 16 fr0	No	Yes

NOTE 1: Consequent actions related to the generation of failure information will be specified in ETS 300 010-2 (currently under development). These actions could be taken at the level of the equipment (e.g. bell, lamp, etc.) or at the level of the management of the equipment.
NOTE 2: Provision shall be made for disabling this action.
NOTE 3: In order to enable appropriate actions at the remote end, the indication of reception of AIS may be transmitted in addition to any other defect information to the remote end. The use of the 4 kbit/s data link on Sa4 in TS 0 NFAS or the use of a free Sa bit of TS 0 NFAS is suggested for this application.
NOTE 4: The detection of this defect condition is optional.
NOTE 5: This consequent action is optional.

A.4.3 Defect or failure conditions and consequent actions for the core of the equipment (subclause 11.2)

A.4.3.1 Failure of a connection (subclause 11.2.1.1)

A connection inside the equipment shall be deemed to have failed when either the 64 or n x 64 kbit/s path or associated signalling a, b, c, d path or both paths between the A1 and A2 reference points of the relevant ports is (are) not available for a period of more than 1 s.

A.4.3.2 Consequent actions (subclause 11.2.2)

Table 2 of subclause 11.2.2 is replaced by table A.2.

Table A.2: Defect or failure conditions and consequent actions for the core of the equipment

Defect or failure condition point	Consequent actions			
	Failure information generated (note 1)	Defect indication to remote end at A1 reference point	AIS applied at J1 reference point (or J2 or A1)	
			Data TS	TS 16 bits
Failure of a connection		No	Yes (if practicable) (note 3)	
Loss of synchronization signal(s)		Yes, (note 2)	No	No

NOTE 1: As for table 1.
NOTE 2: This action should be taken at the level of all A1 reference points. In order to enable appropriate actions at the remote ends, the indication of loss of synchronization signal(s) may be transmitted. The use of the 4 kbit/s data link on Sa4 in TS 0 NFAS or the use of a free Sa bit of TS 0 NFAS is suggested for this application.
NOTE 3: Application of AIS to Data TS corresponds only to the failure of 64 or n x 64 kbit/s path. Application of 1111 to TS 16 bits corresponds only to the failure of associated signalling path.

A.5 Transfer delay (subclause 12.3)

A.5.1 64 and n x 64 kbit/s signals

The transfer delay of 64 and n x 64 kbit/s signals through a cross connect equipment should be as small as possible taking account of buffer sizes. The delay shall not exceed 650 µs between the connectors of the corresponding access ports. For a temporary period this limit may be exceeded for existing equipment.

A.5.2 Channel associated signalling in TS 16

The transfer delay of channel associated signalling data in TS 16 shall not exceed 7 ms between the connectors of the corresponding access ports.

Annex B (normative): Additional TS allocation

Network operators may require additional TS allocation for n x 64 kbit/s signals. This is described in this annex.

Where references are made to the relevant clauses and subclauses of this ETS, the corresponding clauses or subclauses are given in parentheses after the title.

B.1 Cross connection (subclause 8.1)

Cross connection of 64 and n x 64 kbit/s signals, bidirectional. The n x 64 kbit/s signals shall be either:

- according to CCITT Recommendation G.704 [2], § 5.2. 6 x 64 kbit/s (384 kbit/s) signals according to CCITT Recommendation G.735 [5], § 2.2.3 should be taken into account in the design of the equipment. The equipment shall maintain octet sequence integrity of the signals being cross connected; or

- not according to the TS order given in CCITT Recommendation G.704 [2], § 5.2, or CCITT Recommendation G.735 [5], § 2.2.3, or where the formats differ between input and output ports. The equipment shall maintain octet sequence integrity of signals being cross connected.

  NOTE: For some n x 64 kbit/s applications it may be necessary to maintain octet sequence integrity within each frame.

B.2 Frame structure (subclause 9.1.2)

The details of frame structure carrying channels at various bit rates in 2 048 kbit/s shall be according to CCITT Recommendation G.704 [2], § 2.3 and § 5. Bit 1 of the frame shall be used in accordance with CCITT Recommendation G.704 [2], § 2.3.3, i.e. for a CRC check bit procedure. However, CCITT Recommendation G.735 [5], § 2.2.3 for TS allocation of 384 kbit/s sound programme signals contained in a 2 048 kbit/s frame should be taken into account. Some 2 048 kbit/s signals contain n x 64 kbit/s signals which are not according to the TS order given in CCITT Recommendation G.704 [2], § 5.2 or CCITT Recommendation G.735 [5], § 2.2.3.

Annex C (normative): Other timing and slip performance requirements

When the application of the cross connect equipment requires more stringent or less stringent performance requirements for timing and slips, one of the options given in clauses C.1 and C.2 can be selected. For more stringent performance requirements, the requirements of clause C.1 shall be selected, for less stringent performance requirements, the requirements of clause C.2 shall be selected.

Where references are made to the relevant clauses and subclauses of this ETS, the corresponding clauses or subclauses are given in parentheses after the title.

C.1 More stringent performance

C.1.1 Timing performance (subclause 7.2.2)

The timing performance of the internal clock shall comply with CCITT Recommendation G.812 [9]. In the holdover mode, the transit clock requirements of CCITT Recommendation G.812 [9], § 2.2.3 shall be met.

C.2 Less stringent performance

C.2.1 Timing performance (subclause 7.2.2)

Performance requirements shall be consistent with subclause C.2.2.

C.2.2 Slips (subclause 12.4)

Three situations should be considered:

a) in normal operation the timing signal and the relevant input signal are timed from the same CCITT Recommendation G.811 [8] 1×10^{-11} clock. No slip should occur, assuming adequate wander buffers are provided;

b) the timing signal and the relevant input signal are timed from separate CCITT Recommendation G.811 [8] clocks. In this plesiochronous mode of operation, the rate of controlled slips should be in accordance with CCITT Recommendation G.822 [10], § 2.3;

c) the timing signal and the relevant input signal are independently timed as the result of loss of all synchronization signals. Depending on the way the cross connect equipment is synchronized one of the two following options can be chosen:

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

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

Annex D (normative): Additional requirements for cross connection

D.1 Additional requirements for cross connection of unstructured signal 2 048 kbit/s signal

This clause describes the additional requirements for cross connect equipment when two, or n x 2, 2 048 kbit/s unstructured signals have to be cross connected through the equipment.

D.1.1 Function

The bi-directional 2 048 kbit/s unstructured signal at the A reference point of a selected access port can be cross connected to/from the 2 048 kbit/s unstructured signal present at the A reference point of any other access port.

D.1.2 Characteristics

D.1.2.1 Type of cross connection

The cross connection is bi-directional.

D.1.2.2 Framing structure

The 2 048 kbit/s signal is considered by the access port as not containing any frame structure; i.e. the access port does not perform any monitoring nor action function associated with any frame structure.

NOTE: Although the 2 048 kbit/s is declared to the DXC as being unstructured, this signal may contain certain framing structure such as CCITT Recommendation G.704 [2].

D.1.2.3 Bit sequence independence

The cross connect equipment shall be insensitive to any bit pattern within the 2 048 kbit/s unstructured signal.

D.1.3 Performance

D.1.3.1 Blocking

There shall not be any blocking effect in the establishment of new bi-directional cross connection through the equipment due to the existence of any number of 2 048 kbit/s cross connection within the limit of the cross connection capacity.

D.1.3.2 Integrity

The equipment shall maintain bit sequence integrity.

D.1.3.3 Transfer delay

There shall not be any extra delay in comparison with the performance criterion given in subclause 12.3.

D.1.3.4 Slips

The performance parameter for this subclause is according to subclause 12.4. In this application, the cross connect equipment continue to align signals which are not synchronous to the internal timing signal by controlling slips based on groups of 256 bits.

D.1.4 Defect or failure conditions and consequent actions

D.1.4.1 Defect or failure conditions at the A2 reference point

The equipment shall detect the following conditions.

D.1.4.1.1 Loss of incoming 2 048 kbit/s signal

A Loss Of incoming 2 048 kbit/s Signal (LOS) defect shall be detected if the incoming signal has "no transitions" for a consecutive number of pulse positions N, where $x \leq N \leq Y$, see figure D.1.

The LOS defect shall be cleared if the incoming signal has "no transition-free intervals" for a consecutive number of pulse positions N', where $X' \leq N' \leq Y'$.

> A signal with "no transition-free intervals" corresponds to a CCITT Recommendation G.703 [1] compliant signal. The criteria for detection of "no transition" condition and "transition" condition is indicated in figure D.1.

Values for X, Y, X', Y' and Q are given in the table D.1.

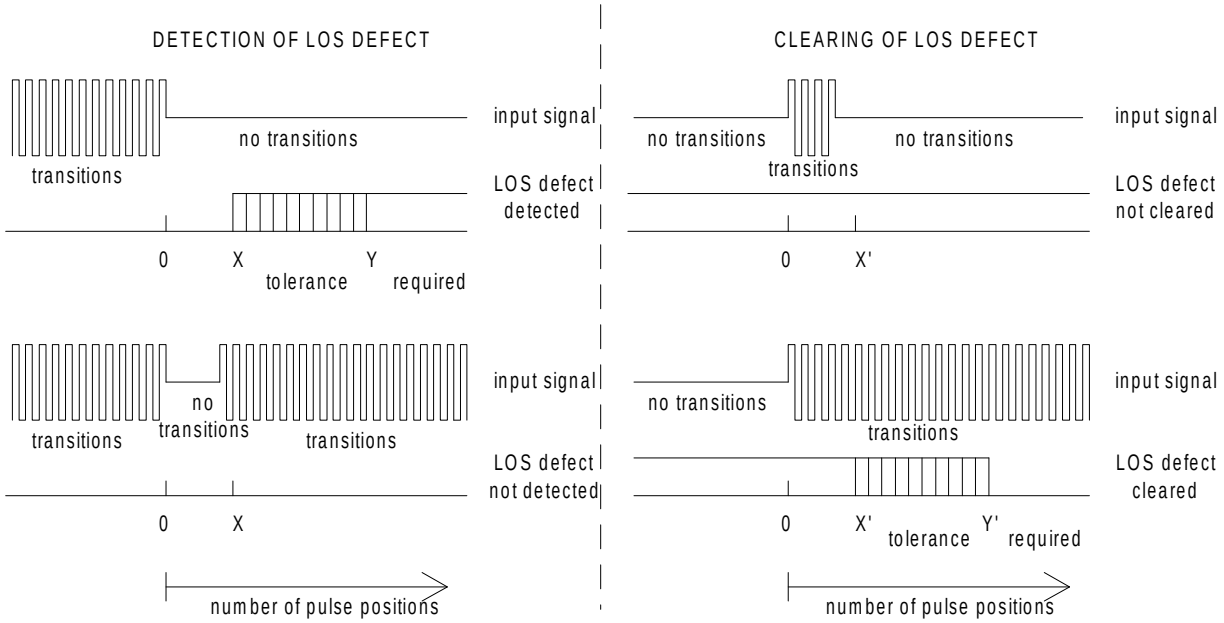


Figure D.1: Timing of LOS defect detection and clearing

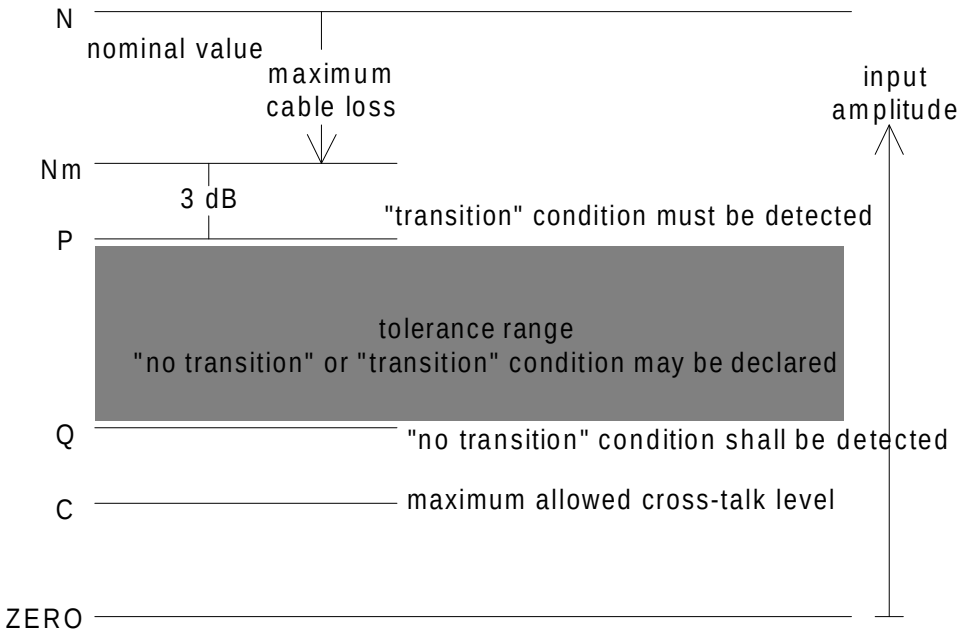


Figure D.2: Criteria for determination of transition conditions

LOS defect shall be detected if the signal level is at level "Q" or below;
LOS defect shall be cleared at level "P" or above.

Table D.1: LOS defect criteria

Bit rate (kbit/s)	Pulse time (ns)	X (No. of pulses)	Y (No. of pulses)	X' (No. of pulses)	Y' (No. of pulses)	Q (dB)
2 048	488,28	10	255	10	255	35

D.1.4.1.2 Line code violation

The detection of this anomaly event is performed by the detection of HDB3 code violations.

D.1.4.2 Defect or failure conditions in the core equipment

The equipment shall detect the following condition.

- **failure of power supply.**

  This defect condition shall be detected when it has an impact on any unstructured 2 048 kbit/s bi-directional cross connection.

D.1.4.2.1 Consequent actions

Further to the detection of a defect or failure condition, appropriate consequent actions shall be taken as specified in table D.2.

The consequent actions should be taken as soon as possible:

- AIS at the J2 reference point should be applied within 3 ms of the detection of the relevant defect or failure condition;

- the maximum period between the detection of a defect or failure condition and the generation of any failure information is dependant on the maintenance strategy for the equipment. This is covered in ETS 300 010-2 (currently under development) specifying the management aspect of 64 kbit/s cross connect equipment.

Table D.2: Consequent actions

Defect or failure condition at the A2 reference point	Consequent action	
	Failure information generated (note)	AIS applied at J2 reference point
Failure of power supply		Yes if practicable
Line code violation		No
LOS		Yes
NOTE: These actions could be taken at the level of the equipment (e.g. bell, lamp, etc.) or at the level of the management of the equipment. Complementary information is given in ETS 300 010-2 (currently under development) specifying the management aspects of the cross connect equipment.		

D.2 Additional requirements for cross connection of CCITT Recommendation G.704 framed 2 048 kbit/s signal

This clause describes the additional requirements for cross connect equipment when 2 048 kbit/s signals framed according to CCITT Recommendation G.704 [2] have to be cross connected through the equipment.

D.2.1 Function

The bi-directional CCITT Recommendation G.704 [2] framed 2 048 kbit/s signal at the A1 and A2 reference points of a selected access port can be cross connected to/from the CCITT Recommendation G.704 [2] framed 2 048 kbit/s signal present at the A2 and A1 reference points respectively of any other access port.

Two situations may be considered:

- the cross connection consists of the 1 984 kbit/s signal (bit 9 to bit 256) plus the San bits of the NFAS (contained within bits 1 to 8) according to subclause 2.3 of CCITT Recommendation G.704 [2];

- the CCITT Recommendation G.704 [2] framed 2 048 kbit/s signal contains a signalling multiframe in TS 16 according to CCITT Recommendation G.704 [2], § 2.3 and § 5.2, the cross connection consists of the 30 x 64 kbit/s signals with the associated a, b, c and d signalling bits of TS 16 plus the San bits of TS 0 NFAS.

D.2.2 Characteristics

D.2.2.1 Type of cross connection

This function provides bi-directional cross connection.

D.2.2.2 CRC 4 procedure

The bit 1 of the CCITT Recommendation G.704 [2] frame is not cross connected. The CRC 4 procedure shall be terminated in the path termination function.

D.2.2.3 Far end defect or failure indication

D.2.2.3.1 TS 0 NFAS

Bit 3 of TS 0 NFAS and any other San bit used for the transport of additional far end defect or failure indication are not cross connected. The far end defect or failure information shall be terminated in the path termination function.

D.2.2.3.2 Bit 6 TS 16 fr0

When the CCITT Recommendation G.704 [2] framed 2 048 kbit/s signal contains a signalling multiframe in TS 16, the cross connection of TS 16 complies with annex A. Bit 6 TS 16 fr0 shall be terminated in the path termination function.

D.2.3 Performance

D.2.3.1 Blocking

There shall not be any blocking effect in the establishment of a new cross connection through the equipment due to the existence of any number of CCITT Recommendation G.704 [2] framed 2 048 kbit/s cross connected signals in the limit of the cross connection capacity.

D.2.3.2 Integrity

Considering the cross connection of CCITT Recommendation G.704 [2] framed 2 048 kbit/s signals not carrying channel associated signalling, the equipment shall maintain bit and frame sequence integrity in the limit of the function described in subclause D.2.2.3.1 (i.e. non cross connection of bit 1 of TS 0 and of far end defect or failure indications).

Considering the cross connection of CCITT Recommendation G.704 [2] framed 2 048 kbit/s signals carrying channel associated signalling, the equipment shall maintain a, b, c, d bits and word sequence integrity.

D.2.3.3 Transfer delay

There shall not be any extra delay in comparison with the performance criteria given in subclause 12.3 and clause A.5.

D.2.4 Defect or failure conditions and consequent actions

This subclause is according to subclauses 11.1 and 11.2 when considering the cross connection of CCITT Recommendation G.704 [2] framed 2 048 kbit/s signals not carrying channel associated signalling.

This subclause is according to subclauses A.4.1 and A.4.3 when considering the cross connection of CCITT Recommendation G.704 [2] framed 2 048 kbit/s signals carrying channel associated signalling.

NOTE: The definition of the failure of a connection given in subclause 11.2.1.1 is extended to the internal path providing the cross connection of TS 0 information.

D.3 Additional requirements for TS 0 cross connection

This clause describes an additional requirement for cross connect equipment, regarding the (partial) cross connection of TS 0 from some 2 048 kbit/s access ports to (unidirectional application) or from/to (bi-directional application) any time slot, excluding TS 0, of a number of selected other 2 048 kbit/s access ports.

Unidirectional application may be required for monitoring A and San bits. Bi-directional application may be required for an add/drop function on the 4 (or n x 4) kbit/s data link on San bit(s). Other applications are not precluded, but should be according to the following subclauses.

D.3.1 Function

TS 0 NFAS of a CCITT Recommendation G.704 [2] framed 2 048 kbit/s signal at the A2 (and A1, in case of bi-directional cross connection) reference point(s) of a selected access port shall be cross connected or partially cross connected to (or from/to any TS, excluding TS 0), of the CCITT Recommendation G.704 [2] framed 2 048 kbit/s signal at the A1 (and A2) reference point(s) of an other access port.

D.3.2 Characteristics

D.3.2.1 Type of cross connection

The cross connection is:

- either unidirectional, TS 0 NFAS access port i $\rightarrow$ TSn access port j ($n \neq 0$);

- either bi-directional, partial TS 0 NFAS access port i $\leftrightarrow$ TSn access port j ($n \neq 0$).

D.3.2.2 Transformation/substitution of Frame Alignment Signal (FAS)

To prevent false frame alignment at the far end network element connected to access port j or either at the cross connect equipment, the following conventions apply:

- the FAS from the TS 0 of the 2 048 kbit/s signal at access port i shall not be transferred to the TSn of the 2 048 kbit/s signal at access port j, but overwritten by repeating the content of TS 0 NFAS from the 2 048 kbit/s signal at access port i;

- the 2 048 kbit/s signal received at access port j shall not contain any FAS in the TSn ($n \neq 0$).

NOTE: For simplicity, it is assumed that these TSn ($n \neq 0$) of the 2 048 kbit/s signal received at access port j contain the TS 0 NFAS information to be cross connected to TS 0 NFAS of 2 048 kbit/s signal at access port i duplicated in two consecutive frames.

D.3.2.3 TS allocation

The TS 0 bits of a 2 048 kbit/s signal at access port i that shall be cross connected to a selected TSn ($n \neq 0$) at the A1 reference point of access port j are:

- bit 1 to bit 8 of the TS 0 NFAS. Depending on the application, some of these bits may be inhibited from cross connection.

The bits of a selected TSn ($n \neq 0$) at the A2 reference point of access port j that shall be cross connected to the TS 0 NFAS at the A1 reference point of a selected 2 048 kbit/s access port i are:

- bit 4 to bit 8. Depending on the application, some of these bits may be inhibited from cross connection.

D.3.2.4 CRC 4 procedure

If the CRC 4 procedure is in operation at the A2 and A1 reference points of access port i, then bit 1 of TS 0 NFAS is not cross connected. From reference point A2 at access port i to reference point A1 at access port j it is forced to binary 1. At the A1 reference point of access port i, it is generated according to the CRC 4 procedure.

D.3.2.5 Far end defect or failure indication

While TS 0 NFAS of access port i is cross connected, the relevant far end defect or failure indications are still monitored at the A2 reference point of access port i.

D.3.3 Defect or failure conditions and consequent actions

D.3.3.1 Access port i

The equipment shall detect the defect or failure conditions at the A2 reference point of access port i in accordance to subclause 11.1.1.

The consequent actions at the A1 reference point of access port i shall be according to the relevant parts of subclause 11.1.2.

The consequent actions in TSn at the J1 reference point of access port j is the application of binary 1 in place of the cross connected bits. This action should be taken within 3 ms of the detection of the failure condition.

D.3.3.2 Access port j

The equipment shall detect the defect or failure conditions at the A2 reference point of access port j in accordance to subclause 11.1.1.

The consequent actions at the A1 reference point of access port j shall be according to the relevant parts of subclause 11.1.2.

The consequent actions in TS 0 at the J1 reference point of access port i is the application of binary 1 in place of the cross connected San bits. This action should be taken within 3 ms of the detection of the failure condition.

D.3.4 Performance

D.3.4.1 Blocking

The TS 0 cross connection function shall not impact on the blocking factor for the equipment.

D.3.4.2 Transfer delay

The transfer delay for the cross connection of signals in TS 0 is according to subclause 12.3.

D.3.4.3 Integrity

Considering the cross connection of TS 0 from CCITT Recommendation G.704 [2] framed 2 048 kbit/s signals the equipment shall maintain Sa4 to Sa8 bits and word sequence integrity.

Annex E (informative): Bibliography

The following references are given for informative purposes.

1) ETS 300 010-2: "Transmission and Multiplexing (TM); Synchronous cross connect equipment 64 and n x 64 kbit/s cross connection rate 2 048 kbit/s access ports; Part 2: Management" (DE/TM-01014-3).

2) ETS 300 166: "Transmission and Multiplexing (TM); Physical/electrical characteristics of hierarchical digital interfaces for equipment using the 2 048 kbit/s-based plesiochronous or synchronous digital hierarchies".

3) ETS 300 167: "Transmission and Multiplexing (TM); Functional characteristics of 2 048 kbit/s interfaces".

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