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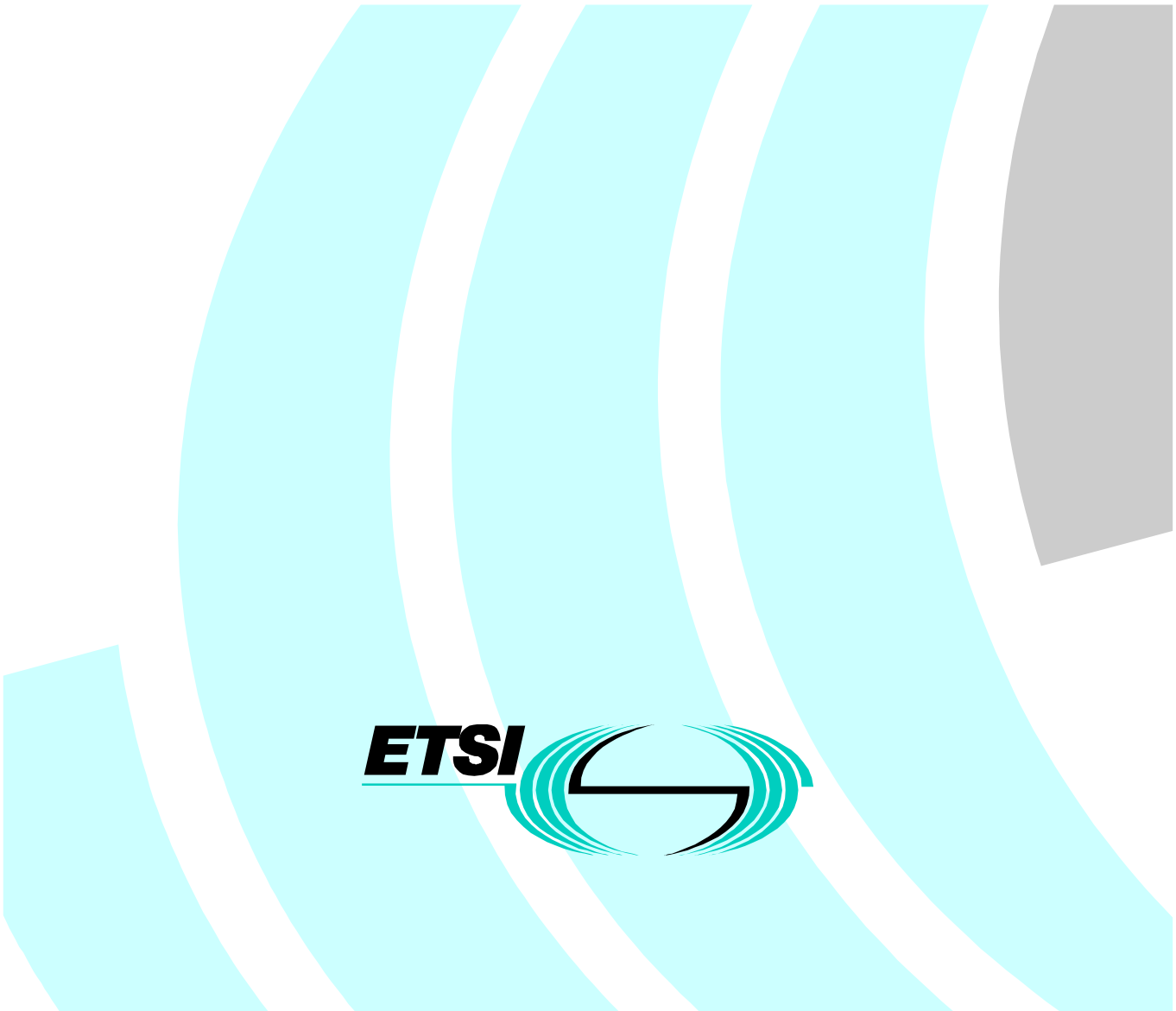
European Standard (Telecommunications series)

Access and Terminals (AT); 2 048 kbit/s digital structured leased lines (D2048S); Connection characteristics



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Contents

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Access and Terminals (AT), and is now submitted for the ETSI standards One-step Approval Procedure.

The present document resulted from a mandate from the Commission of the European Community (CEC) to provide standards for support of the Directive on Open Network Provision (ONP) of leased lines (92/44/EEC).

There are two other standards directly related to the present document:

- EN 300 418: "Access and Terminals (AT); 2 048 kbit/s digital unstructured and structured leased lines (D2048U and D2048S); Network interface presentation";
- EN 300 420: "Access and Terminals (AT); 2 048 kbit/s digital structured leased lines (D2048S); Terminal equipment interface".

The present document is based on information from ITU-T Recommendations and ETSI publications and the relevant documents are quoted where appropriate.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

Introduction

The Council Directive on the application of ONP to leased lines (92/44/EEC) concerns the harmonization of conditions for open and efficient access to, and use of, the leased lines provided over public telecommunications networks, and the availability throughout the European Union (EU) of a minimum set of leased lines with harmonized technical characteristics.

The consequence of the Directive is that telecommunications organizations within the EU shall make available a set of leased lines between points in these countries with specified connection characteristics and specified interfaces. Under the Directive 91/263/EEC, later replaced by 98/13/EC, terminal equipment for connection to these leased lines was required to fulfil certain essential requirements.

The present document has been produced to introduce some necessary changes.

ITU-T Recommendation I.340 for Integrated Services Digital Network (ISDN) connection types was used as a basis for the connection characteristics. ETS 300 167 and ITU-T Recommendations G.704 and G.706 are used as the basis for the structure.

1 Scope

The present document specifies the technical requirements and test principles for connection characteristics of Open Network Provision (ONP) 2 048 kbit/s digital structured leased lines. The leased line operates at 2 048 kbit/s and provides an information transmission capability, without restriction on binary content, of 1 984 kbit/s. The remaining 64 kbit/s provides an 8 kHz framing structure in accordance with ETS 300 167 and ITU-T Recommendations G.704 and G.706.

A connection is presented via interfaces at Network Termination Points (NTPs) and includes any equipment that may provide the NTP. Signals between terminal equipments are subject to impairments during their transfer over the connection. The limits to these impairments are stated in the present document. Together with the companion standard, EN 300 418 [4] defining the network interface presentation, the present document describes the technical characteristics of the leased line service offered to the user.

The tests specified in the present document cannot be carried out by the leased line provider, while the leased line is in service, i.e. carrying users' traffic. Thus the tests are designed for bringing into and returning into service, although there is no obligation to perform these tests each time a leased line is brought into or returned into service. However, because the connection is structured, the error performance may be monitored by the leased line provider while the line is in service.

The present document is applicable for leased lines, including part time leased lines, for which the establishment or release does not require any protocol exchange or other intervention at the NTP.

The present document specifies the compliance tests for the connection requirements. The present document does not include details concerning the implementation of the tests, nor does it include information on any relevant regulations.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] ITU-T Recommendation O.151 (1992): "Error performance measuring equipment operating at the primary bit rate and above".

[2] ITU-T Recommendation O.153 (1992): "Basic parameters for the measurement of error performance at bit rates below the primary rate".

[3] ITU-T Recommendation O.171 (1997): "Timing jitter and wander measuring equipment for digital systems which are based on the plesiochronous digital hierarchy (PDH)".

[4] ETSI EN 300 418: "Access and Terminals (AT); 2 048 kbit/s digital unstructured and structured leased lines (D2048U and D2048S); Network interface presentation".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Background Block Error (BBE): errored block not occurring as part of a Severely Errored Second (SES)

BBE ratio: ratio of errored blocks to total blocks during a fixed measurement interval excluding all blocks during severely errored seconds and while the leased line connection is in the unavailable state (see ITU-T Recommendation G.826)

block: set of 2 048 consecutive bits equivalent to one Sub-MultiFrame (SMF). Each block is monitored by means of a Cyclic Redundancy Check-4 bit (CRC-4) error check. The length of each block corresponds to a period of 1 ms

NOTE: This definition is relevant only to the present document and is more specific than the generic definition given in ITU-T Recommendation G.826.

controlled slip: irretrievable loss or gain of a set of consecutive digit positions in a digital signal, in which both the magnitude and instant of that loss or gain are controlled, to enable the signal to accord with a rate different from its own

errored block: block in which one or more bits are in error (see ITU-T Recommendation G.826)

Errored Second (ES): one-second period with one or more errored blocks (see ITU-T Recommendation G.826)

ES ratio: ratio of ES to total seconds during a fixed measurement interval. The ES ratio is not evaluated while the leased line connection is in the unavailable state (see ITU-T Recommendation G.826)

errored Sub-MultiFrame: Sub-MultiFrame (SMF) where the calculated CRC-4 does not correspond with the CRC-4 contained within the next SMF (see subclause B.2.2)

frame: sequence of 256 bits of which the first 8 bits define the frame structure (see annex B)

frame slip: slip of one complete frame

leased lines: telecommunications facilities provided by a public telecommunications network that provide defined transmission characteristics between NTPs and that do not include switching functions that the user can control (e.g. on-demand switching)

multiframe: sequence of two SMFs containing the multiframe alignment word (see annex B)

Network Termination Point (NTP): all physical connections and their technical access specifications which form part of the public telecommunications network and are necessary for access to, and efficient communication through, that public network

PRBS(2^9-1): Pseudo Random Bit Sequence (PRBS) (as defined in subclause 2.1 of ITU-T Recommendation O.153 [2])

PRBS(2^{15}-1): PRBS (as defined in subclause 2.1 of ITU-T Recommendation O.151 [1])

S_a bits: bits 4 to 8 (bits S_{a4} to S_{a8}) in frames not containing the frame alignment signal (see annex B)

satellite transmission: transmission via an earth orbiting satellite

severely disturbed period: for out-of-service measurements, a severely disturbed period occurs when, over a period of time equivalent to four contiguous blocks, either all the contiguous blocks are affected by a high bit error density of = 10^{-2}, or a loss of signal is observed. For in-service monitoring purposes, a severely disturbed period is estimated by the occurrence of loss of signal or loss of frame alignment (see ITU-T Recommendation G.826)

Severely Errored Second (SES): one-second period which contains = 805 errored blocks or at least one severely disturbed period (see ITU-T Recommendation G.826)

SES ratio: ratio of SES to total seconds during a fixed measurement interval. The SES ratio is not evaluated while the leased line connection is in the unavailable state (see ITU-T Recommendation G.826)

Sub-MultiFrame (SMF): sequence of 8 frames, each of 256 bits, over which the CRC-4 is calculated (see annex B)

uncontrolled slip: loss or gain of a digit position or a set of consecutive digit positions in a digital signal, resulting from an aberration of the timing processes associated with transmission or switching of a digital signal, and in which either the magnitude or the instant of that loss or gain is not controlled

unavailability period: unavailability period begins at the onset of 10 consecutive SES. These 10 s are considered to be part of the unavailability period. The unavailability period ends at the onset of 10 consecutive non-SES. These 10 s are not considered part of the unavailability period

unavailable state: leased line connection is in the unavailable state if an unavailability period is occurring in one or both directions of transmission

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

BBE	Background Block Error
BIS	Bringing Into Service
CRC-4	Cyclic Redundancy Check-4 bit
D2048S	2 048 kbit/s digital structured ONP leased line
D2048U	2048 kbit/s digital structured ONP leased line
EMC	ElectroMagnetic Compatibility
ES	Errored Second
HDB3	High Density Bipolar code of order 3
NTP	Network Termination Point
ONP	Open Network Provision
ppm	parts per million
PRBS	Pseudo Random Bit Sequence
PRC	Primary Reference Clock
RAI	Remote Alarm Indication
RX	RX is a signal input (at either the leased line interface or the test equipment)
SES	Severely Errored Second
SMF	Sub-MultiFrame
TX	TX is a signal output (at either the leased line interface or the test equipment)
UI	Unit Interval

4 Requirements

The performance of the leased line shall comply with these requirements only if the conditions of supply of the network equipment providing the NTP are met (e.g. if the equipment is connected to an appropriate power supply on the customer's premises).

The ITU-T attribute technique is used to express the connection requirements. The following attributes from ITU-T Recommendation I.140 are specified in the present document:

- transfer rate;
- information transfer susceptance;
- structure;
- establishment of connection;
- symmetry;
- connection configuration;
- network performance.

The following network performance sub-attributes are considered relevant for the present document:

- transmission delay;
- jitter;
- slip;
- error.

4.1 Attributes

The connection attributes are displayed in table 1. In effect, these attributes define the service being offered.

The values and the associated compliance tests can be found in the subsequent subclauses.

Table 1: Connection attributes

Connection type attributes	**Value**	
Description	**Nature**	**Reference subclause**
Transfer rate Leased line timing Information transfer rate	 2 048 kbit/s 1 984 kbit/s	 See 4.1.1.1 See 4.1.1.2
Information transfer susceptance	No restriction on binary content	See 4.1.2
Structure	Frame integrity	See 4.1.3
Establishment of connection	Without user intervention	See 4.1.4
Symmetry	Symmetrical in both directions	See 4.1.5
Connection configuration	Point-to-point	See 4.1.6
Network performance sub-attributes		
Connection type attributes	**Value**	
Description	**Nature**	**Reference subclause**
Transmission delay	Terrestrial and satellite options	See 4.1.7.1
Jitter	Input and output ports	See 4.1.7.2
Slip (controlled slip)	≤ 5 per 24 hour period	See 4.1.7.3
Error parameters (see 5.1.7.4)	**Terrestrial**	**Satellite**
End-to-end performance objectives Errored Seconds (ES) ratio Severely Errored Seconds (SES) ratio Background Block Errors (BBE) ratio	 < 2,000 % < 0,100 % < 0,015 %	 < 3,120 % < 0,156 % < 0,023 %
Performance level over 24 hour period (24 hour test limit) Errored Seconds (ES) Severely Errored Seconds (SES) Background Block Errors (BBE)	 < 1 645 < 68 < 12 732	 < 2 592 < 112 < 19 933

4.1.1 Transfer rate

4.1.1.1 Leased line timing

Requirement: The leased line shall either:

a) carry user timing within the range 2 048 kbit/s ± 50 parts per million (ppm); or

b) provide timing that is synchronous to the network timing; or

c) take user timing within the range 2 048 kbit/s ± 50 ppm from one input and provide this timing at both outputs of the leased line.

NOTE 1: In case b), network timing is timing that is derived from the source or sources of timing that are used for the network. Thus the timing provided by the leased line will be similar to that provided by other digital services.

NOTE 2: When the timing in both directions is not synchronous, the number of transmitted E-bits differs from the number of received SMFs. As a consequence, either some valid E-bits are lost or meaningless E-bits are inserted.

Test: There is no specific test; the leased line provider shall declare which type of timing the leased line provides and this shall be taken into account during the subsequent tests defined in annex A.

4.1.1.2 Information transfer rate

Requirement: The connection shall be capable of transferring a nominal information rate of 1 984 kbit/s which is contained within the frame structure defined for the leased line (see subclause 4.1.3).

Test: The test shall be conducted according to subclause A.2.1.

4.1.2 Information transfer susceptance

Requirement: The connection shall be capable of transferring digital information with bit sequence integrity, and without restriction on binary content, at the nominal rate of 1 984 kbit/s within the defined frame structure (see subclause 4.1.3).

Test: The test shall be conducted according to subclause A.2.1.

4.1.3 Structure

The purpose of the structure is to allow the leased line provider to monitor the error performance of the leased lines from NTP to NTP. The CRC-4 is, therefore, not necessarily transmitted transparently from NTP to NTP; it may be updated by the leased line provider to determine the location of errors. In order to allow the terminal equipment to monitor the integrity of the path between the terminal equipment and the NTP, the NTP is required to provide a correct CRC-4, and to respond correctly with the E-bits in the event of an incorrectly received CRC-4.

Requirement: For each direction of transmission, the leased line shall accept an input bit stream with a frame and multiframe structure as defined in annex B. When the leased line input has the above frame structure and the connection is not in the unavailable state, the output of the leased line shall also conform to the frame and multiframe structure defined in annex B, with the structure having the same relationship to the information transferred as at the input, maintaining the frame structure integrity.

Test: The test shall be conducted according to subclauses A.2.1 and A.2.5.1.

4.1.3.1 CRC-4

Requirement: At each NTP, the CRC-4 bits transmitted in the output bit stream shall be as defined in tables B.1 and B.2 for a complete CRC-4 multiframe and shall correspond to the data transmitted at the output of the leased line interface, (i.e. the CRC-4 shall be recalculated in the equipment providing the NTP).

Test: The test shall be conducted according to subclause A.2.5.1.

4.1.3.2 Use of the E-bits

Requirement: At each NTP, the E-bits transmitted in the output bit stream shall indicate errored SMFs in the input bit stream at that NTP. One E-bit in each multiframe shall be set to binary ZERO for each errored SMF received in the input bit stream. The E-bits corresponding to non-errored SMFs shall be set to binary ONE. Any delay between the detection of an errored SMF and the setting of the E-bit that indicates the errored SMF shall be less than 1 s.

NOTE: The intention is that the CRC-4 verification, and the associated generation of the E-bits, will be performed in the equipment that provides the NTP in order to indicate only those errors that have occurred between the terminal equipment and the NTP and not those errors that have occurred within the network.

Test: The test shall be conducted according to subclause A.2.5.2.

4.1.3.3 Frame synchronization and data transmission capability

Requirement: The leased line shall continue to transparently transmit data in the event of receiving one or two consecutive incorrect frame alignment signals. On receipt of:

- three consecutive incorrect frame alignment signals; or
- there being = 915 errored SMFs out of 1 000 SMFs,

the leased line shall consider frame alignment to have been lost and initiate a search for frame alignment during which time the leased line may cease transparent transmission of data.

NOTE: Some implementations may also consider frame alignment to have been lost in the event that bit 2 in frames not containing the frame alignment signal is in error on three consecutive occasions. This situation is unlikely to occur except in the event of high error rates between the terminal equipment and the NTP.

Frame alignment shall not be considered as having been regained until:

a) for the first time, the presence of the correct frame alignment signal; and

b) the absence of the frame alignment signal in the following frame detected by verifying that bit 2 of the basic frame is a binary ONE; and

c) for the second time, the presence of the correct frame alignment signal in the next frame,

in which case transparent transmission of the data shall commence within 20 ms provided that the data does not contain any simulated frame alignment words.

Test: The test shall be conducted according to subclause A.2.5.3.

4.1.3.3.1 Multiframe alignment

Requirement: CRC-4 multiframe alignment shall be achieved if at least two valid CRC-4 multiframe alignment signals can be located within 8 ms (the time separating two CRC-4 multiframe alignment signals being 2 ms or a multiple of 2 ms). If multiframe alignment cannot be achieved within 8 ms it shall be assumed that frame alignment is due to a spurious frame alignment signal and a research for frame alignment shall be initiated.

NOTE: The research for frame alignment should be started at a point just after the location of the assumed spurious frame alignment signal. This will usually avoid realignment onto the spurious frame alignment signal.

Test: The test shall be conducted according to subclause A.2.5.4.

4.1.3.4 Use of the A-bit

There is no requirement of the use of the A-bit within the present document. The value of the A-bit is undefined at the output of the leased line.

4.1.3.5 Use of the S_a bits

There is no requirement of the use of the S_a bits within the present document. The values of the S_a bits are undefined at the output of the leased line.

4.1.4 Establishment of connection

Requirement: Establishment or release of the connection shall not require any protocol exchange or other intervention at the NTP by the user.

Test: By declaration.

4.1.5 Symmetry

Requirement: The connection shall be symmetrical, i.e. each direction of transmission shall have the same frame structure and information transfer capability.

Test: The test shall be conducted according to subclause A.2.1.

4.1.6 Connection configuration

Requirement: The connection configuration shall be point-to-point.

Test: By declaration.

4.1.7 Network performance

The network performance sub-attributes are displayed in table 1. The values and the associated compliance tests can be found in the subsequent subclauses.

4.1.7.1 Transmission delay

Requirement: The requirement depends upon whether satellite transmission is involved in the connection or not:

- for connections where satellite transmission is not involved, the one way end-to-end delay shall be less than (10 + 0,01 G) ms, where G is the geographical distance in kilometres, as shown in figure 1; or
- for connections where satellite transmission is involved, the one way end-to-end delay shall be less than 350 ms.

NOTE: These requirements are based on subclauses annex A.2 and A.3 of ITU-T Recommendation G.114.

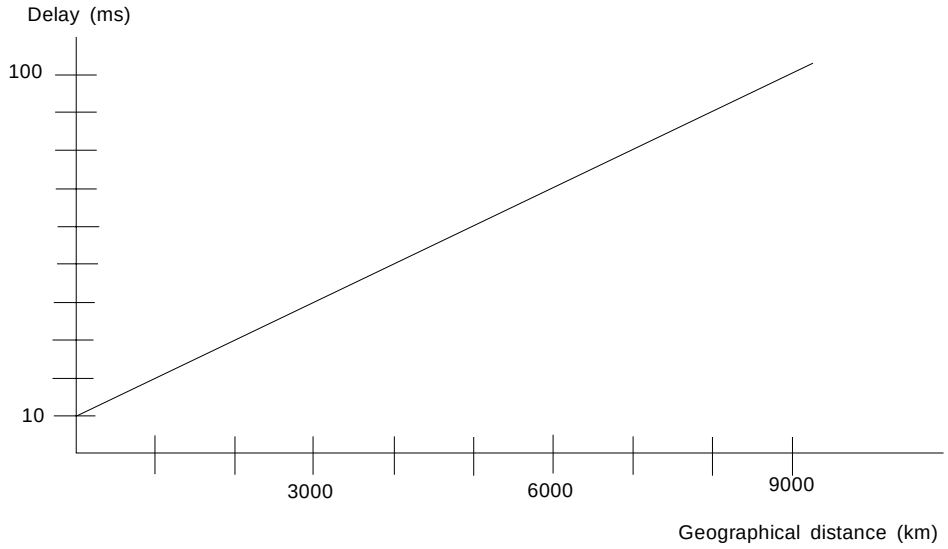


Figure 1: Upper limit of delay

There are no requirements for low frequency (below 20 Hz) variation of one way end-to-end delay under the present document.

Test: The test shall be conducted according to subclause A.2.2.

4.1.7.2 Jitter

4.1.7.2.1 Jitter tolerance at the network input port

Requirement: The leased line shall function as specified with input jitter being the sum of two band limited components as defined in table 2.

NOTE: The jitter tolerance for the connection is defined in this way instead of specifying single jitter frequencies, for the following reasons:

- this method is more representative of the jitter encountered in practice; and
- long regenerator chains may be especially sensitive to single jitter frequencies.

Table 2: Components of input jitter

Filters for generation of jitter spectrum (first order)		Bandpass filter for measurement of input jitter	Input jitter measured by bandpass filter
Lower cut-off (high pass)	Upper cut-off (low pass)	(lower cut-off first order)	Unit Interval (UI) peak-to-peak (maximum)
Only low pass	4 Hz	4 Hz to 100 kHz	1,1 UI
40 Hz	100 kHz	40 Hz to 100 kHz	0,11 UI
NOTE: The purpose of the first order low pass linear filter with an upper cut-off of 4 Hz is to generate a slope of 20 dB per decade from 4 Hz to 40 Hz on the input jitter spectrum. The level of jitter (or more correctly wander) generated by this method at frequencies below 4 Hz is of the order of 1 UI. In principle, there is no requirement for wander and this wander is an unintended by-product of the method of specifying the jitter. In practice, wander of this level should not cause any problems for the network.			

Test: The test shall be conducted according to subclause A.2.3.

4.1.7.2.2 Maximum jitter at the network output port

Requirement: The maximum jitter at the output port of the network shall not exceed the limits specified in table 3, when measured with linear filters with the defined cut-off frequencies.

At frequencies below the lower 3 dB point, the attenuation of the high pass filter shall rise with a value greater than, or equal to, 20 dB per decade. At frequencies above the upper 3 dB point, the attenuation of the low pass filtration shall rise with a value greater than, or equal to, 60 dB per decade.

NOTE: This requirement is taken from ITU-T Recommendation G.823.

Table 3: Maximum network output jitter

Measurement filter bandwidth		Output jitter
Lower cut-off (high pass)	Upper cut-off (low pass)	UI peak-to-peak (maximum)
20 Hz	100 kHz	1,5 UI
18 kHz	100 kHz	0,2 UI

Test: The test shall be conducted according to subclause A.2.3.

4.1.7.3 Controlled slip

Requirement: For at least one of two consecutive periods of 24 hours the number of controlled slips shall be less than or equal to 5.

NOTE 1: This requirement is based on clause 2 and table 1 of ITU-T Recommendation G.822.

NOTE 2: For leased lines operating within the same Primary Reference Clock (PRC) domain, there should be no slips as long as all secondary clocks are locked to the PRC. Slips within the specified limit occur only when one or both timing chains from the NTPs to the PRC are disturbed.

NOTE 3: Figures for uncontrolled slips are not available and are not specified within the present document.

Test: The test shall be conducted according to subclause A.2.4.

4.1.7.4 Error

ESs, SESs and BBEs shall be excluded from the measurement of the error performance if the leased line is in the unavailable state.

NOTE: When microwave links are used in the connection it may not be possible to meet the requirement in rare periods with very adverse propagation conditions.

4.1.7.4.1 Bringing Into Service (BIS) limits

There are no BIS limits defined under the present document.

NOTE: BIS limits may be added to the present document in a later revision. The calculation of BIS limits is specified in ITU-T Recommendations M.1340 and M.2100.

4.1.7.4.2 Performance level

Requirement: The performance of a leased line either in service or taken out of service in order to perform an error measurement, shall meet the requirements of table 4.

Table 4: Performance levels over a 24 hour test period for a block length of 2 048 bits

Performance parameter	Terrestrial	Satellite
ES	< 1 645	< 2 592
SES	< 68	< 112
BBE	< 12 732	< 19 933

Test: The test shall be conducted according to subclause A.2.4.

4.1.7.5 Availability

There is no requirement on availability under the present document.

NOTE 1: Annex D provides guidelines on an approach to the specification of availability requirements for 2 048 kbit/s leased lines.

NOTE 2: At present some leased line providers include availability performance, defined on an individual basis as a quality of service parameter, as part of the contracted supply conditions for their leased line offerings.

Annex A (normative): Test methods

A.1 General

This annex describes the test principles to determine the compliance of a connection against the requirements of the present document.

It is outside the scope of the present document to identify the specific details of the implementation of the tests.

Details of test equipment accuracy and the specification tolerance of the test devices are not included in all cases. Where such details are provided they shall be complied with, but the way they are expressed shall not constrain the method of implementing the test.

NOTE: Attention is drawn to the issue of measurement uncertainty which may be addressed in future documents. Not all the required test results make allowance for spurious events during testing (e.g. errors due to ElectroMagnetic Compatibility (EMC) effects), which may make it necessary to repeat a test.

The test configurations given do not imply a specific realization of the test equipment or test arrangement, or the use of specific test devices. However, any test configuration used shall provide those test conditions specified under "connection state", "stimulus" and "monitor" for each individual test.

The test equipment shall be a device, or group of devices that is capable of generating a stimulus signal conforming to EN 300 418 [4] and capable of monitoring the signal received from the network interface.

A.1.1 Equipment connection

The leased line may be supplied with either a socket or a hardwired connection. Testing shall be performed at the defined NTP as this is the point at which compliance with the present document is required.

A.1.2 Sequence of performing the tests

Error and slip should be tested before jitter and delay; jitter should be tested before information transfer rate, susceptance, structure and symmetry.

A.2 Test methods

One test may cover more than one requirement. The scope of each test is defined under the heading "purpose".

A.2.1 Information transfer rate, susceptance and symmetry

Purpose: To verify compliance with the requirements for information transfer rate (subclause 4.1.1.2), information transfer susceptance (subclause 4.1.2) and symmetry (subclause 4.1.5).

Test configuration: Test equipment shall be connected to the leased line and the leased line shall be looped back at the far end by a test equipment capable of reducing jitter to the levels specified in the present document (see figure A.1).

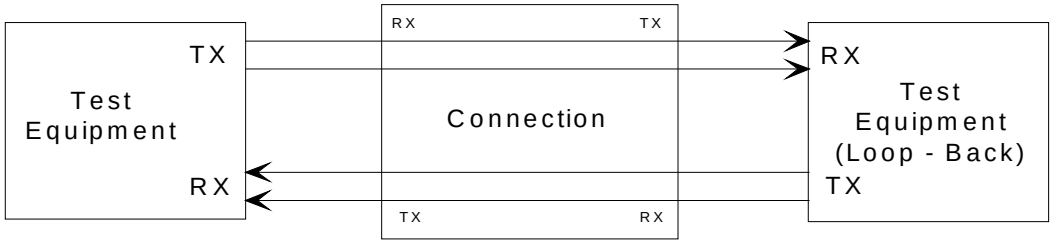


Figure A.1: Information transfer rate, susceptance and symmetry

Connection State: Available.

Stimulus: The test equipment shall generate a High Density Bipolar code of order 3 (HDB3) encoded bit stream complying with a waveform shape as defined in EN 300 418 [4], structured according to annex B, containing in bits 9 to 256 of the frame the bit sequences defined in a, b and c below; this shall be applied to the input of the leased line. Where the leased line provides network timing, the test shall be performed with the test equipment synchronous with the timing provided at the connection output. Where the leased line is capable of carrying user timing, the tests shall be performed at the bit rate limits of 2 048 kbit/s + 50 ppm and 2 048 kbit/s - 50 ppm.

a) A PRBS(2^{15}-1).

b) A sequence of successive binary ZEROs.

c) A sequence of successive binary ONEs.

Monitor: The bit stream at the output of the leased line.

Results: For each stimulus a), b) and c), for a continuous period of at least one second no alterations to the binary content shall occur.

For stimulus a), i.e. the PRBS(2^{15}-1), the integrity of the frame structure shall be maintained, (i.e. where bits 9 to 256 contain a given sequence at the input of the leased line, the identical sequence shall be contained in bits 9 to 256 at the output of the leased line).

A.2.2 Delay

Purpose: To verify compliance with the requirements for the one way transmission delay as specified in subclause 4.1.7.1.

Test configuration: Test equipment shall be connected to the leased line and the leased line shall be looped back at the far end by a test equipment capable of reducing jitter to the levels specified in the present document (see figure A.2).

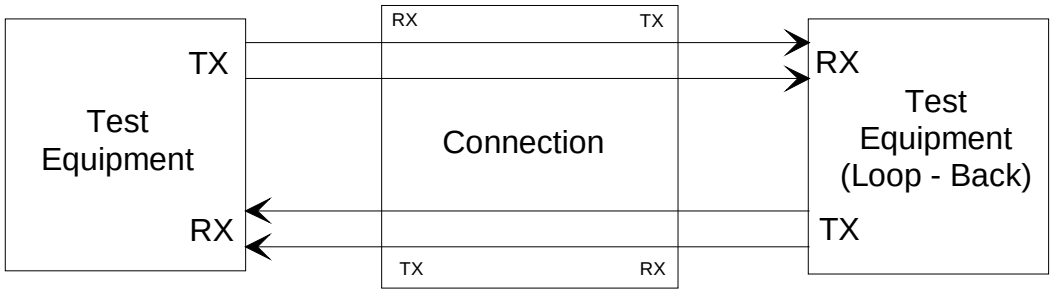


Figure A.2: Delay

Connection State: Available.

Stimulus: The test equipment shall generate a HDB3 encoded bit stream complying with a waveform shape as defined in EN 300 418 [4], structured according to annex B, containing in bits 9 to 256 of the frame a bit stream with a bit sequence whose repetition period is at least one second; this signal shall be applied to the input of the leased line. Where the leased line provides network timing, the test shall be performed with the test equipment synchronous with the timing provided at the connection output. Where the leased line is capable of carrying user timing, the tests shall be performed at a bit rate within the limits of 2 048 kbit/s + 50 ppm and 2 048 kbit/s - 50 ppm.

Monitor: The round trip delay between transmission and reception of the bit sequence in bits 9 to 256.

Results: The round trip delay after deduction of the delay introduced by the loop-back test equipment, shall be less than twice the delay specified in the requirement of subclause 4.1.7.1.

NOTE: It is not practicable to provide a test of the transmission delay in each individual direction.

A.2.3 Jitter

Purpose: To verify compliance with the requirements for jitter tolerance at the network input port as specified in subclause 4.1.7.2.1 and for the maximum jitter allowed at the network output port as specified in subclause 4.1.7.2.2.

NOTE: Further information on the measurement of jitter can be found in ITU-T Supplement number 3.8, Fascicle IV.4 (1988).

Test configuration: Test equipment shall be connected to both ends of the leased line (see figure A.3). Each direction shall be tested separately.

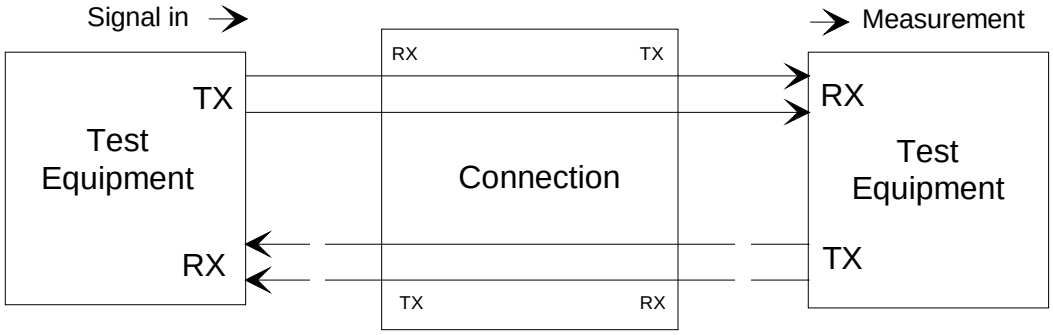


Figure A.3: Jitter

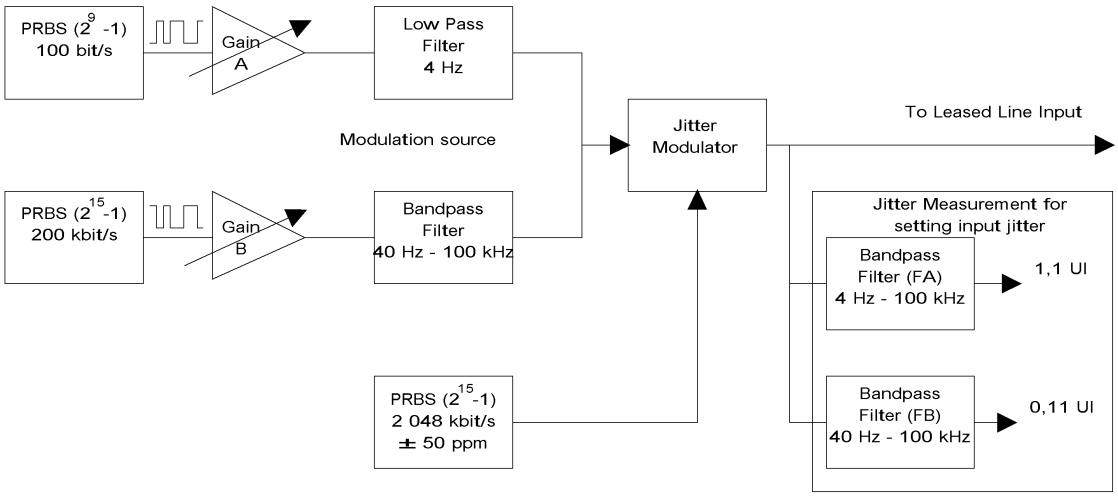
Connection State: Available.

Stimulus: The test equipment shall generate a HDB3 encoded bit stream complying with a waveform shape as defined in EN 300 418 [4], structured according to annex B, and this bit stream shall be applied to the input of the connection. Where the leased line provides network timing, the test shall be performed with the test equipment synchronous with the timing provided at the connection output. Where the leased line is capable of carrying user timing, the tests shall be performed at the bit rate limits of 2 048 kbit/s + 50 ppm and 2 048 kbit/s - 50 ppm.

Jitter is applied to the input bit stream, where jitter is produced by a voltage controlled jitter modulator, (see figure A.4), modulated by a signal which consists of the following two signals added together:

a) a square wave signal produced by a PRBS(2^9-1) bit stream generated at a frequency of 100 Hz. The square wave signal shall be filtered by a first order linear low pass filter with the cut off frequency of 4 Hz. The voltage amplitude of the square wave pulses shall be constant and of a value that results in measured jitter of 1,1 UI in the bandwidth of 4 Hz to 100 kHz;

b) a square wave signal produced by a PRBS(2^{15}-1) bit stream generated at a frequency of 200 kHz. The square wave signal shall be filtered by a first order linear band pass filter with the cut off frequencies of 40 Hz and 100 kHz. The voltage amplitude of the square wave pulses shall be constant and of a value that results in measured jitter of 0,11 UI in the bandwidth of 40 Hz to 100 kHz.



NOTE: The filter gains to determine the jitter levels are set individually. Filter FA is used when setting the value of A, with signal B disconnected. Filter FB is used when setting the value of B, with signal A disconnected.

Figure A.4: Input jitter generation

Monitor:
- The jitter extracted from the signal at the network output port, using equipment complying with ITU-T Recommendation O.171 [3]; and
- the bit stream extracted from the signal at the network output port.

Results:
- The peak to peak jitter at the connection output port shall comply with table 3; and
- at least one out of 10 periods of 10 s no alterations to the binary content shall occur.

A.2.4 Error and slip

Purpose: To verify compliance with the requirements for error as specified in subclause 4.1.7.4.2 and slip as specified in subclause 4.1.7.3.

Test configuration: Test equipment shall be connected to both ends of the leased line (see figure A.5). Each direction shall be tested separately.

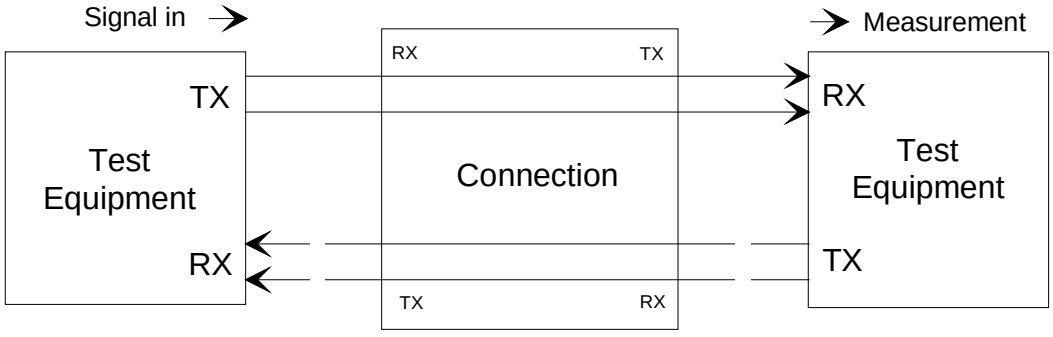


Figure A.5: Error and slip

Connection State: Available.

Stimulus: A HDB3 encoded bit stream complying with a waveform shape as defined in EN 300 418 [4], structured according to annex B, containing a PRBS(2^{15}-1) in bits 9 to 256 of the frame, shall be applied to the input of the connection and shall be transmitted for two consecutive periods of 24 hours, with jitter modulated and filtered as described by table 2.

Where the leased line provides network timing, the test shall be performed with the test equipment synchronous with the timing provided at the connection output. Where the leased line is capable of carrying user timing, the tests shall be performed at the bit rate limits of 2 048 kbit/s + 50 ppm and 2 048 kbit/s - 50 ppm for alternate 12 hour periods.

Monitor:

- The number of ESs;
- the number of SESs;
- the number of BBEs;
- the number of frame slips.

Error measurement shall not be performed when the leased line is in the unavailable state. If an unavailability period of more than one hour occurs during the measuring period, the measuring period shall be extended accordingly.

Results: When monitoring a line that is in service, or when monitoring a line that has been taken out of service to perform a measurement, the number or errors, SESs and BBEs shall be less than the performance levels given in subclause 4.1.7.4.2 and the number of slips shall be less than or equal to the limit given in subclause 4.1.7.3.

NOTE: If the requirements are met during the first continuous period of 24 hours, the test need not be continued for the second period of 24 hours.

A.2.5 Structure

A.2.5.1 Output structure and CRC-4 generation

Purpose: To verify the correct frame structure and correct generation of CRC-4 at the leased line output port as specified in subclauses 4.1.3 and 4.1.3.1.

Test configuration: Figure A.6.

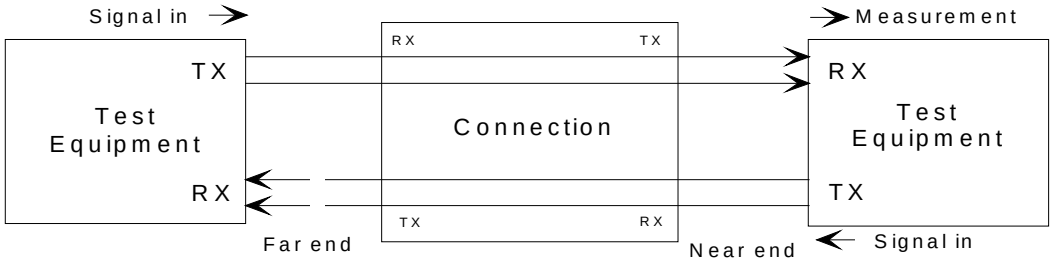


Figure A.6: Frame structure

Connection State: Available.

Stimulus: A HDB3 encoded bit stream complying with a waveform shape as defined in EN 300 418 [4], structured according to annex B, containing a PRBS(2^{15}-1) in bits 9 to 256 of the frame, shall be applied to each input of the connection. Where the leased line provides network timing, the test shall be performed with the test equipment synchronous with the timing provided at the connection output. Where the leased line is capable of carrying user timing, the test shall be performed at a bit rate within the limits of 2 048 kbit/s + 50 ppm and 2 048 kbit/s - 50 ppm.

Monitor: The CRC-4 in the output bit stream from the leased line.

Results: For a period of at least 100 iterations of the PRBS(2^{15}-1) (approximately 1,6 s), the CRC-4 shall correspond with the data in the previous SMF, as defined in subclause B.2.1.

A.2.5.2 Use of the E-bits

Purpose: To verify that the E-bits are set correctly to indicate errored SMFs in the bit stream received from the terminal equipment at the NTP, as specified in subclause 4.1.3.2.

Test configuration: Figure A.6.

Connection State: Available.

Stimulus: A HDB3 encoded bit stream complying with a waveform shape as defined in EN 300 418 [4], structured according to annex B, containing a PRBS(2^{15}-1) in bits 9 to 256 of the frame, shall be applied to each input of the connection. The bit stream at the input at which the measurement is to be performed (the near end) shall have the CRC-4 bits altered as shown in table A.1. Where the leased line provides network timing, the test shall be performed with the test equipment synchronous with the timing provided at the connection output. Where the leased line is capable of carrying user timing, the test shall be performed at a bit rate within the limits of 2 048 kbit/s + 50 ppm and 2 048 kbit/s - 50 ppm, with both directions of transmission having the same rate (i.e. with one test equipment applying a clock loop).

Table A.1: Errored SMFs

Stimulus from test equipment	Result
One SMF with an incorrect CRC-4 within a stream of SMFs with correct CRC-4s.	One E-bit of E = 0, sent within 1 s of the errored SMF, the other E-bits being E = 1.
Two consecutive SMFs with incorrect CRC-4s within a stream of SMFs with correct CRC-4s.	Two consecutive E-bits of E = 0, sent within 1 s of the errored SMF, the other E-bits being E = 1.
NOTE: Two consecutive E-bits may be in consecutive multiframes.	

Monitor: The E-bits in the output bit stream from the leased line.

Results: The E-bits shall be as defined in table A.1.

A.2.5.3 Frame synchronization and data transmission capability

Purpose: To verify that data transmission capability is maintained or regained following errors in the frame alignment signal in the bit stream received from the terminal equipment at the NTP, as specified in subclause 4.1.3.3.

Test configuration: Figure A.5.

Connection State: Available.

Stimulus: A HDB3 encoded bit stream complying with a waveform shape as defined in EN 300 418 [4], structured according to annex B, containing a fixed data pattern in bits 9 to 256 of the frame, shall be applied to each input of the connection; this fixed data pattern shall not contain a simulated frame alignment signal. The bit stream at the input opposite to that at which the measurement is to be performed (the far end) shall be altered as shown in table A.2. Where the leased line provides network timing, the test shall be performed with the test equipment synchronous with the timing provided at the connection output. Where the leased line is capable of carrying user timing, the test shall be performed at a bit rate within the limits of 2 048 kbit/s + 50 ppm and 2 048 kbit/s - 50 ppm.

Table A.2: Transmission capability

	Stimulus from test equipment (see notes 1, 2 and 3)	Result
1	Continuous frame sequence containing one incorrect frame alignment signal. (..2 F 2 F 2 /F 2 F 2 F..)	No break in transmission.
2	Continuous frame sequence containing two consecutive incorrect frame alignment signals. (..2 F 2 F 2 /F 2 /F 2 F 2 F..)	No break in transmission.
3	Continuous frames sequence containing three consecutive incorrect frame alignment signals. (..2 F 2 F 2 /F 2 /F 2 /F 2 F 2 F..)	Any break in transmission shall be less than 20,5 ms.
4	Continuous frames with three consecutive incorrect frame alignment signals, then N x frame sequences alternating correct and incorrect frame alignment signals (4N frames), a correct frame, then M x frame sequences with the correct frame alignment signal but with the frames not containing the frame alignment signal with bit 2 = 0 (2M frames), followed by continuous correct frames. (..2 F 2 F 2 /F 2 /F 2 /F Nx(2 F 2 /F) 2 F Mx(/2 F) 2 F 2 F..)	Any break in transmission shall be less than 20,75 + 0,5x(N+M/2) ms. It is recommended that M and N be between 40 and 100.
5	Continuous frame sequence with two consecutive frames not containing the frame alignment signal having bit 2 = 0. (..2 F 2 F /2 F /2 F 2 F 2 F..)	No break in transmission.
6	Continuous frames with three consecutive frames not containing the frame alignment signal having bit 2 = 0. (..2 F 2 F /2 F /2 F /2 F 2 F 2 F..)	A break in transmission may occur in some implementations. Any break in transmission shall be less than 20,5 ms.
7	Continuous frames with 914 consecutive errored SMFs, followed by 86 consecutive non-errored SMFs, followed by 914 consecutive errored SMFs, followed by continuous non-errored SMFs. (..SMF SMF 914x/SMF 86xSMF 914x/SMF SMF)	No break in transmission.
8	Continuous frames with 915 consecutive errored SMFs followed by 85 consecutive non-errored SMFs, followed by 915 consecutive errored SMFs, followed by continuous non-errored SMFs. (..SMF SMF 915x/SMF 85xSMF 915x/SMF SMF)	Any break in transmission shall be less than 1 020,5 ms.

NOTE 1: Each test defined within the table shall be preceded by sufficient correct frames to ensure frame and multiframe alignment.

NOTE 2: F is a frame with a correct frame alignment signal;
/F is a frame with an incorrect frame alignment signal;
2 is the frame not containing the frame alignment signal having bit 2 set to 1;
/2 is the frame not containing the frame alignment signal having bit 2 set to 0;
SMF is a Sub-MultiFrame having correct frame alignment and correct CRC-4 bits;
/SMF is a Sub-MultiFrame having correct frame alignment and incorrect CRC-4 bits.

NOTE 3: The results are defined on the basis that there are no errors generated within the connection for the duration of the test.

Monitor: Breaks in transmission at the far end of the leased line.

Results: The breaks in transmission at the far end of the leased line shall be as defined in table A.2.

A.2.5.4 Multiframe alignment

Purpose: To verify that multiframe alignment can be achieved, as specified in subclause 4.1.3.3.1.

Test configuration: Figure A.6.

Connection State: Available.

Stimulus: A HDB3 encoded bit stream complying with a waveform shape as defined in EN 300 418 [4], structured according to annex B, containing a fixed data pattern in bits 9 to 256 of the frame, shall be applied to each input of the connection; this fixed data pattern shall not contain a simulated frame alignment signal. The bit stream at the input at which the measurement is to be performed (the near end) shall be altered as shown in table A.3. Where the leased line provides network timing, the test shall be performed with the test equipment synchronous with the timing provided at the connection output. Where the leased line is capable of carrying user timing, the test shall be performed at a bit rate within the limits of 2 048 kbit/s + 50 ppm and 2 048 kbit/s - 50 ppm.

Table A.3: Multiframe alignment

	Stimulus from test equipment (see notes 1 and 2)		Result
1	10*MF	Correct multiframes to set initial condition.	
	/F 2 /F 2 /F 2 /F 2	Force loss of frame and	
	/F 2 /F 2	multiframe alignment.	
	F 2 F 2	Regain frame alignment.	
	/MF MF /MF MF	Two multiframe signals in 8 ms.	Multiframe alignment.

NOTE 1: Each test defined within the table shall be preceded by sufficient correct frames to ensure frame and multiframe alignment.

NOTE 2: F is a frame with a correct frame alignment signal;
/F is a frame with an incorrect frame alignment signal;
2 is the frame not containing the frame alignment signal having bit 2 set to 1;
/SMF is a SMF having correct frame alignment and incorrect CRC-4 bits;
MF is a multiframe having correct frame alignment signal, bit 2 = 1, correct multiframe alignment signal and correct CRC-4 bits;
/MF is a multiframe having correct frame alignment signal, bit 2 = 1, incorrect multiframe alignment signal and correct CRC-4 bits.

Monitor: Monitor for multiframe alignment at the network interface; the leased line provider shall declare how this is done. Those leased using the A-bit may send Remote Alarm Indication (RAI) when multiframe alignment is not found.

Results: Multiframe alignment shall be achieved following the test sequence of table A.3.

Annex B (normative): Definition of frame structure

B.1 Frame structure

The bit stream shall be structured into a frame of length 256 bits, numbered 1 to 256. The frame repetition rate shall be nominally 8 000 Hz. The allocation of bits 1 to 8 within the frame shall be as shown in table B.1.

Table B.1: Allocation of bits 1 to 8

Bit no	Frame containing the frame alignment signal	Frame not containing the frame alignment signal
1	CRC-4 (see clause B.2)	CRC-4 (see clause B.2)
2	0	1
3	0	A (see note 1)
4	1	S_{a4} (see note 2)
5	1	S_{a5} (see note 2)
6	0	S_{a6} (see note 2)
7	1	S_{a7} (see note 2)
8	1	S_{a8} (see note 2)

NOTE 1: Bit A: RAI (see subclause 4.1.3.4).
NOTE 2: Bits S_{a4} to S_{a8} are for the use of the leased line operator. Their value at the output port of a leased line is undefined.

B.2 CRC-4

The allocation of the CRC-4 bits shall be as given in table B.2 for a complete CRC-4 multiframe. Each CRC-4 multiframe, which is composed of 16 frames numbered 0 to 15, shall be divided into two 8-frame SMFs, designated SMF I and SMF II which shall signify their respective order within the CRC-4 multiframe structure. The SMF is the block (size 2 048 bits) for the CRC-4.

In those frames containing the frame alignment signal, bit 1 shall be used to transmit the CRC-4 bits. These shall be the 4 bits designated C_1, C_2, C_3 and C_4 in each SMF. In those frames not containing the frame alignment signal, bit 1 shall be used to transmit the six bit CRC-4 multiframe alignment signal and two CRC-4 error indication bits (E-bits). The CRC-4 multiframe alignment signal shall have the form 001011.

Table B.2: Allocation of CRC-4 bits with a multiframe

	SMF	Frame	Bit 1
Multiframe	SMF I	0	C1
		1	0
		2	C2
		3	0
		4	C3
		5	1
		6	C4
		7	0
	SMF II	8	C1
		9	1
		10	C2
		11	1
		12	C3
		13	E
		14	C4
		15	E

B.2.1 CRC-4 generation

A particular CRC-4 word, located in SMF N shall be the remainder after multiplication by x^4 and then division (modulo 2) by the generator polynomial $x^4 + x + 1$, of the polynomial representation of SMF (N-1). When representing the contents of the check block as a polynomial, the first bit in the block, i.e. frame 0 bit 1 or frame 8 bit 1, shall be taken as the most significant bit. Similarly, C_1 is defined to be the most significant bit of the remainder and C_4 the least significant bit of the remainder.

The CRC-4 encoding process is described below:

a) the CRC-4 bits in the SMF are replaced by binary ZEROs;

b) the SMF is then acted upon by the multiplication/division process defined above;

c) the remainder resulting from the multiplication/division process is stored, ready for insertion into the respective CRC-4 locations of the next SMF.

NOTE: The CRC-4 bits thus generated do not affect the result of the multiplication/division process in the next SMF because, as indicated in a) above, the CRC-4 bit positions in a SMF are initially set to binary ZERO during the multiplication/division process.

B.2.2 CRC-4 monitoring

The CRC-4 monitoring process used to detect errored SMFs shall be as described below:

- a received SMF is acted upon by the multiplication/division process defined in subclause B.2.1 after having its CRC-4 bits extracted and replaced by ZEROs;

- the remainder resulting from the multiplication/division process is stored and subsequently compared on a bit by bit basis with the CRC-4 bits received in the next SMF;

- if the remainder calculated in the decoder does not exactly correspond to the CRC-4 bits received in the next SMF, the SMF is defined as being an errored SMF.

Annex C (informative): Derivation of error performance limits

C.1 Introduction

Errors are caused by various influences such as:

- human intervention;
- thermal noise;
- induced voltages in equipment and cables due to lightning, radio transmissions and other electromagnetic effects;
- loss of Synchronization following uncontrolled slips;
- joints and connections.

The main cause of errors is induced voltages and such errors frequently occur in dense bursts due to particular phenomena. Due to improvements in technology resulting in part from a greater understanding of electromagnetic effects, there is a long-term trend for error rates to reduce.

Studies in ITU-T have concluded that error rates for lines have a low dependence on distance.

C.2 Reference connections

ITU-T Recommendation G.826 contains error performance limits for a hypothetical reference connection of 27 500 km. In order to apply these figures to a leased line, it is necessary to define reference connections to represent the leased lines covered by the present document. A terrestrial reference connection and a satellite reference connection are defined in subclauses C.2.1 and C.2.2 based on ITU-T Recommendation G.826.

C.2.1 Terrestrial connection

Figure C.1 shows the reference connection for a terrestrial connection used in the derivation of error performance limits specified in the present document.

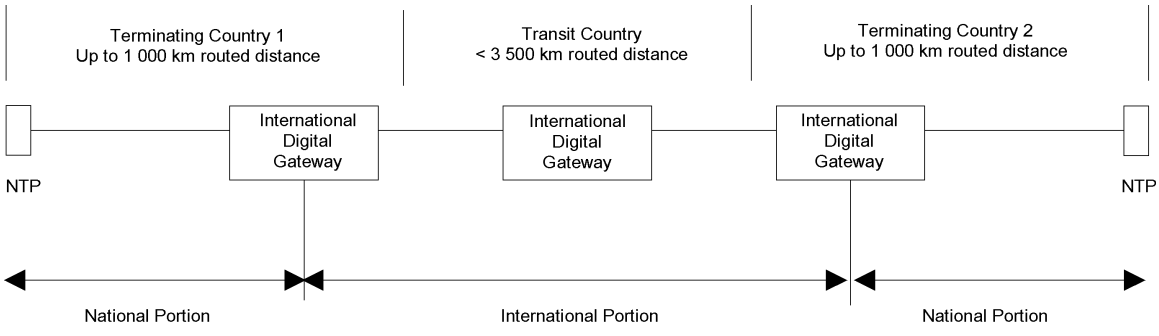


Figure C.1: Reference connection for terrestrial 2 048 kbit/s digital leased line

The reference connection given in figure C.1 comprises two terminating countries and a single transit country. For each terminating country, there is a routed distance of up to 1 000 km between the NTP and the international digital gateway. For the transit country there is a single international gateway and a routed distance up to 3 500 km. The routed distance is given by 1,5 x straight line distance, except that for undersea cable the actual routed length should be used.

NOTE: This model allows for a total routed distance of up to 5 500 km. Although this reference connection shows separate national portions, the present document does not apportion errors between different countries and the errors may be apportioned differently.

C.2.2 Satellite connection

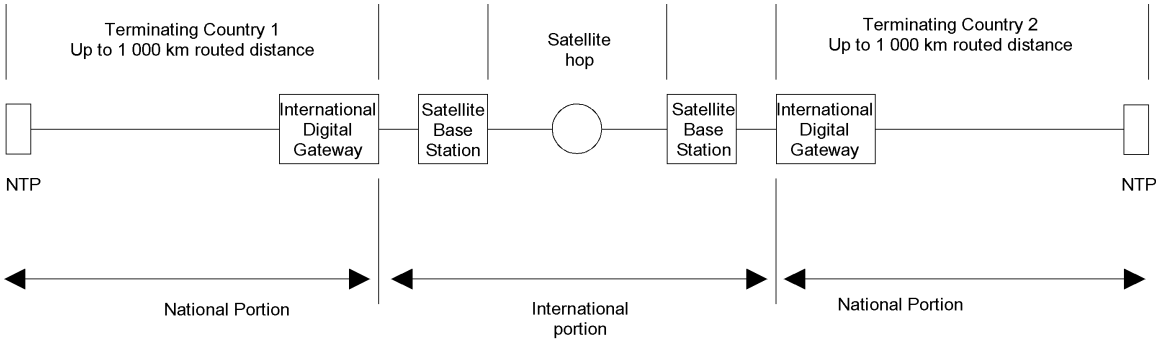


Figure C.2: Reference connection for satellite 2 048 kbit/s digital leased line

The reference connection in figure C.2 contains a satellite link connecting the two terminating countries. For each terminating country a routed distances of 1 000 km is assumed.

C.3 Error performance objectives

Tables C.1 and C.2 show the percentage allocation of the overall error performance objectives specified in ITU-T Recommendation G.826 to the various portions of the leased lines specified in the reference connections (terrestrial and satellite) defined in clause C.2. The tables include both fixed allocations and distance dependent allocations of 1 % per 500 km routed distance.

Table C.1: Allocation of error performance objectives derived from G.826 - terrestrial connection

Path portion (terrestrial link)	Allocation
Terminating country 1 (fixed allocation)	17,5 %
Terminating country 1 (routed 1 000 km)	2,0 %
International transit termination	1,0 %
International transit (fixed allocation)	2,0 %
International transit (routed 3 500 km)	7,0 %
International transit termination	1,0 %
Terminating country 2 (routed 1 000 km)	2,0 %
Terminating country 2 (fixed allocation)	17,5 %
TOTAL	50,0 %

Table C.2: Allocation of error performance objectives derived from G.826 - satellite connection

Path portion (satellite link)	Allocation
Terminating country 1 (fixed allocation)	17,5 %
Terminating country 1 (routed 1 000 km)	2,0 %
International termination	2,0 %
Satellite connection	35,0 %
International termination	2,0 %
Terminating country 2 (routed 1 000 km)	2,0 %
Terminating country 2 (fixed allocation)	17,5 %
TOTAL	78,0 %

NOTE: The inclusion of additional transit countries to the terrestrial connection would require an additional fixed allocation (2 %), transit termination (1 %) and a routed portion (1 % per 500 km). Further information is given in ITU-T Recommendation G.826.

ITU-T Recommendation G.826 defines error performance objectives in terms of ESs, SESs and BBEs for a hypothetical reference path of 27 500 km; these rates are given in table C.3, column 2.

The application of the percentage figures given in tables C.1 and C.2 to the error performance objectives given in ITU-T Recommendation G.826 gives error rates for the D2048S leased line shown in table C.3 columns 3 and 4 for terrestrial and satellite connections.

Table C.3: Long-term error performance objectives for D2048S leased line

Performance parameter	G.826	terrestrial	satellite
ES ratio	4,00 %	2,000 %	3,120 %
SES ratio	0,20 %	0,100 %	0,156 %
BBE ratio	0,03 %	0,015 %	0,023 %
NOTE: The figures in this table have been rounded; exact figures have been used in the calculation of the limits in the following subclauses.			

C.4 Long-term error performance

The error performance ratios derived in clause C.3 for the specific reference connections can be used to calculate the long-term error performance requirements, expressed as an absolute figure over a 24 hour period; these are given in row 1 of table C.4 and table C.5 for the terrestrial and satellite connections.

The error performance requirements specified are, however, statistical figures based on long-term measurements (greater than one month) which are not statistically valid over a 24-hour measurement period. Therefore ITU-T Recommendation M.2100 presents a method of reducing these limits to 24-hour test limits S1 and S2. S1 is the limit below which the line meets the requirement, S2 is the limit above which the line fails to meet the requirement. Between S1 and S2 the results are inconclusive. Therefore, in order for the line to be assumed to meet the long-term requirement, the 24-hour test result should be better than the limit S1.

S1 and S2 are derived from:

$$S1 = (\text{requirement}) - 2 \times \sqrt{(\text{requirement})}$$
$$S2 = (\text{requirement}) + 2 \times \sqrt{(\text{requirement})}$$

Table C.4: Derivation of test limits for a block length of 2 048 bits - terrestrial connection

Parameter	ES	SES	BBE
Long-term error performance	1 728 / 24 h	86 / 24 h	12 960 / 24 h
24 hour test limits			
Accept (S1)	1 645 / 24 h	68 / 24 h	12 732 / 24 h
Reject (S2)	1 811 / 24 h	105 / 24 h	13 188 / 24 h

Table C.5: Derivation of test limits for a block length of 2 048 bits - satellite connection

Parameter	ES	SES	BBE
Reference performance objective	2 696 / 24 h	135 / 24 h	20 218 / 24 h
24 hour test limits			
Accept (S1)	2 592 / 24 h	112 / 24 h	19 933 / 24 h
Reject (S2)	2 800 / 24 h	158 / 24 h	20 502 / 24 h

Annex D (informative): Availability

D.1 General

The availability of a leased line should be assessed over a long period of time and cannot be measured using a single test. ITU-T Recommendation M.1016 proposes that any observation period should be three calendar months. For the purpose of observing availability, the following terms should be considered:

D.1.1 Unavailability

$$\text{Unavailability} = \frac{\sum \text{Unavailability periods}}{\text{observation period}}$$

with unavailability generally expressed as a percentage

D.1.2 Outage intensity

$$\text{Outage intensity} = \frac{\text{Number of unavailability periods}}{\text{observation period}}$$

D.1.3 Mean time between failures

$$\text{Mean time between failures} = \frac{\text{(observation period)} - (\sum \text{unavailability periods})}{\text{number of unavailability periods}}$$

This equation is only valid for a high number of unavailability periods within the observation period.

D.1.4 Mean time to restore service

$$\text{Mean time to restore service} = \frac{\sum \text{unavailability period}}{\text{number of unavailability periods}}$$

D.2 Recommendations

Figures for availability and outage intensity for leased lines, based on the terrestrial and satellite reference connections of figures C.1 and C.2, are given in table D.1. The figures for standard performance indicate the level of performance to be expected from the leased line specified within the present document. The mean value is the figure to be met for the average of all the leased lines of an operator; the worst case value is the value that no leased line should exceed (i.e. be worse than this figure). Customers who require a very high availability may require diverse routing of two or more lines.

The figures in table D.1 are taken from draft I-ETS 300 416 which provides values for 2 048 kbit/s path elements between customer premises. For the situations where the leased line connections are outside the scope of these reference connections, figures can be derived from I-ETS 300 416.

Table D.1: Target availability and outage intensity

	Terrestrial				Satellite	
	Availability		Outage intensity (per year)		Availability	
Performance	**mean**	**worst case**	**mean**	**worst case**	**mean**	**worst case**
Standard performance	97,3 %	94,7 %	590	1 590	undefined	97,0 %
High performance	99,5 %	98,2 %	230	625	undefined	99,2 %

NOTE 1: The availability and outage figures for the terrestrial connection are derived from I-ETS 300 416 using 2 international path core elements of 375 km each, one inter-country path core element of 750 km, one inter-country path core element of 1 250 km and one international path core element of 750 km to give a total transit distance of 3 500 km. Each national path element is 1 000 km.

NOTE 2: The availability figures for the satellite connection are derived from I-ETS 300 416 using 2 international path core elements of 375 km each. Each national path element is 1 000 km.

Annex E (informative): Bibliography

- Council Directive 91/263/EEC of 29 April 1991 on the approximation of the laws of Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity.
- Council Directive 92/44/EEC of 5 June 1992 on the application of Open Network Provision to leased lines.
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