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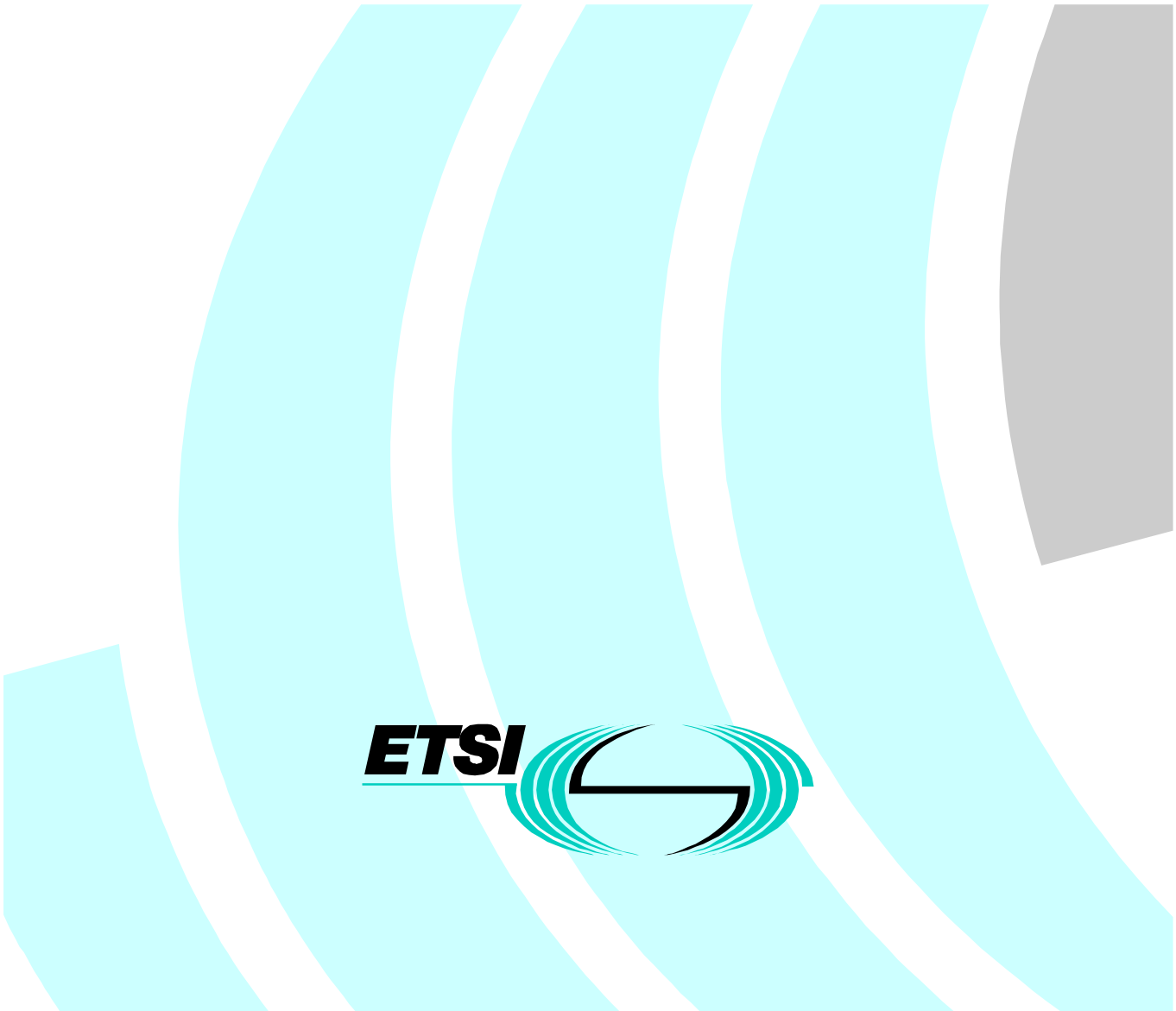
European Standard (Telecommunications series)

Access and Terminals (AT); 2 048 kbit/s digital unstructured leased line (D2048U); 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 results from a mandate from the Commission of the European Community (CEC) to provide standards for the 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 300 248: "Access and Terminals (AT); 2 048 kbit/s digital unstructured leased line (D2048U) 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 Open Network Provision (ONP) to leased lines (92/44/EEC) (see annex C), concerns the harmonization of conditions for open and efficient access to, and use of, the leased lines provided on public telecommunications networks and the availability throughout the Community (EEC) of a minimum set of leased lines with harmonized technical characteristics.

The consequence of the Directive is that Telecommunications Organizations within the EEC 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 (see annex C), later replaced by 98/13/EC (see annex C), terminal equipment for connection to these leased lines was required to fulfil certain essential requirements.

The present version of the present document has been produced to introduce some necessary changes.
ITU-T Recommendation I.340 (see annex C) for ISDN connection types was used as a basis for the connection characteristics.

1 Scope

The present document specifies the technical requirements and test principles for connection characteristics of ONP 2 048 kbit/s digital unstructured leased lines.

A connection is presented via interfaces at Network Termination Points (NTP) 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 [3] defining the interface presentation, the present document describes the service offered.

The leased line provides access to the full digital bit rate of 2 048 kbit/s with no restrictions on the binary content.

The tests specified in the present document cannot be carried out, nor can the performance be monitored 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.

The present document is applicable to leased lines, including part time leased lines, for which the establishment or release do 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.

The present document describes those characteristics of the connection that cannot be determined only by the equipment providing the NTPs. The related standard EN 300 418 [3] defines the interface presentation and places no further constraints on the connection.

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

[4] ETSI EN 300 248: "Access and Terminals (AT); 2 048 kbit/s digital unstructured leased line (D2048U) Terminal equipment interface".

3 Definitions and abbreviations

3.1 Definitions

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

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

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

unavailability period: period of time beginning at the first of 10 consecutive severely errored seconds and ending immediately before the first following period of 10 consecutive seconds none of which are severely errored

errored block: block with one or more bit errors (see ITU-T Recommendation G.826 (see annex C))

NOTE: The duration of a block is 1 millisecond.

errored second: one-second period with one or more errored blocks (see ITU-T Recommendation G.826 (see annex C))

severely disturbed period: occurs when, over a minimum period of time equivalent to four contiguous blocks, either all the contiguous blocks are affected by a high binary error density of at least 10^{-2}, or a loss of signal information is observed (see ITU-T Recommendation G.826 (see annex C))

severely errored second: one-second period which contains at least 30 % errored blocks or at least one severely disturbed period (see ITU-T Recommendation G.826 (see annex C))

slip: sequence of one or more extra or missing consecutive unit intervals in the bit stream

errored seconds ratio: ratio of errored seconds over all seconds within a specified measuring period, where neither are counted during unavailability periods (see ITU-T Recommendation G.826 (see annex C))

severely errored seconds ratio: ratio of severely errored seconds over all seconds within a specified measuring period, where neither are counted during unavailability periods (see ITU-T Recommendation G.826 (see annex C))

background block error ratio: ratio of errored blocks over all blocks within a specified measuring period, where neither are counted during unavailability periods nor during severely errored seconds (see ITU-T Recommendation G.826 (see annex C))

satellite transmission: transmission via an earth orbiting satellite

3.2 Abbreviations

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

D2048U	2 048 kbit/s digital unstructured ONP leased line
ONP	Open Network Provision
NTP	Network Termination Point
ppm	parts per million
PRBS(2^9 - 1)	Pseudo Random Bit Sequence (as defined in clause 2.1 of ITU-T Recommendation O.153 [2])
PRBS(2^{15} - 1)	Pseudo Random Bit Sequence (as defined in clause 2.1 of ITU-T Recommendation O.151 [1])
RX	Receive (a signal input at either the leased line interface or the test equipment)
TX	Transmit (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 (see annex C) are specified in the present document:

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

NOTE: "Bit rate" is equivalent to "information transfer rate" in the present document.

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 clauses.

Table 1: Connection attributes

Connection type attributes	**Value**	
Description	**Nature**	**Reference clause**
Information transfert rate	2 048 ± 50 ppm kbit/s	See 5.1.1
Information transfer susceptance	Unrestricted digital	See 5.1.2
Structure	Unstructured	See 5.1.3
Establishment of communication	Without user intervention	See 5.1.4
Symmetry	Symmetrical in both directions	See 5.1.5
Communication configuration	Point-to-point	See 5.1.6
Network performance sub-attributes		
Connection type attributes	**Value**	
Description	**Nature**	**Reference clause**
Transmission delay	Terrestrial and satellite options	See 5.1.7.1
Jitter	Input and output ports	See 5.1.7.2
Slip	5 per 24 hour period	See 5.1.7.3
Error parameters		
Time interval with errored blocks	**Value**	
Description	**Nature**	**Reference clause**
Errored seconds	2 889 per 24 hour period	See 5.1.7.4.1
Severely errored seconds	117 per 24 hour period	See 5.1.7.4.2
Background block errors	22 395 per 24 hour period	See 5.1.7.4.3

4.1.1 Information transfer rate

Requirement: The connection shall be capable of transferring an information rate of 2 048 kbit/s ± 50 ppm.

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

4.1.2 Information transfer susceptance

Requirement: The connection shall be capable of transferring unrestricted digital information.

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

4.1.3 Structure

Requirement: The connection shall be unstructured. The full bit rate of 2 048 kbit/s shall be available to the user for unrestricted digital information transfer.

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

4.1.4 Establishment of communication

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 nominal characteristics, although the actual values shall be independent.

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

4.1.6 Communication 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 clauses.

4.1.7.1 Transmission delay

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

a) 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

b) for connections where satellite transmission is involved the one-way end-to-end delay shall be less than 350 ms.

NOTE 1: Requirements a) and b) are based on ITU-T Recommendation G.114 (see annex C), clauses A.2 and A.3.

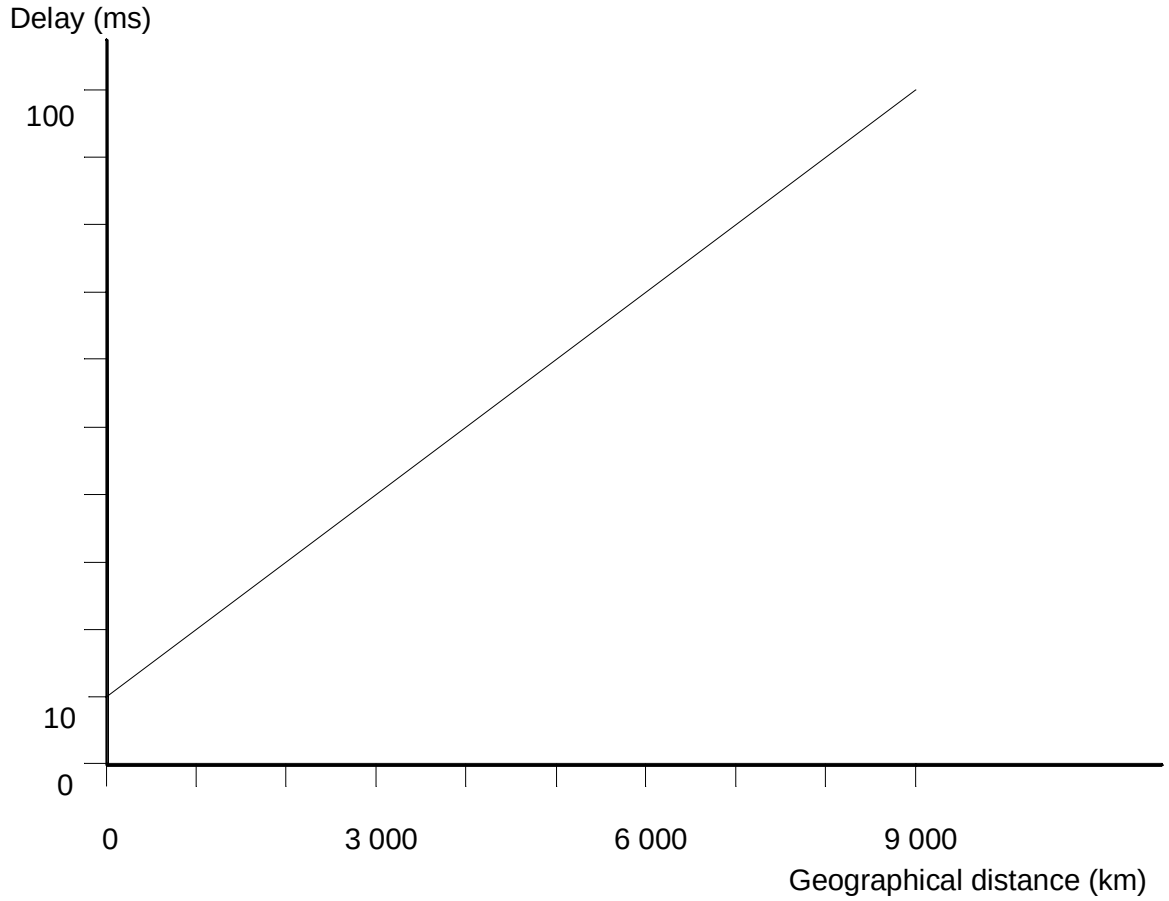

Figure 1: Upper limit of delay

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

NOTE 2: A requirement for low frequency (below 20 Hz) variation of one-way end-to-end delay may be added to the present document when appropriate specifications become available.

Test: The test shall be conducted according to clause 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:

a) this method is more representative of the jitter encountered in practice; and

b) 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)	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

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

4.1.7.2.2 Maximum jitter at the network output port

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

NOTE: This requirement is taken from ITU-T Recommendation G.823 (see annex C).

Table 3: Maximum network output jitter

Measurement filter bandwith		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 clause A.2.3.

4.1.7.3 Slip

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

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

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

4.1.7.4 Error

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 Errored seconds

Requirement: For at least one of two consecutive 24 hours measuring periods, the number of errored seconds shall be less than 2 889.

NOTE: This test limit corresponds to a mean errored seconds ratio of $3,5 \times 10^{-2}$ (see annex B).

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

4.1.7.4.2 Severely errored seconds

Requirement: For at least one of two consecutive 24 hours measuring periods, the number of severely errored seconds shall be less than 117.

NOTE: This test limit corresponds to a mean severely errored seconds ratio of $1,7 \times 10^{-3}$ (see annex B).

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

4.1.7.4.3 Background block errors

Requirement: For at least one of two consecutive 24 hours measuring periods, the number of background block errors shall be less than 22 395.

NOTE: This test limit corresponds to a mean background block error ratio of $2,6 \times 10^{-4}$ (see annex B).

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

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. The required test results do not make allowance for spurious events during testing (e.g. errors due to electro-magnetic compatibility effects).

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 [3] and capable of monitoring the receive signal from the 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

It is essential for the logic that error and slip be tested before jitter and delay, and that jitter 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, structure and symmetry

Purpose: To verify compliance with the requirements for information transfer rate, susceptance, structure and symmetry.

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 in accordance with the specifications in the present document (see figure A.1).

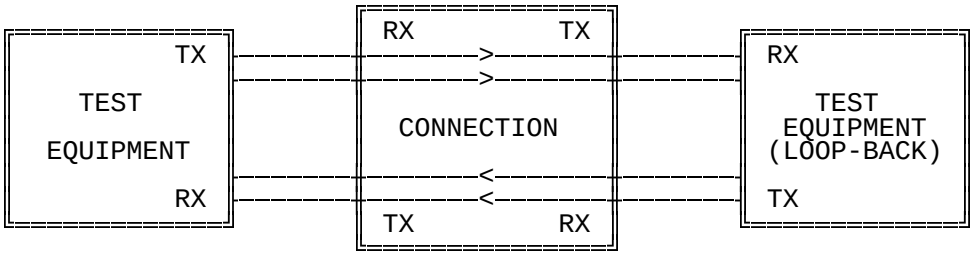

Figure A.1: Information transfer rate, susceptance, structure and symmetry

Connection State: Available.

Stimulus:

a) a Pseudo Random Bit Sequence, as defined in clause 2.1 of ITU-T Recommendation O.151 [1] (PRBS(2^{15}-1)), bit stream transmitted at bit rates of 2 047 898 bit/s and 2 048 102 bit/s;

b) a sequence of successive binary ZEROs transmitted at bit rates of 2 047 898 bit/s and 2 048 102 bit/s;

c) a sequence of successive binary ONEs transmitted at bit rates of 2 047 898 bit/s and 2 048 102 bit/s.

Monitor: The bit stream.

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.

A.2.2 Delay

Purpose: To verify compliance with the requirements for the one way delay.

NOTE: The one-way delay can be estimated as half the round trip delay, as both directions of transmission are assumed to follow the same route.

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 in accordance with the specifications in the present document (see figure A.2).

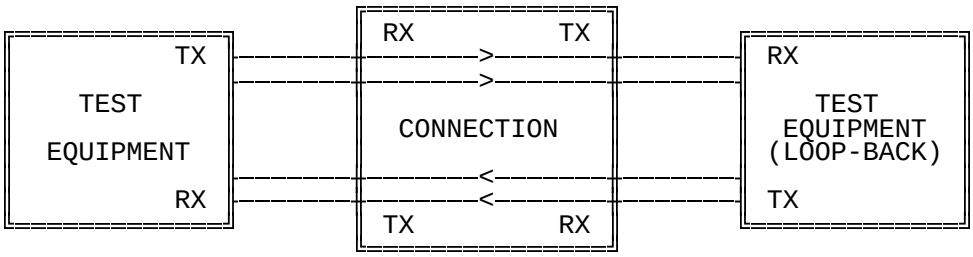

Figure A.2: Delay

Connection State: Available.

Stimulus: A bit stream with one detectable bit sequence.

Monitor: The round trip delay.

Results: The round trip delay after deduction of the delay introduced by the loop-back test equipment, shall be less than twice the nominal maximum one-way delay.

A.2.3 Jitter

Purpose: To verify compliance with the requirements for jitter tolerance at the network input port and for the maximum allowed jitter at the network output port.

NOTE: Further information on the measurement of jitter can be found in ITU-T Supplement number 3.8 (see annex C).

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

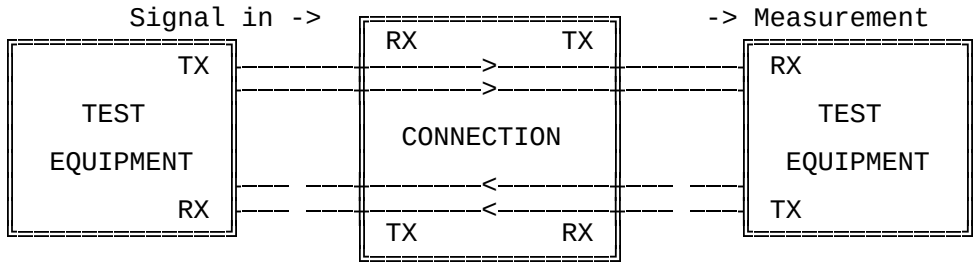

Figure A.3: Jitter

Connection State: Available.

Stimulus: A PRBS(2^{15}-1) is applied to the input of the connection, at bit rates of 2 047 898 bit/s and 2 048 102 bit/s. 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 Pseudo Random Bit Sequence, as defined in clause 2.1 of ITU-T Recommendation O.153 [2] (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.

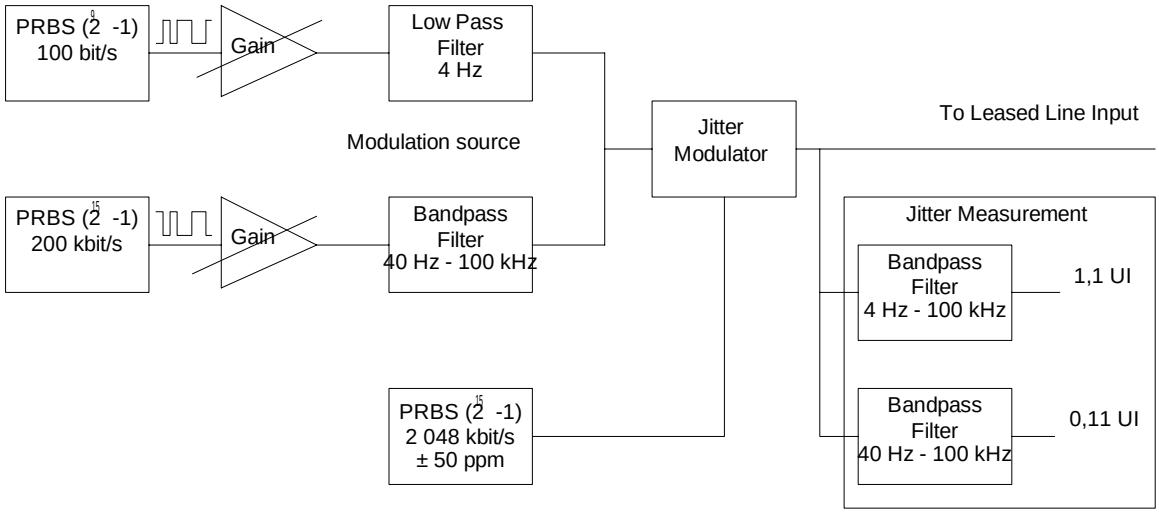

Figure A.4: Input jitter generation

Monitor:
a) The jitter extracted from the signal at the network output port; and
b) the bit stream extracted from the signal at the network output port.

Results:
a) For both bit rates, the peak to peak jitter at the connection output port shall comply with clause 5.1.7.2.2, table 3; and
b) for both bit rates, at least one out of 10 periods of 10 seconds no alterations to the binary content shall occur.

A.2.4 Error and slip

Purpose: To verify compliance with the requirements for error and slip.

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

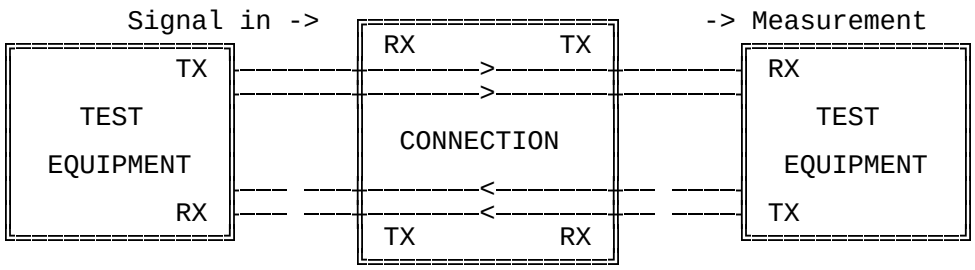

Figure A.5: Error and slip

Connection State: Available.

Stimulus: PRBS(215 - 1) transmitted for two consecutive periods of 24 hours with jitter modulated by white noise and filtered as described by clause 5.1.7.2.1, table 2. For each period of 24 hours the bit rates shall be 2 047 898 bit/s and 2 048 102 bit/s for alternate 12 hour periods. If an unavailability period of more than one hour has occurred during the measuring period, this unavailability period shall be disregarded and the measuring period shall be extended accordingly.

Monitor:

a) the number of errored seconds;

b) the number of severely errored seconds;

c) the number of background block errors;

d) the number of slips.

Results:

a) for the first or the last or both consecutive 24-hour periods the number of errored seconds shall be less than 2 889;

b) for the first or the last or both consecutive 24-hour periods the number of severely errored seconds shall be less than 117;

c) for the first or the last or both consecutive 24-hour periods the number of background block errors shall be less than 22 395;

d) for the first or the last or both consecutive 24-hour periods the number of slips shall be less than 5.

NOTE: If all the requirements a), b), c) and d) are met during the first consecutive period of 24 hours, the test need not be continued for the last period of 24 hours.

Annex B (informative): Reduction of the measuring period for error

B.1 Introduction

In the present document, the test values from draft ITU-T Recommendation G.826 (see annex C) have been transformed to fit a measuring period of 24 hours instead of one month so that:

- the probability of rejecting a system not conforming to the requirements in draft ITU-T Recommendation G.826 (see annex C) has been preserved;
- the probability of rejecting a system conforming to the requirements in draft ITU-T Recommendation G.826 (see annex C) has not been increased, provided that design values are used, which are slightly lower than those implied by draft ITU-T Recommendation G.826 (see annex C) although higher than the bringing into service limits from ITU-T Recommendation M.2100 (see annex C).

This annex explains the method used.

B.2 Explanation

Draft ITU-T Recommendation G.826 (see annex C) is taken as a starting point which recommends the following error measures for international digital connections at or above the primary rate:

- Errored Seconds Ratio (ESR);
- Severely Errored Seconds Ratio (SESR); and
- Background Block Error Ratio (BBER).

NOTE 1: The block size is 1 millisecond for 2 048 kbit/s.

As the G.826 values are test limits for a measuring period of one month, applicable to the Hypothetical Reference Configuration (HRX) defined in ITU-T Recommendation G.801 (see annex C), figure 1/G.801, the following transformations have to be performed:

a) derive the long term design value (the long term mean (see note)) from the test limits;

NOTE 2: The mean is a real number associated with a probability-distribution and should not be confused with the average, which is the sum of a set of observations divided by the number of observations. The mean is a fixed real number, whereas the average is a random variable which may change its value if the experiment is repeated. In this context the mean is the long term average.

b) reduce the long-term means from HRX to configurations relevant for Europe;

c) derive new long-term means relevant for a 24 hours measuring period;

d) derive new test limits relevant for a 24 hours measuring period.

Table B.1 shows the results in $column_2$ to $column_5$. Systems with a design value (long term mean) higher than the values in $column_6$ will be rejected by the 24-hour test with 95 % probability. $Column_7$ displays long-term means, which ensures that at least 97 % of the 24 hours tests will be passed by systems designed according to these long-term means.

The remainder of this annex gives a short explanation for the reasoning behind getting from one column to the next. As in all cases the number of errors turns out to be greater than 50, normal distributions are used.

ASSUMPTION: To derive the long term mean it is assumed that the standard deviation of the distribution of the number of e.g. errored seconds during an observation period of one month is 2 times the square root of its mean. For a Poisson distribution the standard deviation equals the square root of the mean, but as, especially, severely errored seconds tend to arrive in bursts, the standard deviation is here chosen greater than the square root of the mean. The above value of 2 corresponds to bursts of an average length of 4. It is based on limited experience and could be questioned, but it is essential to choose the standard deviation greater than the square root of the mean, in order not to arrive at requirements that are too weak.

NOTE 3: The assumption above is not very critical as the changes in $column_6$ and $column_7$ resulting from doubling the standard deviation are less than a factor of 2.

Table B.1: Comparison of error parameters and test limits

	1 month Test Limit Worldwide	1 month Mean Worldwide	1 month Mean Europe	24 hours Mean Europe	24 hours Test Limit Europe	Upper limit Alternative hypothesis	Design value (98 % of tests passed)
Col No.	1	2	3	4	5	6	7
ES	103 680	102 623	90 308	3 010	2 889	3 072	2 649
SES	5 184	4 952	4 358	145	117	159	76
BBE	777 600	774 695	681 732	22 724	22 395	22 894	21 708

The figures in the table are numbers of errors within the defined periods. The error ratios can be derived by dividing by the number of seconds in the period, e.g. the ESR(4 %) test limit for a period of 1 month world-wide corresponds to a ratio of 103 680 * 100 / 2 592 000 = 4 %.

The reasoning underlying the steps from one column to the next is as follows:

$Column_1$ -> $Column_2$ ("Test limit" -> "Mean"):

ITU-T, as usual, only gives test limits for a given observation period and not for the long term mean, which must therefore be derived. As the observations are assumed to follow a normal distribution with standard deviation equal to 2 times the square root of its mean, this can be done by solving the following equation, considering the values in $column_1$ as 95 % quantiles:

$$Column_1 = Column_2 + 3{,}3 \times (Column_2)^{½}$$

$Column_2$ -> $Column_3$ ("World wide" -> "Europe"):

The draft ITU-T Recommendation G.826 (see annex C) proposal for international proportion and transit country allocation is taken as a basis:

Termination countries:	37 %
4 transit countries:	8 %
9 000 km:	18 %
Total:	63 % of errors

or, alternatively:

Termination countries:	37 %
1 satellite:	35 %
4 transit countries:	8 %
4 000 km:	8 %
Total:	88 % of errors

Thus, for Europe, the lowest possible error allowance could be 37 %. As the error allowances are of the same order of magnitude as this lowest possible value, only one common set of distance independent error parameter values has been chosen for all possible 2 048 kbit/s leased line connections.

Thus: $Column_3 = 0,88 \times Column_2$

$Column_3$ -> $Column_4$ ("1 month" -> "24 hours"):

$$Column_4 = Column_3 / 30$$

$Column_4$ -> $Column_5$ and $Column_6$ ("Mean" -> "Test limit" and "Alternative hypothesis"):

The straight-forward way of deriving a 24 hour test limit from the long term mean would be to do the opposite of what was done under "$column_1$ - > $column_2$"; to choose the 95 % quantile of the normal distribution with variance equal to 4 times the mean.

Thus: $Column_5 = Column_4 + 3,3 \times (Column_4)^{½}$

But this would lead to a weaker test than the corresponding test for 1 month (the test specified in draft ITU-T Recommendation G.826 (see annex C)), meaning that leased lines with a worse long term performance than the performance specified in $column_3$ and $column_4$ would pass the test with a probability higher than for the test specified in draft ITU-T Recommendation G.826 (see annex C) (for severely errored seconds approximately 90 % probability of accepting a "bad" system in the sense described below).

To control this, a specific alternative hypothesis is chosen,

H_1: "The mean number of errored seconds during 24 hours is 2,07 % greater than $Column_4$ (i.e. equal to $Column_4$ + 2,07 %)".

$Column_4$ + 2,07 % is denoted $Column_6$

NOTE 4: The 2,07 % has been chosen according to draft ITU-T Recommendation G.826 (see annex C) in the following sense:

If the long term mean number of errored seconds per month is in fact as high as $Column_2$ + 2,07 %, then the observed number of errored seconds per month fails the test with 95 % probability. For severely errored seconds the 2,07 % shall be replaced by 9,59 % and for background millisecond error ratio by 0,75 %.

In analogy with what is described in the note, the resulting value in $column_6$ should be tight enough to be accepted by the user as an "almost sure" upper limit for the number of errors in the sense that, if the long term rate were in fact as high as this upper limit, then the observed number of errors would fail the test with 95 % probability.

Thus: $Column_5 = Column_6 - 3,3 \times (Column_6)^{½}$

$Column_7$ ("Design value"):

If the leased line provider uses the long term mean as a long term design value (see note) with the values from $column_5$ as test limits, the user is almost sure to get the specified error performance. But only few leased lines will pass the test.

NOTE 5: The long term design value is the desired long term mean, and should not be confused with the bringing into service design value which takes account of ageing etc.

However, if the leased line provider uses the slightly lower long term design values displayed in $column_7$, still with the values from $column_5$ as test limits, then 99 % of the tests will be passed as regards ESR, SESR and BBER separately and at least 97 % will be passed jointly.

Using the 99 % quantile, $column_7$ can be derived from the equation:

$$Column_5 = Column_7 + 4,66 \times (Column_7)^{½}$$

Annex C (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.
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