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Connection characteristics

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New presentation - see History box

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Business Telecommunications (BT) Technical Committee of the European Telecommunications Standards Institute (ETSI).

This ETS results from a mandate from the Commission of the European Community (CEC) to provide harmonised 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 this ETS:

ETS 300 246: "Open Network Provision (ONP) technical requirements; 2 048 kbit/s digital unstructured leased line (D2048U), Network interface presentation";

ETS 300 248: "Open Network Provision (ONP) technical requirements; 2 048 kbit/s digital unstructured leased line (D2048U), Terminal equipment interface".

This ETS is based on information from CCITT Recommendations and ETSI publications and the relevant documents are quoted where appropriate.

Introduction

The Council Directive on the application of Open Network Provision (ONP) to leased lines (92/44/EEC), concerns the harmonisation 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 harmonised technical characteristics.

The consequence of the Directive is that Telecommunications Organisations 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 Second Phase Directive (91/263/EEC), terminal equipment for connection to these leased lines will be required to fulfil certain essential requirements.

CCITT Recommendation I.340 for ISDN connection types is used as a basis for the connection characteristics.

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1   Scope

This ETS 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 this ETS. Together with the companion standard, ETS 300 246 [3] defining the interface presentation, this ETS 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 this ETS 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.

This ETS 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.

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

This ETS describes those characteristics of the connection that cannot be determined only by the equipment providing the NTPs. The related standard ETS 300 246 [3] defines the interface presentation and places no further constraints on the connection.

2   Normative references

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

[1]   CCITT Recommendation O.151 (1988):   "Error   performance   measuring equipment for digital systems at the primary bit rate and above".

[2]   CCITT Recommendation O.153 (1988): "Basic parameters for the measurement of error performance at bit rates below the primary rate".

[3]   ETS 300 246 (1993): "Open Network Provision (ONP) technical requirements; 2 048kbit/s digital unstructured leased line (D2048U), Network interface presentation".

   NOTE: This ETS also contains a number of informative references which have been included to indicate the sources from which various material has been derived, hence they do not have an associated normative reference number. Details of these publications are given in Annex C. In some cases the same publication may have been referenced in both a normative and an informative manner.

3   Definitions

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

Leased lines: the 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: a 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[1): a block with one or more bit errors.

> NOTE: The duration of a block is 1 millisecond.

Errored second[1]: a one-second period with one or more errored blocks.

Severely disturbed period[1): 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.

Severely errored second[1): a one-second period which contains at least 30 % errored blocks or at least one severely disturbed period.

Slip: a sequence of one or more extra or missing consecutive unit intervals in the bit stream.

Errored seconds ratio[1): the ratio of errored seconds over all seconds within a specified measuring period, where neither are counted during unavailability periods.

Severely errored seconds ratio[1): the ratio of severely errored seconds over all seconds within a specified measuring period, where neither are counted during unavailability periods.

Background block error ratio[1): the ratio of errored blocks over all blocks within a specified measuring period, where neither are counted during unavailability periods nor during severely errored seconds.

Satellite transmission: transmission via an earth orbiting satellite.

4   Symbols and abbreviations

For the purposes of this ETS, 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 § 2.1 of CCITT Recommendation O.153 [2])
PRBS(2^{15}-1)	Pseudo Random Bit Sequence (as defined in § 2.1 of CCITT Recommendation O.151 [1])
RX	Receive (a signal input at either the leased line interface or the test equipment)

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1 These definitions are based on CCITT Recommandation G.826.

TX   Transmit (a signal output at either the leased line interface or the test equipment)

UI   Unit Interval

5   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 CCITT attribute technique is used to express the connection requirements. The following attributes from CCITT Recommendation I.140 are specified in this ETS:

-        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 this ETS.

The following network performance sub-attributes are considered relevant for this ETS:

-        Transmission delay;
-        Jitter;
-        Slip;
-        Error.

5.1   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**
Information transfer 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 subclause**
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 subclause**
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

5.1.1 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 Annex A, subclause A.2.1.

5.1.2 Information transfer susceptance

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

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

5.1.3 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 Annex A, subclause A.2.1.

5.1.4 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.

5.1.5   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 Annex A, subclause A.2.1.

5.1.6   Communication configuration

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

Test: By declaration.

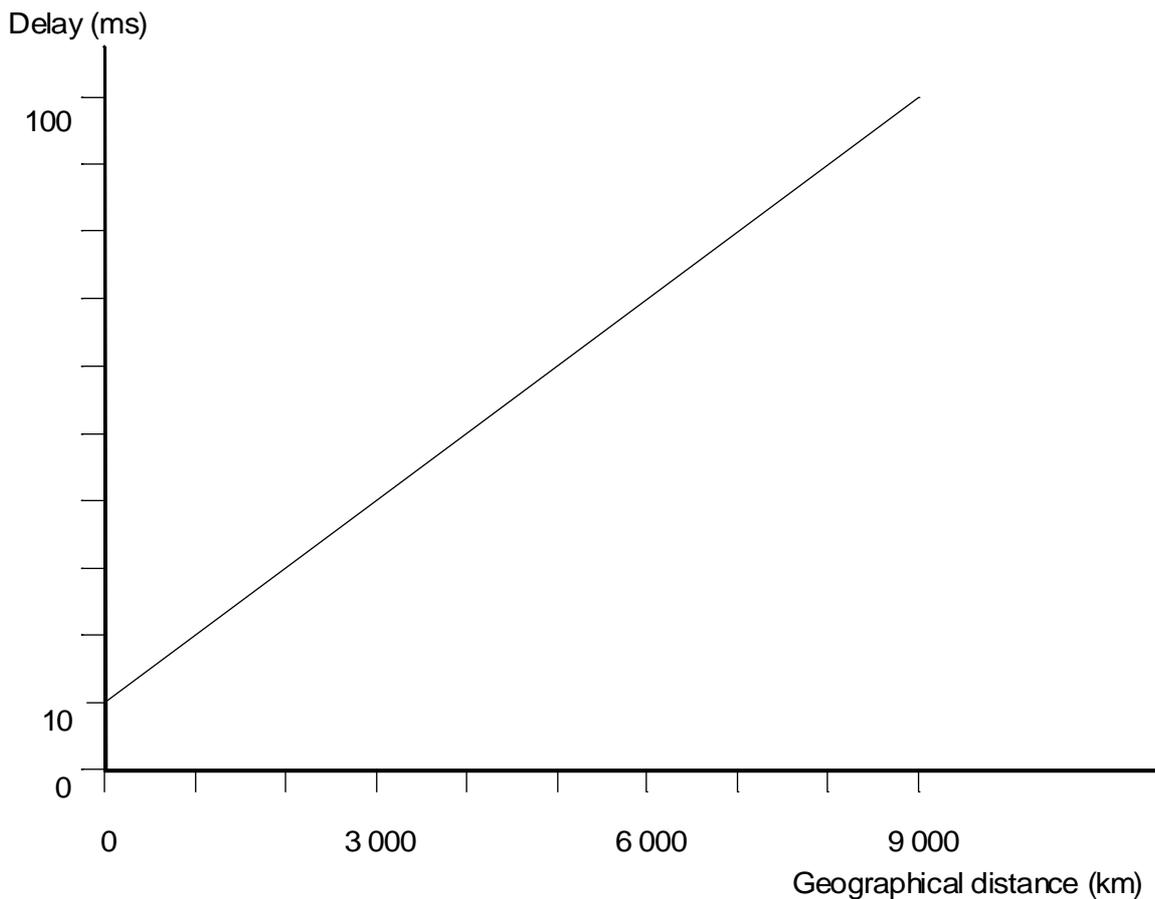### 5.1.7   Network performance

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

5.1.7.1   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 CCITT Recommendation G.114, subclauses 2.2 and 2.3.

Delay (ms)

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 this ETS.

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

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

5.1.7.2 Jitter

5.1.7.2.1 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 cutoff 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 Annex A, subclause A.2.3.

5.1.7.2.2 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 CCITT 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 Annex A, subclause A.2.3.

5.1.7.3 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 CCITT Recommendation G.822, § 2 and table 1/G.822.

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

5.1.7.4 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.

5.1.7.4.1 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 Annex A, subclause A.2.4.

5.1.7.4.2 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 Annex A, subclause A.2.4.

5.1.7.4.3 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 Annex A, subclause 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 this ETS.

It is outside the scope of this ETS 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 realisation 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 ETS 300 246 [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 this ETS 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 this ETS (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 § 2.1 of CCITT
                              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
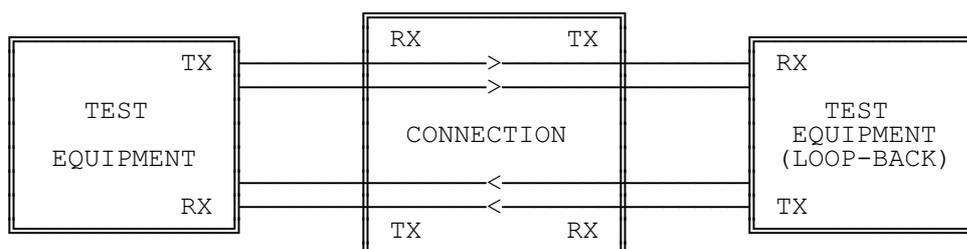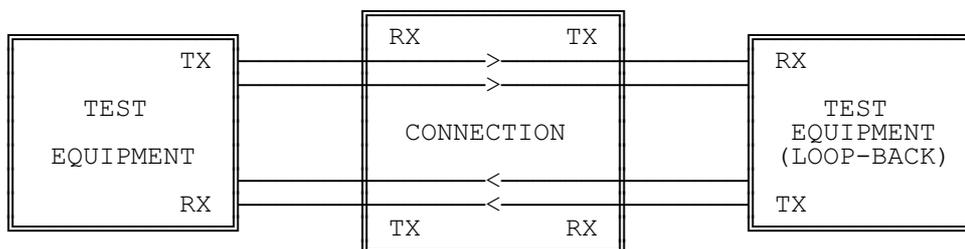   accordance with the specifications in this ETS (see figure A.2).

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 CCITT 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.
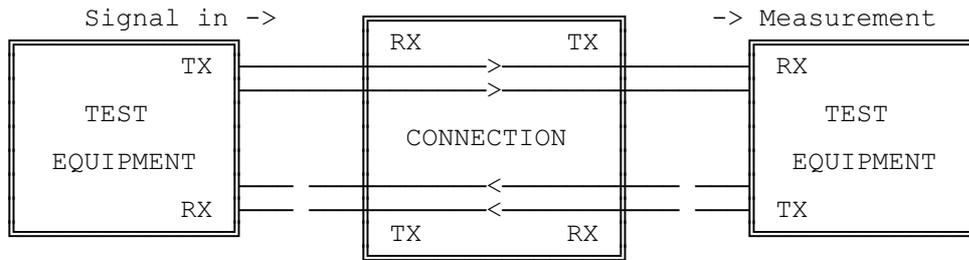
```
     Signal in ->                                  -> Measurement
   ┌───────────────┐        ┌─────────────────┐   ┌───────────────┐
   │            TX │   RX   │           TX    │   │ RX            │
   │               │  ────────────>           │   │               │
   │     TEST      │  ────────────>           │   │     TEST      │
   │               │        │  CONNECTION     │   │               │
   │  EQUIPMENT    │        │                 │   │  EQUIPMENT    │
   │               │  <────────────           │   │               │
   │            RX │  <────────────           │   │ TX            │
   │               │   TX   │           RX    │   │               │
   └───────────────┘        └─────────────────┘   └───────────────┘
```

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 § 2.1 of CCITT 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.
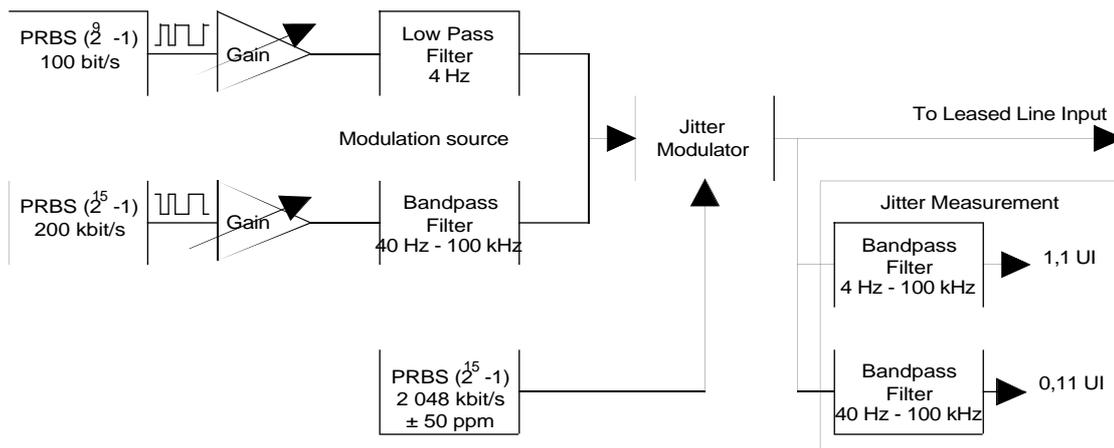

Figure A.4: Input jitter generation

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 subclause 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.
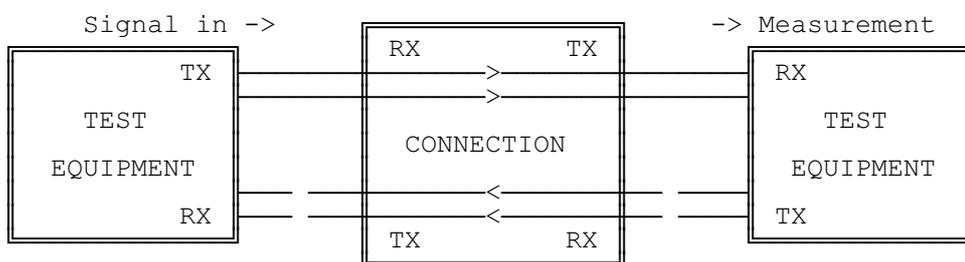
```
        Signal in ->                              -> Measurement
                        ┌──────────────────────┐
              TX     ┌──┤ RX            TX ├──┐  │ RX
       ┌─────────┐   │  │     >─              │  │ ┌─────────┐
       │         ├───┘  │     >─              └──┘ │         │
       │  TEST   │      │                          │  TEST   │
       │EQUIPMENT│      │     CONNECTION           │EQUIPMENT│
       │         │      │        <─                │         │
       │      RX ├──┐   │        <─            ┌───┤ TX      │
       └─────────┘  └───┤ TX            RX ├───┘   └─────────┘
                        └──────────────────────┘
```

Figure A.5: Error and slip

Connection State: Available.

Stimulus: PRBS(2^{15}-1) transmitted for two consecutive periods of 24 hours with jitter modulated by white noise and filtered as described by subclause 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 this ETS, the test values from draft ITU-T Recommendation G.826 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 has been preserved;

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

This annex explains the method used.

B.2   Explanation

Draft ITU-T Recommendation G.826 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: 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 CCITT Recommendation G.801, figure 1/G.801, the following transformations have to be performed:

a)   derive the long term design value (the long term mean[2]) from the test limits;

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

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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.

deviation greater than the square root of the mean, in order not to arrive at requirements that are too weak.

NOTE: 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"):

CCITT, 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:

$$\text{Column}_1 = \text{Column}_2 + 3{,}3 \times (\text{Column}_2)^{½}$$

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

The draft ITU-T Recommendation G.826 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: $\qquad$ $Column_3 = 0{,}88 \times Column_2$

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

$$Column_4 = Column_3 / 30$$

$Column_4 \rightarrow Column_5$ 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: $\qquad$ $Column_5 = Column_4 + 3{,}3 \times (Column_4)^{\frac{1}{2}}$

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

$$Column_4 + 2{,}07 \text{ % is denoted } Column_6$$

NOTE: $\qquad$ The 2,07 % has been chosen according to draft ITU-T Recommendation G.826 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: $\qquad$ $Column_5 = Column_6 - 3{,}3 \times (Column_6)^{\frac{1}{2}}$

$Column_7$ ("Design value"):

If the leased line provider uses the long term mean as a long term design value[3] 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.

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:

$$Column_5 = Column_7 + 4.66 \times (Column_7)^{\frac{1}{2}}$$

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[3] $\qquad$ 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.

Annex C (informative): Bibliography

1)   91/263/EEC: "Council Directive of 29 April 1991 on the approximation of the laws of Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity".

2)   92/44/EEC: "Council Directive of 5 June 1992 on the application of Open Network Provision to leased lines".

3)   CCITT Recommendation G.114 (1988): "Mean one-way propagation time".

4)   CCITT Recommendation G.801 (1988): "Digital transmission models".

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

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

7)   Draft ITU-T Recommendation G.826 (1993): "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".

8)   CCITT Recommendation I.140 (1988): "Attribute techniques for the characterisation of telecommunication services supported by an ISDN and network capabilities of an ISDN".

9)   CCITT Recommendation I.340 (1988): "ISDN connection types".

10)   CCITT Recommendation M.2100 (1992): "Performance limits for bringing into service and maintenance of international digital paths, sections and transmission systems".

11)   CCITT Supplement number 3.8, Fascicle IV.4 (1988): "Guidelines concerning the measurement of jitter".

History

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