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# Business Telecommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U) Connection characteristics

**ETSI**

European Telecommunications Standards Institute

**ETSI Secretariat**

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

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

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## Foreword

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

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

> ETS 300 288: "Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U), Network interface presentation";
>
> ETS 300 290: "Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U), 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 over 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 the connection characteristics of ONP 64 kbit/s digital unrestricted leased lines with octet integrity. The leased line provides access to the full digital bit rate of 64 kbit/s, with network timing for both directions of the transmission, with no restrictions on the binary content.

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, and these limits apply only where the terminal output signals are synchronous with the output of the leased line. Together with the companion standard, ETS 300 288 [2] defining the network interface presentation, this ETS describes the service offered.

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 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.

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 300 288 [2], defines the network 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.152 (1988): "Error performance measuring equipment for 64 kbit/s paths".

[2] ETS 300 288 (1994): "Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U), 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 second[1)]:** a second with one or more bit errors.

**Severely errored second[1)]:** a second where at least 0,1 % of the bits are errored.

**Slip:** one or more extra or missing consecutive unit intervals in the bit stream.

**Octet slip:** a slip of one complete octet.

**Errored Seconds Ratio (ESR)[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 (SESR)[1)]:** the ratio of severely errored seconds over all seconds within a specified measuring period, where neither are counted during unavailability periods.

**Satellite transmission:** transmission via an earth orbiting satellite.

## 4 Symbols and abbreviations

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

| | |
|---|---|
| D64U | 64 kbit/s digital unrestricted ONP leased line with octet integrity |
| ESR | Errored Seconds Ratio |
| HRX | Hypothetical Reference configuration |
| NTP | Network Termination Point |
| ONP | Open Network Provision |
| PRBS($2^{11}$-1) | Pseudo Random Bit Sequence (as defined in § 2.1 of CCITT Recommendation O.152 [1]) |
| RX | Receive (a signal input at either the leased line interface or the test equipment) |
| SESR | Severely Errored Seconds Ratio |
| 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 that provides the NTP are met, (e.g. if the equipment is connected to an appropriate power supply on the customer's premises).

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1) These definitions are taken from CCITT Recommendation G.821.

The CCITT attribute technique is used to express the connection requirements. The following attributes from CCITT Recommendation I.140 are considered relevant for this ETS:

- Information transfer rate;
- Information transfer susceptance;
- Structure;
- Establishment of communication;
- Symmetry;
- Connection 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;
- Octet 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 | 64 kbit/s | See 5.1.1 |
| Information transfer susceptance | Unrestricted digital | See 5.1.2 |
| Structure | Octet integrity | 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 |
| Octet 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<br>Severely errored seconds | 5 324 per 24 hour period<br>105 per 24 hour period | See 5.1.7.4.1<br>See 5.1.7.4.2 |

### 5.1.1 Information transfer rate

**Requirement:** The connection shall be capable of transferring information at a nominal information rate of 64 kbit/s which shall be synchronous to the network timing.

NOTE: Network timing is timing that is derived from the source or sources of timing that are used for the whole network. Thus the timing provided by the leased line will be similar to that provided by other digital services.

**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 capable of transferring the octet timing present at the input.

NOTE**:** When there is no input signal or octet timing is not present at the leased line distant input or when there is a failure in the leased line connection, the octet timing at the leased line output will not be meaningful.

**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 information transfer capability.

**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, § 2.2 and 2.3.

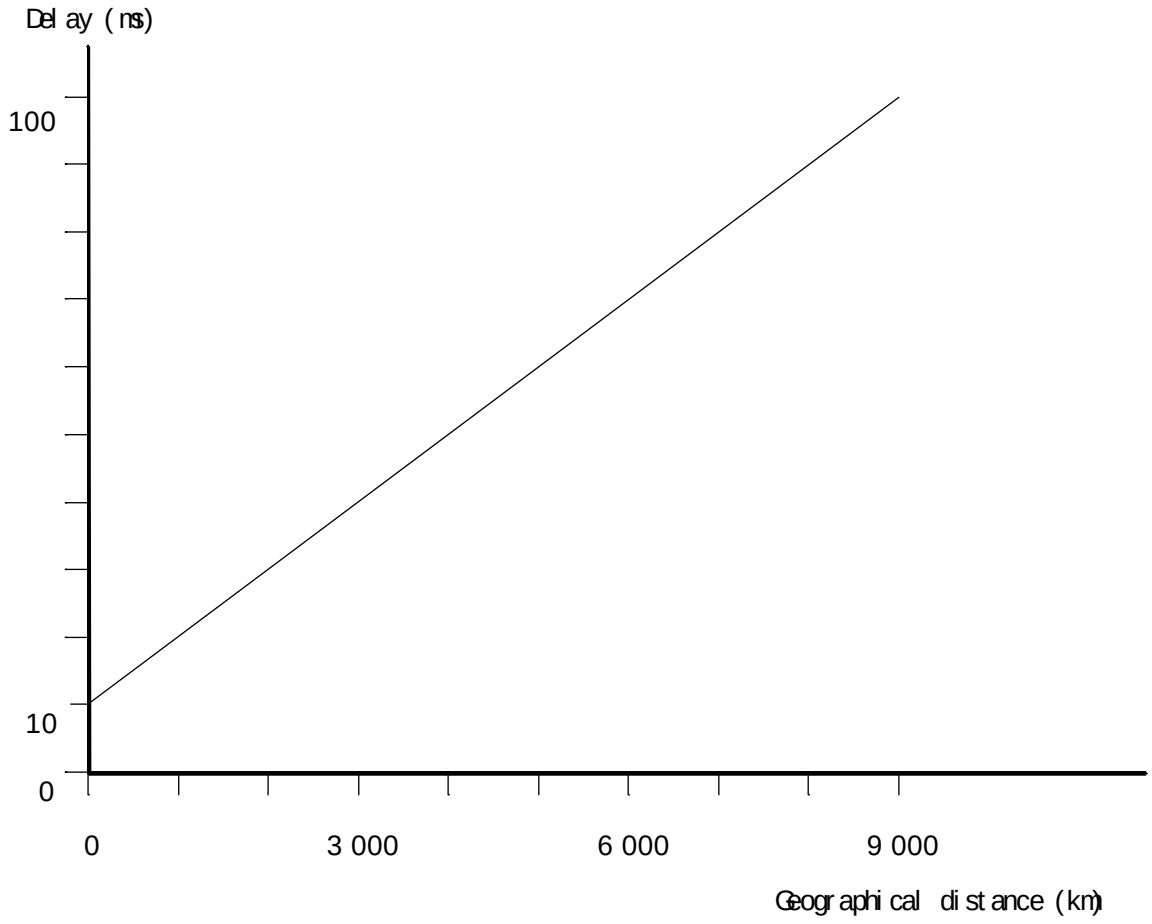


**Figure 1: Upper limit of delay**

There are no requirements for low frequency (below 20 Hz) variation of one way end-to-end delay under 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 the maximum sinusoidal input jitter as shown in table 2 and figure 2.

**Table 2: Input jitter tolerance**

| **Peak-to-peak amplitude (UI)** | | **Frequency (Hz)** | | | |
|---|---|---|---|---|---|
| A1 | A2 | f1 | f2 | f3 | f4 |
| 0,25 | 0,05 | 20 | 600 | 3 000 | 20 000 |
| NOTE: 0,25 UI = 3,9 µs; 0,05 UI = 0,78 µs. | | | | | |

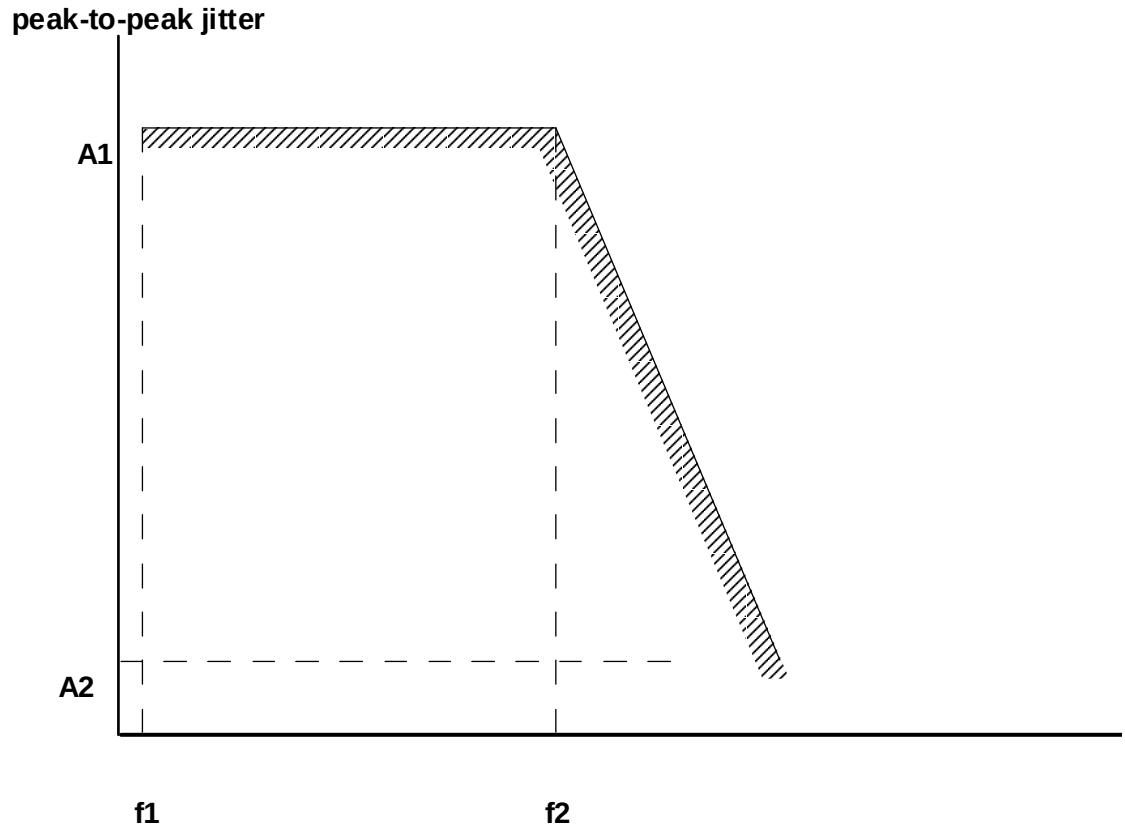


**Figure 2: Limit of maximum tolerable input jitter**

**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 of the network shall not exceed the limits specified in table 3, with input jitter as specified in subclause 5.1.7.2.1, when measured with first order linear filters with the defined cut-off frequencies.

**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 | 20 kHz | 0,25 UI |
| 3 kHz | 20 kHz | 0,05 UI |

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

#### 5.1.7.3 Octet slip

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

NOTE 1: This requirement is based on CCITT Recommendation G.822, § 2 and table 1/G.822.

NOTE 2: Slips other than octet slips are considered as errors.

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

#### 5.1.7.4 Error

NOTE 1: When microwave links are used in the connections, it may not be possible to meet the requirement in rare periods with very adverse propagation conditions.

NOTE 2: The error requirements are derived from CCITT Recommendation G.821 (1988) as described in Annex B of the ETS.

##### 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 5 324.

NOTE: This 24 hour test limit (as shown in column 5 of table B.1) corresponds to a mean errored seconds ratio of $6{,}4 \times 10^{-2}$ (equivalent to the 24 hour mean limit of 5 490 shown in column 4 of table B.1).

**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 105.

NOTE: This test limit (as shown in column 5 of table B.1) corresponds to a mean severely errored seconds ratio of $1{,}5 \times 10^{-3}$ (equivalent to the 24 hour mean limit of 132 shown in column 4 of table B.1).

**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. Not all the required test results make allowance for spurious events during testing (e.g. errors due to EMC effects), which may make it necessary to repeat a test.

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 300 288 [2] 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 this ETS 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, 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 to the limits specified in this ETS, see figure A.1.

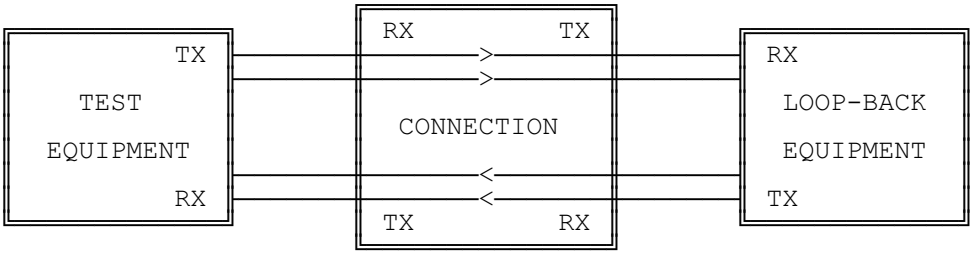


**Figure A.1: Information transfer rate, susceptance, structure and symmetry**

Connection State: Available.

Stimulus:
a) A PRBS($2^{11}$-1) bit stream, transmitted at a bit rate of 64 kbit/s, synchronised to the network.

b) A bit stream of binary ZEROs, transmitted at a bit rate of 64 kbit/s, synchronised to the network.

c) A bit stream of binary ONEs, transmitted at a bit rate of 64 kbit/s, synchronised to the network.

Monitor: The bit streams.

Results:
a) For at least one continuous period of one second no alterations to the octet content shall occur.

b) For at least one continuous period of one second no alterations to the binary content shall occur.

c) For at least one continuous period of 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.

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 limits specified in this ETS, see figure A.2.

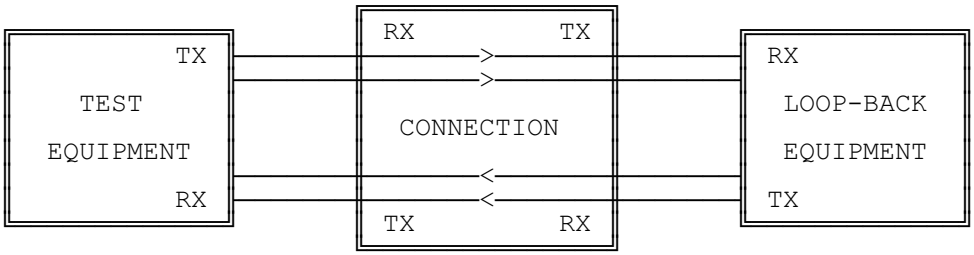


**Figure A.2: Delay**

Connection State: Available.

Stimulus: A bit stream with one detectable bit sequence.

Monitor: The round trip delay.

Results: The round trip delay shall be less than twice the delay specified in the requirement of subclause 5.1.7.1.

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 and for the maximum jitter allowed at the network output port.

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

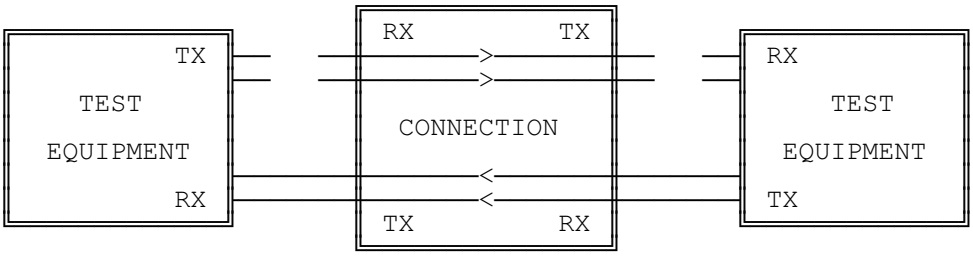


**Figure A.3: Jitter**

Connection State: Available.

Stimulus: A PRBS($2^{11}$-1) bit stream, transmitted at a bit rate of 64 kbit/s synchronised to the network, but modulated by a modulation source that shall generate individual components of sinusoidal jitter at points on the curve of figure 2 and table 2 of this ETS.

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) The peak to peak jitter at the connection output port shall comply with subclause 5.1.7.2.2, table 3; and
b) for at least one continuous period of one second no alterations to the octet content shall occur.

### A.2.4 Error and octet slip

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

Test configuration: Test equipment shall be connected to both ends of the leased line, see figure A.4. Each direction shall be tested separately.

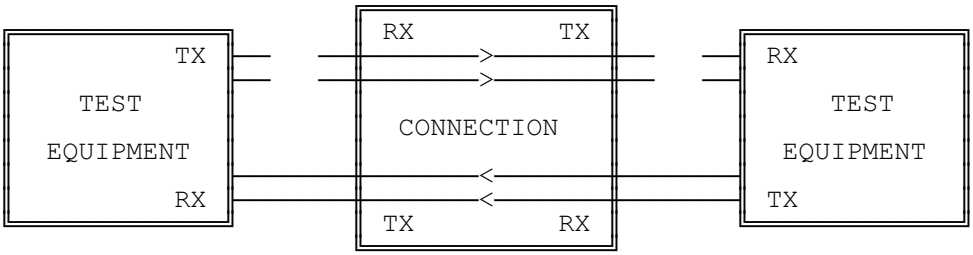


**Figure A.4: Error and octet slip**

Connection State: Available.

Stimulus: A PRBS($2^{11}$-1) bit stream, transmitted for two consecutive periods of 24 hours at a bit rate of 64 kbit/s synchronised to the network, with jitter as defined by subclause 5.1.7.2.1, table 2. If an unavailability period of more than one hour has occurred during the measuring period, 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 octet slips.

Results:

a) For the first or the last continuous 24 hour period the number of errored seconds shall be less than 5 324.

b) For the first or the last continuous 24 hour period the number of severely errored seconds shall be less than 105.

c) For the first or the last continuous 24 hour period the number of octet slips shall be less than 5.

NOTE: If all the requirements a), b) and c) are met during the first continuous 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 CCITT Recommendation G.821 (1988), 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 CCITT Recommendation G.821 has been preserved;

- the probability of rejecting a system conforming to the requirements in CCITT Recommendation G.821 has not been increased, provided that design values are used, which are slightly lower than those from CCITT Recommendation G.821 although higher than the bringing into service limits from CCITT Recommendation M.2100.

This annex explains the method used.

### B.2 Explanation

CCITT Recommendation G.821 (1988) is taken as a starting point which recommends the following error measures for 64 kbit/s international digital connections:

- Errored Seconds Ratio (ESR); and
- Severely Errored Seconds Ratio (SESR).

As the G.821 values are test limits for a measuring period of one month applicable for the Hypothetical Reference Configuration (HRX) as 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 98 % 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 any 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: The assumption above is not very critical as the changes in $Column_6$ and $Column_7$ resulting from doubling the standard deviation turn out to be less than a factor of 2.

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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.

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

| G.821 | 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(8 %) | 207 360 | 205 863 | 164 690 | 5 490 | 5 324 | 5 570 | 4 995 |
| SES | 5 184 | 4 952 | 3 962 | 132 | 105 | 145 | 67 |

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(8 %) test limit for a period of 1 month world-wide corresponds to a ratio of 207 360 * 100 / 2 592 000 = 8 %.

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:

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

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

The CCITT Recommendation G.821 proposal for international proportion and transit country allocation is taken as a basis:

| | |
|---|---|
| Termination countries: | 60 % |
| 9 000 km: | 18 % |
| Total | 78 % of errors |

or, alternatively:

| | |
|---|---|
| Termination countries: | 60 % |
| 1 satellite: | 20 % |
| Total | 80 % of errors |

Thus, for Europe, the lowest possible error allowance could be 30 %. 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 64 kbit/s leased line connections.

Thus: $Column_3 = 0{,}8 \times Column_2$

**$Column_3$ -> $Column_4$ ("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 CCITT Recommendation G.821), 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 CCITT Recommendation G.821 (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 1,46 % greater than $Column_4$ (i.e. equal to $Column_4$ + 1,46 %)".

$Column_4$ + 1,46 % is denoted $Column_6$

NOTE: The 1,46 % has been chosen according to CCITT Recommendation G.821 in the following sense:

If the long term mean number of errored seconds per month is in fact as high as $Column_2$ + 1,46 %, then the observed number of errored seconds per month fails the test with 95 % probability. For severely errored seconds the 1,46 % shall be replaced by 9,59 %.

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[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 and SESR separately and at least 98 % will be passed jointly.

Using the 99 % quantile, $Column_7$ can be derived from the equation:

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

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**3)** 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".

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

7) CCITT Recommendation G.823 (1988): "The control of jitter and wander within digital networks which are based on the 64 kbit/s hierarchy".

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

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

## History

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