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# Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U); Attachment requirements for terminal equipment interface

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## Foreword

This Technical Basis for Regulation (TBR) has been produced by the Business TeleCommunications (BTC) Technical Committee of the European Telecommunications Standards Institute (ETSI) and was adopted after having passed through the ETSI standards approval procedure.

This TBR results from a mandate from the Commission of the European Community (CEC) to provide harmonized standards for the support of the Terminal Equipment Directive (91/263/EEC).

This TBR 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 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.

Two classes of standard will be used for the interfaces of terminal equipment designed for connection to the ONP leased lines. European Telecommunication Standards (ETSs), which are voluntary, give the full technical specifications for these interfaces, whereas Technical Basis for Regulations (TBRs) give the essential requirements under the Second Phase Directive (91/263/EEC) for attachment to the leased lines. This TBR is a subset of the corresponding ETS 300 290 (1993).

CCITT Recommendation G.703 (1991), as qualified by ETS 300 166 (1993), is used as the basis for the terminal interface.

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# 1 Scope

This TBR specifies the attachment requirements and corresponding test principles for a terminal equipment interface for connection to the network termination points of ONP 64 kbit/s digital unrestricted leased lines with octet integrity.

The term "attachment requirements" in the context of this TBR describes the essential requirements for access which have to be fulfilled under the Second Phase Directive (91/263/EEC). Conformance to these requirements does not guarantee end-to-end interoperability.

This TBR is applicable to interfaces designed for connection to the ONP 64 kbit/s unrestricted leased line with octet integrity. It covers the physical and electrical characteristics of the terminal equipment interface.

Customer premises wiring and installation between the equipment and the Network Termination Point (NTP) are outside the scope of this TBR.

# 2 Normative references

This TBR 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 TBR only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

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

[2] CCITT Recommendation O.152 (1988): "Error performance measuring equipment for 64 kbit/s paths".

[3] ETS 300 046-3 (1992): "Integrated Services Digital Network (ISDN); Primary rate access - safety and protection, Part 3: Interface $I_a$ - protection".

[4] ISO/IEC 10173 (1991): "Information technology - Integrated Services Digital Network (ISDN) primary access connector at reference points S and T".

NOTE: This TBR 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 TBR, 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.

**Safety Extra-Low Voltage (SELV) circuit**: a secondary circuit which is so designed and protected that under normal and single fault conditions, the voltage between any two accessible parts and, for class 1 equipment, between any accessible part and the equipment protective earthing terminal does not exceed a safe value (subclause 1.2.8.5 of EN 60950).

**Terminal Equipment (TE)**: equipment intended to be connected to the public telecommunications network, i.e.:

a) to be connected directly to the termination of a public telecommunication network; or

b) to interwork with a public telecommunications network being connected directly or indirectly to the termination of a public telecommunications network,

in order to send, process, or receive information.

## 4 Symbols and abbreviations

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

| | |
|---|---|
| ac | alternating current |
| dc | direct current |
| D64U | 64 kbit/s digital unrestricted ONP leased line with octet integrity |
| EMC | Electro-Magnetic Compatibility |
| 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 [2]) |
| RX | Receive (a signal input at either the terminal equipment interface or the test equipment) |
| SELV | Safety Extra-Low Voltage |
| TE | Terminal Equipment |
| TX | Transmit (a signal output at either the terminal equipment interface or the test equipment) |
| UI | Unit Interval |

## 5 Requirements

The terminal equipment interface is for use with 64 kbit/s unrestricted leased lines with octet integrity, which provide bidirectional, point-to-point digital connections with a usable bit rate of 64 kbit/s where the leased line output timing is provided from the network. The interface timing arrangements are codirectional.

### 5.1 Physical characteristics

**Requirement:** The terminal equipment shall provide an 8-contact plug of the type specified in ISO/IEC 10173 [4] with contact assignments as specified in table 1. In addition, the terminal equipment may provide an alternative method of connection.

NOTE 1: The use of a shielded cord or cable may be necessary to meet radiation and immunity requirements defined in Electro-Magnetic Compatibility (EMC) standards. The common reference point does not necessarily need to be earthed.

NOTE 2: The alternative connection method is primarily for the purpose of permitting hardwired presentations of the leased line using insulation displacement terminals and wire with solid conductors having diameters in the range from 0,4 mm to 0,6 mm.

**Table 1: Contact assignment**

| Contact | Terminal interface |
|---|---|
| 1 & 2 | Receive pair |
| 3 | Shield reference point (if provided) |
| 4 & 5 | Transmit pair |
| 6 | Shield reference point (if provided) |
| 7 | Unused |
| 8 | Unused |
| NOTE 1: | The transmit pair is the output from the terminal equipment interface. The receive pair is the input to the terminal equipment interface, as shown in figure 1. Where the terms "output" and "input" are used without qualification in this TBR, they refer to the terminal equipment interface. |
| NOTE 2: | For connection of the shield, or shields, to the common reference point at the NTP contacts 3 and 6 shall be used. |

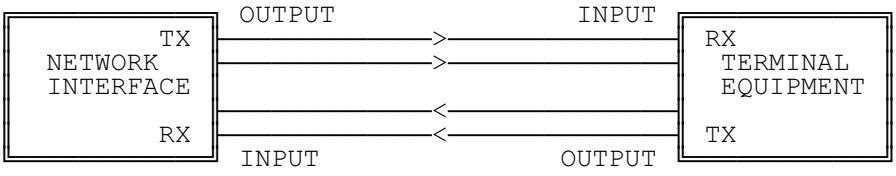


**Figure 1**

**Test:** There shall be a visual inspection that the plug is of the correct type. The contact assignments are tested indirectly through the tests in Annex A.

### 5.2 Electrical characteristics

#### 5.2.1 Output port

##### 5.2.1.1 Signal coding

**Requirement:** The signal transmitted at the output port shall comply with the encoding rules given in Annex B.

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

##### 5.2.1.2 Waveform shape

**Requirement:** The pulse at the output port shall comply with the requirements given in figure 2, figure 3 and table 2, based on CCITT Recommendation G.703 [1].

**Table 2: Waveform shape at output port**

| | |
|---|---|
| Pulse shape<br>(nominally rectangular) | All pulses of a valid signal shall conform with the masks (see figures 2 and 3) irrespective of the polarity |
| Test load impedance | 120 Ω non-reactive |
| Nominal peak voltage V of a mark (pulse) | 1 V |
| Peak voltage of a space (no pulse) | 0 ± 0,1 V |
| Nominal pulse width | 3,9 µs for a single pulse<br>7,8 µs for a double pulse |
| Ratio of the amplitudes of positive and negative pulses at the centre of the pulse interval | 0,95 to 1,05 |
| Ratio of the widths of positive and negative pulses at the nominal half amplitude | 0,95 to 1,05 |

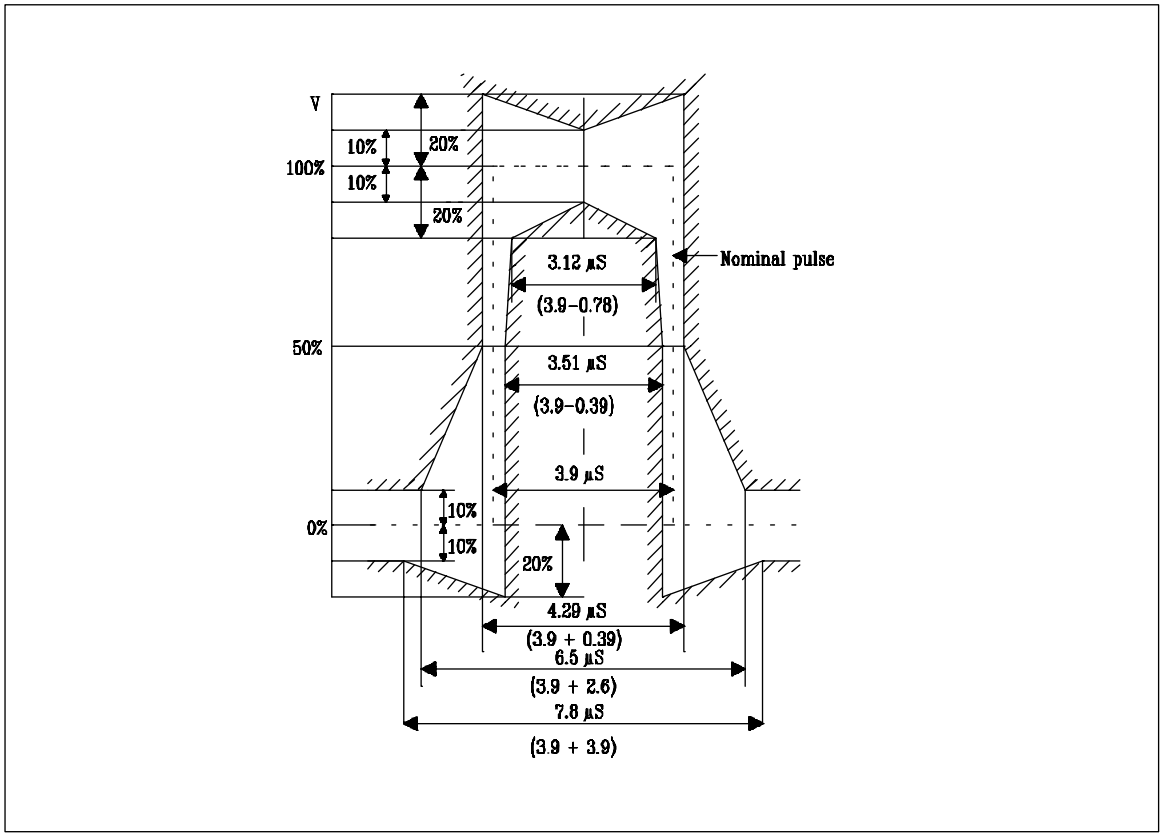


**Figure 2: Pulse mask for single pulse**

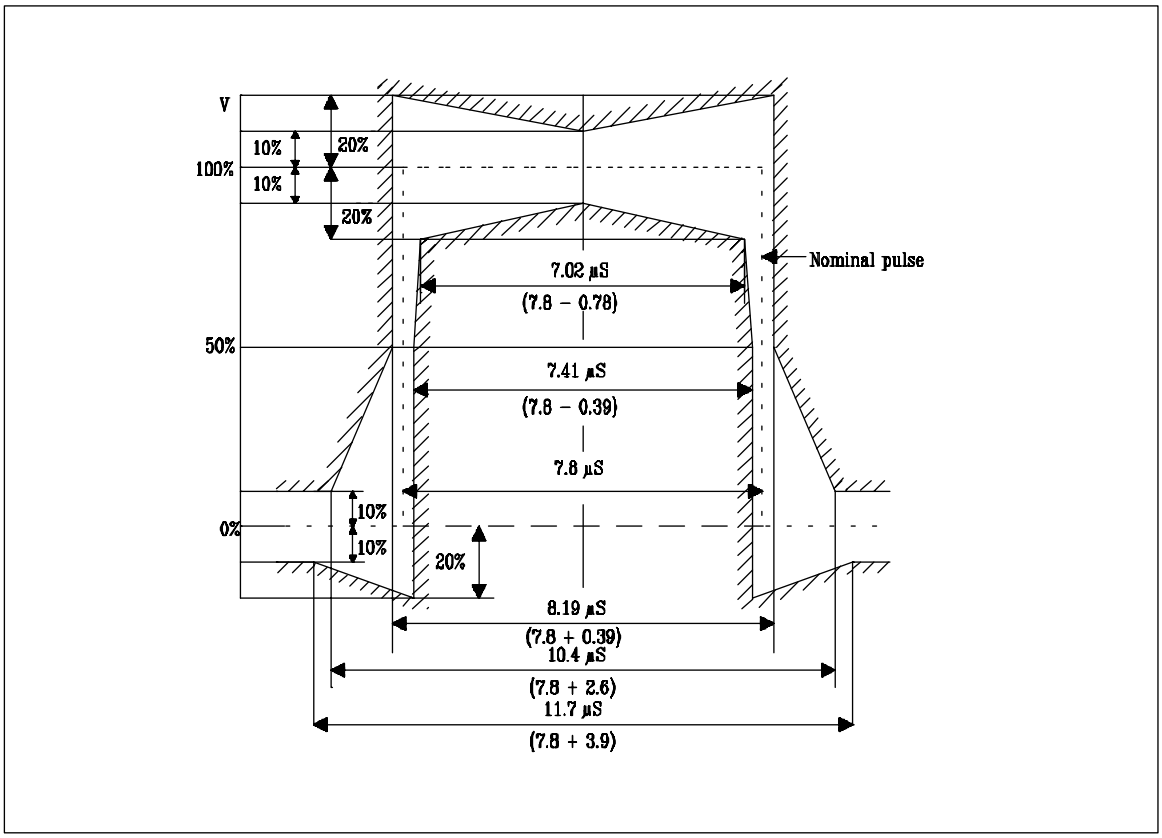


**Figure 3: Pulse mask for double pulse**

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

### 5.2.1.3 Output jitter

This requirement applies when the terminal equipment is producing the timing from an internal clock source or when the terminal equipment is deriving the output timing from an external source (including derivation from the input signal).

**Requirement[1)]:** The peak-to-peak output jitter shall not exceed the limits of table 3 when measured with first order linear filters with the defined cut-off frequencies. For the purpose of testing, any signal input from which the output timing is derived shall be provided with the maximum tolerable input jitter and with the maximum tolerable input frequency deviation specified by the manufacturer.

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**1)** This requirement differs from that in ETR 005 (1990) which defines maximum output jitter in terms of intrinsic jitter and a jitter transfer characteristic. Intrinsic jitter is limited to 0,05 UI from 20 Hz to 20 kHz. The jitter transfer characteristic is limited to 0,5 dB from 20 Hz to 3 kHz, decreasing to -16 dB at 20 kHz.

**Table 3: Maximum 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 |

Where the output timing of the terminal equipment is taken from the leased line, the input to the terminal equipment shall be provided with components of sinusoidal jitter at points on the curve of figure 4 and table 4.

**Table 4: Input jitter for output measurement**

| 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. | | | | | |

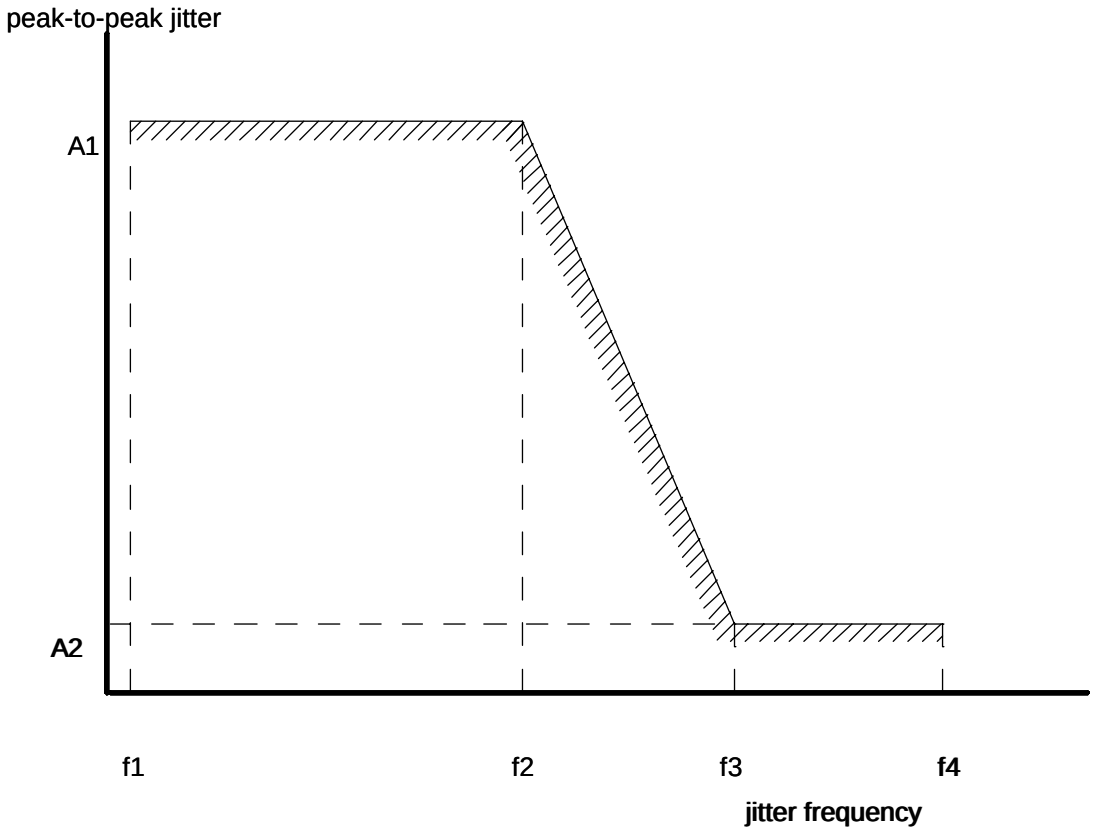



**Figure 4: Input jitter tolerance**

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

### 5.2.2 Input port

There are no requirements on the input port under this TBR.

## 5.3 Safety

There are no safety requirements under this TBR.

NOTE: Safety requirements are imposed under the Low Voltage Directive (73/23/EEC) and articles 4a and 4b of the Second Phase Directive (91/263/EEC). ETS 300 288, subclause 5.3 defines the terminal equipment interface as an SELV circuit. Detailed requirements for SELV circuits are given in EN 60950.

## 5.4 Overvoltage protection

For the purpose of the following subclauses 5.4.1 to 5.4.3 on protection, the term referred to as $I_a$ in ETS 300 046-3 [3] shall be deemed to be the point of test referred to in Annex A, subclause A.1.1.

For the purpose of the following subclauses 5.4.1 to 5.4.3 on protection, the connection to the interface cable shield as defined in ETS 300 046-3 [3] shall only be made when a shielded cable is provided with the terminal equipment.

### 5.4.1 Impulse transfer from mains, common mode

**Requirement:** If the terminal equipment is supplied from the mains, it shall transfer less than 1 kV common mode voltage and less than 250 V transverse voltage to the terminal equipment interface when a common mode surge of either polarity and of 2,5 kV (10/700 µs) is applied to the mains supply port.

**Test:** The test shall be conducted according to subclause 5.7.1 of ETS 300 046-3 [3].

### 5.4.2 Impulse transfer from mains, transverse mode

**Requirement:** If the terminal equipment is supplied from the mains, it shall transfer less than 1 kV common mode voltage and less than 250 V transverse voltage to the terminal equipment interface when a transverse mode surge of either polarity and of 2,5 kV (10/700 µs) is applied to the mains supply port.

**Test:** The test shall be conducted according to subclause 5.7.1 of ETS 300 046-3 [3].

### 5.4.3 Conversion of common mode to transverse mode

**Requirement:** The transverse mode voltage shall not be more than 250 V peak when 2 common mode surges of 1 kV (1,2/50 µs) (one of each polarity) are applied to the terminal equipment interface.

**Test:** The test shall be conducted according to subclause 5.7.3 of ETS 300 046-3 [3].

## 5.5 Electro-magnetic compatibility

There are no EMC requirements under this TBR.

NOTE: General EMC requirements are imposed under the EMC Directive (89/336/EEC). Requirements specific to terminal equipment will be added to this TBR when appropriate specifications become available.

# Annex A (normative): Test methods

## A.1 General

This annex describes the test principles to determine the compliance of a terminal equipment against the requirements of this TBR.

It is outside the scope of this TBR to identify the specific details of the implementation of the tests.

A terminal equipment may be designed for through-connecting and may fulfil the electrical requirements only if through-connected. In these cases the requirements of this TBR are valid and the tests are carried out with the through-connection terminated as specified by the equipment supplier.

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 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 "interface state", "stimulus" and "monitor" for each individual test.

The test equipment shall be a device, or a group of devices, generating a stimulus signal conforming to this annex and capable of monitoring the signal received from the interface.

The terminal equipment interface under test shall have the ability to transmit a bit pattern for test purposes, e.g. Pseudo Random Bit Sequence as defined in § 2.1 of CCITT Recommendation O.152 [2] (PRBS($2^{11}$-1)). Where this cannot be provided, an alternative method of conducting the test shall be provided.

### A.1.1 Equipment connection

The tests shall normally be applied at the plug for connection to the NTP. However, in the case of the test specified in subclause A.2.2, an alternative method of connection may be provided by the terminal equipment supplier for test purposes. In this case, this method of connection shall be used for this test because the requirement does not make allowances for the electrical characteristics of any connection cords.

NOTE: This alternative method of connection is for test purposes only and has been introduced because the characteristics tested in subclause A.2.2 are based on CCITT Recommendation G.703 [1] which makes no allowance for the normal plug and cord. This alternative method may not be the same as the alternative method of connection referred to in subclause 5.1 which is for operational use.

### A.1.2 Test environment

All tests shall be performed at:

- an ambient temperature in the range from +19°C to +25°C;

- a relative humidity in the range from 10 % to 75 %.

For terminal equipment which is not designed to operate within the environmental range specified above, all tests shall be performed in an environmental condition as specified by the supplier.

For terminal equipment which is directly powered (either wholly or partly) from the mains supply, all tests shall be carried out with ± 5 % of the rated voltage of that supply. If the equipment is powered by other

means and those means are not supplied as part of the apparatus (e.g. batteries, stabilized ac supplies, dc, etc.) all tests shall be carried out within the power supply limit declared by the supplier. If the power supply is ac, the test shall be conducted within ± 4 % of the rated frequency limit.

## 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 Signal coding at output port

Requirement: Subclause 5.2.1.1.

Purpose: To test the correct signal coding at the terminal equipment output port.

Test configuration: Figure A.1.

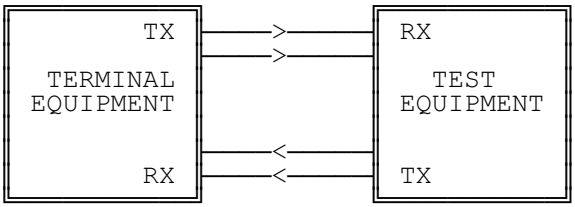



**Figure A.1: Signal coding at output port**

Interface state: Powered.

Stimulus: The terminal shall transmit a bit stream including both binary ONEs and binary ZEROs, for example a PRBS($2^{11}$-1).

Monitor: The output bit stream.

Results: Within a test duration of up to 5 minutes there shall be at least one period of one minute during which there are no errors in the decoded bit stream.

### A.2.2 Waveform shape at output port

Requirement: Subclause 5.2.1.2.

Purpose: To verify the output waveform.

Test configuration: Figure A.2.

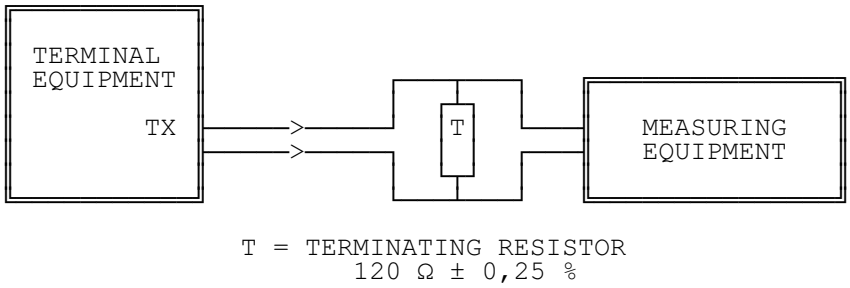



**Figure A.2: Waveform shape at output port**

Interface state: Powered.

Stimulus: Undefined.

Monitor: Marks and spaces transmitted by the terminal equipment, measuring the amplitude and shape of positive and negative pulses (measured at the centre of the pulse interval) and the time duration of positive and negative pulses (measured at the nominal half of the pulse amplitude, i.e. 0,5 V).

The overall measurement accuracy shall be better than 30 mV. All the measurements shall be performed using measuring equipment capable of recording dc. A bandwidth of 200 MHz or greater shall be used to ensure the capture of over or undershoot of the pulse.

Results: Both positive and negative pulses shall be within the masks of figures 2 and 3 as appropriate where V = 100 % shall be 1 V.

The bit interval corresponding to a space shall not present voltages higher than ± 0,1 V.

The ratio between the amplitude of positive and negative pulses shall be contained in the range from 0,95 to 1,05.

The ratio between the pulse widths of positive and negative pulses shall be in the range from 0,95 to 1,05.

### A.2.3 Output jitter

Requirement: Subclause 5.2.1.3.

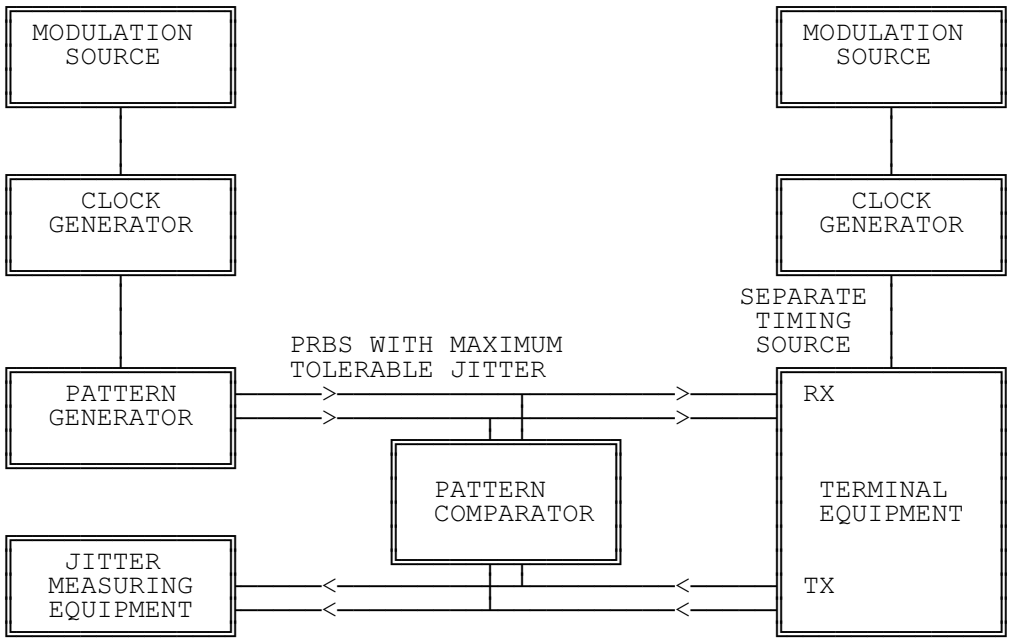
Purpose: This test is used to measure the maximum output jitter.

Test Configuration: Figure A.3.

The terminal equipment shall be tested in each of the following configurations (where these modes of operation are supported):

a) with output timing referenced to the internal clock; and

b) with output timing referenced to any external clock source from which timing can be derived (including derivation from the input signal).




NOTE: The modulation source may be included in the clock generator and/or the pattern generator, or it may be provided separately.

**Figure A.3: Jitter measurement**

Interface state: Powered.

Stimulus: The output signal of the pattern generator shall be encoded as in § 1.2.1.1.5 of CCITT Recommendation G.703 [1] and conform to a pulse shape as defined in table 1/G.703 and figure 5/G.703 of CCITT Recommendation G.703 [1]. The binary content shall be a PRBS($2^{11}$-1). If this signal causes the equipment to operate in such a manner that the test is not valid, the supplier shall declare how a suitable test signal shall be applied.

Measurements shall be made at the nominal digital rate of 64 kbit/s.

It may be necessary to synchronize the pattern generator:

a) to the output of the terminal equipment when the terminal equipment is running from its own internal clock; or

b) to the external clock source when the terminal equipment is running from this clock source,

in order to avoid a high occurrence of slips.

The modulation source for the terminal equipment signal input shall generate individual components of sinusoidal jitter at the frequencies of 20 Hz, 600 Hz, 3 kHz and 20 kHz on the curve of figure 3 and table 4 of this TBR.

The modulation source for the external timing (if needed) shall be independent from that for the input signal and shall generate the maximum tolerable jitter as specified by the manufacturer of the terminal equipment.

Monitor: The jitter at the output port using first order linear filters with the cut-off frequencies defined in table 3 of this TBR.

Results: The peak-to-peak jitter shall comply with table 3 of this TBR.

## Annex B (normative): Code conversion rules

This annex specifies the code conversion rules for the 64 kbit/s codirectional interface, defined in § 1.2.1.1.5 of CCITT Recommendation G.703 [1].

Step 1: A 64 kbit/s bit period is divided into four unit intervals.

Step 2: A binary 1 is encoded as a block of the following four bits:

1 1 0 0

Step 3: A binary 0 is encoded as a block of the following four bits:

1 0 1 0

Step 4: The binary signal is converted into a three-level signal by alternating the polarity of consecutive blocks.

Step 5: The alteration in polarity of the blocks is violated every 8th block. The violation marks the last bit in an octet.

These conversion rules are illustrated in figure B.1.

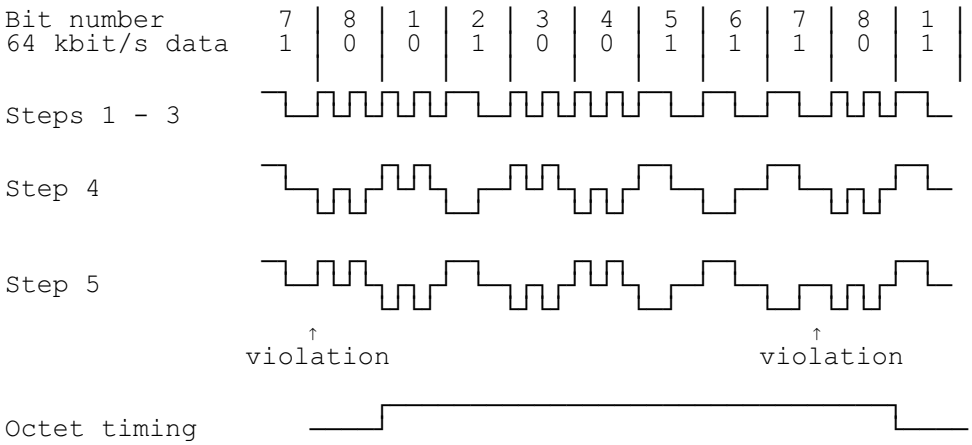



**Figure B.1: 64 kbit/s code conversion**

## Annex C (informative): Bibliography

1) 89/336/EEC: "Council Directive of 3 May 1989 on the approximation of the laws of Member States relating to electromagnetic compatibility".

2) 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".

3) 92/44/EEC: "Council Directive of 5 June 1992 on the application of Open Network Provision to leased lines".

4) EN 60950 (1992): "Safety of information technology equipment including electrical business equipment".

5) ETR 005 (1990): "Terminal Equipment (TE); Technical requirements for data terminal equipment for connection to high speed digital fixed connection services".

6) ETS 300 166 (1993): "Transmission and Multiplexing (TM); Physical/electrical characteristics of hierarchical digital interfaces for equipment using the 2 048 kbit/s-based plesiochronous or synchronous digital hierarchies".

7) ETS 300 288 (1994): "Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U), Network interface presentation".

8) ETS 300 289 (1994): "Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U), Connection characteristics".

9) ETS 300 290 (1994): "Business TeleCommunications (BTC); 64 kbit/s digital unrestricted leased line with octet integrity (D64U), Terminal equipment interface".

## History

| Document history | |
|---|---|
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