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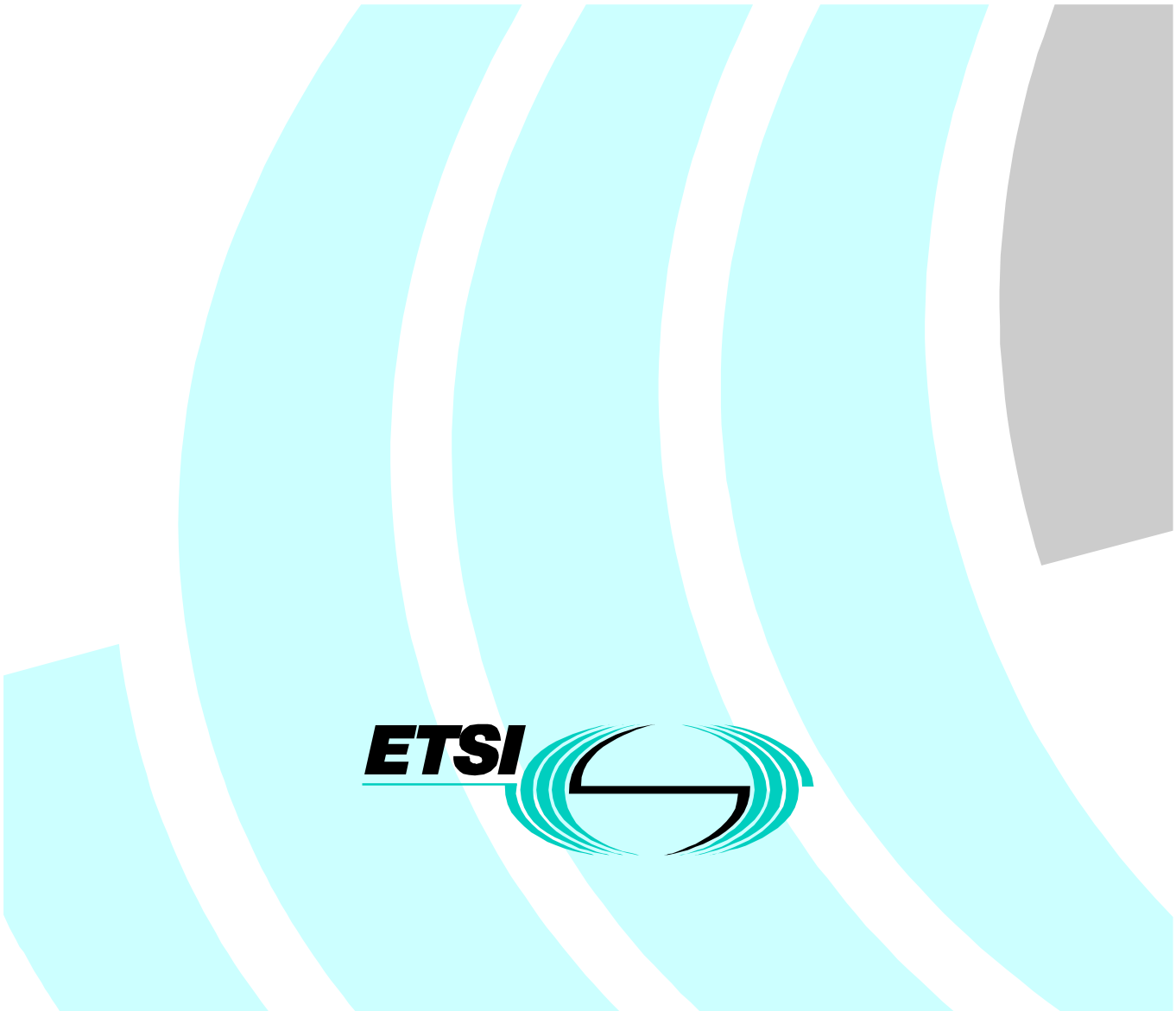
European Standard (Telecommunications series)

Access and Terminals (AT);
2 048 kbit/s digital unstructured leased line (D2048U);
Terminal equipment interface



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Contents

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Access and Terminals (AT).

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

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

- EN 300 418: "Access and Terminals (AT); 2 048 kbit/s digital unstructured and structured leased lines (D2048U and D2048S); Network interface presentation";
- EN 300 247: "Access and Terminals (AT); 2 048kbit/s digital unstructured lease line (D2048U); Connection characteristics".

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

National transposition dates	
Date of adoption of this EN:	29 June 2001
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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 (EC) of a minimum set of leased lines with harmonized technical characteristics.

The consequence of the Directive is that Telecommunications Organizations within the EC shall make available a set of leased lines between points in these countries with specified connection characteristics and specified interfaces.

EN 300 166 and ITU-T Recommendation G.703 [1] were used as the basis for the terminal interface.

Two categories (voluntary and regulatory) of standard were used for the interfaces of terminal equipment designed for connection to the ONP leased lines. Technical Basis for Regulations (TBRs) gave the earlier essential requirements under the Directive 91/263/EEC, later replaced by 98/13/EC, for attachment to the leased lines, whereas other voluntary standards (ETSs or ENs) gave the full technical specifications for these interfaces. This document, which is based on an earlier ETS, belongs to the second category.

The requirements of TBR 12 are a subset of the present document.

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

1 Scope

The present document specifies the physical and electrical characteristics (except safety, overvoltage and EMC aspects) and corresponding test principles for a terminal equipment interface for connection to the network termination points of ONP 2 048 kbit/s digital unstructured leased lines using 120 Ω interfaces.

The present document is to ensure that the interface of the terminal equipment is compatible with the ONP 2 048 kbit/s digital unstructured leased line. It is applicable to all interfaces designed for connection to the leased line, however in the cases of apparatus that carries a particular service, of complex apparatus and of apparatus in private networks, other requirements may apply in addition to the present document.

Customer premises wiring and installation between the terminal equipment and the Network Termination Point (NTP) are outside the scope of the present document.

2 References

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

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

[1] ITU-T Recommendation G.703 (1998): "Physical/electrical characteristics of hierarchical digital interfaces".

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

3 Definitions

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

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

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

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 telecommunications 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 Abbreviations

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

D2048U	2 048 kbit/s digital unstructured ONP leased line
DC	Direct Current
EMC	Electro-Magnetic Compatibility
HDB3	High Density Bipolar code of order 3 (see annex B)
NTP	Network Termination Point
ONP	Open Network Provision
ppm	parts per million
PRBS(2^{15}-1)	Pseudo Random Bit Sequence (as defined in clause 2.1 of ITU-T Recommendation O.151 [2])
rms	root mean square
RX	Receive (a signal input at either the terminal equipment interface or the test equipment)
SDH	Synchronous Digital Hierarchy
TE	Terminal Equipment
TX	Transmit (a signal output at either the terminal equipment interface or the test equipment)
UI	Unit Interval

5 Requirements

The 2 048 kbit/s unstructured leased line provides a bidirectional point-to-point digital leased line with a usable bit rate of 2 048 kbit/s where timing is not provided from the network. The provision of circuit timing is the responsibility of the user. No structuring of the data is provided by the network and any structuring is the responsibility of the user.

5.1 Physical characteristics

Currently no standardized connector is readily available. Consequently, the only method of connection that can be specified in the present document is the use of solid conductors of 0,4 mm to 0,6 mm. The present document requires the TE to be capable of presenting either a point for the attachment of unterminated solid conductors, or solid conductors themselves (see clause 5.1.1). It is a requirement that such a connection method be available to be provided for use with the TE if necessary.

In order to allow connection to be made using other methods (e.g. connectors), the TE is permitted to be supplied with a connection method suitable for use with those methods (see clause 5.1.2).

NOTE 1: The following are examples of arrangements that comply with the requirements. The list below should not be regarded as an exhaustive list of all permitted arrangements:

a) a cord, permanently connected to the terminal equipment at one end and unterminated at the other end, with wires that are solid conductors with diameters in the range 0,4 mm to 0,6 mm;

b) a cord, connected via a plug and socket to the terminal equipment at one end and unterminated at the other end, with wires that are solid conductors with diameters in the range 0,4 mm to 0,6 mm;

c) an insulation displacement connector, designed to accept wires with solid conductors with diameters in the range 0,4 mm to 0,6 mm, but with no cord;

d) a screw connector, designed to accept wires with solid conductors with diameters in the range 0,4 mm to 0,6 mm, but with no cord;

e) the arrangement in b) plus one or more additional alternative cords with the same plug or socket arrangement at the terminal end and any plug or socket at the other end;

f) the arrangement in c) or d) plus one or more cords suitable for connection to the terminal equipment at one end and any plug or socket at the other end.

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 the present document, they refer to the terminal equipment interface.

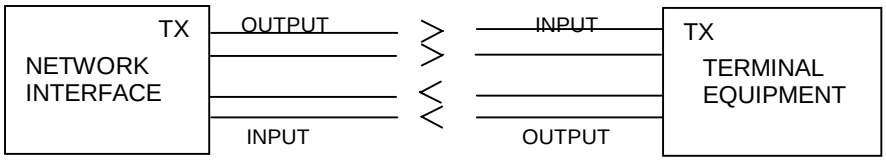


Figure 1

NOTE 2: The use of a shielded cord or cable may be necessary to meet radiation and immunity requirements defined in ElectroMagnetic Compatibility (EMC) standards.

5.1.1 Hardwired connection

Requirement: The terminal equipment shall provide:

a) a set of connection contacts (e.g. an insulation displacement connector or a screw terminal block) to which solid wire conductors with diameters in the range 0,4 mm to 0,6 mm may be connected; or

b) a wiring arrangement connected by any means to the terminal equipment, with unterminated solid wire conductors with diameters in the range 0,4 mm to 0,6 mm at the end distant from the terminal equipment.

Test: There is no test. All subsequent tests are carried out via the specified connection method.

5.1.2 Alternative means of connection

Any alternative means of connection may be provided in addition to the connection arrangements under clause 5.1.1.

5.2 Electrical characteristics

5.2.1 Output port

5.2.1.1 Signal coding

Requirement: Coding of the digital signal transmitted at the output port shall be in accordance with High Density Bipolar code of order 3 (HDB3) encoding rules (see annex B).

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

5.2.1.2 Waveform shape

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

Test: The test shall be conducted according to annex A, clause A.2.2.

Table 1: Waveform shape at output port

Pulse shape (nominally rectangular)	All marks of a valid signal shall conform with the mask (see figure 2) irrespective of the polarity. The value V corresponds to the nominal peak voltage of a mark.
Test load impedance	120 Ω non-reactive
Nominal peak voltage V of a mark	3 V
Peak voltage of a space	0 ± 0,3 V
Nominal pulse width	244 ns
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

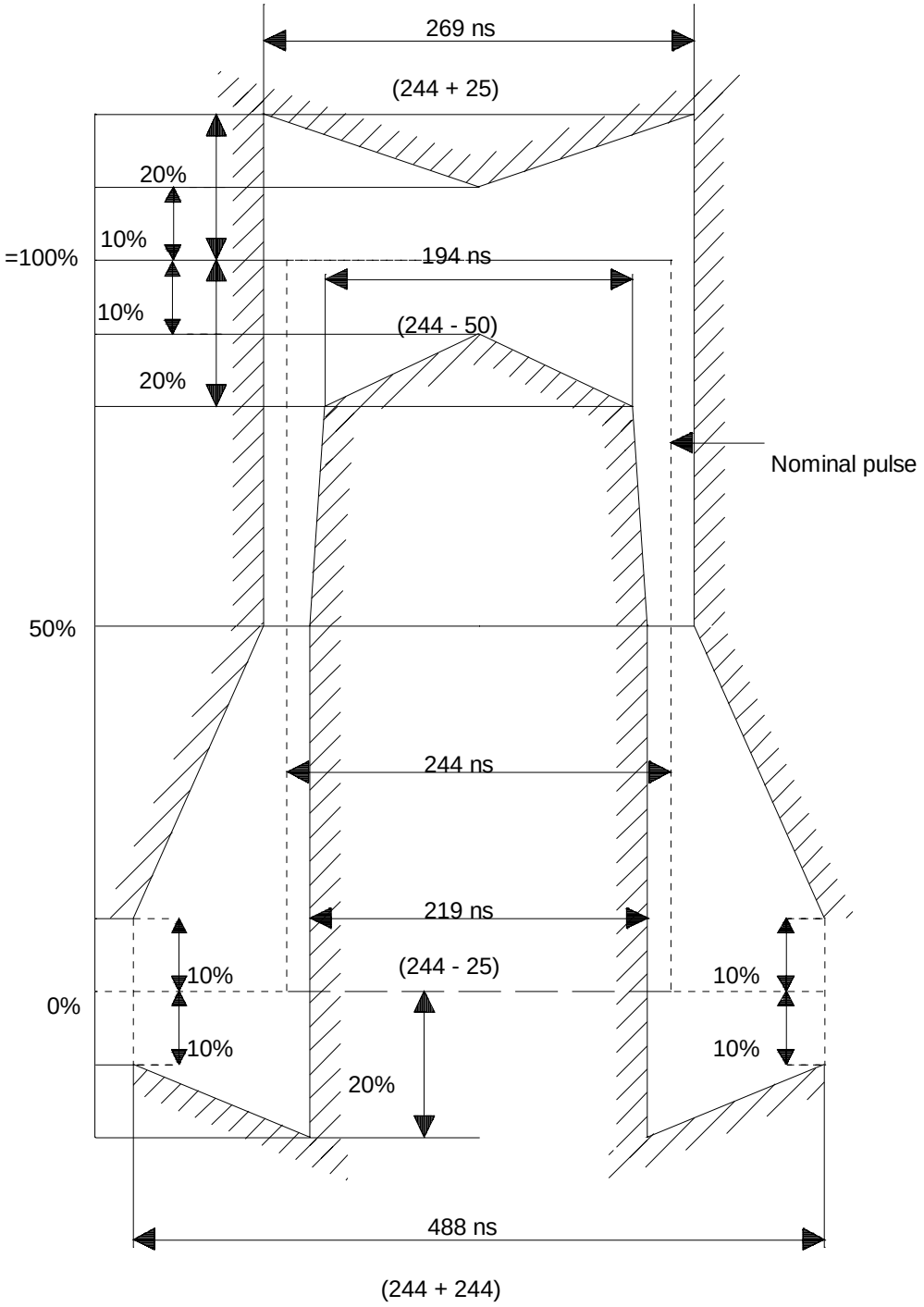


Figure 2: Pulse mask for 2 048 kbit/s pulse

5.2.1.3 Clock accuracy

Requirement: Where a Terminal Equipment (TE) has an internal clock, in the absence of any external reference signal timing, the output port shall have a bit rate of 2 048 kbit/s ± 50 ppm.

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

5.2.1.4 Impedance towards ground

Requirement: Where the terminal equipment has a ground, the impedance towards ground of the output port shall be greater than 1 000 Ω for frequencies in the range 10 Hz to 1 MHz when measured with a sinusoidal test voltage of 2 V rms. For the purpose of this requirement, ground shall be the terminal equipment common reference point or the equipment test reference point.

NOTE: This requirement is included to allow transformerless implementations.

Test: The test shall be conducted according to annex A, clause A.2.7.

5.2.1.5 Output jitter

Requirement: The peak-to-peak output jitter shall not exceed the limits of table 3 when measured with a bandpass filter with first order linear cut-off 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, as specified by the manufacturer.

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 3 and table 5 (see clause 5.2.2.7).

NOTE: A separate requirement for output jitter at frequencies in the range 4 Hz to 40 Hz is not required because this frequency band is covered sufficiently by the first order linear filter which produces 20 dB attenuation at 4 Hz.

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)
40 Hz	100 kHz	0,11 UI

Test: The test shall be conducted according to annex A, clause A.2.8.

5.2.1.6 Output return loss

There are no requirements for output return loss under the present document.

NOTE: A requirement for output return loss may be added to the present document when appropriate specifications become available.

5.2.1.7 Output signal balance

There are no requirements for output signal balance under the present document.

NOTE: The effects of the output signal imbalance are covered under the EMC Directive (89/336/EEC).

5.2.2 Input port

5.2.2.1 Signal coding

Requirement: The input port shall correctly decode without errors HDB3 encoded signals in accordance with HDB3 encoding rules (see annex B).

Test: The test shall be conducted according to annex A, clause A.2.6.

5.2.2.2 Input return loss

Requirement: The input return loss with respect to 120 Ω at the interface shall be greater than or equal to the values given in table 4 taken from clause 9.3 of ITU-T Recommendation G.703 [1].

Table 4: Input port minimum return loss

Frequency range	Return loss
51 kHz to 102 kHz	12 dB
102 kHz to 2 048 kHz	18 dB
2 048 kHz to 3 072 kHz	14 dB

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

5.2.2.3 Input loss tolerance

Requirement: The input port shall correctly decode without errors a 2 048 kbit/s signal as defined in clauses 5.2.1.1 and 5.2.1.2 above but modified by a cable or artificial cable with the following characteristics:

a) attenuation that follows a ´f law with values throughout the range 0 dB to 6 dB at 1 024 kHz; and

b) characteristic impedance of 120 Ω with a tolerance of ±20 % in the frequency range from 200 kHz up to, but not including, 1 MHz, and ±10 % at 1 MHz.

Test: The test shall be according to annex A, clause A.2.5.

5.2.2.4 Immunity against reflections

Requirement: When a signal comprising a combination of a normal signal and an interfering signal is applied to the input port, via an artificial cable with a loss in the range 0 dB to 6 dB at 1 MHz, no errors shall result due to the interfering signal.

The normal signal shall be a signal encoded according to HDB3, shaped according to the mask of figure 2 and with a binary content in accordance with a Pseudo Random Bit Sequence as defined in clause 2.1 of ITU-T Recommendation O.151 [2] (PRBS(2^{15}-1)).

The interfering signal shall be the same as the normal signal except that the level shall be attenuated by 18 dB, the bit rate shall be within 2 048 kbit/s ±50 ppm and not synchronized to the normal signal.

Test: The test shall be conducted according to annex A, clause A.2.5.

5.2.2.5 Tolerable longitudinal voltages

Requirement: The receiver shall operate without errors with any input signal in the presence of a longitudinal voltage of magnitude 2 V rms over the frequency range 10 Hz to 30 MHz.

NOTE: This requirement is included to allow transformerless implementations.

Test: The test shall be conducted according to annex A, clause A.2.6.

5.2.2.6 Impedance towards ground

Requirement: Where the terminal equipment has a ground, the impedance towards ground of the input port shall be greater than 1 000 Ω for frequencies in the range 10 Hz to 1 MHz when measured with a sinusoidal test voltage of 2 V rms. For the purpose of this requirement, ground shall be the terminal equipment common reference point or the equipment test reference point.

NOTE: This requirement is included to allow transformerless implementations.

Test: The test shall be conducted according to annex A, clause A.2.7.

5.2.2.7 Input jitter tolerance

Requirement: The terminal equipment shall tolerate at its input port the maximum input jitter as shown in table 5 and figure 3.

NOTE: Terminal equipment with more than one input will normally need to be designed with a wander buffer of at least 18 microseconds, however, to accommodate the wander that may be produced by Synchronous Digital Hierarchy (SDH) networks, up to 40 microseconds may be needed.

Table 5: Input jitter tolerance

Peak-to-peak amplitude (UI)		Frequency (Hz)			
A1	A2	f1	f2	f3	f4
1,5	0,2	20	2 400	18 000	100 000

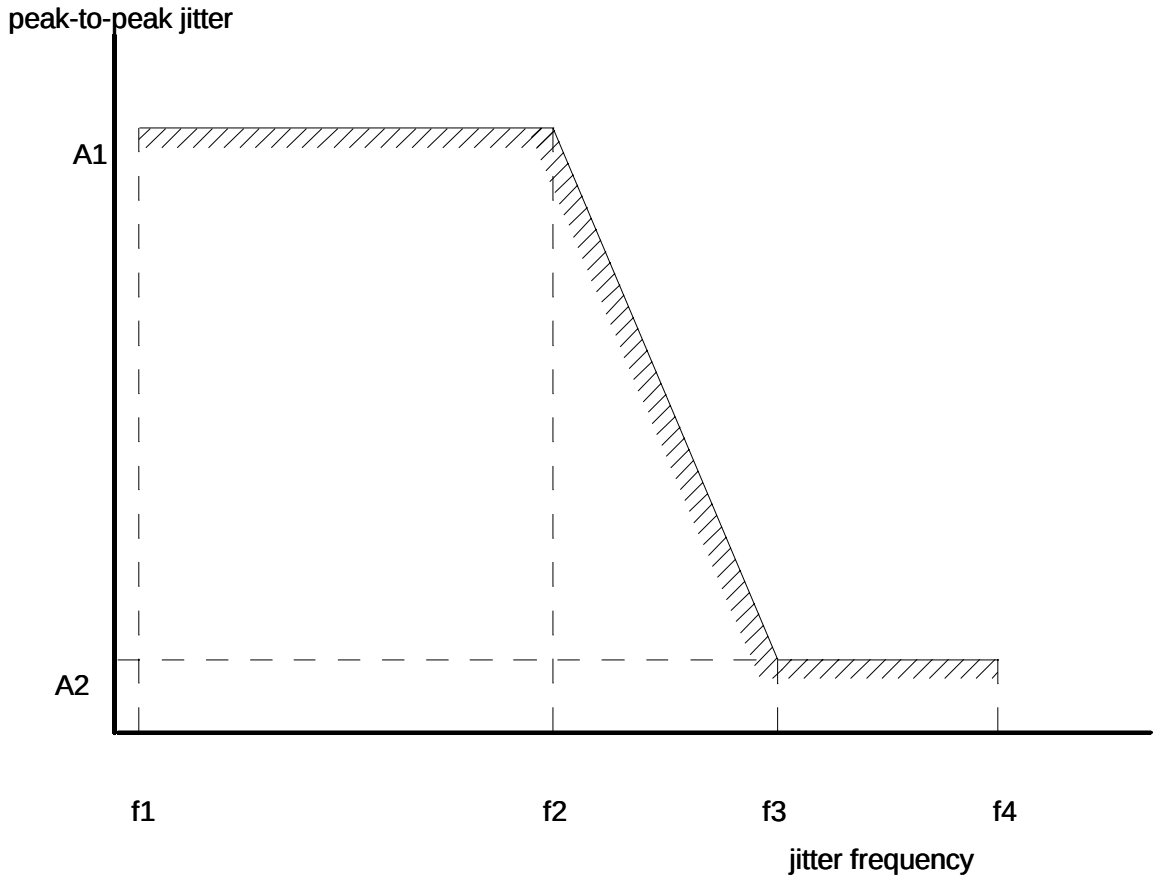


Figure 3: Input jitter tolerance

Test: The test shall be conducted according to annex A, clause A.2.8.

5.2.2.8 Input clock tolerance

Requirement: The terminal equipment shall correctly decode without error HDB3 encoded signals over the frequency range 2 048 kbit/s ± 50 ppm.

Test: The test shall be conducted in accordance with annex A, clause A.2.8.

5.3 Safety

Requirements for safety are outside the scope of the present document.

Safety standards are published by CENELEC.

NOTE 1: An example of such a CENELEC product safety standard is EN 60950 (see annex C).

NOTE 2: For safety categories of interfaces, see EG 201 212 This document is also available from CENELEC as ROBT-002.

NOTE 3: Designers should take into account the minimum impedance towards ground specified in the present document.

5.4 Overvoltage

Overvoltage aspects are outside of the scope of the present document.

5.5 Electro-magnetic compatibility

EMC requirements are outside the scope of the present document.

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 the present document.

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

A terminal equipment may be designed for through-connecting and may only fulfil the electrical requirements if through-connected. In these cases the requirements of the present document are valid and the tests are carried out with the through-connection suitably terminated as defined 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. The required test results do not make allowance for spurious events during testing (e.g. errors due to EMC effects).

The test configurations given do not imply a specific realization of test equipment or arrangement or use of specific test devices for conformance testing. 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, that is capable of generating a stimulus signal conforming to the present document and capable of monitoring the signal received from the interface.

A.1.1 Additional information to support the test

The following facilities shall be provided by the terminal equipment interface under test:

a) an ability to configure the terminal equipment such that it provides a transparent loopback of the input to the output; and

b) an ability to transmit a given bit pattern, e.g. PRBS(2^{15}-1); or

c) where a) or b) cannot be provided, an alternative means of performing the test.

A.1.2 Equipment connection

The tests in the present document shall be carried out using the connection method suitable for use with unterminated solid conductors as defined in clause 5.1.1. However, in the case of the tests specified in clauses A.2.2, A.2.4 and A.2.7, 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 these tests because the requirements do not make allowances for the electrical characteristics of any cord.

NOTE: This alternative method of connection is for test purposes only and has been introduced because the characteristics tested in clauses A.2.2, A.2.4 and A.2.7 are based on ITU-T Recommendation G.703 [1] which makes no allowance for additional wiring. This alternative method may not be the same as the alternative method of connection referred to in clause 5.1.2 which is for operational use.

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

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

Test configuration: Figure A.1.

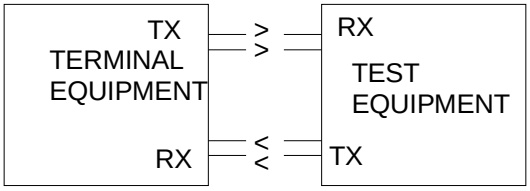


Figure A.1: Signal coding at output port

Interface state: Powered.

Stimulus: The terminal shall transmit a bit stream including the sequences <0000><even number of binary ONEs><0000> and <0000><odd number of binary ONEs><0000> which shall be encoded into HDB3; where 0 = space and 1 = mark input to the HDB3 encoder (see note).

Monitor: The output bit stream for a test period of sufficient time to allow transmission of 100 occurrences of the above patterns plus the latency period of the error detection mechanism.

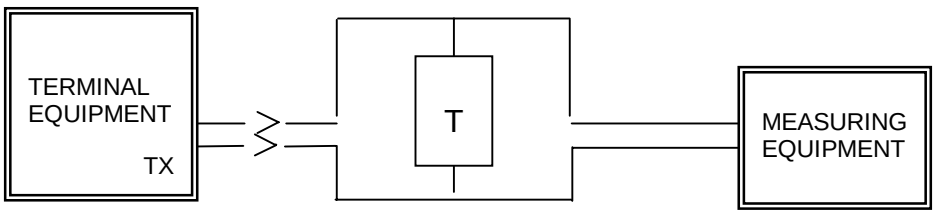
Results: There shall be no errors in the decoded bit stream.

NOTE: A pseudo random bit stream, e.g. PRBS(2^{15}-1), will be acceptable if the bit patterns of the above clause are included in the bit stream.

A.2.2 Waveform shape at output port

Purpose: To verify the output waveform.

Test configuration: Figure A.2.



T = TERMINATING RESISTOR
120 Ω ±0,25 %

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. 1,5 V).

The overall measurement accuracy shall be better than 90 mV. All the measurements shall be performed using measuring equipment capable of recording Direct Current (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 mask of figure 2, where V = 100 % shall be 3 V.

The bit interval corresponding to a space shall not present voltages higher than ±0,3 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 Clock accuracy at the output port

Purpose: To measure the bit rate when the terminal equipment is generating timing from an internal source.

Test configuration: Figure A.3.

The terminal equipment shall be configured to provide output timing from an internal source. The terminal equipment output shall be any HDB3 encoded bit stream.

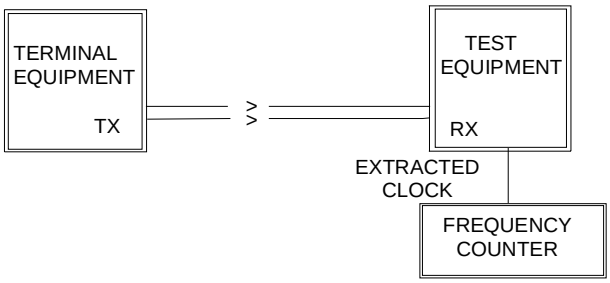


Figure A.3: Clock accuracy at the output port

Interface State: Powered.

Stimulus: Undefined.

Monitor: The bit rate from the terminal equipment output port. The measurement accuracy shall be better than 1 Hz.

Results: The bit rate shall be within the limits of 2 048 kbit/s ±50 ppm.

A.2.4 Return loss at input port

Purpose: To measure the return loss of the receive pair of the terminal equipment interface.

Test configuration: Figure A.4.

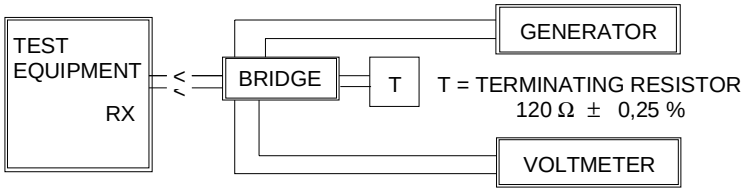


Figure A.4: Return loss at input port

Interface state: Powered.

Stimulus: Sinusoidal signal of 3 V peak at the input to the terminal equipment with a frequency variable between 51 kHz and 3 072 kHz.

Monitor: Voltage measured across the bridge, representing a terminating resistor of 120 Ω, using a selective voltmeter with a bandwidth of less than 1 kHz.

Results: The measured return loss shall be greater than or equal to the values in table 4 of clause 5.2.2.2 of the present document.

NOTE: The characteristics of the generator and of the voltmeter may be different depending on the implementation of the bridge however the total error of the test set-up should be less than 0,5 dB in the range between 10 dB and 20 dB. When connected to a 120 Ω ±0,25 % resistor the measured return loss of the bridge should be 20 dB higher than the limits specified for the interface.

A.2.5 Input loss tolerance and immunity against reflections

Purpose: To check the input port immunity against an interfering signal combined with the input signal with a cable attenuation of maximum 6 dB.

Test configuration: Figure A.5.

The interfering signal shall be combined with the main signal in a combining network of impedance 120 Ω, with zero dB loss in the main path and an attenuation in the interference path of 18 dB.

The cable simulator shall have an attenuation of 6 dB measured at 1 024 kHz and an attenuation characteristic that follows a ´f law.

The conformance of the interface shall be verified in the following test conditions:

a) without cable simulator and without interfering signal; and

b) with cable simulator and without interfering signal; and

c) without cable simulator and with interfering signal; and

d) with cable simulator and with interfering signal.

The test shall be repeated with the wires at the interface input reversed.

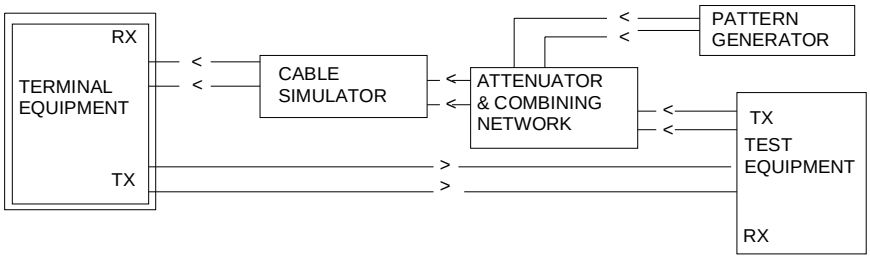


Figure A.5: Input loss tolerance and immunity against reflections

Interface state: Powered, with received data looped back to the output port.

Stimulus: The output signal of the test equipment shall be HDB3 encoded and conform to a pulse shape as defined in figure 15 of ITU-T Recommendation G.703 [1], which is reproduced in figure 2 of the present document. The binary content shall be a PRBS(2^{15}-1). The bit rate shall be within the limits 2 048 kbit/s ±50 ppm.

The interfering signal from the pattern generator shall be HDB3 encoded and conform to a pulse shape as defined in figure 15 of ITU-T Recommendation G.703 [1], which is reproduced in figure 2 of the present document. The binary content shall be a PRBS(2^{15}-1). The bit rate shall be within the limits 2 048 kbit/s ±50 ppm and shall not be synchronized to the output signal of the test equipment.

Monitor: Data at output port of the terminal equipment.

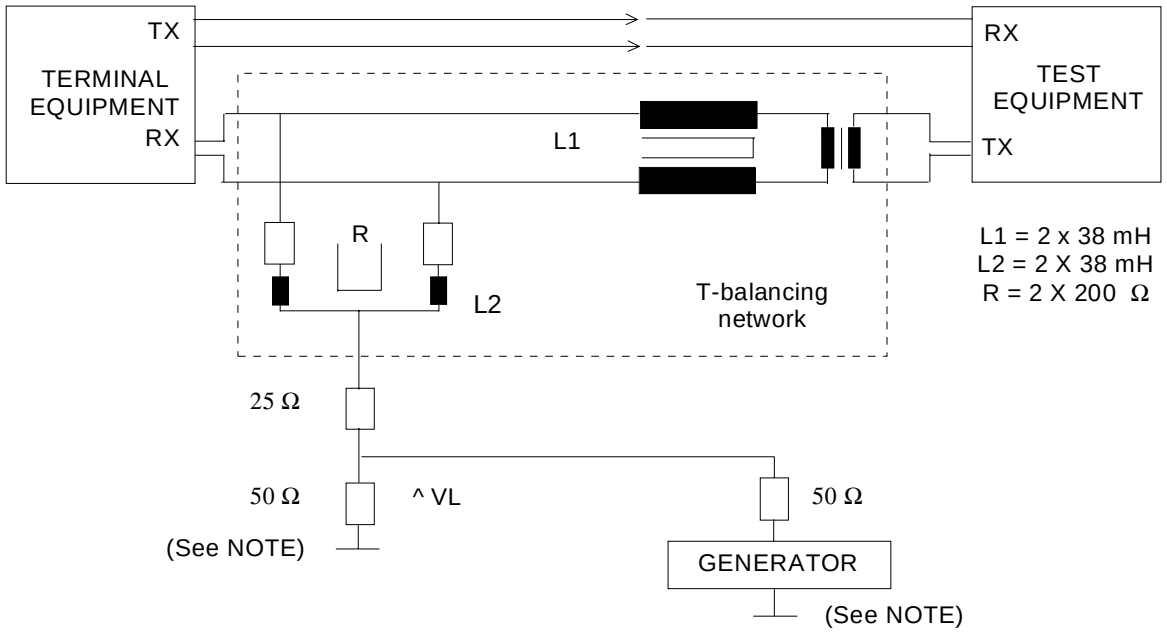
Results: Verify that the data received from the equipment under test is identical with the generated sequence for a period of at least one minute.

NOTE: The √f law of the cable simulator shall apply in the frequency range 100 kHz to 10 MHz.

A.2.6 Tolerable longitudinal voltage and HDB3 input coding

Purpose: To check minimum tolerance to longitudinal voltages at the input of the terminal equipment and correct recognition of HDB3 code.

Test configuration: Figure A.6.



NOTE: This point is connected to the terminal equipment common reference point or to the equipment test reference point.

Figure A.6: Tolerable longitudinal voltage and HDB3 input coding

Interface state: Powered, with received data looped back to the output port.

Stimulus: The output signal of the test equipment shall be HDB3 encoded and conform to a pulse shape as defined in figure 15 of ITU-T Recommendation G.703 [1], which is reproduced in figure 2 of the present document. The binary content shall be a PRBS(2^{15}-1).

A longitudinal voltage VL of 2 V rms, ±20 mV with a frequency variable between 10 Hz and 30 MHz shall be applied for a minimum of 2 seconds.

Monitor: Data at output port of the terminal equipment.

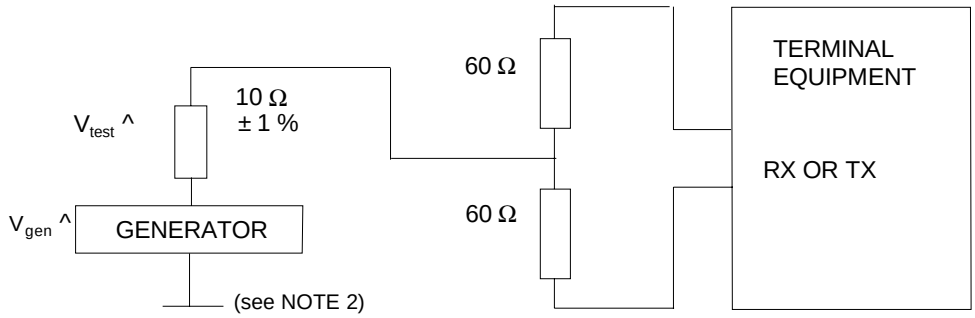
Results: Verify that the data received from the equipment under test is identical with the generated sequence.

NOTE: The inherent longitudinal conversion loss of the T-balancing network should be greater than 30 dB.

A.2.7 Impedance towards ground

Purpose: To check terminal equipment input and output ports impedance towards ground.

Test configuration: Figure A.7.



NOTE 1: The 60 Ω resistors shall be within 1 % and matched to better than 0,1 %.
NOTE 2: This point is connected to the terminal equipment common reference point or to the equipment test reference point.

Figure A.7: Impedance towards ground

Interface state: Powered.

Stimulus: Sinusoidal test signal (V_{gen}) of 2 V rms, ± 20 mV applied over the frequency range 10 Hz to 1 MHz.

Monitor: Voltage of V_{test}.

Results: Voltage V_{test} shall be less than 19,2 mV rms.

A.2.8 Jitter

Purpose: This test is used to measure tolerance to input jitter, maximum output jitter and operation over the specified timing input range.

NOTE 1: Further information on the measurement of jitter can be found in ITU-T Supplement number 3.8, Fascicle IV.4 (1988).

Test configuration: Figure A.8.

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

a) output timing referenced to the internal clock; and

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

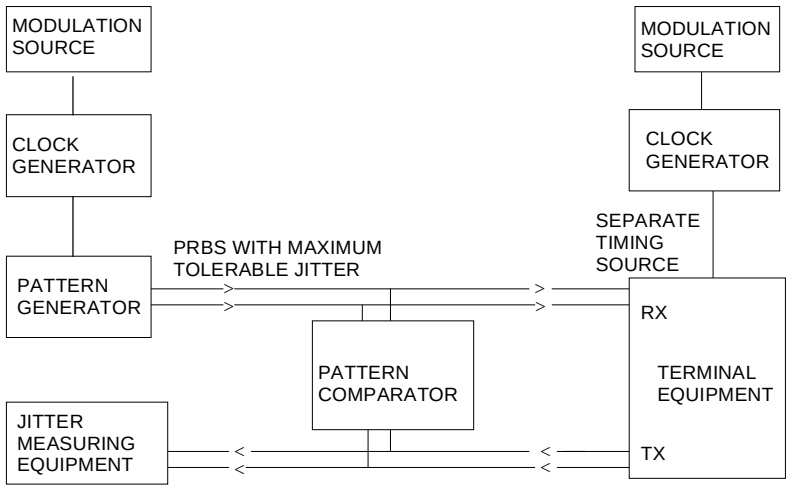


Figure A.8: Jitter measurement

Interface state: Powered, with received data looped back to the output port.

Stimulus: The output signal of the pattern generator shall be HDB3 encoded and conform to a pulse shape as defined in figure 15 of ITU-T Recommendation G.703 [1], which is reproduced in figure 2 of the present document. The binary content shall be a PRBS(2^{15}-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 with both the input signals at the digital rate limits and between these limits, sufficient to verify jitter compliance over the specified frequency range. As a minimum the test shall be performed at the upper and lower limits and at the nominal rate.

The modulation source shall generate individual components of sinusoidal jitter at points on the curve of figure 3 and table 5 of the present document.

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, and maximum frequency deviation, as specified by the manufacturer of the terminal equipment.

Monitor: a) the signal transmitted by the terminal equipment; and

b) the jitter extracted from this signal.

Results:

a) there shall be no bit errors reported by the test equipment within the period of the test; and

b) the peak-to-peak jitter shall comply with table 3 of clause 5.2.1.5 of the present document when measured with first order linear filters with the defined cut-off frequencies.

NOTE 2: The modulation source may be included in the clock generator and/or the pattern generator, or it may be provided separately.

Annex B (normative): Definition of HDB3 code

B.1 General

This annex specifies the modified Alternate Mark Inversion (AMI) code HDB3. The contents of this annex are based on annex A of ITU-T Recommendation G.703 [1].

In this code, binary 1 bits are represented by alternate positive and negative pulses, and binary 0 bits by spaces. Exceptions are made when strings of successive 0 bits occur in the binary signal.

In the definition below, B represents an inserted pulse corresponding to the AMI rule, and V represents an AMI violation.

B.2 Definition

Each block of 4 successive zeros is replaced by 000V or B00V. The choice of 000V or B00V is made so that the number of B pulses between consecutive V pulses is odd. In other words, successive V pulses are of alternate polarity so that no DC component is introduced.

Annex C (informative): Bibliography

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

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

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

Council Directive 98/13/EC relating to telecommunications terminal equipment and satellite earth station equipment, including the mutual recognition of their conformity.

ITU-T Supplement number 3.8, Fascicle IV.4 (1988): "Guidelines concerning the measurement of jitter".

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

ETSI EN 300 247 : "Access and Terminals (AT); 2048kbit/s digital unstructured lease line (D2048U); Connection characteristics".

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

ETSI EG 201 212: "Electrical safety; Classification of interfaces for equipment to be connected to telecommunication networks". This document is also available from CENELEC as ROBT-002.

CENELEC EN 60950: "Safety of information technology equipment".

History

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