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2 048 kbit/s digital unstructured leased line (D2048U)
Attachment requirements for terminal equipment**

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Foreword

This Technical Basis for Regulation (TBR) has been produced by the Business Telecommunications (BT) 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 harmonised standards for the support of the Second Phase 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 harmonisation of conditions for open and efficient access to, and use of, the leased lines provided on public telecommunications networks and the availability throughout the Community (EEC) of a minimum set of leased lines with harmonised technical characteristics.

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

Two classes of standard will be used for the interfaces of terminal equipment designed for connection to the ONP leased lines. European Telecommunications 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 300 248 (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 2 048 kbit/s digital unstructured leased lines using 120 ohm interfaces.

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 all interfaces designed for connection to the ONP 2 048 kbit/s unstructured leased line. It covers the essential requirements for the physical and electrical characteristics of the terminal equipment interface.

Customer premises wiring and installation between the terminal 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 O.151 (1988), § 2.1: "Error performance measuring equipment for digital systems at the primary rate and above".
- [2] ETS 300 046-3 (1992): "Integrated Services Digital Network (ISDN); Primary rate access - safety and protection, Part 3: Interface I_a - protection".
- [3] 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, or between one accessible part and the equipment protective earthing terminal for a class I equipment, 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
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)
ONP	Open Network Provision
PRBS(2 ¹⁵ -1)	Pseudo Random Bit Sequence (as defined in § 2.1 of CCITT Recommendation O.151 [1])
RX	Receive (a signal input at either the terminal equipment interface or the test 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

Requirement: The terminal equipment shall provide an 8-contact plug of the type specified in ISO/IEC 10173 [3] 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.

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 0,4 to 0,6 mm.

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.

Table 1: Contact assignment

Contact	Terminal interface
1 & 2	Receive pair
3	Shield reference point
4 & 5	Transmit pair
6	Shield reference point
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 standard, 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.

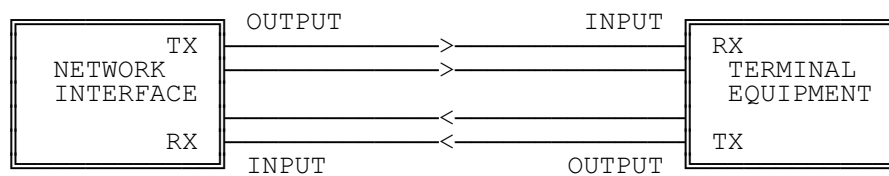


Figure 1

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, subclause A.2.1.

5.2.1.2 Waveform shape

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

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

Table 2: Waveform shape at output port

Pulse shape (nominally rectangular)	All marks of a valid signal must 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 ohms non-reactive
Nominal peak voltage V of a mark	3 volts
Peak voltage of a space	$0 \pm 0,3$ volts
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

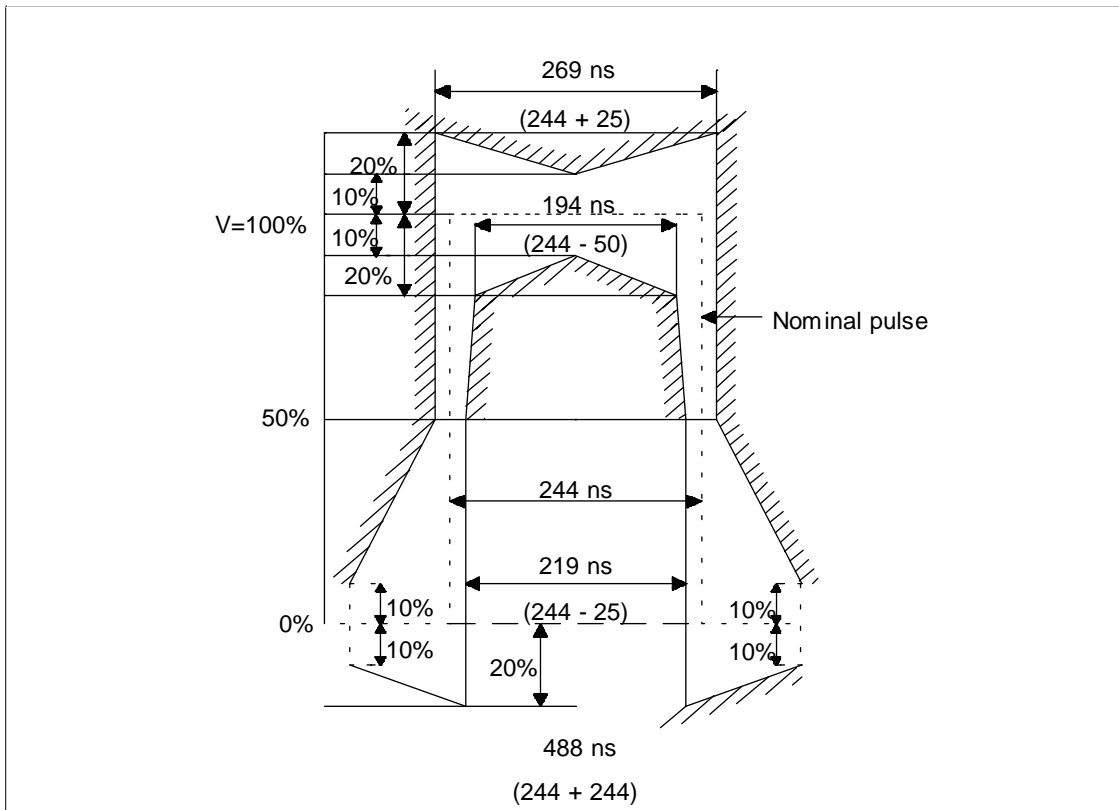


Figure 2: Pulse mask for 2 048 kbit/s pulse

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 \pm 50 ppm.

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

5.2.1.4 Output jitter

Requirement: 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, 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 4.

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

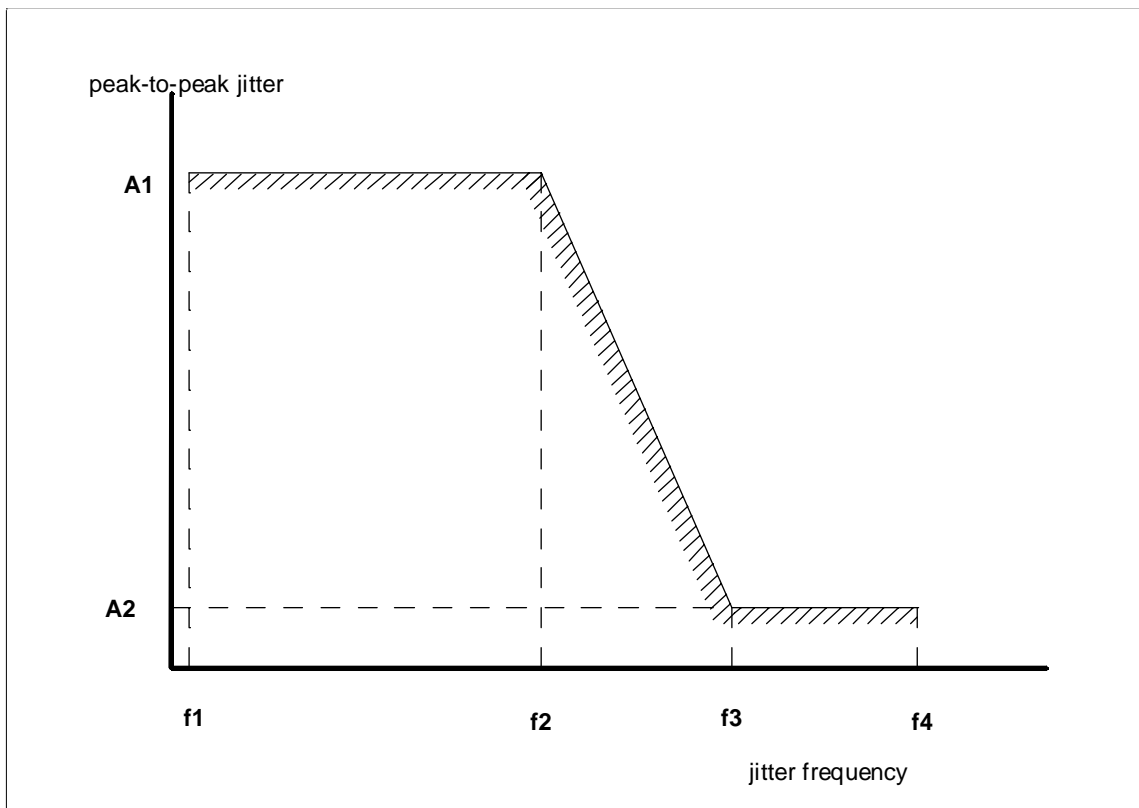


Figure 3: Input jitter for output jitter measurement

Table 4: Input jitter for output jitter measurement

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

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

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 300 248 subclause 5.3 defines the terminal equipment interface as a Safety Extra-Low Voltage (SELV) circuit. Detailed requirements for SELV circuits are given in EN 60950.

5.4 Overvoltage protection

For the purpose of the following subclauses on protection, the term referred to as I_a in ETS 300 046-3 [2] shall be deemed to be the point of test referred to in Annex A, subclause A.1.1.

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 volts transverse voltage to the terminal equipment interface when a common mode surge of either polarity and of 2,5 kV (10/700 μ s) is applied to the mains supply port.

Test: The test shall be conducted according to subclause 5.7.1 of ETS 300 046-3 [2].

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 volts transverse voltage to the terminal equipment interface when a transverse mode surge of either polarity and of 2,5 kV (10/700 μ s) is applied to the mains supply port.

Test: The test shall be conducted according to subclause 5.7.1 of ETS 300 046-3 [2].

5.4.3 Conversion of common mode to transverse mode

Requirement: The transverse mode voltage shall not be more than 250 volts peak when 2 common mode surges of 1 kV (1,2/50 μ s) (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 [2].

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 for conducted emissions will be added to this TBR when appropriate specifications become available if these requirements are not imposed under the EMC Directive.

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 only fulfil the electrical requirements if through-connected. In these cases the requirements of this TBR 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 regulatory documents. The required test results do not make allowances for spurious events during testing (e.g. errors due to EMC effects).

The test configurations given do not imply a specific realisation 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, generating a stimulus signal conforming to this TBR and capable of monitoring the receive signal 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.151 [1] (PRBS(2¹⁵-1)). 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 connection method may be provided by the terminal equipment supplier for test purposes. In this case, this alternative method of connection shall be used for this test because the requirement does 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 subclause A.2.2 are based on CCITT Recommendation G.703 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 +19°C to +25°C;
- a relative humidity in the range 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, stabilised Alternating Current (AC) supplies, Direct Current (DC)) 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 $\pm 4\%$ 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.

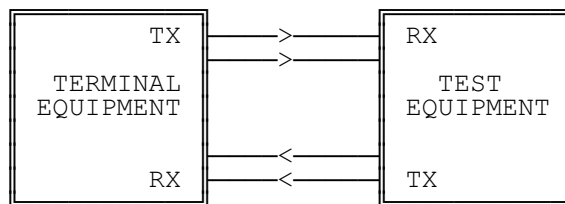


Figure A.1: Signal coding at output port

Interface state: Powered.

Stimulus: The terminal shall transmit a bit stream including 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 HDB3 encoding.

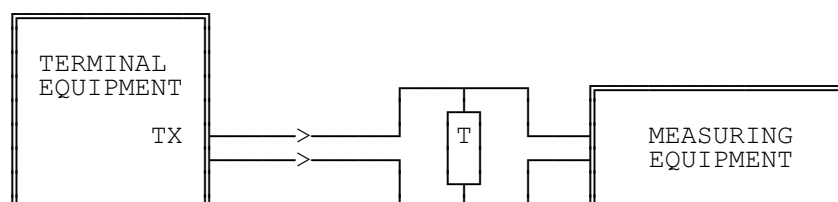
NOTE: A pseudo random bit stream, e.g. PRBS($2^{15}-1$), will be acceptable if the bit patterns of the above subclause are included in the bit stream.

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.



T = TERMINATING RESISTOR
 $120\ \Omega \pm 0,25\ \%$

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 volts).

The overall measurement accuracy shall be better than 90 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 mask of figure 2, where $V = 100\%$ shall be 3 volts.

The bit interval corresponding to a space shall not present voltages higher than $\pm 0,3$ volts.

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

Requirement: Subclause 5.2.1.3.

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.

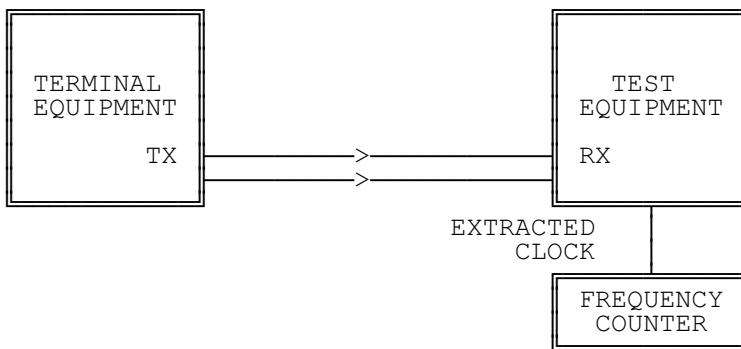


Figure A.3: Clock accuracy at the output port

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 \pm 50 ppm.

A.2.4 Jitter

Requirement: Subclause 5.2.1.4.

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

Test Configuration: Figure A.4.

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.

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

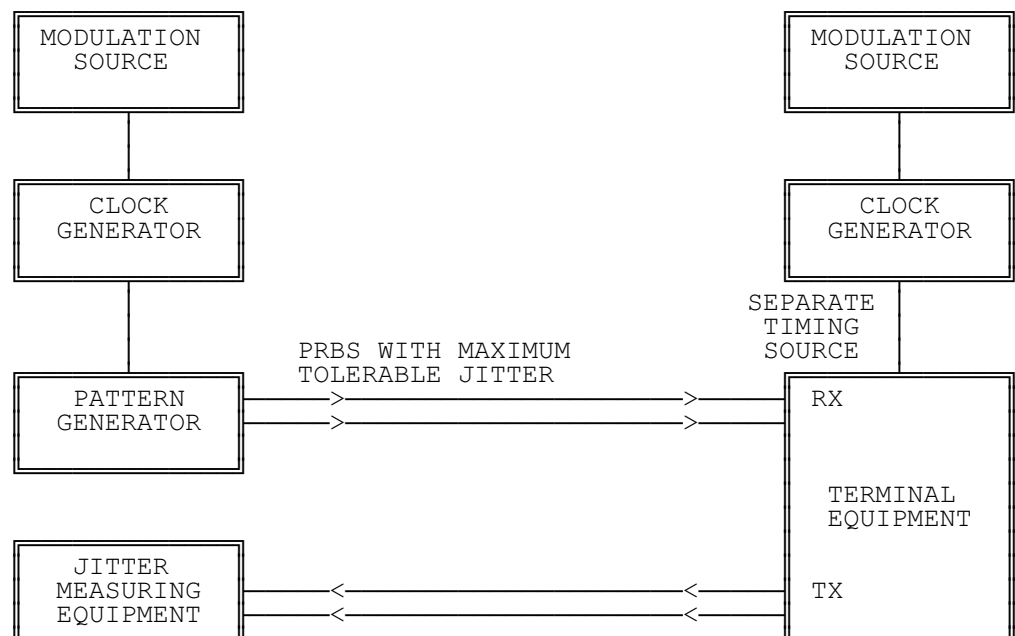


Figure A.4: Jitter measurement

Interface state: Powered.

Stimulus: The output signal of the pattern generator shall be HDB3 encoded and conform to a pulse shape as defined in figure 2 and table 2 of this TBR. The binary content shall be a PRBS(2¹⁵-1). 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.

Where the output timing of the terminal equipment is taken from the leased line, the modulation source shall generate individual components of sinusoidal jitter at points 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, and maximum frequency deviation, as specified by the manufacturer of the terminal equipment.

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

Results: The peak-to-peak jitter shall comply with the values specified in table 3 of subclause 5.2.1.4 of this TBR.

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 CCITT Recommendation G.703 (1991).

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

- 1) 73/23/EEC: "Council Directive of 19 February 1973 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits".
- 2) 89/336/EEC: "Council Directive of 3 May 1989 on the approximation of the laws of Member States relating to electromagnetic compatibility".
- 3) 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".
- 4) 92/44/EEC: "Council Directive of 5 June 1992 on the application of Open Network Provision to leased lines".
- 5) CCITT Recommendation G.703 (1991): "Physical/electrical characteristics of hierarchical digital interfaces".
- 6) EN 60950 (1992): "Safety of information technology equipment including electrical business equipment".
- 7) ETS 300 166 (1993): "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".
- 8) ETS 300 246 (1993): "Open Network Provision (ONP) technical requirements; 2 048 kbit/s digital unstructured leased line (D2048U), Interface presentation".
- 9) ETS 300 247 (1993): "Open Network Provision (ONP) technical requirements; 2 048 kbit/s digital unstructured leased line (D2048U), Connection characteristics".
- 10) ETS 300 248 (1993): "Open Network Provision (ONP) technical requirements; 2 048 kbit/s digital unstructured leased line (D2048U), Terminal equipment interface".

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