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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 the support of the Directive on Open Network Provision (ONP) of leased lines (92/44/EEC).

There are four other standards directly related to this ETS:

- ETS 300 687: "Business TeleCommunications (BTC); 34 Mbit/s digital leased lines (D34U and D34S); Connection characteristics";

- ETS 300 688: "Business TeleCommunications (BTC); 140 Mbit/s digital leased lines (D140U and D140S); Connection characteristics";

- ETS 300 689: "Business TeleCommunications (BTC); 34 Mbit/s digital leased lines (D34U and D34S); Terminal equipment interface";

- ETS 300 690: "Business TeleCommunications (BTC); 140 Mbit/s digital leased lines (D140U and D140S); Terminal equipment interface".

Transposition dates	
Date of adoption of this ETS:	15 March 1996
Date of latest announcement of this ETS (doa):	30 June 1996
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	31 December 1996
Date of withdrawal of any conflicting National Standard (dow):	31 December 1996

This ETS is based on information from ITU-T 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 European Union of a minimum set of leased lines with harmonised technical characteristics.

The 34 Mbit/s and 140 Mbit/s unstructured and structured leased lines are not part of the minimum set of leased lines under the leased line Directive, however these standards are being written with the intention that where 34 Mbit/s or 140 Mbit/s leased lines are offered, they will be in accordance with these harmonised standards.

Under the Second Phase Directive (91/263/EEC), terminal equipment for connection to these leased lines will be required to fulfil certain essential requirements.

ETS 300 166 and ITU-T Recommendation G.703 are used as the basis for the interface presentation requirements.

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1 Scope

This ETS specifies the technical requirements and conformance tests for the network interface presentations of 34 Mbit/s and 140 Mbit/s digital leased lines. This includes:

- the 34 Mbit/s Digital Unstructured leased line operating at 34 368 kbit/s;

- the 140 Mbit/s Digital Unstructured leased line operating at 139 264 kbit/s;

- the 34 Mbit/s digital structured leased line operating at 34 368 kbit/s for the support of an unstructured 33 920 kbit/s information transfer rate;

- the 140 Mbit/s digital structured leased line operating at 139 264 kbit/s for the support of an unstructured 138 240 kbit/s information transfer rate.

A connection is presented via interfaces at Network Termination Points (NTPs). This ETS defines the network interface as presented by the leased line provider and should be used in conjunction with the appropriate companion standard, ETS 300 687 (34 Mbit/s) or ETS 300 688 (140 Mbit/s), which specifies the connection characteristics between NTPs of the leased line. This ETS and the appropriate connection characteristics standard together describe the technical characteristics of the relevant leased line.

This ETS is applicable to leased lines, including part time leased lines, whose establishment or release does not require any protocol exchange or other intervention at the NTP.

This ETS covers the mechanical and electrical characteristics of the network interface and specifies the conformance tests for equipment of the kind that provides the interface presentation. Some of the tests described in this ETS are not designed to be applied to the interface of an installed leased line; such tests may be applied to equipment of the kind used to provide the interface. This ETS does not include details concerning the implementation of the tests nor does it include information on any regulations concerning testing. There is no requirement for each leased line to be tested in accordance with this ETS before it is brought into service or returned into service following repair.

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 into it by amendment or revision. For undated references the latest edition of the publication referred to applies.

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

[2] IEC 169-8:1978: "Radio frequency connectors - Part 8: R.F coaxial connectors with inner diameters of outer conductor 6,5 mm (0,256 in) with bayonet lock - Characteristic impedance 50 ohms (Type BNC)".

[3] IEC 169-13 (1976): Part 13: "R.F. coaxial connectors with inner diameter of outer conductor 5,6 mm (0,22 in) - Characteristic impedance 75 ohms (Type 1,6/5,6) - Characteristic impedance 50 ohms (Type 1,8/5,6) with similar mating dimensions".

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

[5] ITU-T Recommendation G.703 (1991): "Physical/electrical characteristics of hierarchical digital interfaces".

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

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 D. In some cases the same publication may have been referenced in both a normative and an informative manner.

3 Definitions and abbreviations

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

3.1 Definitions

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.

PRBS(2^{23}-1): A Pseudo Random Bit Sequence (PRBS) (as defined in subclause 2.2 of ITU-T Recommendation O.151 [6]).

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 [1]).

3.2 Abbreviations

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

ac	alternating current
AMI	Alternate Mark Inversion
BNC	Bayonet Nut Connector
CMI	Coded Mark Inversion
D140S	140 Mbit/s Digital Structured leased line
D140U	140 Mbit/s Digital Unstructured leased line
D34S	34 Mbit/s Digital Structured leased line
D34U	34 Mbit/s Digital Unstructured leased line
dc	direct current
EMC	ElectroMagnetic Compatibility
HDB3	High Density Bipolar code 3
NTP	Network Termination Point
ONP	Open Network Provision
ppm	parts per million
PRBS	Pseudo Random Bit Sequence
RX	RX is a signal input (at either the leased line interface or the test equipment, see figure 1)
SELV	Safety Extra-Low Voltage
TX	TX is a signal output (at either the leased line interface or the test equipment, see figure 1)

4 Requirements

These requirements define the network interface presentation for:

- the 34 Mbit/s Digital Unstructured leased line (D34U) which provides a bi-directional point-to-point digital transmission capability with a usable bit rate of 34 368 kbit/s - no structuring of the data is provided, or shall be required, by the network and any structuring is the responsibility of the user;

- the 140 Mbit/s Digital Unstructured leased line (D140U) which provides a bi-directional point-to-point digital transmission capability with a usable bit rate of 139 264 kbit/s - no structuring of the data is provided, or shall be required, by the network and any structuring is the responsibility of the user;

- the 34 Mbit/s Digital Structured leased line (D34S) which provides a bi-directional point-to-point digital transmission capability for the support of an unstructured 33 920 kbit/s information transfer rate; the frame structure in the 34 368 kbit/s bit stream is defined in ETS 300 687 - any structuring of the data within the transparent 33 920 kbit/s part of the frame is the responsibility of the user;

- the 140 Mbit/s Digital Structured leased line (D140S) which provides a bi-directional point-to-point digital transmission capability for the support of an unstructured 138 240 kbit/s information transfer rate; the frame structure in the 139 264 kbit/s bit stream is defined in ETS 300 688 - any structuring of the data within the transparent 138 240 kbit/s part of the frame is the responsibility of the user.

The provision of timing is the responsibility of the user, however in certain installations, the leased line provider may be able to offer a service which is synchronised to the network.

NOTE 1: The network interface is not designed for power feeding capabilities.

NOTE 2: If equipment providing the interface requires a mains supply, the leased line provider should bring this to the attention of the user so that the user can provide mains supply back-up facilities, if required.

The mechanical characteristics, safety, overvoltage protection requirements and ElectroMagnetic Compatibility (EMC) requirements are common for the 34 Mbit/s and 140 Mbit/s leased lines. The electrical characteristics are different and are defined in separate subclauses.

4.1 Mechanical characteristics

Requirement: The network interface shall provide two coaxial 75 Ω sockets, one each for transmit and receive, these sockets being either:

a) 75 Ω sockets (type 1,6/5,6) complying with IEC 169-13 [3]; or

b) 75 Ω BNC sockets complying with the general requirements of IEC 169-8 [2] with the mating dimensions specified in annex B of ISO/IEC 10173 [4].

The outer conductor of the coaxial pair shall be connected to signal ground both at the input port and at the output port.

NOTE 1: When connecting the terminal equipment to the Network Termination Point (NTP), any difference in ground potential between the two equipments may produce a voltage across the signal ground connection and may cause damage. See DEN/EE-02004 for details of earthing requirements within the customer's premises.

NOTE 2: The transmit pair is the output from the network interface. The receive pair is the input to the network interface, as shown in figure 1. Where the terms "output" and "input" are used without qualification in this ETS, they refer to the network interface.

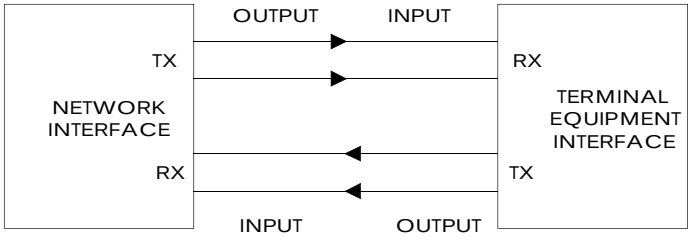


Figure 1

Test: There shall be a visual inspection that the sockets are of the correct type.

4.2 Electrical characteristics - 34 Mbit/s

4.2.1 Output port

4.2.1.1 Signal coding at the output port

Requirement: The signal transmitted at the output port shall comply with the High Density Bipolar code 3 (HDB3) encoding rules (see annex B).

Test: The test shall be conducted according to subclause A.2.1.1.

4.2.1.2 Waveform shape

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

Test: The test shall be conducted according to subclause A.2.2.1.

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). The value V corresponds to the nominal peak voltage of a mark.**
Test load impedance	75 Ω non-reactive
Nominal peak voltage V of a mark	1,0 V
Peak voltage of a space	0 ± 0,1 V
Nominal pulse width	14,55 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

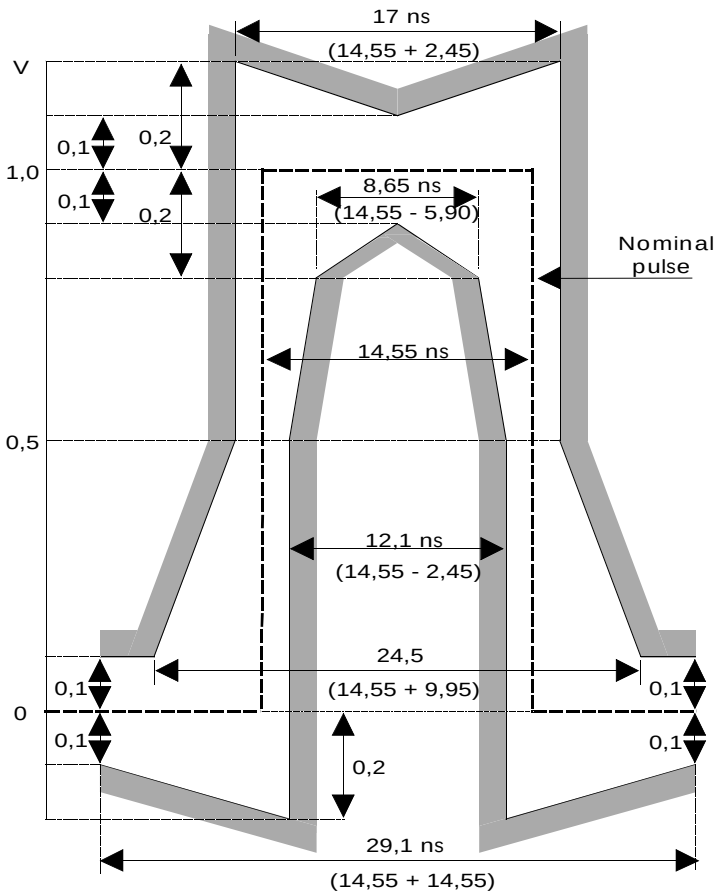


Figure 2: Pulse mask for 34 Mbit/s pulse

4.2.1.3 Output timing under failure conditions

Requirement: When there is a failure within the network and if a signal is presented at the network interface output, the output timing shall be 34 368 kbit/s ± 20 ppm.

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

4.2.1.4 Output return loss

Requirement: The output return loss at the network interface, with respect to 75 Ω, shall be greater than or equal to the values given in table 2, which is based on annex 3 of ETS 300 166.

Table 2: Output port minimum return loss

Frequency range	Return loss
860 kHz to 1 720 kHz	6 dB
1 720 kHz to 51 550 kHz	8 dB

Test: The test shall be conducted according to subclause A.2.6.

4.2.1.5 Output timing and jitter

NOTE: Output timing requirements and jitter limits for the D34U and D34S leased lines are specified in the connection standard ETS 300 687.

4.2.2 Input port

4.2.2.1 Signal coding at the input port

Requirement: The input port shall decode High Density Bipolar code 3 (HDB3) encoded signals without error in accordance with HDB3 encoding rules (see annex B).

Test: The test shall be conducted according to subclause A.2.4.1.

4.2.2.2 Input return loss

Requirement: The input return loss at the network interface, with respect to 75 Ω, shall be greater than or equal to the values given in table 3, which is taken from subclause 8.3.3 of ITU-T Recommendation G.703.

Table 3: Input port minimum return loss

Frequency range	Return loss
860 kHz to 1 720 kHz	12 dB
1 720 kHz to 34 368 kHz	18 dB
34 368 kHz to 51 550 kHz	14 dB

Test: The test shall be conducted according to subclause A.2.5.

4.2.2.3 Input loss tolerance

Requirement: The input port shall correctly decode without errors a 34 368 kbit/s signal as defined in 4.2.1.1 and 4.2.1.2 above but modified by a cable or artificial cable with the following characteristics:

a) attenuation that follows a $\sqrt{f}$ law with values throughout the range 0 dB to 12 dB at 17 184 kHz; and

b) characteristic impedance of 75 Ω with a tolerance of ± 20 % over the frequency range 860 kHz to 51 550 kHz.

Test: The test shall be conducted according to subclause A.2.4.1.

4.2.2.4 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 12 dB at 17 184 kHz, 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, with a binary content in accordance with a PRBS(2^{23}-1). The interfering signal shall be the same as the normal signal except that the level shall be attenuated by 20 dB, the bit rate shall be within 34 368 kbit/s ± 20 ppm and the timing shall not be synchronised to the normal signal.

Test: The test shall be conducted according to subclause A.2.4.1.

4.2.2.5 Input timing and jitter tolerance

NOTE: Input timing requirements and jitter tolerance for the D34U and D34S leased lines are specified in the connection standard ETS 300 687.

4.3 Electrical characteristics - 140 Mbit/s

4.3.1 Output port

4.3.1.1 Signal coding at the output port

Requirement: The signal transmitted at the output port shall comply with the Coded Mark Inversion (CMI) encoding rules (see annex C).

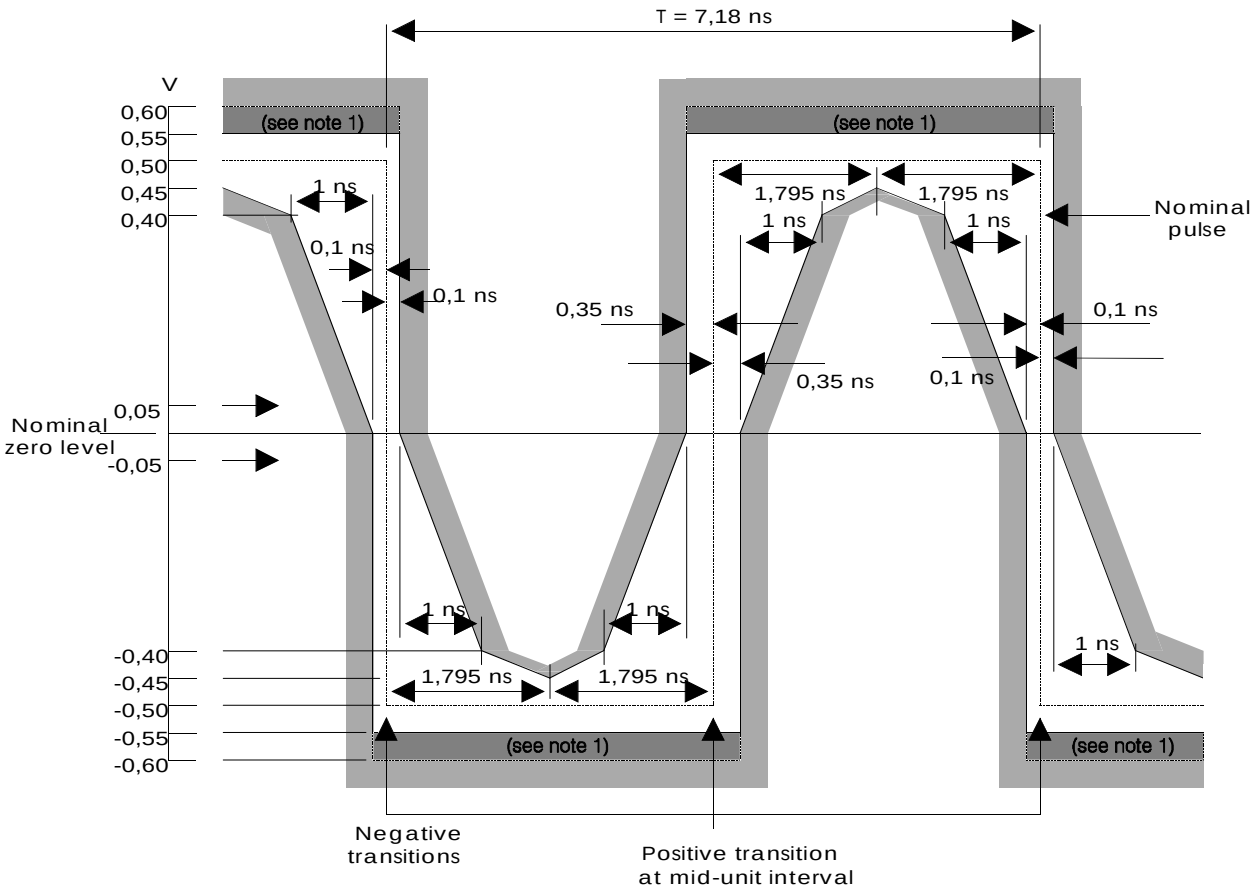
Test: The test shall be conducted according to subclause A.2.1.2.

4.3.1.2 Waveform shape

Requirement: The pulse at the output port shall comply with the requirements given in figures 3 and 4 and table 4, based on ITU-T Recommendation G.703.

Table 4: Waveform shape at output port

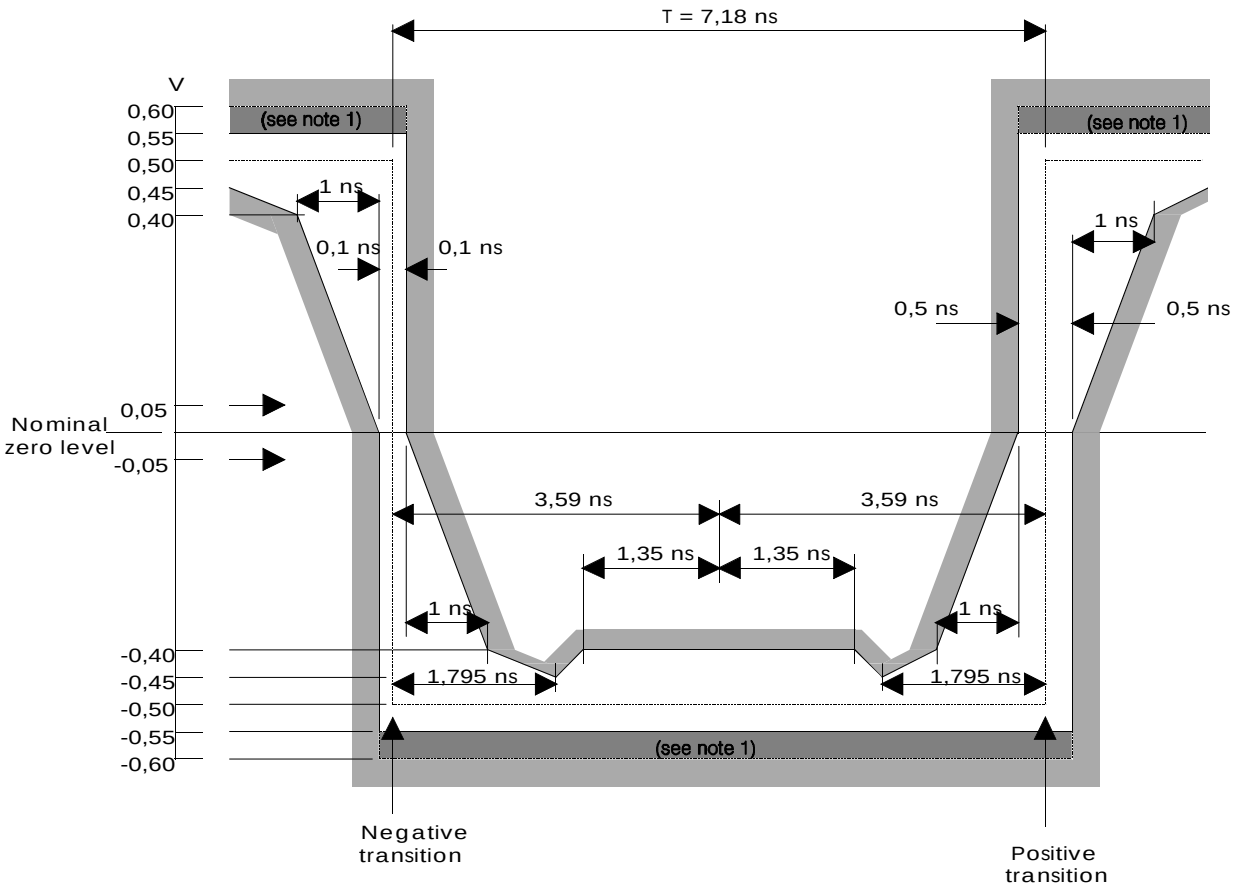
Pulse shape	**Nominally rectangular and conforming with the masks shown in figures 3 and 4.**
Test load impedance	75 Ω non-reactive
Peak to peak voltage	1,0 ± 0,1 V
Rise time between 10 % and 90 % amplitudes of the measured steady state amplitude	≤ 2 ns
Transition timing tolerance (referred to the mean value of the 50 % amplitude points of the negative transition)	Negative transitions: ± 0,1 ns Positive transitions at unit interval boundaries: ± 0,5 ns Positive transitions at mid-interval: ± 0,35 ns



NOTE 1: The maximum "steady state" amplitude shall not exceed the 0,55 V limit. Overshoots and other transients are permitted to fall into the dotted area, bounded by the amplitude levels 0,55 V and 0,60 V, provided they do not exceed the steady state level by more than 0,05 V.

NOTE 2: The rise time and decay time shall be measured between -0,4 V and 0,4 V and shall not exceed 2 ns.

Figure 3: Mask of a pulse corresponding to a binary 0



NOTE 1: The maximum "steady state" amplitude shall not exceed the 0,55 V limit. Overshoots and other transients are permitted to fall into the dotted area, bounded by the amplitude levels 0,55 V and 0,60 V, provided they do not exceed the steady state level by more than 0,05 V.

NOTE 2: The inverse pulse shall have the same characteristics, noting that the timing tolerance at the level of the negative and positive transitions are ± 0,1 ns and ± 0,5 ns respectively.

NOTE 3: The rise time and decay time shall be measured between -0,4 V and 0,4 V and shall not exceed 2 ns.

Figure 4: Mask of a pulse corresponding to a binary 1

Test: The test shall be conducted according to subclause A.2.2.2.

4.3.1.3 Output timing under failure conditions

Requirement: When there is a failure within the network and if a signal is presented at the network interface output, the output timing shall be 139 264 kbit/s ± 15 ppm.

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

4.3.1.4 Output return loss

Requirement: The output return loss at the network interface, with respect to 75 Ω, shall be greater than or equal to the values given in table 5, which is taken from subclause 9.2 of ITU-T Recommendation G.703.

Table 5: Output port minimum return loss

Frequency range	Return loss
7 MHz to 210 MHz	15 dB

Test: The test shall be conducted according to subclause A.2.6.

4.3.1.5 Output timing and jitter

NOTE: Output timing requirements and jitter limits for the D140U and D140S leased lines are specified in the connection standard ETS 300 688.

4.3.2 Input port

4.3.2.1 Signal coding at the input port

Requirement: The input port shall decode CMI encoded signals without error in accordance with CMI encoding rules (see annex C).

Test: The test shall be conducted according to subclause A.2.4.2.

4.3.2.2 Input return loss

Requirement: The input return loss at the network interface, with respect to 75 Ω, shall be greater than or equal to the values given in table 6, which is taken from subclause 9.3 of ITU-T Recommendation G.703.

Table 6: Input port minimum return loss

Frequency range	Return loss
7 MHz to 210 MHz	15 dB

Test: The test shall be conducted according to subclause A.2.5.

4.3.2.3 Input loss tolerance

Requirement: The input port shall correctly decode without errors a 139 264 kbit/s signal as defined in 4.3.1.1 and 4.3.1.2 above but modified by a cable or artificial cable with the following characteristics:

a) attenuation that follows a $\sqrt{f}$ law with values throughout the range 0 dB to 12 dB at 70 MHz; and

b) characteristic impedance of 75 Ω with a tolerance of ± 20 % over the frequency range from 7 MHz to 210 MHz.

Test: The test shall be conducted according to subclause A.2.4.2.

4.3.2.4 Input timing and jitter tolerance

NOTE: Input timing requirements and jitter tolerance for the D140U and D140S leased lines are specified in the connection standard ETS 300 688.

4.4 Safety

The tests associated with the requirements in this subclause are not suitable for use on installed leased lines. Such tests may be applied to equipment of the kind used to provide the interface.

Requirement: The leased line interface shall comply with the requirements for accessible parts of an SELV circuit.

Test: The test shall be conducted according to EN 60950 [1].

4.5 Overvoltage protection

There are no overvoltage protection requirements under this ETS.

NOTE 1: Requirements for overvoltage protection requirements on a 75 Ω interface are under study. Requirements may be added to this ETS when appropriate specifications become available.

NOTE 2: If the cables between the NTP and the terminal equipment leave the building, additional protection may be required as detailed in draft IEC 801-5, with a test level of 4.0 kV, applying failure criteria A from clause 7 of ITU-T Recommendation K.20.

4.6 ElectroMagnetic Compatibility (EMC)

There are no EMC requirements under this ETS.

NOTE 1: EMC requirements are imposed under the EMC Directive (89/336/EEC). Requirements for conducted emissions and immunity to continuous conducted signals may be added to this ETS when appropriate specifications become available if these requirements are not imposed under the EMC Directive.

NOTE 2: It is recommended that the interface requirements should be met when the electromagnetic environment in which the equipment providing the NTP is placed does not exceed the limits defined in EN 50082-1.

Annex A (normative): Test methods

A.1 General

This annex describes the test principles to determine the compliance of a leased line interface against the requirements of this ETS. There is no requirement for each leased line to be tested in accordance with this ETS before it is brought into, or returned into, service. The following tests are not designed for use on installed leased lines: A.2.1, A.2.3, A.2.4. Such tests may be applied to equipment of the kind used to provide the interface.

It is outside the scope of this annex 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 "interface 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 this ETS and capable of monitoring the signal received from the network interface.

A.1.1 Additional information to support the test

The following facilities shall be provided:

a) an ability to configure the interface 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^{23}-1); or

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

A.1.2 Equipment connection

Testing shall be performed at the sockets that provides the NTP as this is the point at which compliance with this ETS is required.

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 the output port

A.2.1.1 Signal coding at the output port - 34 Mbit/s

Purpose: To verify that the signal coding at the leased line output port complies with the HDB3 coding rules as required by subclause 4.2.1.1.

Test configuration: Figure A.1.

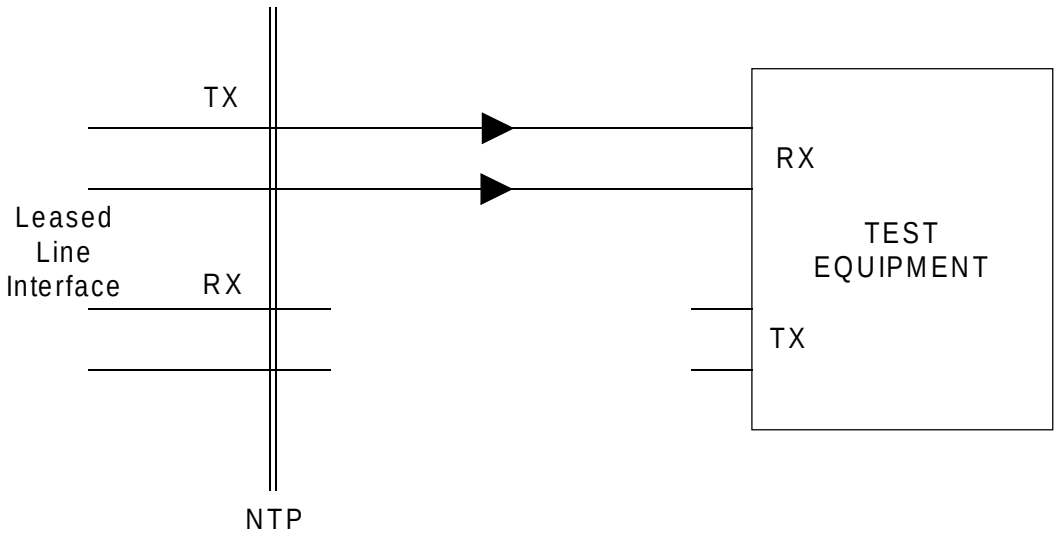


Figure A.1: Signal coding at output port

Interface state: Powered.

Stimulus: The leased line interface 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).

NOTE: A pseudo random bit stream, e.g. PRBS(2^{23}-1), will be acceptable if the bit patterns of the above subclause are included in the bit stream. For a leased line interface which can generate a structured signal in accordance with ETS 300 687 the PRBS may be transmitted in the payload section of the frame. For a leased line interface which cannot generate such a structured signal, the PRBS should be transmitted in the whole bit stream.

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.

A.2.1.2 Signal coding at the output port - 140 Mbit/s

Purpose: To verify that the signal coding at the leased line output port complies with the CMI coding rules as required by subclause 4.3.1.1.

Test configuration: Figure A.1.

Interface state: Powered.

Stimulus: The leased line interface shall transmit a pseudo random bit stream, e.g. PRBS(2^{23}-1). For a leased line interface which can generate a structured signal in accordance with ETS 300 688 the PRBS may be transmitted in the payload section of the frame. For a leased line interface which cannot generate such a structured signal, the PRBS should be transmitted in the whole bit stream.

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 CMI encoding.

A.2.2 Waveform shape at the output port

A.2.2.1 Waveform shape at the output port - 34 Mbit/s

Purpose: To verify conformance of the output waveform shape with the requirements of subclause 4.2.1.2.

Test configuration: Figure A.2.

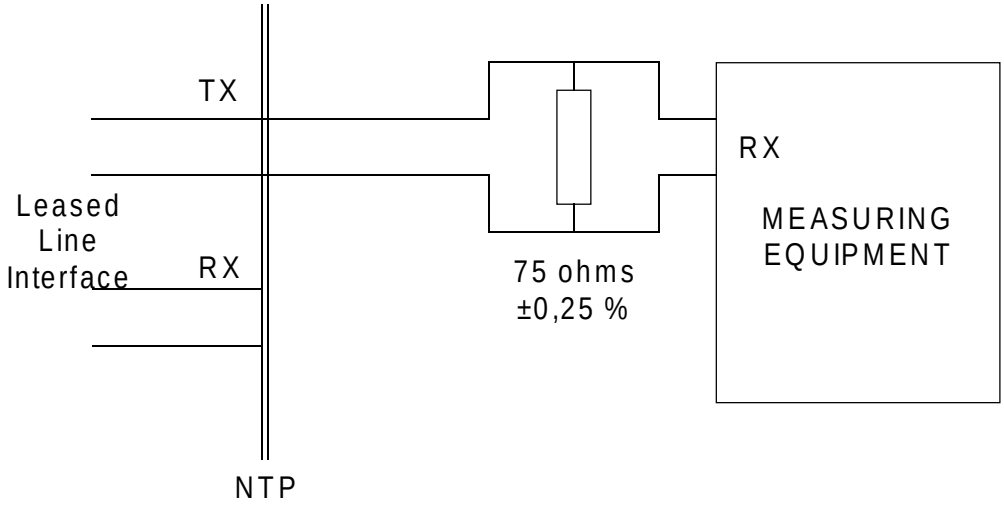


Figure A.2: Waveform shape at output port

Interface state: Powered.

Stimulus: Undefined.

Monitor: Marks and spaces transmitted from the NTP, 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 mask of figure 2, where the nominal pulse amplitude is 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 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.2.2.2 Waveform shape at the output port - 140 Mbit/s

Purpose: To verify conformance of the output waveform shape with the requirements of subclause 4.3.1.2.

Test configuration: Figure A.2.

Interface state: Powered.

Stimulus: Undefined.

Monitor: Marks and spaces transmitted from the NTP, measuring the amplitude and pulse shapes corresponding to binary 0 and binary 1. A bandwidth of 1 GHz or greater shall be used to ensure the capture of over or undershoot of the pulse.

The overall measurement accuracy shall be better than 30 mV. For all measurements using these masks, the signal shall be ac coupled, using a capacitor of not less than 0,01 µF, to the input of the oscilloscope (or other equipment) used for the measurement. The nominal zero for both masks shall be aligned with the oscilloscope trace with no input signal. With the signal then applied, the vertical position of the trace can then be adjusted with the objective of meeting the limits of the masks. Any such adjustment shall be the same for both masks and shall not exceed ± 0,05 V. This shall be checked by removing the input signal again and ensuring that the trace lies within ± 0,05 V of the nominal zero level of the masks.

The masks allow for high frequency jitter caused by inter symbol interference in the output stage, but not for jitter present in the timing signal associated with the source of the interface signal.

When using an oscilloscope technique to determine pulse compliance with the mask, it is important that successive traces of the pulses overlay in order to suppress the effects of low frequency jitter. This can be accomplished by several techniques, e.g.:

a) triggering the oscilloscope on the measured waveform; or

b) providing both the oscilloscope and the pulse output circuits with the same clock signal.

Results: Each pulse in a coded pulse sequence shall meet the limits of the relevant mask given in figures 3 and 4, irrespective of the state of the preceding or succeeding pulses, with both pulse masks fixed in the same relation to a common timing reference, i.e. with their normal start and finish edges coincident.

The rise and decay time shall be measured between -0,4 V and 0,4 V and shall not exceed 2 ns.

A.2.3 Output timing under failure conditions

Purpose: To measure the output timing if an output signal is present under network failure conditions as specified in subclause 4.2.1.3 or 4.3.1.3.

Test Configuration: Figure A.3.

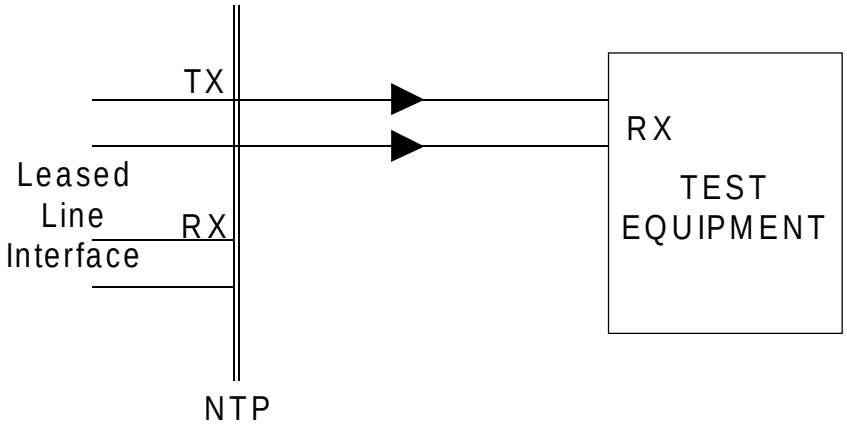


Figure A.3: Output timing under network failure conditions

Interface state: Powered.

Stimulus: The interface shall be configured to provide whatever signal is provided under network failure conditions.

Monitor: The bit rate of the signal decoded from output port of the leased line interface.

Results: The bit rate shall be within the appropriate limits given in subclause 4.2.1.3 or 4.3.1.3.

A.2.4 Input signal coding, loss tolerance and immunity against reflections

A.2.4.1 Input signal coding, loss tolerance and immunity against reflections - 34 Mbit/s

Purpose: To verify the input port signal coding (subclause 4.2.2.1) and immunity against an interfering signal combined with the input signal, (subclause 4.2.2.4), both without cable (i.e. 0 dB attenuation loss) and with a cable attenuation of 12 dB (subclause 4.2.2.3).

Test configuration: Figure A.4.

The interfering signal shall be combined with the main signal in a combining network of impedance 75 Ω, with zero dB loss in the main path and an attenuation in the interference path of 20 dB.

The cable simulator shall have an attenuation of 12 dB measured at 17 184 kHz and an attenuation characteristic that follows a $\sqrt{f}$ law over the frequency range 860 kHz to 51 550 kHz.

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.

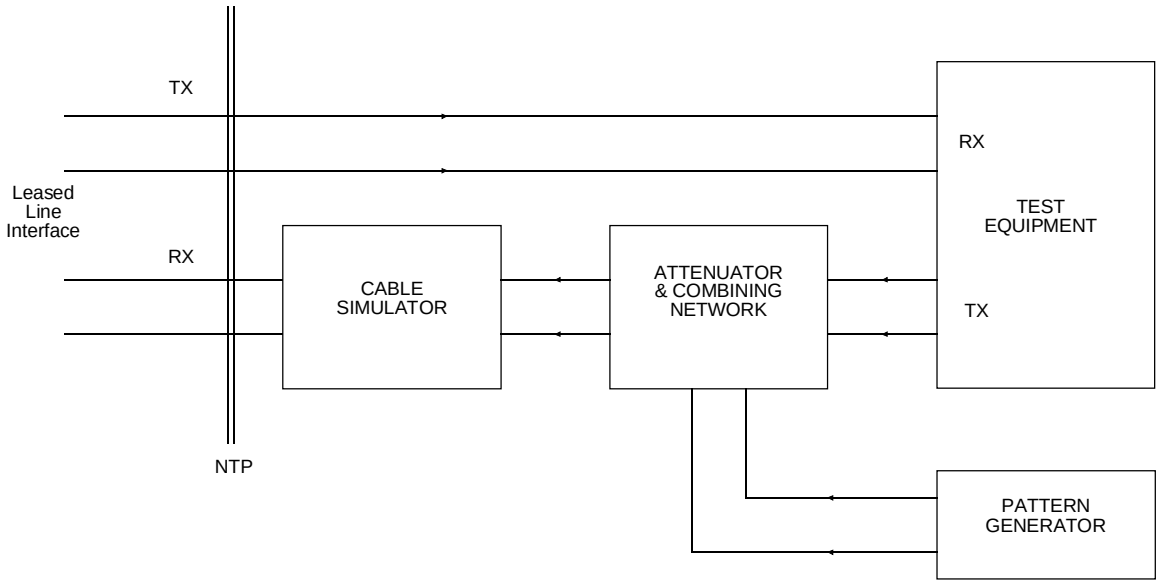


Figure A.4: Input coding, loss tolerance and immunity against reflections

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 17 of ITU-T Recommendation G.703 [5], which is reproduced in figure 2 of this ETS. The binary content shall be a PRBS(2^{23}-1). The bit rate shall be within the limits 34 368 kbit/s ± 20 ppm.

If it is necessary for the correct operation of the leased line interface, the bit stream may be structured into frames in accordance with ETS 300 687. The binary content of the data contained in the payload of the frame shall be a PRBS(2^{23}-1).

The interfering signal from the pattern generator shall:

a) be HDB3 encoded and conform to a pulse shape as defined in figure 17 of ITU-T Recommendation G.703 [5], which is reproduced in figure 2 of this ETS; and

b) have a binary content with a PRBS(2^{23}-1); and

c) have a nominal bit rate of 34 368 kbit/s, not synchronised to the output signal of the test equipment.

Monitor: Data at output port.

Results: There shall be no bit errors for at least one minute.

A.2.4.2 Input signal coding and loss tolerance - 140 Mbit/s

Purpose: To verify the input port signal coding (subclause 4.3.2.1) both without cable (i.e. 0 dB attenuation loss) and with a cable attenuation of 12 dB (subclause 4.3.2.3).

Test configuration: Figure A.5.

The cable simulator shall have an attenuation of 12 dB measured at 70 MHz and an attenuation characteristic that follows a $\sqrt{f}$ law over the frequency range 7 MHz to 210 MHz.

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

a) without cable simulator; and
b) with cable simulator.

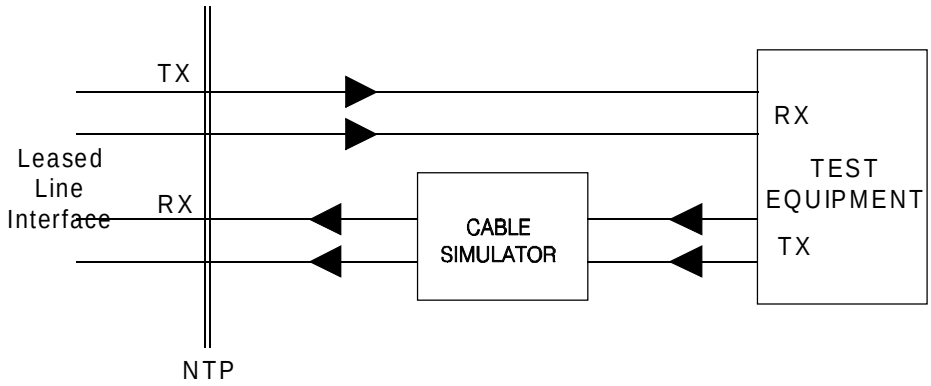


Figure A.5: Input coding and loss tolerance

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

Stimulus: The output signal of the test equipment shall be CMI encoded and conform to a pulse shape as defined in figures 19 and 20 of ITU-T Recommendation G.703 [5], which are reproduced in figures 3 and 4 of this ETS. The binary content shall be a PRBS(2^{23}-1). The bit rate shall be within the limits 139 264 kbit/s ± 15 ppm.

If it is necessary for the correct operation of the leased line interface, the bit stream may be structured into frames in accordance with ETS 300 688. The binary content of the data contained in the payload of the frame shall be a PRBS(2^{23}-1).

Monitor: Data at output port.

Results: There shall be no bit errors for at least one minute.

A.2.5 Input return loss

Purpose: To verify the return loss of the input port of the leased line interface complies with the applicable requirement of subclause 4.2.2.2 or 4.3.2.2.

Test configuration: Figure A.6.

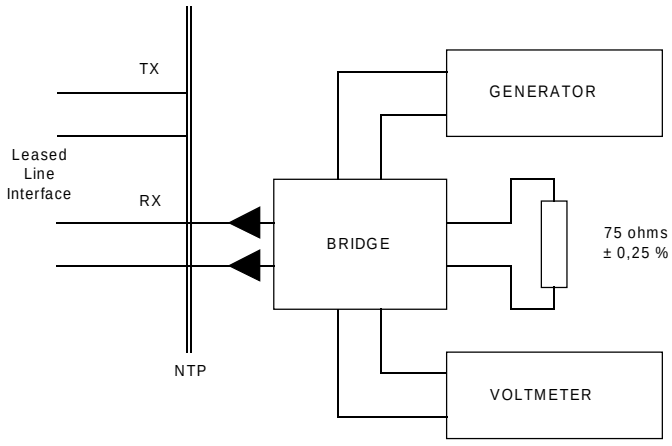


Figure A.6: Return loss at input port

Interface state: Powered.

Stimulus: Sinusoidal signal of 1 V peak applied to the input of the network interface with a frequency variable between the limits given in table A.1.

Table A.1: Test frequency limits for input return loss

Leased line type	Frequency range
D34U and D34S	860 kHz and 51 550 kHz
D140U and D140S	7 MHz to 210 MHz

Monitor: Voltage measured across the bridge, representing a terminating resistor of 75 Ω using a selective voltmeter with a bandwidth of less than 10 kHz.

Results: The measured return loss shall be greater than or equal to the values specified in applicable subclause 4.2.2.2 or 4.3.2.2.

NOTE 1: 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 75 Ω ± 0,25 % resistor, the measured return loss of the bridge should be 20 dB higher than the limits specified for the interface.

NOTE 2: Where the generator and voltmeter are implemented by means of a network analyser, a measurement bandwidth of 100 Hz and a sweep time of 10 s is recommended.

A.2.6 Output return loss

Purpose: To verify the return loss of the output port of the leased line interface complies with the applicable requirement of subclause 4.2.1.4 or 4.3.1.4.

Test configuration: Figure A.7.

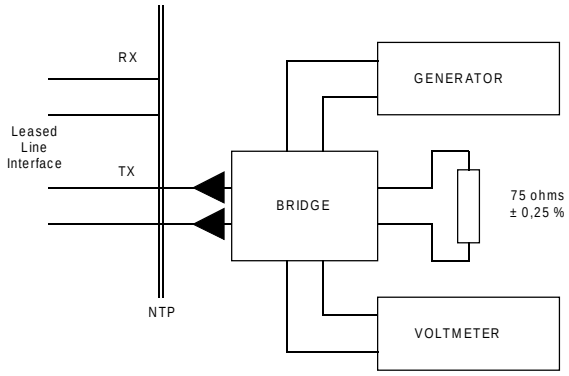


Figure A.7: Return loss at output port

Interface state: Powered.

Stimulus: Sinusoidal signal of 1 V peak applied to the output of the network interface with a frequency variable between the limits given in table A.2.

Table A.2: Test frequency limits for output return loss

Leased line type	Frequency range
D34U and D34S	860 kHz and 51 550 kHz
D140U and D140S	7 MHz to 210 MHz

The output return loss shall be measured under dynamic conditions with a PRBS(2^{23}-1) transmitted at the output. For a leased line interface which can generate a structured signal in accordance with ETS 300 688 the PRBS may be transmitted in the payload section of the frame. For a leased line interface which cannot generate such a structured signal, the PRBS should be transmitted in the whole bit stream.

Monitor: Voltage measured across the bridge, representing a terminating resistor of 75 Ω using a selective voltmeter with a bandwidth of less than 10 kHz.

Results: The measured return loss shall be greater than or equal to the values specified in the applicable subclause 4.2.1.4 or 4.3.1.4 of this ETS.

NOTE 1: 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 75 Ω ± 0,25 % resistor the measured return loss of the bridge should be 20 dB higher than the limits specified for the interface.

NOTE 2: Where the generator and voltmeter are implemented by means of a network analyser, a measurement bandwidth of 100 Hz and a sweep time of 10 s is recommended to restrict the influence of the output signal on the test result.

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.

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 (normative): Definition of CMI code

C.1 General

This annex specifies the Coded Mark Inversion (CMI) code. The contents of this annex are based on subclause 9.1 of ITU-T Recommendation G.703.

C.2 Definition

CMI is a 2-level non-return-to-zero code in which binary 0 is coded so that both amplitude levels, A_1 and A_2, are attained consecutively, each for half a unit time interval T/2.

Binary 1 is coded by either of the amplitude levels A_1 or A_2, for one full unit time interval (T), in such a way that the level alternates for successive binary 1s.

An example is given in figure C.1.

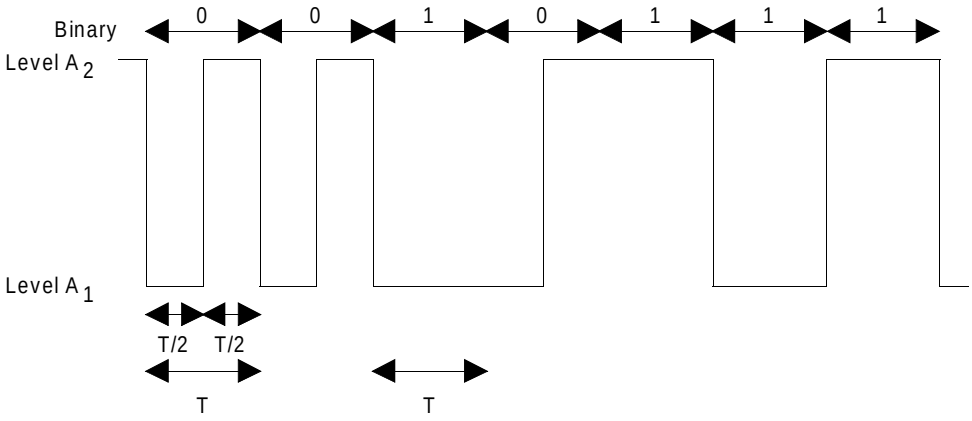


Figure C.1: Example of CMI coded binary signal

Annex D (informative): Bibliography

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

- 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".

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

- ETS 300 687: "Business TeleCommunications (BTC); 34 Mbit/s digital leased lines (D34U and D34S); Connection characteristics".

- ETS 300 688: "Business TeleCommunications (BTC); 140 Mbit/s digital leased lines (D140U and D140S); Connection characteristics".

- ETS 300 689: "Business TeleCommunications (BTC); 34 Mbit/s digital leased lines (D34U and D34S); Terminal equipment interface".

- ETS 300 690: "Business TeleCommunications (BTC); 140 Mbit/s digital leased lines (D140U and D140S); Terminal equipment interface".

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