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TBR 013

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Foreword

This Technical Basis for Regulation (TBR) has been produced by the Business Telecommunications (BTC) Technical Committee of the European Telecommunications Standards Institute (ETSI).

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

This TBR 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 on public telecommunications networks, and the availability throughout the European Union (EU) of a minimum set of leased lines with harmonized technical characteristics.

The consequence of the Directive is that telecommunications organisations within the EU 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 300 420.

CCITT Recommendations G.703, G.704 and G.706, as qualified by ETS 300 166, are 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 (NTPs) of ONP 2 048 kbit/s digital structured leased lines (D2048S) using 120 õ interfaces with an information rate of 1 984 kbit/s without restriction on binary content. A terminal equipment interface that conforms to this TBR will also conform with TBR 012 for connection to an ONP 2 048 kbit/s unstructured leased line.

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 structured 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 NTP are outside the scope of this TBR.

2 Normative references

This TBR incorporates by dated and 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 into it by amendment or revision. For undated references the latest edition of the publication referred to applies.

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

[2] CCITT Recommendation G.704 (1991): "Synchronous frame structures used at primary and secondary hierarchical levels".

[3] CCITT Recommendation O.151 (1992), subclause 2.1: "Error performance measuring equipment for digital systems at the primary rate and above".

[4] CCITT Recommendation O.171 (1992): "Timing jitter measuring equipment for digital systems".

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

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

3 Definitions and abbreviations

3.1 Definitions

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

errored Sub-MultiFrame: A Sub-MultiFrame (SMF) where the calculated Cyclic Redundancy Check-4 bit (CRC-4)1 does not correspond with the CRC-4 contained within the next SMF (see subclause C.2.2).

frame: A sequence of 256 bits of which the first 8 bits define the frame structure (see annex C).

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

multiframe: A sequence of two SMFs containing the multiframe alignment word (see annex C).

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^{15}-1): Pseudo Random Bit Sequence (PRBS) (as defined in subclause 2.1 of CCITT Recommendation O.151 [3]).

S_a bits: Bits 4 to 8 (bits S_{a4} to S_{a8}) in frames not containing the frame alignment signal (see annex C).

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).

Sub-Multiframe (SMF): A sequence of 8 frames, each of 256 bits, over which the CRC-4 is calculated (see annex C).

terminal equipment: Equipment intended to be connected to the public telecommunications network, i.e.:

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

- 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.

3.2 Abbreviations

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

ac	alternating current
AIS	Alarm Indication Signal
AMI	Alternate Mark Inversion
CRC-4	Cyclic Redundancy Check-4 bit
D2048S	2 048 kbit/s digital structured leased line
dc	direct current
EMC	ElectroMagnetic 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	Pseudo Random Bit Sequence
RAI	Remote Alarm Indication
RX	RX is a signal input (at either the terminal equipment interface or the test equipment, see figure 1)
SELV	Safety Extra-Low Voltage
SMF	Sub-MultiFrame
TX	TX is a signal output (at either the terminal equipment interface or the test equipment, see figure 1)
TBR-RT	TBR Requirements Table
UI	Unit Interval

4 Requirements

The terminal equipment interface is for use with 2 048 kbit/s structured leased lines which provide bi-directional, point-to-point digital connections with an information transfer rate of 1 984 kbit/s without restriction on binary content. Any structuring of the data within the transparent 1 984 kbit/s part of the frame is the responsibility of the user.

4.1 Physical characteristics

Justification: Without a connection method defined, it is impossible for the terminal equipment to connect to the network, therefore this is required for the terminal equipment to interwork with the network (article 4f).

Currently no standardised connector is readily available. Consequently, the only method of connection that can be specified in this TBR is the use of solid conductors of 0,4 mm to 0,6 mm. This TBR requires the terminal equipment to be capable of presenting either a point for the attachment of unterminated solid conductors, or solid conductors themselves (see subclause 4.1.1). It is a requirement that such a connection method be available to be provided for use with the terminal equipment if necessary.

In order to allow connection to be made using other methods (e.g. connectors), the terminal equipment is permitted to be supplied with a connection method suitable for use with those methods (see subclause 4.1.2).

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 this TBR, they refer to the terminal equipment interface.

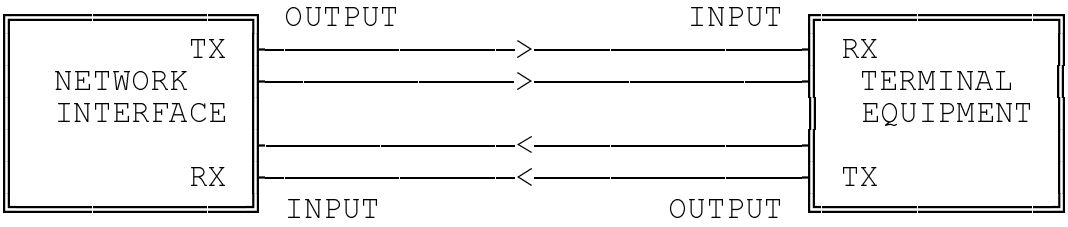


Figure 1

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.

4.1.1 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.

4.1.2 Alternative means of connection

Any alternative means of connection may be provided in addition to the connection arrangements under subclause 4.1.1.

4.2 Electrical characteristics

4.2.1 Output port

4.2.1.1 Signal coding

Justification: The correct signal coding is necessary for the output signals from the terminal equipment to be received correctly at the input to the NTP, otherwise the leased line will not achieve frame alignment and possibly send Alarm Indication Signal (AIS) forward within the network; therefore a requirement on signal coding should be included for interworking with the network (article 4f).

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

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

4.2.1.2 Waveform shape

Justification: The correct waveform shape serves to limit the voltages to line preventing harm to the network (article 4d). It is also necessary for the output signals from the terminal equipment to be received correctly at the input to the NTP, otherwise the leased line will not achieve frame alignment and possibly send AIS forward within the network; therefore a requirement on the waveform shape should be included for interworking with the network (article 4f).

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

Table 1: 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 Nominal peak voltage V of a mark Peak voltage of a space Nominal pulse width	120 õ non-reactive 3 V 0 ± 0,3 V 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

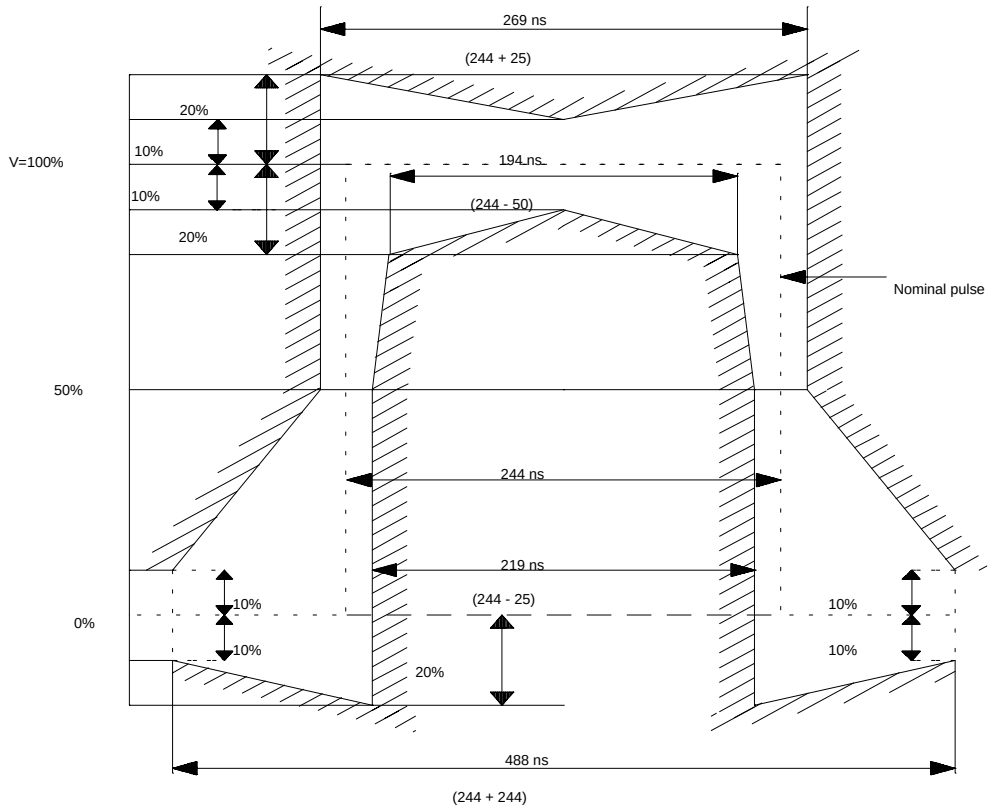


Figure 2: Pulse mask for 2 048 kbit/s pulse

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

4.2.1.3 Output timing

Justification: A certain level of timing accuracy is necessary for the bit stream to be received correctly at the input to the NTP, otherwise the leased line will not achieve frame alignment and possibly send AIS forward within the network; therefore a requirement on output timing should be included for interworking with the network (article 4f). An output clock accuracy of 2 048 kbit/s ± 50 parts per million (ppm) is sufficient for the input signal to be received correctly although this may result in a number of slips.

Requirement: In the absence of any external reference signal timing, the output signal shall have a bit rate within the limits of 2 048 kbit/s ± 50 ppm.

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

4.2.1.4 Output jitter

Justification: A high level of jitter causes error reports within some networks, therefore this requirement is included to prevent harm to the network, (article 4d). It is necessary for the output signals from the terminal equipment to be received correctly at the input to the NTP, otherwise the leased line will not achieve frame alignment and possibly send AIS forward within the network; therefore a requirement on output jitter should be included for interworking with the network (article 4f).

Requirement: The peak-to-peak output jitter shall not exceed the limits of table 2 when measured with a bandpass filter with linear cut-off with the defined cut-off frequencies. At frequencies below the lower 3 dB point, the attenuation of the high pass filter shall rise with a value equal to 20 dB per decade. At frequencies above the upper 3 dB point, the attenuation of the low pass filtration shall rise with a value greater than, or equal to, 60 dB per decade.

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 table 3 and figure 3.

NOTE: A separate requirement for output jitter at frequencies below 40 Hz is not required because the measurement filter with a first order lower cut-off will allow the jitter to have a spectrum whose amplitude rises at 20 dB/decade as the frequency reduces below 40 Hz. Where timing is taken from the leased line, the test uses input jitter frequencies from 20 Hz upwards.

Table 2: Maximum output jitter

Measurement filter bandwidth		**Output jitter**
Lower cut-off (high pass)	Upper cut-off (low pass)	Unit Interval (UI) peak-to-peak (maximum)
40 Hz	100 kHz	0,11 UI

Table 3: 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

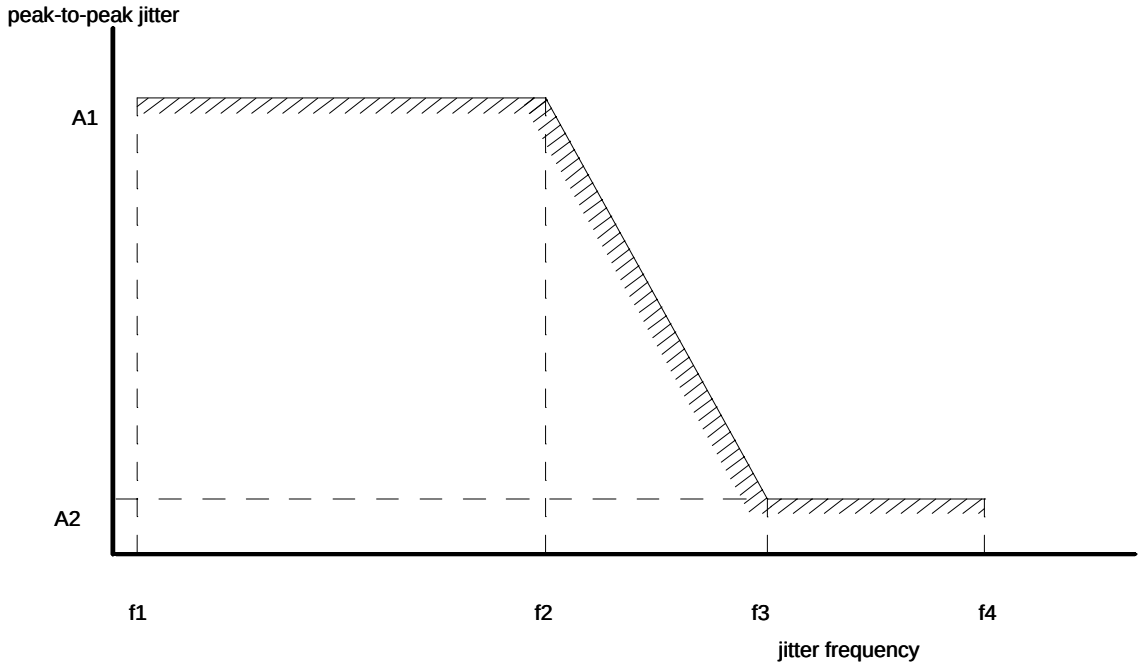


Figure 3: Input jitter for output jitter measurement

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

4.2.1.5 Output structure

Justification: It is necessary for the output signals from the terminal equipment to be received correctly at the input to the NTP, otherwise the leased line will not achieve frame alignment and possibly send AIS forward within the network; therefore a requirement on the output structure should be included for interworking with the network (article 4f).

Requirement: The bit stream transmitted at the output of the terminal equipment shall be structured as defined in clause C.1.

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

4.2.1.5.1 CRC-4

Justification: It is necessary for the CRC-4 from the terminal equipment to be correct at the output from the terminal equipment, otherwise the occurrence of · 915 errored SMFs will cause the leased line to believe that frame alignment is lost and possibly send AIS forward within the network; therefore a requirement on the CRC-4 should be included for interworking with the network (article 4f).

Requirement: The CRC-4 bits transmitted at the output of the terminal equipment shall be as defined in tables C.1 and C.2 and subclause C.2.1 of annex C and shall correspond to the data transmitted at the output of the terminal equipment.

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

4.2.1.5.2 Use of the E-bits

There is no requirement on the use of the E-bits within this TBR.

Justification: The E-bits received at the NTP indicate errors that have occurred in the bit stream from the NTP to the terminal equipment. The connection standard for the D2048S leased line (ETS 300 419) does not require the network to take any action as a result of receiving an indication of errors, therefore, there should be no requirement on the E-bits at the output from the terminal equipment.

4.2.1.5.3 Use of the A-bit

Justification: Although the connection standard for the D2048S leased line (ETS 300 419) does not require the network to take any action as a result of receiving an alarm indication (A = 1), there are many networks that will respond, either at the NTP or within the network, to an input signal indicating an alarm indication. Therefore, to ensure no harm to the network (article 4d) and correct interworking, i.e. continued transmission, (article 4f) the terminal equipment should ensure that the alarm indication is not sent when correct frames are received at the input.

NOTE: This requirement does not impose any essential requirement on the input port of the terminal equipment, or any requirement to monitor the input bit stream for loss of signal. The requirement can be met with the A-bit permanently set to A = 0.

Requirement: When the input signal to the terminal equipment comprises continuous error free frames and multiframes, structured according to annex C, with the calculated CRC-4 corresponding to the data in the previous SMF, the A-bit at the output of the terminal equipment shall be set to binary ZERO.

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

4.2.1.5.4 Use of the S_a bits

There is no requirement on the use of the S_a bits within this TBR.

Justification: Bits S_{a4} to S_{a8} are reserved for the use of the leased line operator and these are not necessarily transmitted transparently across the connection. Therefore there is no harm to the network (article 4d) or failure to interwork (article 4f) caused by any potential setting of these bits.

4.2.2 Input port

There are no requirements on the input port under this TBR beyond those imposed in subclauses 4.4.1 to 4.4.3.

Justification: The requirements imposed on the terminal equipment output port do not require the correct receipt of data at the terminal equipment input port. The network output port is protected against both short circuit and open circuit. Therefore there are no requirements within the base standard (ETS 300 420), beyond those related to overvoltage protection, that can be considered as essential requirements.

4.3 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). Subclause 4.3 of ETS 300 420 defines the terminal equipment interface as an Safety Extra-Low Voltage (SELV) circuit. Detailed requirements for SELV circuits are given in EN 60950.

4.4 Overvoltage protection

Justification: The requirements of subclauses 4.4.1 to 4.4.3 limit the common mode and transverse mode voltages at the terminal equipment output to the levels to which the network interface presentation is protected (as specified in ETS 300 418). Any voltages in excess of those specified could cause harm to the network (article 4d).

NOTE: Subclauses 4.4.1 to 4.4.4 of the base standard (ETS 300 420) which specify surge simulation and mains simulation are not included in this TBR as they are concerned with protection of the terminal equipment itself and not protection of the network; these are therefore outside the scope of this TBR.

For the purpose of the following subclauses on protection, the term referred to as I_a in ETS 300 046-3 [5] shall be deemed to be the point of test referred to in subclause A.1.1.

4.4.1 Impulse transfer from mains, common mode

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

Test: The test shall be conducted according to subclause 5.7.1 of ETS 300 046-3 [5].

4.4.2 Impulse transfer from mains, transverse mode

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

Test: The test shall be conducted according to subclause 5.7.1 of ETS 300 046-3 [5].

4.4.3 Conversion of common mode to transverse mode

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

Test: The test shall be conducted according to subclause 5.7.3 of ETS 300 046-3 [5].

4.5 ElectroMagnetic Compatibility (EMC)

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

Details of test equipment accuracy and the specification tolerance of the test devices are not included in all cases. Where such details are provided they shall be complied with, but the way they are expressed shall not constrain the method of implementing the test.

NOTE: Attention is drawn to the issue of measurement uncertainty which may be addressed in future documents. Not all the required test results make allowance for spurious events during testing (e.g. errors due to EMC effects), which may make it necessary to repeat a test.

The test configurations given do not imply a specific 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 a group of devices, generating a stimulus signal conforming to this annex and capable of monitoring the signal received from the interface.

The terminal equipment interface under test shall have the ability to transmit a bit pattern for test purposes, e.g. a PRBS(2^{15}-1). Where this cannot be provided, an alternative method of conducting the test shall be provided by the terminal equipment supplier.

A.1.1 Equipment connection

The tests in this TBR shall be carried out using the connection method suitable for use with unterminated solid conductors as defined in subclause 4.1.1. However, in the case of the test specified in subclause A.2.2, an alternative method of connection may be provided by the terminal equipment supplier for test purposes. In this case, this method of connection shall be used for this test because the requirement considers any wiring to be part of the installation cabling.

NOTE: This alternative method of connection is for test purposes only and has been introduced because the characteristics tested in A.2.2 are based on CCITT Recommendation G.703 [1] which makes no allowance for additional wiring.

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, stabilized 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 ± 4 % of the rated frequency.

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

Requirement: Subclause 4.2.1.1.

Purpose: To verify that the signal coding at the terminal equipment output port complies with the HDB3 coding rules.

Test configuration: Figure A.1.

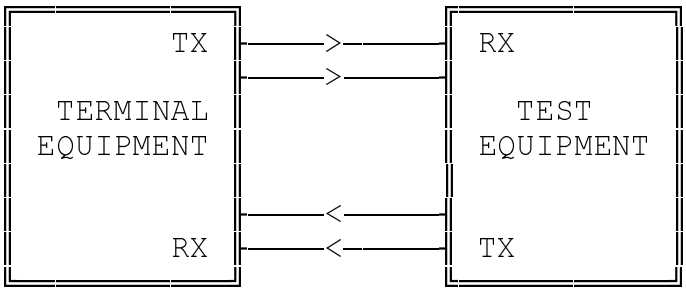


Figure A.1: Signal coding

Interface state: Powered.

Stimulus: The terminal equipment shall transmit an HDB3 bit stream according to the frame structure of annex C of this TBR. The binary content of the data contained in bits 9 to 256 of the frame shall be a bit stream including the sequences <0000><even number of binary ONEs><0000> and <0000><odd number of binary ONEs><0000>, 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.

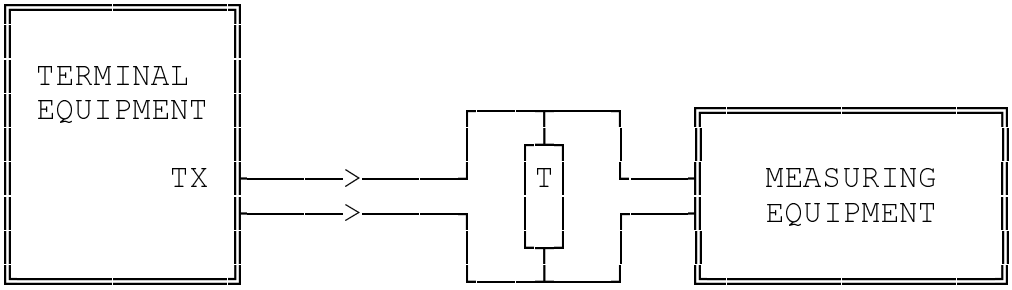
NOTE: A PRBS(2^{15}-1), will be acceptable if the bit patterns of the above subclause are included in the bit stream.

A.2.2 Waveform shape at output port

Requirement: Subclause 4.2.1.2.

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

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 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

Requirement: Subclause 4.2.1.3.

Purpose: To measure the bit rate when the terminal equipment is generating timing in the absence of any external reference signal timing.

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.

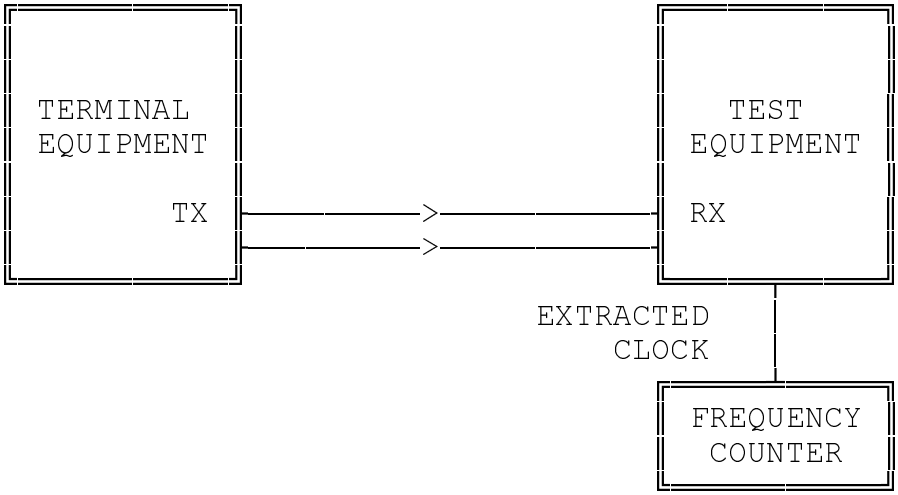


Figure A.3: Clock accuracy at the output port

Interface State: Powered.

Stimulus: Undefined.

Monitor: The bit rate from the terminal equipment output port.

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

A.2.4 Output jitter

Requirement: Subclause 4.2.1.4.

Purpose: This test is used to measure the maximum output jitter and operation 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 (including derivation from the input signal).

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

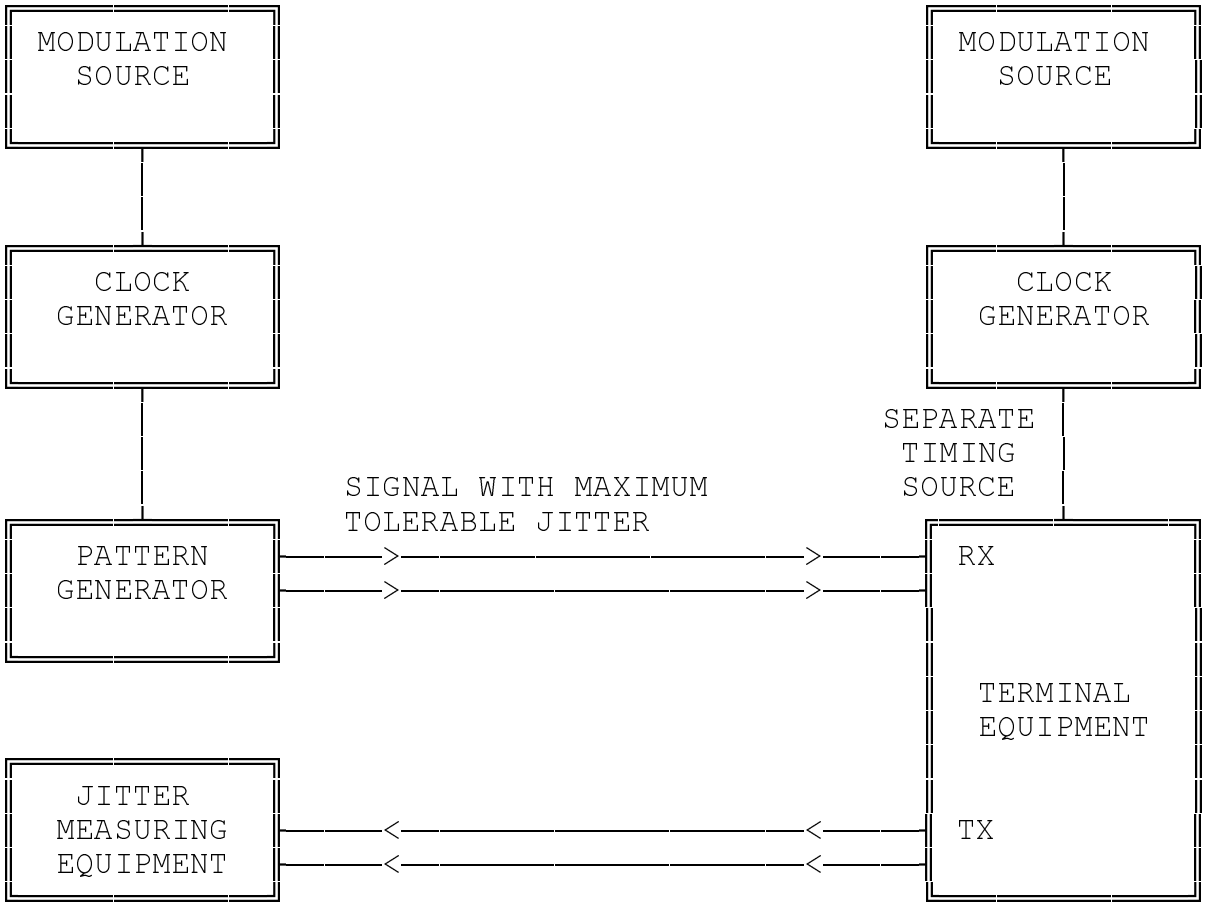


Figure A.4: Jitter measurement

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 CCITT Recommendation G.703 [1], which is reproduced in figure 2 of this TBR. The bit stream shall be structured into frames, with the CRC-4, according to CCITT Recommendation G.704 [2]. Within the frames not containing the frame alignment signal, bit 3 (Remote Alarm Indication (RAI)) shall be set to 0 and bits 4 to 8 (S_{a4} to S_{a8}) shall be set to 1. The binary content of the data contained in bits 9 to 256 of the frame shall be a PRBS(2^{15}-1).

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 3.

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.

It may be necessary to synchronize the two clock generators to avoid a high occurrence of slips.

Monitor: The jitter at the output port using equipment complying with CCITT Recommendation O.171 [4] with the defined cut-off frequencies as shown in table 2 of this TBR.

Results: The peak-to-peak jitter shall comply with the values specified in table 2.

A.2.5 Frame structure

Reference: Subclauses 4.2.1.5 and 4.2.1.5.1 and 4.2.1.5.3.

Purpose: To test the correct output structure (subclause 4.2.1.5), CRC-4 generation (subclause 4.2.1.5.1) and the correct setting of the A-bit (subclause 4.2.1.5.3), on receipt of correct frames, at the terminal equipment output port.

Test configuration: Figure A.5.

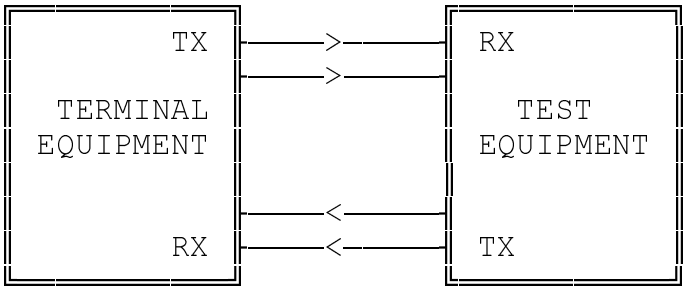


Figure A.5: Frame structure

Interface state: Powered.

Stimulus: The output signal of the test equipment shall be HDB3 encoded and conform to a pulse shape as defined in figure 15 of CCITT Recommendation G.703 [1], which is reproduced in figure 2 of this TBR, and a framing structure as defined in CCITT Recommendation G.704 [2].

The terminal equipment shall transmit an HDB3 bit stream with a binary content that has a frame structure according to annex C of this TBR. The binary content of the data contained in bits 9 to 256 of the frame shall be a pseudo random bit stream, e.g. PRBS(2^{15}-1).

Monitor: The frame alignment signal, CRC-4 and the A-bit in the output bit stream from the terminal equipment.

Results: The frame alignment signal and bit 2 of the frame not containing the frame alignment signal shall be as defined in table C.1.

The CRC-4 shall correspond with the data in the previous SMF, as defined in clause C.2 and subclause C.2.1.

The A-bit shall be set to binary ZERO.

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 [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 (normative): Definition of frame structure

C.1 Frame structure

The bit stream shall be structured into a frame of length 256 bits, numbered 1 to 256. The frame repetition rate shall be nominally 8 000 Hz. The allocation of bits 1 to 8 within the frame shall be as shown in table C.1.

Table C.1: Allocation of bits 1 to 8

Bit no	Frame containing the frame alignment signal	Frame not containing the frame alignment signal
1	CRC-4 (see clause C.2)	CRC-4 (see clause C.2)
2	0	1
3	0	A (see note 1)
4	1	S_{a4} (see note 2)
5	1	S_{a5} (see note 2)
6	0	S_{a6} (see note 2)
7	1	S_{a7} (see note 2)
8	1	S_{a8} (see note 2)
NOTE 1: Bit A: RAI (see subclause 4.2.1.5.3). NOTE 2: Bits S_{a4} to S_{a8} are for the use of the leased line operator. Their value at the output port of a leased line and terminal equipment is undefined.		

C.2 CRC-4

The allocation of the CRC-4 bits shall be as given in table C.2 for a complete CRC-4 multiframe. Each CRC-4 multiframe, which is composed of 16 frames numbered 0 to 15, shall be divided into two 8-frame SMFs, designated SMF I and SMF II which shall signify their respective order within the CRC-4 multiframe structure. The SMF is the block (size 2 048 bits) for the CRC-4.

In those frames containing the frame alignment signal, bit 1 shall be used to transmit the CRC-4 bits. These shall be the 4 bits designated C_1, C_2, C_3 and C_4 in each SMF. In those frames not containing the frame alignment signal, bit 1 shall be used to transmit the six bit CRC-4 multiframe alignment signal and two CRC-4 error indication bits (E-bits). The CRC-4 multiframe alignment signal shall have the form 001011.

Table C.2: Allocation of CRC-4 bits with a multiframe

	SMF	Frame	Bit 1
Multiframe	SMF I	0	C_1
		1	0
		2	C_2
		3	0
		4	C_3
		5	1
		6	C_4
		7	0
	SMF II	8	C_1
		9	1
		10	C_2
		11	1
		12	C_3
		13	E
		14	C_4
		15	E
NOTE: There is no requirement on the value of the E-bits (see subclause 4.2.1.5.2).			

C.2.1 CRC-4 generation

A particular CRC-4 word, located in SMF N shall be the remainder after multiplication by x^4 and then division (modulo 2) by the generator polynomial $x^4 + x + 1$, of the polynomial representation of SMF (N-1). When representing the contents of the check block as a polynomial, the first bit in the block, i.e. frame 0 bit 1 or frame 8 bit 1, shall be taken as the most significant bit. Similarly, C_1 is defined to be the most significant bit of the remainder and C_4 the least significant bit of the remainder.

The CRC-4 encoding process is described below:

a) the CRC-4 bits in the SMF are replaced by binary ZEROs;

b) the SMF is then acted upon by the multiplication/division process defined above;

c) the remainder resulting from the multiplication/division process is stored, ready for insertion into the respective CRC-4 locations of the next SMF.

NOTE: The CRC-4 bits thus generated do not affect the result of the multiplication/division process in the next SMF because, as indicated in a) above, the CRC-4 bit positions in an SMF are initially set to binary ZERO during the multiplication/division process.

Annex D (normative): TBR Requirements Table (TBR-RT)

Table D.1: TBR-RT for attachment requirements for terminal equipment to 2 048 kbit/s digital structured leased lines (D2048S)

TBR reference			TBR 13		
No	**Category (note 1)**	**Reference**	**Requirement**	**Status (note 2)**	**Support (note 3)**
1	F	4.1.1	Hard wired connection	M	
2	D,F	4.2.1.1	Signal coding	M	
3	D,F	4.2.1.2	Waveform shape	M	
4	F	4.2.1.3	Output timing	M	
5	D,F	4.2.1.4	Output jitter	M	
6	D,F	4.2.1.5	Output structure	M	
7	D,F	4.2.1.5.1	CRC-4	M	
8	-	4.2.1.5.2	Use of the E-bits	M	
9	D,F	4.2.1.5.3	Use of the A-bit	M	
10	-	4.2.1.5.4	Use of the S_a bits	N	
11	-	4.3	Safety	N	
12	D	4.4.1	Impulse transfer from mains, common mode	C1	
13	D	4.4.2	Impulse transfer from mains, transverse mode	C1	
14	D	4.4.3	Conversion of common mode to transverse mode	M	
15	-	4.5	ElectroMagnetic Compatibility (EMC)	N	

C1 If the terminal is mains powered then M else N.

NOTE 1: The category is the specific subclause of article 4 of directive 91/263/EEC, i.e. article 4a to article 4g, under which inclusion of the requirement is justified within the TBR.
NOTE 2: Status is "M" (mandatory), "N" (not a requirement) or "O" (optional).
NOTE 3: Support is "Y" (equipment conforms to the TBR), "X" (equipment does not conform to this TBR) or "N" (equipment does not claim to conform to this TBR).

Annex E (informative): Bibliography

- 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".

- 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".

- CCITT Recommendation G.706 (1991): "Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in Recommendation G.704".

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

- 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".

- ETS 300 418: "Business TeleCommunications (BTC); 2 048 kbit/s digital unstructured and structured leased lines (D2048U and D2048S); Network interface presentation".

- ETS 300 419: "Business TeleCommunications (BTC); 2 048 kbit/s digital structured leased line (D2048S); Connection characteristics".

- ETS 300 420: "Business TeleCommunications (BTC); 2 048 kbit/s digital structured leased line (D2048S); Terminal equipment interface".

- TBR 012 (1993): "Business Telecommunications (BT); Open Network Provision (ONP) technical requirements; 2 048 kbit/s digital unstructured leased line (D2048U) Attachment requirements for terminal equipment interface".

History

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