

Essential requirements for connection of terminal equipment to 2-wire analogue interfaces, without capacitive termination, of public switched telecommunication networks using either the earth calling, the loop calling-disconnect clearing, the loop calling-guarded clearing or the loop calling-unguarded clearing signalling method

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Foreword

This Published Document has been prepared by Project Teams under the direction of the Telecommunications Standards Policy Committee (TCT/-) and at the request of the DTI Telecommunications and Post Division (DTI/TP). Any enquiries relating to this document should be directed to BSI quoting the committee reference TCT/-/2/2, which was involved in the preparation of the document. This Published Document supersedes PD 7002 : 1995 which is withdrawn.

This edition introduces technical changes but it does not reflect a full review or revision of the document, which will be undertaken in due course.

This Published Document forms one of a series of Published Documents that have been produced to record the essential requirements, consistent with Directive 91/263/EEC, for the connection of apparatus to the various public telecommunications systems (i.e. designated as public telecommunications systems by an order made under Section 9 of the Telecommunications Act 1984).

The requirements specified in this Published Document are intended to ensure that apparatus conforming to them, when connected to public telecommunications systems, will neither adversely affect any public system nor interfere with the service available to other users of public telecommunications systems.

The requirements specified in the Published Document were drawn from the following documents.

Reference Number	Title	Published by
BS 6450 : Part 1 : 1993	<i>Private branch exchanges for connection to public switched telephone networks run by certain public telecommunications operators : Specification for general requirements</i>	BSI
BS 6450 : Part 2 : 1993	<i>Private branch exchanges for connection to public switched telephone networks run by certain public telecommunications operators : Specification for private branch exchanges with terminating stations treated as an entirety.</i>	BSI
BS 6450 : Section 6.1 : 1993	<i>Private branch exchanges for connection to public switched telephone networks run by certain public telecommunications operators : Simple call-routeing mode SCRM : Specification for the simple call-routeing mode of PBX operation, with terminating stations treated as an entirety.</i>	BSI

This Published Document is presented for designation under Section 22 of the Telecommunications Act 1984.

The document is submitted to the DTI for designation as the National Technical Requirement for approval of the equipment defined in the Scope.

A copy of any designation document will be included, when available, with all copies of this Published Document. Any further information on, or details of, the designation may be obtained from the Office of Telecommunications (OFTEL), 50 Ludgate Hill, London EC4M 7JJ.

BSI waives copyright in respect of tables B.1 to B.8.

Summary of pages

This loose leaf document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 44, an inside back cover and a back cover.

Attention is drawn to the Telecommunications Act 1984.

1 Scope

This Published Document specifies technical requirements under Section 22 of the Telecommunications Act 1984, for terminal equipment intended for connection to analogue interfaces of public networks run by certain public telecommunications operators that provide the following:

- 1) a 2-wire presentation without capacitive termination; and
- 2) either earth calling, loop calling-disconnect clearing, loop calling-guarded clearing or loop calling-unguarded clearing signalling methods; and
- 3) loop disconnect pulsing and multifrequency (MF) tone call routing signalling methods; and
- 4) either 8 dB, 6 dB or 3 dB maximum line loss; and
- 5) either normal or enhanced d.c. feeding characteristics;

where the terminal equipment is either self or line powered.

These technical requirements are aligned with Articles 4 (c) to 4 (f) of Directive 91/263/EEC. This Published Document does not contain any essential requirements for terminal-to-terminal interworking via the public network.

This document applies to all terminal equipment that is intended for connection to the forms of access referred to above, irrespective of whether the terminal equipment provides additional interfaces, telecommunications services or functions.

NOTE 1. Compliance with this Published Document will not necessarily ensure that the terminal equipment is satisfactory for the user's purposes.

NOTE 2. This Published Document may be used for the approval of through-connecting equipment (such as PBXs) which may in the past have been approved as an entirety in conjunction with specialised terminals, the 'black box' approval. Under Directive 91/263/EEC, guidance given by TRAC and corresponding changes to the UK national approvals, such through-connecting equipment (including PBXs) may now be approved separately from the specialised terminals if the manufacturer presents the equipment as a separate product. The principles for applying approval standards are given in the document 'Restructuring UK National Approvals: An Overview' produced by the DTI, and available from BABT and UK laboratories.

2 References

2.1 Normative references

This Published Document incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover.

For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this Published Document only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This Published Document refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Abbreviations, definitions and notation

3.1 Abbreviations

For the purposes of this Published Document, the following abbreviations apply.

3.1.1 CSA

Called subscriber answer.

3.1.2 d.c.

Direct current.

3.1.3 MF

Multifrequency.

3.1.4 NTP

Network terminating point.

3.1.5 PTO

Public telecommunication operator.

3.1.6 PSTN

Public switched telephone network.

3.1.7 SUT

System under test.

3.1.8 TE

Terminal Equipment.

3.2 Definitions

For the purposes of this Published Document the following definitions apply.

3.2.1 answer signal

Signal to indicate that a call has been answered.

3.2.2 A-wire; B-wire

The designation of the individual wires comprising the connection point to the PSTN.

NOTE. For testing purposes it is necessary for the A- and B- wires to be individually identified.

3.2.3 called subscriber answer signal (CSA signal)

Signal, initiated by a called party, to indicate to the PSTN that he has answered a call incoming to him.

3.2.4 calling state

Portion of a call during which a PSTN seize signal is applied.

3.2.5 clear signal

Signal, initiated by a calling or called party, to indicate that he is in the process of reverting to, or has reverted to, the idle state.

3.2.6 connection point

That interface of terminal equipment intended for connection to an appropriate NTP.

3.2.7 dialling

The sending of information needed by the PSTN to set up a required connection or invoke a desired service.

NOTE. This term includes the use of a keypad as well as a dial, and loop-disconnect signalling, MF tone signalling, or other signalling.

3.2.8 earth calling signalling method

Method that calls the PSTN on an outgoing call by means of an earth condition applied to the B-wire. When the PSTN has been seized, a loop is applied between the A- and B-wires and the earth condition is removed. On an incoming call from the PSTN, a CSA signal is returned by means of a loop between the A- and B-wires. At the end of each call a PSTN end-of-call clear signal is received from the PSTN. The A-wire potential is disconnected by the PSTN during the idle state.

3.2.9 exchange line potential

The voltages that appear on the A- and B-wires of the NTP which in the idle state is represented by the negative battery potential appearing on the B-wire and earth or 0 V potential appearing on the A-wire.

NOTE. In other states the exchange line potential may be of reverse polarity on the A- and B-wires to that of the idle state or be replaced by a calling indicator signal.

3.2.10 internally generated signal

A signal, the transmission of which is stimulated by a signal or event not associated with the level, amplitude or character of the transmitted signal.

3.2.11 loop

A d.c. path between the A- and B-wires that permits the seizure and holding of a PSTN line.

3.2.12 loop calling, disconnect clearing signalling method

Method that calls the PSTN on an outgoing call or returns a CSA signal to the PSTN on an incoming call, by means of a loop between the A- and B-wires. At the end of each call a PSTN disconnect clear signal is received from the PSTN.

NOTE. In the loop calling, disconnect clearing signalling method, the protocol is identical to that of a simple telephone connected to the PSTN with the addition of the PSTN disconnect clear signal.

3.2.13 loop calling, unguarded clearing signalling method

A signalling method whereby the on-line condition is employed to seize the PSTN and where no signalling interaction takes place between the PSTN and the terminal equipment during the clearing phase of a call.

NOTE. Unlike other signalling methods, the use of the loop calling unguarded clearing signalling method will increase the risk of double connections and follow-on outgoing calls.

3.2.14 negative battery potential

A voltage, derived from an exchange battery with its positive pole earthed, that has limits in the range 40 V to 57 V.

NOTE. Negative battery potential may have ripple components up to 2 mV psophometric present. Step changes in the open circuit voltage may occur within the stated limit. The open circuit voltage that appears at the NTP may not always be the negative battery potential. Such voltages will fall in the following ranges:

- a) B-wire -70 V to 0 V relative to exchange earth;
- b) A-wire more positive than B-wire but not exceeding 0 V relative to exchange earth.

3.2.15 park state

A condition into which the PSTN may place a PSTN line that is seized but not active on a call.

NOTE. The PSTN reduces the line loop current to approximately 4 mA for the loop calling guarded clearing signalling method and approximately 8 mA for the loop calling disconnect clearing signalling method.

3.2.16 proceed indication

Indication (e.g. dial tone) to a caller, subsequent to his having initiated a seize signal, that appropriate PSTN equipment is ready to receive routing information.

3.2.17 PSTN answer signal

Signal initiated by the PSTN, to indicate to the caller's terminal equipment that the outgoing call that has been made has now been answered.

3.2.18 PSTN disconnect clear signal

Signal, initiated by the PSTN towards a terminal equipment, on a PSTN line provided with the loop calling, disconnect clearing signalling method, to indicate that the PSTN regards the call as irrevocably having come to an end.

3.2.19 PSTN end-of-call clear signal

Signal, initiated by the PSTN towards a terminal equipment, on a PSTN line provided with the earth calling signalling method, to indicate that the PSTN regards the call as irrevocably having come to an end.

NOTE. The signal arises from the reversion to the idle state of this type of PSTN termination, and has the same function as the PSTN disconnect clear signal.

3.2.20 PSTN equipment seized signal

Signal, initiated by the PSTN towards a terminal equipment, on a PSTN line provided with the earth calling signalling method, to indicate that the PSTN equipment has recognized, and is acting upon, a PSTN seize signal.

The PSTN equipment seized signal is the application to the A-wire of a resistance of up to $1050\ \Omega$ in series with a voltage source connected to the terminal equipment earth reference point. This voltage comprises in turn each of the following:

- a) up to 5 V r.m.s. at 50 Hz; or
- b) a value between -10 V d.c. and $+5\text{ V d.c.}$; or
- c) a) and b) in series.

3.2.21 PSTN guarded release signal

Signal, generated by the PSTN when the loop calling, guarded clearing signalling method is used, to indicate that the call has come to an irrecoverable end and that the PSTN is releasing the connection. The signal will occur at one of the following three points of a call:

- a) just prior to the park state, indicating that the PSTN is about to park the line if a PBX clear signal is not received;
- b) at the end of a normal call clearing sequence prior to the PSTN restoring to the idle state;
- c) prior to the PSTN restoring to the idle state from the park state.

NOTE. The signal at the public exchange is a reduction in the feed current to less than 1 mA for a period of 400 ms to 510 ms. Owing to PSTN line characteristics, the reduction in the feed current to less than 1 mA will not necessarily be immediately detectable at the connection point. The period at the connection point below 1 mA will be not less than 220 ms.

3.2.22 PSTN operator

A service provided by a PSTN that includes assistance with call control functions.

3.2.23 PSTN seize signal

Seize signal from a terminal equipment to the PSTN.

3.2.24 reference instrument

A terminal equipment that meets the requirements of 8.2 but with a rate of pulsing of (10 ± 0.2) pulses per second and a break period of $(67 \pm 1)\%$.

3.2.25 seize signal

Signal initiated by a caller to indicate that he intends to set up a new call.

3.2.26 single transfer, incoming call barring and group transfer

PSTN provided facilities activated by connection of a resistor with a value in the range $28\text{ k}\Omega$ to $35\text{ k}\Omega$ across the basic network loop.

3.3 Notation

For the purposes of this Published Document the following notations apply.

3.3.1 dBm

Absolute power level with respect to 1 mW, expressed in decibels.

3.3.2 dBmp

Absolute psophometric power level (weighted for telephony) with respect to 1 mW, expressed in decibels.

3.3.3 dBV

Absolute voltage level with respect to 1 V, expressed in decibels.

NOTE. Further information on all expressions for power levels used in this standard is given in CCITT Recommendation B.12.

4 Conformance principles

4.1 Requirements

4.1.1 Annex A specifies the relationship between the requirements and the terminal. The supplier shall provide information on the functions implemented in the terminal and this information shall be used to determine which of the requirements apply and the manner in which the tests are performed.

NOTE. This information may be provided by completing the tables in annex B.

4.1.2 This document does not specify any additional requirements to cover the case of terminal equipment that can be attached to a PSTN via multiple interfaces. Where there is more than one interface on the terminal equipment and these interfaces are implemented in the same manner, the tests shall be applied to one of the interfaces only.

4.1.3 Except where the earth calling signalling method is implemented the requirements of this Published Document shall be met for both polarities of PSTN line connection.

NOTE. PSTN line polarity reversals, other than as part of the operation of a signalling system, will normally occur only when the terminal equipment is in the idle state.

4.1.4 Where relevant, the requirements in this Published Document apply for line currents in the range from 25 mA to the value when the terminal is connected to a voltage source of 50 V d.c. in series with a $400\ \Omega$ resistor.

4.1.5 Where the output signal of the terminal is derived in whole or in part from a signal at another interface, electrical or acoustic, unless otherwise stated, the requirements of this Published Document apply with a signal at that other interface as the maximum level that the supplier has stated that the interface is intended to receive.

4.2 Tests

4.2.1 Unless otherwise stated the tests shall be performed with three non-reactive $50\text{ k}\Omega$ resistors, one between the relevant A- and B-wires and one between each wire and earth.

NOTE. These resistances simulate the worst conditions present on the PSTN.

4.2.2 Unless otherwise stated in this document, measurements shall be made at the PSTN line connection point. For the purposes of performing the tests the PSTN connection point is a point specified by the supplier.

4.2.3 Where figures show an earth, this earth shall be connected to the earth reference point of the terminal equipment.

NOTE. Where figures do not show an earth, and where for signalling purposes the line potential(s) need to be referenced to earth, the terminal equipment may need to be artificially set in the appropriate signalling state for the test.

4.2.4 Details of information needed specifically for the purpose of testing is given in tables B.1 and B.8. The tables provide space for the supplier to provide information on the functions implemented in the terminal.

NOTE. See foreword for BSI waiver of its copyright on tables B.1 to B.8 inclusive.

4.2.5 Unless otherwise stated the tolerances associated with values of components and physical quantities referred to in tests and figures shall be as given in annex D.

5 Connection arrangement

5.1 The interface at the connection point shall be presented at terminals capable of terminating a solid copper conductor of diameter in the range 0.4 mm to 0.6 mm.

Conformity shall be checked by inspection.

5.2 The interface at the connection point shall be presented as solid copper conductors of diameter in the range 0.4 mm to 0.6 mm.

Conformity shall be checked by inspection.

6 Off-line state

6.1 Off-line, idle state

6.1.1 Idle state current

The current flowing between the terminal equipment and the PSTN shall be not greater than 120 μ A in either direction. Where applicable, the special signalling conditions associated with single transfer, incoming calls barred and group transfer shall be disabled.

Conformity shall be checked by measurement of the current flowing when each circuit of the terminal equipment is connected in turn to a 50 V d.c. source with its positive pole earthed applied in series with a 200 Ω resistor, the measurement being made with the other circuit earthed.

During the test for conformity, currents greater than 120 μ A shall be ignored if the duration of any current in excess of 120 μ A does not exceed 10 ms in any one 110 ms duration.

NOTE 1. The requirement of 4.2.1 does not apply to this test.

NOTE 2. PTOs do not guarantee that it will be possible in all present and future circumstances to draw 120 μ A from the PSTN.

NOTE 3. In order to enable PTOs to perform accurate fault prediction testing, it is recommended that the resistance of any intentional earth path is stable to within 3 %.

6.1.2 Direct potentials applied to the PSTN

6.1.2.1 Positive potential

If the terminal equipment applies a steady-state positive potential relative to earth on the A- or B-wires, the potential shall not exceed 10 V. Conformity shall be checked by measurement of the open-circuit voltage.

6.1.2.2 Negative potential

The terminal equipment shall not apply any negative potential exceeding 60 V relative to earth on either the A- or B-wires.

Conformity shall be checked by measurement of the open-circuit voltage.

6.1.3 Power level

The total idle state noise power level of the terminal equipment shall be not greater than -30 dBm.

The total power level in any 3 kHz bandwidth contained wholly above 5.1 kHz shall be not greater than the limit given in table 1 and shown in figure 1, for the centre frequency of the band.

The limit curve shall be determined by straight lines joining successive coordinates given in table 1 when power, in dBm, is plotted on a linear scale against frequency on a logarithmic scale.

Conformity shall be checked by measurement with the terminal equipment connected to a simulated network test circuit as described in C.1.1, C.1.2 and C.1.6.

6.2 Off-line, ringing state

6.2.1 Capacitive termination

When in the idle state the connection point shall present to the PSTN a capacitance C between the A- and B-wires of between 1.62 μ F and 2.64 μ F in series with a resistance R of between 1 k Ω and 10 k Ω .

Conformity shall be checked as described in C.2.

6.2.2 Restriction of signals sent to the PSTN line

When a ringing detector is active the total psophometrically weighted voltage level measured at the connection point shall be not greater than -10 dBV.

Conformity shall be checked by measurement as described in C.10.

6.2.3 Impedance

The wire-to-earth impedance shall not be less than $10\text{ k}\Omega$ in the frequency range 16 Hz to 3400 Hz .

Conformity shall be checked by measurement with 1 V a.c. r.m.s. applied.

Table 1. Coordinates of power level limit curve	
Centre Frequency KHz	Power level in 3 kHz band dBm
5.5	-40
8.9	-40
50	-70
1000	-70
2000	-58
4000	-46
7998.5	-34
NOTE. The curve is shown in figure 1. It is recommended that suppression of signals to less than -34 dBm should continue above 8 MHz .	

7 On-line state

NOTE. Longitudinal voltages, likely to be rich in harmonics, with a basic frequency of 50 Hz and a voltage, at the PSTN exchange, in the range 40 V to 45 V where the current available at the connection point is approximately 1 mA r.m.s. , may be induced into the PSTN line. The duration of such signals at the exchange is in the range 200 ms to 595 ms , but regenerative distortion can elongate pulses to durations longer than 1 s at the connection point.

7.1 Impedance balance about earth

For terminal equipment with an earth connection, the impedance balance about earth shall be not less than 46 dB in the frequency range 300 Hz to 3400 Hz . Conformity shall be checked by measurement as described in C.3.

During the test for conformity, an impedance balance about earth outside the specified limit shall be ignored if the duration in which the impedance balance about earth is outside the specified limit does not exceed 10 ms in any one 110 ms duration.

7.2 Signal balance about earth

For terminal equipment with an earth connection, the voltage imbalance ratio shall be not less than 46 dB .

Conformity shall be checked using measurements obtained from the test of C.4.

Table 2. Coordinates of limit curves for power level in a 10 Hz bandwidth

Limit curve	Frequency Hz	Power level in a 10 Hz bandwidth dBm
Upper limit	30	-33
	100	-16
	200	-6
	3000	-6
	3200	-6
	3800	-15
	4000	-44
Area A	2130	-6
	2220	-33
	2340	-33
	2430	-6
	2130	-6
Area B	900	-6
	1000	-23
	1000	-45
	2000	-45
	2000	-23
	2130	-6
	900	-6

7.3 Signal power presented to the PSTN

7.3.1 Mean power level

7.3.1.1 For fixed power level terminal equipment the mean power level in the frequency range 200 Hz to 3800 Hz of any internally generated signal shall be not greater than -9 dBm .

Conformity shall be checked by measurement as described in C.1. 1 and C.1.2.

7.3.1.2 For terminal equipment where the power level is adjustable, the mean power level in the frequency range 200 Hz to 3800 Hz of any internally generated signal shall be not greater than 0 dBm and the range of adjustment shall include a setting at which the mean power level is equal to or less than -9 dBm .

Conformity shall be checked by measurement with the 1 minute mean power level adjusted to -9 dBm , or the nearest lower level value for which a setting is practicable as described in C.1.1 and C.1.2.

7.3.1.3 For terminal equipment incorporating facilities for sending to line stored speech the mean power in the frequency range 200 Hz to 3800 Hz shall be not greater than -9 dBm whilst active.

For terminal equipment incorporating facilities for sending to line music or simultaneous speech and music signals the mean power level in the frequency range 200 Hz to 3800 Hz shall not exceed -12 dBm whilst active.

Conformity shall be checked by measurement as described in C.1. 1 and C.1.2 with the averaging performed over either the period of the active signal or 1 minute, whichever is the shorter.

NOTE. It is recommended that the minimum level of the speech and/or music should be not more than 6 dB below the level specified above.

7.3.1.4 For terminal equipment incorporating facilities for sending to line signals from an integral acoustic interface, in the loop condition the maximum sending sensitivity shall be less than $+3.0$ dBV/Pa over the frequency range 200 Hz to 3800 Hz. This requirement shall be met when the output is terminated in a load of $600\ \Omega$.

Conformity shall be checked by the measurement described in C.1.7.6.

7.3.2 Total power level in a 10 Hz band

The total power level in a 10 Hz bandwidth contained wholly within the frequency range 30 Hz to 4000 Hz of any internally generated signal shall be not greater than the upper limit given in table 2 and shown by the full line in figure 2, except for signals in area A as given in table 2 and shown by additional dotted lines in figure 2.

Where a signal occurs in area A, it shall be accompanied by a signal or signals in area B, as given in table 2 and shown by additional dotted lines in figure 2, at a total power level not less than a level that is 12 dB below the power level of the signal in area A.

Where there is no signal in area B, the total power in the frequency range 2220 Hz to 2340 Hz shall be not greater than -33 dBm.

The limit curves of table 2 shall be determined by straight lines joining successive coordinates given in the table.

Conformity shall be checked by measurement with the 1 minute mean power level adjusted to -9 dBm, or the nearest lower level value for which a setting is practicable as described in C.1.1 and C.1.3.

NOTE.1. Signals transmitted at allowable levels at frequencies above 3000 Hz (areas C and D of figure 2) may be relatively highly attenuated in the network and may therefore not be effectively received by the terminal equipment at the destination. In particular, it will be generally the case that no significant signal will be received for such signals transmitted at frequencies above 3800 Hz (area D of figure 2).

NOTE.2. The curve is shown in figure 2. It is recommended that suppression of signals to less than -33 dBm should continue below 30 Hz.

7.3.3 Maximum instantaneous power level

The maximum instantaneous power level of any internally generated signal shall be not greater than a level corresponding to that of a sine wave of $+4$ dBm. Exceptionally, signals that exceed the limit of $+4$ dBm shall be allowed provided that all other requirements of 7.3 are met and the signals that exceed the limit account for not more than 0.001% (1 in 10^{-5}) of all samples during a 5 min measurement period.

Conformity shall be checked by the method described in C.1.1 and C.1.4.

7.3.4 Limits of signals to line, from an electrical interface

For signals transferred from any electrical interface of the terminal equipment, including signals received and stored for later transmission, the signal level shall be not greater than $+10$ dBV.

Conformity shall be checked by measurement as described in C.1. 7.

NOTE. Where the maximum signal level that is intended to be received by an interface from which signals are to be transferred, via the terminal equipment, to the NTP under test is not one of those specified in item 12 of table B.8 the supplier should state the maximum signal level in the Instructions for Use.

7.3.5 Power level in a 3 kHz bandwidth

The total power level in any 3 kHz bandwidth contained wholly above 4 kHz shall be not greater than the limit given in table 1 and shown in figure 1, for the centre frequency of the band.

Exceptionally, individual signals with frequencies of $(24 + 8n)$ kHz with a tolerance of $\pm(1.2 + 0.4n)$ Hz where n is zero or any positive integer between 1 and 396) shall be permitted to have a power level that exceeds the limit but shall not exceed -50 dBm.

NOTE. This tolerance is equal to ± 50 parts per million.

Where the output signal is not internally generated, this requirement applies when no stimulus is applied to any interface from which the output signal is derived in whole or in part.

Conformity shall be checked by measurement, with the mean power level set to an indicated mean power level of -9 dBm, or the nearest lower value for which a setting is practicable and with the terminal equipment connected to a simulated network test circuit as described in C.1.1 and C.1.5.

7.4 Immunity to PSTN line disturbances

7.4.1 *Earth calling, loop calling-disconnect clearing and loop calling-unguarded clearing signalling methods*

A terminal equipment configured for either the earth calling, the loop calling-disconnect clearing or the loop calling-unguarded clearing signalling method shall continue to conform to the requirements applicable to outgoing PSTN calls if PSTN line disturbances of Type 5 as described below are received. Conformance in the presence of the other types of disturbance is recommended but not required.

All values of resistance are quoted at the connection point.

- a) Type 3. The change of polarity used as an answer signal by many public exchanges is the exchange line voltage applied as a negative battery potential connected to the A-wire, and the B-wire connected to earth.

NOTE1. Type 1 and 2 conditions were defined in earlier standards but are now obsolete.

- b) Type 4. The PSTN line feeding conditions are modified as follows immediately prior to the receipt of proceed indication. The A- and B-wires are both connected to the nominal 50 V negative supply, each through a resistance of between 470 Ω and 1470 Ω for up to 100 ms.

- c) Type 5. The PSTN line feeding conditions are modified as follows after the clear signal has been sent by the terminal equipment on an outgoing call to any of the operator services. The A- and B-wires are connected to nominal 50 V and 100 V negative supplies respectively, the A-wire through a resistance of up to 1 k Ω and the B-wire through a resistance of up to 3.1 k Ω , depending on both PSTN line length and the exact sequence of events during the clearing of the call.

NOTE. This requirement is retained to support access to the emergency services.

For terminal equipment configured for the loop calling, disconnect clearing signalling method conformity shall be checked by the method described in C.5.1 and C.5.2.

For terminal equipment configured for the earth calling signalling method conformity shall be checked by the method described in C.5.1 and C.5.3.

For terminal equipment configured for the loop calling, unguarded clearing signalling method conformity shall be checked by the method described in C.5.1 and C.5.2.

NOTE. The above is not an exhaustive list of signalling anomalies.

7.4.2 *Loop calling-guarded clearing signalling method*

A terminal equipment configured for the loop calling guarded clearing signalling method should continue to conform with the requirements applicable to

outgoing calls if, during an outgoing call, the change of polarity that may be used as an answer signal is the exchange line voltage applied as a negative battery potential connected to the A-wire, and the B-wire connected to earth.

A method is described in C.5.1 and C.5.4.

7.5 d.c. characteristics

NOTE. The requirements of 7.5 continue to apply when the terminal equipment provides a call path from one PSTN line to another PSTN line.

7.5.1 For terminal equipment intended for connection to PSTN lines with normal d.c. characteristics the steady state voltage measured at the connection point for values of current in the range of 0 mA to 125 mA shall not be greater than the limit as given in table 3 and shown in figure 4 and not less than zero.

The limit curve shall be determined by straight lines joining successive coordinates as given in table 3.

Conformity shall be checked by measurement (starting at the lowest current) with the terminal equipment connected to a source capable of providing current up to the value obtained when the terminal equipment is connected to a voltage source of 50 V in series with a 400 Ω resistor. A d.c. characteristic outside the limits shall be ignored if the period in which the d.c. characteristic is outside the limit does not exceed 10 ms in any 110 ms.

NOTE. The duration of an undesignated interruption or random break in the d.c. path caused by the terminal equipment should not exceed 10 ms.

7.5.2 For terminal equipment intended for connection to PSTN lines with enhanced d.c. characteristics the steady state voltage measured at the connection point for values of current in the range of 0 mA to 125 mA shall not be greater than the limit given in table 3 and shown in figure 4 and not less than zero except that the voltages in table 3 and figure 4 shall be increased by a voltage numerically equal to the current in mA x 0.2.

The limit curve shall be determined by straight lines joining successive coordinates as given in table 3.

Conformity shall be checked by measurement (starting at the lowest current) with the terminal equipment connected to a source capable of providing current up to the value obtained when the terminal equipment is connected to a voltage source of 50 V in series with a 400 Ω resistor. A d.c. characteristic outside the limits shall be ignored if the period in which the d.c. characteristic is outside the limit does not exceed 10 ms in any 110 ms.

NOTE. The duration of an undesignated interruption or random break in the d.c. path caused by the terminal equipment should not exceed 10 ms.

Table 3. Coordinates of d.c. characteristics upper limit curve

Current mA	Voltage V
0	9
25	9
33.5	10
42	12.5
45	32
125	0

NOTE. The curve is shown in figure 4.

7.6 Impedance

The input impedance of the terminal equipment shall:

- a) when in a state in which it is capable of sending signals, other than call routing information signals, to the PSTN, have a return loss:

- with respect to, either the network shown in figure 3 of not less than 8 dB, or
- with respect to 600 Ω of not less than 12 dB with an inductive component of less than 50 Ω

in the frequency range 200 Hz to 4000 Hz and at those values of terminal equipment current in the sequence 25, 40, and that current obtained when the terminal equipment is connected to a voltage source of 50 V in series with a 400 Ω resistor.

- b) when in a state in which it is not capable of sending signals to the PSTN either comply with 7.6a or have a value, in ohms, within the range bounded by the coordinates (240, +j30); (300, +j30); (240, -j30) and (300, -j30).

Conformity to 7.6a shall be checked by measurement as described in C.6 and conformity to 7.6b shall be checked by measurement.

8 Call routing signalling methods

8.1 Sending call routing information to the PSTN

Where the sending of call routing information to the PSTN is automatically initiated the terminal equipment shall not commence to send call routing information until, if applicable, the terminal equipment has responded to application of the PSTN equipment seized signal and, either,

- proceed indication is received by the terminal equipment; or,
- by a period of at least 1s has elapsed since establishment of the on-line state.

Conformity to 8.1a shall be checked by inspection and conformity to 8.1b shall be checked by measurement.

8.2 Loop-disconnect signalling

NOTE. The requirements of clause 7 do not apply during loop-disconnect signalling to the PSTN.

8.2.1 When terminal equipment is sending call routing information in loop-disconnect form, no frequency component of the MF call routing signalling method shall exceed a power level of -33 dBm for a period in excess of 15 ms.

Conformity shall be checked by measurement.

8.2.2 For loop-disconnect signalling, the terminal equipment shall interrupt the network loop current in the following way.

- Rate: the rate of pulsing shall be 10 ± 1 pulses per second.
- Ratio: the break period shall be $67 \pm \frac{5}{4}$ % of the total pulse period. At some instant during a break pulse, the device shall draw not more than 500 μ A from the line.
- Overall timing:

NOTE 1. A loop-disconnect timing diagram is shown in figure 5.

- For a period of not less than 240 ms before the first break period of any pulse train, and not less than 28 ms after the last break period of any pulse train, the current drawn by the terminal equipment shall be either not less than the current normally in the basic network loop or not less than the current in the pulsing loop, whichever is the lower.

- For terminal equipment with an automatically controlled source of pulses, the effective interdigital pause shall be not less than 720 ms.

NOTE 2. It is recommended that the effective interdigital pause should not exceed 920 ms.

- For terminal equipment with a manually controlled rotary dial the automatically inserted dial pause shall be not less than 240 ms.

- Coding: for transmitted digit 1 to 9, the basic network loop shall be interrupted and restored for the number of times that equals the value of the digit sent. For digit 0, the number of times shall be 10.

- Distortion: the pulsing performance of the terminal equipment shall be adequate for normal operation under extremes of condition and configurations.

Conformity to the requirements other than item 3) of c) and e) shall be checked by measurement with a terminal equipment current equal to the current obtained when the terminal equipment is connected to a 50 V source in series with a 400 Ω resistor. Break and make timings shall be measured between the start of the exponential fall and the start of the exponential rise of loop current.

Conformity to the requirements of item 3) of c) shall be checked by measurement of the relevant mechanical features of the dial mechanism, or by timing, making corrections for the actual speed of the dial under test.

Conformity to the requirement of e) shall be checked by the test of C.7.

After the test of C.7, the values of output break period of the terminal equipment and, where applicable, of the reference instrument shall lie within the limits of the range determined by the reference sources for every condition under which the test is made.

8.3 Multifrequency signalling

NOTE 1. If a terminal equipment is to use MF signals to transmit data after an outgoing call has been established an allowance should be made for a possible PSTN line polarity reversal upon the answer of such a call.

8.3.1 General

When sending call routing information to the PSTN, the terminal equipment shall comply with 7.1, 7.2 and 7.5.

8.3.2 Coding format

The signal transmitted by the terminal equipment to the network to represent each digit shall consist of two, and only two, frequencies. The nominal frequencies for each digit shall be as given in table 4.

Conformity shall be checked by measurement with a current of 25 mA and with the current obtained when the terminal equipment is connected to a 50 V d.c. source in series with a 400 Ω resistor.

The difference between each measured frequency and the corresponding nominal frequency shall be not more than $(0.015f + 0.4)$ Hz, where f is the corresponding nominal frequency, in hertz.

NOTE. The coding format is derived from CCITT Recommendation Q.23. Network responses are obtained for the three left-hand columns to be encoded in table 4. There are no requirements in respect of MF codes for *, #, A, B, C and D.

Table 4. MF coding frequencies				
				Low frequency band values Hz
Digit to be encoded	1	2	3	697
	4	5	6	770
	7	8	9	852
		0		941
High frequency band values, Hz	1209	1336	1477	

8.3.3 Absolute signalling power levels to the PSTN

The absolute signalling power levels shall conform to either a) or b).

a) The absolute signalling power levels shall be as given in table 5.

Conformity shall be checked by measurement, with the PSTN line connection point of the terminal equipment connected to the circuit shown in figure 7 with a direct current of 25 mA flowing through the ammeter. Conformity shall also be checked at the maximum current level flow in the circuit when it is connected to an e.m.f. of 50 V in series with a resistance of 400 Ω .

b) The absolute signalling power levels shall be within the appropriately marked area of figure 16.

Conformity shall be checked by measurement, with the terminal equipment connected at its PSTN line connection point to the circuit shown in figure 17, with terminals A and B terminated with a 600 Ω non-reactive resistor, connected to a high impedance measuring set.

NOTE. Selection of the appropriate absolute signalling power level requirement, and application of the corresponding compliance check is dependent on the absolute signalling power classification determined by the supplier.

8.3.4 Differential level of two components

The high tone of an MF signal shall have a signal level between 1 dB and 4 dB higher than the associated low tone.

Conformity shall be checked by inspection of the measurement results of 8.3.3.

8.3.5 Transients

The peak voltage of transients presented to the PSTN during MF transmission shall not exceed 5 V.

Conformity shall be checked by connecting the terminal equipment to the test circuit shown in figure 6 with a current of 40 mA, or the current obtained when the terminal equipment is connected to a 50 V d.c. source in series with a 400 Ω resistor, whichever is the less, and by measurement with an instantaneous reading voltmeter.

8.3.6 Stability

The steady state power of the composite MF signal shall not vary by more than ± 1 dB.

Conformity shall be checked by measurement using the test circuit shown in figure 7.

Table 5. Absolute MF signalling power levels					
Impedance Z_1 in figure 7	Send levels: high frequency band		Send levels: low frequency band		Classification
	min.	max.	min.	max.	
Figure 3	-15 dBV	-9 dBV	-17 dBV	-11 dBV	B1
600 Ω	-13 dBm	-7 dBm	-15 dBm	-9 dBm	B2

8.3.7 Unwanted frequency components during signalling

8.3.7.1 During signalling, the total power of unwanted frequency components shall be not greater than a level 20 dB below the lowest power level of any one signalling tone of a digit tone burst of the terminal equipment.

Conformity shall be checked by the test of C.1.1 and C.1.3 with a current of 25 mA and with the current obtained when the terminal equipment is connected to a 50 V d.c. source in series with a 400 Ω resistor.

8.3.7.2 The power level of a single unwanted frequency component in the frequency range 300 Hz to 3400 Hz shall be not greater than -33 dBm.

Above 3400 Hz the power in a 30 Hz bandwidth shall be not greater than the limit given in table 1 and shown in figure 1. With the exception that the words 'in a 3 kHz bandwidth' on the ordinate shall be omitted for the purpose of this requirement.

8.3.8 Spillover

8.3.8.1 Signalling state

When the terminal equipment is transmitting digits in MF form to the PSTN, no frequency component of MF signals other than those intended as call routing information shall exceed a power level of -33 dBm for a period in excess of 15 ms.

Conformity shall be checked by measurement.

NOTE. This requirement avoids the unintentional operation of any PSTN MF equipment.

8.3.8.2 Silent period

When the terminal equipment is not transmitting digits in MF form, the total power of all signals shall be not greater than -60 dBm.

Conformity shall be checked by the test of C.1.1 and C.1.2 with a current of 25 mA, and with the current obtained when the terminal equipment is connected to a 50 V d.c. source in series with a 400 Ω resistor.

8.3.9 Overall timing format, rise and fall of tone waveform

The signal power shall reach and remain within the power limits specified in 8.3.3 during the period beginning not later than 15 ms after the start of the signal output.

The signal power shall fall below the quiescent power level specified in 8.3.8.2 during the period not later than 10 ms after the instant of signal termination.

Conformity shall be checked by the test of C.1.1 and C.1.2 with a current of 40 mA, or the current obtained when the terminal equipment is connected to a 50 V d.c. source in series with a 400 Ω resistor, whichever is the lesser.

8.3.10 Overall timing format: digit and interdigital timing

For terminal equipment with an automatic call routing information sending function the digit period shall be not less than 68 ms and the interdigital pause shall be not less than 68 ms, excluding for both periods the rise and fall time of the tone burst. The ratio of the digit period to the sum of the digit period and the interdigital pause, i.e. the MF-tone signalling duty cycle, shall be not greater than 60 %.

Conformity is determined by measurement.

9 Call control signalling methods

NOTE. It is recommended that the action of the PSTN placing a PSTN line, that is in the on-line state, into the park state does not cause the terminal equipment to clear and reinitialize the PSTN line.

9.1 Earth calling signalling method

9.1.1 PSTN seize signal

9.1.1.1 The PSTN seize signal shall be applied to the B-wire such that:

a) the current drawn by the B-wire of the terminal equipment when connected to a 41 V source with one pole earthed in series with a resistance of 1270 Ω , is greater than or equal to that drawn by a resistance of 500 Ω when connected to a 41 V source with one pole earthed in series with a resistance of 1270 Ω ; and

b) the current drawn by the B-wire of the terminal equipment, when connected to a 57 V source with one pole earthed in series with a resistance of 180 Ω , is less than or equal to that drawn by a resistance of 300 Ω , when connected to a 57 V source with one pole earthed in series with a resistance of 180 Ω .

Conformity shall be checked by the method described in C.8.1 and C.8.2.

NOTE. In a) and b) the source consists of an e.m.f. with its most positive terminal connected to the earth reference point of the terminal equipment.

9.1.1.2 The A-wire shall comply with 6.1.2 prior to the PSTN equipment seized signal being connected.

9.1.2 Detection of PSTN equipment seized signal

9.1.2.1 The terminal equipment shall respond to the PSTN equipment seized signal (see 3.2.12) by connection of the on-line state across the A- and B-wires followed by disconnection of the PSTN seize signal.

Conformity shall be checked by the method described in C.8.1 and C.8.4.

NOTE 1. The calling state is followed by one of the on-line, loop disconnect dialling or MF code signalling states, as appropriate.