BRITISH STANDARD

BS EN 60495:1994
IEC 495:1993

Single sideband power-line carrier terminals

The European Standard EN 60495:1994 has the status of a British Standard

UDC 621.3.052.63:621.315

Cooperating organizations

The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the national committees of the following countries:

Austria	Italy
Belgium	Luxembourg
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Finland	Norway
France	Portugal
Germany	Spain
Greece	Sweden
Iceland	Switzerland
Ireland	United Kingdom

This British Standard, having been prepared under the direction of the Power Electrical Engineering Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 August 1994

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Contents

National foreword

This British Standard has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee and is the English language version of EN 60495:1994 *Single sideband power-line carrier terminals,* published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 495:1993, published by the International Electrotechnical Commission (IEC).

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 32, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60495

March 1994

UDC 621.3.052.63:621.315.027.3:621.395.44

Descriptors: Power-line carrier terminal, carrier frequency, information transmission, single sideband, telecommunications, power line, transmission line, performance characteristic, operating requirement, electromagnetic compatibility

English version

Single sideband power-line carrier terminals

(IEC 495:1993)

Equipements terminaux à courants porteurs sur lignes d'énergie, à bande, latérale unique
(CEI 495:1993)

Geräte für die Einseitenband-Trägerfrequenz-Nachrichtenübertragung über Hochspannungsleitungen
(IEC 495:1993)

This European Standard was approved by CENELEC on 1993-12-08. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Ref. No. EN 60495:1994 E

Foreword

The text of document 57(CO)63, as prepared by IEC Technical Committee 57: Telecontrol, teleprotection and associated telecommunications for electric power systems, was submitted to the IEC-CENELEC parallel vote in October 1992.

The reference document was approved by CENELEC as EN 60495 on 8 December 1993.

The following dates were fixed:

— latest date of publication of an identical national standard (dop) 1994-12-01

— latest date of withdrawal of conflicting national standards (dow) 1994-12-01

For products which have complied with the relevant national standard before 1994-12-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 1999-12-01.

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given only for information. In this standard, Annex A and Annex ZA are normative and Annex B, Annex C and Annex D are informative.

Contents

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Introduction

The complexity and extensive size of present-day electricity generation, transmission and distribution systems are such that it is possible to control them only by means of an associated and often equally large and complex telecommunication system having a high order of reliability. The facilities which can normally be provided as part of the telecommunication system can be listed as follows:

— telephony (operation, maintenance and administration speech circuits);

— facsimile transmission;

— telegraphy;

— telecontrol;

— load frequency control;

— teleprotection;

— data transmission.

The communication channels can be provided by circuits leased from public facilities, by means of utility-owned private circuits or, national regulations permitting, by a combination of both types of circuit. The need for a high availability on these circuits generally calls for the provision of multiple routing, preferable by geographically diverse routes.

In many countries, Power Line Carrier (PLC) channels represent a main part of the utility-owned telecommunication system. A circuit which would normally be routed via a PLC channel may also be routed via a channel using a different transmission medium, such as a point to point radio or open-wire circuit. Since, in many cases, automatic switching is used, the actual rerouting, although predetermined, is unpredictable. It is important, therefore, that the voice frequency input and output criteria of all equipment used in the communications system are compatible. This compatibility is also beneficial in creating the ability to interchange and interwork equipment from different sources.

This International Standard has been prepared to enable compatibility between PLC links from different sources or between PLC links and other transmission media to be achieved and to define the terminal performance required in PLC networks.

This International Standard covers basically 4 kHz and 2,5 kHz bandwidth single channel PLC equipments that use amplitude modulation with single sideband transmission.

The application of this International Standard to multichannel equipment is described in Annex A.

1 General

1.1 Scope and object

This International Standard applies to Single Sideband (SSB) Power Line Carrier (PLC) Terminals used to transmit information over High Voltage (HV) Lines.

The object of this standard is to establish recommended values for characteristic input and output quantities of single sideband PLC terminals (see Figure 1) and the definitions essential for an understanding of these recommendations. All the tests verifying the requirements shall be considered as type tests as defined in the International Electrotechnical Vocabulary (IEV 151-04-15).

This standard defines two versions of the PLC equipment intended for two different applications:

— **standard terminal,** i.e. equipment with a voice frequency side interface which offers transmission of a frequency band of 300 Hz to 3 400 Hz on a four-wire basis plus signalling facilities. This equipment is capable, via analog interfaces, of being connected to networks that may consist of transmission equipment of different types and from different manufacturers. There may be facilities for additional point-to-point connections (e.g. a teleprotection connection) which may fall outside the frequency band of 300 Hz to 3 400 Hz (see Figure 2);

— **speech-plus terminal,** i.e. equipment where specific interfaces for signals like speech, data and teleprotection are present at the voice frequency side (see Figure 3).

The two versions will have parts in common and the requirements of these common parts are dealt with in **5.2** and **5.3.1**.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 38:1983, *IEC standard voltages.*

IEC 50 (55):1970, *International Electrotechnical Vocabulary (IEV) — Chapter 55: Telegraphy and telephony.*

IEC 50 (151):1978, *International Electrotechnical Vocabulary (IEV) — Chapter 151: Electrical and magnetic devices.*

IEC 255-4:1976, *Electrical relays — Part 4: Single input energizing quantity measuring relays with dependent specified time.*

IEC 255-5:1977, *Electrical relays — Part 5: Insulation tests for electrical relays.*

IEC 255-22-1:1988, *Electrical relays — Part 22: Electrical disturbance tests for measuring relays and protection equipment — Section 1: 1 MHz burst disturbance tests.*

IEC 663:1980, *Planning of (single-sideband) power line carrier systems.*

IEC 721-3-1:1987, *Classification of environmental conditions — Part 3: Classification of groups of environmental parameters and their severities — Storage.*

IEC 721-3-2:1985, *Classification of environmental conditions — Part 3: Classification of groups of environmental parameters and their severities — Transportation.*

IEC 721-3-3:1987, *Classification of environmental conditions — Part 3: Classification of groups of environmental parameters and their severities — Stationary use at weatherprotected locations.*

IEC 721-3-4:1987, *Classification of environmental conditions — Part 3: Classification of groups of environmental parameters and their severities. Stationary use at non-weatherprotected locations.*

IEC 801-2:1991, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 2: Electrostatic discharge requirements.*

IEC 801-3:1984, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 3: Radiated electromagnetic field requirements.*

IEC 801-4:1988, *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 4: Electrical fast transient/burst requirements.*

IEC 834-1:1988, *Performance and testing of teleprotection equipment of power systems — Part 1: Narrow-band command systems.*

CCITT Blue Book, Volume V, 1988, *Telephone transmission quality. Series P recommendations.*

CCITT Blue Book, Volume III, Fascicle III.1, 1988, *General characteristics of international telephone connections and circuits. Recommendations G.100 to G.181.*

CCITT Blue Book, Volume III, Fascicle III.2, 1988, *International analogue carrier systems. Recommendations G.211 to G.544.*

2 Definitions

2.1 General

For the purpose of this International Standard, the following definitions apply.

Other terms used in this standard and not defined in this clause have the meaning attributed to them according to the International Electrotechnical Vocabulary (IEV).

In addition to these, a number of relevant established telecommunications terms are given in Annex B.

2.2 Frequency bands

2.2.1
carrier-frequency range

the total band available for power line carrier use

2.2.2
basic carrier-frequency band

the elementary subdivision of the carrier frequency range or part thereof allocated to a single PLC transmit or receive channel

2.2.3
nominal carrier-frequency band

the frequency band in which a particular PLC transmitter or receiver is operating

2.2.4
effectively transmitted speech-band

that part of the voice-frequency band used for telephone communication, not including the telephone signalling channel

2.2.5
effectively transmitted signal-frequency band

that part of the voice-frequency band used for the transmission of signals essential for the operation of power systems (including data transmission, protection signals and any other signals); this band may include the telephone signalling channel

2.3
nominal impedance

the nominal impedance, as used in this standard, is the value of impedance for which an input or output circuit has been designed and for which the prescribed requirements apply

2.4 Carrier-frequency output power

2.4.1
nominal carrier-frequency output power

the nominal carrier-frequency output power of a PLC terminal is the peak envelope power, PEP, (see Annex B) for which the equipment has been designed, compatible with the requirements for spurious emissions, available at the carrier-frequency output (point G of Figure 2 and Figure 3) across a resistive load equal to the nominal impedance

2.4.2
mean carrier-frequency output power

the mean carrier-frequency output power of a PLC terminal is the output power averaged over a time sufficiently long compared with the cycle time of the lowest modulation frequency and during which this average power assumes the highest value for which the equipment has been designed

NOTE 1 The ratio between peak envelope power and mean power depends on all factors influencing the multiplex signal (speech level, presence or absence of a compressor, number, type and level of signals). This ratio may be assumed to lie typically between 8,5 dB and 10 dB under normal service conditions.

NOTE 2 The power injected at the coupling point of the HV line (see Figure 1) is less than the power measured at the carrier-frequency output and is sometimes limited by national telecommunications authorities.

2.5
spurious emissions

spurious emissions are emissions, at one or more frequencies, located outside the nominal carrier-frequency band

spurious emissions comprise harmonics, parasitic signals and intermodulation products

3 Operating conditions

3.1 Temperature and humidity

The equipment, including its protection, shall meet the requirements of this standard while operating under the conditions specified in IEC 721-3-3, class 3K5 amended as follows:

— *High air temperature*

The equipment shall operate without damage at temperatures up to + 55 °C for a period of not more than 24 h per month. In these conditions a temporary degradation in performance may be accepted.

— *Low air temperature*

The lower temperature limit of operation shall be 0 °C.

— *Condensation; formation of ice*

In normal operation the formation of ice shall not occur. The equipment shall not be exposed to any type of water spraying.

Temporary condensation may occur during maintenance when spare parts are introduced which have been stored at a lower temperature than that prevailing in the telecommunication equipment environment.

Table I (Classification of climatic conditions) and Figure B.5 (Climatogram for class 3K5) of IEC 721-3-3 are shown in Annex C.

3.2 Power supply

NOTE The requirements of this subclause may be changed some time in the future in order to correspond more closely with identical clauses of other International Standards within the scope of IEC technical committee 57.

3.2.1 A.C. supply

Nominal a.c. voltages shall be in accordance with the preferred values listed in IEC 38, but the following values are recommended:

220 V
110 V } 50 Hz or 60 Hz

Requirements are given in Table 1.

Table 1 — Power supply requirements

		Requirement
A.C. supply	Voltage tolerance	+ 10 % to – 15 %
	Frequency tolerance	± 5 %
	Harmonic content	< 10 %
D.C. supply	Voltage tolerance	+ 20 % to – 15 %
	Ripple peak-to-peak	≤ 5 %

3.2.2 D.C. supply

Nominal d.c. voltages shall be in accordance with the preferred values listed in IEC 38, but the following value is recommended:

48 V

Requirements are given in Table 1.

The equipment shall be capable of operating with the positive pole earthed.

Conducted noise:

The noise measured across the power supply terminals of the equipment shall not be greater than 3 mV psophometrically weighted (see CCITT Recommendation P.53 for psophometer weighting coefficients). The test circuit is indicated in Figure 4.

4 Storage and transportation conditions

4.1 Storage conditions

The equipment, including its protection (not the equipment itself), shall meet during storage the requirements in IEC 721-3-1, class 1K5.

Table I (Classification of climatic conditions) of IEC 721-3-1 is shown in Annex D.

4.2 Transportation conditions

The requirements for the equipment, including its protection (not the equipment itself) depends on the means of transportation and the transportation route.

IEC 721-3-2 can serve as a guide.

5 Requirements for input and output quantities of PLC terminals

5.1 General

In all test procedures which require the use of a pair of PLC terminals, the carrier-frequency inputs and outputs (point G of Figure 2 and Figure 3) shall be connected by an artificial line (resistive attenuator with an attenuation in dB which is equal to the nominal carrier-frequency output power level in dBm minus 15 dB), matched to the nominal impedance of the terminals.

$$A\ (\text{dB}) = L_{\text{nom}}\ (\text{dBm}) - 15\ \text{dB}$$

where

A is the artificial line attenuation.;

L_{nom} is the nominal carrier-frequency output power level.

5.2 Carrier-frequency side

5.2.1 Carrier-frequency range and bands

The typical carrier-frequency range is 40 kHz to 500 kHz and the manufacturer shall state the range of carrier frequencies within which the recommended values will be maintained. Parts of the range may be barred by national regulations.

5.2.2 Nominal impedance, return loss and tapping loss

The nominal impedance at the carrier-frequency interface shall be 75 Ω (unbalanced) or 150 Ω (balanced). Other impedance values may be agreed between manufacturer and purchaser.

The return loss within the nominal carrier-frequency transmit band shall be not less than 10 dB.

The impedance outside the nominal carrier-frequency transmit and receive band shall be such that any other PLC equipment, connected to the same coupling equipment, shall not suffer from a tapping loss higher than indicated in Figure 5.

5.2.3 Balance to ground

For carrier-frequency interface of the balanced type the balance to ground shall not be less than 40 dB at power frequency (50 Hz or 60 Hz).

The measuring circuit for the determination of the balance to ground is indicated in Figure 6a.

5.2.4 Spurious emissions

The maximum permitted level of spurious emissions is indicated in Figure 7.

In order to measure spurious emissions, the transmitter shall be modulated by two sinusoidal signals of equal amplitude, the transmitter being terminated with a resistive load equal to the nominal impedance.

For equipment with a 4 kHz basic carrier-frequency band the frequencies shall be 350 Hz and 3 300 Hz.

For equipment with a 2,5 kHz basic carrier-frequency band the frequencies shall be 350 Hz and 2 300 Hz.

The amplitude of the test signals shall be chosen so that each produces a quarter of the stated nominal carrier-frequency output power.

The measurement shall be made with the aid of a selective level measuring set with an adequate bandwidth. It is necessary to ensure that the limiting action of the limiter, if any, does not occur when making this measurement.

5.2.5 Carrier-frequency levels

The carrier-frequency levels of speech and signals shall be subject to agreement between manufacturer and purchaser. IEC 663 may serve as a guideline.

5.2.6 Frequency accuracy

The virtual carrier-frequency shall not differ from its nominal value by more than ± 10 Hz.

5.3 Voice-frequency side

The following requirements apply to terminals without compandors. If compandors are used, reference can be made to the relevant CCITT Recommendations (Volume III, Fascicle III.1). Guidelines on the use of compandors are given in IEC 663.

5.3.1 Common requirements

This subclause contains requirements that are common to the two versions defined as “Standard terminal” and “Speech-plus terminal”.

5.3.1.1 *Automatic gain control*

In the case of a 30 dB change in carrier-frequency signal level within the regulation range, the change in voice-frequency receive levels of both speech and signals shall be less than 1 dB. The automatic gain control characteristic shall be coordinated with the teleprotection requirements.

5.3.1.2 *Transmit/receive frequency difference*

In a pair of PLC terminals, the frequency difference between a voice-frequency signal applied to the transmit end and that received at the receive end shall not exceed 2 Hz (CCITT Recommendation G.135).

For data transmission synchronization of the PLC terminals is recommended.

5.3.1.3 *Noise generated within the terminals*

The weighted telephone noise level, measured at the voice-frequency output or the speech output (point A′ in Figure 2 or point B′ in Figure 3) of a pair of PLC terminals shall not exceed – 55 dBm0p.

The measurement shall be made in the absence of any signal transmission (except for pilot signal or reduced carrier).

5.3.1.4 *Harmonic distortion*

The harmonic distortion of a pair of PLC terminals shall be measured at the output (point A′ in Figure 2 or point B′ in Figure 3). A test sinusoidal signal with a frequency of 350 Hz and a level of – 3 dBm0 shall be injected at the input (point A in Figure 2 or B in Figure 3). The level of each component measured at the output shall be lower than – 40 dBm0.

5.3.1.5 *Selectivity*

When a sinusoidal signal with a frequency of 300 Hz outside the nominal carrier-frequency receive band is injected at the carrier-frequency side of a PLC terminal with a level of + 10 dBm0, the level of the received signal at the voice-frequency side shall be less than – 55 dBm0.

When a sinusoidal signal with a frequency of 4 kHz or more outside the nominal carrier-frequency receive band, for the 4 kHz basic carrier-frequency band version, is injected with a level of + 20 dBm0, the level of the received signal at the voice-frequency side shall be less than – 55 dBm0.

For the 2,5 kHz version the signal injected outside the nominal carrier-frequency receive band shall be 2,5 kHz or more.

The test is carried out on a link by injecting the signal at the carrier-frequency interface of one terminal by means of an external signal source and a hybrid (see Figure 8).

5.3.1.6 *Nominal impedance and return loss*

The nominal impedance of all voice-frequency inputs and outputs shall be 600 Ω (balanced).

The return loss shall not be less than 14 dB within the effectively transmitted frequency band.

5.3.1.7 *Balance to ground*

For all voice-frequency inputs and outputs the balance to ground shall not be less than 40 dB within the effectively transmitted frequency band. Measuring circuits are indicated in Figure 6a and Figure 6b.

5.3.1.8 *Telephone signalling channel*

The manufacturer shall specify the type of modulation and the frequency band used.

The pulse distortion shall not exceed 10 % when the signalling channel is operated at a speed of 30 bauds.

The signalling channel shall be operated by a potential free open or closed contact or by earthing at the transmit side (point C in Figure 2 or Figure 3) and shall provide a potential free contact or earth at the receive side (point C′ in Figure 2 or Figure 3).

The input shall operate with a loop resistance of up to 500 Ω.

The output contact shall be able to switch up to 72 V and 50 mA on a resistive load.

5.3.1.9 *Limiter action*

The limiter associated with the channel shall produce a limiting effect defined as follows.

The action of the limiter shall start between – 3 dBm0 and 0 dBm0 for any sinusoidal signal of a frequency between 300 Hz and the upper frequency of the channel.

The level of the carrier-frequency output signal (point G in Figure 2 and Figure 3) measured by means of a true r.m.s. non-selective level meter shall not exceed + 3 dBm0 for an increase in the voice-frequency input signal to a level of + 15 dBm0.

5.3.1.10 *Teleprotection interface*

Both the standard terminal and the speech-plus terminal may have separate interfaces for teleprotection signals. The interfaces may consist of voice-frequency inputs, voice-frequency outputs and control circuits.

Frequency band

The nominal frequency band used shall be specified by the manufacturer. The inputs and outputs should preferably be decoupled from the other signal inputs and outputs.

Levels

The maximum specified carrier-frequency output power for the teleprotection signal should preferably be obtained for any level between 0 dBm to – 20 dBm at the teleprotection transmit input. For the maximum received teleprotection carrier-frequency level, the level at the teleprotection receive output should preferably be between 0 dBm and – 20 dBm. Specific values are subject to agreement between the manufacturer and the purchaser.

Control circuits

Control inputs may be provided to accomplish boosting of the teleprotection signal to a maximum specified carrier-frequency output power and to interrupt the other signals for a short time of typically less than 500 ms during teleprotection transmission or reception.

The control inputs shall operate with a loop resistance of up to 500 Ω.

Control outputs may be provided to give an alarm to the teleprotection equipment in case of maloperation of the PLC link.

5.3.1.11 *Voltage withstand and electromagnetic compatibility requirements*

NOTE The requirements of this subclause may be changed some time in the future in order to correspond more closely with identical clauses of other International Standards within the scope of IEC technical committee 57.

The requirements are listed in Table 2 and Table 3.

The insulation test shall be carried out with the equipment under test ready to operate, but not switched on.

The EMC tests shall be carried out with the equipment in operation.

The equipment shall not suffer permanent damage from the tests, and after the tests the equipment shall be checked for correct operation. The test procedures shall be in accordance with the IEC standards listed in Table 2 and Table 3.

5.3.2 Standard equipment

5.3.2.1 *Frequency band*

The effectively transmitted voice-frequency band is 300 Hz to 3 400 Hz.

Outside this band there may be available bandwidth for local point-to-point connection (e.g. for telephone signalling, teleprotection or data transmission).

5.3.2.2 *Attenuation distortion*

The attenuation distortion of a pair of PLC terminals measured between the voice-frequency input and output (points A and A′ in Figure 2) shall meet the CCITT Recommendation G.232 (see Figure 9).

5.3.2.3 *Group-delay distortion*

The group-delay distortion of a pair of PLC terminals measured between the voice-frequency input and output (points A and A′ in Figure 2) shall meet the CCITT Recommendation G.232 (see Figure 10).

5.3.2.4 *Near-end and far-end crosstalk due to signals above 3 400 Hz*

Near-end and far-end crosstalk, due to signals in this band, in a pair of PLC terminals shall not give rise to a weighted disturbance power level of more than – 50 dBm0p measured at the output (point A′ in Figure 2) both for the near-end and far-end PLC terminals.

5.3.2.5 *Input and output levels*

The input level should preferably be adjustable from 0 dBr to – 20 dBr, and the output level should preferably be adjustable between 0 dBr and – 20 dBr.

5.3.3 Speech-plus equipment

5.3.3.1 *Speech-band*

Recommended values for the effectively transmitted speech band are:

— 300 Hz to 2 400 Hz

— 300 Hz to 2 000 Hz

5.3.3.2 *Attenuation distortion*

The attenuation distortion of a pair of PLC terminals measured between the speech input and output (points B and B′ in Figure 3) shall meet the requirements in Figure 11.

5.3.3.3 *Group-delay distortion*

The group-delay distortion of a pair of PLC terminals measured between the speech input and output (points B and B′ in Figure 3) shall meet the requirements in Figure 12.

5.3.3.4 *Near-end and far-end crosstalk due to signal channels*

Near-end and far-end crosstalk, due to signal channels, either individually or collectively, in a pair of PLC terminals, shall not give rise to a weighted disturbance power level of more than – 50 dBm0p measured at the output (point B′ in Figure 3) both for the near-end and the far-end PLC terminals.

The test shall be carried out by injecting a single sinusoidal voice-frequency signal with a level of – 8 dBm0 at point D in Figure 3. The signal shall be slowly swept over the frequency band used.

If there is no continuously transmitted signal present in the frequency band above the speech band, a second sinusoidal signal with a level of – 8 dBm0 and a frequency of 3 300 Hz for the 4 kHz basic carrier-frequency band version or 2 300 Hz for the 2,5 kHz basic carrier-frequency band version shall be injected for the test.

5.3.3.5 ***Speech levels***

The relative four-wire levels used for speech (points B and B′ of Figure 3) differ from country to country. They should preferably lie within the following ranges:

— four-wire transmit: 0 dBr to – 17 dBr;

— four-wire receive: + 8 dBr to – 3,5 dBr.

Specific values are subject to agreement between the manufacturer and the purchaser.

The recommended values are:

— four-wire transmit: – 3,5 dBr;

— four-wire receive: – 3,5 dBr;

— two-wire transmit: 0 dBr;

— two-wire receive: – 7 dBr.

NOTE There may be a need for a system measuring signal below the level where the action of the limiter starts. In lining up levels it is imperative that limiting is not taking place.

5.3.3.6 ***Frequency band above speech-band***

To utilize the frequency band above the speech-band there are two different solutions:

— Broad-band solution, where the band limitation is carried out in the connected equipment. Attenuation distortion and group-delay distortion shall be according to **5.3.2.2** and **5.3.2.3** for the applicable part of the frequency band.

— Band-limited solution, where the manufacturer defines the effective bandwidth. Attenuation distortion and group-delay distortion are subject to agreement between the manufacturer and the purchaser.

The input level should preferably be adjustable from 0 dBr to – 20 dBr, and the output level should preferably be adjustable from 0 dBr to – 20 dBr. Specific values are subject to agreement between the manufacturer and the purchaser.

Table 2 — Voltage withstand requirements

IEC standards	Power supply	Carrier frequency input/ output	Voice frequency interface			Alarm and signalling contacts	Accessible measuring points on front panel
			Speech	Voice-frequency signals	Teleprotection IEC 834-1		
INSULATION A.C., mains supply IEC 255-5	2 000 V_{rms}	—	—	—	—	—	—
D.C., battery supply Supply voltage < 60 V ≥ 60 V, ≤ 300 V IEC 255-5	 500 V_{rms} 2 000 V_{rms}	 — —	 — —	 — —	 — —	 — —	 — —
Inputs/outputs galvanically separated	—	2 000 V_{rms}	500 V_{rms}	500 V_{rms}	500 V_{rms}	500 V_{rms}	—
Insulation resistance IEC 255-5, 500 V	≥ 10 MΩ	≥ 10 MΩ	≥ 10 MΩ	≥ 10 MΩ	≥ 10 MΩ	≥ 10 MΩ	—

Table 3 — Electromagnetic compatibility requirements

IEC standards	Power supply	Carrier frequency input/output	Voice frequency interface			Alarm and signalling contacts	Accessible measuring points on front panel
			Speech	Voice-frequency signals	Teleprotection IEC 834-1		
Electromagnetic compatibility							
Impulse voltage with-stand test IEC 255-4	CM DM	CM DM	CM DM	CM DM	CM DM	CM DM	—
Class III	5 kV 5 kV	5 kV 5 kV					
Class II			1 kV 1 kV	1 kV 1 kV	1 kV 1 kV	1 kV 1 kV	—
High frequency disturbance test IEC 255-22-1	CM DM	CM DM	CM DM	CM DM	CM DM	CM DM	—
Classe III	2,5 kV 1 kV	2,5 kV 1 kV					
Classe II			1 kV 0,5 kV	1 kV 0,5 kV	1 kV 0,5 kV	1 kV 0,5 kV	—
Electrostatic discharge requirements IEC 801-2 Class III	—	—	—	—	—	—	8 kV
Radiated electromagnetic field requirements IEC 801-3	10 V/m						
Electrical fast transient/bursts requirements IEC 801-4 Level 3	2 kV	2 kV	1 kV	1 kV	1 kV	1 kV	—

CM: Common mode

DM: Differential mode

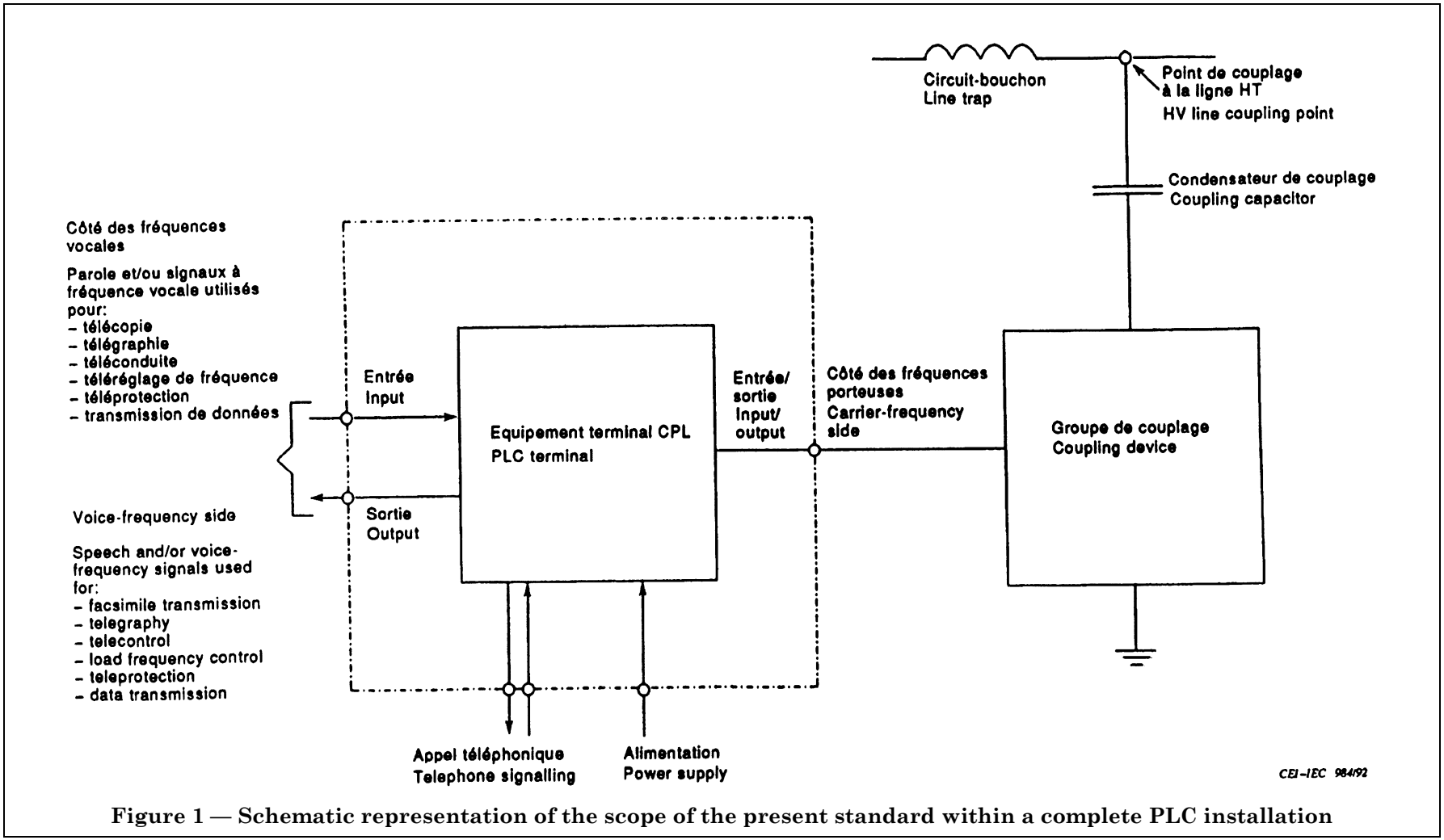


Figure 1 — Schematic representation of the scope of the present standard within a complete PLC installation

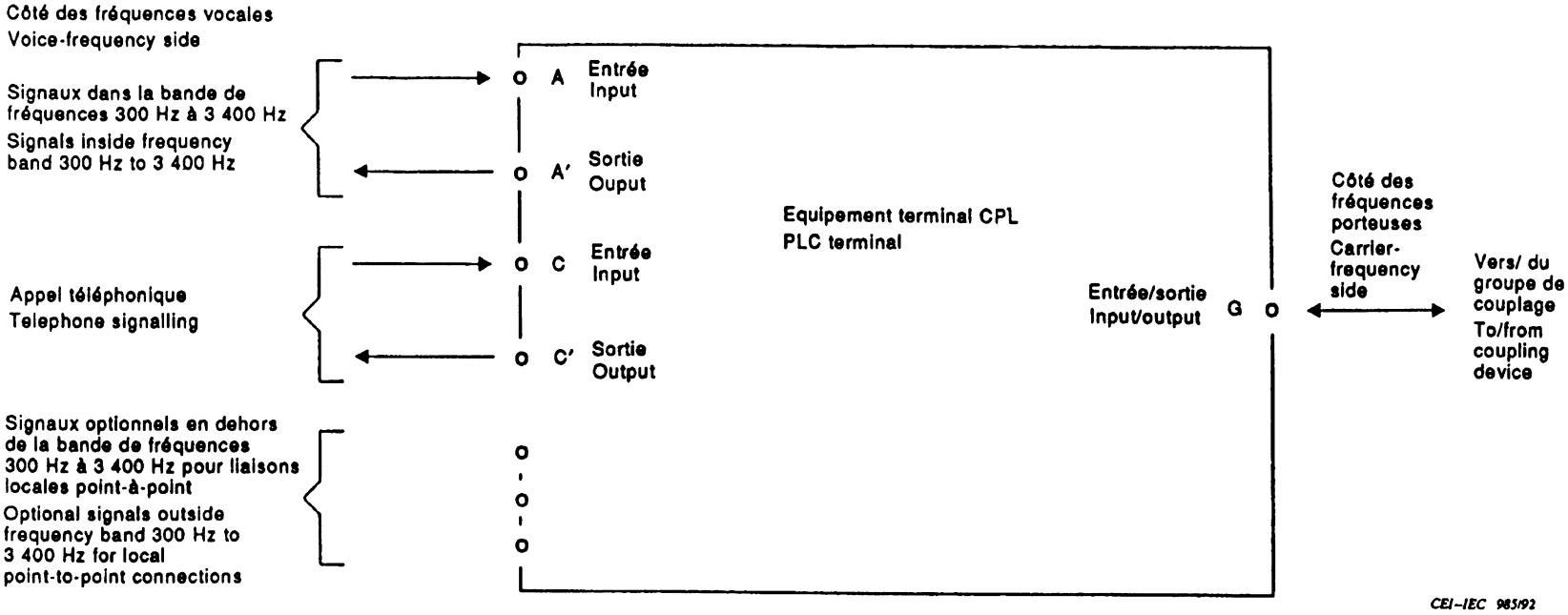


Figure 2 — Schematic representation of a standard PLC terminal

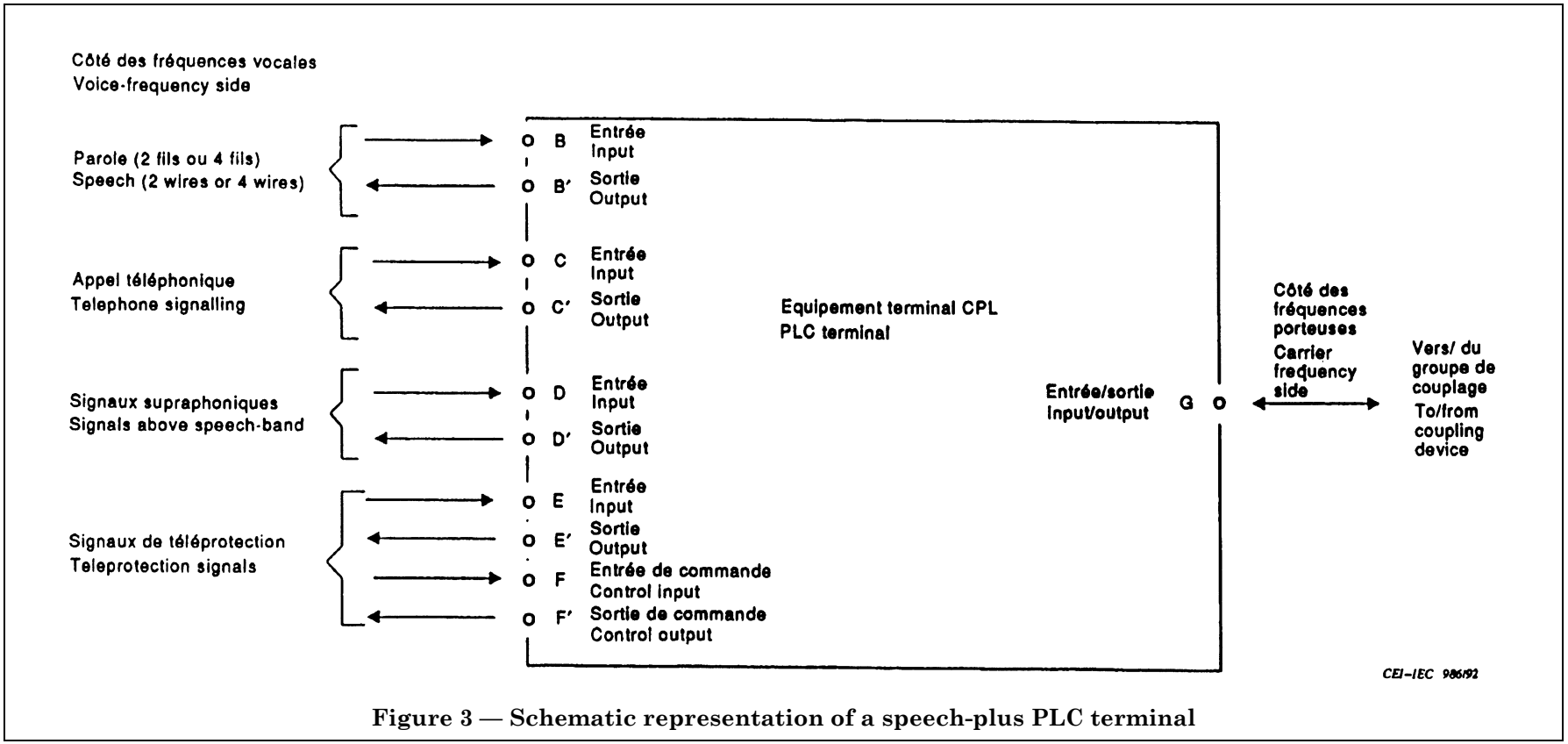


Figure 3 — Schematic representation of a speech-plus PLC terminal

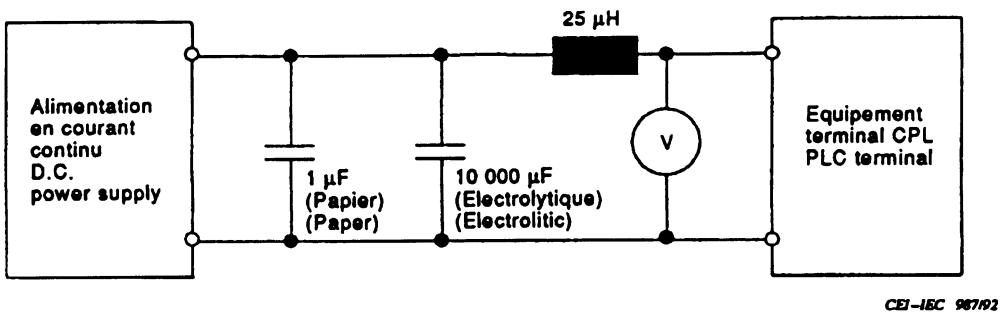
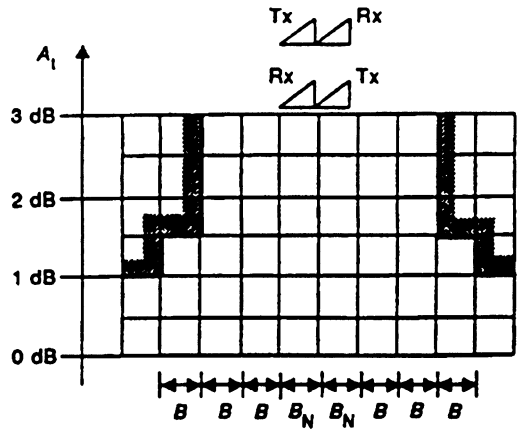
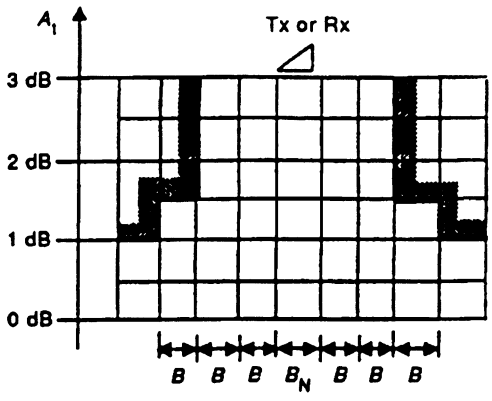


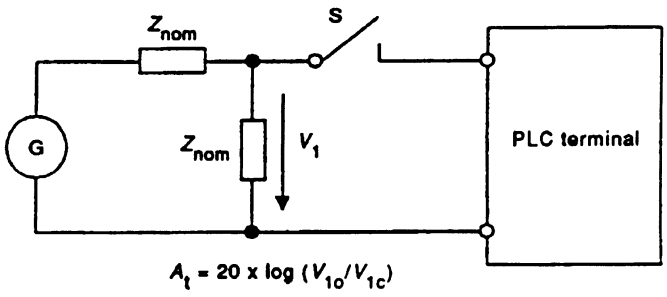
Figure 4 — Test circuit for conducted noise from PLC terminal to DC power supply measurement



Adjacent transmit and receive bands

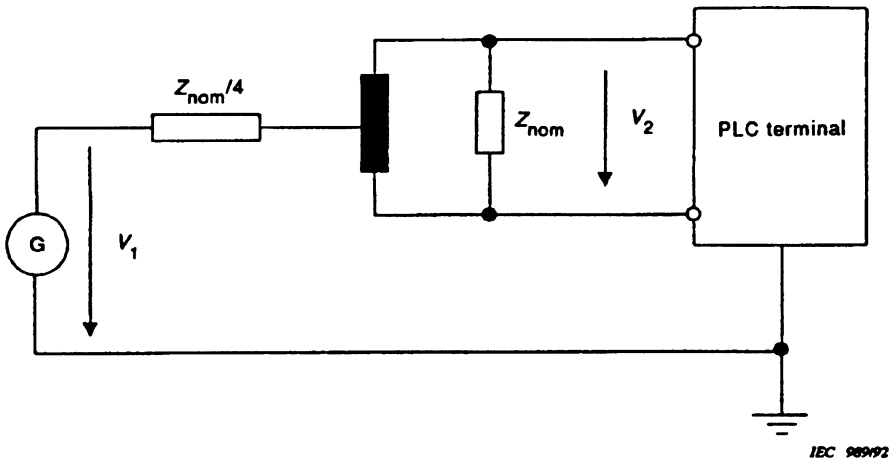


Non-adjacent transmit and receive bands



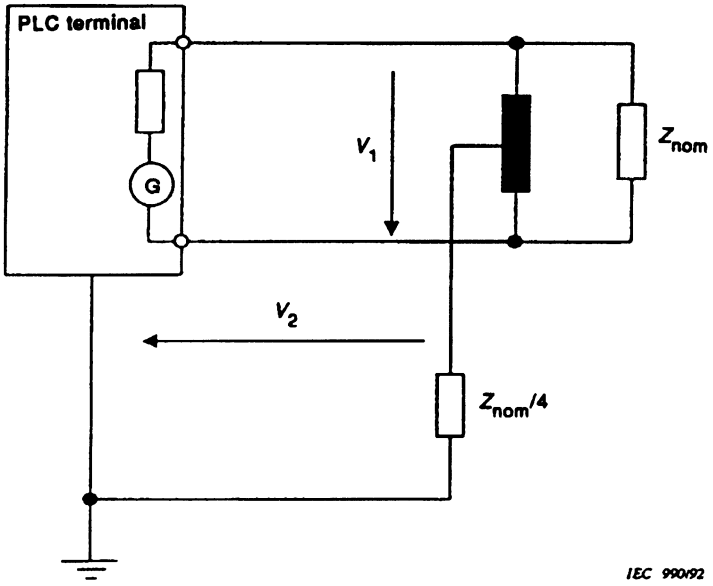
A_t is the tapping loss;
V_{1o} is the signal level with switch S open;
V_{1c} is the signal level with switch S closed;
B_N is the nominal carrier-frequency band ;
B is the basic carrier-frequency band.

Figure 5 — Permissible limits for the tapping loss for a single channel PLC terminal



Balance to ground = $20 \times \log (V_1/V_2)$ (dB)
NOTE See CCITT Recommendation 0.121, subclause **2.1**.

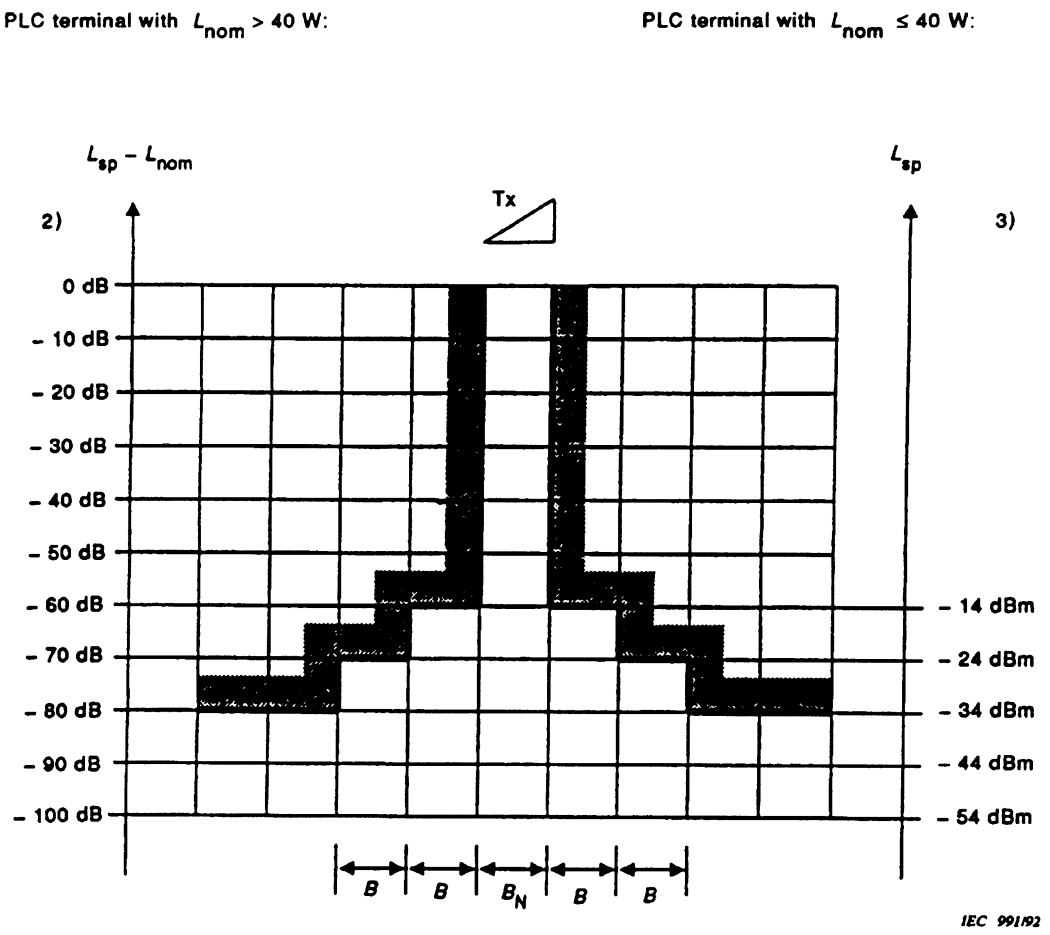
Figure 6a — Circuit for points A and G in Figure 2 and points B, D, E and G in Figure 3



Balance to ground = $20 \times \log (V_1/V_2)$ (dB)
NOTE See CCITT Recommendation 0.121, subclause **2.7.**

Figure 6b — Circuit for point A′ in Figure 2 and points B′, D′, and E′ in Figure 3

Figure 6 — Test circuits for balance to ground measurement



B is the basic carrier-frequency band;

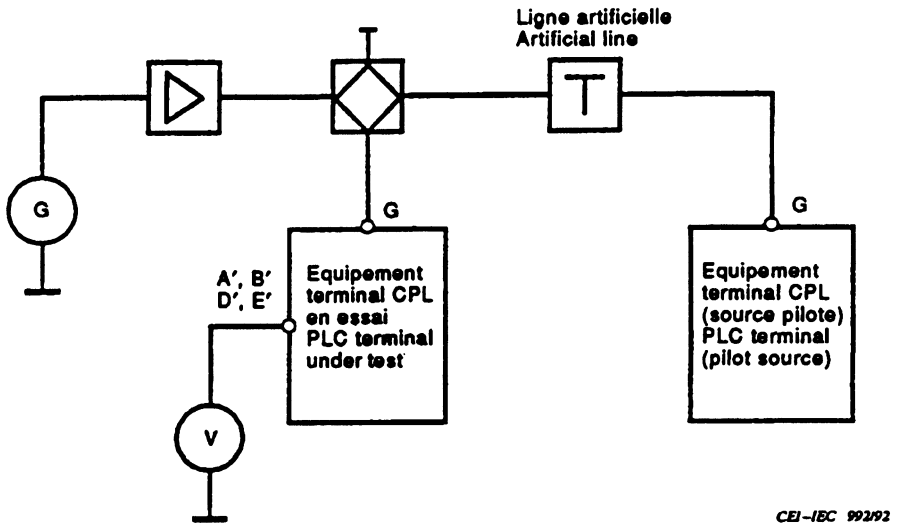
B_N is the nominal carrier-frequency transmit band;

L_{sp} is the level of spurious emissions;

L_{nom} is the nominal carrier-frequency output power level.

NOTE 1 Spurious emission shall be measured as described in **5.2.4**.
NOTE 2 The scale in dB holds for PLC terminals with a nominal carrier-frequency output power in excess of 40 W.
NOTE 3 The scale in dBm holds for PLC terminals with a nominal carrier-frequency output power of 40 W or less.

Figure 7 — Maximum level of spurious emissions outside the nominal carrier-frequency transmit band for a single channel PLC terminal



NOTE Points A′, B′, C′ and G refer to Figure 2 and Figure 3.

Figure 8 — Test circuit for selectivity measurement

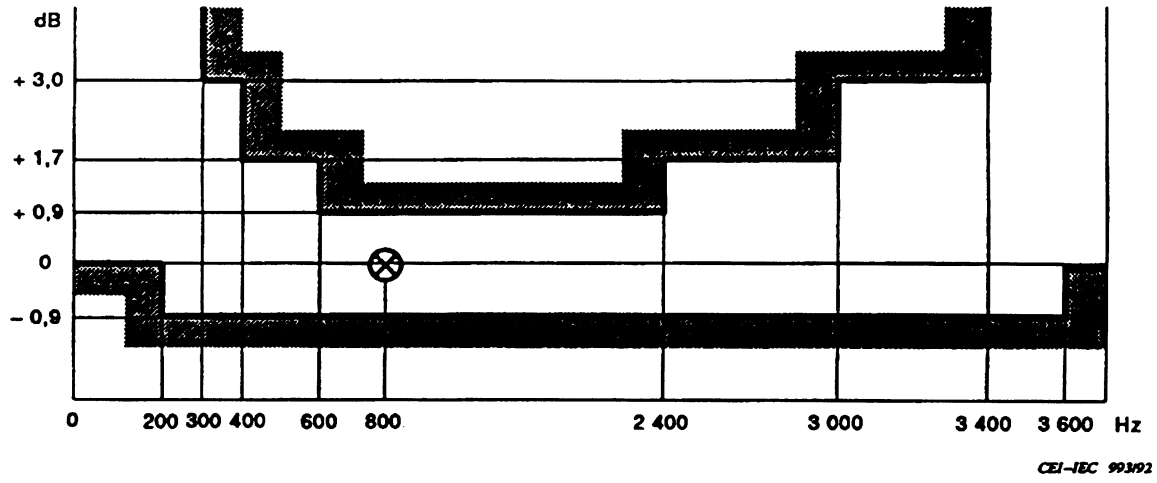


Figure 9 — Standard terminal — Permissible limits for the attenuation distortion of a pair of transmitting and receiving PLC terminals

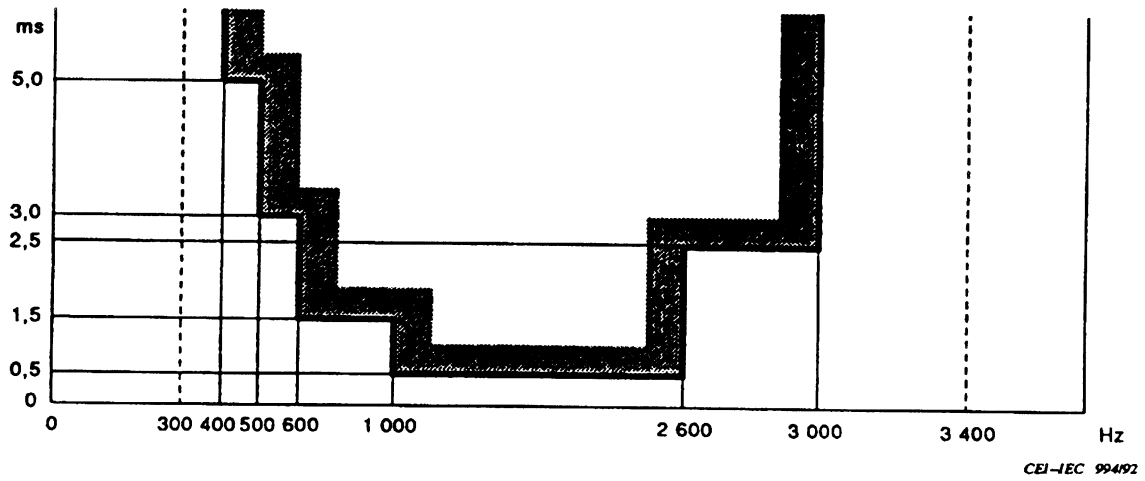
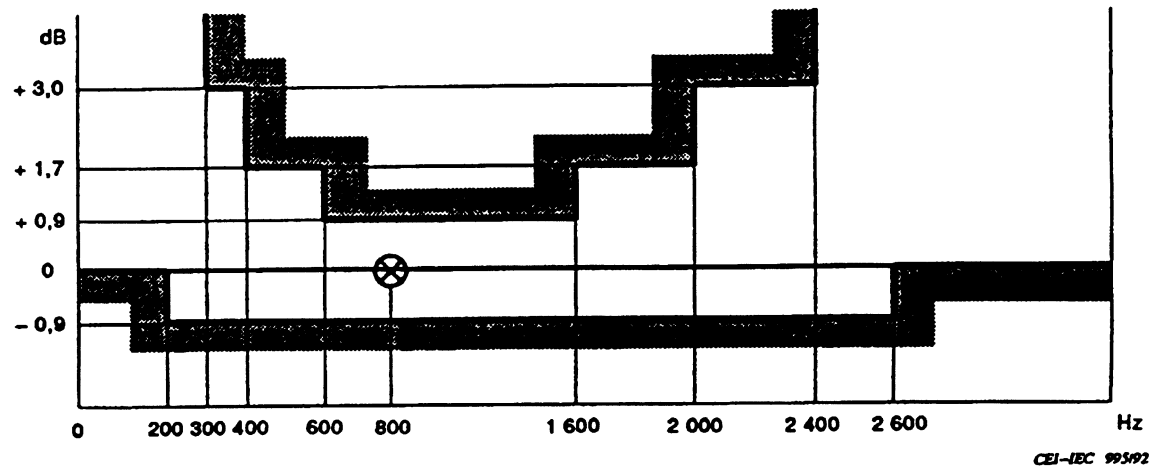


Figure 10 — Standard terminal — Permissible limits for the group-delay distortion of a pair of transmitting and receiving PLC terminals



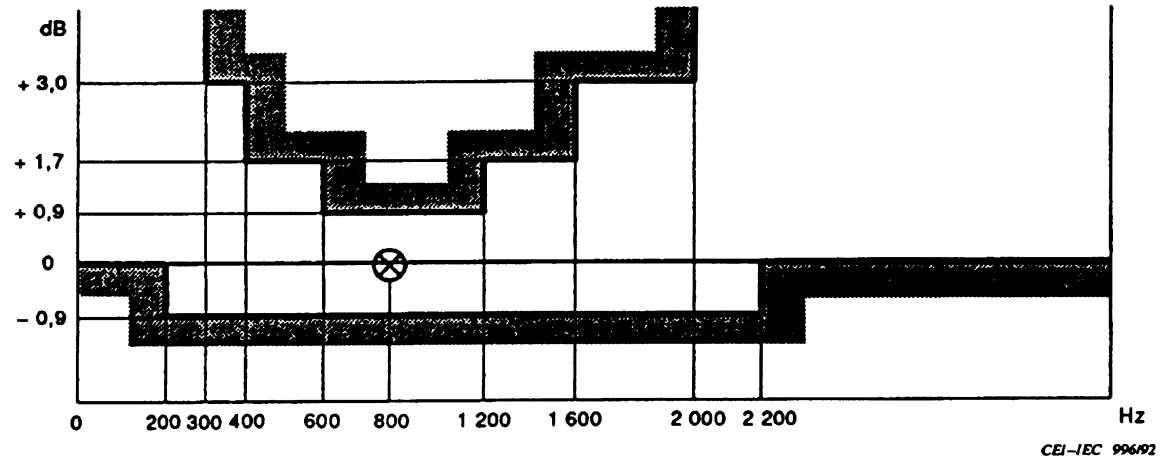


Figure 11 — Speech-plus terminal — Permissible limits for attenuation distortion of a pair of transmitting and receiving PLC terminals for the two versions of speech band

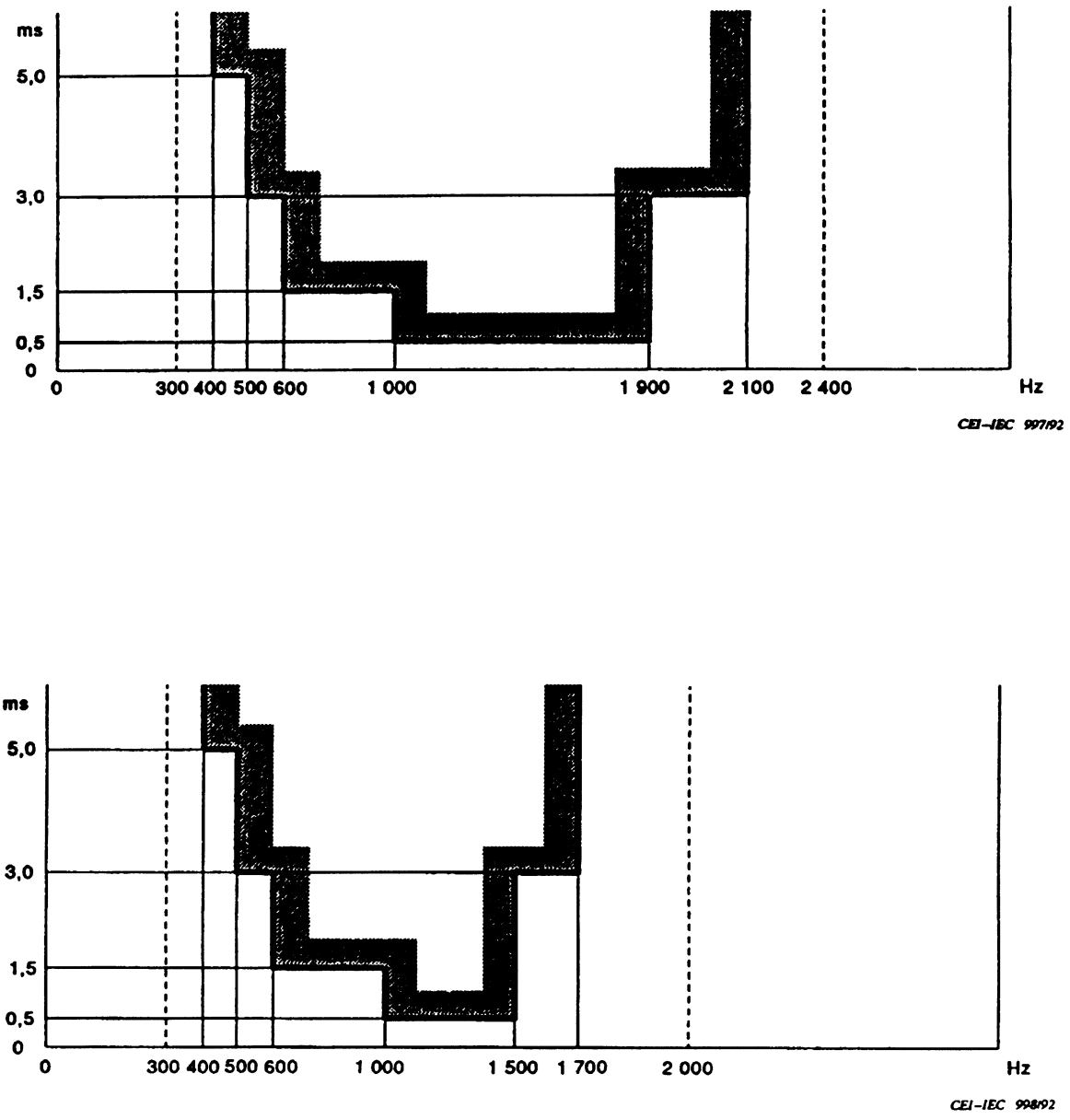


Figure 12 — Speech-plus terminal — Permissible limits for group-delay distortion of a pair of transmitting and receiving PLC terminals for the two versions of speech band

Annex A (normative)
Particular recommendations for multichannel terminals

A.1 Scope and object

These recommendations apply to multichannel equipments where the general requirements listed in clause **5** of this International Standard are not pertinent.

For multichannel equipment the general requirements in clause **5** will apply unless specifically amended or augmented in this annex.

The object of this annex is the same as in the general case (clause **1.1**) but the two versions defined in **1.1** may both be applicable to a multichannel equipment. In one multichannel equipment some channels may have "standard terminal" interfaces and others "speech-plus terminal" interfaces.

A.2 Definitions

The definitions in clause **2** apply with these comments:

A.2.1 *Nominal carrier-frequency band* (see **2.2.3**)

Generally each one-way channel of a multichannel PLC equipment uses a band equal to the basic carrier-frequency band and these bands are adjacent; so the nominal carrier-frequency band of the equipment has a bandwidth equal to $n \times B$ (n = number of channels; B = basic carrier-frequency band). Generally n is even (2, 4 or 6). The transmit and receive carrier-frequency bands may be adjacent or non-adjacent.

A.2.2 *Carrier-frequency output power* (see **2.4**)

Generally, the peak envelope power of an equipment is limited by spurious emissions due to the carrier-frequency output amplifier. In this case, assuming the same power for each channel, the ratio between the peak envelope power of the equipment and the peak envelope power of one channel is n^2.

A.3 Requirements for input and output quantities of PLC terminals

The recommendations in clause **5** apply with these changes and additions:

A.3.1 *General* (see **5.1**)

The artificial line shall have an attenuation in dB which equals:

$$A\ (\text{dB}) = L_{\text{nom}}\ (\text{dBm}) - 15\ \text{dB} - 20 \log (n)$$

where

A	is the artificial line attenuation;
L_{nom}	is the nominal carrier-frequency output power level;
n	is the number of channels.

A.3.2 *Nominal impedance, return loss and tapping loss* (see **5.2.2**)

The impedance outside the nominal carrier-frequency transmit and receive band shall be such that any other PLC equipment, connected to the same coupling equipment, shall not suffer from a tapping loss higher than indicated in Figure A.1.

A.3.3 *Spurious emissions* (see **5.2.4**)

In order to measure spurious emissions, the transmitter shall be modulated by a sinusoidal voice-frequency signal of 2 000 Hz applied simultaneously with the same amplitude to each voice-frequency channel interface, the transmitter being terminated with a resistive load equal to the nominal impedance.

The amplitude of the test signal shall be chosen so as to produce a $1/n^2$ part of the stated nominal carrier-frequency output power of the terminal.

The maximum permitted level of spurious emissions is indicated in Figure A.2.

A.3.4 *Interchannel crosstalk attenuation*

The near-end and far-end crosstalk attenuation measured between points A, B or D of a channel and points A′, B′ or D′ of the other channels for the near-end terminal, and between points A′, B′ or D′ of the considered channel and points A′, B′ or D′ of the other channels for the far-end terminal, in a pair of multichannel PLC terminals, shall be not less than 50 dB (see Figure 2 and Figure 3).

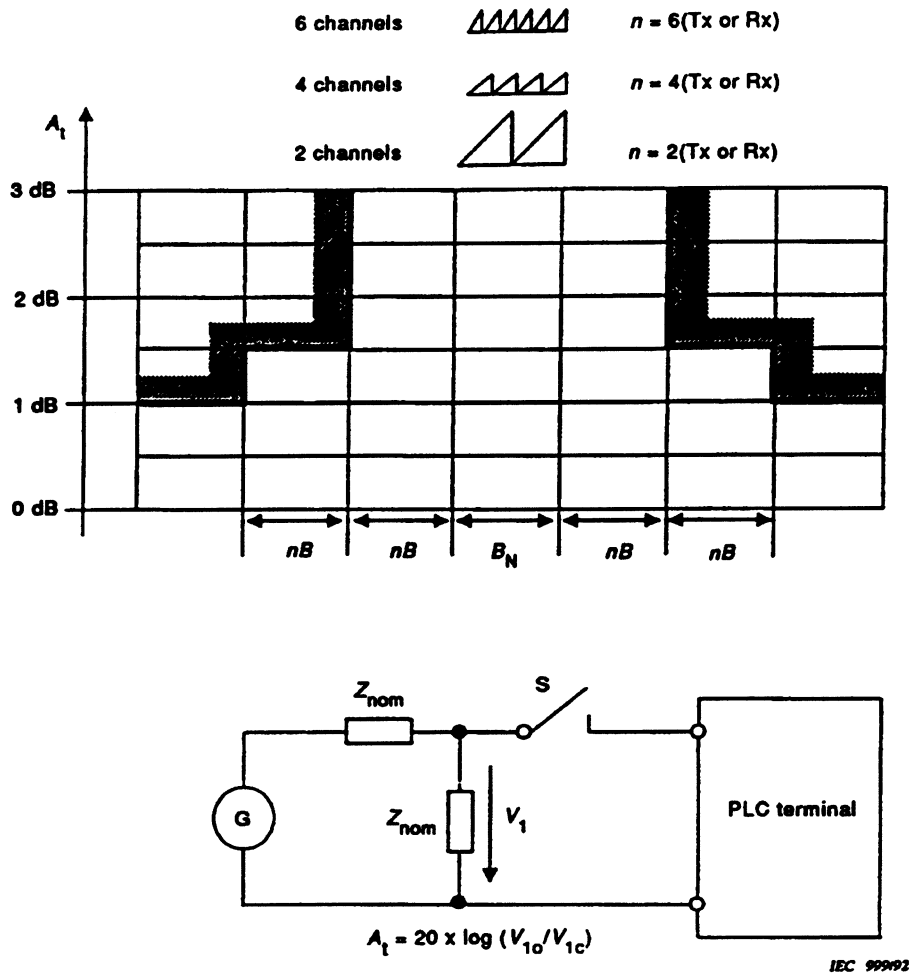
The test shall be carried out by injecting two sinusoidal voice-frequency signals in one channel in the absence of any other signal transmission.

For equipment with a 4 kHz basic carrier-frequency band, the signal frequencies shall be 350 Hz and 3 300 Hz, (the 3 300 Hz signal being injected in the signal band in the case of a speech-plus channel).

For equipment with a 2,5 kHz basic carrier-frequency band, the signal frequencies shall be 350 Hz and 2 300 Hz (the 2 300 Hz signal being injected in the signal band in the case of a speech plus-channel).

The amplitude of these test signals shall be chosen so that each one produces a 1/4 n^2 part of the stated nominal carrier-frequency output power of the PLC terminal.

The measurement shall be made with a selective level measuring set with an adequate bandwidth and shall include harmonics and intermodulation products. Limiting shall not take place when making this measurement.



A_t is the tapping loss;

V_{1o} is the signal level with switch S open;

V_{1c} is the signal level with switch S closed;

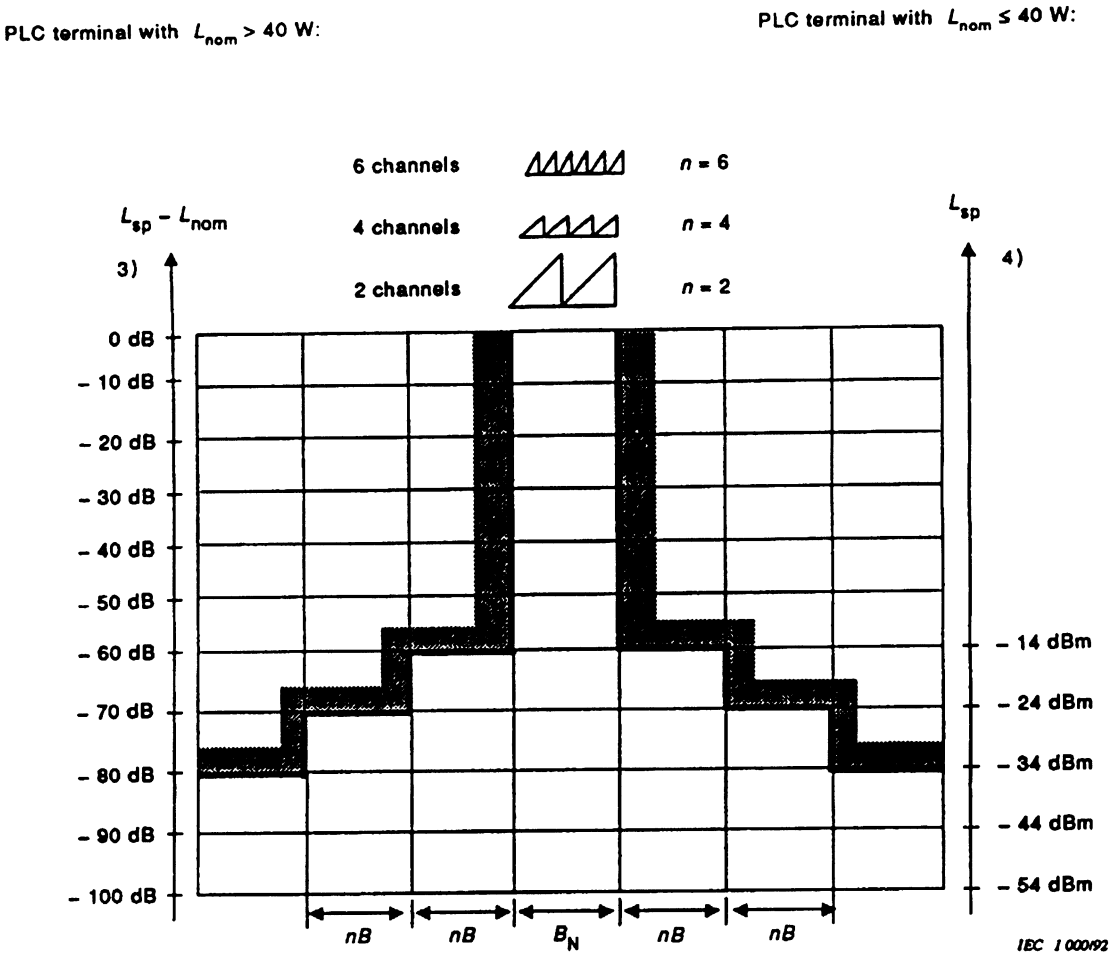
B_N is the nominal carrier-frequency band;

B is the basic carrier-frequency band;

n is the number of channels.

NOTE The channels may be arranged in any combination of frequency erect or frequency inverted position.

Figure A.1 — Permissible limits for the tapping loss for a multichannel PLC terminal



B is the basic carrier-frequency band;

B_N is the nominal carrier-frequency transmit band;

L_{sp} is the level of spurious emissions;

L_{nom} is the nominal carrier-frequency output power;

n is the number of channels.

NOTE 1 Spurious emissions shall be measured as described in **A.3.3**.
NOTE 2 The channels may be arranged in any combination of frequency erect or frequency inverted position.
NOTE 3 The scale in dB holds for PLC terminals with a nominal carrier-frequency output power in excess of 40 W.
NOTE 4 The scale in dBm holds for PLC terminals with a nominal carrier-frequency output power of 40 W or less.

Figure A.2 — Maximum level of spurious emissions outside the nominal carrier-frequency transmit band for a multichannel PLC terminal

Annex B (informative)
Definitions

B.1 Level notations

B.1.1 *Power ratios*

Decibels are used as a measure of the logarithmic ratio, to the base of 10, of powers, of voltages or of currents, which may also be referred to as levels.

Power ratios are defined as follows:

$$X\ \text{dB} = 10 \log \frac{P_1}{P_2} \qquad \text{[IEV 55-05-120, modified]}^{a}$$

[a] IEC 50(55): 1970, *International Electrotechnical Vocabulary (IEV) — Chapter 55: Telegraphy and telephony*.

B.1.2 *Absolute power level*

The absolute power level referred to 1 mW is defined by the expression:

$$X\ \text{dBm} = 10 \log \frac{P}{1\text{mW}} \qquad \text{[IEV 55-05-130, modified]}$$

B.1.3 *Relative power level*

The relative power level referred to the power level at a reference point (generally the origin of the transmission system) is defined by the expression:

$$X\ \text{dBr} = 10 \log \frac{P}{P_{\text{ref}}} \qquad \text{[IEV 55-05-155, modified]}$$

Thus a power level of X dBm will be measured at an X dBr point if a 1 mW test signal is present at a point of zero relative level, assuming that no limiting action is taking place.

B.1.4 *System power level*

The term of X dBm0 is used to indicate a power level of X dB above or below 1 mW at the point of zero relative level of the system, according to whether X is positive or negative, i.e. X dB above or below the test level at any point of the system.

B.1.5 *System psophometric power level*

The term dBm0p is used in the same sense as dBm0 when the level is measured with a psophometer instead of a flat-response level measuring set.

B.2 Test level in the speech circuit

The test level in the speech circuit is the absolute power level at any point of the circuit when the reference point, generally the origin of the system (the virtual or physical two-wire send leg input) is energized by means of a generator having an internal resistance of R ohms equal to the nominal impedance at the point of origin, and an e.m.f U_o equal to:

$$U_o = 2\sqrt{\frac{R}{1\,000}} \quad \text{V}$$

The test signal, unless otherwise specified, is of a frequency of 800 Hz [IEV 55-05-140, modified].

B.3 Peak envelope power

The (carrier-frequency) peak envelope power of a multiplex signal transmitter is the average power present during one cycle of the carrier-frequency at the highest crest of the modulation envelope (clause **1**, paragraph 95, and CCIR Recommendation 326-1, point 1.1).[1)]

It is recommended that in order to determine the peak envelope power the transmitter should be modulated by two sinusoidal voice-frequency signals of equal amplitude, located within the effectively transmitted frequency band. The transmitter is terminated by a resistive load equal to its nominal impedance and the limiter is not in operation.

[1)] XII plenary assembly of CCITT, 1970, Volume I.

The amplitude of the modulation signals shall so be chosen as to satisfy the requirements for spurious emissions. The peak envelope power is then considered to be four times the power of one of these signals, selectively measured (CCIR Recommendation 326-1, point 3.1.3.1).

B.4 Return loss

The return loss A_e is a measure for the mismatch between the nominal impedance of the equipment and its effective value observed at a particular frequency, and is expressed by:

$$A_e = 20 \log \left| \frac{Z + R}{Z - R} \right| \text{ (dB)}$$

where

Z is the effective impedance of the equipment;

R is the nominal value of the impedance [IEV 55-05-195 modified].

Annex C (informative)
Climatic conditions — Operation

Table C.1 — Classification of climatic conditions (from IEC 721-3-3, Table I)

Environmental parameter	Unit	Class										
		3K1	3K2	3K3	3K4	3K5	3K6	3K7	3K7L	3K8	3K8H	3K8L
a) Low air temperature	°C	+ 20[c]	+ 15	+ 5	+ 5	– 5	– 25	– 40	– 40	– 55	– 25	– 55
b) High air temperature	°C	+ 25[c]	+ 30	+ 40	+ 40	+ 45	+ 55	+ 70	+ 40	+ 70	+ 70	+ 55
c) Low relative humidity	%	20	10	5	5	5	10	10	10	10	10	10
d) High relative humidity	%	75	75	85	95	95	100	100	100	100	100	100
e) Low absolute humidity	g/m^3	4	2	1	1	1	0,5	0,1	0,1	0,02	0,5	0,02
f) High absolute humidity	g/m^3	15	22	25	29	29	29	35	35	35	35	29
g) Rate of change of temperature[a]	°C/min	0,1	0,5	0,5	0,5	0,5	0,5	1,0	1,0	1,0	1,0	1,0
h) Low air pressure[b]	kPa	70	70	70	70	70	70	70	70	70	70	70
i) High air pressure[b]	kPa	106	106	106	106	106	106	106	106	106	106	106
j) Solar radiation	W/m^2	500	700	700	700	700	1 120	1 120	None	1 120	1 120	1 120
k) Heat radiation	None	No	[f]	[f]	[f]	[f]	[f]	[f]	[f]	[f]	[f]	[f]
l) Movement of surrounding air[d]	m/s	0,5	1,0[e]	1,0[e]	1,0[e]	1,0[e]	1,0[e]	5,0[e]	5,0[e]	5,0[e]	5,0[e]	5,0[e]
m) Condensation	None	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
n) Wind-driven precipitation (rain, snow, hail, etc.)	None	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
o) Water from sources other than rain	None	No	No	No	[f]	[f]	[f]	[f]	[f]	[f]	[f]	[f]
p) Formation of ice	None	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[a] Averaged over a period of time of 5 min.
[b] Conditions in mines are not considered.
[c] These are air-conditioned locations with a tolerance of ± 2 °C on stated temperature values.
[d] A cooling system based on non-assisted convection may be disturbed by adverse movement of surrounding air.
[e] If applicable, a special value may be selected from table II of IEC 721-3-3.
[f] Conditions occurring at the locations concerned to be selected from Table II of IEC 721-3-3.

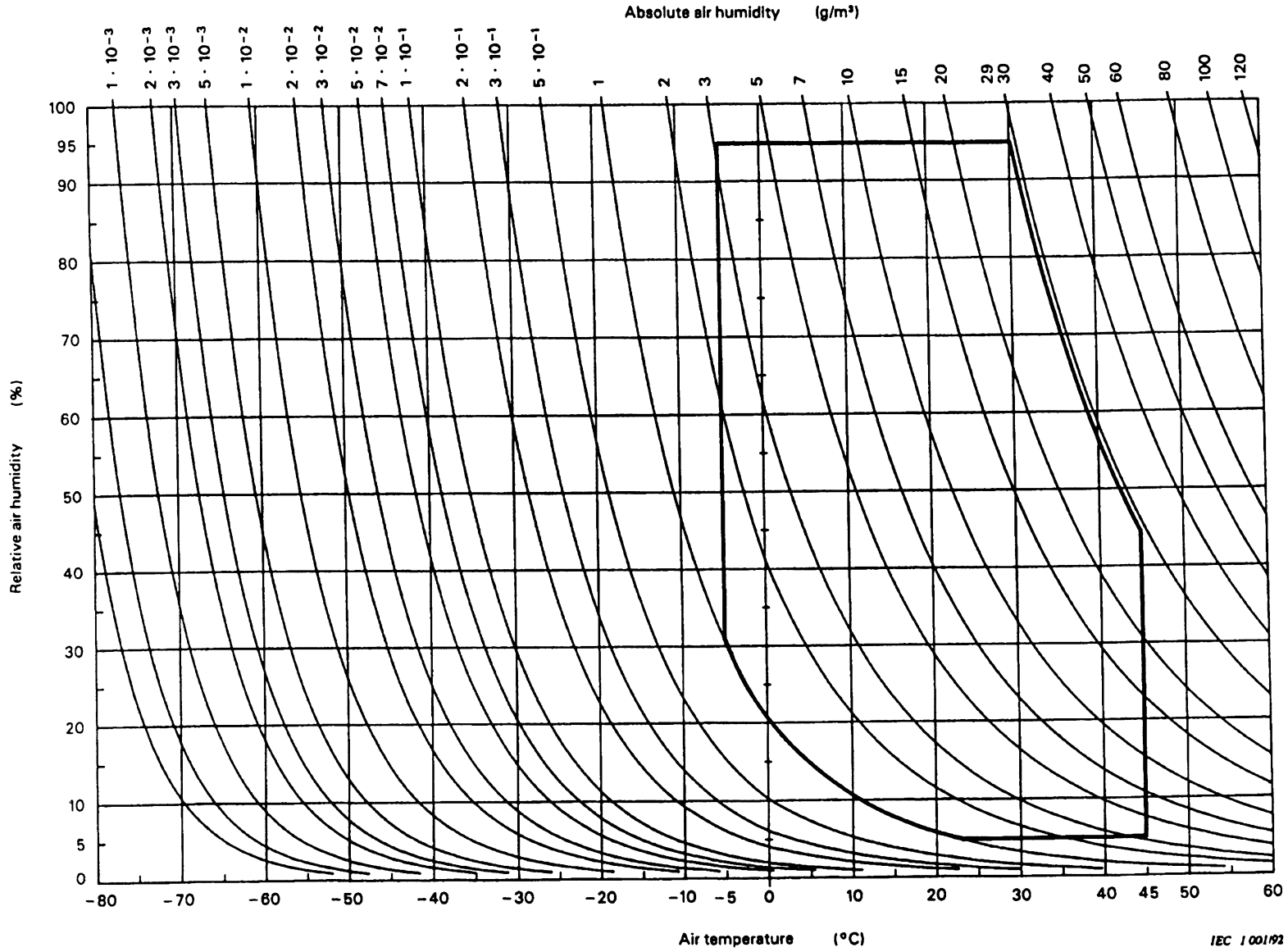


Figure C.1 — Climatogram for class 3K5 (from IEC 721-3-3, Figure B.5)

Annex D (informative)
Climatic conditions — Storage

Table D.1 — Classification of climatic conditions (from IEC 721-3-1, Table I)

Environmental parameter	Unit	Class[j]								
		1K1	1K2	1K3	1K4	1K5	1K6	1K7	1K8	1K9
a) Low air temperature	°C	+ 20[f]	+ 5	– 5	– 25	– 40	– 55	– 20	– 33	– 65
b) High air temperature	°C	+ 25[f]	+ 40	+ 45	+ 55	+ 70	+ 70	+ 35	+ 40	+ 55
c) Low relative humidity[a]	%	20	5	5	10	10	10	20	15	4
d) High relative humidity[a]	%	75	85	95	100	100	100	100	100	100
e) Low absolute humidity[a]	g/m^3	4	1	1	0,5	0,1	0,02	0,8	0,26	0,003
f) High absolute humidity[a]	g/m^3	15	25	29	29	35	35	22	25	36
g) Rate of change of temperature[b]	°C/min	0,1	0,5	0,5	0,5	1,0	1,0	0,5	0,5	0,5
h) Low air pressure[c]	kPa	70	70	70	70	70	70	70	70	70
i) High air pressure[c]	kPa	106	106	106	106	106	106	106	106	106
j) Solar radiation	W/m^2	500	700	700	1 120	1 120	1 120	1 120	1 120	1 120
k) Heat radiation	None	No	[g]	[g]	[g]	[g]	[g]	[g]	[g]	[g]
l) Movement of surrounding air[d]	m/s	0,5	1,0[h]	1,0[h]	1,0[h]	5,0[h]	5,0[h]	[h]	[h]	[h]
m) Condensation	None	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
n) Precipitation (rain, snow, hail, etc.)	None	No	No	No	Yes[i]	Yes[i]	Yes[i]	Yes	Yes	Yes
o) Rain intensity	mm/min	None	None	None	None[i]	None[i]	None[i]	6	6	15
p) Low rain temperature[e]	°C	None	None	None	None[i]	None[i]	None[i]	+ 5	+ 5	+ 5
q) Water from sources other than rain	None	No	No	[g]	[g]	[g]	[g]	[g]	[g]	[g]
r) Formation of ice and frost	None	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[a] The low and high relative humidities are limited by the low and high absolute humidities, so that e.g. for environmental parameters a) and c), or b) and d), the severities given in Table I of IEC 721-3-1 do not occur simultaneously.

[b] Averaged over a period of time of 5 min.

[c] The value of 70 kPa represents a limit for open-air conditions, normally at an altitude of 3 000 m. In some geographical areas open-air conditions may occur at higher altitudes. Conditions in mines are not considered.

[d] A cooling system based on non-assisted convection may be disturbed by adverse movement of surrounding air.

[e] This rain temperature should be considered together with high air temperature b) and solar radiation j). The cooling effect of the rain has to be considered in connection with the surface temperature of the product.

[f] These are air-conditioned locations with a tolerance of ± 2 °C on stated temperature value.

[g] Conditions occurring at the location concerned to be selected from Table II of IEC 721-3-1.

[h] If applicable, a special value may be selected from Table II of IEC 721-3-1.

[i] Applies to wind-driven precipitation at partially weatherprotected locations.

[j] The classes of climatic conditions of this standard include the classes of IEC Publications 721-3-3 and 721-3-4 as follows:

1K1 covers 3K1 1K3 covers 3K5 1K5 covers 3K7 1K7 covers 4K1 1K9 covers 4K4

1K2 covers 3K3 1K4 covers 3K6 1K6 covers 3K8 1K8 covers 4K2

Annex ZA (normative)
Other international publications quoted in this standard with the references of the relevant European publications

This European Standard 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 European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

NOTE When the international publication has been modified by CENELEC common modifications, indicated by (mod), the relevant EN/HD applies.

IEC publication	Date	Title	EN/HD	Date
38 (mod)	1983	*IEC standard voltages*[a]	HD 472 S1	1989
50(55)	1970	*International Electrotechnical Vocabulary (IEV)*	—	—
		Chapter 55 *Telegraphy and telephony*		
50 (151)	1978	Chapter 151 *Electrical and magnetic devices*	—	—
255-4	1976	*Electrical relays*	—	—
		Part 4 *Single input energizing quantity measuring relays with dependent specified time*		
255-5	1977	Part 5 *Insulation tests for electrical relays*	—	—
255-22-1	1988	Part 22 *Electrical disturbance tests for measuring relays and protection equipment*	—	—
		Part 1 *1 MHz burst disturbance tests*		
663	1980	*Planning of (single-sideband) power line carrier systems*	—	—
721-3-1	1987	*Classification of environmental conditions*	EN 60721-3-1[b]	1993
		Part 3 *Classification of groups of environmental parameters and their severities*		
		Storage		
721-3-2	1985	*Transportation*	EN 60721-3-2[b]	1993
721-3-3	1987	*Stationary use at weatherprotected locations*	EN 60721-3-3[b]	1993
721-3-4	1987	*Stationary use at non-weatherprotected locations*	EN 60721-3-4[b]	1993
801-2	1991	*Electromagnetic compatibility for industrial-process measurement and control equipment*	EN 60801-2	1993
		Part 2: *Electrostatic discharge requirements*		
801-3	1984	Part 3: *Radiated electromagnetic field requirements*	HD 481.3 S1	1987
801-4	1988	Part 4: *Electrical fast transient/burst requirements*	—	—
834-1 (mod)	1988	*Performance and testing of teleprotection equipment of power systems*	HD 543.1 S1	1991
		Part 1: *Narrow-band command systems*		

[a] The title of HD 472 S1 is: *Nominal voltages for low voltage public electricity supply systems*

[b] EN 60721-3-1 includes A1:1991 to IEC 721-3-1
EN 60721-3-2 includes A1:1991 to IEC 721-3-2
EN 60721-3-3 includes A1:1991 to IEC 721-3-3
EN 60721-3-4 includes A1:1991 to IEC 721-3-4

Other publications

CCITT Blue Book, Volume V, 1988 — *Telephone transmission quality. Series P recommendations.*

CCITT Blue Book, Volume III, Fascicle III.1, 1988 — *General characteristics of international telephone connections and circuits Recommendations G. 100 to G.181.*

CCITT Blue Book, Volume III, Fascicle III.2, 1988 — *International analogue carrier systems — Recommendations G.211 to G.544.*

National annex NA (informative)
Committees responsible

The United Kingdom participation in the preparation of this European Standard was entrusted by the Power Electrical Engineering Standards Policy Committee (PEL/-) to Technical Committee PEL/89 upon which the following bodies were represented:

Association of Consulting Engineers
BEAMA Ltd.
BEAMA Metering Association (BMA)
Electricity Association
Federation of the Electronics Industry
GAMBICA (BEAMA Ltd.)
Transmission and Distribution Association (BEAMA Ltd.)

National annex NB (informative)
Cross-references

Publication referred to	Corresponding British Standard
IEC 50(55):1970	BS 4727 *Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms*
	Part 3 *Terms particular to telecommunications and electronics:*
	Group 01:1971 *General telecommunication and electronics terminology*
IEC 50(151):1978	Part 1 *Terms common to power, telecommunications and electronics*
	Group 02:1980 *Electrical and magnetic devices terminology*
IEC 255-5:1977	BS 5992 *Electrical relays*
	Part 3:1980 *Specification for the insulation testing of electrical relays*
IEC 255-22-1:1988	BS 142 *Electrical protection relays*
	Part 1 *Information and requirements for all protection relays*
	Subsection 1.4.1:1990 *1 MHz burst disturbance tests*
	BS EN 60721 *Classification of environmental conditions*
	Part 3 *Classification of groups of environmental parameters and their severities*
IEC 721-3-1:1987	BS EN 60721-3-1:1993 *Storage*
IEC 721-3-2:1985	BS EN 60721-3-2:1993 *Transportation*
IEC 721-3-3:1987	BS EN 60721-3-3:1993 *Stationary use at weatherprotected locations*
IEC 721-3-4:1987	BS EN 60721-3-4:1993 *Stationary use at non-weatherprotected locations*
	BS EN 60801 *Electromagnetic compatibility for industrial-process measurement and control equipment*
IEC 801-2:1991	Part 2:1993 *Electrostatic discharge requirements*
	BS 6667 *Electromagnetic compatibility for industrial-process measurement and control equipment*
IEC 801-3:1984	Part 3:1985 *Method of evaluating susceptibility to radiated electromagnetic energy*
IEC 834-1:1988	BS 7494 *Performance and testing of teleprotection equipment of power systems*
	Part 1 *Specification for narrow-band command systems*

BS EN 60495:1994 IEC 495:1993

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