INTERNATIONAL STANDARD

ISO/IEC 7480

Second edition
1991-12-15

Information technology — Telecommunications and information exchange between systems — Start-stop transmission signal quality at DTE/DCE interfaces

Technologies de l'information — Télécommunications et échange d'information entre systèmes — Qualité des signaux de transmission arythmique aux interfaces ETTD/ETCD

Reference number
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Foreword

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In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 7480 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

This second edition cancels and replaces the first edition (ISO 7480:1984), of which it constitutes a technical revision.

Annex A of this International Standard is for information only.

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Introduction

The intent of this International Standard is to complement the electrical characteristics specified in CCITT V-series recommendations, and to provide a measurement for the transmission signal quality characteristics not covered in those documents.

The signal quality requirement that start-stop transmission equipment should meet is in part dependent on the application and in part dependent on the mechanism for timing derivation used by the equipment. For early start-stop transmission equipment, timing was derived or controlled from a mechanical source but nowadays an electronic source is commonplace.

An additional factor is that, whereas most start-stop transmission carries the timing information inherently within the signalling between the transmitting equipment and the receiving equipment, start-stop equipment may interface to a converter which encodes the information within a synchronous transmission system in which case, the required signal quality at the interface to the converter may need to be more tightly controlled.

To cover both types of equipment in both types of application, the signal quality specification in this International Standard is given separately for four performance categories, two of which (P1 and P2) are intended for DTEs using mechanical timing[1)] and two for DTEs using electronic timing. By having two mechanical categories, early start-stop transmission equipment with very limited signal quality capability is accommodated (Category P1). For the two electronic categories, the more stringent (Category II) is for equipment to be connected to synchronous DCEs operating in asynchronous mode in accordance with CCITT Recommendation V.14. For each of the four categories defined for the transmitting elements of DTEs (I, II, P1 and P2), four complementary categories are defined for the receiving elements of DTEs (A, B, PA, PB).

Notwithstanding the obvious pairings implied by the complementary categories, the intention is that any receiving equipment may operate with any transmitting equipment, the actual selection being dependent on such factors as channel characteristics and economic considerations of the data communication system. The importance of this International Standard is particularly evident when the transmitting and receiving equipments are furnished by different organizations as it provides a basis for agreement between the parties involved.

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1) It is intended to delete the mechanical categories at the next revision (see footnote 2 to table 1. At that time, consideration will be given to amending the electronic timing definition by replacing "a signal" in the first line by "an isochronous signal" and amending the other definitions accordingly.

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Information technology — Telecommunications and information exchange between systems — Start-stop transmission signal quality at DTE/DCE interfaces

1 Scope

1.1 This International Standard specifies signal quality requirements for serial data transmission at the interface between start-stop transmission Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE). The interface referred to in this International Standard conforms to CCITT Recommendations V.24 (telephone networks) and X.24 (data networks) as specified in DCEs of the following CCITT Recommendations:

— V.21, V.22, V.22 bis, V.23, V.26 ter, V.32, V.32 bis, X.20, X.20 bis together with V.28 electrical characteristics;

— X.20 together with V.10 and/or V.11 electrical characteristics.

The signal quality requirement is limited to start-stop transmission at the interface with asynchronous DCEs, or with synchronous DCEs operating in asynchronous mode in accordance with CCITT Recommendations V.14 or V.42. Signal quality pertaining to DTEs working in a synchronous mode of operation is not part of this International Standard.

This International Standard is also applicable when the interface as specified in the above CCITT Recommendations is provided at the ISDN Reference point R as defined in CCITT Recommendation I.411 and as specified in CCITT Recommendations V.110, V.120 and X.30.

1.2 The signal quality characteristics apply regardless of whether or not multiplexing equipment is included. They do not apply where there is intermediate equipment and no signal regeneration is provided between interconnected sections.

1.3 This International Standard does not describe the signal quality of the DCE or the line associated with it. Neither does it describe any requirement for an acceptable bit error rate.

1.4 This International Standard does not specify the speed characteristics. The nominal value of the modulation rate and the character interval are application dependent.

2 Normative references

The following standards 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 standards 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 standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

CCITT Recommendation I.411:1988, *ISDN user-network interfaces — Reference configurations.*

CCITT Recommendation V.10 (= X.26):1988, *Electrical characteristics for unbalanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications.*

CCITT Recommendation V.11 (= X.27):1988, *Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications.*

CCITT Recommendation V.14:1988, *Transmission of start-stop characters over synchronous bearer channels.*

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CCITT Recommendation V.21:1988, *300 bits per second duplex modem standardized for use in the general switched telephone network.*

CCITT Recommendation V.22:1988, *1 200 bits per second duplex modem standardized for use in the general switched telephone network and on point-to-point 2-wire leased telephone-type circuits.*

CCITT Recommendation V.22 bis:1988, *2 400 bits per second duplex modem using the frequency division technique standardized for use on the general switched telephone network and on point-to-point 2-wire leased telephone-type circuits.*

CCITT Recommendation V.23:1988, *600/1 200 baud modem standardized for use in the general switched telephone network.*

CCITT Recommendation V.24:1988, *List of definitions for interchange circuits between data terminal equipment and data circuit-terminating equipment.*

CCITT Recommendation V.26 ter:1988, *2 400 bits per second duplex modem using the echo cancellation technique standardized for use on the general switched telephone network and on point-to-point 2-wire leased telephone-type circuits.*

CCITT Recommendation V.28:1988, *Electrical characteristics for unbalanced double-current interchange circuits.*

CCITT Recommendation V.32:1988, *A family of 2-wire, duplex modems operating at data signalling rates of up to 9 600 bit/s for use on the general switched telephone network and on leased telephone-type circuits.*

CCITT Recommendation V.32 bis:1990, *A duplex modem operating at data signalling rates of up to 14 400 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone-type circuits.*

CCITT Recommendation V.42:1988, *Error-correcting procedures for DCEs using asynchronous-to-synchronous conversion.*

CCITT Recommendation V.110:1988, *Support of data terminal equipments (DTEs) with V-series type interfaces by an integrated services digital network (ISDN).*

CCITT Recommendation V.120:1988, *Support by an ISDN of data terminal equipment with V-series type interfaces with provision for statistical multiplexing.*

CCITT Recommendation X.20:1988, *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for start-stop transmission services on public data networks.*

CCITT Recommendation X.20 bis:1988, *Use on public data networks of data terminal equipment (DTE) which is designed for interfacing to asynchronous duplex V-series modems.*

CCITT Recommendation X.24:1988, *List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) on public data networks.*

CCITT Recommendation X.30:1988, *Support of X.21, X.21 bis and X.20 bis based data terminal equipments (DTEs) by an integrated services digital network (ISDN).*

3 Definitions

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

3.1 electronic timing: An implementation in which a signal serves to determine the duration of signal elements and to achieve synchronization within a transmission system, and is derived from an electronic circuit.

3.2 mechanical timing: An implementation in which a signal serves to determine the duration of signal elements and to achieve synchronization within a transmission system, and is generally derived from the angular velocity of an electric motor (power frequency used as timing source is also included in this category).

3.3 start-stop system: Data transmission system in which each signal representing a character is preceded by a start signal which serves to prepare the receiving device for the reception of a character signal and registration of a character, and is followed by a stop signal which serves to prepare the receiving device for the reception of a subsequent start signal.

3.4 start-stop transmission: Asynchronous transmission such that each group of signals representing a character is preceded by a start signal and is followed by a stop signal.

3.5 continuous start-stop operation: Method of operation in start-stop transmission in which the signals representing a series of characters follow one another contiguously.

3.6 signal element: Each of the parts constituting a telegraph or data signal and distinguished from the others by its nature, magnitude, duration and relative position (or by one or some of these features only).

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3.7 unit interval: In a system using an equal length code, or in a system using an isochronous modulation, the interval of time such that the theoretical durations of the significant intervals of a telegraph modulation (or restitution) are whole multiples of this interval.

3.8 modulation rate: Reciprocal of the unit interval measured in seconds. This rate is expressed in baud.

3.9 character interval: The duration of a character expressed as the total number of unit intervals (including information and parity check) plus the start and stop signals.

3.10 start signal: In start-stop transmission, a signal at the beginning of a character that prepares the receiving device for the reception of the code elements.

NOTE 1 A start signal is limited to one signal element generally having the duration of a unit interval.

3.11 start transition: In a character transmitted in a start-stop system, the mark-to-space transition at the beginning of the start signal.

3.12 stop signal: In start-stop transmission, a signal at the end of a character that prepares the receiving device for the reception of a subsequent character.

NOTE 2 A stop signal is usually limited to one signal element having any duration equal to or greater than a specified minimum value.

3.13 degree of start-stop distortion

(1) Ratio to the unit interval of the maximum measured difference, irrespective of sign, between the actual and theoretical intervals separating any significant instant of modulation (or of restitution) from the significant instant of the start element immediately preceding it.

(2) The highest absolute value of individual distortion affecting the significant instants of a start-stop modulation.

The degree of distortion of a start-stop modulation (or restitution) is usually expressed as a percentage.

NOTES

3 The result of the measurement should be completed by an indication of the period, usually limited, of the observation.

4 Distinction can be made between the degree of late (or positive) distortion and the degree of early (or negative) distortion.

5 The theoretical intervals are related to the mean actual incoming modulation rate and not necessarily to the nominal modulation rate.

3.14 degree of gross start-stop distortion: Degree of distortion determined when the unit interval and the theoretical intervals assumed are exactly those appropriate to the nominal modulation rate.

NOTE 6 The result of the measurement should be completed by an indication of the period, usually limited, of the observation.

For a prolonged modulation (or restitution) it will be appropriate to consider the probability that an assigned value of the degree of distortion will be exceeded.

In accordance with the CCITT definition of the theoretical duration of a significant interval, in practical measurements the unit interval and the theoretical intervals assumed are those appropriate to the actual mean rate of modulation (or of restitution).

3.15 degree of synchronous start-stop distortion: Degree of distortion determined when the unit interval and the theoretical intervals assumed are those appropriate to the actual mean rate of modulation (or of restitution).

NOTES

7 See note 6.

8 The degree of distortion is the time displacement of the transitions between signal states from their ideal instants.

3.16 margin: Maximum degree of distortion compatible with a correct translation when the signals are presented to a receiver under the most unfavourable conditions where the composition of the signals and of the distortion is concerned.

The maximum degree of distortion which results in incorrect translation applies without reference to the form of distortion affecting the signals. In other words, it is the maximum value of the most unfavourable distortion causing incorrect translation which determines the value of the margin.

3.16.1 synchronous margin: Margin represented by the degree of distortion for the margin indicated in 3.16 when the mean unit interval of the modulation applied to the apparatus is equal to that which would result from a transmission from the apparatus under examination, assuming it to include a transmitter as well as a receiver.

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3.16.2 net margin: Margin represented by the degree of distortion indicated in 3.16 when the rate of modulation applied to the apparatus is exactly equal to the standard theoretical rate.

3.16.3 practical margin: Net margin whereby no signal element duration is less than a specified value.

4 Signal quality from the transmitting DTE

Start-stop transmitting DTEs shall operate within one of the four specified signal quality categories shown in table 1. The applicable category shall be stated if conformance with this International Standard is claimed. The alphabetical designations in the following clauses refer to the value specified in the same table.

4.1 Distortion of the transmitting DTE

The signal provided by the transmitting DTE on CCITT circuit 103 (see CCITT Recommendation V.24), or circuit T (see CCITT Recommendation X.24), shall have a degree of synchronous start-stop distortion not greater than N % and a degree of gross start-stop distortion not greater than P %, provided that no signal element has a duration of less than Q % of the unit interval.

Table 1 — Signal quality characteristics

DTE	Clause	Designation	Symbol	Unit	Signal quality category [1]			
					Electronic timing		Mechanical timing	
					I	II	P1[2]	P2[2]
Transmitting DTE	4.1	Synchronous start-stop distortion	$N \leqslant$	%	5[3]	1	8	12
	4.1	Gross start-stop distortion	$P \leqslant$	%	7	3	16	20
	4.1	Minimum signal element	Q	% UI	90	98	84	76
	4.2	Character interval requirement						
	4.2.1	Average: nominal reduced by	$R \leqslant$	% UI	8	[4]	10	10
	4.2.1	Averaged over	S	Char	2	[4]	2	2
	4.2.2	Minimum: nominal reduced by	$T \leqslant$	% UI	16	[4]	20	20
	4.3	Modulation rate accuracy	$M \leqslant$	%	0,2	0,2	0,75	0,75

DTE	Clause	Designation	Symbol	Unit	Signal quality category [1]			
					Electronic timing		Mechanical timing	
					A	B	PA[2]	PB[2]
Receiving DTE	5.1	Synchronous margin	$U \geqslant$	%			38	33
	5.1	Practical margin	$V \geqslant$	%	40	40	30	25
	5.1	Minimum signal element	W	% UI	30	30	30	34
	5.2	Character interval requirement						
	5.2.1	Average: nominal reduced by	X	% UI	20	20	25	25
	5.2.1	Averaged over	S	Char	2	2	2	2
	5.2.2	Minimum: nominal reduced by	Y	% UI	40	40	50	50
	5.3	Minimum duration start element	Z	% UI	60	60	50	50

1) When categorizing signal quality of DTEs using the table, modulation rate, character interval, operating mode and environmental conditions may be indicated for completeness.

2) At the next revision of this International Standard, it is intended to delete the categories P1, P2, PA and PB.

3) The first edition of this International Standard specified a value of 8 % together with a corresponding value of P of 10 %.

4) The character interval requirement cannot be determined from present CCITT recommendations. This point is for further study.

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4.2 Character interval

In continuous start-stop operation the signals on CCITT circuit 103, or circuit T, may have a minimum average character interval which is shorter than the nominal character interval and an occasional character having a still shorter duration called the minimum character interval according to the following requirements.

4.2.1 Minimum average character interval

The interval between successive start transitions on CCITT circuit 103, or circuit T, averaged over S consecutive characters shall not be less than the nominal character interval reduced by R % of the unit interval.

4.2.2 Minimum character interval

The interval between successive start transitions on CCITT circuit 103, or circuit T, shall not be less than the nominal character interval reduced by T % of the unit interval.

4.3 Modulation rate accuracy

The difference between the actual average rate of modulation of the signal and the nominal modulation rate shall not exceed M %.

5 Margin of the receiving DTE

Receiving DTEs shall operate within one of the four specified signal quality categories shown in table 1. The applicable category shall be stated if conformance with this International Standard is claimed.

5.1 Margin of the receiver

In start-stop transmission, the receiving DTE shall have a synchronous margin of U % when specified and a practical margin of V % and shall not respond to any signal element having a duration of less than W % of the unit interval.

A suitable set of characters shall be taken for continuously repeated testing. Also means shall be provided to determine the point when the translation of test characters becomes erroneous.

5.2 Character interval

In continuous start-stop operation the receiving DTE shall respond to signals on CCITT circuit 104 (see CCITT Recommendation V.24), or circuit R (see CCITT Recommendation X.24), which have a minimum average character interval which is shorter than the nominal character interval and an occasional character having a still shorter duration called the minimum character interval, according to the following requirements.

5.2.1 Minimum average character interval

The receiving DTE shall respond to successive start transitions on CCITT circuit 104, or circuit R, which follow their previous start transitions by a character interval, averaged over S consecutive characters, which is not less than the nominal character interval reduced by X % of the unit interval.

5.2.2 Minimum character interval

When the above average is met, the receiving DTE shall respond to a start transition on CCITT circuit 104, or circuit R, which follows the start transition of the preceding character by an interval which is not less than the nominal character interval reduced by Y % of the unit interval.

5.3 Minimum duration start element

In a start-stop transmission, the receiving DTE shall not start reception of a character on a space condition on CCITT circuit 104, or circuit R, which has a duration of less than Z % of the unit interval.

6 Measurements at the interchange point

Measurements of the signal quality shall meet one out of three sets of requirements depending on whether the electrical interface characteristics comply with CCITT Recommendation V.28 or V.10 (= X.26) or V.11 (= X.27).

NOTE 9 The signal quality requirements are defined for the operating conditions stated for the measurement method. In an actual application, the operating conditions may be different and this may result in changes in the quality achieved, but such changes should be small

6.1 Measurement of the V.28 generator characteristics

6.1.1 Use of the standard test load

Distortion shall be measured on the particular interchange circuit concerned at the generator side while the circuit is terminated with the standard test load. This standard test load may be the input impedance of the device or may be an external device, but in all cases the total load on the interchange circuits shall meet the requirements of 6.1.2.

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6.1.2 Specification of the standard test load

The standard test load shall consist of a 3 000 Ω resistance shunted by a 2 500 pF capacitance and shall be connected from the signal interchange circuit under test to CCITT circuit 102 or circuit Ga or circuit Gb as shown in the test arrangement of figure 1.

6.1.3 Distortion of the transmitting DTE

The distortion measurement shall be made using a + 3,0 V and a − 3,0 V threshold to determine the occurrence of signal transitions.

A mark-to-space transition shall be taken to occur at the instant V_{1G} crosses + 3,0 V on a positive-going transition.

A space-to-mark transition shall be taken to occur at the instant V_{1G} crosses − 3,0 V on a negative-going transition.

6.2 Measurement on the V.28 load side

6.2.1 Test arrangement

Measurements of margin on the load side of the interface shall be made using the test arrangement of figure 2.

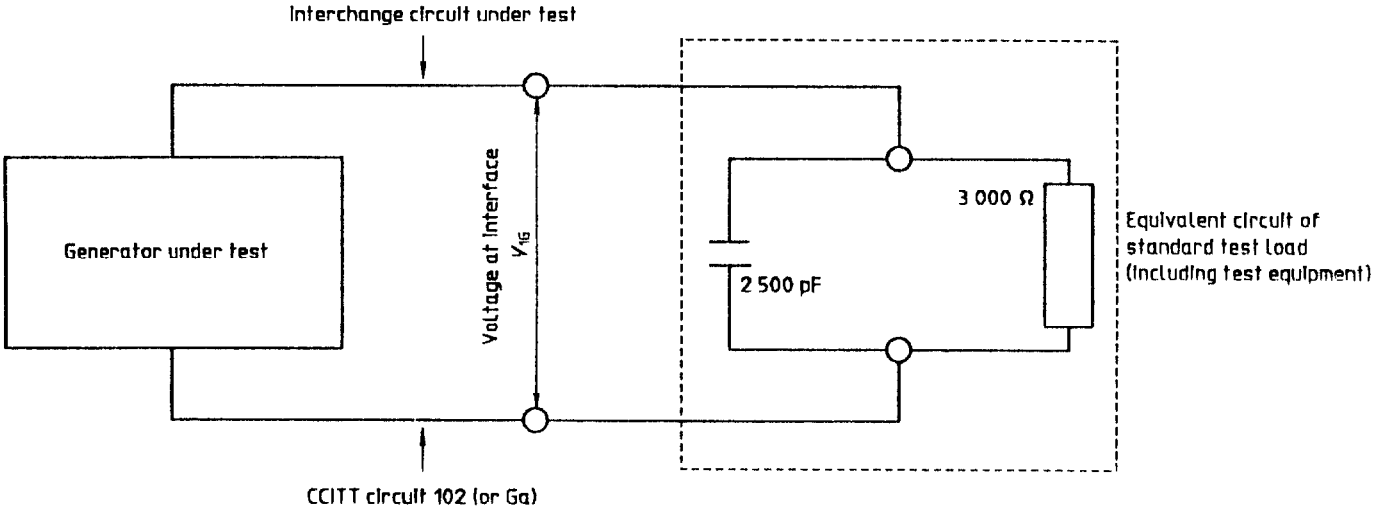

Figure 1 — Test arrangement for V.28 generators

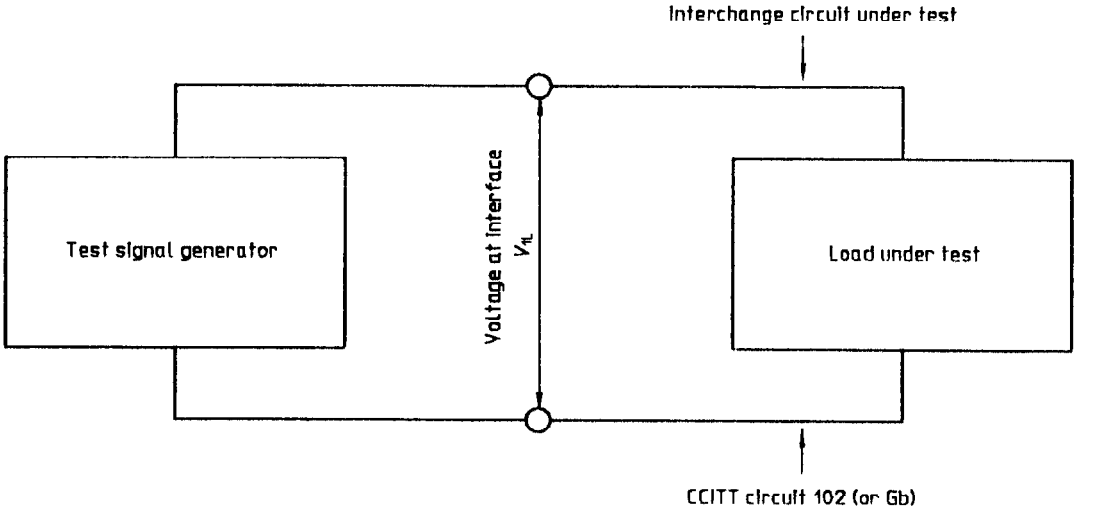

Figure 2 — Test arrangement for V.28 loads

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6.2.2 Margin of receiving DTE

The measurement of the margin shall be made using a signal V_{1L} of $\pm$ 5,0 V when working into the load under test. The transitions of the test signal shall be deviated from their ideal instants in such a way as to measure the margin (see 5.1). The deviations of the transition in time shall be taken to occur when the signal crosses the $\pm$ 3,0 V thresholds.

A mark-to-space transition shall be taken to occur at the instant V_{1L} crosses + 3,0 V on a positive-going transition.

A space-to-mark transition shall be taken to occur at the instant V_{1L} crosses − 3,0 V on a negative-going transition.

6.3 Measurement of the V.10 generator characteristics

6.3.1 Use of the standard test load

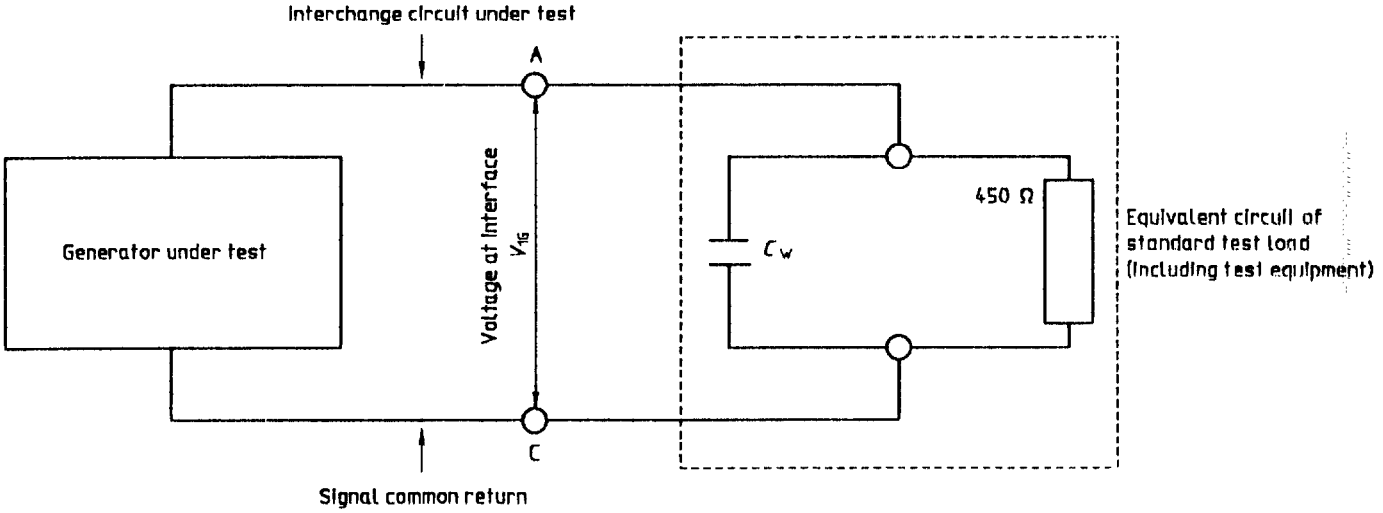
Distortion shall be measured on the particular interchange circuit concerned at the generator side while the circuit is terminated with a standard test load. This standard test load may be the input impedance of the test device or may be an external device but in all cases the total load on the interchange circuit shall meet the requirements of 6.3.2.

6.3.2 Specification of the standard test load

The standard test load shall consist of a 450 Ω resistance shunted by a capacitance C_W and shall be connected from the signal interchange circuit under test to signal common return as shown in the test arrangement of figure 3. The value of C_W depends on the data signalling rate and shall be the value given in the table annexed to figure 3 but reduced by the value of any capacitance included in the generator for wave shaping.

6.3.3 Distortion of the transmitting DTE

The distortion measurement shall be made using thresholds in the range $\pm$ 0,3 V to determine the occurrence of signal transitions. A threshold at nominal 0 V is preferred.



C_W (μF)	Data signalling rate (kbit/s)
1,000	0 to 2,5
0,470	2,5 to 5,0
0,220	5,0 to 10,0
0,100	10,0 to 25,0
0,047	25,0 to 50,0
0,022	50,0 to 100,0

Figure 3 — Test arrangement for V.10 generators and values of C_W

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6.4 Measurement on the V.10 load side

6.4.1 Test arrangement

Measurements of margin on the load side of the interface shall be made using the test arrangement of figure 4.

6.4.2 Margin of receiving DTE

The measurement of the margin shall be made using a signal V_{IL} of $\pm$ 4,0 V when working into the load under test. The transitions of the test signal shall be deviated from their ideal instants in such a way as to measure the margin (see 5.1). The deviations of the transition in time shall be taken to occur when the signal crosses the thresholds (see 6.3.3).

6.5 Measurement of the V.11 generator characteristics

6.5.1 Use of the standard test load

Distortion shall be measured on the particular interchange circuit concerned at the generator side while the circuit is terminated with a standard test load. This standard test load may be the input impedance of the test device or may be an external device but in all cases the total load on the interchange circuit shall meet the requirements of 6.5.2.

6.5.2 Specification of the standard test load

The standard test load shall consist of a 100 Ω resistance and shall be connected between the output points A and B of the generator under test as shown in the test arrangement of figure 5.

6.5.3 Distortion of the transmitting DTE

The distortion measurement shall be made using thresholds in the range $\pm$ 0,3 V to determine the occurrence of signal transitions. A threshold at nominal 0 V is preferred.

6.6 Measurement on the V.11 load side

6.6.1 Test arrangement

Measurements of margin on the load side of the interface shall be made using the test arrangement of figure 6.

6.6.2 Margin of receiving DTE

See 6.4.2 and figure 6.

6.7 Accuracy of measuring equipment

Unless specified otherwise, standard test loads shall have a tolerance not exceeding 1 %, distortion measuring equipment shall have an accuracy not worse than 1 % of the unit interval and test generators shall have an accuracy of at least 1 %.

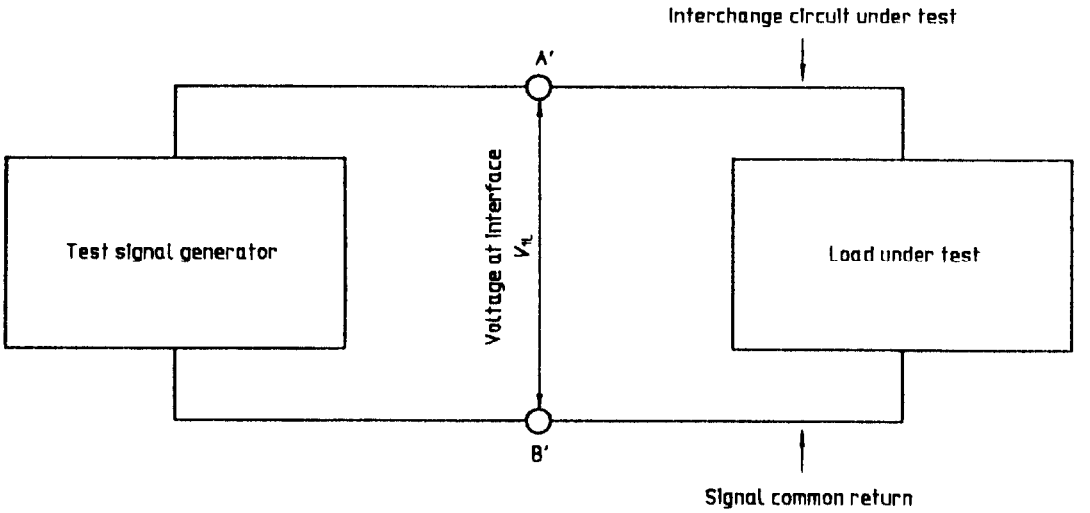

Figure 4 — Test arrangement for V.10 loads

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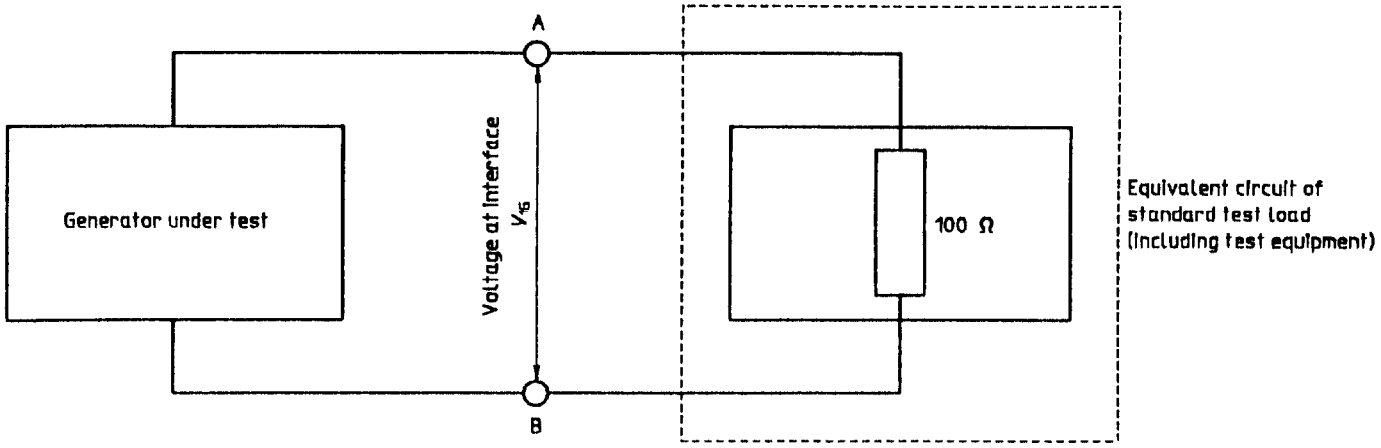

Figure 5 — Test arrangement for V.11 generators

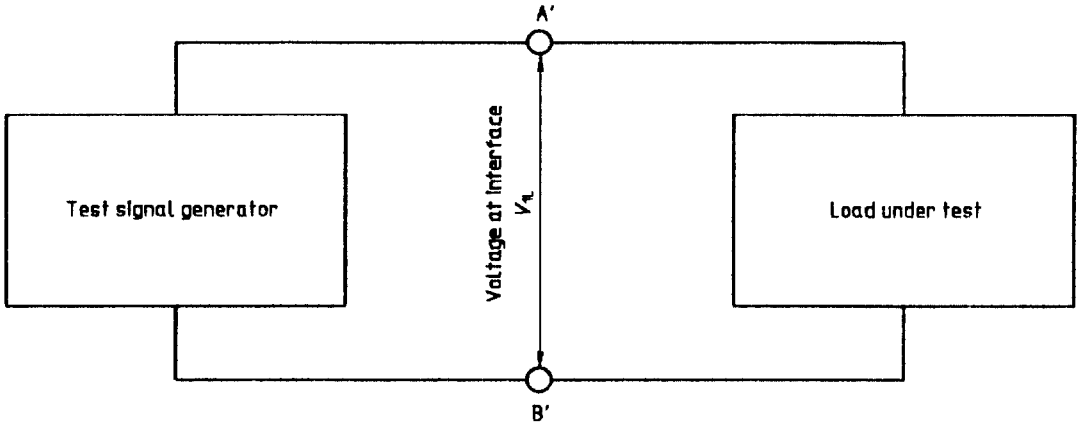

Figure 6 — Test arrangement for V.11 loads

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Annex A
(informative)

Signal quality at asynchronous transmission interfaces — Mathematical relationship between signal quality parameters

In order to assist users in interpreting the various measurements indicated in this International Standard, attention is drawn to certain mathematical relationships that exist. Several of the parameters listed in table 1 can be derived from the others as follows.

A.1 For transmitting equipment, the two fundamental parameters

— synchronous start-stop distortion, N, and

— modulation rate accuracy, M,

can be used to derive gross start-stop distortion, P, minimum signal element, Q, and character interval requirements.

In electronically timed systems operating in continuous start-stop mode, the reductions in character interval, minimum, T, and average, R, are related to the cumulative clock error due to modulation rate accuracy and are independent of the number of characters, S, over which it is averaged.

A.1.1 Gross start-stop distortion, P, is given by

$$P = (N + nM)$$

where

N is the synchronous start-stop distortion;

M is the modulation rate accuracy;

n is the number of elements in the character.

A.1.2 Minimum signal element, Q, is given by

$$Q = (100 - 2N)\ \%\ \text{of unit interval}$$

where N is the synchronous start-stop distortion.

A.2 For receiving equipment, the fundamental parameter synchronous margin, U, can be used to derive the practical margin, V, which is given by the formula

$$V = U - nM$$

where

U is the synchronous margin;

M is the modulation rate accuracy (of the transmitter);

n is the number of elements in the character.

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