

Method for specifying the performance of digital electronic d.c. voltmeters and d.c. electronic analogue-to-digital convertors

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Cooperating organizations

The Electronic Equipment Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

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- British Electrical and Allied Manufacturers' Association (BEAMA)
- British Radio Equipment Manufacturers' Association
- Cable and Wireless Limited
- Cable Television Association of Great Britain
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The organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

- British Industrial Measuring and Control Apparatus Manufacturers' Association
- Department of Industry (British Calibration Service)
- Department of Industry (National Physical Laboratory)
- Individual experts

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National foreword

This British Standard is identical with IEC Publication 485 “*Digital electronic d.c. voltmeters and d.c. electronic analogue-to-digital convertors*” published in 1974 by the International Electrotechnical Commission (IEC). It is published under the direction of the Electronic Equipment Standards Committee.

Terminology and conventions. The text of the International Standard has been approved as suitable for publication, without deviation, as a British Standard. Some terminology and certain conventions are not identical with those used in British Standards; attention is especially drawn to the following.

Wherever the word “recommendation” appears, referring to this standard, it should be interpreted as “British Standard”.

Cross-references

International Standard	Corresponding British Standard
IEC 68	BS 2011 <i>Basic environmental testing procedures</i> (see note 1)
IEC 144:1963	BS 5420:1977 <i>Specification for degrees of protection of enclosures of switchgear and controlgear for voltages up to and including 1 000 V a.c. and 1 200 V d.c.</i> (Identical)
IEC 186:1969	BS 3941:1975 <i>Voltage transformers</i> (Related) (see note 2)
IEC 278:1968	BS 4308:1978 <i>Documentation to be supplied with electronic measuring apparatus</i> (Identical)
IEC 335:	BS 3456 <i>Specification for safety of household electrical appliances</i>
Part 1:1970	Part 1:1969 <i>General requirements</i> (see note 3)
IEC 348:1971	BS 4743:1971 <i>Safety requirements of electronic measuring apparatus</i> (Technically equivalent)
IEC 359:1971	BS 4889:1973 <i>Method For specifying the performance of electronic measuring equipment</i> (Technically equivalent)

NOTE 1 The British Standard is published in a number of Parts which are each identical with a Part of the IEC standard. The only reference is in clause 12C which does not refer to any specific test method and therefore closer identification of the corresponding British Standard is not possible.

NOTE 2 IEC 186 does not, at present, include any method for determination of electromagnetic radiation.

NOTE 3 The requirements of the British Standard are less onerous than those of IEC 335-1 and to this extent the description (see note 2 to 12.1.9 of this standard) may be considered as not being equivalent.

NOTE 4 *Textual error.* The title to Figure 11 has been omitted in the text. It should be “Input configurations”.

Additional information. Attention is drawn to the fact that some of the definitions adopted for the purposes of this standard in clause 2 differ significantly from definitions in BS 5233:1975 “*Glossary of terms used in metrology*”. BS 5233 draws on the practice of the International Organization of Legal Metrology (OIML), whereas this standard takes account of the definitions of the International Electrotechnical Vocabulary (IEV), the International Federation for Information Processing and International Computation Centre (IFIP-ICC) Vocabulary and the Vocabulary of Information Processing of the International Organization for Standardization (ISO). Since publication of IEC publication 485, some sections of the latter vocabulary have been published by ISO as separate Sections in ISO 2382 “*Data processing — Vocabulary*”.

Obsolescent (by Amendment No. 1)

The need for this method has been reviewed and it has been decided that, in the interests of rationalization, it should be declared obsolescent. Its application is therefore not recommended. The standard will be withdrawn in due course. A new IEC Publication which may supersede IEC Publication 485 is in preparation.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 50, 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.

1 General

1.1 Scope

1.1.1 This recommendation applies to digital electronic measuring instruments for the measurement of direct voltages, hereinafter referred to as measuring instruments and to electronic analogue-to-digital convertors used in equipment and systems for data and information processing for the conversion of direct voltages, hereinafter referred to as convertors.

NOTE This recommendation is not applicable to apparatus measuring/converting alternating voltages.

1.1.2 This recommendation is also applicable to accessories, when they are associated with the apparatus, inasmuch as the calibration of the apparatus has been or can be carried out together with the accessory, the recommendation being then valid for the combination of the apparatus and its accessory.

1.1.3 Some parts of this recommendation may be applicable also to other types of analogue-to-digital converting apparatus, e.g., digital ohmmeters and ammeters, but this recommendation is not intended to provide a complete set of technical requirements for these devices.

1.1.4 This recommendation does not explicitly consider apparatus with non-linear conversion and some of the following definitions and requirements may not apply to them.

1.1.5 Safety requirements are not dealt with in this recommendation. Unless otherwise agreed upon, devices such as those specified in Sub-clause 1.1 shall comply with IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus.

1.1.6 Where the term “apparatus” is used without any special reference in this recommendation, it covers both measuring instruments and convertors.

Where the term “conversion” is used in a general sense without any special reference in this recommendation, it covers the over-all action performed by measuring instruments or convertors.

Throughout this recommendation, wherever “output information” is mentioned, the “indication” (i.e. the output information in visual form) is also implied.

1.2 Object

The object of this recommendation is:

- to specify the particular terminology related to digital electronic measuring instruments for the measurement of direct voltages and to convertors according to Sub-clause 1.1,
- to unify the means of expressing electrical and other functional properties of these types of apparatus,
- to specify conditions for testing them in order to verify compliance with this recommendation.

2 Definitions

The following definitions apply for the purpose of this recommendation.

Some of the definitions have been taken from the International Electrotechnical Vocabulary (I.E.V.), and others from the IFIP-ICC Vocabulary¹⁾, or from the Vocabulary of Information Processing (draft-proposal prepared by the ISO). For the relevant definition, the reference is given in parentheses. A number of definitions have been copied from IEC Publication 359, Expression of the Functional Performance of Electronic Measuring Equipment.

2.1 General terms

2.1.1

electrical signal

an electrical quantity one or more parameters of which convey information

NOTE Throughout this recommendation where the term “signal” is used, an electrical signal having only one information parameter is to be understood.

2.1.2

information parameter of an electrical signal

a parameter of an electrical signal conveying information

¹⁾ International Federation for Information Processing and International Computation Centre.

2.1.3

analogue representation of a physical quantity

the representation of one physical quantity by another physical quantity in which the representing quantity may continuously assume any value between specified limits, when the physical quantity to be represented is varied continuously between corresponding limits

2.1.4

digital representation of a physical quantity

the representation of a physical quantity by discrete numerals or digital signals or both when the physical quantity to be represented is varied between specified limits

2.1.5

analogue signal

a signal having one or more continuous ranges of values of the signal parameters, different information being associated with each of these values

for a quantity, the analogue signal is the analogue representation of that quantity

2.1.6

digital signal

a signal having a discrete number of ranges of values of the signal parameter, different information being associated with each of the ranges

for a quantity, the digital signal is the digital representation of that quantity

2.1.7 Quantization

A process in which the range of a variable is divided into a finite number of distinct sub-ranges (called quanta), not necessarily equal, each of which is represented by an assigned or “quantized” value within the sub-range (IFIP-ICC Vocabulary, E 29).

Example:

A person’s age is quantized for most purposes with a quantum of one year.

2.1.7.1

quantization unit

the width of sub-ranges when these are nominally equal

NOTE When the quantization units become unequal, linearity errors will result.

2.1.7.2

quantization step

the widths of sub-ranges when they are intentionally not equal

NOTE Then the quanta of these steps will be taken into consideration during encoding.

2.1.8

code

an agreed set of unambiguous rules to specify the way in which data may be represented by the characters of a character set (IFIP-ICC Vocabulary, A 10)

2.1.9

encode (to)

to convert by applying a code (IFIP-ICC Vocabulary F 23)

NOTE In digital voltmeters, the visual output is usually coded in decimal digits and the electrical output in BCD form. Analogue-to-digital convertors usually have output codes such as: two’s complement binary, excess three, biquinary, BCD, etc.

2.1.10

binary element (binary digit, bit)

the information in digital electrical form is represented by a group of statements, each being realized by a digital signal. The meaning of each statement is determined by the code of the system and is represented by the position in time (or space) of the corresponding signal values

each statement consists of either a logical “one” or a logical “zero”, corresponding to the “one” level state or the “zero” level state of the representing signal. Each of these two values constitutes a binary element, and is represented by a binary digit, or bit

2.1.11**character**

a member of a set of elements intended for use in conveying information, either when arranged together in an agreed fashion (in general sequentially), or when isolated (IFIP-ICC Vocabulary, D 1, modified)

2.1.12**word**

a character string (or a binary element string) that is convenient for some purpose to consider as an entity (ISO Vocabulary)

NOTE Figure 1, page 43, illustrates the application of the terms “character”, “word”, “binary digit” and “bit”, to particular representation methods.

2.1.13**analogue-to-digital conversion**

the transformation of an analogue quantity into a digital representation by means of sampling, quantization and encoding, and the necessary auxiliary operations

2.1.14**electronic analogue-to-digital convertor**

an electronic device for performing the analogue-to-digital conversion of electrical signals, and for supplying the converted values in digital electrical form

NOTE Some types of analogue-to-digital convertors are also provided with a visual digital display.

2.1.15**digital electronic voltmeter**

an instrument containing an analogue-to-digital convertor and visually indicating the value of measured voltage in the form of decimal numerals

NOTE Some types of digital electronic voltmeters are also provided with digital electrical output facilities.

2.1.16 Accessory

Circuit element or elements (probes, cables, etc.) which is, or which are, associated with the apparatus, either permanently and essential for its operation, or non-permanently and required for the purpose of modifying its characteristics in a prescribed manner.

2.1.16.1**interchangeable accessory**

an accessory having its own properties and accuracy, these being independent of those of the apparatus with which it may be associated

2.1.16.2**non-interchangeable accessory**

an accessory which has been adjusted to take into account the electrical characteristics of one particular apparatus. In this case, this recommendation applies to the combination of apparatus and accessory

2.1.17**scaling**

an analogue operation, generally preceding analogue-to-digital conversion, of either amplification or attenuation to modify the measurement (conversion) range of the apparatus

2.2 Auxiliary general terms**2.2.1****distortion factor**

the ratio of the r.m.s. value of the harmonic content to the r.m.s. value of a non-sinusoidal quantity (I.E.V. 05-02-120)

2.2.2**warm-up time**

the time interval after switching on the apparatus under specified conditions, necessary for it to comply with all performance requirements

2.2.3 preliminary adjustment

the preliminary operation by means of which certain adjusting parts are set according to the manufacturer's instructions so as to cause the apparatus to perform with the specified accuracy

2.2.4 calibration

application of a calibrating voltage (Sub-clause 2.2.5) to the input of the apparatus under operating conditions in order to compare the corresponding output value with the calibration value (Sub-clause 2.2.6), and possibly making them equal with the aid of a special control called a calibration adjuster

NOTE Calibration is always a part of the preliminary adjustment, but calibration in itself can also be performed from time to time during operation.

2.2.5 calibrating voltage

a voltage of a sufficiently known and stable value, internally or externally applied from a reference source to the apparatus and intended to serve as the basis for comparison during calibration

2.2.6 calibration value

visually indicated number or output information signal value which should appear as a result of calibration

2.2.7 electrical zero

the output information value obtained when the apparatus is connected to a supply voltage, and switched on but with no input quantity intentionally applied between its input terminals which are protected from external fields, and only connected to an external circuit when this is specifically indicated by the manufacturer

NOTE This definition does not apply to apparatus which is not intended to deliver output information of zero value when no input quantity is applied, e.g., apparatus with displaced zero or those intended to deliver " $-\infty$ " (negative overflow).

2.2.8 electrical zero adjuster

the means by which it is possible to shift the electrical zero to zero indication or to the appropriate value

2.2.9 supply

the source of power required for operation of the apparatus

2.3 Terms concerning inputs

2.3.1 Input terminals

Connection points at which the electrical quantity to be measured (converted) is applied to the apparatus.

NOTE Almost all combinations of the arrangements described in Sub-clauses 2.3.1.1 to 2.3.1.7 are possible (e.g., symmetrical plus grounded, floating plus guarded).

2.3.1.1 asymmetrical input

a three-terminal input circuit where the nominal values of the impedances between the common terminal and each of the other two terminals are different

2.3.1.2 symmetrical (balanced) input

a three-terminal input circuit where the nominal values of the impedances between the common terminal and each of the other two terminals are equal

2.3.1.3 difference input

an input circuit with two input terminals, having a high impedance to the common point, intended to measure the electrical quantity between these terminals

NOTE The result of the measurement is intended to be largely independent of their respective voltages with reference to a common point.

2.3.1.4**grounded input (single-ended input)**

an input circuit in which one input terminal is directly connected to measuring earth. This is often the common point terminal

2.3.1.5**floating input**

an input circuit which is isolated from the frame, from the mains and from any of the output circuit terminals

2.3.1.6**input with isolated common point**

an input circuit having one input terminal connected to one output terminal but being isolated from the frame and from the mains

2.3.1.7**guarded input**

a screened (shielded) input circuit where the screen/shield is isolated from earth and the common point terminal, being arranged so that the screen may nominally be at the same potential as one of the signal-carrying conductors

2.3.2 Quantities at the input**2.3.2.1****input quantity/input signal**

the analogue quantity (signal) applied to the input terminals

NOTE Where there is no possibility of ambiguity, the value of the input quantity is referred to hereinafter as “input value”.

2.3.2.2**rate of change of the input voltage**

the derivative of the input voltage with respect to time

2.3.2.3**common mode voltage**

that part of the input voltage which exists, equal in amplitude and phase, between both measuring terminals and the common terminal; the common terminal may be the frame terminal or the measuring earth terminal

2.3.2.4**series mode voltage**

an unwanted part of the input voltage which is superimposed on the voltage to be measured

NOTE Typical examples of a series mode voltage are thermopotentials or induced voltages, e.g., an a.c. ripple on a d.c. signal.

2.3.2.5**spurious feedback appearing at the input terminals**

internally generated disturbance fed back to the source through the input terminals of the apparatus, or between one input terminal and the measuring earth or the screen terminal

2.3.2.6**overload**

an input signal exceeding the measurement (conversion) range referring to the voltage limit of the input circuits of the apparatus

2.3.2.7**maximum permissible input/output voltage**

the highest value of the voltage between two terminals or relative to frame which may be applied to the input/output terminals when connected to an external circuit in rated operating conditions

2.3.3 Impedances at the input

2.3.3.1

source impedance

the impedance of the output circuit of the source connected to the input terminals of the apparatus

2.3.3.2

input impedance

the impedance of the input circuit measured between the input terminals of the apparatus under operating conditions

NOTE In general, the impedance before and during measuring time can be different from that at the end of the measuring time.

2.3.3.3

equivalent input impedance

when the input circuit of an apparatus is such that the instantaneous value of the current flowing into the input terminals is a non-linear function of the instantaneous value of the input voltage under given conditions of frequency and voltage, the equivalent input impedance is the impedance of a combination of a resistance and a reactance that absorbs the same active power as the above-mentioned input circuit and into which flows a reactive current equal to the component at the fundamental frequency that is flowing into the non-linear input circuit of the apparatus

2.3.3.4

other impedances

impedances measured under operating conditions of the apparatus between any pairs of the following terminals (excluding pairs of input and output terminals): each input terminal, each output terminal, input earth terminal, frame, screen and protective earth

NOTE Terms such as "leakage capacitance" or "insulation resistance" are used to describe such impedances.

2.3.4 Input interferences

2.3.4.1

common mode interference

the change in the output information caused by the application of a common mode voltage
(Sub-clause 2.3.2.3)

2.3.4.2

series mode interference

the change in output information caused by the application of a series mode voltage (Sub-clause 2.3.2.4)

2.3.4.3

common mode rejection factor

term used to designate the sensitivity of the apparatus to common mode interference. It is expressed as the ratio of the peak value of the signal applied between the common point and the two terminals connected by specified circuit to the signal required between the input terminals to produce the same output information value

2.3.4.4

series mode rejection factor

term used to designate the sensitivity of the apparatus to series mode interference. It is expressed as the ratio of the peak value of the interfering voltage to the increment of the input signal required to produce the same change in the output information value

NOTE The common mode rejection factor and the series mode rejection factor are often expressed in decibels (or as a percentage) and may be given for different frequencies.

2.4 Terms concerning operation of the apparatus

2.4.1 Conversion (in general)

2.4.1.1

linear conversion

conversion having a nominally constant ratio for each change in the output value to the corresponding change in the input value

2.4.1.2

non-linear conversion

conversion having a ratio of changes in the output value corresponding to changes in the input value, which is a function of the input value

NOTE A typical kind of non-linear conversion is logarithmic conversion.

2.4.1.3

commutation point (transition point)

the point within each representation unit (Sub-clause 2.5.2.2.3) at which the output signal (indication) jumps from one value to the adjacent one when the value of the input quantity is varied

NOTE According to the position of the commutation point, distinction should be made between:

- a) Apparatus having the commutation point at the centre of each representation unit (see Figure 2 a), page 44);
- b) Apparatus having the commutation point at the end of each representation unit (see Figure 2 b), page 44).

2.4.1.4

conversion command

the pulse or voltage level which initiates a conversion cycle

NOTE The conversion command may initiate either a conversion cycle from zero or a follow-up operation.

2.4.2 Basic modes of operation

Depending on the origin of the conversion command, the following modes of operation are the most typical:

- triggered,
- repetitive,
- tracking,

NOTE Other modes of operation are, for example:

- maximum-seeking,
- minimum-seeking.

2.4.2.1

triggered mode of operation

in this mode, the conversion command is of external origin (manual or electrical)

2.4.2.2

repetitive (cyclic) mode of operation

in this mode, the conversion command is initiated by an internal clock

2.4.2.3

tracking mode of operation

in this mode, the conversion command is initiated by internal circuits sensing a change of the quantity to be measured/converted (see also Sub-clause 2.7.4.3.3)

2.4.3 Operating principles

2.4.3.1 Instantaneous value conversion

Conversion resulting in a digital representation of the instantaneous value existing during the conversion time of the input quantity.

NOTE Typical principles of operation of apparatus for measuring/converting the instantaneous values of the input quantity are given in Sub-clauses 2.4.3.1.1 to 2.4.3.1.4.

2.4.3.1.1**successive approximation type**

an operating principle in which a feedback voltage generator provides a set of regulated voltages, the values of which correspond to binary or decimal digits. Comparison of these voltages with the scaled input voltage is made in a prescribed sequence by steps of decreasing magnitude

2.4.3.1.2**servo-balancing type**

an operating principle in which the feedback generator consists of a servo-controlled feedback element coupled to a numerical indicator

the feedback voltage is continuously compared with the scaled input voltage. A difference between them causes the servo-element to re-establish the balanced state and to change simultaneously the numerical indication

2.4.3.1.3**linear ramp type**

an operating principle in which a voltage generator periodically or upon command produces a voltage which changes linearly with time (ramp signal) and is compared with the scaled input voltage by an error detector synchronized with the initiation of the ramp or with the coincidence of a value of the ramp with a reference voltage, a gate on a clock oscillator is opened and kept open for the time interval required for the ramp to become equal to the scaled input value at which instant the gate is closed. During this interval, the number of clock pulses gated out is counted by a counter circuit. By relating the slope of the ramp to the clock frequency, the value of the output information is made numerically equal to the value of the input quantity

2.4.3.1.4**stepped ramp type**

an operating principle similar to the linear ramp type, except that the ramp is made up of equal voltage steps, the number of which is counted

2.4.3.2 Integrating conversion

Conversion resulting in a digital representation of the integral of the input signal over a specified time interval.

NOTE Typical principles of operation of apparatus which are used for measuring or converting the integral or the average value of the input quantity are given in Sub-clauses 2.4.3.2.1 and 2.4.3.2.2.

2.4.3.2.1**input quantity to frequency conversion type**

an operating principle according to which the apparatus generates a frequency directly proportional to the value of the input quantity. A count of the number of cycles occurring in a fixed time interval gives the measure of the average value of the input quantity during this interval

2.4.3.2.2**linear dual slope type**

an operating principle in which the scaled input quantity is converted to a proportional current. A capacitor is charged by this current over a defined period of time and subsequently discharged linearly by a current having a defined value

the period of time required to remove the charge produced by the input quantity is directly proportional to the integral of the input quantity. It is usually measured by gating a clock into a counter

2.4.4 Time functions

The presence and sequence of the time intervals listed in this sub-clause and their delay or overlap depend on the operation process of the apparatus.

The magnitude of the time intervals, and in some cases even their occurrence, may be either internally fixed or dependent on the characteristics of the input quantity and/or of the source impedance.

Unlike the internal time intervals defined in Sub-clauses 2.4.4.3 to 2.4.4.14, which may be useful when stated for information purposes, the response times of Sub-clauses 2.4.4.16.1 to 2.4.4.16.3 are defined for testing purposes.

2.4.4.1**conversion rate**

number of complete conversions within the stated accuracy limits obtained, per unit time

2.4.4.2**total time**

time interval during which one complete measurement (conversion) takes place

NOTE 1 Explanations as to total time and its typical components are given in Figure 3 and Figure 4, page 45.

NOTE 2 The reciprocal of the conversion rate is not equal to the total time when the operation includes delay or overlap.

2.4.4.3**measuring time**

time interval between the moment at which the conversion command is applied and the moment at which the complete digital information is available at the output

2.4.4.4**sampling time (aperture time)**

time interval during which the input quantity is sensed by the conversion circuits

2.4.4.5**input settling time**

after an input step has been applied, the time interval required before a conversion can be started within the stated accuracy limits

NOTE The input settling time is in general affected by the source impedance connected to the input.

2.4.4.6**internal settling time**

the time interval, after a conversion command, provided internally by the apparatus necessary for it to start conversion within the given accuracy limits

2.4.4.7**reset time**

time interval provided internally by the apparatus, necessary to reset the conversion circuits to starting conditions

2.4.4.8**polarity changing time**

for apparatus with automatic polarity sensing the time interval required for determining the polarity and/or a change of polarity, as well as for making the apparatus ready for conversion of the input quantity with the given polarity

for apparatus with external polarity setting, the time interval required for making the apparatus ready for conversion of the input quantity with the given polarity

2.4.4.9**range changing time**

for apparatus with automatic range changing, the time interval for determining the range and, if necessary, a change of range

2.4.4.10**digitizing time**

the time interval required to perform sampling, quantization and encoding

2.4.4.11**sample and hold facility**

a device which senses and stores the input value within specified tolerances independent of the actual conversion and holds this value available until its conversion has been completed

2.4.4.12

integration time

with integrating conversion, the time interval between the limits of which the integral of the input value is formed

2.4.4.13

output information setting time

time needed for setting the visual display corresponding to the converted value and/or for delivering the total output signal to the output terminals

NOTE Depending on the construction of the apparatus, this time interval may overlap the digitizing time (e.g. with some apparatus with series output system), or the time of the next measuring process (e.g. apparatus with buffer store, etc.).

2.4.4.14

read-out time

time interval during which the output signal is available for reading under continuous operation at maximum conversion rate

2.4.4.15

overload recovery time

time interval required after removal of a specified overload input value before a measurement (conversion) can be made within the stated accuracy limits

2.4.4.16 Response time

The time interval between an abrupt (step) change of the input signal and the steady-state indication of its new value within the stated accuracy limits.

2.4.4.16.1

step response time

response time resulting from a step change of specified magnitude of the input signal within a range without polarity change

2.4.4.16.2

polarity response time

response time resulting from a step change of specified magnitude of the input signal that causes a change in the indicated polarity

2.4.4.16.3

range response time

response time resulting from a step change of specified magnitude of the input signal, without a polarity change, that causes switching to an adjacent range

2.5 Terms concerning outputs

2.5.1 Output terminals

Connection points of the apparatus across which the output information signals are available in the form of specified voltage (current) levels or are represented by specified impedance states (e.g. short-circuit and open circuit).

2.5.1.1

auxiliary terminals

terminals other than input and output terminals which supply or receive auxiliary analogue or digital signals

2.5.2 Quantities at the output

2.5.2.1 Output signal

The signal which results from conversion.

NOTE Where there is no possibility of ambiguity, the value of the output signal is referred to hereinafter as the "output value".

2.5.2.1.1**output signal “one” level**

the value of the electrical signal occurring between a pair of output terminals so as to represent a binary “one”

2.5.2.1.2**output signal “zero” level**

the value of the electrical signal occurring between a pair of output terminals so as to represent a binary “zero”

2.5.2.1.3**auxiliary output signals**

output signals, in general appearing across auxiliary terminals, intended to facilitate the evaluation of the output information signals

NOTE Typical auxiliary output signals are: clock pulses, gate signals, start, stop and other command signals for the associated apparatus.

2.5.2.1.4**overflow**

condition which occurs when the output information exceeds the set of the digital representation

2.5.2.1.5**overflow indication**

a warning signal indicating that overflow occurs

2.5.2.1.6**uninterrupted stepwise progression**

the sequence of output information (see Sub-clause 2.5.2.2.1) in which all possible output states appear in correct order of succession

NOTE When checking uninterrupted stepwise progression, the value of the input quantity shall be changed sufficiently slowly.

2.5.2.1.7**monotonicity**

the output value is monotonic, if the difference between successive output values always has the same sign or is equal to zero, when the input value is varied in one direction

2.5.2.2 Representation form of output information**2.5.2.2.1****output information**

the digital (electrical and/or visual) representation of the measured (converted) quantity resulting from the conversion process

2.5.2.2.2**output state**

the output state is a dimensionless discrete condition of the output information during read-out time

2.5.2.2.3**representation unit**

the representation unit is the minimum increment between two successive output states (see Figure 5, page 46). Illustrations of different magnitudes of the representation unit in decimal notation is given in Table I

NOTE 1 In decimal output representation, it is possible that not every digit is displayed in all decades. For the least significant digits, examples are given in the centre and right columns of Table I. In some apparatus, the most significant digit may only assume “0” or “1”.

NOTE 2 The resolution of an apparatus is determined by its output range together with the total number of possible output states within that range.



Table I — Examples of output states

Representation unit = 1	Representation unit = 2	Representation unit = 5
12340	12340	12340
12341		
12342	12342	
12343		
12344	12344	
12345		12345
12346	12346	

2.5.2.3 Systems for supplying output information

2.5.2.3.1

series output system

output system arrangement in which the output signal consists of a series of consecutive binary digits appearing between a single pair of output terminals

2.5.2.3.2

parallel output system

output system arrangement in which all binary digits appear simultaneously across a group of output terminal pairs

2.5.2.3.3

series-parallel output system

combined output system arrangement comprising more than one pair of output terminals across which binary digits may appear simultaneously, and across all of which a number of consecutive binary digits may appear (e.g. characters in series, elementary binary digits in parallel)

NOTE In some types of apparatus, for example, the elementary-parallel binary digits correspond to an encoded decimal figure, and the consecutive binary digit groups correspond to consecutive decimal figures.

2.5.2.4

read-out clock rate

in a series or in a series-parallel output system, the number of binary digits supplied between each pair of output terminals per unit time

2.5.3 Relations between input and output

2.5.3.1

sensitivity

ratio of the change in the output value to the corresponding change in the input value. It is expressed in representation units per unit input quantity

NOTE 1 In graphical representation of the relationship between input and output values, the slope of that curve represents the sensitivity.

NOTE 2 For apparatus with intentionally non-linear conversion characteristics, the sensitivity is a function of the input value.

2.5.3.2

conversion coefficient

the reciprocal of sensitivity

2.5.3.3

resolution

resolution is expressed in one of the following ways:

- a) By the equivalent of the representation unit in terms of the measured (converted) quantity.
- b) By the number of representation units (e.g. 14 bits).

NOTE 1 The resolution is a theoretical value assigned to the apparatus, and does not consider the effects during operation such as dead zone, lack of monotonicity or hysteresis.

NOTE 2 The resolution contributes to the error in conversion; however, a high resolution will not necessarily result in a small error.