

Specification for

Direct-current and low-frequency electronic measuring instruments with a digital display

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Foreword

This British Standard has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee and is based on BS 89¹⁾, the format of which it generally follows for ease of use.

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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 22, 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⁾ Revision in preparation.

1 Scope

This standard specifies requirements for the performance of electronic measuring instruments with a digital display intended for measuring analogue quantities of voltage and/or current.

It also applies to instruments for indicating other quantities including non-electrical quantities, provided that the relationship between the indicated quantity and the measurand is known.

This standard applies to self-contained instruments having their own enclosure, terminals, etc., and also to instruments for fitting in an enclosure where the enclosure is not provided by the supplier of the instrument [original equipment manufacture (OEM) instruments].

This standard applies only to instruments measuring current and voltage at d.c. and at a.c. at distribution system frequencies and their harmonics. It applies to the digital parts of an instrument having a combined analogue/digital display.

This standard does not specify requirements concerning dimensions of instruments and does not apply to instruments having a digital or coded measurand input. It does not apply to special purpose instruments which are covered by their own British Standards and contains no requirements for the visibility of the display. It also does not apply to accessories.

NOTE 1 The values of a.c. quantities given in this standard are r.m.s. values unless otherwise stated.

NOTE 2 The publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 7194, the definitions given in BS 4727 apply, together with the following.

2.1 General terms

2.1.1 measurand

a quantity subjected to measurement

2.1.2 digital display instrument

a measuring instrument that provides a display in digital form. (Referred to hereinafter as instrument)

2.1.3 indicating instrument

a measuring instrument that displays at any time the value of the measurand without recording it

NOTE The indicated value may be different from the value of the quantity measured by the instrument and may be in units of a different quantity.

2.1.4 electronic measuring instrument

a measuring instrument intended to measure an electrical or non-electrical measurand using electronic means

2.1.5 single function instrument

a measuring instrument intended for the measurement of one kind of measurand only

2.1.6 multi-function instrument

a measuring instrument with a single means of indication intended for the measurement of more than one kind of measurand (e.g. an instrument measuring current, voltage and resistance)

2.1.7 fixed instrument

a measuring instrument designed to be permanently mounted and which is intended to be connected to an external circuit(s) by means of permanently installed conductors

2.1.8 portable instrument

a measuring instrument specifically designed to be carried by hand and to be connected and disconnected by the user

2.1.9 instrument with magnetic screen

a measuring instrument shielded by ferro-magnetic material from the influence of a magnetic field of external origin

2.1.10 instrument with electric screen

a measuring instrument shielded by conductive material from the influence of an electric field of external origin

2.1.11 accessory

an element, group of elements or device associated with the measuring circuit of a measuring instrument in order to confer specified characteristics to the measuring instrument

2.1.12 instrument lead

a lead comprising one or more conductors, specially designed for connecting measuring instruments to external circuits

2.1.13 calibrated instrument lead

an instrument lead whose resistance has a specified value

2.1.14**distortion factor (total harmonic distortion factor) of a measurand**

the ratio of the r.m.s. value of the harmonic content to the r.m.s. value of the non-sinusoidal measurand

NOTE Ratio = $\frac{H}{M}$
where

H is the value of the harmonic content;

M is the value of the non-sinusoidal measurand.

2.1.15**ripple content of a measurand**

the ratio of the fluctuating current to the value of the d.c. component

NOTE Ratio = $\frac{C_f}{C_{dc}}$
where

C_f is the value of the fluctuating component;

C_{dc} is the value of the d.c. component.

2.1.16**peak factor**

the ratio of the peak value to the r.m.s. value of a periodic measurand

2.1.17**common mode voltage**

that part of a voltage measurand which exists between each of the voltage circuit terminals and a reference point

NOTE This reference point may be the frame terminal, the signal terminal or another defined point.

2.1.18**series mode voltage**

an unwanted part of the input voltage which is superimposed on the voltage produced by the measurand

2.2 Description of instruments according to their method of operation**2.2.1****rectifier instrument**

a measuring instrument that combines a measuring instrument sensitive to direct current and a rectifying device whereby alternating currents or voltages may be measured

2.2.2**r.m.s. responding instrument**

a measuring instrument that, over a specified frequency range, provides an indication which is intended to be proportional to the root-mean-square value of the measurand, even when it contains a d.c. component or is not sinusoidal

2.3 Constructional features of instruments**2.3.1****measuring circuit (of an instrument)**

the part of the electrical circuit internal to the instrument, together with the interconnecting leads, if any, which is energized by a voltage or a current, one of these quantities being a prime factor in determining the value of the measurand

2.3.2**current circuit**

a measuring circuit through which flows a current that is a prime factor in determining the value of the measurand

NOTE The current may be either directly involved in the measurement or a proportional current supplied by an external current transformer or derived from an external shunt.

2.3.3**voltage circuit**

a measuring circuit to which a voltage is applied that is a prime factor in determining the value of the measurand

NOTE The voltage may be either directly involved in the measurement or a proportional voltage supplied by an external voltage transformer or an external voltage divider.

2.3.4**external measuring circuit**

the part of the electrical circuit external to the instrument from which the value of the measurand is obtained

2.3.5**auxiliary circuit**

a circuit, other than a measuring circuit, required for the operation of the instrument

2.3.6**auxiliary supply**

an auxiliary circuit that provides electrical energy

2.3.7**indicating device**

the part of a measuring instrument that displays values corresponding to the measurand

2.3.8**electrical zero**

the indication given by the instrument when the measurand is either zero or a stated value

2.3.9**electrical zero adjuster**

the mechanism by means of which the instrument may be adjusted so that the electrical zero coincides with the appropriate indication

2.3.10**electrical span adjuster**

the mechanism by means of which the instrument may be adjusted so that the lower/upper limit of the measuring range coincides with the appropriate indication

2.4 Characteristic features of instruments**2.4.1****span**

the algebraic difference between the upper and lower limits of the measuring range which is expressed in units of the measurand

2.4.2**measuring range**

the range defined by two values of the measurand within which the limits of error of a measuring instrument are specified

NOTE A measuring instrument may have several measuring ranges.

2.4.3**response time**

the time taken for the indication to reach, and remain within, a band centred on the final steady indication, when the measurand is abruptly changed from zero (the unenergized condition) to a value such that the final steady indication is a specified proportion of the span

2.4.4**display update time (rate)**

the time interval between successive occasions on which, in response to a changing measurand, the display is changed

NOTE When the time interval is short, it is usual to give the display update rate, being the quantity of updates per second.

2.4.5**sampling time**

the time interval during which the value of measurand is being investigated in order to produce the display

2.4.6**sampling rate**

the number of times per second that the measurand is investigated in order to produce the display

2.5 Characteristic values**2.5.1****nominal value**

a value of a quantity indicating the intended use of an instrument. The intended characteristics of instruments and accessories are also nominal values

2.5.2**rated value**

a value of a quantity assigned, generally by a manufacturer, for a specified operating condition

2.5.3**fiducial value**

a clearly specified value to which reference is made in order to define the fiducial error

NOTE This value may be, for example, the upper limit of the measuring range, the scale length or another clearly stated value.

2.5.4**fiducial error**

the ratio of the absolute error to the fiducial value

2.6 Influence quantity, reference conditions, nominal range of use and preconditioning**2.6.1****influence quantity**

any quantity, generally external to the measuring instrument and/or accessory, that may affect its performance

2.6.2**reference conditions**

the appropriate set of specified values and specified ranges of values of influence quantities under which the permissible errors of an instrument are specified

NOTE Each influence quantity may have either a reference value or a reference range.

2.6.3**reference value**

a specified value of one of a set of reference conditions

2.6.4**reference range**

a specified range of values of one of a set of reference conditions

2.6.5**nominal range of use**

a specified range of values that an influence quantity can assume without causing a variation exceeding the specified amount

2.6.6**limiting values of an influence quantity**

extreme values that an influence quantity can assume without the instrument being damaged or permanently altered in such a way that it no longer satisfies the requirements of its class index

NOTE The limiting values may depend on the duration of their application.

2.6.7**warming-up period**

the interval between the energizing of the auxiliary circuit and the instant when the instrument may be used, as specified in the manufacturer's instructions

2.6.8**preconditioning**

the action whereby a specified value of the measurand is applied to the measuring circuit prior to carrying out testing or use of the instrument, generally for a specified period

2.7 Errors and variations**2.7.1****(absolute) error**

for an instrument, the value obtained by subtracting the true value from the indicated value

NOTE Since the true value cannot be obtained by measurement, a value obtained under specified test conditions and at a specified time is used instead. This value is derived from national measurement standards or measurement standards which have been agreed.

2.7.2**intrinsic error**

the error of an instrument when under reference conditions

2.7.3**variation**

the difference between the two indicated values for the same value of the measurand of an instrument when a single influence quantity successively assumes two different specified values within the nominal range of use

2.8 Accuracy, accuracy class and class index**2.8.1****accuracy**

for a measuring instrument the closeness of the indicated value to the true value

NOTE The accuracy of a measuring instrument is defined by the limits of intrinsic error and by the limits of variations.

2.8.2**accuracy class**

a group of measuring instruments which meet certain metrological requirements intended to keep permissible errors and variations within specified limits

2.8.3**class index**

the number that designates the accuracy class

NOTE Some instruments may have more than one class index.

3 Classification

Class indices shall be selected from a 1, 2, 5 sequence or a decimal multiple or a submultiple thereof.

4 Reference conditions and intrinsic errors**4.1 Reference conditions**

The reference values shall be either:

- a) 23 °C as given in Table 1; or
- b) 20 °C or 27 °C in which case they shall be marked in accordance with clause 8.

4.2 Limits of intrinsic error

When the instrument is under the reference conditions given in Table 1 and is used between the limits of its measuring range in accordance with the manufacturer's instructions, the intrinsic error, when measured by the method of 4.2, and expressed as a percentage of the fiducial value, shall not exceed the limits appropriate to its class index given in Table 1. If a table of corrections is supplied with the instrument it shall not be taken into account in determining the errors.

NOTE 1 Recommended methods of test are given in Table 2.

NOTE 2 The intrinsic error includes other errors such as those due to component drift, etc.

NOTE 3 The maximum permissible error is related to the accuracy class such that the class index is used as the limit of error, expressed as a percentage with positive and negative signs. For example, for a class index of 2, the limits of intrinsic error are $\pm 2\%$ of the fiducial value (see Appendix B).

NOTE 4 The fiducial value for an ammeter or a voltmeter corresponds to the following.

- a) The upper limit of each measuring range for instruments in which the indication is in units of the measurand. The class index is marked using symbol E-1 given in Table 4 (see clause 8).
- b) The span for an instrument whose indication does not correspond directly to its electrical input quantity. The class index is marked using symbol E-10 given in Table 4 (see clause 8).

Item b) does not apply to a voltmeter or ammeter designed to be used in conjunction with a shunt, a resistive divider or an instrument transformer. These instruments should be treated in accordance with item a).

5 Nominal range of use and variations
(see Appendix B)

NOTE Recommended methods of test are given in Table 2.

5.1 Nominal range of use

5.1.1 Either the limits of the nominal range of use for influence quantities shall be as given in Table 2 or, when a nominal range of use is specified which is different from that shown in Table 2, it shall include the reference range (or reference value with permitted tolerances) and will normally exceed that range in at least one direction. Such ranges shall be marked in accordance with clause 8.

5.1.2 For values in the nominal range of use beyond the reference range (or reference value), the permissible variation shall be as stated in Table 2.

Example. For an instrument having a class index of 0.2, the variation (as a percentage of the fiducial value) due to ripple of 20 % on a d.c. measurand shall not exceed:

$$0.2 \left(\frac{50}{100} \right) = 0.1$$

Table 1 — Reference conditions and tolerances for testing purposes relating to the influence quantities

Influence quantity		Reference conditions unless otherwise marked	Tolerances for testing purposes, applicable for a single reference value ^a	
			Class index 0.2 and smaller	Class index 0.5 and greater
Ambient temperature		23 °C	± 1 °C	± 2 °C
Humidity		Relative humidity 40 % to 60 %	—	—
Ripple on d.c. measurand (series mode voltage)		Ripple content zero	Ripple content 0.01	Ripple content 0.03
Common mode voltage		Total absence	1 % of the maximum value of the measurand for each range	3 % of the maximum value of the measurand for each range
Distortion of a.c. measurand	Distortion factor	Zero	± 0.01	
	Peak factor	√2, approx. 1.414 (sinewave)	± 0.05	
Frequency of a.c. measurand		45 Hz to 65 Hz	± 2 % of the reference value or ± $\frac{1}{10}$ of the reference range for frequency (if any), whichever is the smaller	
Magnetic field of external origin		Total absence	0.04 kA/m ^b at frequencies from d.c. to 65 Hz in any direction	
Electric field of external origin		Total absence	1 kV/m at frequencies from d.c. to 65 Hz in any direction	
Auxiliary supply	Voltage	Nominal value or nominal range	± 5 % of the nominal value	
	Frequency	Nominal value or nominal range	± 1 % of the nominal range	

^a These tolerances apply when a single reference value is specified in this table or is marked by the manufacturer. For a reference range, no tolerance is allowed.
^b 0.04 kA/m is approximately the highest value for the Earth’s magnetic field.