

# Electricity meters —

## **Part 1: Specification for Class 0.5, 1 and 2 single-phase and polyphase, single rate and multi-rate watt-hour meters**

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# Cooperating organizations

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

- Associated Offices Technical Committee
- Association of Short Circuit Testing Authorities
- British Electrical and Allied Manufacturers' Association (BEAMA)
- British Railways Board
- British Steel Corporation
- Department of Energy (Electricity)\*
- Electrical Contractors' Association
- Electrical Contractors' Association of Scotland
- Electrical Research Association
- Electricity Supply Industry in England and Wales\*
- Engineering Equipment Users' Association
- Institute of Purchasing and Supply
- Institution of Electrical Engineers\*
- Ministry of Defence
- National Coal Board
- National Economic Development Office
- Trades Union Congress

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:

- BEAMA Meter Association
- Electrical Power Engineers' Association

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## Foreword

This British Standard has been prepared under the direction of the Power Electrical Engineering Standards Committee. It closely follows IEC Publication 521 “*Class 0.5, 1 and 2 alternating-current watt-hour meters*”, although it has been necessary to put in additional clauses and consequent modifications to cater for British requirements already standardized. Significant technical additions and deviations are indicated by vertical lines in the margin.

This standard is harmonized with HD 309.1 of the European Committee for Electrotechnical Standardization with regard to Class 2 meters.

BS 5685, in four Parts, will supersede all the various Parts of BS 37. BS 37-6, BS 37-8 and BS 37-10 were withdrawn in December 1983 without replacement. This Part of BS 5685 supersedes BS 37-2, BS 37-4, BS 37-7, BS 37-11 and BS 37-12, which have been withdrawn. BS 5685-2 will supersede BS 37-3; BS 5685-3 will supersede BS 37-5 and BS 5685-4 will supersede BS 37-9. On completion of the four Parts of BS 5685, BS 37-1 will be withdrawn.

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 and ii, pages 1 to 26, 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 Scope and references

**1.1 Scope.** This standard specifies the mechanical and electrical requirements and type tests, for single-phase and polyphase, single rate and multi-rate, induction type watt-hour meters of accuracy Classes 0.5, 1 and 2, for the measurement of alternating current electrical active energy of a frequency in the range of 45 Hz to 65 Hz, and having a voltage across the connection terminals not exceeding 600 V (line-to-line for meters for polyphase systems).

The standard does not apply to measuring devices, such as those used for telemetering electrical energy, which are dealt with in other standards, nor to maximum demand indicators. The standard does not apply to meters for testing purposes, nor to special types of watt-hour meters such as excess meters (although it does apply to multi-rate meters).

**1.2 References.** The titles of the publications referred to in this standard are listed on the inside back cover.

## 2 Units

The units employed in this standard are in accordance with BS 5775-5.

## 3 Definitions

For the purposes of this British Standard the following definitions apply. For further definitions relating to measurement see BS 4727-1:Group 04.

### 3.1

**watt-hour meter** (active-energy meter)

an integrating instrument which measures active energy in watt hours or in decimal multiples thereof

### 3.2

**induction meter**

a meter in which currents in fixed coils react with the currents induced in the conducting moving element, generally a disc or discs, which causes its movement

### 3.3

**multi-rate meter**

a meter provided with a register consisting of more than one set of drums or dials, each set becoming operative at times corresponding to different tariff rates

### 3.4

**meter rotor**

the moving element of the meter upon which the magnetic fluxes of fixed windings and of braking elements act, and which operates the register

### 3.5

**meter driving element**

a working part of the meter which produces a torque by the action of its magnetic fluxes upon the currents induced in the moving element. It generally comprises electromagnets with their control devices

### 3.6

**meter braking element**

the part of the meter which produces a braking torque by the action of its magnetic flux upon the currents induced in the moving element. It comprises one or more magnets and their adjusting devices

### 3.7

**register of a meter** (counting mechanism of a meter)

the part of the meter which registers the energy, or more generally the value of the quantity measured by the meter

### **3.8 meter base**

The back of the meter by which it is generally fixed and to which are attached the frame, the terminals or the terminal block and the cover; for a flush-mounted meter, it may include the sides of the case.

#### **3.8.1 meter socket**

an enclosure with jaws to accommodate terminals of a detachable watt-hour meter and which has connectors from the termination of the circuit conductors. It may be a single-position socket for one meter or a multiple-position socket for two or more meters

#### **3.9 meter cover**

the enclosure on the front of the meter, made either wholly of transparent material or opaque material provided with window(s) through which the movement of the rotor can be seen and the register can be read

#### **3.10 meter case**

this comprises the base and the cover

#### **3.11 meter frame**

the part to which are affixed the driving elements, the rotor bearings, the register, usually the braking element, and sometimes the adjusting devices

#### **3.12 accessible conducting part**

a conducting part which can be touched by the standard test finger<sup>1)</sup>, when the meter is installed ready for use

#### **3.13 protective earth terminal**

the terminal connected to accessible conducting parts of a meter, for safety purposes

#### **3.14 terminal block**

a support made of insulating material on which all or some of the terminals of the meter are grouped together

#### **3.15 terminal cover**

a cover which covers the meter terminals and, generally, the ends of the external wires or cables connected to the terminals

#### **3.16 current circuit**

the winding of the driving element and the internal connections of the meter through which flows the current of the circuit to which the meter is connected

NOTE When the meter incorporates a current transformer, the current circuit also includes the transformer windings.

#### **3.17 voltage circuit**

the winding of the driving element and internal connections of the meter, supplied with the voltage of the circuit to which the meter is connected

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<sup>1)</sup> See 6.1.1 of BS 5458:1977.

**3.18****auxiliary circuit**

the elements (windings, lamps, contacts, etc.) and connections of an auxiliary device within the meter case intended to be connected to an external device, i.e. clock, relay, or impulse counter

**3.19****basic current<sup>2)</sup> ( $I_b$ )**

the value of current in accordance with which the relevant performance of the meter is fixed

**3.20****rated maximum current<sup>2)</sup> ( $I_{max}$ )**

the highest value of current at which the meter purports to meet the accuracy requirements of this standard

**3.21****reference voltage<sup>2)</sup>**

the value of voltage in accordance with which the relevant performance of the meter is fixed

**3.22****reference frequency**

the value of frequency in accordance with which the relevant performance of the meter is fixed

**3.23****basic speed**

the nominal speed of rotation of the rotor expressed in revolutions per minute when the meter is under reference conditions and carries basic current at unity power factor

**3.24****basic torque**

the nominal value of the torque on the rotor when at rest, when the meter is under reference conditions and carries basic current at unity power factor

**3.25****meter constant**

a constant expressing the relation between the energy registered by the meter and the corresponding number of revolutions of the rotor, either in revolutions per kilowatt hour or watt hours per revolution

**3.26****reference temperature**

the ambient temperature specified for reference conditions

**3.27****clearance**

the shortest distance measured in air between conductive parts

**3.28****creepage distance**

the shortest distance measured over the surface of insulation between conductive parts

**3.29****type**

the designation used for defining a particular design of meter, manufactured by one manufacturer, having:

- a) similar metrological properties,
- b) the same uniform construction of parts determining these properties,

<sup>2)</sup> The terms voltage and current indicate r.m.s. values unless otherwise specified.

c) the same number of ampere turns for the current winding at basic current and the same number of turns per volt for the voltage winding at reference voltage,

d) the same ratio of the maximum current to the basic current.

they may have several values of basic current and several values of reference voltage

these meters are designated by the manufacturer by one or more groups of letters or numbers, or of a combination of letters and numbers. Each type has one designation only

NOTE 1 The type is represented by the sample meter(s) intended for the type tests, and whose characteristics (basic currents and reference voltages) are chosen from the values given in the tables proposed by the manufacturer.

NOTE 2 Where the number of ampere turns would lead to a number of turns other than a whole number, the product of the number of turns of the windings and the value of the basic current may differ from that of the sample meter(s) representative of the type.

It is advisable to choose the next number immediately above or below in order to have whole numbers of turns.

Only for this reason may the number of turns per volt of the voltage windings differ, but by not more than 20 %, from that of the sample meters representative of the type.

NOTE 3 The ratio of the highest to the lowest basic speed of the rotors of each of the meters of the same type should not exceed 1.5.

### **3.30**

#### **type test**

a test carried out under prescribed conditions to verify one of the characteristics of the type of the meter

### **3.31**

#### **type approval procedure**

the procedure according to which the series of type tests is carried out on one meter or on a small number of meters of the same type having identical characteristics, selected by the manufacturer, to verify that the respective type of meter complies with all the requirements of the standard for the relevant class of meters

### **3.32**

#### **qualification procedure**

the procedure according to which type tests are carried out on one meter or on a small number of meters of the same type having identical characteristics, selected at random, to verify that the meter type has no serious systematic abnormalities. The precise tests and the number of meters to be tested are to be agreed between the parties

NOTE In practice, it is considered that no serious systematic abnormalities exist when two out of three meters tested comply with the relevant requirements of this standard for the test under consideration.

### **3.33**

#### **percentage error**

the percentage error is given by the following formula:

$$\text{Percentage error} = \frac{\text{energy registered by the meter} - \text{true energy}}{\text{true energy}} \times 100$$

NOTE Since the true value cannot be determined, it is approximated by a value with a stated uncertainty that can be traced to standards agreed upon between manufacturer and user or to national standards.

### **3.34**

#### **variation of error due to an influence quantity**

the difference between the percentage errors of the meter when only one influence quantity assumes successively two specified values

### **3.35**

#### **influence quantity or factor**

any quantity or any factor other than the measured quantity whose effects may modify the measured results

### **3.36**

#### **distortion factor**

the ratio of the r.m.s. value of the harmonic content (obtained by subtracting from a non-sinusoidal alternating quantity its fundamental term) to the r.m.s. value of the non-sinusoidal quantity.

The distortion factor is usually expressed as a percentage

**3.37****mean temperature coefficient**

the ratio of the variation of the percentage error to the change of temperature which produces this variation

**3.38****vertical working position**

the position of the meter in which the shaft of the rotor is vertical

**3.39****class index**

a number which gives the limits of the permissible percentage error, for all values of current between  $0.1 I_b$  and  $I_{max}$ , for unity power factor (and, in the case of polyphase meters, with balanced loads) when the meter is tested under reference conditions (including permitted tolerances on the reference values) as defined in this standard

**4 Classification**

In this standard, meters are classified according to their respective class indices, i.e. 0.5, 1 and 2.

**5 Mechanical requirements**

**5.1 General.** Meters shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially:

- a) personal safety against electric shock;
- b) personal safety against effects of excessive temperature;
- c) safety against spread of fire.

All parts which are subject to corrosion under normal working conditions shall be effectively protected. Any protective coating shall not be liable to damage by ordinary handling nor injuriously affected by exposure to air, under normal working conditions.

The meter shall have adequate mechanical strength and shall withstand the elevated temperature which is likely to occur in normal working conditions.

The components shall be reliably fastened and secured against loosening.

The electrical connections shall be such as to prevent any opening of the circuit, including any overload conditions specified in this standard.

The construction of the meter shall be such as to minimize the risks of short-circuiting of the insulation between live parts and accessible conducting parts due to accidental loosening or unscrewing of the winding, screws, etc.

**5.2 Case.** The meter shall have a reasonably dustproof case which can be sealed in such a way that the internal parts of the meter are accessible only after breaking the seals.

The cover shall not be removable without the use of a tool, coin or any similar device.

The case shall be so constructed and arranged that any non-permanent deformation cannot prevent the satisfactory operation of the meter.

The case of a Class 0.5 meter shall be constructed so that, if mounted according to the manufacturer's instructions, the meter shall not deviate by more than  $0.5^\circ$  in all directions from its vertical position (see footnote b to Table 10).

For single-phase, two wire meters, the overall dimensions of the meter and the spacing of fixing holes shall be in accordance with the relevant values given in Table 20.

Unless otherwise specified, meters intended to be connected to a supply mains where the voltage under normal conditions exceeds 250 V to earth, and whose case is wholly or partially made of metal, shall be provided with a protective earth terminal.

**5.3 Windows.** If the meter cover is not transparent, one or more windows shall be provided for reading the register and observation of the rotor. These windows shall be covered by plates of transparent material which cannot be removed without breaking the seals.

**5.4 Terminals, terminal block(s) and protective earth terminal.** Terminals may be grouped in a terminal block(s) having adequate insulating properties and mechanical strength. In order to satisfy such requirements, when choosing insulating materials for the terminal block(s), adequate testing of materials should be taken into account.

The material of which the terminal block is made shall be capable of passing the tests specified in BS 2782-1:Method 121A for a temperature of 135 °C.

The holes in the insulating material, which form a prolongation of the terminal holes, shall be of sufficient size to accommodate the insulated conductors.

Unless otherwise specified by the user, it shall be possible to disconnect easily the relevant voltage terminal(s) from the input current terminal(s).

The manner of fixing the conductors to the terminals shall ensure adequate and durable contact such that there is no risk of loosening or undue heating.

All direct connected meters for rated maximum currents up to and including 160 A, and all meters operated from external current transformers, shall have two screws in each current terminal for effectively clamping the external conductors or thimbles.

Screw connections transmitting contact force and screw fixings which may be loosened and tightened several times during the life of the meter, shall screw into a metal nut.

Electrical connections shall be so designed that contact pressure is not transmitted through insulating material.

The clearances and creepage distances of the terminal block and those between the terminals and the surrounding parts of the metal enclosure shall be not less than the values specified in Table 1 for voltages existing when operating under reference conditions.

**Table 1 — Clearances and creepage distances**

| Voltage         | Clearance | Creepage distance |
|-----------------|-----------|-------------------|
| V               | mm        | mm                |
| Up to 25        | 1         | 1                 |
| From 26 to 60   | 2         | 2                 |
| From 61 to 250  | 3         | 3                 |
| From 251 to 450 | 3         | 4                 |
| From 451 to 600 | 4         | 6                 |

For current circuits, the voltage is considered to be the same as for the related voltage circuit.

Terminals with different potentials which are grouped close together shall be protected against accidental short-circuiting. Protection may be obtained by insulating barriers. Terminals of one current circuit are considered to be at the same potential.

The terminals, the conductor fixing screws, or the external or internal conductors shall not be liable to come into contact with metal terminal covers.

The clearance between the terminal cover, if made of metal, and the upper surface of the screws, when screwed down to the maximum applicable conductor which can be fitted, shall be not less than the relevant values indicated in Table 1.

For single-phase, two wire meters, the dimensions and spacing of the terminals shall be in accordance with the relevant values given in Table 20. (See Figure 1.)

For polyphase meters, the current terminals of direct connected meters having rated maximum currents up to and including 100 A shall be in accordance with the values *K*, *L* and *P* given in Table 20.