BS 7856:2017

BSI Standards Publication

Specification for special design and other features of alternating current watthour meters for active energy for use in the UK (Accuracy Classes A and B)

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Contents

Summary of pages

This document comprises a front cover, and inside front cover, pages i to iv, pages 1 to 26, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 July 2017. It was prepared by Technical Committee PEL/13, *Electricity meters*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 7856:2013, which is withdrawn.

Relationship with other publications

The standard specifies several conditions which are more stringent than currently exist within other European metering standards, reflecting the differences in working practices that exist between the United Kingdom and other European Union member states. It is, however, important to note that this British Standard is intended to augment the provisions of certain European standards (see Clause 2, "Normative references") and so, in instances where this document is non-prescriptive, the provisions of these other standards prevail and are therefore to be taken into account.

Information about this document

This standard has been revised to take account of the introduction of the IEC standard for electricity meter safety (IEC 62052-31) and developments in the UK metering market, principally the roll-out of smart metering to the residential market. The decision to further revise the standard came about because of:

- the incorporation of a supply control switch in every meter, particularly with regard to design considerations related to appropriate utilization categories, switch life (endurance) concerns and the thermal stresses placed upon such switches during overcurrent episodes. Furthermore, to give advice relating to supply control switches within polyphase meters in order to avoid issues due to partial switching arising from fault conditions;
- the inadequacies of some forms of service fusing as a means of providing protection to metering equipment and the need to align the overload requirements with British national specifications e.g. 1.45 I_{max};
- the need to ensure that the provisions for installation sealing arrangements continue to meet the national specifications within the MOCOPA [N1].

In addition, legacy sections relating to meters of older design have been removed. Reference to current transformer operated metering has also been removed as the majority of the standard no longer applies to such metering equipment. However, at the time of writing, consideration is being given to additional work to incorporate current transformer operated metering in an additional standard.

The decision has also been taken to convert BS 7856 from a Code of Practice to a Specification as some of the new requirements relating to the national specifications are normative and safety related.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. "organization" rather than "organisation").

Requirements in this standard are drafted in accordance with *Rules for the structure and drafting of UK standards*, subclause **G.1.1**, which states, "Requirements should be expressed using wording such as: 'When tested as described in Annex A, the product shall ...'". This means that only those products that are capable of passing the specified test will be deemed to conform to this standard.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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1 Scope

This British Standard specifies requirements for special design and other features of newly manufactured directly connected alternating current watthour meters with ratings up to and including 100 A I_{max} for installation in domestic and small commercial/industrial premises.

This standard is principally aimed at the UK market, although it might also be of use to other markets. Within the UK the standard is aimed at manufacturers who intend to design and market meters, meter operators engaged in meter installation activities and those involved in meter procurement, such as energy suppliers and meter asset providers.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document, including any amendments, applies.

Standards publications

BS 6004:2012, *Electric cables — PVC insulated and PVC sheathed cables for voltages up to and including 300/500 V, for electric power and lighting*

BS EN 50470-1:2006, *Electricity metering equipment (a.c.) — Part 1: General requirements, tests and test conditions — Metering equipment (Class indexes A, B and C)*

BS EN 50470-2:2006, *Electricity metering equipment (a.c.) — Part 2: Particular requirements — Electromechanical meters for active energy (Class indexes A and B)*

BS EN 50470-3:2006, *Electricity metering equipment (a.c.) — Part 3: Particular requirements — Static meters for active energy (Class indexes A, B and C)*

BS EN 60947-1:2007+A2:2014, *Low-voltage switchgear and controlgear — Part 1: General rules*

BS EN 62052-11, *Electricity metering equipment (AC) — General requirements, tests and test conditions — Part 11: Metering equipment*

BS EN 62052-31:2016, *Electricity metering equipment (AC) — General requirements, tests and test conditions — Part 31: Product safety requirements and tests*

IEC 60502-1, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV) — Part 1: Cables for rated voltages of 1 kV (U_m = 1,2 kV) and 3 kV (U_m = 3,6 kV)*

Other publications

[N1] MOCOPA, *Meter Operation Code of Practice Agreement*, www.mocopa.org.uk

[N2] WELMEC, *Guide for sealing of Utility meters*, WELMEC 11.3 Issue 1 May 2012

3 Terms and definitions

For the purposes of this British Standard the terms and definitions given in BS EN 50470 (all parts):2006, BS EN 62052-11, BS EN 62052-31, IEC 60502-1 and the following apply.

3.1 overcurrent protection device (OCPD)

device providing protection against both overload and short-circuit current that is capable of breaking and, for a circuit-breaker, making any overcurrent up to and including the prospective short-circuit current at the point where the device is installed

[SOURCE: IEC 60364-4-43, **432.1**]

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4 Mechanical features

4.1 For a single-phase, two-wire meter:

a) the overall dimensions of the meter and spacing of fixing holes shall be in accordance with the appropriate values given in Table 1; and

b) the dimensions and spacing of the current terminals shall be in accordance with the appropriate values given in Table 1 and shown in Figure 1.

NOTE Not referred to in Table 1 or Figure 1 but where fitted, auxiliary terminal(s) for single-phase directly connected meters should preferably be provided on the right-hand side of the terminal block, enabling auxiliary wiring to clear 18 mm to the right of a vertical line which is central to the four main terminals.

For polyphase meters, the current terminals of directly connected meters having rated currents up to and including 100 A, shall be in accordance with dimensions *K* and *L* and also conform to *P* given in Table 1.

For any current terminal, into which a correctly prepared cable conforming to BS 6004:2012, 8181Y, of down to 16 mm^2 is inserted, no visible conductive material shall be exposed.

Table 1 — *Dimensions and spacing of fixing holes and terminals*

Dimensions in mm

Letter designation	Dimension	Value
A A)	Maximum overall height (measured from lower face of terminal block)	209.6
B	Maximum overall width	158.8
C	Maximum overall projection (measured from front of meter board)	146.1
D B)	Vertical distance between centre of top fixing hole and centreline of bottom fixing holes	141.3 (max)
E A)B)	Vertical distance from centreline of bottom fixing holes to lower face of terminal block	23.8 to 27.0
F B)F)	Distance between centres of bottom fixing holes to a vertical line which is central to the four main terminals	51.6 to 53.2
G B)F)	From centrelines of current terminal holes 2 and 3 to a vertical line which is central to the four main terminals	10.3 to 11.9
H	Height of terminal bosses (if present). The design of the meter can either incorporate cable entry bosses or be flat bottomed depending upon the manufacturer's preference.	0 to 5.0
J B)F)	From centrelines of current terminal holes 1 and 4 to a vertical line which is central to the four main terminals	34.1 to 35.7
K	Size of aperture in current terminal to accept 8.0 mm diameter cable	8.0 (min)
L A)	Length of parallel portion of cable aperture plus depth of any lead-in from lower face of terminal block	28.5 (min)
M	From front of meter board to centreline of current terminal holes	17.4 to 20.7
N	Diameter of fixing holes	5.1 to 5.6
P C)	Terminal clamping screw flat-ended slightly chamfered, M6 E)	—
Q C)	Length of standard pin to enter the current terminal hole	27.0 (max)
W D)	From centreline of bottom fixing holes to centreline of lower pinch screws	12.5 to 15.0
Y D)	From centreline of lower pinch screws to centreline of upper pinch screws	7.5 to 10.5

NOTE The items applicable to single-phase, two-wire meters are shown in Figure 1.

A) This measurement shall include the length of any terminal boss if present.

B) For the purpose of estimating the tolerances, the datum line for the dimensions *D*, *E*, *F*, *G*, *J* should be:

vertical datum: the vertical line which is central to the four main terminals.

horizontal datum: centreline of bottom fixing holes. See also note F) below.

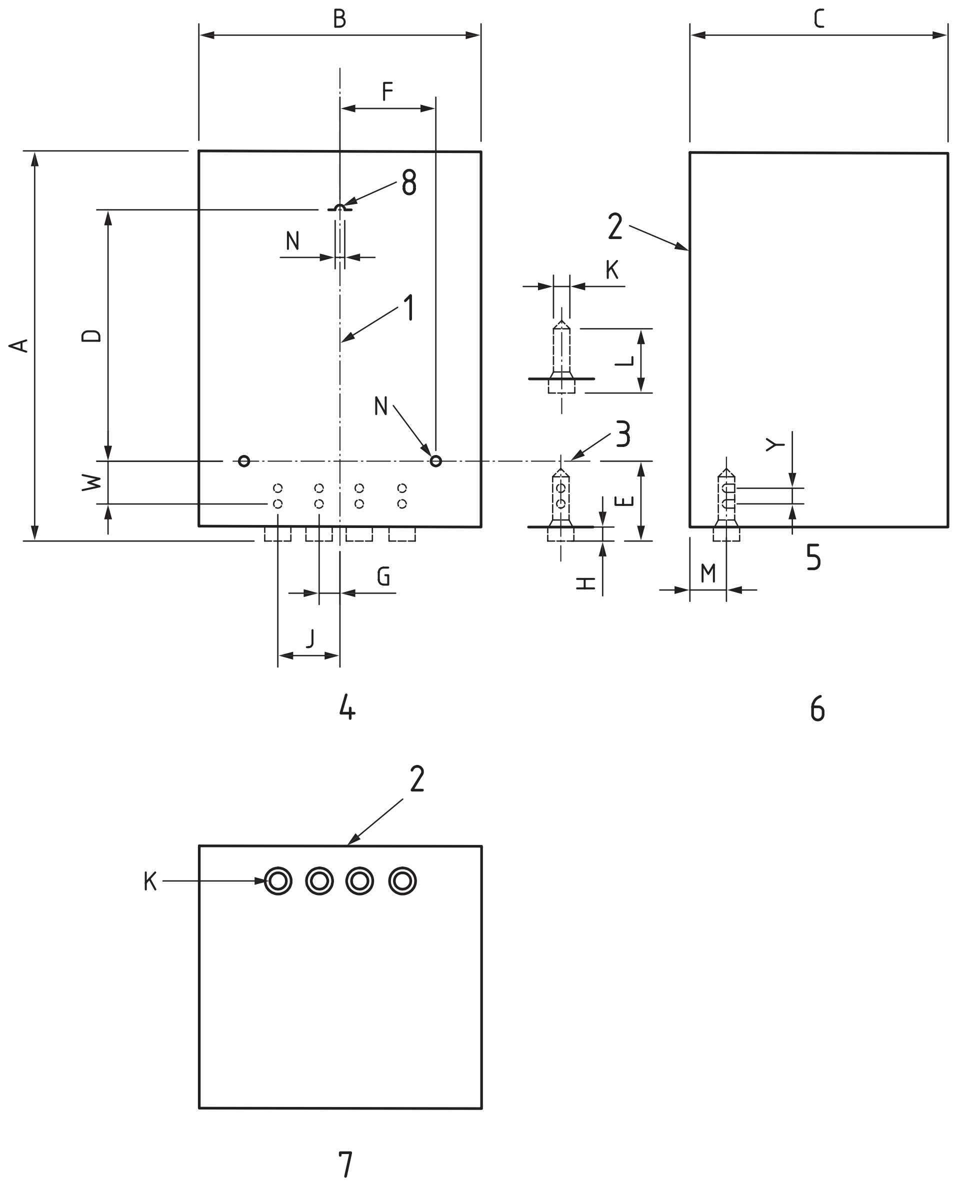
C) This dimension is not shown in Figure 1.

D) Reference only applies to double screw fitted terminals.

E) This screw should give a grip on any conductor from 10 mm^2 to 35 mm^2.

F) It should be noted that the vertical line central to the four main load terminals will not necessarily align with the centreline of the meter. Such misalignment can occur with single phase 5 terminal meters. In such circumstances it is important to maintain the position of the lower fixing holes relative to the first four main terminals as the lower fixing holes are used to locate the first, second and fourth terminals on the test rig pin frames.

Figure 1 — *Spacing of fixing holes and terminals for single-phase, two-wire meter*



Key

1	Datum – Vertical	5	Base of meter case
2	Meter back board	6	Side elevation
3	Datum – Horizontal	7	Plan
4	Front elevation	8	Top fixing hole if fitted

NOTE Dimensions are given in Table 1.

4.2 All conductors connected to the main and load terminals shall be clamped effectively and be capable of passing the test in accordance with Annex A. For a screw-fitted terminal, as indicated in Figure 1, there shall be two screws in each terminal.

NOTE However, other cable clamping arrangements are permissible.

When tested in accordance with Annex A:

a) all main and load terminals, irrespective of design and construction, shall resist the movement of any connected cable due to axial and/or rotational forces applied to the cables;

b) all main and load terminals, irrespective of design and construction, shall not allow slippage of a cable within a connection block; and

c) the meter case shall not fracture, break or distort to the extent that any hazard is created.

4.3 Under single fault conditions, when the meter's main and load terminal screws have been incorrectly overtightened:

a) the meter case shall not fracture, break or distort to the extent that any hazard is created; and

b) the main and load terminals shall not fracture, break or distort to the extent that any hazard is created.

4.4 There shall not be a facility in single-phase directly connected meters for the disconnection of the voltage circuit from the input current terminal.

NOTE Polyphase meters may be fitted with such arrangements at the purchaser's discretion.

4.5 The figure height of a register display shall be not less than 4.5 mm.

5 Electrical features

NOTE For single-phase and polyphase meters for use where the neutral is available, external control of the rate change should be achieved by connecting the rate change terminal(s) to neutral. For polyphase meters where external control of the rate change is provided, any internal connection to a phase for the rate change control should always be to phase A.

5.1 For multi-rate meters, the rate switching logic shall conform to Annex B.

5.2 For single and polyphase meters, the registers shall not decrease under net system energy flows in the opposite direction to that of the intended measurement.

5.3 The nominal and maximum rated currents for different types of meters shall be in accordance with Table 2.

NOTE These are metrological values relating to the range of measurement.

Table 2 — *Standard currents for meters of Class A or Class B*

Minimum current[A)]	**Transitional current**	**Nominal current**[B)]	**Maximum current**[C)]
I_{min} **A**	I_{tr} **A**	I_n **A**	(I_{max}) **A**
1	2	20	(100)
0.5	1	10	(100)
0.25	0.5	5	(100)

NOTE The values in this table are derived from BS EN 50470-1.

A) Minimum current at which the accuracy of the meter is specified.

B) Nominal current of meter.

C) Maximum metrological current rating of the meter.

5.4 The connections of a directly connected meter shall be as shown in Figure 2 to Figure 5.

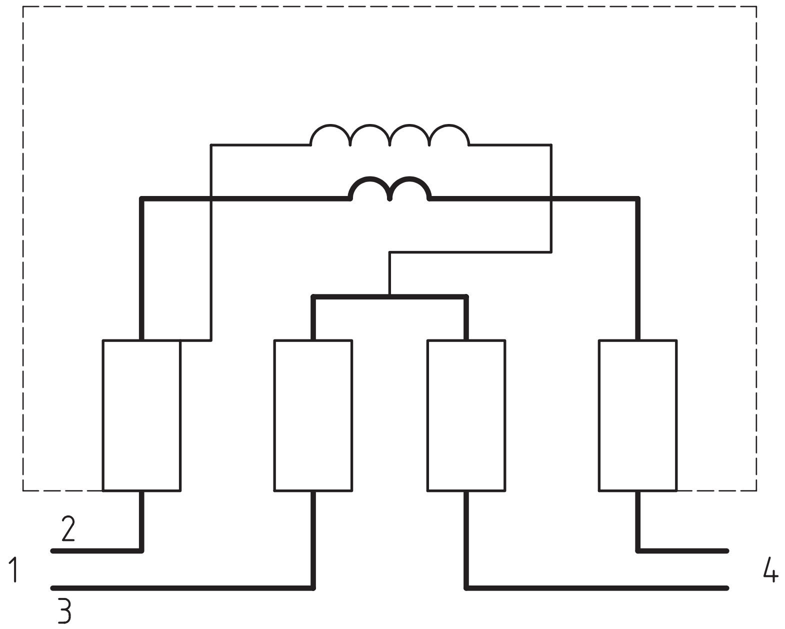
5.5 Where a meter is fitted with switches, there shall be a means of exercising them to enable checks on their state and operation.

5.6 The performance characteristics of meters fitted with supply control and load control switches shall conform to the requirements in Annex C and Annex D.

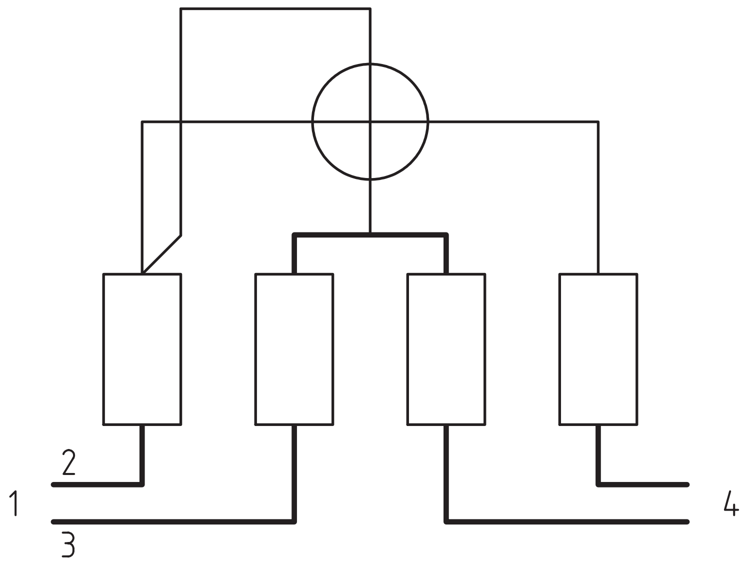
NOTE Attention is drawn to Annex F which gives further advice relating to operational considerations related to switches inside meters.

5.7 The performance characteristics of meters without supply control or load control switches shall conform to the requirements in Annex C.

Figure 2 — *Diagrams of connections for a single-phase, two-wire, one-rate meter*



a) Electromechanical

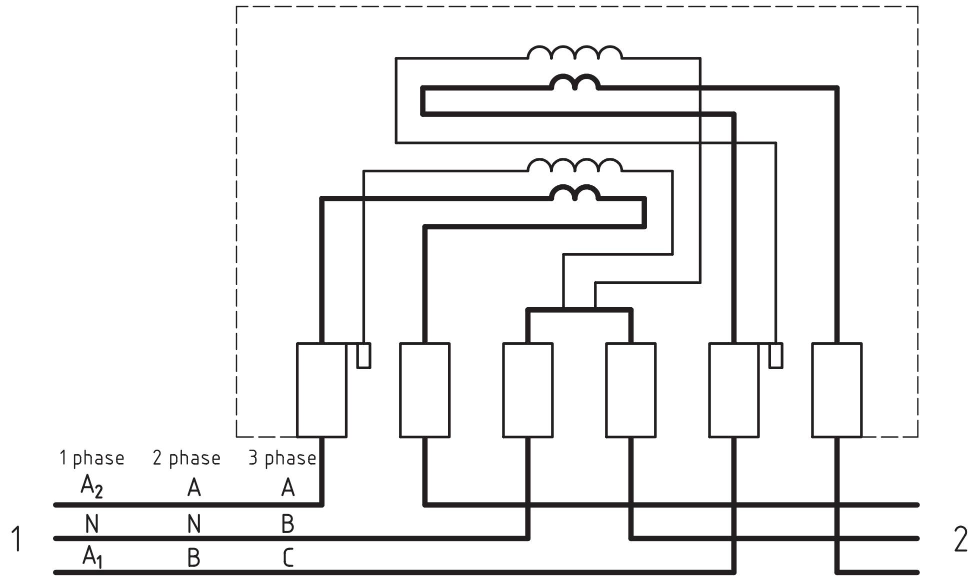


b) Static

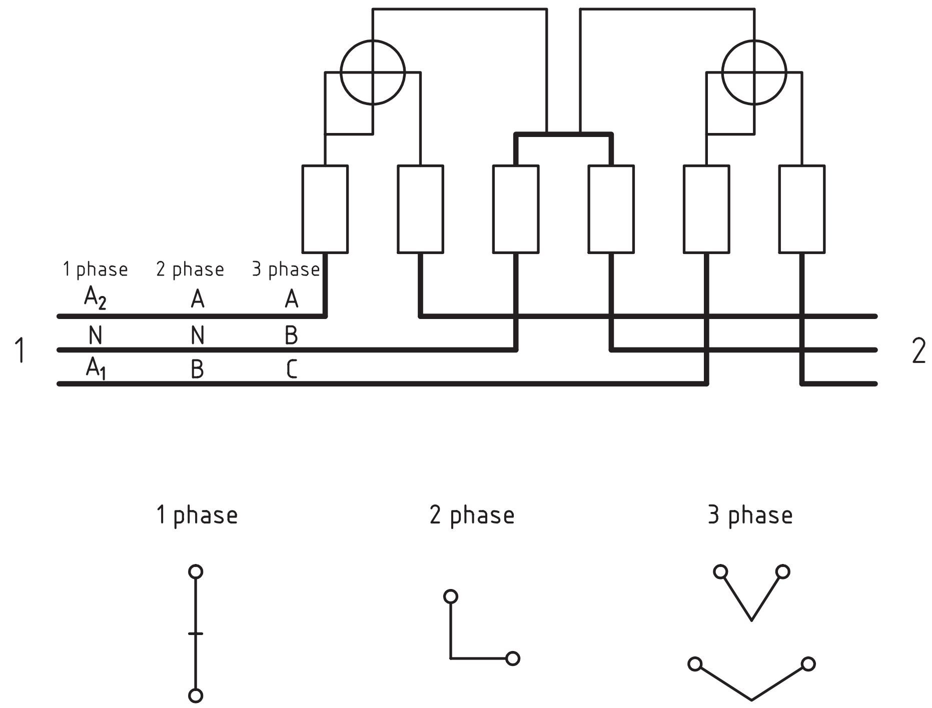
Key

1	Main
2	Line
3	Neutral
4	Load

Figure 3 — *Diagrams of connections and graphical symbols for a two-element meter used on three-wire systems*



a) Electromechanical

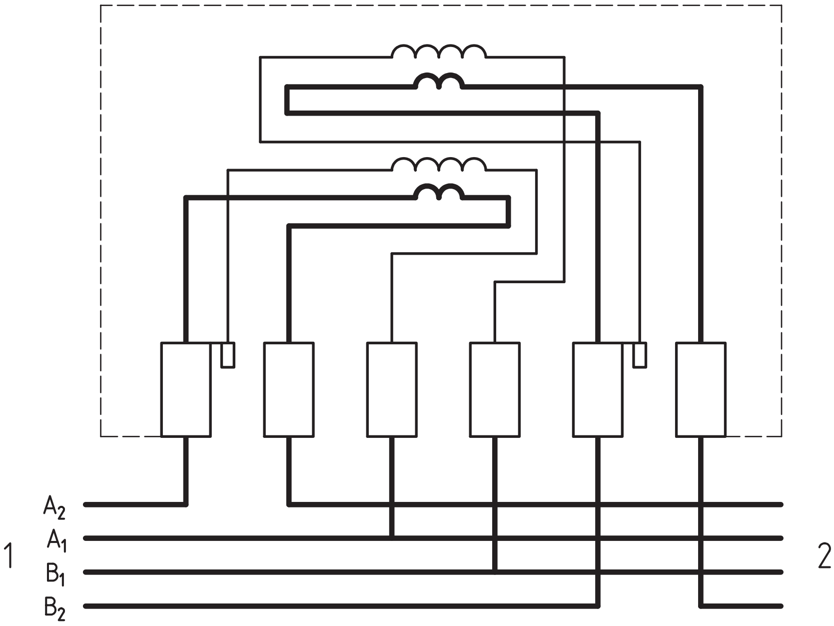


b) Static

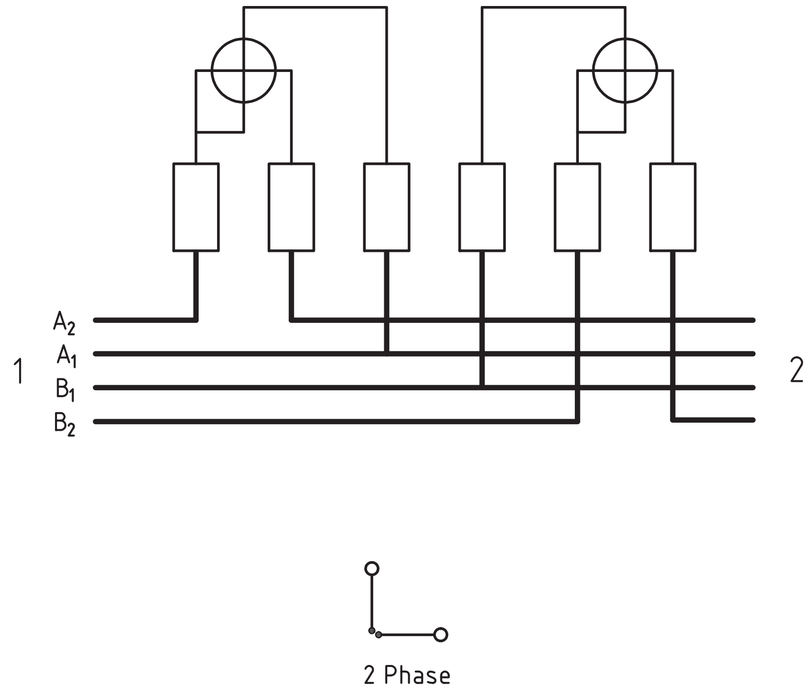
Key

1	Main	A	Phase A
2	Load	B	Phase B
		C	Phase C
		N	Neutral

Figure 4 — *Diagrams of connections and graphical symbols for a two-element meter used on a two-phase, four-wire system*



a) Electromechanical



b) Static

Key

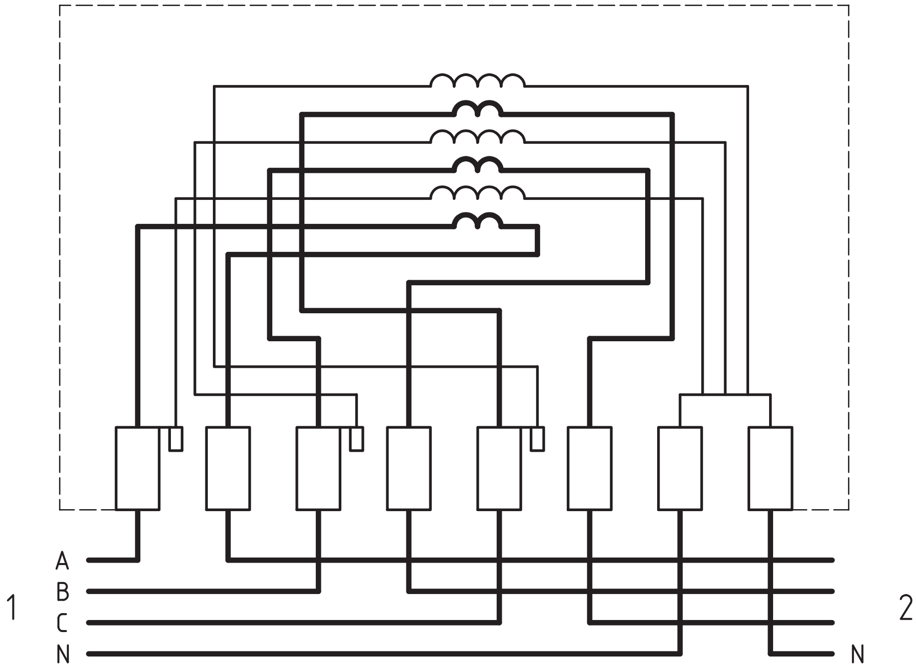
1 Main

2 Load

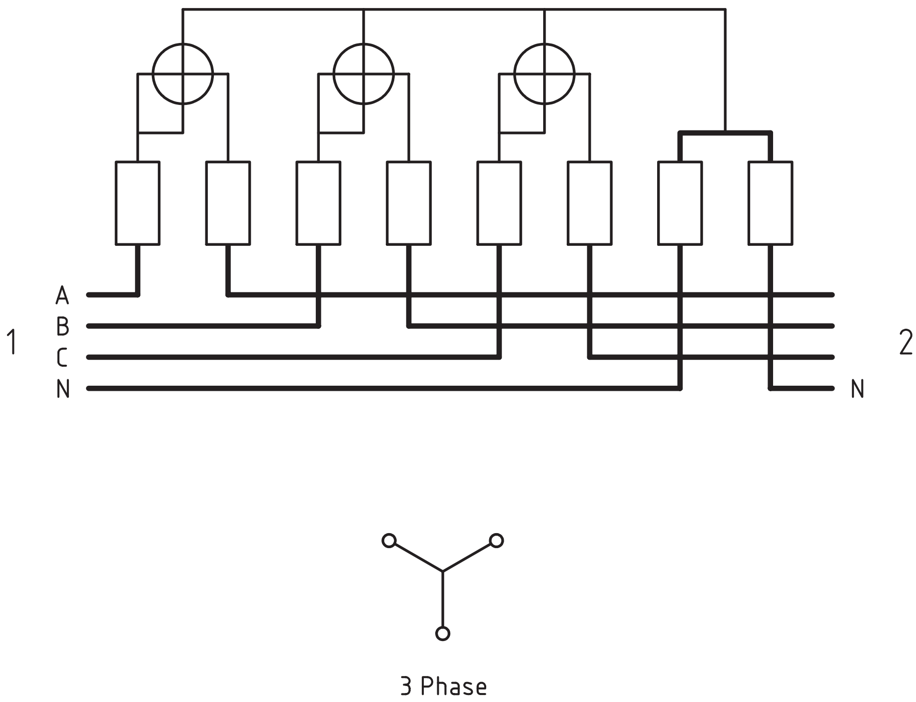
A Phase A

B Phase B

Figure 5 — *Diagrams of connections and graphical symbols for a three-element meter used on a three-phase, four-wire system*



a) Electromechanical



b) Static

Key

1	Main	A	Phase A
2	Load	B	Phase B
		C	Phase C
		N	Neutral

6 Other features

NOTE For multi-rate meters, each register indicating a rate should be capable of being identified in a two-character code as specified in data item J0010 of the Data Transfer Catalogue [1].

6.1 A meter which has a cover capable of being removed from its base to permit access to that part of the meter which measures supply shall be sealed with a metrological security seal conforming to Annex E as soon as practicable after initial verification.

6.2 Where fixing holes are recessed into the terminal block, the meter shall incorporate pilot guides to aid installation.

Annex A (normative) Test method of a terminal's ability to safely clamp standard UK cables

A.1 Apparatus

A.1.1 *Cable*, 25 mm² 7-core copper meter tail conforming to BS 6004.

A.1.2 *Meter*

A.1.3 *Clamp*, tightened onto conductors.

A.2 Procedure

Figure A.1 depicts the necessary requirements and method of conducting a meter terminal efficiency test.

Strip the insulation of a straight 200 mm length of cable (**A.1.1**) to match the terminals of the meter under test. The stripped end is otherwise to be "unprepared", i.e. the lay of the cable is not to be disturbed and the strands not deliberately twisted in either direction.

Mount the meter (**A.1.2**) normally (i.e. vertically) and insert the cable into the terminal, parallel with the rear plane of the meter, then tighten the terminal screws to the torque setting that has been specified by the meter manufacturer or else with the torque specified in Table 4 of BS EN 60947-1:2007+A2:2014

At a point 100 mm from the meter terminal entrance, using a suitable clamping arrangement (**A.1.3**), twist the free part of the cable about its axis through an angle of (90 ± 5)° such that this would tend to loosen the spiral lay of the cable.

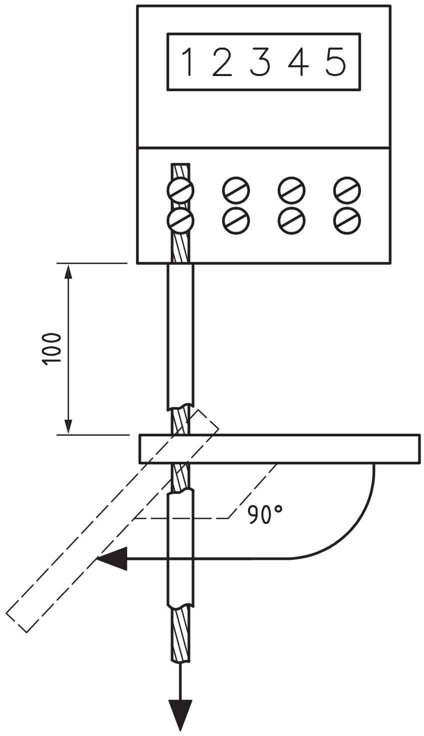
Remove the twisting force and then apply an axial force of 400 N to the free end of the conductor, normal to the meter terminal face, for at least 60 s.

Examine the terminal connection to determine whether the cable has detached from the terminal or has slipped within the terminal.

Repeat the test with all the current terminals, including any switched load outputs (but excluding auxiliary control switch terminals for rate or contactor control), using a new length of tail each time.

Figure A.1 — Test arrangement for clamping ability of a meter terminal

Dimensions in millimetres



NOTE 1 Direction of twisting shown is for a cable with anticlockwise lay.

NOTE 2 This drawing depicts twin pinch-screw terminations. Other terminal arrangements are acceptable but still need to pass this test.

Annex B (normative) External rate switching logic for multi-rate meters

B.1 General

NOTE 1 Multi-rate meters might have externally switched registers for each rate or switching can be by internal logic. The convention used in this standard is that an open switch or logic low is designated '0' and a closed switch or logic high is designated '1'.

The basis of the switching or logic sequence shall be that:

a) when all switches are open or logic states low the register indicates the highest (i.e. most expensive) rate; and

b) when all switches are closed or logic states high the register indicates the lowest (i.e. least expensive) rate.

The sequence for multi-rate registers having two to (a maximum of) eight rates shall be in accordance with Table B.1.

NOTE 2 External control switches are designated A, B and C and the control terminals of the multi-rate register are designated a, b and c. Switch A and terminal a are required for a 2-rate register. Switches A and B and terminals a and b are required for 3- or 4-rate registers. Switches A, B and C and terminals a, b and c are required for 5- to 8-rate registers.

Logic outputs shall follow the same sequence, i.e. A, B and C.

Table B.1 — *Sequence for multi-rate registers having two to eight rates*

Switch rate			**Number of tariff rates**						
A	B	C	2	3	4	5	6	7	8
0	0	0	H	H	H	H	H	H	H
0	0	1	H	H	H	I_1	I_1	I_1	I_1
0	1	0	H	I_1	I_1	I_1	I_1	I_1	I_2
0	1	1	H	I_1	I_1	I_1	I_1	I_2	I_3
1	0	0	L	I_1	I_2	I_2	I_2	I_3	I_4
1	0	1	L	I_1	I_2	I_2	I_3	I_4	I_5
1	1	0	L	L	L	I_3	I_4	I_5	I_6
1	1	1	L	L	L	L	L	L	L
Switches used			A	A + B		A + B + C			
NOTE H denotes high rate, I_1 to I_6 denote intermediate rates and L denotes low rate.									

B.2 Supplementary information

NOTE Meters having multi-rate registers might need to be operated at a lower number of rates than the maximum possible.

The manufacturer shall provide details of connections and/or set-up options for this to be made possible.

Annex C (normative)
Long-term overcurrent test requirements

Before the application of test currents above I_{max}:

a) The registration errors of the meter (on each circuit for multi-element single-phase meters, and on each phase for polyphase meters) shall be determined under reference conditions (ambient temperature, supply voltage and frequency) at nominal current and unity power factor.

b) For meters with supply control switches, the mV drop across each current circuit with a supply control switch shall be measured at the meter terminals, at I_{max}, with the newly manufactured supply control switch in the closed position. The results shall be recorded as a current circuit resistance(s) in ohms.

The meter shall then be tested in accordance with Clause **10** of BS EN 62052-31:2016, dealing with equipment temperature limits and resistance to heat, under the following conditions:

1) a single sample shall be tested with a current of I_{max} for two hours, followed immediately by a test current of I_{ovl} for a further two hours;

2) the overload current I_{ovl} shall be 1.45 * I_{max} per current circuit. A balanced load shall be used for polyphase meters. In the case of multi-element meters each current circuit shall be tested at its maximum current, with the other circuits carrying current such that the total current through the meter equates to the I_{max} or I_{ovl} current as appropriate;

3) the test cables shall be 25 mm^2 7-core copper meter tails conforming to BS 6004;

4) terminals shall be tightened in accordance with the torque settings specified by the meter manufacturer or else with the torque specified in Table 4 of BS EN 60947-1:2007+A2:2014;

5) thereafter, the meter shall be left connected to the voltage supply for a period of at least two hours (±30 min) with load current of 0 A.

When subsequently tested under reference conditions (ambient temperature, supply voltage and frequency) at nominal current and unity power factor, the additional error shall not exceed a critical change value of ±1.5% in accordance with the effect of short term overcurrents specified in BS EN 50470-3.

The overload rating of the meter shall be marked.

Annex D (normative)
Performance criteria for load switches inside meters

D.1 Load switching capability

Any switch in a current circuit of a meter shall be able to break the load for which it is intended, as well as withstand the passage of fault currents which the meter is intended to cope with, in accordance with Table D.1.

NOTE 'Load' in this context generally refers to the total consumer demand passing through a meter which should be related to the meter's I_{max}. However, in some equipment there are switches related to specific loads less than I_{max}, e.g. space and water heating installations.

Table D.1 — *Performance criteria for supply control and load control switches*

Criteria	References	
	Supply control switches rated at I_{max} of the meter	**Load control switches rated at I_{max} or less of the meter**
Load switching	BS EN 62052-31, Utilization Category 2 (UC2)[A)]	BS EN 62052-31

A) The possibility that a site might have a higher prospective short-circuit current should be taken into account. In such circumstances a meter that has been tested in accordance with the requirements of BS EN 62052-31, UC3 should be used.

D.2 Supply control switch endurance test

A supply control switch (SCS) inside a meter shall conform to the endurance test requirements of **6.10.6.4** of BS EN 62052-31:2016, with the following conditions:

- the test circuit shall be as shown in Figure 8a of BS EN 60947-1:2007+A2:2014; C_p and R_p shall not be fitted as a transient recovery voltage is not specified;
- the test circuit shall have a shunt resistor "r" fitted across the air-core reactor as specified in **8.3.3.5.2 d)** of BS EN 60947-1:2007+A2:2014;
- the on load test voltage tolerance shall be ±5%;
- meter terminals shall be tightened to the torque settings specified by the manufacturer or else with the torque specified in Table 4 of BS EN 60947-1:2007+A2:2014; and
- the polyphase method shall be in accordance with **6.10.6.4** of BS EN 62052-31:2016.

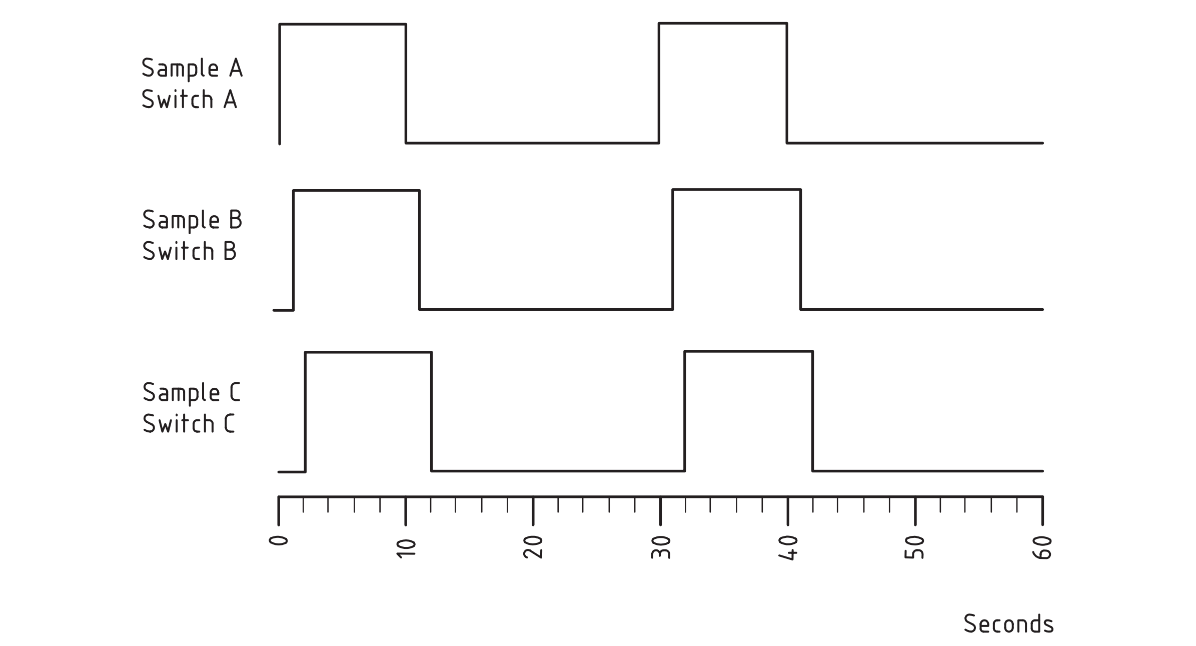
NOTE Polyphase meters without mechanical linkages between the phase switches may be tested with three meter samples controlled to have staggered timing of a single switch per sample per phase with timing that is 10 s on, 20 s off and 1 s between phase switching (see Figure D.1)

Before, during and after the endurance test, the mV drop between the line and load terminals of each current circuit shall be recorded for every cycle when the switch is closed. The test results shall be provided as a graph of the 10 000 recorded values converted to resistances, with a trend line formed from a 100 point moving average of the values, as shown in Figure D.2. The following parameters shall be calculated and recorded:

- the average resistance of all 10 000 readings;
- the best case (lowest) trend line resistance; and

- the worst case (highest) trend line resistance.

Figure D.1 — *Polyphase meter supply control switch test timing*



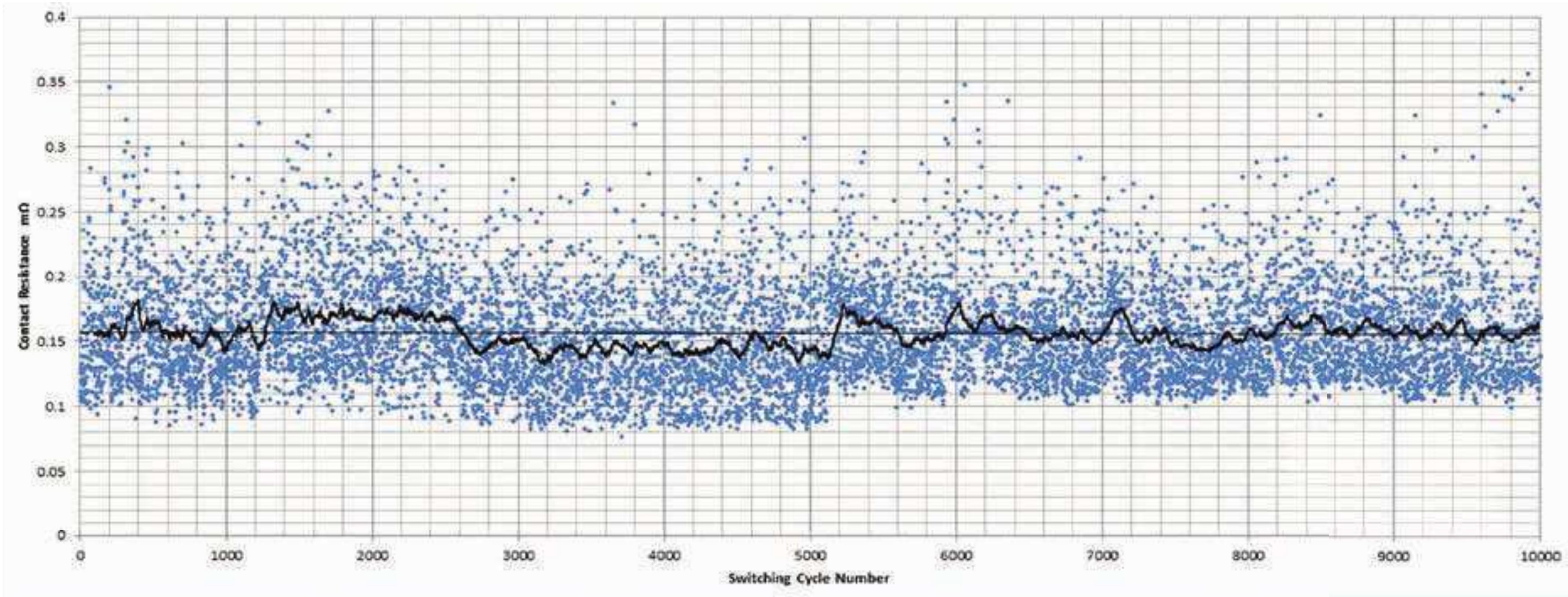
With reference to Figure D.2, the following pass/fail criteria shall apply:

a) To ensure that service life heat rise conditions are not significantly higher than those recorded during the heat rise test of Annex C, the (average) resistance during the endurance test shall be not greater than 3.0 times the initial resistance recorded before the heat rise test of Annex C; and

b) To ensure that arcing damage to contacts does not result in thermal runaway towards end of life, the worst case trend line resistance shall be not greater than 3.0 times the best case trend line resistance.

NOTE For safety integrity purposes, it is expected that adequate controls are implemented by the manufacturer to prevent and/or detect unrecorded changes to make, model and contact characteristics of SCSs used in volume production, when compared to the characteristics of the SCS used for this type of test.

Figure D.2 — *Contact resistance derived from mV drop measured at meter terminals at* I_{max}



Key

◆	Contact resistance mΩ
━━	Moving average (100)
——	Linear (contact resistance mΩ)

Annex E (normative) Sealing criteria

E.1 Meter sealing arrangements

Two forms of meter sealing arrangement shall be provided as follows:

a) installation sealing arrangements associated with components that require removal and replacement as part of normal onsite installation and maintenance arrangements, e.g. meter terminal covers, communication ports, modules and other ancillary arrangements; and

b) metrology sealing arrangements to secure the main chamber of the meter containing the metrological element(s), clock and control functionality.

*NOTE Metrology sealing arrangements can either take the form of physical seals as described in **E.3** a) to c) or take the form of a permanently closed meter as described in **E.3** d) wherein the main chamber is contained within a casing from which the cover cannot be separated without permanent damage.*

E.2 Installation seals

Installation sealing arrangements shall conform to the requirements of specified seals as described in Meter Operator Code of Practice Agreement (MOCOPA [N1]), Appendix 8.

NOTE This is in order to ensure that the installation sealing arrangements can accommodate the seals specified within the MOCOPA, which are nationally accepted for use throughout the UK.

E.3 Metrology seals

Metrology sealing arrangements shall be applied by the manufacturer to the main cover of the meter, after verification of the meter accuracy, in such a way that prevents unauthorized access without visual evidence:

NOTE 1 Metrology sealing arrangements are intended to remain intact for the life of the meter and are not normally removed on site. When metrology sealing arrangements are disturbed or damaged, the meter ceases to be fit for purpose, and can no longer be used for revenue billing purposes.

a) Physical metrology seals shall require the use of a restricted issue tool for placement. Access to such tooling shall be strictly controlled and manufacturers shall at all times be able to account for the whereabouts of such tools.

b) Physical metrology seals shall require the use of a tool for removal and shall not be easily broken or damaged.

c) When fitted, one or more physical metrology seals shall be indelibly inscribed, embossed or marked with the last two digits of the year of verification: 'YY'.

   NOTE 2 Additional metrology seals may be inscribed, embossed or marked with industry agreed alpha characters.

d) Permanently closed meter cases without metrology seals shall be indelibly marked or printed to identify them as sealed for life.

e) The manufacturer shall specify where seals and markings have been applied.

f) Metrology sealing arrangements shall conform to the sealing requirements contained in the WELMEC *Guide for sealing of Utility meters* [N2].

Annex F (informative) Operational considerations related to switches inside meters

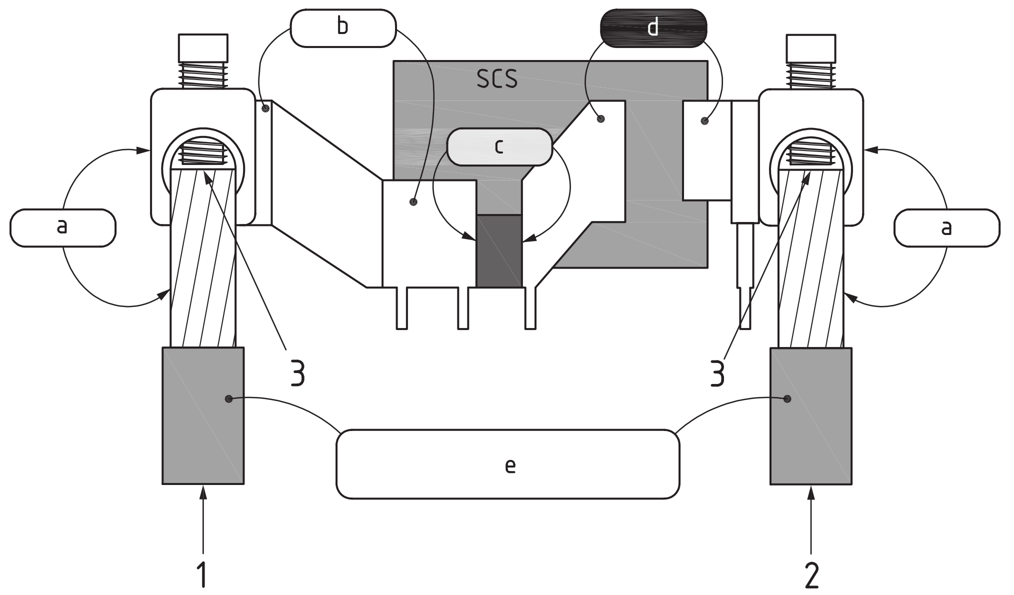
F.1 Introduction

The incorporation of electromechanical switches inside an electricity meter requires substantial changes to be made to the heat rise, overcurrent and endurance tests, as well as related material selection criteria during design. Semi-conductor supply control switches (SCSs) are not permitted inside a meter due to excessive thermal dissipation problems.

The 25 K temperature rise criteria in **7.2** of BS EN 50470-1:2006 was found to be inadequate for meters containing switches and an informal agreement to permit a 35 K temperature rise for meters with a switch in their current circuits was agreed by IEC TC 13/WG 11 in November 2007. However, this subsequently proved to be inadequate, so more complex heat rise and overload tests were specified in Clause **10** of BS EN 62052-31:2016.

Typical thermal contributions in the current circuit of a single-phase meter are shown in Figure F.1 to highlight the dominant effect of the highly variable SCS contact resistance. The contact tip resistance alters each time the switch operates due to arcing that occurs on the contact tip surfaces. Unlike the current circuit resistance of a meter without switches, the arc erosion of the contacts introduces a service life ageing factor, as seen in Figure D.2. The worst case resistance can occur early in the switch's service life, depending on the characteristics of the contact tip compounds and associated processing.

Figure F.1 — *Typical heating in a 100 AI_{max} meter when subjected to 1.45 * I_{max}*



Key

1	Line in	a	0.3W cable connection
2	Line out	b	1.3W circuit conductor
3	mV measurement point	c	3.4W measuring element
		d	7.6W switch contact
		e	10W/per metre for 35 mm^2 cable
			15W/per metre for 25 mm^2 cable

Heating also arises from the meter's power supply (about 2 W) and in the case of meters providing power to auxiliary devices, a further 2 W of heating occurs. The meter design caters for this heating up to currents of I_{max}. However, depending on the meter's single fault overcurrent capabilities (I_{OVL}), the excessive heat rise due to overload currents might gradually degrade the mechanical and dielectric properties of a meter case or meter components. This might be further exacerbated by restricted meter cabinet ventilation, solar radiation and/or multiple thermal sources in the meter cabinet.

Heat rise within a polyphase meter is particularly difficult to control due to the contribution of three separate current circuits in a meter volume marginally larger than a single-phase meter. The service life of contact tips in a SCS might be compromised when internal meter temperatures exceed the annealing temperature of the contact tip compounds (i.e. typically about 150 °C).

Therefore, in addition to the known problems of managing terminal torques during installation and service, factors new to the meter industry now need to be considered including:

- the difference in resistance of a newly manufactured load switch, such as those with polished and/or sacrificially coated contacts used during the heat rise test, to the in-service resistance as arc damage ages the switch contacts, as tested in Annex D;
- use of cable sizes with smaller cross-sections leading to increased heat within the meter and at the meter terminals, resulting in terminal temperatures that might exceed the cable insulation's maximum temperature rating;
- meter cabinet ventilation restrictions and environmental (indoor/outdoor) conditions; and
- surveillance and in-service (safety) testing of current circuit resistances.

Avoiding fitting switches inside meters does not avoid these thermal problems, as this simply moves these issues to another device fitted elsewhere in the installation. The rising demand for energy management, energy efficiency, load management, demand response, electric vehicle charging services and similar functionality, increasingly requires the use of switches in current circuits so these heat rise factors should be tested and validated.

There is a long history of satisfactory use of supply control switches in harsh environments from the prepayment electricity meter industry in Africa and Asia. This confirms that the safe use of a SCS in a meter is possible with proper design and good component quality control.

F.2 Guidance on coordination of meter and overcurrent protection device (OCPD) capabilities

The dependability and durability of a meter, and any internal SCS, is directly influenced by the type and rating of the overcurrent protection device (OCPD) that is fitted upstream of the meter. Within the UK such OCPDs normally take the form of a service fuse, whereas in other geographical areas circuit breakers are sometimes used.

The meter installer is responsible for ensuring that the meter selected for installation (and any internal SCS) is properly coordinated with the upstream OCPD that is already installed.

Note that coordination should be taken to include both the overload capability of the meter (I_{OVL}) and the utilization category (UC) of the meter, in respect of the maximum overload current and the prospective short-circuit current of the installation. See Table F.1 and Table F.2.

Table F.1 illustrates typical overload stresses on a 100 AI_{max} rated meter when protected by common types and ratings of service fuses in use within the UK.

Table F.1 — *Thermal stresses on a 100 A SCS protected by various OCPD ratings*

Magnitude of overcurrent	Primary concern if sustained or repeated	80 A fuse HD 60269	100 A fuse HD 60269	100 A BS 3036
80 A	None	Continuous	Continuous	~~Continuous~~
100 A	None	Continuous	Continuous	~~Continuous~~
120 A	Internal heating	2 h	Continuous	~~Continuous~~
145 A	**Internal heating**	**15 min**	**2 h**	**~~Continuous~~**
200 A	Internal heating	2 min	15 min	~~2 h~~
300 A	Contact damage leading to extra heat	10 s	3 min	~~15 min~~
500 A	Contact damage leading to extra heat	1 s	5 s	~~3 min~~
1 000 A	Contact damage leading to extra heat	100 ms	250 ms	~~5 s~~
2 500 A (UC2) 3 000 A (UC3) 4 500 A (UC4)	Contact damage (remain operational test, 3 events)	10 ms, only 3 events	10 ms, only 3 events	~~10 ms,~~ ~~only 3 events~~

Table F.2 provides details of common service fuses in use within the UK.

Table F.2 — *Characteristics of OCPDs in common domestic use in the UK*

OCPD standard	Fuse type	Voltage rating	Current ratings	Breaking capacity	Fusing factor[A)]
IEC 60364-4-43	—	1.1 Un	—	—	1.45 (2 h + 2 h)
BS HD 60269-3	System C	230 Vac	5 to 45	16 kA	1.5 (4 h)
BS 88-3	Type gG	400 Vac	63, 80, 100	31.5 kA	1.6 (2 h)
BS 1361 cartridge	Type I	240 Vac	5 to 45	16.5 kA	1.5 (4 h)
	Type II	415 Vac	60, 80, 100	33 kA	1.5 (4 h)
~~BS 3036 semi-enclosed~~	~~S1A~~	—	~~5 to 60~~	~~1 kA~~	~~2.0 (1.5 h)~~
	~~S2A, S4A~~		~~45, 60, 100~~	~~2 kA, 4 kA~~	~~2.0 (2 h)~~

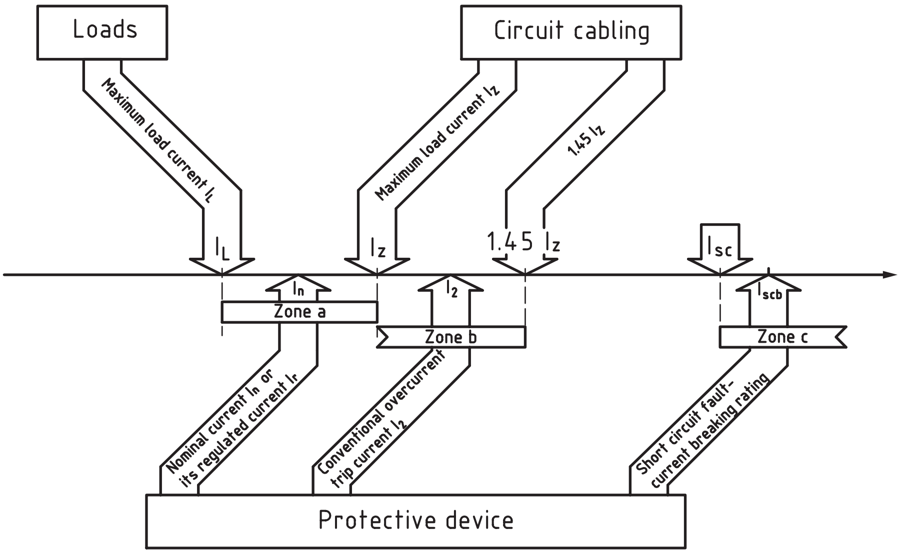
A) Multiple of the fuses rated current, at which the fuse operates within the specified fusing time under specified conditions.

Note that a semi-enclosed (i.e. rewirable) 100 A fuse conforming to BS 3036 is not capable of providing overload protection or safe short circuit breaking capacity for a meter with a 100 A I_{max} rating. In Table F.1 and Table F.2, these conditions are marked with a strikethrough. These problematic conditions arise due to the high fusing factor and low breaking capacity associated with this type of fuse. Furthermore it is also questionable as to whether a lower rated semi-enclosed fuse would be capable of providing adequate short circuit protection again due to its inherently low breaking capacity. Accordingly BS 3036 fuses should not be used as the means of providing protection for a meter.

Figure F.2 illustrates current circuit loading conditions that should be considered when coordinating overcurrent protection for a meter.

- Current less than Zone A – The meter is working accurately within its specified operating range. The OCPD does not operate or deteriorate in any way.
- Current in Zone A – The guaranteed no-trip range of the OCPD. The meter is now operating above its specified I_{max} rating and measurement accuracy at these currents will be reduced. The meter will remain safe but its accuracy can drift if the condition is sustained for long periods of time. The OCPD does not operate or deteriorate in any way.
- Current in Zone B – The range of currents at which the OCPD is guaranteed to trip after a delay period not exceeding four hours. Meter accuracy is not specified during this delay period and overheating of meter touch surfaces can occur. The meter will remain safe but its lifetime and accuracy will be reduced marginally each time this occurs.
- Current between Zone B and Zone C – This area of operation is seldom encountered. The OCPD operates and protects the meter. The meter will remain safe but its lifetime and accuracy will be reduced each time this occurs.
- Current in Zone C – The current passing through the meter is massively in excess of the meter's metrological rating due to a fault or short circuit on the wiring. The OCPD will trip and clear the fault extremely quickly, however the meter metrology and SCS contacts can be irreparably damaged if this condition is regularly encountered e.g. meter tampering by wilful repetition of short circuit currents.

Figure F.2 — *Current levels for determining OCPD characteristics*



$I_L \leq I_n \leq I_z$ zone a
$I_2 \leq 1.45\ I_z$ zone b
$I_{SCB} \geq I_{SC}$ zone c

Meter manufacturers are encouraged to provide information on their meters stating:

- the overload current rating of the meter, i.e. the I_{OVL} value used for heat rise testing;
- a table of OCPD types and ratings, similar to Table F.1, indicating which are acceptable, marginal or unacceptable when used to protect the meter and cable (when specified cable types and sizes are used within typical installations).

F.3 Consideration of supply control switches

The purpose of a SCS is to provide a means of enabling or disabling the supply to a meter's load. In the majority of cases this in effect is a means of enabling or disabling the supply to the premises. All smart metering for use in the UK requires a SCS, which is available for use as a means of providing prepayment functionality together with remote switching capability for load management and possibly debt management requirements.

It is important to recognize that the SCS switches within meters are not provided as a means of isolation and as such no reliance should be placed upon them for maintenance or safety purposes. Accordingly, electricians and others engaged in maintenance activities should therefore continue to use purpose-built switchgear for such purposes or request the services of the network operator or meter operator (as appropriate) to safely isolate supplies.

With regard to polyphase installations, BS 7671 wiring regulations call for a "linked" main switch, which ensures that all phase contacts are either open or closed in normal operation. This can be achieved by means of a mechanically linked polyphase switch, or in the case of polyphase SCS functionality provided by means of separate switching devices, it can be achieved by software monitoring arrangements incorporated into the design, to detect recoverable fault conditions and then to execute reasonable corrective action(s). It is beneficial to have monitoring of mechanically linked switches to detect instances of contact welding or severe arc erosion.

Alternatively polyphase SCS functionality can be provided by means of separate switching devices overseen by software monitoring arrangements incorporated within the design, which are capable of detecting recoverable fault conditions and executing reasonable corrective action(s). For example, in the case where a meter has received a command to open its SCS, if only one or two of the contacts actually open, the monitoring software should detect this, reclose all open contacts and raise an alert condition. Accordingly, it is recommended that procurement documents specify that SCS functionality is monitored to ensure correct operation, and that an alert is raised whenever a malfunction is detected.

With regard to smart metering within the UK there are optional alerts defined within the GBCS (Great Britain Companion Specification) [2].

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1361 (withdrawn), *Specification for cartridge fuses for A.C. circuits in domestic and similar premises*

BS 3036, *Specification – Semi-enclosed electric fuses – Ratings up to 100 amperes and 240 volts to earth*

BS 7671, *Requirements for electrical installations – IET Wiring Regulations*

BS EN 60269-1, BS 88-1, *Low-voltage fuses – Part 1: General requirements*

BS HD 60269-2, BS 88-2, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Examples of standardized systems of fuses A to K*

BS HD 60269-3, BS 88-3, *Low-voltage fuses – Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications) – Examples of standardized systems of fuses A to F*

IEC 60364-4-43, *Low-voltage electrical installations – Part 4-43: Protection for safety – Protection against overcurrent*

PD IEC/TR 60269-5, *Low-voltage fuses – Part 5: Guidance for the application of low-voltage fuses*

Other publications

[1] MASTER REGISTRATION AGREEMENT SERVICE COMPANY. MRA Data Transfer Catalogue (DTC) Available from https://dtc.mrasco.com (last viewed 5 April 2017).

[2] DEPARTMENT FOR BUSINESS. ENERGY & INDUSTRIAL STRATEGY. Great Britain Companion Specification (GBCS), Version 2.0, 31 January 2017.

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