

BRITISH STANDARD 3535: 1962

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SPECIFICATION FOR
SAFETY ISOLATING
TRANSFORMERS
FOR INDUSTRIAL & DOMESTIC PURPOSES

Confirmed

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BRITISH STANDARDS INSTITUTION

**SPECIFICATION FOR
SAFETY ISOLATING
TRANSFORMERS
FOR INDUSTRIAL & DOMESTIC PURPOSES**

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Incorporating amendment issued November 1964 (PD 5385)

BRITISH STANDARDS INSTITUTION

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THIS BRITISH STANDARD, having been approved by the Electrical Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 17th October, 1962.

B.S. 794. First published April, 1938.

B.S. 831. First published April, 1939.

B.S. 832. First published April, 1939.

First revision October, 1945.

Revised and combined as B.S. 3535, October, 1962.

The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 9,000, fully indexed and with a note of the contents of each, will be found in the BSI Catalogue which may be purchased from BSI Sales Department. The Catalogue may be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

- B.S. 7. Rubber-insulated cables and flexible cords for electric power and lighting (for working voltages up to and including 11 kV).
- B.S. 196. Plugs, socket outlets, cable-couplers and appliance couplers with earthing contacts.
- B.S. 205. Glossary of terms used in electrical engineering.
- B.S. 372. Two-pin side-entry wall plugs and sockets for domestic purposes.
- B.S. 546. Two-pole and earthing-pin plugs, socket-outlets and socket-outlet adaptors for circuits up to 250 volts.
- B.S. 562. Reversible connectors for portable electrical appliances.

- B.S. 816. Requirements for electrical appliances and accessories.
- B.S. 1363. Two-pole and earthing-pin fused-plugs and shuttered socket-outlets for a.c. circuits up to 250 volts.
- B.S. 2004. PVC-insulated cables and flexible cords for electric power and lighting.
- B.S. 2757. Classification of insulating materials for electrical machinery and apparatus on the basis of thermal stability in service.
- B.S. 3283. Non-reversible connectors and appliance inlets for portable electrical appliances (for circuits up to 250 volts and 13 amperes).

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following B.S.I. references relate to the work on this standard:
Committee references ELE/51 and ELE/51/1.
Draft for comment A(ELE) 5554.

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CO-OPERATING ORGANIZATIONS

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

- *Admiralty
- *Air Ministry
 - Associated Offices' Technical Committee
- *Association of Consulting Engineers (Incorporated)
 - Association of Mining Electrical and Mechanical Engineers.
 - Association of Supervising Electrical Engineers
- *British Electrical and Allied Industries Research Association
- *British Electrical and Allied Manufacturers' Association
- *British Electrical Development Association
- *British Railways, The British Transport Commission
- *Cable Makers' Association
 - Crown Agents for Oversea Governments and Administrations
 - Electric Lamp Industry Council
 - Electric Light Fittings Association
- *Electrical Contractors' Association (Incorporated)
 - Electrical Contractors' Association of Scotland.
- *Electricity Council, Generating Board and the Area
 - Boards in England and Wales
 - Electronic Engineering Association
- *Engineering Equipment Users' Association
 - Independent Cable Makers' Association
- *Institution of Electrical Engineers
 - Ministry of Aviation
- *Ministry of Labour (Factory Inspectorate)
 - Ministry of Power
- *Ministry of Public Buildings and Works
 - Municipal Passenger Transport Association, Incorporated
 - National Inspection Council for Electrical Installation Contracting
 - National Physical Laboratory (D.S.I.R.)
 - Oil Companies Materials Association
 - Post Office
 - Public Transport Association (Incorporated).
- *South of Scotland Electricity Board
 - War Office

The Government departments and scientific and industrial 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 standard:

British Toy Manufacturers Association Ltd.

Engineer Surveyors' Association.

High Commission of India

London Transport Executive, The British Transport
Commission

National Coal Board

Portable Electrical Tool Manufacturers Association.

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BRITISH STANDARD SPECIFICATION FOR

SAFETY ISOLATING TRANSFORMERS

For Industrial and Domestic Purposes

FOREWORD

This British Standard, prepared under the authority of the Electrical Industry Standards Committee, is based on the specification for small isolating transformers issued by the International Commission on Rules for the Approval of Electrical Equipment (C.E.E. Publication No. 15*). The standard departs, however, from the C.E.E. Specification in some places to suit British practice. It supersedes British Standards 794, 831, and 832, and therefore covers small transformers for use with a wide variety of low-voltage electrical appliances.

Because of the wide variety of applications for which low-voltage transformers are required, Part 1 contains requirements that are generally applicable to all types. Any exceptions or additional requirements, e.g. for use with electrically operated toys, domestic appliances, portable tools, etc., are given in Part 2 of the specification which details the clauses of Part 1 which require modification to make them applicable for transformers for particular applications.

SPECIFICATION

PART 1. GENERAL

SECTION ONE : GENERAL

SCOPE

1. This British Standard applies to single-phase and polyphase isolating transformers with output voltages not exceeding 110 volts, with rated input voltages not exceeding 650 volts and having rated outputs not exceeding 6.5 kVA.

The transformers are generally suitable for industrial and domestic applications, i.e. for use in situations in which the ambient temperature does not normally exceed 25°C, though occasionally reaching 35°C. Different values are, however, specified for some of the transformers for particular applications, dealt with in Part 2.

* CEE.15, 'Small isolating transformers with extra low output voltages'.

Transformers complying with this British Standard are not necessarily suitable for use in locations where higher ambient temperatures or other special environmental conditions prevail. Attention is also drawn to the following standards which cover transformers for certain special applications.

B.S. 355. Mining-type transformers.

B.S. 1538. Intrinsically-safe transformers primarily for bell-signalling circuits.

B.S. 2214. The performance of power transformers (not exceeding 2 kVA rating) for radio and allied electronic equipment.

B.S. 2538. Air-cooled flameproof single-phase lighting transformer units supplied from high-voltage systems.

DEFINITIONS

2. The terms used in this specification have the general meanings assigned to them in B.S. 205, 'Glossary of terms used in electrical engineering'. In addition, for the purposes of this specification, the following special definitions apply; the terms *current* and *voltage* refer to r.m.s. values unless otherwise stated and the term flexible cord also includes flexible cable.

(i) *Transformer*. Where the term '*transformer*' is used in the specification, it includes coil, core and other components contained within the one enclosure (see also *unshrouded transformer* in Section F, Part 2).

(ii) *Isolating transformer*. A transformer in which there is no electrical connection between input and output windings.

(iii) *Portable transformer*. A transformer designed to be used with a flexible connection to the input side and which is intended to be carried by hand to the place of use.

(iv) *Transportable transformer*. A transformer designed for use with a flexible connection to the input side but which, because of size and weight, is not intended to be carried by hand.

(v) *Fixed transformer*. A transformer designed for use with fixed external wiring on the input side.

(vi) *Class I transformer*. A transformer having some parts which are intended to be earthed.

(vii). *Class II transformer*. A transformer which has no provision for earthing because it is either:

A—an all-insulated transformer, or

B—a double-insulated transformer.

(viii) *All-insulated transformer*. A transformer in which a durable and substantially continuous enclosure of insulating material envelopes all metal

(xxiv) *Double insulation.* A method of insulation by which accessible metal parts are separated from live parts by both protective and functional insulation.

(xxv) *Reinforced insulation.* A type of improved functional insulation used only in parts of a double insulated transformer where the principle of double insulation cannot reasonably be applied, and able to pass specified tests to ensure that at least an equivalent degree of safety is provided.

(xxvi) *Cut-out.* A safety device which limits the temperature of a transformer by automatically opening the circuit or by reducing the current. It has to be re-set or replaced by hand.

(xxvii) *Non-detachable flexible cord or cable.* A flexible cord or cable so connected to the transformer that it can be removed only with the use of tools.

(xxviii) *Detachable part.* A part which can be removed or replaced without the use of tools.

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SECTION TWO : GENERAL REQUIREMENTS

CLASSIFICATION

3. Transformers shall be classified:
- a. According to the type of protection against electric shock.
 - (i) Class I.
 - (ii) Class II.
 - b. According to the type of protection against short-circuit.
 - (i) Inherently short-circuit-proof.
 - (ii) Non-inherently short-circuit-proof.
 - (iii) Non-short-circuit-proof.
 - c. According to the degree of protection against ingress of moisture.
 - (i) Ordinary (not specially protected).
 - (ii) Drip-proof.
 - (iii) Splash-proof.

NOTE. Other types of enclosure are not excluded, but these should be for agreement between manufacturer and purchaser.

RATED OUTPUT VOLTAGES, OUTPUTS AND FREQUENCY

4. For Class I transformers, the rated output voltage shall not exceed 110 volts*; where the rated output voltage of a winding of a single-phase transformer exceeds 55 volts, the winding shall have a centre tapping available. In three-phase transformers, the star point on the output side shall be available.

For Class II transformers, the rated output voltage shall not exceed 55 volts*.

The following are preferred rated output voltages*:

12, 25, 50 and 110 volts.

Preferred values for rated outputs are:

- a. Single-phase transformers:
 - 25, 63, 100, 160, 250, 400, 630, 1000, 1600 and 2500 VA.
- b. Three-phase transformers:
 - 630, 1000, 1600, 2500, 4000 and 6300 VA.
- c. The frequency shall be 50 c/s unless otherwise specified.

NOTE. Transformers for other voltages, outputs and/or frequencies, but which comply in all other respects with the requirements of the specification may be regarded as safety isolating transformers.

* For three-phase transformers, this is the line-to-line voltage.

GENERAL DESIGN AND CONSTRUCTION

5. Transformers shall be so designed and constructed that they cannot endanger the user or the surroundings even in the event of defects which may occur in reasonable use, and they shall comply with the requirements of Part 1, except in so far as they may be modified by Part 2 of this specification.

GENERAL CONDITIONS RELATING TO TESTS

6. Transformers shall be capable of passing the tests which are detailed under the various clauses of the specification.

A representative sample shall be subjected to all the tests.

Every transformer shall be tested in accordance with Clauses 10, 17*b* (Items 1, 5 and 6 or 7 of Table 5 except that metal foil is not applied), 17*c* and 27.

The following conditions shall apply:

a. Tests shall be carried out in the order of the clauses.

b. Unless otherwise specified, the tests shall be carried out at rated frequency, at an ambient temperature of $20 \pm 5^{\circ}\text{C}$ and on the transformer in the most unfavourable position of normal use.

c. Transformers designed for more than one rated input voltage, for a rated input voltage range or for more than one rated frequency, shall be tested at the most unfavourable input voltage and frequency for the test concerned. a.c. test voltages shall be of substantially sine-wave form.

d. The impedance of the supply source shall be such that it exerts negligible influence on the test.

e. Where practicable, test measurements shall be made with instruments that do not appreciably affect the quantity being measured. If this is impracticable, test results shall be corrected to compensate for the inaccuracies so caused.

MARKING

7. Marking shall be durable and easily legible.

Marking shall not be on screws or similar removable parts.

Marking shall, with the exception of that related to the terminals, be so placed on the transformer as to be clearly discernible when the transformer is ready for use.

Marking related to terminals shall be on or adjacent to the terminal so as to be clearly discernible after removal of any cover that has to be removed to gain access.

a. General markings. Transformers shall be marked with the following information:

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- (i) The words ISOLATING TRANSFORMER and the number of this British Standard, i.e. B.S. 3535.
- (ii) The rated input voltage or voltages, or the limits of the rated input voltage range in volts.
- (iii) The rated output voltage or voltages in volts.
Where a range of input voltage is marked the output marking shall be the rated output voltage at the mean of the input voltage range.
- (iv) The rated output in volt-amperes or kilovolt-amperes.
- (v) The rated frequency or frequencies in cycles per second.
- (vi) For Class II transformers* the symbol:  No provision made for earthing.
- (vii) For drip-proof transformers the symbol: 
- (viii) For splash-proof transformers the symbol: 
- (ix) For non-short-circuit proof transformers: The current rating of the necessary fuse or other protective device in the supply circuit.
- (x) The manufacturer's name or trade mark.
- (xi) The manufacturer's model or type number.

b. Terminal identification. Terminals shall be so marked that the input and output terminations are clearly distinguished.

The value of the rated voltage associated with each terminal shall be marked adjacent to that terminal, except that where space is not available other means of positive identification such as a wiring diagram marked on the case may be provided.

If the ratings of different windings are not the same, it shall be made clear which rating applies to which winding.

Earth terminals† shall be marked with the symbols $\perp$ E.

If a neutral terminal is provided on the output side of a three-phase transformer, it shall be marked with the letter *n*.

c. Switches and control devices. The operating positions of switches and control devices on the transformer shall be so marked as to be easily understood.

TEST. All markings shall remain legible after rubbing with pieces of cloth, one soaked with water and another soaked with petroleum spirit.

* The dimensions of the symbol for Class II transformers should preferably be such that the length of the side of the outer square is twice the length of the side of the inner square.

† The symbol $\perp$ has been established internationally, but until it becomes widely known in the United Kingdom it is considered that this symbol and the letter 'E' should both be used to ensure the correct interpretation of their meaning.

SECTION THREE : DETAILED REQUIREMENTS

PROTECTION AGAINST ELECTRIC SHOCK

8. *a. Enclosures.* The transformer shall be provided with an enclosure having no openings giving access to live parts, or, in the case of a Class II transformer, functional insulation or functionally insulated metal parts, except for the openings necessary for the installation of the transformer. Such necessary openings shall be provided with covers that cannot be removed without the use of tools. This requirement applies even after the removal of detachable parts.

Where the no-load output voltage of a transformer is 25 volts or less, the requirements of the above paragraph do not apply to the accessibility to live parts of the transformer which are connected to the output windings.

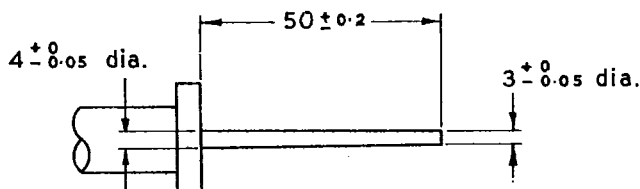
For the purposes of this clause, lacquer and enamel are not deemed to provide adequate insulation between live parts and accessible metal parts, neither is the covering of live parts with paper, cotton or similar materials which are unimpregnated, deemed to provide adequate protection against contact with such parts.

Metal parts of Class II transformers, separated from live parts by functional insulation only, are deemed to be live parts for the purposes of this requirement.

Parts providing protection against accidental contact shall have adequate mechanical strength and shall not work loose in normal use*.

Functional insulation shall not form part of the enclosure.

TEST. Compliance is checked with the test pin shown in Fig. 1. After removal of any detachable parts it shall not be possible to touch live parts, functional insulation or functionally insulated metal parts of any Class II transformer when the test pin is inserted through any opening.



Dimensions are in millimetres.

Fig. 1. Test pin

b. Handles operating levers, knobs and the like. Shafts of handles, operating levers, knobs and the like shall be insulated from both input and output windings.

Handles, operating levers, knobs and the like, with metal shafts which are not metallically connected to the earth terminal and which may become alive in

* This requirement is verified by the test of Clause 15.

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the event of a fault, shall be either of insulating material or, if such knobs have exposed metal parts, insulation equivalent to *protective* insulation shall be interposed between such metal and the metal shaft.

*c. Arrangement of windings and connections**. Transformers shall be so designed and constructed that there is no possibility of any connection between input and output windings, either directly or through other metal parts.

In particular, precautions shall be taken to prevent:

- (i) Displacement of input and output windings, or the turns thereof, of internal wiring, or of wires for external connections.
- (ii) Undue displacement of parts of windings or internal wiring in the event of rupture or loosening of connections.

Random windings shall not be used.

Input and output windings on a single spool, side by side or concentric, shall not be used on Class II transformers.

Transformers having concentric input and output windings shall have interposed between these windings a metallic screen connected to the earthing terminal.

d. Capacitors. Capacitors shall not be connected between:

Input and output windings.

Input winding and core.

Input winding and accessible metal parts.

e. Insulation of Class II transformers. Accessible metal parts of Class II transformers shall be separated from live parts by double insulation except that

* The requirements of this clause, as far as windings are concerned can be met by any of the following methods of construction:

Class I transformers only.

a. Windings on a single spool with a partition wall provided that the spool and partition wall are pressed or moulded in one piece or that push-on partition walls have an intermediate sheath or covering over the joint between the spool and the partition wall.

b. Concentric windings on cheekless formers, provided that each layer of the windings is interleaved with insulating material projecting beyond the end of each layer, and that the windings are impregnated with a hard baking material which fully penetrates the interstices and effectively seals off the end turns and the insulation between primary and secondary windings.

Class I or Class II transformers.

c. Windings on separate spools, fixed so that they cannot move with respect to each other and to the core.

d. Windings on cheekless formers on separate limbs of the core, provided that each layer of the windings is interleaved with insulating material projecting beyond the ends of each layer, and that the windings are impregnated with a hard baking material which fully penetrates the interstices and effectively seals off the end turns.

reinforced insulation may be used on connector sockets, switches, and the like, where double insulation is not practicable.

CHANGE OF VOLTAGE SETTING

9. Transformers with more than one rated input voltage shall be so constructed that the voltage setting cannot be changed or access to the means of adjustment cannot be gained without the use of tools.

TOLERANCE ON RATED OUTPUT VOLTAGE

10. The tolerance on the rated output voltage shall be:

- | | |
|---|-------------------|
| a. Inherently short-circuit-proof transformers with one rated output voltage | ± 10 per cent |
| b. Inherently short-circuit-proof transformers having more than one rated output: | |
| Highest rated output voltage | ± 10 per cent |
| Other rated output voltages | ± 15 per cent |
| c. All other transformers | ± 5 per cent |

TEST. Compliance shall be checked by measuring the output voltage at rated input voltage, rated output and unity power factor. For *type tests* these measurements shall be made after the transformer has attained its steady operating temperature. The *routine tests* may be carried out with the transformer at room temperature, any necessary correction for temperature effect being made.

NOTE. If the transformer has terminations for more than one rated input voltage the test is made using the terminations associated with the highest input voltage. If it has a rated input voltage range the test is made at the mean of that range.

NO-LOAD OUTPUT VOLTAGE

11. Transformers shall be so designed that at rated frequency and the highest rated input voltage, the no-load output voltage shall not exceed 120 volts for Class I transformers and 60 volts for Class II transformers.

The difference between the no-load output voltage and the voltage at rated output, expressed as a percentage of the latter voltage, shall not exceed the values shown in Table 1.

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TABLE 1

Type of transformer	Difference between output voltages at no-load and at rated output
Inherently short-circuit-proof transformers:	Percentage of rated output voltage
Up to and including 50 VA	100
Over 50 VA	
Up to and including 500 VA	50
Over 500 VA	20
Other transformers:	
Up to and including 50 VA	15
Over 50 VA up to and including 500 VA	10
Over 500 VA	5

TEST. Compliance shall be checked by measuring the no-load output voltage at rated input voltage, immediately after the supply has been switched on, the transformer being at ambient temperature. If the transformer has terminations for more than one rated input voltage the test shall be made using the terminations associated with the highest input voltage. If the transformer has an input voltage range, the test shall be made at the highest voltage of the range.

The output voltage at no-load shall not exceed the value specified.

For transformers rated for a specific voltage or voltages, the difference between the output voltage measured at no-load and that measured at rated output (Clause 10), expressed as a percentage of the latter value, shall not exceed the value shown in Table 1.

For transformers designed for an input voltage range or ranges the test of Clause 10 shall be repeated with the input voltage equal to the maximum of the voltage range. The difference between the no-load output voltage and this value, expressed as a percentage of the latter, shall not exceed the value shown in Table 1.

NO-LOAD REQUIREMENTS

12. The no-load input current shall not exceed 33 per cent of the current calculated from the rated input voltage and the rated output or an output of 50 VA, whichever is the greater.

For transformers with a rated frequency of 40 c/s or more, the no-load loss in watts shall not exceed 3 watts or 10 per cent of the rated output in volt-amperes, whichever is the greater.