

Specification for

Current transformers

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Foreword

This British Standard has been prepared under the authority of the Electrical Industry Standards Committee. It is a revision of the 1965 edition to bring it more into line with the corresponding IEC Recommendations given in Publication 185, “*Current transformers*”.

The insulation test levels that are included in the present edition differ from those given in IEC Publication 185 because this subject is still under general discussion in the IEC, and it is considered that the test levels for current transformers should be in agreement with the values likely to be adopted for switchgear.

The accuracy classes and limits of error have now been brought into agreement with IEC Publication 185 but the Class X category of protective current transformer for special purpose applications has been retained.

Changes have been made to some of the appendices but the appendix giving correction factors for atmospheric conditions during voltage tests has been deleted as no longer serving a useful purpose. For the same reason, a number of the diagrams given in the 1965 edition have also been deleted.

This standard does not at present include dew-point tests, or any information on the measurement of partial discharges in current transformers, because these subjects are still under discussion nationally and internationally.

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 to iv, pages 1 to 34, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 General

1.1 Scope

This British Standard specifies the requirements for current transformers suitable for frequencies of 15 Hz to 100 Hz, and intended for use with electrical measuring instruments and electrical protective devices such as are covered, in general, by the following:

BS 37, BS 89, BS 90, BS 142, and BS 3950

It also covers transformers for operating circuit-break trip coils.

The requirements to be met by all current transformers are specified in Section 2.

Section 3 specifies additional requirements for current transformers for use with electrical measuring instruments.

Section 4 specifies the additional requirements that are necessary for current transformers for use with electrical protective relays, and in particular for the forms of protection in which the prime requirement is the maintenance of accuracy up to several times the rated current. It also specifies requirements for current transformers for special purpose applications.

The information to be given by the purchaser on enquiry and order is listed in Appendix F.

NOTE The titles of the British Standards referred to in this standard are listed on the inside back cover.

1.2 Definitions

For the purposes of this British Standard the following definitions apply:

1.2.1

accuracy class

a designation assigned to a current transformer the errors of which remain within specified limits under prescribed conditions of use

1.2.2

actual transformation ratio

the ratio of the actual primary current to the actual secondary current

1.2.3

bar-primary current transformer

a current transformer in which the primary winding is a straight conductor

1.2.4

burden

the value of the impedance of the secondary circuit expressed in ohms (or in volt-amperes at the rated secondary current) at the relevant power factor

1.2.5

bushing current transformer

a bar-primary current transformer in which the primary winding is either a cable or an insulated component of other apparatus

1.2.6

composite error (see Appendix J)

under steady state conditions, the r.m.s. value of the difference between:

- a) the instantaneous values of the primary current, and
 - b) the instantaneous values of the actual secondary current multiplied by the rated transformation ratio,
- the positive signs of the primary and secondary currents corresponding to the convention for terminal markings

the composite error is generally expressed as a percentage of the r.m.s. values of the primary current according to the mathematical expression:

$$\epsilon_c = \frac{100}{I_p} \sqrt{\frac{1}{T} \int_0^T (K_n i_s - i_p)^2 dt}$$

where K_n = the rated transformation ratio

I_p = the r.m.s. value of the primary current

i_p = the instantaneous value of the primary current

i_s = the instantaneous value of the secondary current

T = the duration of one cycle

1.2.7

creepage distance

the shortest distance, following the contour along the external surface of an outdoor insulator, from the earthed flange to live metal

1.2.8

current error (ratio error)

the error which a transformer introduces into the measurement of a current and which arises from the fact that the actual transformation ratio is not equal to the rated transformation ratio

the current error expressed as a percentage is given by the formula:

$$\text{current error \%} = \frac{(K_n I_s - I_p) \times 100}{I_p}$$

where K_n is the rated transformation ratio,

I_p is the actual primary current, and

I_s is the actual secondary current when I_p is flowing under the conditions of measurement.

1.2.9

current transformer

a transformer for use with electrical measuring instruments, electrical protective and/or control equipment, for the transformation of current and in which the current in the secondary winding, in normal conditions of use, is substantially proportional to the current in the primary winding and differing from it by an angle which approaches zero for an appropriate direction of the connections

1.2.10

earthed neutral system

a system in which the neutral is connected to earth, either solidly, or through a resistance or reactance of low enough value to reduce materially transient oscillations and to give a current sufficient for selective earth fault protection:

- a) A system with *effectively-earthed neutral* at a given location is a system characterized by an earthing factor at this point which does not exceed 80 %.

NOTE This condition is obtained in general when, for all system configurations, the ratio of zero-sequence reactance to positive-sequence reactance is less than three and the ratio of zero-sequence resistance to positive-sequence reactance is less than one.

- b) A system with *non-effectively earthed neutral* at a given location is a system characterized by an earthing factor at this point that may exceed 80 %.

NOTE A non-effectively earthed system includes resonant earthed and resistance earthed systems where earth faults are not allowed to persist for longer than 8 h in any 24 h or a total of 125 h per annum. For other cases where there is no intentional connection to earth except through indicating, measuring or protective devices of very high impedance or where the duration of earth faults exceed the periods referred to above, the manufacturer should be consulted.

1.2.11**earthing factor (coefficient of earthing)**

the ratio, expressed as a percentage, of the highest r.m.s. line-to-earth power-frequency voltage on a sound phase at the selected location during a fault to earth affecting one or more phases, to the line-to-line r.m.s. power-frequency voltage which would be obtained at the selected location with the fault removed

1.2.12**electrically exposed installation**

an installation in which the apparatus is subject to over-voltages of atmospheric origin, e.g. an installation connected to overhead transmission lines, either directly or through short lengths of cable

1.2.13**electrically non-exposed installation¹⁾**

an installation in which the apparatus is not subject to over-voltages of atmospheric origin, e.g. an installation connected to a cable network

1.2.14**high-reactance current transformer**

a transformer in which the effects of leakage flux are such as to prevent an assessment of its performance being made from a knowledge of the exciting current, secondary winding resistance and turns ratio (see 4.4.2 and K.5.1.2 of Appendix K)

1.2.15**isolated neutral system**

a system which has no intentional connection to earth except through indicating, measuring or protective devices of very high impedance

1.2.16**knee-point e.m.f.**

that sinusoidal e.m.f. of rated frequency applied to the secondary terminals of the transformer, all other windings being open-circuited, which, when increased by 10 % causes the exciting current to increase by 50 %

1.2.17**low-reactance current transformer**

a transformer of which a knowledge of the secondary exciting current, secondary winding resistance and turns ratio is sufficient for an assessment of its performance (see 4.4.2 and K.5.1.1 of Appendix K)

1.2.18**measuring current transformer**

a current transformer intended to supply indicating instruments, integrating meters and similar apparatus

1.2.19**phase displacement**

the displacement in phase between the primary and secondary current vectors, the direction of the vectors being so chosen that the angle is zero for a perfect transformer

the phase displacement is said to be positive when the secondary current vector leads the primary current vector, and negative when it lags behind the primary current vector; it is usually expressed in minutes or in centiradians

1.2.20**primary winding**

the winding through which flows the current to be transformed

¹⁾ Apparatus may be required for installations which are semi-exposed to over-voltages of atmospheric origin, that is, to over-voltages of a magnitude less than for an exposed installation. Such installations are usually connected to overhead transmission lines through double winding transformers, or cable, which may reduce the amplitude of incoming over-voltages. These cases require special consideration.

1.2.21

protective current transformer

a current transformer intended to supply electrical protective equipment

1.2.22

rated accuracy limit factor

the ratio of the rated accuracy limit primary current to the rated primary current (see **B.5.2** of Appendix B)

1.2.23

rated accuracy limit primary current

the value of primary current up to which the transformer will comply with the requirements for composite error

1.2.24

rated accuracy limit secondary current

the secondary current equal to the rated accuracy limit primary current divided by the rated transformation ratio

1.2.25

rated burden

the value of the burden on which the accuracy requirements of this standard are based

1.2.26

rated continuous thermal current

the value of the current which can be permitted to flow continuously in the primary winding, the secondary winding being connected to the rated burden, without the temperature rise exceeding the values specified

1.2.27

rated dynamic current (I_{dyn})

the peak value of the primary current which a transformer will withstand, without being damaged electrically or mechanically by the resulting electromagnetic forces, the secondary winding being short-circuited

1.2.28

rated frequency

that frequency marked on the rating plate and on which the accuracy requirements are based

1.2.29

rated highest equipment voltage

the highest r.m.s. phase-to-phase voltage for which the current transformer is designed, and which is marked on the rating plate

1.2.30

rated insulation level

that combination of voltage values, both power-frequency and impulse, which characterizes the insulation of a transformer with regard to its capability to withstand dielectric stresses

1.2.31

rated knee-point e.m.f.

the nominal knee-point e.m.f. on which the performance of the current transformer is based and which is marked on the rating plate

1.2.32

rated output

the value, marked on the rating plate, of the apparent power (in volt-amperes) that a transformer is intended to supply to the secondary circuit at the rated secondary current and at the specified power factor without causing the errors to exceed the values specified

1.2.33**rated primary (or secondary) current**

the value, marked on the rating plate, of the primary (or secondary) current upon which the performance of a transformer is based

1.2.34**rated short-time thermal current (I_{th})**

the r.m.s. value of the primary current which a transformer will withstand for rated time without suffering harmful effects, the secondary winding being short-circuited or with an agreed value of burden connected

1.2.35**rated time**

the value marked on the rating plate as the time in seconds for which a current transformer will withstand the rated short-time thermal current in accordance with the relevant clause of this standard

1.2.36**rated transformation ratio**

the ratio of the rated primary current to the rated secondary current

1.2.37**resonant earthed system**

(a system earthed through an arc-suppression coil.) A system earthed through a reactor, the reactance being of such a value that during a single line-to-earth fault, the power-frequency inductive current passed by this reactor essentially neutralizes the power-frequency capacitive component of the earth-fault current

NOTE With resonant earthing of a system, the current in the fault is limited to such an extent that an arcing fault in air would be self-extinguishing.

1.2.38**secondary circuit**

the external circuit supplied by the secondary winding of a transformer

1.2.39**secondary exciting current**

the r.m.s. value of the current taken by the secondary winding of a current transformer when sinusoidal voltage of rated frequency is applied to the secondary terminals, the primary and any other windings being open-circuited

1.2.40**secondary limiting e.m.f. of a low-reactance transformer**

the product (in volts) of the rated accuracy limit secondary current (in amperes) and the vectorial sum of the rated burden and the resistance (corrected to 75 °C) of the secondary winding (in ohms)

1.2.41**secondary winding**

the winding which supplies the current circuits of measuring instruments, meters, relays or similar apparatus

1.2.42**short-time factor (S.T.F.)**

the ratio of the rated short-time thermal current to the rated primary current

1.2.43**surge protected installation**

an installation where transient over-voltages are limited by appropriate means to values less than the specified insulation level of the apparatus with a reasonable safety margin

1.2.44**wound-primary current transformer**

a current transformer in which the primary winding consists of a single turn loop or multi-turn coil integral with the transformer

2 Requirements for all current transformers

2.1 Service conditions

Unless otherwise specified, current transformers shall be suitable for use under the following service conditions:

1) *Ambient air temperatures*

	°C
Maximum	40
Daily mean, not exceeding	35
Minimum, for indoor type transformers	– 5
Minimum, for outdoor type transformers	– 20

2) *Altitude*

Up to 1 000 m above sea level.

NOTE For altitudes above 1 000 m the manufacturer should be consulted.

3) *Atmospheric conditions*

Atmospheres which are:

- a) normally polluted: see **2.2.9** and Appendix A
- b) heavily polluted: see **2.2.9** and Appendix A.

4) *System earthing*

- a) Isolated neutral system (see definition **1.2.15**)
- b) Resonant earthed system (see definition **1.2.37**)
- c) Earthed neutral system (see definition **1.2.10**)
 - i) Effectively earthed neutral system
 - ii) Non-effectively earthed neutral system

2.2 Rating and performance requirements applicable to all current transformers

2.2.1 Rated frequency. Unless otherwise specified the rated frequency shall be 50 Hz.

2.2.2 Rated primary currents

2.2.2.1 Single ratio transformers. The standard values, in amperes, of rated primary currents are:

10 12.5 15 20 25 30 40 50 60 75

and their decimal multiples or sub-multiples.

The preferred values are those in bold type.

2.2.2.2 Multi-ratio transformers. The standard values given in **2.2.2.1** refer to the lowest values of rated primary current.

2.2.3 Rated secondary currents. The rated secondary currents, in amperes, are 1 A, 2 A and 5 A.

NOTE For transformers intended for delta-connected groups these ratings divided by $\sqrt{3}$ are also standard values.

The preferred rated current of a test winding is 10 A. Where secondary winding test tapplings are provided the rated current shall be related to the rated secondary current (see Appendix H).

2.2.4 Rated continuous thermal current. Unless otherwise specified the rated continuous thermal current shall be the rated primary current (see **3.2.3**).

2.2.5 Rated outputs. The standard values, in volt-amperes, of rated outputs are:

2.5 5 7.5 10 15 and 30

2.2.6 Rated time and short-time current. Current transformers supplied with a fixed primary winding or conductor shall comply with the requirements of **2.2.6.1** and **2.2.6.2**.

2.2.6.1 Thermal rating. A rated short-time current (I_{th}) shall be assigned to a current transformer.

Rated times shall be 0.5, 1.0, 2.0 and 3.0 s.

2.2.6.2 Dynamic rating. The value of the rated dynamic current I_{dyn} shall normally be 2.55 times the rated short-time current I_{th} and it shall be indicated on the rating plate when it is different from this value.

2.2.7 Limits of temperature rise. (See also Appendix D.) The temperature rise of a current transformer when carrying a primary current equal to the rated continuous thermal current, with a unity power factor burden corresponding to the rated output, shall not exceed the appropriate value given in Table 1. These values are based on the service conditions given in 2.1.

If ambient temperatures in excess of the values given in 1) of 2.1 are specified, the permissible temperature rise in Table 1 shall be reduced by an amount equal to the excess ambient temperature.

If a transformer is specified for service at an altitude in excess of 1 000 m and tested at an altitude below 1 000 m, the limits of temperature rise given in Table 1 shall be reduced by the following amounts for each 100 m that the altitude at the operating site exceeds 1 000 m:

- 1) oil immersed transformers 0.4 %
- 2) dry type transformers 0.5 %

The temperature rise of the windings is limited by the lowest class of insulation either of the winding itself or of the surrounding medium in which it is embedded. The maximum temperature rises of the insulation classes are as given in Table 1.

Table 1 — Limits of temperature rise of windings

Class of insulation to BS 2757	Maximum temperature rise measured by self-resistance method
Classes not immersed in compound or oil as follows:	°C
Y	45
A	60
E	75
B	85
F	110
H	135
All classes of insulation in compound to BS 1858	50
All classes of insulation in oil to BS 148	60

When the transformer is fitted with a conservator tank, has an inert gas above the oil, or is hermetically sealed, the temperature rise of the oil at the top of the tank or housing shall not exceed 55 °C.

When the transformer is not so fitted or arranged, the temperature rise of the oil at the top of the tank or housing shall not exceed 50 °C.

The temperature rise measured on the external surface of the core and other metallic parts where in contact with, or adjacent to, insulation shall not exceed the appropriate value in Table 1.

The temperature rise of any test winding shall not exceed 100 °C measured by resistance after the winding has carried continuously its rated current for 15 min (see Appendix H). This condition, for a test winding rated at 10 A, shall be deemed to have been met if the cross-sectional area of the test-winding conductor, when of copper complying with the requirements of BS 4109:1970, or copper equivalent, is not less than 1.5 mm².

2.2.8 Rated insulation levels. For a given rated highest equipment voltage the insulation level shall be one of the appropriate levels given in Table 2A and Table 2B. Where alternative insulation levels are possible for a given rated voltage, the level should be specified by the purchaser.

For voltages of 100 kV up to and including 245 kV two levels are recognized, Level 1 being suitable for both effectively earthed and non-effectively earthed systems, and Level 2 being suitable for effectively earthed systems only.