BRITISH STANDARD

BS EN
60044-3:2003

Instrument transformers —

Part 3: Combined transformers

The European Standard EN 60044-3:2003 has the status of a British Standard

ICS 17.220.20; 29.180

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 60044-3:2003. It is identical with IEC 60044-3:2002. It supersedes BS 7628:1993 which will be withdrawn on 2005-12-01.

The UK participation in its preparation was entrusted to Technical Committee PEL/38, Instrument transformers, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Supersedes HD 548.3 S1:1992

English version

Instrument transformers
Part 3: Combined transformers
(IEC 60044-3:2002)

Transformateurs de mesure
Partie 3: Transformateurs combinés
(CEI 60044-3:2002)

Messwandler
Teil 3: Kombinierte Wandler
(IEC 60044-3:2002)

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CENELEC
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Foreword

The text of document 38/287/FDIS, future edition 2 of IEC 60044-3, prepared by IEC TC 38, Instrument transformers, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60044-3 on 2002-12-01.

This European Standard supersedes HD 548.3 S1:1992.

This standard shall be used in conjunction with EN 60044-1:1999 and EN 60044-2:1999.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2003-09-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2005-12-01

Annexes designated "informative" are given for information only.
In this standard, annex A is informative.

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Endorsement notice

The text of the International Standard IEC 60044-3:2002 was approved by CENELEC as a European Standard without any modification.

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CONTENTS

INSTRUMENT TRANSFORMERS –

Part 3: Combined transformers

1 Scope and object

This part of IEC 60044 applies to newly manufactured combined transformers for use with electrical measuring instruments and electrical protective devices at frequencies from 15 Hz to 100 Hz.

The requirements and tests of this standard, in addition to the requirements and tests of IEC 60044-1, IEC 60044-2 and IEC/PAS 60044-5 cover current, voltage and capacitor voltage transformers, that are necessary for combined instrument transformers.

2 Definitions

For the purposes of this part of IEC 60044, the definitions given in IEC 60044-1 and IEC 60044-2 and the following definition apply.

2.1
combined instrument transformer
instrument transformer consisting of a current and a voltage transformer in the same case

3 Normal and special service conditions

For the purposes of this part of IEC 60044, Clause 3 of IEC 60044-1 and Clause 4 of IEC 60044-2 apply to current and voltage transformers respectively.

4 Ratings

4.1 General

For the purposes of this part of IEC 60044, in addition to Clause 4 of IEC 60044-1 and Clause 5 of IEC 60044-2, the following subclause applies.

4.2 Limits of temperature rise

The temperature rise of a combined instrument transformer shall not exceed the appropriate values of 4.6 of IEC 60044-1 and of 5.4 of IEC 60044-2, respectively, if a voltage as indicated in IEC 60044-2, 5.4, is applied to it and the current transformer is carrying a primary current equal to the rated continuous thermal current. The current transformer is connected to a unity power factor burden corresponding to the rated output and with the voltage transformer being loaded at rated burden, or at the highest rated burden if there are several rated burdens, and at a power factor between 0,8 lagging and unity. The additional tolerance of 10 K proposed in some cases for the voltage transformers is also applicable for the current transformers of the combined instrument transformers.

5 Design requirements

5.1 General

For the purposes of this part of IEC 60044, Clause 5 of IEC 60044-1 and Clause 6 of IEC 60044-2 apply to the current and voltage transformers respectively, unless otherwise specified below.

5.2 Transmitted overvoltages

These requirements apply to combined instrument transformers having $U_m \geq 72{,}5$ kV.

The characteristics of the impulse voltage applied to the primary windings for which the requirements are stated are the following:

– peak value of the applied voltage (U_p): $1{,}6 \times \frac{\sqrt{2}}{\sqrt{3}} \times U_m$

– conventional front time (T_1): 0,50 μs ± 20 %

– time to half-value (T_2): ≥50 μs

The peak values of the overvoltages transmitted from the primary to the secondary terminals (U_s), for both current and voltage transformers, shall not exceed 1,6 kV, under the test and measuring conditions described in 9.3.

NOTE 1 The wave-shape characteristics are representative of voltage oscillations due to switching operations.

NOTE 2 Other transmitted overvoltage limits may be agreed upon between manufacturer and purchaser.

The transmitted overvoltage peak limits of 1,6 kV, measured in accordance with the methods specified in 9.3, should ensure sufficient protection of electronic equipment connected to the secondary windings.

6 Tests

6.1 Classification of tests

The test specified in this standard are classified as type tests, routine tests and special tests.

Type test

A test made on a transformer of each type to demonstrate that all transformers made to the same specification comply with the requirements not covered by routine tests.

NOTE A type test may also be considered valid if it is made on a transformer which has minor deviations. Such deviations should be subject to agreement between manufacturer and purchaser.

Routine test

A test to which each individual transformer is subjected.

Special test

A test other than a type or a routine test, agreed on by manufacturer and purchaser.

6.2 Type tests

The following tests are type tests; for details, reference should be made to the relevant subclauses:

a) short-time current test on current transformers (see 7.1 of IEC 60044-1);

b) temperature-rise test (see 7.2);

c) lighting impulse test (see 7.3 and also 7.3.2 of IEC 60044-1 for current transformers and 8.3.2 of IEC 60044-2 for voltage transformers);

d) switching impulse test (see 7.3 and see also 7.3.3 of IEC 60044-1 for current transformers and 8.3.3 of IEC 60044-2 for voltage transformers);

e) wet test for outdoor transformers (see 7.4 of IEC 60044-1 for current transformers and 8.4 of IEC 60044-2 for voltage transformers);

f) short-circuit withstand capability test on voltage transformers (see 8.2 of IEC 60044-2);

g) determination of errors (see Clause 11);

h) measurement of the radio interference voltage (RIV) (see 8.5 of IEC 60044-2).

All the dielectric type tests shall be carried out on the same transformer, unless otherwise specified.

After the transformer has been subjected to the dielectric type test of this subclause, it shall be subjected to all the routine tests of 6.3.

6.3 Routine tests

The following tests apply to each individual transformer:

a) verification of terminal marking (see 8.1 of IEC 60044-1 for current transformers and 9.1 of IEC 60044-2 for voltage transformers);

b) power-frequency withstand test on the primary winding (see 8.2 and see also 8.2 of IEC 60044-1 for current transformers and 9.2 of IEC 60044-2 for voltage transformers);

c) partial discharge measurement for voltage transformers (see 9.2.4 of IEC 60044-2);

d) power-frequency withstand test on secondary windings (see 8.3 of IEC 60044-1 for current transformers and 9.3 of IEC 60044-2 for voltage transformers);

e) power-frequency withstand test between sections (see 8.3 of IEC 60044-1 for current transformers and 9.3 of IEC 60044-2 for voltage transformers);

f) inter-turn overvoltage test for current transformers (see 8.4 of IEC 60044-1);

g) determination of errors (see 11.4).

The order of the tests is not standardized but the determination of errors shall be performed after each test.

Repeated power-frequency tests on primary windings should be performed at 80 % of the specified test voltage.

6.4 Special tests

The following tests shall be performed upon agreement between manufacturer and purchaser:

a) chopped impulse test on the primary winding (see 7.3 and also 9.1 of IEC 60044-1 for current transformers and 10.1 of IEC 60044-2 for voltage transformers);

b) measurement of capacitance and dielectric dissipation factor (see 9.2 and also 9.2 of IEC 60044-1 for current transformers and 10.2 of IEC 60044-2 for voltage transformers);

c) multiple chopped impulse tests on the primary winding for current transformers (see 7.3 and also annex B of IEC 60044-1);

d) mechanical test for voltage transformers (see 10.3 of IEC 60044-2);

e) transmitted overvoltage measurement (see 9.3).

7 Type tests

7.1 General

For the purposes of this part of IEC 60044, Clause 7 of IEC 60044-1 and Clause 8 of IEC 60044-2 apply to the current and voltage transformer respectively, unless otherwise specified below.

7.2 Temperature-rise test

A test shall be made in order to prove compliance with 4.2. For the purpose of this test, combined instrument transformers shall be considered to have attained a steady-state temperature when the rate of temperature rise does not exceed 1 K/h. The ambient temperature may be between 10 °C and 30 °C.

When there is more than one secondary winding, the tests shall be made with the appropriate rated burden connected to each secondary winding unless otherwise agreed between manufacturer and user. For the test, the transformer shall be mounted in a manner representative of the mounting in service. The prescribed current and voltage are applied simultaneously to the combined instrument transformer. For this purpose, it is necessary that the primary winding and the secondary winding of the transformer generating the high current which excites the current transformers are insulated in relation to one another for the full voltage of the network.

If such a transformer is not available, two other test arrangements are recommended.

a) The combined instrument transformer may be installed insulated. The high voltage is then applied simultaneously to the frame, to the casing, to the terminal of the primary winding usually earthed in service, and to one terminal of each secondary winding, whilst the terminal of the primary winding applied to the mains line in service is earthed. Thus the insulation of the transformer generating the current need not be constructed for high voltage.

b) The high voltage is applied to the terminal which is connected to the main line in service. Primary terminals of the current transformer are short-circuited and connected to the high voltage. The rated continuous thermal current in the short-circuited primary winding shall be obtained by energizing one or more secondary windings of the current transformer.

The results of all three methods are the same and the choice of the method is left to the manufacturer.

The temperature rise of windings shall be measured by the increase in resistance method. For primary windings of the current transformer with very low resistance, thermocouples may be employed. The temperature rise of parts other than windings may be measured by means of thermometers or thermocouples.

7.3 Impulse tests on primary windings

In the case of impulse voltage tests for combined instrument transformers, the impulse voltage waves shall be applied to the short-circuited primary winding of the current transformer connected to the terminal of the voltage transformer primary winding, which is at high voltage when in operation. The same connection is valid for chopped and multiple chopped impulse tests.

The tests are carried out as indicated in 7.3 of IEC 60044-1 for current transformers and 8.3 of IEC 60044-2 for voltage transformers.

8 Routine tests

8.1 General

For the purposes of this part of IEC 60044, Clause 8 of IEC 60044-1 and Clause 9 of IEC 60044-2 apply to the current and voltage transformer respectively, unless otherwise specified below.

8.2 Power-frequency withstand test on the primary winding

The induced voltage test for the voltage transformer is also the power-frequency test for the primary winding of the current transformer.

9 Special tests

9.1 General

For the purpose of this part of IEC 60044, Clause 9 of IEC 60044-1 and Clause 10 of IEC 60044-2 apply to the current and voltage transformer respectively, unless otherwise specified below.

9.2 Measurement of capacitance and dielectric dissipation factor

If the primary winding of the voltage transformer is constructed as a multiple coil winding and each coil is connected to the corresponding grading layer inside main insulation, only part of the insulation which refers to the coil connected to the earth potential is checked. In this case, test voltages according to 6.1.2.5 of IEC 60044-2 shall be reduced. The dielectric dissipation factor shall be corrected taking into account the resistance of the coil.

9.3 Transmitted overvoltage measurement

A separate test shall be performed on current and voltage transformers using the circuit described in Figure 6.

A low-voltage impulse (U_1) shall be applied between one of the primary terminals and the earth.

The terminal(s) of the secondary winding(s) intended to be earthed shall be connected to the frame and to the earth.

The transmitted voltage (U_2) shall be measured at the open secondary terminals through a 50 Ω coaxial cable terminated with the 50 Ω input impedance of an oscilloscope having a bandwidth of 100 MHz or higher which reads the peak value.

NOTE Other test methods to avoid the intrusion of the instrumentation may be agreed between manufacturer and purchaser.

If the current and voltage transformer contains more than one secondary winding, the measurement shall be successively performed on each one of the windings.

In the case of secondary windings with intermediate tappings, the measurement shall be performed only on the tapping corresponding to the full winding.

For both current and voltage transformers, the overvoltages transmitted to the secondary winding (U_s) for the specified overvoltages (U_p) applied to the primary winding shall be calculated as follows:

$$U_s = \frac{U_2}{U_1} \times U_p$$

In the case of oscillations on the crest, a mean curve should be drawn, and the maximum amplitude of this curve is considered as the peak value U_1 for the calculation of the transmitted voltage (see Figure 7).

NOTE Amplitude and frequency of the oscillation on the voltage wave may affect the transmitted voltage.

The combined transformer is considered to have passed the test if the value of the transmitted overvoltage on both the current and voltage transformers does not exceed the limits given in 5.2.

10 Marking

10.1 Rating plate marking

The specifications for the current transformer according to 10.2, 11.7 12.7 and 14.5 of IEC 60044-1 and the voltage transformer according to 11.1, 12.5 and 13.8 of IEC 60044-2 shall be marked separately on the rating plate.

The voltage transformer shall carry on the rating plate the value of the voltage U_e induced by the r.m.s. value of the rated short-time thermal current flowing through the current transformer, when the primary winding of the voltage transformer is short-circuited. The induced voltage is measured at the terminals of the secondary winding of the voltage transformer loaded with 15 VA or the rated burden.

NOTE Instead of the voltage U_e induced by the r.m.s. value of the rated short-time thermal current, the rating plate can carry the indication of the proportion of the induced voltage to the current flowing through the current transformer in millivolts per kiloampere.

10.2 Terminal marking

The terminals of the current and voltage transformer parts of combined instrument transformers shall be marked in the same way as for individual transformers.

11 Additional requirements for measuring and protective combined transformer

11.1 General

The error limits for measuring combined transformers shall correspond to the requirements for measuring current transformers, indicated in 11.1, 11.2 and 11.3 of IEC 60044-1, and to the requirements for measuring voltage transformers indicated in 12.1 and 12.2 of IEC 60044-2. The limits of error for protective combined transformers shall correspond to the requirements for protective current transformers indicated in 12.1, 12.2, 12.3, 13.2 and 13.3 of IEC 60044-1, and to the requirements for protective voltage transformers indicated in 13.1, 13.2, 13.3, 13.4 and 13.5 of IEC 60044-2 and to the requirements for capacitor voltage transformers.

11.2 Mutual influence

When operating the current transformer between 5 % of the rated current and the rated continuous thermal current, the voltage transformer shall not exceed the limits of voltage error and phase displacement corresponding to its class within the specified range of burden and between 80 % and 120 % of the rated voltage.

In this case the burden of the current transformer is not important, therefore secondary windings may be short-circuited.

When operating the voltage transformer between 80 % of the rated voltage and the rated voltage multiplied by the rated voltage factor, the current transformer shall not exceed the limits of current error and phase displacement within the range of current corresponding to its class and within the specified range of burden.

11.3 Type test for accuracy of measuring and protective combined transformer

11.3.1 General

The type tests for accuracy shall be carried out according to 11.4, 12.4 and 12.5 of IEC 60044-1, for current transformers, and according to 12.3 and 13.6.2 of IEC 60044-2, for voltage transformers.

11.3.2 Influence of the current transformer on the voltage transformer

In the case of combined instrument transformers, the influence of the current transformer on the voltage transformer shall be tested as follows.

First, the voltage error ε_V and the phase displacement δ_V of the voltage transformer are determined with the current supplied to the current transformer disconnected and in accordance with 12.3 and 13.6.2 of IEC 60044-2 within the specified range of burden (measurement 1). Then the current transformer is supplied with the rated continuous thermal current.

The supply line to the current transformer shall form a horizontal loop at the height of the primary terminals (see Figure 1). The distance, indicated as a in Figure 1, of the return conductor shall correspond to the distance of the other phase in the mains line. The remaining lengths of the current loop shall each be at least 1,6 m. The primary winding of the voltage transformer is short-circuited with a connection as short as possible, which is placed in the vertical plane of the primary terminals of the current transformer.

The voltage induced by the current in the voltage transformer is measured by a millivoltmeter or an oscilloscope at the secondary terminals. This voltage U_v is a measure of the maximum variation of the voltage error.

It is recommended that the voltage transformer be loaded with the rated burden or 15 VA to avoid errors by externally influenced voltage (measurement 2). For protective transformers, it is sufficient to bring the variation $\Delta\varepsilon$ only into relation to 2 % and for measuring transformers into relation to 80 % of rated secondary voltage.

The greatest possible variation of the voltage error is then

$$\pm\Delta\varepsilon_v = \frac{U_v}{0{,}8\ U_{sN}} \times 100 \quad \text{in per cent at 80 \% of the rated secondary voltage}$$

$$\pm\Delta\varepsilon_v = \frac{U_v}{0{,}02\ U_{sN}} \times 100 \quad \text{in per cent at 2 \% of the rated secondary voltage}$$

where

U_{sN} is the secondary rated voltage, in volts, and

U_v is expressed in volts

The greatest possible variation of the phase displacement is then

$\pm\Delta\delta_v = \Delta\varepsilon_v \times 34{,}4$, in minutes, or

$\pm\Delta\delta_v = \Delta\varepsilon_v$, in centiradians.

If the absolute values of the variations of the voltage error $\pm\Delta\varepsilon_v$ and of the phase displacement $\pm\Delta\delta_v$ are added to the absolute values of the measuring results ε_v and δ_v obtained in measurement 1 at 80 % of the rated voltage within the specified range of burden, then the values obtained

$$\pm\varepsilon'_v = |\varepsilon_v| + |\Delta\varepsilon_v| \qquad \text{and} \qquad \pm\delta'_v = |\delta_v| + |\Delta\delta_v|$$

shall not exceed the limits of error for the voltage transformer given in 12.2 and 13.2 of IEC 60044-2 (see Figure 4).

Additionally, it must be ensured that the voltage errors due to the influence of the current do not exceed the limits of error, even at 100 % and 120 % of the rated voltage.

To prove compliance with 10.1, the value of the voltage induced by the rated short-time thermal current which shall be indicated on the rating plate, may be calculated with the voltage U_v measured at the rated continuous thermal current.

The voltage U_e induced at rated short-time thermal current is

$$U_e = U_v \times p$$

where

$$p = \frac{I_{th}}{I_{cth}}$$

U_v is the voltage induced by the rated continuous thermal current;

I_{th} is the rated short-time thermal current;

I_{cth} is the rated continuous thermal current.

NOTE To obtain greater accuracy, it is better to measure the induced voltage U_v at the highest possible current.

11.3.3 Influence of the voltage transformer on the current transformer

In the case of combined instrument transformers, the influence of the voltage transformer on the current transformer has to be tested as follows.

With an unexcited voltage transformer, the current error ε_i and the phase displacement δ_i of the current transformers are determined according to 11.4 and 12.4 of IEC 60044-1 (measurement 1).

A voltage equal to 120 % of the rated voltage and the rated voltage multiplied by the rated voltage factor shall then be applied to the terminal of the voltage transformer which is directly connected to a terminal of the current transformer, the latter not being excited. A capacitive current is generated in the current transformer by the voltage and this is measured as the voltage drop U_i across a resistor R connected to the secondary terminals of the current transformer. The burden of the secondary windings of the voltage transformer does not affect the results. They may therefore be open-circuited.

At the rated secondary current of 1 A, 2 A or 5 A, this recommended resistor can be respectively 100 Ω, 25 Ω or 4 Ω. It is sufficient for the accuracy of the resistor R to be ±10 % of the value. Two measurements shall then be made. First, the voltage drop U_i is measured when the input terminal of the secondary winding of the current transformer is earthed (Figure 2, measurement 2) and then, when its output terminal of the secondary winding is earthed (Figure 3, measurement 3). The greater value of the two measurements is to be considered.

NOTE It is sufficient to earth only the terminal which is earthed in service if agreed upon between the manufacturer and user.

It generally suffices to determine the influence of voltage at 5 % of the rated current.

The variation of the current error is then

$$\pm\Delta\varepsilon_i = \frac{U_i}{R \times 0{,}05\ I_{sN}} \times 100\ [\%] \text{ at 5 \% of the rated current.}$$

where

R is expressed in ohms;

U_i is expressed in volts;

I_{sN} is the rated secondary current in amperes.

The variation of the phase displacement is then

$\pm\Delta\delta_i = \Delta\varepsilon_i \times 34.4$, in minutes, or

$\pm\Delta\delta_i = \Delta\varepsilon_i$, in centiradians;

If the variations of the current error $\pm\Delta\varepsilon_i$ and of the phase displacement $\pm\Delta\delta_i$ are added to the absolute values of the measuring results ε_i and δ_i obtained in Measurement 1 at 5 % of the rated current within the specified range of burden, then the values obtained

$$\pm\varepsilon'_i = |\varepsilon_i| + |\Delta\varepsilon_i| \qquad \text{and} \qquad \pm\delta'_i = |\delta_i| + |\Delta\delta_i| \qquad \text{(see Figure 5)}$$

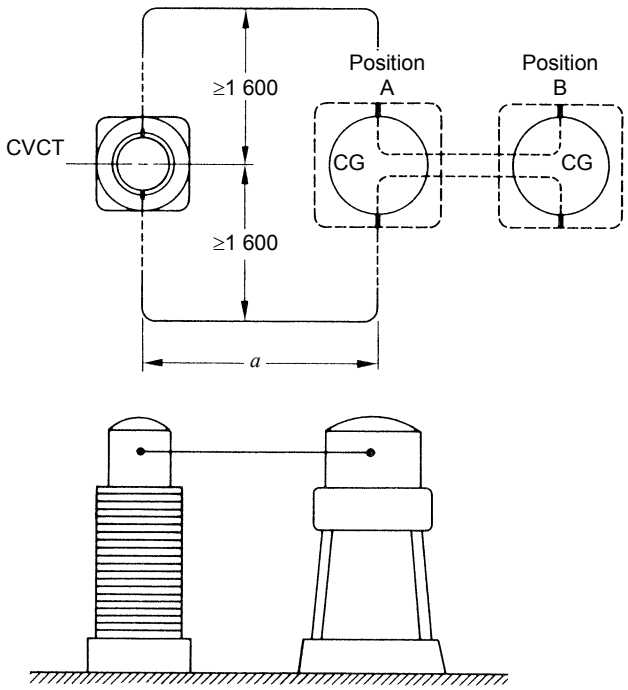
shall not exceed the limits of error for the current transformer given in 11.2 and 12.3 of IEC 60044-1. It must be ensured, however, that current errors do not exceed the limits of error, even between 5 % and 120 % of the rated current and in the case of extended current rating at the rated continuous thermal current.

11.4 Routine accuracy tests for measuring and protective combined transformers

The test for accuracy of the current transformer shall be carried out in accordance with 11.5, 12.4 and 12.6 of IEC 60044-1 for current transformers.

The test for accuracy of the voltage transformer shall be carried out in accordance with 12.4 and 13.7 of IEC 60044-2 for voltage transformers.

The variation of error determined at the type test according to 11.3.2 and 11.3.3 shall be taken into account.



IEC 3000/02

CVCT Combined voltage current transformer

The CG transformer generates the current. The stray field of this transformer shall not influence the combined voltage current transformer. If in position A an influence is detected, then position B shall be used.

The distance of return *a* of the conductor corresponds to the distance of the other phase conductors of the mains line.

	Highest system voltage kV	**Minimum values of distance *a*** mm
	12	150
	24	215
	36	325
	72,5	700
Full	123	1 100
insulation	245	2 200
	123	950
Reduced	245	1 850
insulation	420	2 900

Figure 1 – Geometrical construction of the circuit

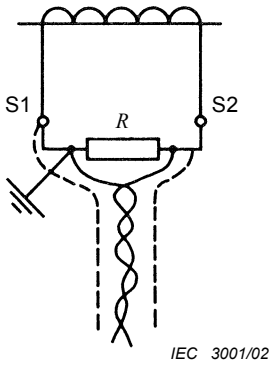


Figure 2 – Measurement 2

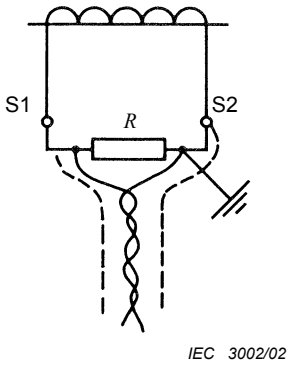


Figure 3 – Measurement 3

$\Delta\varepsilon_V$ is the variation of the error caused by a current.

According to the angle between the current and the voltage phasors, the end points of $\Delta\varepsilon_V$ lie on circles round the points of the voltage transformer errors without current influence.

A is the error of the voltage transformer at an output of 15 VA.

B is the error of the voltage transformer at an output of 90 VA.

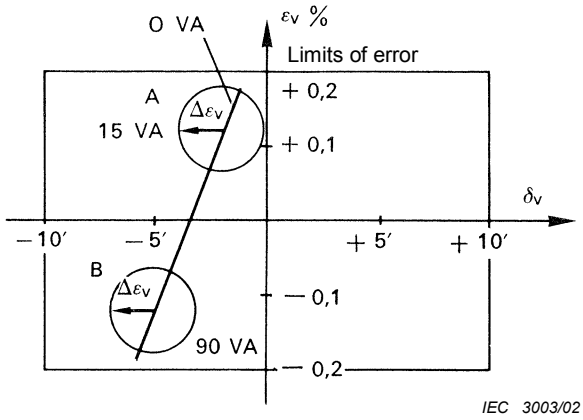
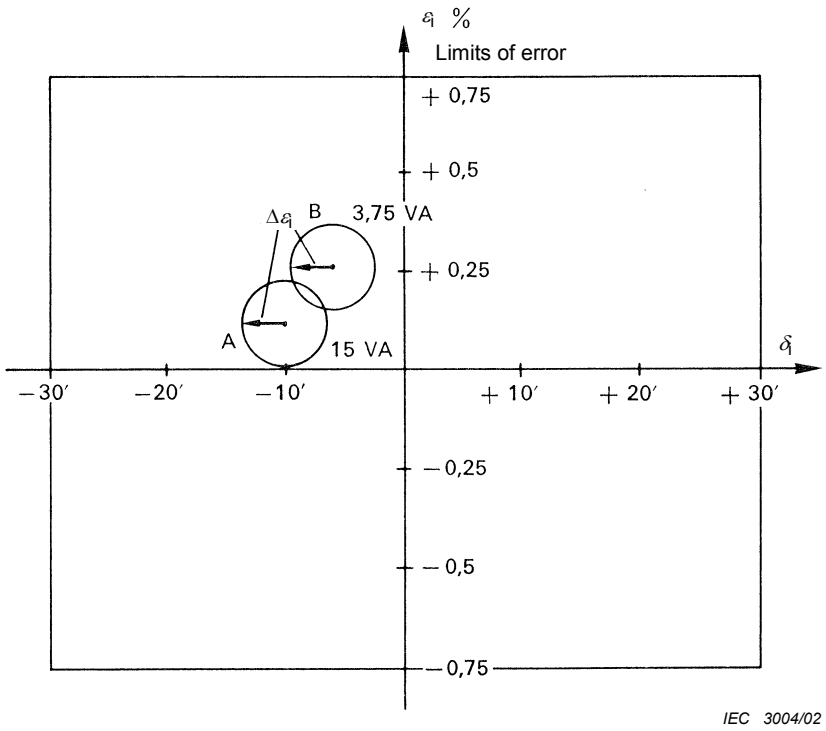


Figure 4 – Error diagram of a voltage transformer class 0,2



$\Delta\varepsilon_i$ is the variation of the error caused by the applied voltage.

According to the angle between the voltage and the current phasors, the end points of $\Delta\varepsilon_i$ lie on circles round the points of current transformer errors without applying voltage.

A error of the current transformer at an output of 15 VA.

B error of the current transformer at an output of 3,75 VA.

Figure 5 – Error diagram of a current transformer class 0,2 at 5 % of rated current

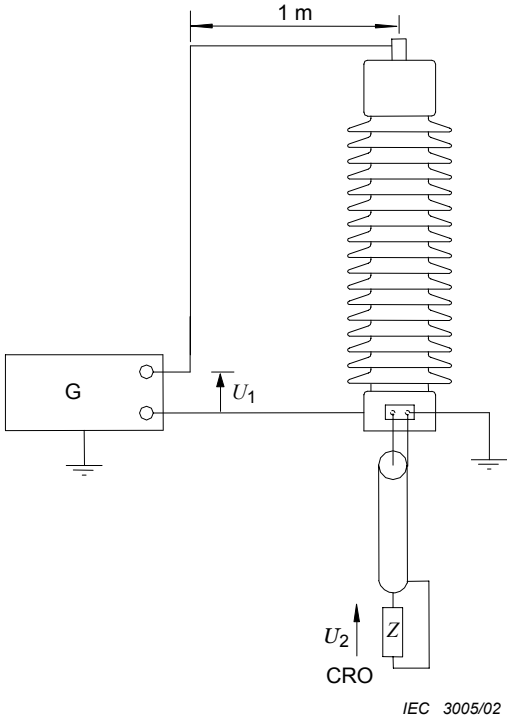


Figure 6 – Transmitted overvoltage measurements

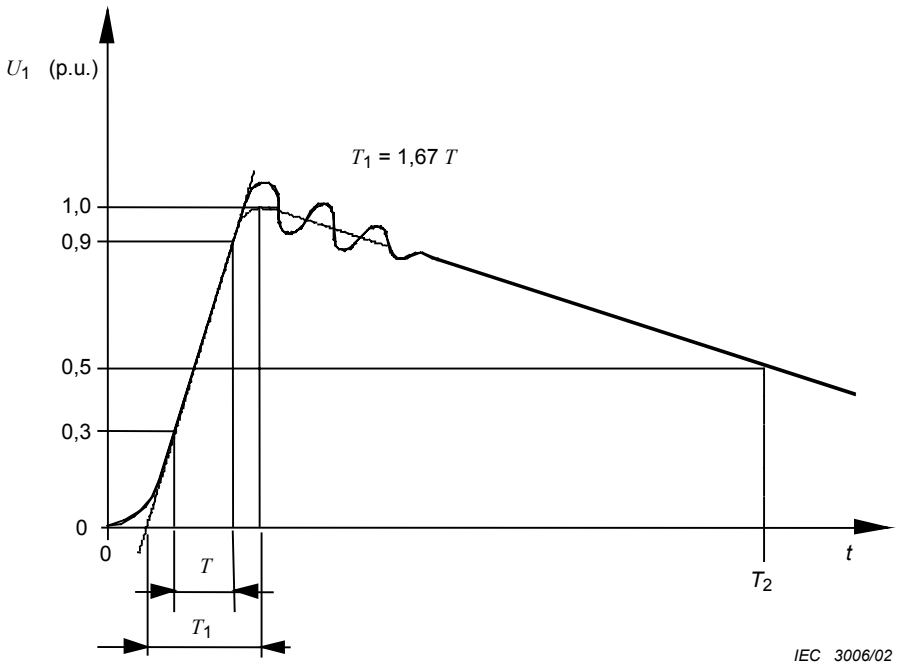


Figure 7 – Waveshape of the input voltage

Annex A
(informative)

The mutual influence of current and voltage transformers

A.1 The influence of the magnetic field of a current-carrying conductor on the error of a voltage transformer

The errors of a voltage transformer can be influenced by the magnetic field of a current-carrying conductor in the vicinity. The influence is greatest when the conductor is positioned horizontally at right angles to the longitudinal direction of the iron core and when the magnetic flux encircling the conductor passes through the coil opening (Figure A.1, influence shown for a transformer rated at 10 kV). However, in the case where the conductor is located parallel to the longitudinal direction of the iron core, the influence is practically negligible. This fact is of importance for combined instrument transformers as care must be taken during construction that the voltage transformer is mounted in the correct position, that is, with the longitudinal direction of the iron core parallel to the current conductor running through the transformer top.

Knowing the influence of the magnetic field of a current conductor on the error of a voltage transformer is important in particular for protection with directional relay.

It is necessary to be assured of the accuracy of the voltage transformers, particularly in relation to the phase shift of the secondary voltage with respect to the primary voltage, since the voltage induced by the current has a phase shift of 90° with respect to the primary voltage.

If, in the case of a fault, the secondary voltage is 0,5 V and the induced voltage is 50 mV, the resultant error on the secondary voltage would be greater than 10 %.

A current conductor can, of course, also have an influence on any voltage transformer with highest system voltage of 0,6 kV or more, and not only on the combined instrument transformer, if the current conductor of the network is laid near the voltage transformer. This requirement therefore also applies to each voltage transformer.

A.2 Influence of the applied voltage on the error of a current transformer

The errors of the current transformers, irrespective of whether they are constructed for low or high voltages, are normally determined at a relatively low potential of a few volts which is just sufficient to generate the necessary current. If high voltage is applied to the primary winding of the transformer, the error may change more or less because the voltage gives rise to a capacitive current from the primary winding to the secondary winding which – in the case of an unshielded secondary winding – partly flows through the instruments connected to it and partly direct to the earthed terminal of the secondary winding. Furthermore, the capacitive current flowing through the primary winding is inductively induced in the secondary winding even when flowing to a secondary electrostatic screen. In particular with 5 % of the rated current, the errors may become so great that the limits of error are exceeded. If the errors of the current transformer are measured applying the high voltage simultaneously, the reference current transformer (standard transformer) used for this purpose as well as the transformer generating the current must be insulated from the high voltage. It is possible to use two separate transformers for the measurement but it is more practical to have only one high current winding for both the reference transformer and the current-generating transformer and to insulate this

winding for the high voltage. It is important to screen the core and the secondary winding of the reference transformer as well as the core and the primary winding of the current-generating transformer.

This high current winding must also be shielded by a screen connected to the high-voltage transformer side of the current winding in order to have the capacitive current from the high voltage to earth flowing immediately from the high-voltage transformer and not via the high-current winding.

The methods for measuring the influence of a current conductor on the voltage transformer described in 11.2.1 and 11.2.2 are indirect methods which may be performed more easily than the direct methods whilst giving the same measuring results. For the indirect methods, the transformer previously described which is insulated for the high voltage is not necessary.

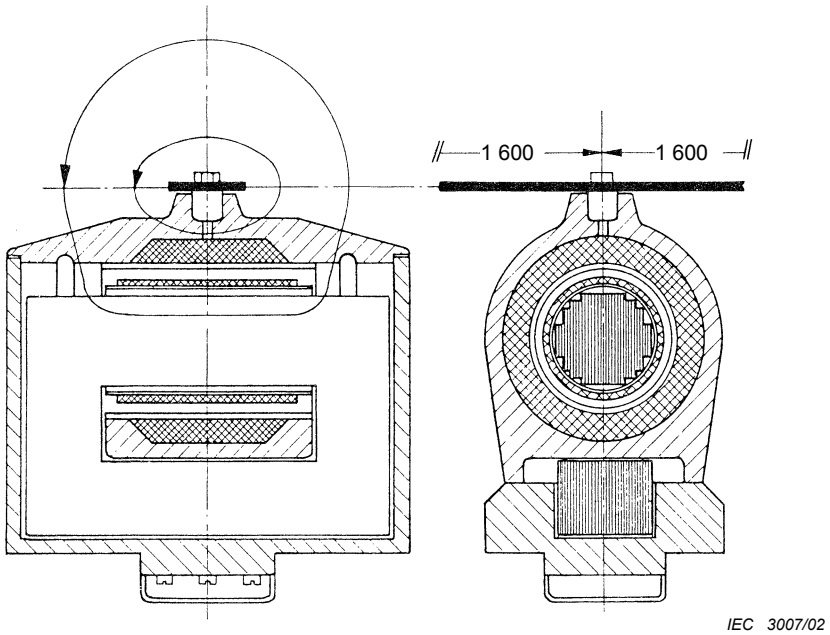


Figure A.1 – Current conductor and magnetic field influencing a voltage transformer

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