SLOVENSKI STANDARD
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Methods of measurement of touch current and protective conductor current

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Verfahren zur Messung von Berührungsstrom und Schutzleiterstrom

Méthodes de mesure du courant de contact et du courant dans le conducteur de protection

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13.260	Varstvo pred električnim udarom. Delo pod napetostjo	Protection against electric shock. Live working
17.220.20	Merjenje električnih in magnetnih veličin	Measurement of electrical and magnetic quantities

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Methods of measurement of touch current and protective conductor current
(IEC 60990:1999)

Méthodes de mesure du courant de contact et du courant dans le conducteur de protection
(CEI 60990:1999)

Verfahren zur Messung von Berührungsstrom und Schutzleiterstrom
(IEC 60990:1999)

This European Standard was approved by CENELEC on 1999-10-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Foreword

The text of document 74/518/FDIS, future edition 2 of IEC 60990, prepared by IEC TC 74, Safety and energy efficiency of IT equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60990 on 1999-10-01.

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) 2000-07-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2002-10-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annexes A, B, C, L and ZA are normative and annexes D, E, F, G, H, J, K and M are informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60990:1999 was approved by CENELEC as a European Standard without any modification.

In the official version, for annex M, Bibliography, the following notes have to be added for the standards indicated:

IEC 60065	NOTE: Harmonized as EN 60065:1998 (modified).
IEC 60335-1	NOTE: Harmonized as EN 60335-1:1988 (modified), which is superseded by EN 60335-1:1994 (modified).
IEC 60364-3	NOTE: Harmonized as HD 384.3 S2:1995 (modified).
IEC 60601-1	NOTE: Harmonized as EN 60601-1:1990 (not modified).
IEC 60950	NOTE: Harmonized as EN 60950:1992 (modified).
IEC 61010-1	NOTE: Harmonized, together with its amendment A1:1992, as EN 61010-1:1993 (modified).

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INTRODUCTION

This International Standard was developed as a response to concerns arising from the advent of electronic switching techniques being broadly applied to power systems and within EQUIPMENT*, giving rise to high-frequency harmonic voltages and currents.

This standard is intended for the guidance of EQUIPMENT committees in preparing or amending the test specifications in their standards for measurement of leakage current. However the term "leakage current" is not used for reasons explained below.

This standard was prepared under the safety pilot function assigned to TC 74, as follows:

Methods of measuring leakage current

This includes, for various types of EQUIPMENT, all aspects of what is referred to as "leakage current", including methods of measurement of current with regard to physiological effects and for installation purposes, under normal conditions and under certain fault conditions.

The methods of measurement of leakage current described herein result from the review of IEC 60479-1 and other publications, including descriptions of earlier methods of measurement.

The following conclusions were derived from a review of the effects of leakage current:

- the primary concern for safety involves possible flow of harmful current through the human body (this current is not necessarily equal to the current flowing through a protective conductor);
- the effect of electric current on a human body is found to be somewhat more complex than was assumed during the development of earlier standards in that there are several body responses which should be considered. The most significant responses for setting limits for continuous waveforms are
  - perception,
  - reaction,
  - let-go, and
  - ELECTRIC BURN.

Each of these four body responses has a unique threshold level. There are also significant differences in the manner in which some of these thresholds vary with frequency.

Two types of current have been identified as needing separate measuring methods: TOUCH CURRENT and PROTECTIVE CONDUCTOR CURRENT.

TOUCH CURRENT only exists when a human body or a body model is a current pathway.

It was also noted that the term "leakage current" has already been applied to several different concerns: TOUCH CURRENT, PROTECTIVE CONDUCTOR CURRENT, insulation properties, etc. Therefore, in this standard, the term "leakage current" is not used.

* Terms in small capitals are defined in clause 3.

Measurement of TOUCH CURRENT

In the past, EQUIPMENT standards have used two traditional techniques for measurement of leakage current. Either the actual current in the protective conductor was measured, or a simple resistor-capacitor network (representing a simple body model) was used, the leakage current being defined as the current through the resistor.

This standard provides measuring methods for the four body responses to the electric current noted above, using a more representative body model.

This body model was chosen for most common cases of electric shock in the general sense. With respect to the path of current flow and conditions of contact, a body model approximating full hand-to-hand or hand-to-foot contact in normal conditions is used. For small areas of contact (e.g. one finger contact), a different model may be appropriate.

Of the four responses, perception, reaction and let-go are related to the peak value of TOUCH CURRENT and vary with frequency. Traditionally, concerns for electric shock have dealt with sinusoidal waveforms, for which r.m.s. measurements are most convenient. Peak measurements are more appropriate for non-sinusoidal waveforms where significant values of TOUCH CURRENT are expected, but are equally suitable for sinusoidal waveforms. The networks specified for the measurement of perception, reaction and let-go currents are frequency-responsive and are so weighted that single limit power-frequency values can be specified and referenced.

ELECTRIC BURNS, however, are related to the r.m.s. value of TOUCH CURRENT, and are relatively independent of frequency. For EQUIPMENT where ELECTRIC BURNS may be of concern (see 7.2), two separate measurements are required, one in peak value for electric shock and a second in r.m.s. value for ELECTRIC BURNS.

EQUIPMENT committees should decide which physiological effects are acceptable and which are not, and then decide on limit values of current. Committees for certain types of EQUIPMENT may adopt simplified procedures based upon this standard. A discussion of limit values, based upon earlier work by various IEC EQUIPMENT committees, is provided in annex D.

Measurement of PROTECTIVE CONDUCTOR CURRENT

In certain cases, measurement of the PROTECTIVE CONDUCTOR CURRENT of EQUIPMENT under normal operating conditions is required. Such cases include:

– selection of a residual current protection device,
– compliance with 471.3.3 of IEC 60364-7-707.

The PROTECTIVE CONDUCTOR CURRENT is measured by inserting an ammeter of negligible impedance in series with the EQUIPMENT protective earthing conductor.

A bibliography of related documents is given in annex M.

This second edition has been prepared on the basis of comments provided by users of the first edition.

Principal changes include the following:

- provision of an earthing alternative for testing, in order to accommodate some test situations;
- provision of a more detailed description of the design and calibration of the measurement network, thus allowing deletion of component tolerances from the network diagrams;
- a minor inaccuracy in one measurement method has been corrected by the inclusion of an additional calculation;
- the discussion of the physiological effects has been clarified.

METHODS OF MEASUREMENT OF TOUCH CURRENT AND PROTECTIVE CONDUCTOR CURRENT

1 Scope

This International Standard defines measurement methods for

– d.c. or a.c. of sinusoidal or non-sinusoidal waveform, which could flow through the human body, and
– current flowing through a protective conductor.

The measuring methods recommended for TOUCH CURRENT are based upon the possible effects of current flowing through a human body. In this standard, measurements of current through networks representing the impedance of the human body are referred to as measurements of TOUCH CURRENT. These networks are not necessarily valid for the bodies of animals.

The specification or implication of specific limit values is not within the scope of this standard. IEC 60479-1 provides information regarding the effects of current passing through the human body from which limit values may be derived.

This standard is applicable to all classes of EQUIPMENT, according to IEC 60536.

The methods of measurement in this standard are not intended to be used for

– TOUCH CURRENTS having less than 1 s duration,
– patient currents as defined in IEC 60601-1,
– a.c. at frequencies below 15 Hz,
– a.c. in combination with d.c. The use of a single network for a composite indication of the effects of combined a.c. and d.c. has not been investigated,
– currents above those chosen for ELECTRIC BURN limits.

This basic safety publication is primarily intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51. It is not intended for use by manufacturers or certification bodies.

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. The requirements, test methods or test conditions of this basic safety publication will not apply, unless specifically referred to or included in the relevant publications.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(195): *International Electrotechnical Vocabulary (IEV) – Chapter 195: Earthing and protection against electric shock*

IEC 60050(604): *International Electrotechnical Vocabulary (IEV) – Chapter 604: Generation, transmission and distribution of electricity – Operation*

IEC 60309-1:1997, *Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements*

IEC 60364-4-41:1992, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 41: Protection against electric shock*

IEC 60364-7-707:1984, *Electrical installations of buildings – Part 7: Requirements for special installations or locations – Section 707: Earthing requirements for the installation of data processing equipment*

IEC 60479-1:1994, *Effects of current on human beings and livestock – Part 1: General aspects*

IEC 60536:1976, *Classification of electrical and electronic equipment with regard to protection against electric shock*

IEC 60536-2:1992, *Classification of electrical and electronic equipment with regard to protection against electric shock – Part 2: Guidelines to requirements for protection against electric shock*

IEC 61140:1997, *Protection against electric shock – Common aspects for installation and equipment*

ISO/IEC Guide 51:1990, *Guideline for the inclusion of safety aspects in standards*

IEC Guide 104:1997, *Guide to the drafting of safety standards and the role of committees with safety pilot functions and safety group functions*

3 Definitions

For the purpose of this International Standard, the following definitions apply:

3.1
touch current
electric current through a human body or through an animal body when it touches one or more accessible parts of an installation or of equipment [IEV 195-05-21]

3.2
protective conductor current
current which flows in a protective conductor

3.3
equipment
as defined in the relevant equipment standard. If not defined in the relevant equipment standard, see annex A

3.4
grippable part
part of the equipment which could supply current through the human hand to cause muscular contraction round the part and an inability to let go. Parts which are intended to be gripped with the entire hand are assumed to be grippable without further investigation (see annex H)

3.5
electric burn
burning of the skin or of an organ, caused by passing an electric current across or through the surface [IEV 604-04-18]

4 Test site

4.1 Test site environment

Test site environmental requirements shall be as specified in the EQUIPMENT standard. If limit values of less than 70 µA r.m.s. or 100 µA peak are specified, or if the EQUIPMENT contains large shields which may be driven by high-frequency signals, product committees shall refer to annex B.

4.2 Test transformer

The use of a test transformer for isolation is optional. For maximum safety, a test transformer for isolation (T2 in figure 2, T in figures 6 to 14) shall be used and the main protective earthing terminal of the EQUIPMENT under test (EUT) earthed. Any capacitive leakage in the transformer must then be taken into account. As an alternative to earthing the EUT, the test transformer secondary and the EUT shall be left floating (not earthed), in which case the capacitive leakage in the test transformer need not be taken into account.

If transformer T is not used, the EUT shall be mounted on an insulating stand and appropriate safety precautions taken, in view of the possibility of the body of the EUT being at hazardous voltage.

4.3 Earthed neutral conductor

EQUIPMENT intended for connection to a TT or TN power distribution system shall be tested with minimum voltage between neutral and earth.

NOTE – Descriptions of various power distribution systems are given in annex J.

The protective conductor and the earthed neutral conductor for the EUT should have a voltage difference of less than 1 % of line-to-line voltage (see example in figure 1).

A local transformer, see 4.2, will achieve this requirement.

Alternatively, if the voltage difference is 1 % or more, the following are examples of methods which, in some cases, will avoid measurement errors due to this voltage:

– connecting the terminal B electrode of the measuring instrument to the neutral terminal of the EUT instead of the protective earthing conductor (see 6.1.2) of the supply;
– connecting the earthing terminal of the EUT to the neutral conductor, instead of the protective earthing conductor, of the supply.

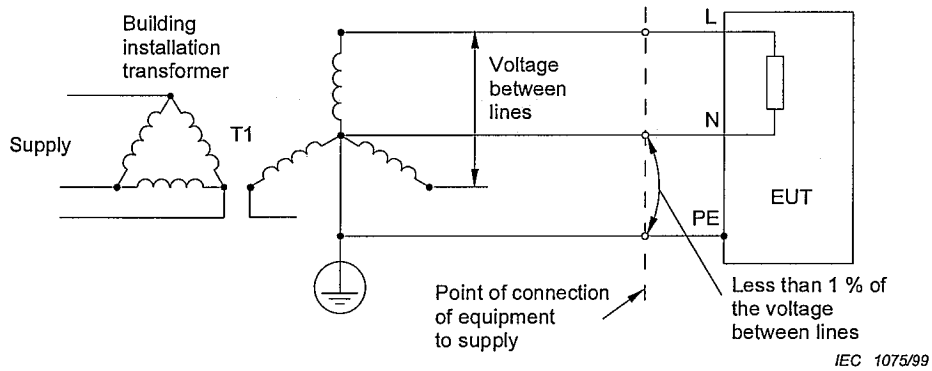


Figure 1 – Example of earthed neutral, direct supply

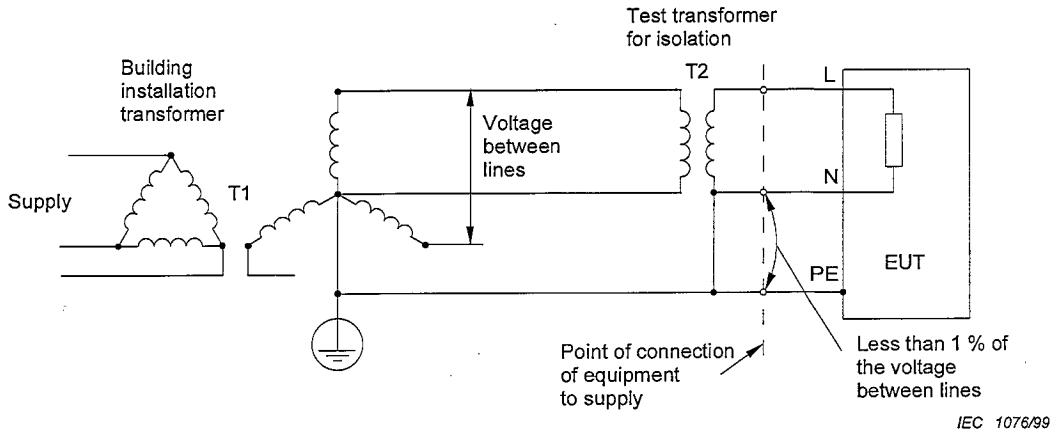


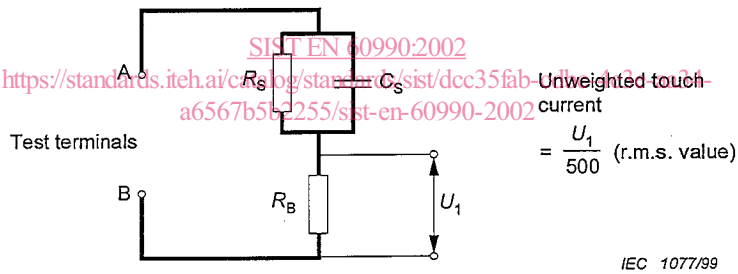
Figure 2 – Example of earthed neutral, with transformer for isolation

5 Measuring equipment

5.1 Selection of measuring network

Measurements shall be made with one of the networks of figures 3, 4 and 5.

NOTE – See annexes E, F and G for further explanation of the three networks.



R_S 1 500 Ω
R_B 500 Ω
C_S 0,22 µF

Figure 3 – Measuring network, unweighted touch current