



Methods of measurement of touch current and protective conductor current



AS IEC 60990:2018

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- Australian Information Industry Association
- CHOICE
- Consumer Electronics Suppliers Association
- Electrical Compliance Testing Association of Australia
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Methods of measurement of touch current and protective conductor current

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Preface

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee TE-001, Safety of Electronic Equipment, to supersede AS/NZS 60990:2002, *Methods of measurement of touch current and protective conductor current*.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this Standard is to define measurement methods for d.c. or a.c. current 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.

This Standard is identical with, and has been reproduced from, IEC 60990:2016 (ED.3.0), *Methods of measurement of touch current and protective conductor current*.

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The terms 'normative' and 'informative' are used in Standards to define the application of the appendices or annexes to which they apply. A 'normative' appendix or annex is an integral part of a Standard, whereas an 'informative' appendix or annex is only for information and guidance.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**METHODS OF MEASUREMENT OF TOUCH CURRENT
AND PROTECTIVE CONDUCTOR CURRENT**

FOREWORD

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International Standard IEC 60990 has been prepared by TC 108: Safety of electronic equipment within the field of audio/video, information technology and communication technology.

This third edition cancels and replaces the second edition published in 1999. It constitutes a technical revision.

The principal changes in this edition as compared with the second edition are as follows:

- the effects names have been updated to reflect increased understanding of the range of effects and is in concert with present usage;
- the conditions of use invoking a GRIPPABLE PART have been reduced in the application of the requirements based upon the current understanding of this effect;
- the references to ISO 10012-1, which has been replaced by management standard of the same number, have been replaced with explanatory text, where needed to maintain the sense of the document;

- former informative Annex H (GRIPPABLE PART) has been deleted from this update as it does not properly represent the full set of conditions under which immobilization can occur. A new informative Annex H (Analysis of frequency filtered touch current circuits measurement) has been added;
- the Bibliography (formerly Annex M) has been updated with additional references for completeness.

The text of this standard is based on the following documents:

FDIS	Report on voting
108/630/FDIS	108/640/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

In this standard, the following print types or formats are used:

- requirements proper and normative annexes: in roman type;
- compliance statements and test specifications: *in italic type*;
- notes/explanatory matter: in smaller roman type;
- normative conditions within tables: in smaller roman type;
- terms defined in Clause 3: SMALL CAPITALS.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

reconfirmed,

withdrawn,

replaced by a revised edition, or

amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 initially prepared under the basic safety function assigned to TC 74 (now TC 108), 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 TS 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,
 - startle-reaction,
 - letgo-immobilization, 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.

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 (for example, small, finger contact), a different model may be appropriate but is not covered here.

Of the four responses, startle-reaction and letgo-immobilization 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 startle-reaction and letgo-immobilization 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 made, one in peak value for electric shock and a second in r.m.s. value for ELECTRIC BURNS each using the appropriate test circuit.

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,
- determination when a high integrity protective earth circuit is required,
- prevent excessive PROTECTIVE CONDUCTOR CURRENT overload in the electrical installation.

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

METHODS OF MEASUREMENT OF TOUCH CURRENT AND PROTECTIVE CONDUCTOR CURRENT

1 Scope

This International Standard defines measurement methods for

- d.c. or a.c. current 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 TS 60479 series 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 61140.

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, and
- 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 independent of product standards.

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 only apply when specifically referred to or included in the relevant publications.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 60479-1:2005, *Effects of current on human beings and livestock – Part 1: General aspects*

IEC TS 60479-2:2007, *Effects of current on human beings and livestock – Part 2: Special aspects*

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

ISO/IEC Guide 51:2014, *Safety aspects – Guidelines for their inclusion in standards*

IEC Guide 104:2010, *The preparation of safety publications and the use of basic safety publications and group safety publications*

3 Terms and definitions

For the purposes of this document, the following terms and 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

[SOURCE: IEC 60050-195:1998, 195-05-21]

3.2

PROTECTIVE CONDUCTOR CURRENT

current which flows in a protective conductor

3.3

EQUIPMENT

organized collection of electromechanical component parts and features to accomplish a defined task (as specified in the relevant product standard).

Note 1 to entry: If not specified in the relevant standard, see Annex A.

3.4

GRIPPABLE PART

part of the EQUIPMENT which could supply current through the human hand to cause muscular contraction around the part and an inability to let go

Note 1 to entry: Parts which are intended to be gripped with the entire hand are assumed to be grippable without further investigation.

3.5

ELECTRIC BURN

burning of the skin or of an organ, caused by passing an electric current across or through the surface

[SOURCE: IEC 60050-604:1987, 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 Figure 6 to Figure 14) shall be used and the main protective earthing terminal of the EQUIPMENT under test (EUT) earthed. Any capacitive leakage in the transformer shall 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.

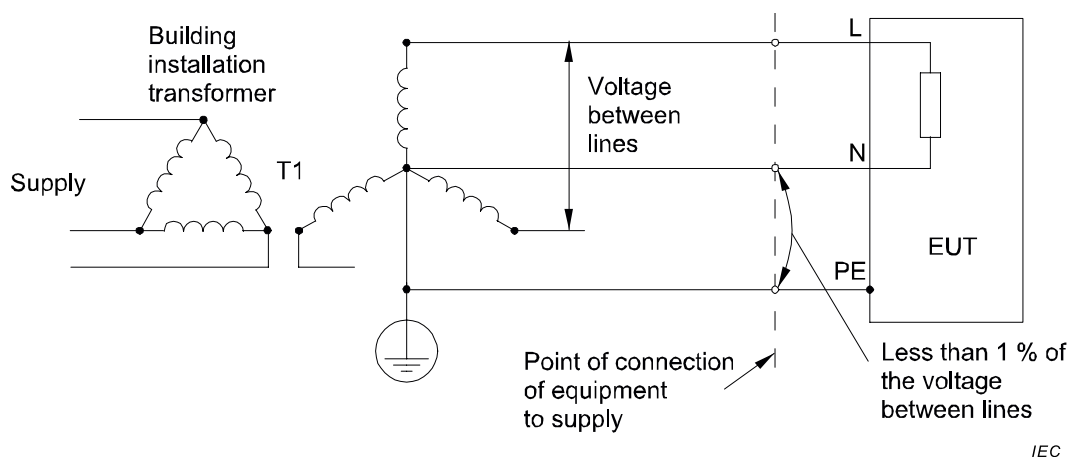
NOTE Descriptions of various power distribution systems are given in Annex I.

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 network 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.



IEC

Figure 1 – Example of earthed neutral, direct supply

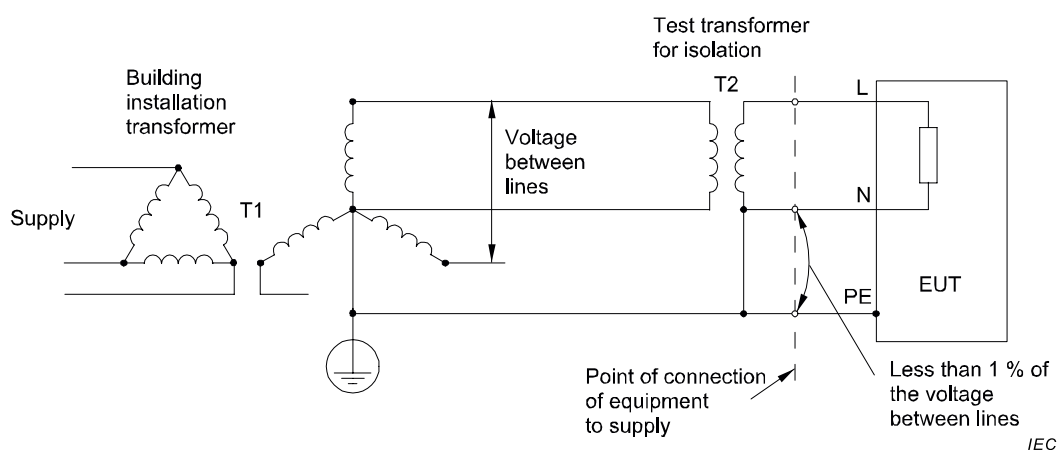


Figure 2 – Example of earthed neutral, with transformer for isolation

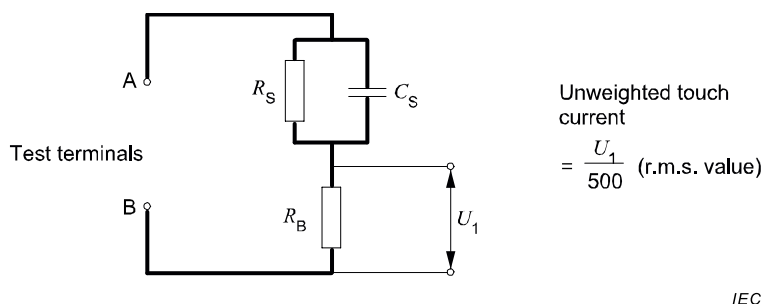
5 Measuring equipment

5.1 Selection of measuring network

5.1.1 General

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

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



$$R_S = 1\,500\ \Omega$$

$$R_B = 500\ \Omega$$

$$C_S = 0,22\ \mu\text{F}$$

Figure 3 – Measuring network, unweighted touch current

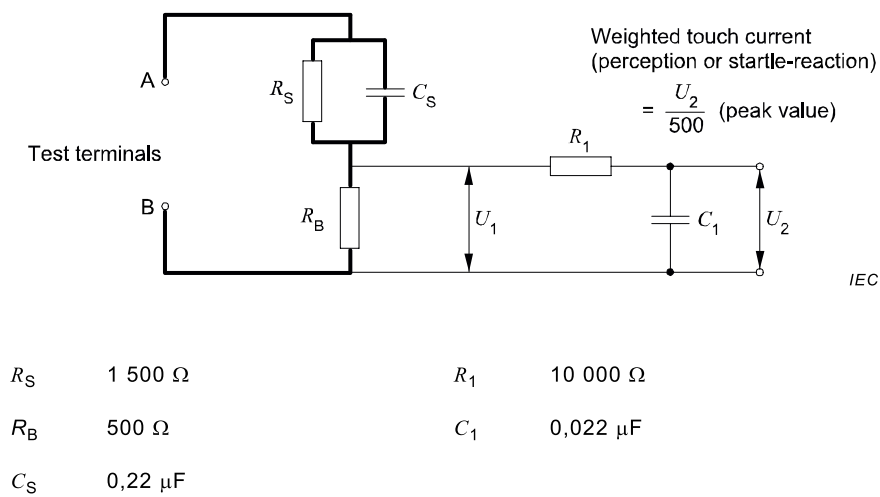
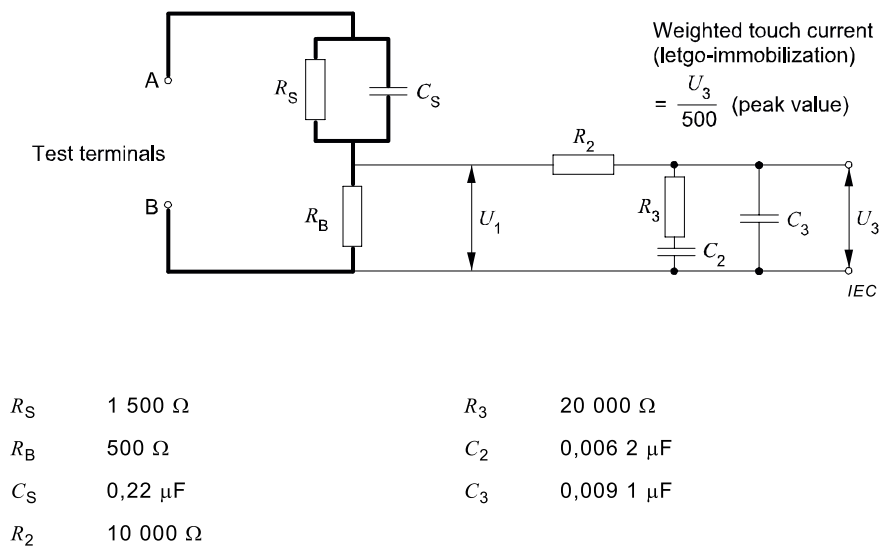


Figure 4 – Measuring network, touch current weighted for perception or startle-reaction



NOTE For special conditions on the use of this network, see 5.1.2.

Figure 5 – Measuring network, touch current weighted for letgo-immobilization

5.1.2 Perception and startle-reaction

The network of Figure 4 shall be used for low level electric shock limits. This circuit is to be applied where the a.c. limit value in the product standard is up to 2 mA r.m.s. or 2,8 mA peak.

5.1.3 Letgo-immobilization

The network of Figure 5 shall be used for higher level electric shock limits. This circuit is to be applied where the a.c. limit value in the product standard is more than 2 mA r.m.s. or 2,8 mA peak.

5.1.4 Electric burn (a.c.)

The unweighted TOUCH CURRENT network of Figure 3 shall be used.

5.1.5 Ripple-free d.c.

Any one of the three networks shall be used. Unless otherwise specified in the EQUIPMENT standard, ripple-free d.c. means less than 10 % peak-to-peak ripple.

5.2 Test electrodes

5.2.1 Construction

Unless otherwise specified in the EQUIPMENT standard, the test electrodes shall be

- a test clip, or
- a 10 cm × 20 cm metal foil to represent the human hand. Where adhesive metal foil is used, the adhesive shall be conductive.

5.2.2 Connection

Test electrodes shall be connected to test terminals A and B of the measuring network.

5.3 Configuration

The EQUIPMENT under test (EUT) shall be fully assembled and ready for use in the maximum configuration; it shall be connected to external signal voltages where applicable, as specified by the manufacturer for a single EQUIPMENT.

EQUIPMENT which is designed for multiple power sources, only one of which is required at a time (for example, for backup), shall be tested with only one source connected.

EQUIPMENT requiring power simultaneously from two or more power sources shall be tested with all power sources connected but with not more than one connection to protective earth.

5.4 Power connections during test

5.4.1 General

NOTE Examples of power distribution systems are given in Annex I.

EQUIPMENT shall be connected in a test configuration as shown in Figure 6 to Figure 14, according to 5.4.2, 5.4.3 or 5.4.4, as appropriate.

EQUIPMENT committees should consider the possible need for the manufacturer to identify the power distribution system (TN, TT, IT) to which an EQUIPMENT is intended to be connected in its final application.

If the EUT is specified by the manufacturer for use only on certain power distribution systems, the EUT shall be tested only when connected to those systems.

EQUIPMENT to be connected only to TN or TT systems shall comply with 5.4.2. EQUIPMENT to be connected to IT systems shall comply with 5.4.3 and may also be connected to TN or TT systems.

For Class 0 and Class II EQUIPMENT (see IEC 61140), the protective conductors in Figure 6 through Figure 14 are ignored.

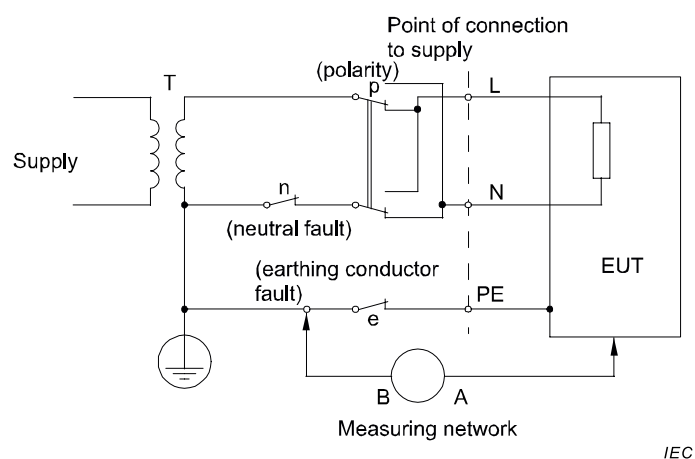
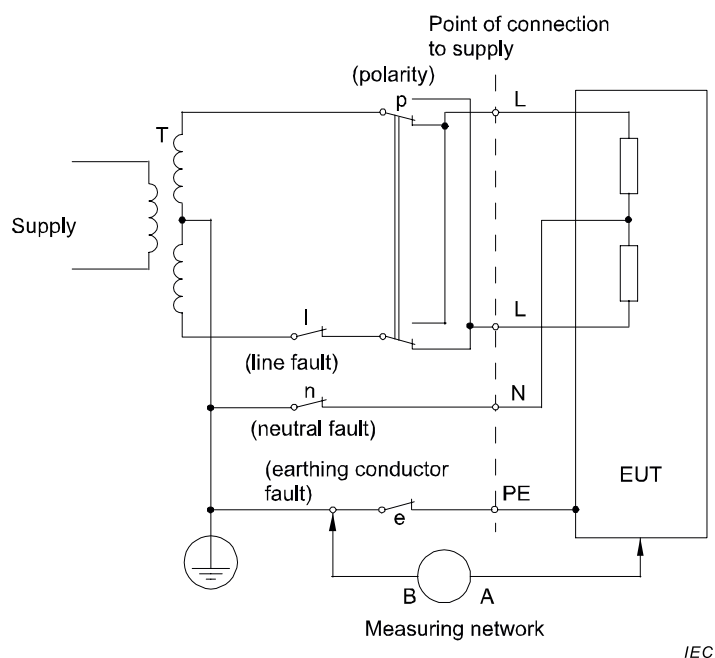


Figure 6 – Single-phase equipment on star TN or TT system



The centre-tapped winding may be one leg of a delta supply.

Figure 7 – Single-phase equipment on centre-earthed TN or TT system

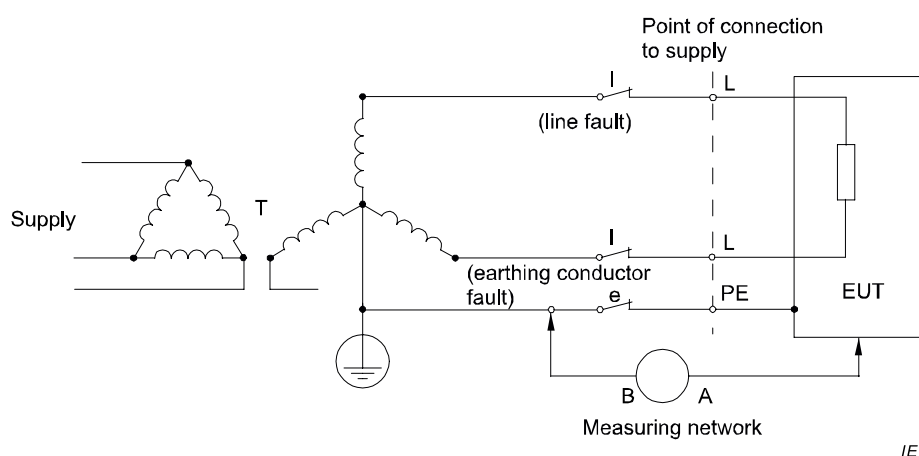
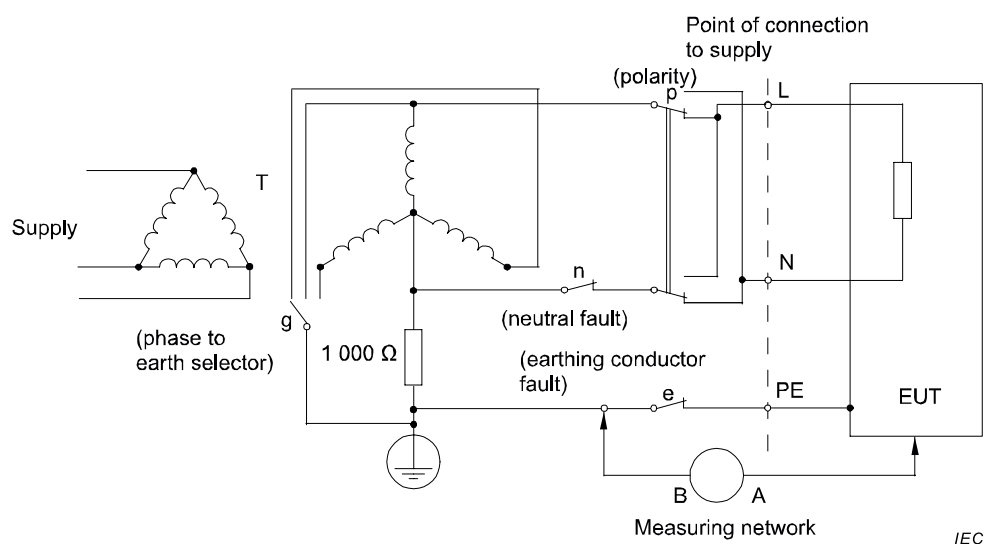
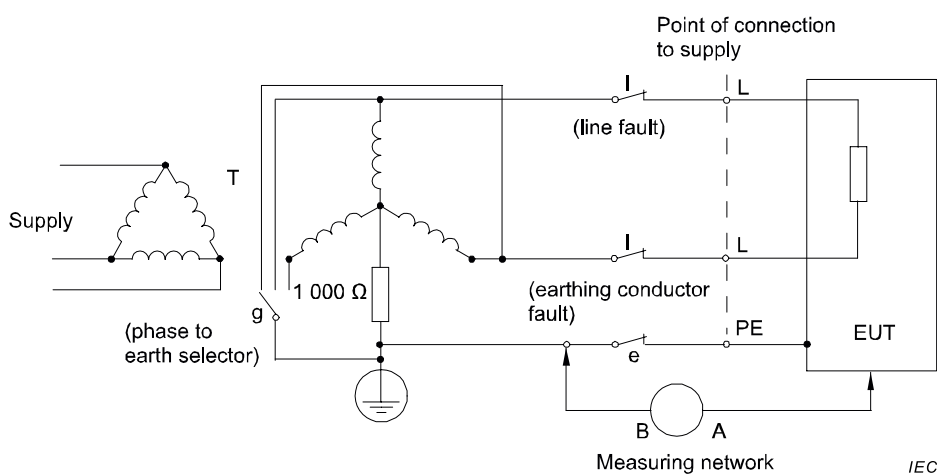


Figure 8 – Single-phase equipment connected line-to-line on star TN or TT system



The 1 000 Ω resistor should be rated for supply system faults.

Figure 9 – Single-phase equipment connected line-to-neutral on star IT system



The 1 000 Ω resistor should be rated for supply system faults.

Figure 10 – Single-phase equipment connected line-to-line on star IT system