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BASIC SAFETY PUBLICATION

Methods of measurement of touch current and protective conductor current

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IEC 60990:2016

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CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	11
2 Normative references.....	11
3 Terms and definitions.....	12
4 Test site.....	13
4.1 Test site environment.....	13
4.2 Test transformer.....	13
4.3 Earthed neutral conductor.....	13
5 Measuring equipment.....	14
5.1 Selection of measuring network.....	14
5.1.1 General.....	14
5.1.2 Perception and startle-reaction (a.c.)	16
5.1.3 Letgo- immobilization (a.c.)	16
5.1.4 Electric burn (a.c.).....	16
5.1.5 Ripple-free d.c.....	16
5.2 Test electrodes.....	17
5.2.1 Construction.....	17
5.2.2 Connection.....	17
5.3 Configuration.....	17
5.4 Power connections during test.....	17
5.4.1 General.....	17
5.4.2 Equipment for use only on TN or TT star power distribution systems.....	22
5.4.3 Equipment for use on IT power distribution systems including unearthed delta systems.....	22
5.4.4 Equipment for use on single-phase centre-earthed power supply systems or on centre-earthed delta power supply systems.....	22
5.5 Supply voltage and frequency.....	22
5.5.1 Supply voltage.....	22
5.5.2 Supply frequency.....	23
6 Test procedure.....	23
6.1 General.....	23
6.1.1 Touch current measurements.....	23
6.1.2 Control switches, equipment and supply conditions.....	23
6.1.3 Use of measuring networks.....	24
6.2 Normal and fault conditions of equipment.....	24
6.2.1 Normal operation of equipment.....	24
6.2.2 Equipment and supply fault conditions.....	24
7 Evaluation of results.....	26
7.1 Perception, startle-reaction and letgo- immobilization	26
7.2 Electric burn.....	26
8 Measurement of protective conductor current.....	26
8.1 General.....	26
8.2 Multiple equipment.....	26
8.3 Measuring method.....	27

Annex A (normative) Equipment	28
Annex B (normative) Use of a conductive plane	29
Annex C (normative) Incidentally connected parts	30
Annex D (informative) Choice of current limits	31
D.1 General	31
D.2 Limit examples	31
D.2.1 Ventricular fibrillation	31
D.2.2 Inability to letgo-immobilization	31
D.2.3 Startle-reaction	31
D.2.4 Perception threshold	31
D.2.5 Special applications	31
D.3 Choice of limits	32
D.4 Electric burn effects of touch current	33
Annex E (informative) Networks for use in measurement of touch current	34
E.1 General	34
E.2 Body impedance network – Figure 3	34
E.3 Perception, Startle-reaction (and body impedance) network – Figure 4	34
E.4 Letgo-immobilization (and body impedance) network – Figure 5	35
Annex F (informative) Measuring network limitations and construction	36
Annex G (informative) Construction and application of touch current measuring instruments	38
G.1 Considerations for selection of components	38
G.1.1 General	38
G.1.2 Power rating and inductance for R_S and R_B	38
G.1.3 Capacitor C_S	38
G.1.4 Resistors R_1 , R_2 and R_3	39
G.1.5 Capacitors C_1 , C_2 and C_3	39
G.2 Voltmeter	39
G.3 Accuracy	39
G.4 Calibration and application of measuring instruments	40
G.5 Records	40
G.6 Confirmation systems	41
Annex H (informative) Grippable part	44
Annex H (informative) Analysis of frequency filtered touch current circuit measurements	44
Annex I (informative) AC power distribution systems (see 5.4)	52
I.1 Introduction General	52
I.2 TN power systems	53
I.3 TT power systems	56
I.4 IT power systems	57
Annex J (informative) Routine and periodic touch current tests, and tests after repair or modification of mains operated equipment	59
Annex K (normative) Network performance and calibration	60
K.1 Network or instrument performance and initial calibration	60
K.2 Calibration in a confirmation system	62
K.2.1 General	62
K.2.2 Measurement of input resistance	62
K.2.3 Measurement of instrument performance	62

Annex M (informative) Bibliography	65
Figure 1 – Example of earthed neutral, direct supply.....	14
Figure 2 – Example of earthed neutral, with transformer for isolation	14
Figure 3 – Measuring network, unweighted touch current.....	15
Figure 4 – Measuring network, touch current weighted for perception or startle-reaction	15
Figure 5 – Measuring network, touch current weighted for letgo-immobilization	16
Figure 6 – Test configuration: Single-phase equipment on star TN or TT system.....	18
Figure 7 – Test configuration: Single-phase equipment on centre-earthed TN or TT system	18
Figure 8 – Test configuration: Single-phase equipment connected line-to-line on star TN or TT system.....	19
Figure 9 – Test configuration: Single-phase equipment connected line-to-neutral on star IT system	19
Figure 10 – Test configuration: Single-phase equipment connected line-to-line on star IT system	20
Figure 11 – Test configuration: Three-phase equipment on star TN or TT system	20
Figure 12 – Test configuration: Three-phase equipment on star IT system	21
Figure 13 – Test configuration: Unearthed delta system.....	21
Figure 14 – Test configuration: Three-phase equipment on centre-earthed delta system	22
Figure A.1 – Equipment.....	28
Figure B.1 – Equipment platform	29
Figure F.1 – Frequency factor for electric burn	36
Figure F.2 – Frequency factor for perception or startle-reaction	37
Figure F.3 – Frequency factor for letgo-immobilization	37
Figure H.1 – Grippable part test device.....	16
Figure H.1 – Triangular waveform touch current, startle-reaction	45
Figure H.3 – 1 ms rise time pulse response, startle-reaction	46
Figure H.4 – 1 ms rise time pulse response, letgo-immobilization.....	46
Figure H.5 – Touch current vs. rise time plot, 20 ms square wave.....	47
Figure H.6 – PFC SMPS touch current waveform.....	47
Figure H.7 – 50 Hz square wave, 0,1 ms rise time, startle-reaction	48
Figure H.8 – 50 Hz square wave, 0,1 ms rise time, letgo-immobilization.....	48
Figure H.9 – IEC TS 60479-2 let-go threshold for AC and DC combinations augmented by additional data, mA each axis	49
Figure H.10 – Ex1 case: showing r.m.s. window	50
Figure H.11 – Waveform ex2 case: showing r.m.s. window	50
Figure I.1 – Examples of TN-S power system	54
Figure I.2 – Example of TN-C-S power system.....	55
Figure I.3 – Example of TN-C power system	55
Figure I.4 – Example of single-phase, 3-wire TN-C power system	56
Figure I.5 – Example of 3-line and neutral TT power system	56
Figure I.6 – Example of 3-line TT power system	57
Figure I.7 – Example of 3-line (and neutral) IT power system	57

Figure I.8 – Example of 3-line IT power system.....	58
Table H.1 – Triangular waveform response comparison.....	45
Table H.2 – Square wave touch current response.....	46
Table H.3 – Square wave monopolar touch current response.....	48
Table H.4 – Mixed ACnDC waveform evaluation, ex1.....	50
Table H.5 – Mixed ACnDC waveform evaluation, ex2.....	51
Table K.1 – Calculated input impedance and transfer impedance for unweighted touch current measuring network (Figure 3).....	60
Table K.2 – Calculated input impedance and transfer impedance for perception or startle -reaction touch current measuring network (Figure 4).....	61
Table K.3 – Calculated input impedance and transfer impedance for letgo- immobilization current measuring network (Figure 5).....	61
Table K.4 – Output voltage to input voltage ratios for unweighted touch current measuring network (Figure 3).....	63
Table K.5 – Output voltage to input voltage ratios for startle-reaction measuring network (Figure 4).....	63
Table K.6 – Output voltage to input voltage ratios for letgo-immobilization measuring network (Figure 5).....	64

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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.

It has the status of a basic safety publication in accordance with IEC Guide 104.

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.

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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

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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 initially prepared under the basic safety ~~pilot~~ 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 [IEC 60990:2016](#)

- 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

^{*} ~~Terms in small capitals are defined in clause 3.~~

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, ~~one~~ small, finger contact), a different model may be appropriate **but is not covered here**.

Of the four responses, ~~perception~~ **startle-reaction** and ~~let-go~~ **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 ~~perception~~ **startle-reaction** and ~~let-go currents~~ **let-go-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 ~~required~~ **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 2016

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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.~~
- **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.

~~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.~~

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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 60479-4 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 ~~60536~~ 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
- ~~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 **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 ~~will not only apply, unless 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.

~~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 TS 60479-1:1994 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 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*

[IEC 60990:2016](#)

ISO/IEC Guide 51:1990 2014, *Safety aspects – Guidelines for their inclusion 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~~

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