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Installations électriques des bâtiments

Sixième partie: Vérification

Chapitre 61: Vérification à la mise en service

Electrical installations of buildings

Part 6: Verification

Chapter 61: Initial verification

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL INSTALLATIONS OF BUILDINGS

Part 6: Verification
Chapter 61: Initial verification

FOREWORD

1) The formal decisions or agreements of the I E C on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.
2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.
3) In order to promote international unification, the I E C expresses the wish that all National Committees should adopt the text of the I E C recommendation for their national rules in so far as national conditions will permit. Any divergence between the I E C recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by I E C Technical Committee No. 64: Electrical Installations of Buildings.

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

Six Months' Rule	Report on Voting
64(CO)152	64(CO)160

Further information can be found in the Report on Voting indicated in the table above.

ELECTRICAL INSTALLATIONS OF BUILDINGS

Part 6: Verification
Chapter 61: Initial verification

610. GENERAL

610.1 Every installation shall, during erection and/or on completion before being put into service by the user, be visually inspected and tested to verify, as far as practicable, that the requirements of this standard have been met.

610.2 The information required by Clause 514.5 shall be made available to the persons carrying out the verification.

610.3 Precautions shall be taken to avoid danger to persons and to avoid damage to property and installed equipment during inspection and testing.

610.4 Where the installation is an extension or alteration of an existing installation, it shall be verified that the extension or alteration complies with this standard and does not impair the safety of the existing installation.

611. VISUAL INSPECTION

611.1 Visual inspection shall precede testing and normally be done with the whole installation dead.

611.2 The visual inspection shall be made to confirm that permanently wired electrical equipment is:

— in compliance with the safety requirements of the relevant equipment standards;

Note. — This may be ascertained by examination of marking or certification.

— correctly selected and erected according to this standard;

— not visibly damaged, so as to impair safety.

611.3 Visual inspection shall include at least the checking of the following, where relevant:

— method of protection against electric shock, including measurement of distances, concerning, for example, protection by barriers or enclosures, by obstacles or by placing out of reach (see Clauses 412.2, 412.3, 412.4, 413.3, Section 471);

Note. — The requirement stated in Clause 413.3 "Protection by non-conducting location" is verifiable only where the installation includes only permanently wired equipment.

— presence of fire barriers and other precautions against propagation of fire and protection against thermal effects (see Chapter 42);

— selection of conductors for current-carrying capacity and voltage drop (see Section 523);

— choice and setting of protective and monitoring devices (see Chapter 53);

— presence of suitable isolating and switching devices correctly located (see Chapter 46 and Section 537);

— selection of equipment and protective measures appropriate to external influences (see Clause 512.2);

— neutral and protective conductors identification (Clause 514.3);

— presence of diagrams, warning notices or other similar information (Clause 514.5);

— identification of circuits, fuses, switches, terminals, etc. (see Section 514);
— adequacy of connections of conductors;
— accessibility for convenience of operation and maintenance.

612. TESTING

612.1 General

The following tests shall be carried out where relevant and should preferably be made in the following sequence:

— continuity of the protective conductors and of the main and supplementary equipotential bonding (see Clause 612.2);
— insulation resistance of the electrical installation (see Clause 612.3);
— protection by separation of circuits (see Clause 612.4);
— floor and wall resistance (see Clause 612.5);
— automatic disconnection of supply (see Clause 612.6) (under consideration);
— polarity test (see Clause 612.7);
— electric strength test (see Clause 612.8);
— functional tests (see Clause 612.9);
— thermal effects (see Clause 612.10) (under consideration);
— voltage drop (see Clause 612.11) (under consideration).

In the event of any test indicating failure to comply, that test and any preceding test, the results of which may have been influenced by the fault indicated, shall be repeated after the fault has been rectified.

The test methods described in this chapter are given as reference methods; other methods are not precluded provided they give no less valid results.

612.2 Continuity of the protective conductors, including the main and supplementary equipotential bonding

A continuity test shall be made. It is recommended that the test be carried out with a supply having a no-load voltage of 4 V to 24 V, d.c. or a.c., and with a minimum current of 0.2 A.

612.3 Insulation resistance of the electrical installation

The insulation resistance shall be measured:

a) between live conductors taken in turn two by two;

Note. — In practice, this measurement can only be carried out during erection of the installation before the connection of the appliances.

b) between each live conductor and earth.

Notes. 1. — In TN-C systems, the PEN conductor is considered as part of the earth.

2. — During this measurement, phase and neutral conductors may be connected together.

TABLE 61A

Minimum value of insulation resistance

Nominal circuit voltage (V)	Test voltage d.c. (V)	Insulation resistance (MΩ)
SELV and functional extra-low voltage, when the circuit is supplied from a safety transformer (Sub-clause 411.1.2.1) and also fulfils the requirements of Sub-clause 411.1.3.3	250	⩾ 0.25
Up to and including 500 V, with the exception of the above cases	500	⩾ 0.5
Above 500 V	1 000	⩾ 1.0

The insulation resistance, measured with the test voltage values indicated in Table 61A, is satisfactory if each circuit, with the appliances disconnected, has an insulation resistance not less than the appropriate value given in Table 61A.

Measurements shall be carried out with direct current. The testing apparatus shall be capable of supplying the test voltage specified in Table 61A when loaded with 1 mA.

When the circuit includes electronic devices, only the measurement between phases and neutral, connected together, to earth shall be made.

Note. — This precaution is necessary because carrying out the test without a connection between live conductors could cause damage to electronic devices.

612.4 **Protection by separation of circuits**

The separation of the live parts from those of other circuits and from earth, according to Clause 413.5, shall be verified by a measurement of the insulation resistance. The resistance values obtained shall be in accordance with Table 61A, with the appliances, as far as possible, connected.

612.5 **Floor and wall resistance**

When it is necessary to comply with the requirements of Clause 413.3, at least three measurements shall be made in the same location, one of these measurements being approximately 1 m from any accessible extraneous conductive part in the location. The other two measurements shall be made at greater distances.

The above series of measurements shall be repeated for each relevant surface of the location.

In Appendix A to this chapter a method for measuring the insulating resistance of floors and walls is given as an example.

612.6 **Automatic disconnection of supply**

Under consideration.

612.7 **Polarity test**

Where the rules forbid the installation of single pole switching devices in the neutral conductor, a test of polarity shall be made to verify that all such devices are connected in the phase only.

612.8 **Electric strength test**

612.8.1 **General**

This test is made on equipment built on site according to the method shown in Appendix E (under consideration).

612.8.2 **Values of the test voltage**

Under consideration.

612.9 **Functional tests**

Assemblies, such as switchgear and controlgear assemblies, drives, controls and interlocks, shall be subjected to a functional test to show that they are properly mounted, adjusted and installed in accordance with the relevant requirements of this standard.

Protective devices shall be submitted to functional tests, if necessary, in order to check whether they are properly installed and adjusted.

Note. — It is intended that in Appendix B (under consideration) methods for testing residual current protective devices are shown as examples.

612.10 **Verification of the protection against thermal effects**

Under consideration.

612.11 **Verification of voltage drop**

Under consideration.

APPENDIX A

METHOD FOR MEASURING THE INSULATION RESISTANCE OF FLOORS AND WALLS

A magneto-ohmmeter or battery-powered insulation tester providing a no-load voltage of approximately 500 V (or 1 000 V if the rated voltage of the installation exceeds 500 V) is used as a d.c. source.

The resistance is measured between the test electrode and a protective conductor of the installation.

The test electrodes may be either of the following types. In case of dispute, the use of test electrode 1 is the reference method.

Note. — It is recommended that the test be made before the application of the surface treatment (varnishes, paints and similar products).

Test electrode 1

The electrode comprises a square metallic plate with sides 250 mm and a square of damped water absorbent paper or cloth from which surplus water has been removed with sides approximately 270 mm which is placed between the metal plate and the surface being tested.

During the measurement a force of approximately 750 N or 250 N is applied on the plate, in the case of floors or of walls respectively.

Test electrode 2

The test electrode comprises a metallic tripod of which the parts resting on the floor form the points of an equilateral triangle. Each supporting part is provided with a flexible base ensuring, when loaded, close contact with the surface being tested over an area of approximately 900 mm^2 and presenting a resistance of less than 5 000 Ω.

Before measurements are made, the surface being tested is moistened or covered with a damp cloth. While measurements are being made a force of approximately 750 N or of 250 N is applied to the tripod, in the case of floors or of walls respectively.

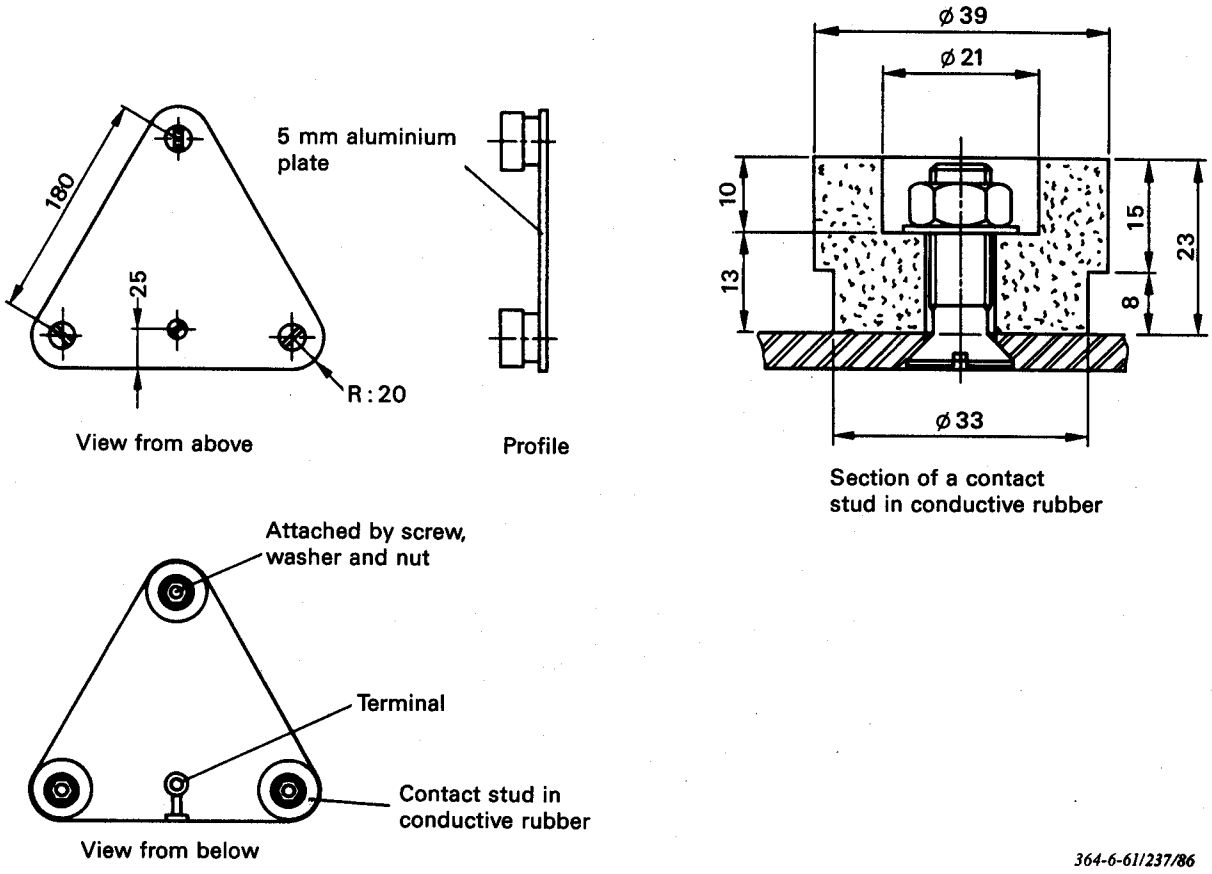

FIG. A1. — Test electrode 2.

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Amendement 1

Installations électriques des bâtiments

Sixième partie:
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Chapitre 61: Vérification à la mise en service

Amendment 1

Electrical installations of buildings

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Bureau Central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève, Suisse

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FOREWORD

This amendment has been prepared by IEC technical committee 64: Electrical installations of buildings.

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

DIS	Report on voting
64(CO)173	64(CO)191

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

Page 3

CONTENTS

Replace the number of the title of clause 610. by the following:

61.1 GENERAL

Page 7

610. . GENERAL

Replace the number of the title of the article as follows:

61.1 GENERAL

Replace the numbers of the existing subclauses 610.1, 610.2, 610.3 and 610.4 by 61.1.1, 61.1.2, 61.1.3 and 61.1.4.

Add the following new subclause:

61.2 *Normative references*

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 364-6-61. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 364-6-61 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 364-1: 1992, *Electrical installations of buildings – Part 1: Scope, object and fundamental principles*

IEC 364-3: 1993, *Electrical installations of buildings – Part 3: Assessment of general characteristics*

IEC 364-4-41: 1992, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 41: Protection against electric shock*

IEC 364-4-42: 1980, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 42: Protection against thermal effects*

IEC 364-4-43: 1977, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 43: Protection against overcurrent*

IEC 364-4-46: 1981, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 46: Isolation and switching*

IEC 364-5-51: 1979, *Electrical installations of buildings – Part 5: Selection and erection of electrical equipment – Chapter 51: Common rules*
Amendment No. 1 (1982)
Amendment No. 2 (1993)

IEC 364-5-523: 1983, *Electrical installations of buildings – Part 5: Selection and erection of electrical equipment – Chapter 52: Wiring systems – Section 523: Current-carrying capacities*

IEC 364-5-53: 1986, *Electrical installations of buildings – Part 5: Selection and erection of electrical equipment – Chapter 53: Switchgear and controlgear*
Amendment No. 2 (1992)

IEC 364-5-537: 1981, *Electrical installations of buildings – Part 5: Selection and erection of electrical equipment – Chapter 53: Switchgear and controlgear – Section 537: Devices for isolation and switching*
Amendment No. 1 (1989)

IEC 364-5-54: 1980, *Electrical installations of buildings – Part 5: Selection and erection of electrical equipment – Chapter 54: Earthing arrangements and protective conductors*

Amendment No. 1 (1982)

IEC 479-1: 1984, *Effects of current passing through the human body – Part 1: General aspects*

IEC 479-2: 1987, *Effects of current passing through the human body – Part 2: Special aspects*

Page 11

612.6 Automatic disconnection of supply

Replace the existing title and text of this subclause by the following:

612.6 Verification of conditions for protection by automatic disconnection of the supply

612.6.1 *General*

The verification of the efficacy of the measures for protection against indirect contact by automatic disconnection of supply is effected as follows:

a) For TN systems

Compliance with the rules of 413.1.3.3 shall be verified by:

1) measurement of the fault loop impedance (see 612.6.3). As an alternative, compliance may be verified by measurement of the resistance of protective conductors (see 612.6.4);

NOTE – The above measurements are not necessary where the calculations of the fault loop impedance or of the resistance of the protective conductors are available and when the arrangement of the installation permits the verification of the length and cross-sectional area of the conductors, in which case the verification of the continuity of the protective conductors (see 612.2) is sufficient.

2) verification of the characteristics of the associated protective device (i.e. by visual inspection of the nominal current setting for circuit-breakers and the current rating for fuses and also by test for r.c.d.'s).

NOTE – Examples of methodes for testing r.c.d.'s are shown in appendix B.

In addition, the effective earthing resistance R_B shall be designed where necessary according to 413.1.3.7.

b) For TT systems

Compliance with the rules of 413.1.4.2 shall be verified by:

1) measurement of the resistance of the earth electrode for exposed conductive parts of the installation (see 612.6.2);

2) verification of the characteristics of the associated protective device. This verification shall be made:

- for residual current devices by visual inspection and by test;

NOTE – Examples of methods for testing r.c.d.'s are shown in appendix B.

- for overcurrent protective devices by visual inspection (i.e. current setting for circuit-breakers, current rating for fuses);
- for the protective conductors by inspection of their continuity (see 612.1).

c) *For IT systems*

Calculation or measurement of the first fault current.

NOTES

1 This measurement is not necessary if all exposed conductive parts of the installation are connected to the power system earth (see 312.2.3) in the case where the system is connected to earth through an impedance (see 413.1.5.1).

2 The measurement is made only if the calculation is not possible, because all the parameters are not known. Precautions are to be taken while making this measurement in order to avoid the danger due to a double fault.

Where conditions which are similar to conditions of TT systems occur in the event of a second fault (see 413.1.5.5a), verification is made according to point b) of this clause.

Where conditions similar to conditions of TN systems occur (see 413.1.5.5b), verification is made according to point a) of this clause.

NOTE – During the measurement of the fault loop impedance, it is necessary to establish a connection of negligible impedance between the neutral point of the system and the protective conductor at the origin of the installation.

612.6.2 *Measurement of the resistance of the earth electrode*

Measurement of the resistance of an earth electrode, where prescribed (see 413.1.4.2 for TT systems and 413.1.3.2 for TN systems and 413.1.5.3 for IT systems), is made by an appropriate method.

NOTES

1 Appendix C gives, as an example, a description of a method of measurement using two auxiliary earth electrodes and the conditions to be fulfilled.

2 Where, in a TT system, the location of the installation (e.g. in towns) is such that it is not possible in practice to provide the two auxiliary earth electrodes, measurement of the fault loop impedance (or resistance) will give an excess value.

612.6.3 *Measurement of fault loop impedance*

Measurement of the fault loop impedance shall be effected at the same frequency as the nominal frequency of the circuit.

NOTE – Methods for measuring fault loop impedance are given as examples in appendix D.

The measured fault loop impedance shall comply with 413.1.3.3 for TN systems and with 413.1.5.6 for IT systems.

NOTE – When the fault loop impedance value might be influenced by significant fault currents, results of measurements made with such current in the factory or laboratory may be taken into account. This particularly applies to factory-built assemblies, including busbar trunking systems, metallic conduits and cables with metallic enclosures.

612.6.4 *Measurement of the resistance of protective conductors*

612.6.4.1 Verification consists of measurement of the resistance R between any exposed conductive part and the nearest point of the main equipotential bonding.

NOTE – Protective conductors include metal conduits and other metal enclosures for conductors in the conditions defined in clause 543.2.

It is recommended that the measurement be carried out with a supply having a no-load voltage of 4 V to 24 V, d.c. or a.c., and with a minimum current of 0,2 A.

The measured resistance R shall meet the following condition:

$$R \leq \frac{U_c}{I_t}$$

where

U_c is the prospective touch-voltage as given in table 61B related to disconnecting times defined in tables 41A and 41B;

I_t is the current causing the automatic operation of the protective device within the time stated in tables 41A and 41B.

Table 61B – Prospective touch-voltage related to disconnecting times

Disconnecting times s	Prospective touch voltages V
0,1 0,2 0,4 0,8 5	350 210 105 68 50
NOTE – The prospective touch-voltage values are determined on the basis of IEC 479-1.	

When, in the conditions stated in 413.1.3.6, a disconnnecting time not exceeding 5 s is permitted, this method is not applicable

612.6.4.2 Where the requirements of 612.6.3 and 612.6.4.1 are not satisfied and supplementary bonding according to 413.1.6 is applied or in case of doubt, the effectiveness of that bonding shall be checked by the method of 413.1.6.2.

Add, after appendix A, the following new appendices:

Appendix B

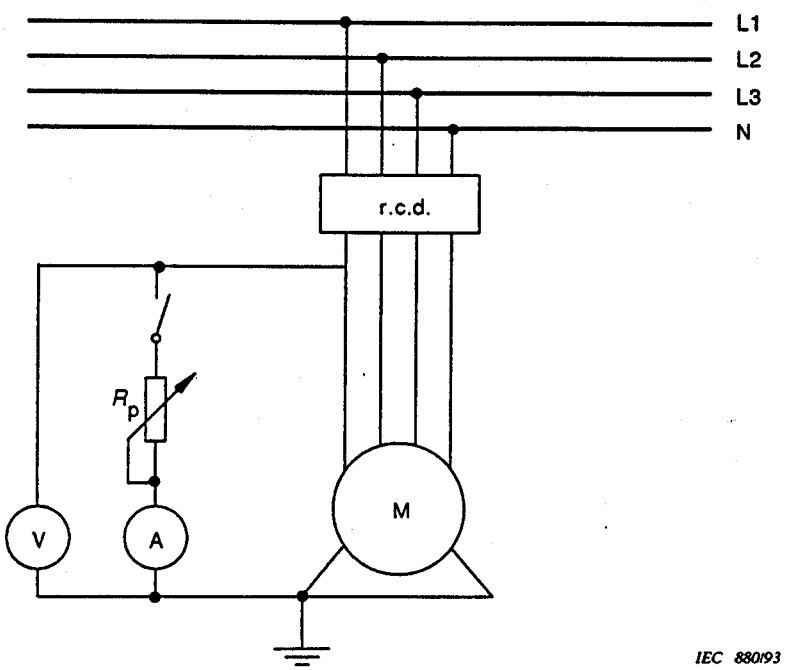
Verification of the operation of residual current protective devices

The following methods are given as examples.

Method 1

Figure B.1 shows the principle of a method where a variable resistance is connected between a live conductor on the load side and the exposed conductive part. The current is increased by reducing the value of the variable resistance R_p.

The current I_Δ at which the r.c.d. operates shall not be greater then $I_{\Delta n}$, the rated residual operating current.



NOTE – Method 1 can be used for TN-S, TT and IT systems. In the IT system, it may be necessary to connect a point of the system directly to earth during the test to obtain the operation of the r.c.d.

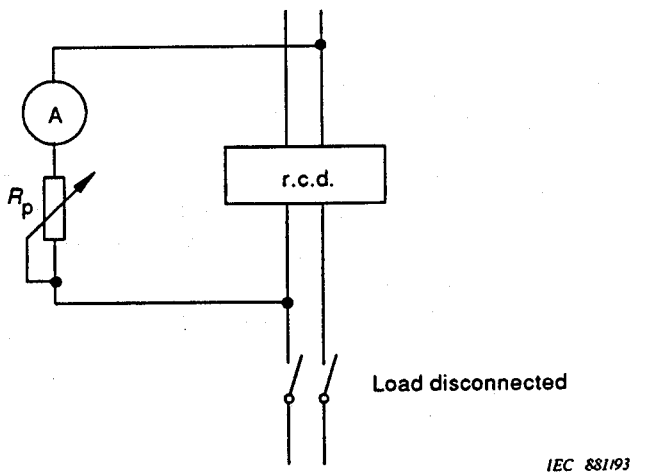
Figure B.1

Method 2

Figure B.2 shows the principle of the method where the variable resistance is connected between a live conductor on the supply side and another live conductor on the load side.

The current is increased by reducing the value of the variable resistance R_P.

The current I_Δ at which r.c.d. operates shall not be greater than $I_{\Delta n}$. The load shall be disconnected during the test.



NOTE – Method 2 can be used for TN-S, TT and IT systems.

Figure B.2

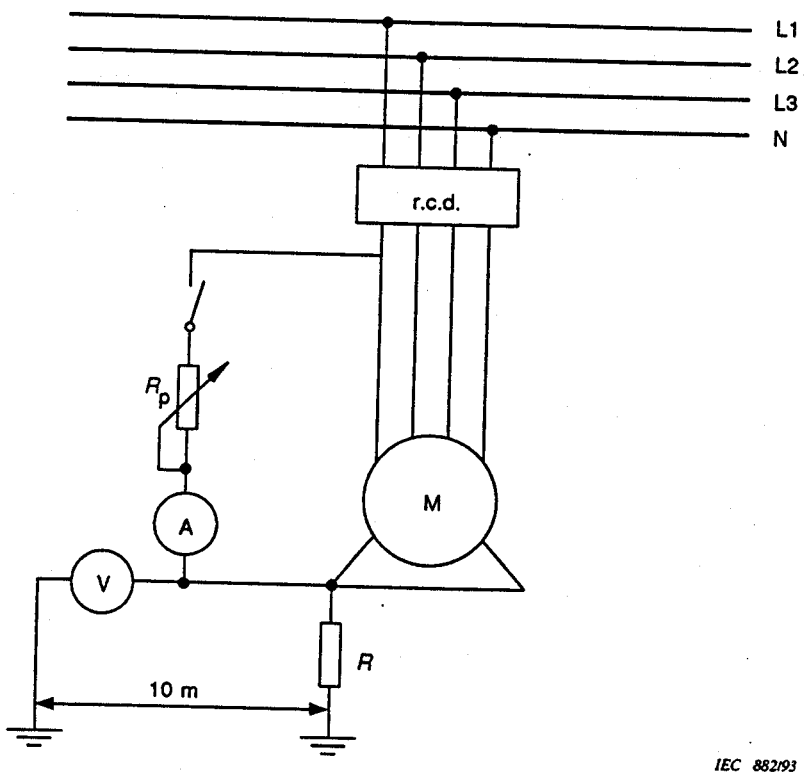
Method 3

Figure B.3 shows the principle of the method using an auxiliary electrode. The current is increased by reducing the value of the variable resistance R_P. Then the voltage U between the exposed conductive parts and an independent auxiliary electrode is measured. The current I_Δ, which shall not be greater than $I_{\Delta n}$ at which the r.c.d. operates, is also measured.

The following condition shall be fulfilled:

$$U \leq U_L \times \frac{I_\Delta}{I_{\Delta n}}$$

where U_L is the conventional touch voltage limit.



NOTES

1 Method 3 can only be used when the location allows the auxiliary electrode.

2 Method 3 can be used for TN-S, TT and IT systems. In IT systems it may be necessary to connect a point of the system directly to earth during the test to obtain the operation of the r.c.d.

Figure B.3

Appendix C

Measurement of earth electrode resistance

As an example, the following procedure may be adopted when the measurement of the earth resistance is to be made (see figure C.1).

An alternating current of a steady value is passed between the earth electrode T and an auxiliary earth electrode T_1 placed at a distance from T such that the resistance areas of the two electrodes do not overlap.

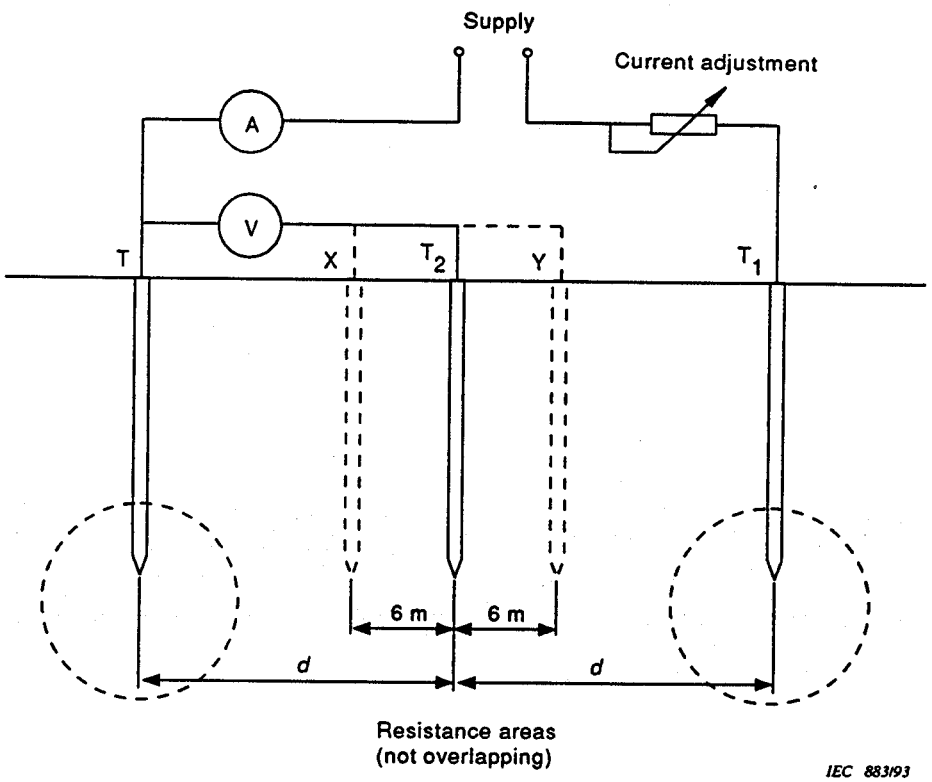
A second auxiliary earth electrode T_2, which may be a metal spike driven into the ground, is then inserted half-way between T and T_1, and the voltage drop between T and T_2 is measured.

The resistance of the earth electrodes is then the voltage between T and T_2, divided by the current flowing between T and T_1, provided that there is no overlap of the resistance areas.

To check that the resistance of the earth electrodes is a true value, two further readings are taken with the second auxiliary electrode T_2 moved some 6 m from and some 6 m nearer to T, respectively. If the three results are substantially in agreement, the mean of the three readings is taken as the resistance of the earth electrode T. If there is no such agreement, the tests are repeated with the distance between T and T_1 increased.

If the test is made with current at power frequency, the internal impedance of the voltmeter used must be at least 200 Ω/V.

The source of the current used for the test shall be isolated from the mains supply (e.g. by a double-wound transformer).



T: earth electrode under test, disconnected from all other sources of supply

T_1: auxiliary earth electrode

T_2: second auxiliary earth electrode

X: alternative position of T_2 for check measurement

Y: further alternative position of T_2 for the other check measurement

Figure C.1

Appendix D

Measurement of the fault loop impedance

As examples, the following methods may be adopted for TN systems when the measurement of fault loop impedances is to be made.

NOTES

1 The methods proposed in this appendix give only approximate values of the fault loop impedance as they do not take into account the vectorial nature of the voltage, i.e. of the conditions existing at the time of an actual earth fault. The degree of approximation is, however, acceptable provided that the reactance of the circuit concerned is negligible.

2 It is recommended to make a continuity test (clause 612.2) between the neutral point and the exposed conductive parts before carrying out the fault loop impedance measurement.

Method 1: Measurement of the fault loop impedance by means of voltage drop

The voltage of the circuit to be verified is measured with and without connection of a variable load resistance, and the fault loop impedance is calculated from the formula:

$$Z = \frac{U_1 - U_2}{I_R}$$

where

Z is the fault loop impedance;

U_1 is the voltage measured without connection of the load resistance;

U_2 is the voltage measured with connection of the load resistance;

I_R is the current through the load resistance.

NOTE – The difference between U_1 and U_2 should be significant.

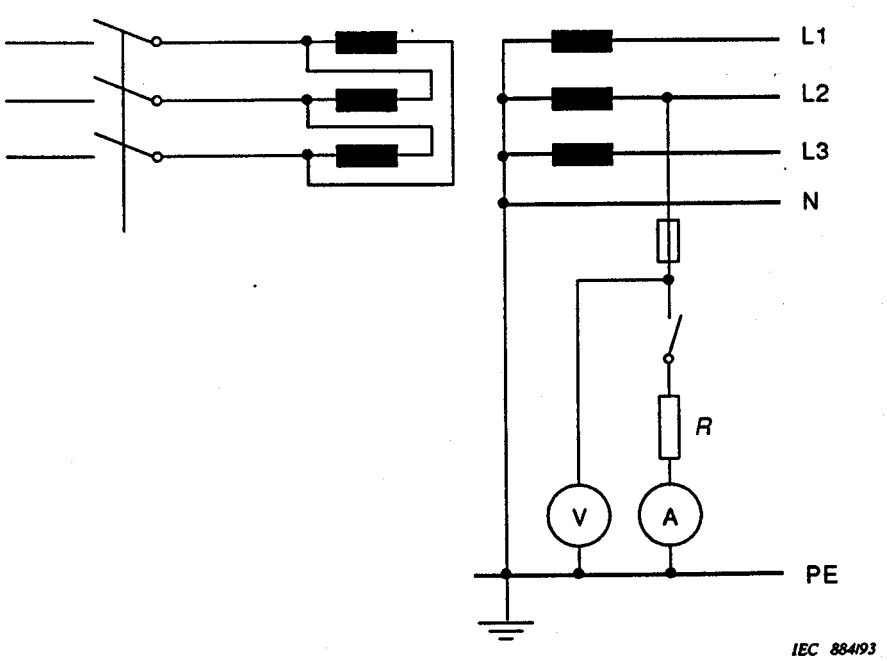


Figure D.1

Méthode 2: Measurement of the fault loop impedance by means of a separate supply

The measurement is made when the normal supply is disconnected and the primary of the transformer is short-circuited. The method uses a voltage from a separate supply (see figure D.2), and the fault loop impedance is calculated from the formula:

$$Z = \frac{U}{I}$$

where

Z is the fault loop impedance;

U is the measured test voltage;

I is the measured test current.

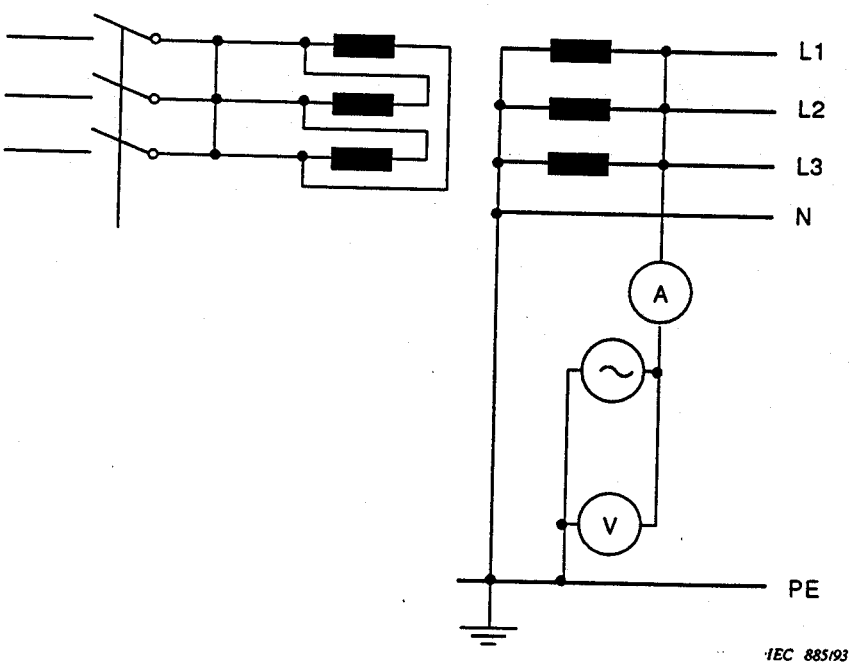


Figure D.2