IEC 60364-6

Edition 2.0 2016-04

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Low voltage electrical installations – Part 6: Verification

Installations électriques à basse tension – Partie 6: Vérification

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LOW VOLTAGE ELECTRICAL INSTALLATIONS –

Part 6: Verification

FOREWORD

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International Standard IEC 60364-6 has been prepared by the IEC technical committee 64: Electrical installations and protection against electric shock.

This second edition cancels and replaces the first edition published in 2006 and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Normative references updated to current publications;
b) Re-numbered to align with current IEC numbering;
c) Initial inspection requirements: 3 items added;
d) Testing sequence changed;
e) General requirements for periodic reporting – more details added;
f) New Annex A: Table A.1 – Specific resistance values for copper conductors;

g) Annex D: Example of a diagram suitable for evaluation of voltage drop. Content removed;

h) Annex E: Recommendation for electrical equipment which is being re-used in an electrical installation. Content removed;

i) Annex F: Content replaced with new Annex E – Model forms for reporting;

j) Annex G: Changed to Annex F – Model forms for inspection of electrical installations;

k) Annex H: Changed to Annex G – Model schedule of circuit details and test results;

l) Annex H: Listing of notes concerning some countries;

m) Bibliography – Updated:

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

FDIS	Report on voting
64/2107/FDIS	64/2114/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.

A list of all parts in the IEC 60364 series, published under the general title *Low voltage electrical installations*, can be found on the IEC website.

The reader's attention is drawn to the fact that Annex H lists all of the “in-some-country” clauses on differing practices of a less permanent nature relating to the subject of this standard.

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- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of September 2017 have been included in this copy.

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LOW VOLTAGE ELECTRICAL INSTALLATIONS –

Part 6: Verification

6.1 Scope

This part of IEC 60364 provides requirements for initial and periodic verification of an electrical installation.

Clause 6.4 provides requirements for initial verification, by inspection and testing, of an electrical installation to determine, as far as reasonably practicable, whether the requirements of the other parts of IEC 60364 have been met and requirements for the reporting of the results of the initial verification. The initial verification takes place upon the completion of a new installation or completion of an addition or an alteration to an existing installation.

Clause 6.5 provides requirements for periodic verification of an electrical installation to determine, as far as reasonably practicable, whether the installation and all its constituent equipment are in a satisfactory condition for use and requirements for the reporting of the results of the periodic verification.

6.2 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.

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IEC 60079-17, *Explosive atmospheres – Part 17: Electrical installations inspection and maintenance*

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IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60364-4-42:2010, *Low-voltage electrical installations – Part 4-42: Protection for safety – Protection against thermal effects*
IEC 60364-4-42:2010/AMD1:2014

IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*
IEC 60364-4-44:2007/AMD1:2015

IEC 60364-5-51:2005, *Electrical installations of buildings – Part 5-51:– Selection and erection of electrical equipment – Common rules*

IEC 60364-5-52:2009, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60364-5-53:2001, *Electrical installations of buildings – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control*
IEC 60364-5-53:2001/AMD1:2002
IEC 60364-5-53:2001/AMD2:2015

IEC 60364-5-54, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*

IEC 61557 (all parts), *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures*

IEC 61557-6, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 6: Effectiveness of residual current devices (RCD) in TT, TN and IT systems*

6.3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

6.3.1
verification
all measures by means of which compliance of the electrical installation with the relevant requirements of IEC 60364 is checked

Note 1 to entry: Verification comprises inspection, testing and reporting.

6.3.2
inspection
examination of an electrical installation using all appropriate senses in order to ascertain correct selection and proper erection of electrical equipment

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6.3.3
testing
implementation of measures to assess an electrical installation by means through which its effectiveness is proved

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Note 1 to entry: Testing includes ascertaining values by means of appropriate measuring instruments, said values not being detectable by inspection.

6.3.4
reporting
recording of the results of inspection and testing

6.3.5
maintenance
combination of all technical and administrative actions, including supervisory actions, intended to retain an item in, or restore it to, a state in which it can perform a required function

6.4 Initial verification

6.4.1 General

6.4.1.1 Every installation shall be verified during erection, as far as reasonably practicable, and on completion, before being put into service.

6.4.1.2 The information required by IEC 60364-5-51:2005, 514.5 and other information necessary for initial verification shall be made available to the person carrying out the initial verification.

6.4.1.3 The initial verification shall include comparison of the results with relevant criteria to confirm that the requirements of the IEC 60364 series have been met.

6.4.1.4 Precautions shall be taken to ensure that the verification shall not cause danger to persons or livestock and shall not cause damage to property and equipment even if the circuit is defective**.**

6.4.1.5 It shall be verified that an extension, addition or alteration to an existing installation complies with the IEC 60364 series and does not impair the safety of that installation, and that the safety of the new installation is not impaired by the existing installation.

6.4.1.6 The verification shall be made by a skilled person, competent in verification.

NOTE Requirements concerning qualifications are a matter for national consideration.

6.4.2 Inspection

6.4.2.1 Inspection shall precede testing and shall normally be done prior to energizing the installation.

6.4.2.2 The inspection shall be made to confirm that electrical equipment which is part of the fixed installation is:

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

NOTE This can be ascertained by examination of the manufacturer's information, marking or certification.

– correctly selected and erected according to the IEC 60364 series and taking into account the manufacturer's instructions;

– not visibly damaged or defective so as to impair safety.

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6.4.2.3 Inspection shall include at least the checking of the following, where relevant:

a) method of protection against electric shock (see IEC 60364-4-41);

b) presence of fire barriers and other precautions against propagation of fire and protection against thermal effects (see IEC 60364-4-42 and IEC 60364-5-52:2009, Clause 527);

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c) selection of conductors for current-carrying capacity (see IEC 60364-4-43 and IEC 60364-5-52:2009, Clauses 523);

d) choice, setting, selectivity and coordination of protective and monitoring devices (see IEC 60364-5-53:2001, Clause 536);

e) selection, location and installation of suitable overvoltage protective devices (SPD) where specified (see IEC 60364-5-53:2001 and IEC 60364-5-53:2001/AMD2:2015, Clause 534);

f) selection, location and installation of suitable isolating and switching devices (see IEC 60364-5-53:2001, Clause 536);

g) selection of equipment and protective measures appropriate to external influences and mechanical stresses (see IEC 60364-4-42:2010, Clause 422, IEC 60364-5-51:2005, 512.2 and IEC 60364-5-52:2009, Clause 522);

h) identification of neutral and protective conductors (see IEC 60364-5-51:2005, 514.3);

i) presence of diagrams, warning notices or similar information (see IEC 60364-5-51:2005, 514.5);

j) identification of circuits, overcurrent protective devices, switches, terminals etc. (see IEC 60364-5-51:2005, Clause 514);

k) adequacy of termination and connection of cables and conductors (see IEC 60364-5-52:2009, Clause 526);

l) selection and installation of earthing arrangements, protective conductors and their connections (see IEC 60364-5-54);

m) accessibility of equipment for convenience of operation, identification and maintenance (see IEC 60364-5-51:2005, Clauses 513 and 514);

n) measures against electromagnetic disturbances (see IEC 60364-4-44:2007, Clause 444);

o) exposed-conductive-parts are connected to the earthing arrangement (see IEC 60364-4-41:2005, Clause 411);

p) selection and erection of the wiring systems (see IEC 60364-5-52:2009, Clauses 521 and 522).

Inspection shall include all particular requirements for special installations or locations.

6.4.3 Testing

6.4.3.1 General

The test methods described in 6.4.3 are given as reference methods; other methods are not precluded, provided they give no less valid results.

Measuring instruments and monitoring equipment and methods shall be chosen in accordance with the relevant parts of the IEC 61557 series. If other measuring equipment is used, it shall provide no less a degree of performance and safety.

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

a) continuity of conductors (see 6.4.3.2);

b) insulation resistance (see 6.4.3.3);

c) insulation resistance testing to confirm the effectiveness of protection by SELV, PELV or electrical separation (see 6.4.3.4);

d) insulation resistance testing to confirm the effectiveness of floor and wall resistance/impedance (see 6.4.3.5);

e) polarity test (see 6.4.3.6);

f) testing to confirm effectiveness of automatic disconnection of supply (see 6.4.3.7);

g) testing to confirm the effectiveness of additional protection (see 6.4.3.8);

h) test of phase sequence (see 6.4.3.9);

i) functional tests (see 6.4.3.10);

j) voltage drop (see 6.4.3.11).

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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.

When testing in a potentially explosive atmosphere appropriate safety precautions in accordance with IEC 60079-17 are necessary.

6.4.3.2 Continuity of conductors

The continuity of conductors and connection to exposed-conductive-parts, if any, shall be verified by a measurement of resistance on:

a) protective conductors, including protective bonding conductors,

b) exposed-conductive-parts, and

c) in the case of ring final circuits, live conductors.

NOTE See also Annex A.

6.4.3.3 Insulation resistance of the electrical installation

The insulation resistance shall be measured between:

a) live conductors, and

b) live conductors and the protective conductor connected to the earthing arrangement.

Where appropriate during this measurement, live conductors may be connected together. In practice, it may be necessary to carry out this measurement during erection of the installation before the connection of the equipment.

Where the circuit includes equipment that is likely to influence the results or be damaged, only a measurement between the live conductors connected together and earth shall be made.

The insulation resistance measured with the test voltages indicated in Table 6.1 shall be considered satisfactory if the main switchboard and each distribution circuit tested separately, with all its final circuits connected but with current-using equipment disconnected, has an insulation resistance not less than the appropriate value given in Table 6.1.

Table 6.1 – Minimum values of insulation resistance

Nominal circuit voltage V	Test voltage d.c. V	Minimum insulation resistance MΩ
SELV and PELV	250	0.5
Up to and including 500 V, including FELV	500	1
Above 500 V	1 000	1

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Table 6.1 shall be applied for a verification of the insulation resistance between non-earthed protective conductors and earth.

FELV circuits shall be tested at the same test voltage as that applied to the primary side of the source.

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Where surge protective devices (SPDs) or other equipment are likely to influence the verification test, or be damaged, such equipment shall be disconnected before carrying out the insulation resistance test.

Where it is not reasonably practicable to disconnect such equipment (e.g. in case of fixed socket-outlets incorporating an SPD) the test voltage for a particular circuit may be reduced to 250 V d.c. but the insulation resistance shall have a value of at least 1 MΩ.

To facilitate measurement, the neutral conductor shall be disconnected from the main earthing terminal (MET).

In TN-C systems, a measurement should be made between the live conductors and the PEN conductor.

Insulation resistance values are usually much higher than those of Table 6.1. When measured values show evident differences between circuits, further investigation to identify the reasons is required.

6.4.3.4 Insulation resistance testing to confirm effectiveness of SELV, PELV or electrical separation

The separation of circuits shall be in accordance with 6.4.3.4.1 in the case of protection by SELV, 6.4.3.4.2 in the case of protection by PELV and 6.4.3.4.3 in the case of protection by electrical separation.

The resistance value obtained in 6.4.3.4.1, 6.4.3.4.2 and 6.4.3.4.3 shall be at least that of the circuit with the highest voltage present in accordance with Table 6.1.

6.4.3.4.1 Protection by SELV

The separation of live parts from those of other circuits and from earth, according to IEC 60364-4-41:2005, Clause 414, shall be confirmed by a measurement of the insulation resistance.

6.4.3.4.2 Protection by PELV

The separation of the live parts from other circuits, according to IEC 60364-4-41:2005 Clause 414, shall be confirmed by a measurement of the insulation resistance.

6.4.3.4.3 Protection by electrical separation

The separation of the live parts from those of other circuits and from earth, according to IEC 60364-4-41:2005, Clause 413, shall be confirmed by a measurement of the insulation resistance.

For electrical separation with more than one item of current-using equipment, it shall be verified either by measurement or by calculation that in the case of two coincidental faults with negligible impedance between different line conductors and either the protective bonding conductor or exposed-conductive-parts connected to it, at least one of the faulty circuits shall be disconnected. The disconnection time shall be in accordance with that for the protective measure automatic disconnection of supply in a TN system.

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6.4.3.5 Insulation resistance/impedance of floors and walls

When it is necessary to comply with the requirements of IEC 60364-4-41:2005, Clause C.1, 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.

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The measurement of resistance/impedance of insulating floors and walls is carried out with the system voltage to earth at nominal frequency.

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

NOTE Further information on the measurement of the insulation resistance/impedance of floors and walls is given in Annex B.

6.4.3.6 Polarity

Where relevant, the polarity of the supply at the origin of the installation shall be verified before the installation is energized.

Where single pole switching devices are not permitted in the neutral conductor, a test shall be made to verify that all such devices are connected in the line conductor(s) only.

During the polarity test, it should be verified that:

a) every fuse and single-pole control and protective device is connected in the line conductor only, and

b) except for E14 and E27 lampholders according to IEC 60238, in circuits having an earthed neutral conductor centre contact bayonet and Edison screw lampholders, the outer or screwed contacts are connected to the neutral conductor, and

c) wiring has been correctly connected to socket-outlets and similar accessories.

6.4.3.7 Protection by automatic disconnection of supply

NOTE Where RCDs are employed also for protection against fire, the verification of the conditions for protection by automatic disconnection of the supply can be considered as covering the relevant requirements of IEC 60364-4-42.

6.4.3.7.1 General

The verification of the effectiveness of the measures for fault protection by automatic disconnection of supply is effected as follows:

a) For a TN system

Compliance with the rules of IEC 60364-4-41: 2005, 411.4.4 and 411.3.2 shall be verified by:

1) Measurement of the earth fault loop impedance where possible (see 6.4.3.7.3).

   Alternatively, where the measurement of earth fault loop impedance is not possible the verification of the electrical continuity of the protective conductors (see 6.4.3.2) is sufficient provided that calculations of earth fault loop impedance or protective conductor resistance are available.

2) Verification of the characteristics and/or the effectiveness of the associated protective device. This verification shall be made:

   – for overcurrent protective devices, by visual inspection or other appropriate methods (i.e. short time or instantaneous tripping setting for circuit-breakers, current rating and type for fuses);

   – for RCDs, by visual inspection and testing.

     The effectiveness of automatic disconnection by RCDs shall be verified using suitable test equipment according to IEC 61557-6 confirming that the relevant requirements in IEC 60364-4-41 are met taking into account the operating characteristic of the device. The effectiveness of the protective measure is verified if disconnection occurs with a fault current lower than or equal to the rated residual operating current $I_{\Delta n}$.

     It is recommended that the disconnection times required by IEC 60364-4-41 be verified. However, the requirements for disconnecting times shall be verified in case of additions and alterations to an existing installation where existing RCDs are also used as disconnecting devices for such additions and alterations.

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Where the effectiveness of the protective measure has been confirmed at a point located downstream of an RCD, the protection of the installation downstream from this point may be proved by confirmation of the continuity of the protective conductors.

b) For a TT system

Compliance with the rules of IEC 60364-4-41: 2005, 411.5.3 and 411.3.2 shall be verified by:

1) Measurement of the resistance R_A of the earth electrode for exposed-conductive-parts of the installation (see 6.4.3.7.2).

   Where a measurement of R_A is not practicable the measured value of external earth fault loop impedance may be used (see Annex C, Methods C2 and C3).

2) Verification of the characteristics and/or the effectiveness of the associated protective device. This verification shall be made:

   – for overcurrent protective devices, by visual inspection or other appropriate methods (i.e. short time or instantaneous tripping setting for circuit-breakers, current rating and type for fuses);

   – for RCDs, by visual inspection and testing.

     The effectiveness of automatic disconnection by RCDs shall be verified using suitable test equipment according to IEC 61557-6 confirming that the relevant requirements in IEC 60364-4-41 are met taking into account the operating characteristic of the device. The effectiveness of the protective measure is verified

if disconnection occurs with a fault current lower or equal to the rated residual operating current $I_{\Delta n}$.

It is recommended that the disconnection times required by IEC 60364-4-41 be verified. However, the requirements for disconnecting times shall be verified in case of additions and alterations to an existing installation where existing RCDs are also used as disconnecting devices for such additions and alterations.

Where the effectiveness of the protective measure has been confirmed at a point located downstream of an RCD, the protection of the installation downstream from this point may be proved by confirmation of the continuity of the protective conductors.

c) For an IT system

Compliance with the rules of IEC 60364-4-41: 2005, 411.6.2 shall be verified by calculation or measurement of the current I_d in case of a first fault of a live conductor.

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 the measurement in order to avoid the danger due to a double fault.

In the case of a double earth fault, the fault loop impedance shall be verified by calculations or by measurements. Where the condition is similar to that of a TT-system (see IEC 60364-4-41:2005, 411.6.4 item b), verification shall be made as for a TT system (see 6.4.3.7.1, item b)). Where conditions are similar to that of a TN-system (see IEC 60364-4-41:2005, 411.6.2), verification by measurement shall be made as follows.

– For IT installations supplied from a local transformer, the earth-loop impedance is measured by inserting a connection with negligible impedance between a live conductor and earth at the origin of the installation. The earth-loop impedance measurement is made between a second live conductor and protective-earth at the end of the circuit. Verification is achieved if the measured value is ≤ 50 % of the maximum allowed loop-impedance.

– For IT systems connected to a public grid, the earth fault loop impedance is determined by verification of the continuity of the protective conductor and measuring the loop-impedance between two live conductors at the end of the circuit. Verification is achieved if the measured value is ≤ 50 % of the maximum permitted loop-impedance. If verification is not achieved, more detailed measurements are necessary.

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6.4.3.7.2 Measurement of the resistance of the earth electrode

Measurement of the resistance of an earth electrode, where prescribed (see IEC 60364-4-41: 2005, 411.5.3, for a TT system, 411.4.1, for a TN system, and 411.6.2, for an IT system), shall be made by an appropriate method. When measuring the resistance is not possible, the resistance may also be calculated using applicable values.

NOTE 1 Annex C, Method C1 gives, as an example, a description of a method of measurement using two auxiliary earth electrodes and the conditions to be fulfilled.

NOTE 2 Where 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 earth fault loop impedance according to 6.4.3.7.3, or Annex C, Methods C2 and C3 will give an acceptable approximate value.

6.4.3.7.3 Measurement of the earth fault loop impedance

An electrical continuity test shall be carried out according to 6.4.3.2 before carrying out the earth fault loop impedance measurement.

The measured earth fault loop impedance shall comply with IEC 60364-4-41: 2005, 411.4.4 for TN systems and with IEC 60364-4-41: 2005, 411.6.4 for IT systems.