

AS/NZS 3017:2022



Australian/New Zealand Standard™

Electrical installations — Verification by inspection and testing



AS/NZS 3017:2022

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- Consumers Federation of Australia
- Electrical Regulatory Authorities Council
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- Electrical Workers Registration Board
- ElectroComms and Energy Utilities Industry Skills Council
- Energy Networks Australia
- Engineering New Zealand
- Engineers Australia
- Institute of Electrical Inspectors
- Master Electricians Australia
- Master Electricians NZ
- National Electrical and Communications Association
- National Electrical Switchboard Manufacturers Association
- The Manufacturers Network
- WorkSafe New Zealand

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Australian/New Zealand Standard™

Electrical installations — Verification by inspection and testing

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Preface

This Standard was prepared by the joint Standards Australia/Standards New Zealand Committee EL-001, Wiring Rules, to supersede AS/NZS 3017:2007 from the date of publication.

This Standard aims to provide people who carry out inspections and tests of an electrical installation with some methods of verifying that the electrical installation complies with the safety requirements for the prevention of fire and the protection of persons and livestock from electric shock.

AS/NZS 3017 may be applied through legislative requirements made in each State and Territory of Australia and in New Zealand.

AS/NZS 3000, *Electrical installations (known as the Australian/New Zealand Wiring Rules)*, requires electrical installations to be inspected and tested before being placed in service. The inspection and test methods in this Standard are provided as a means for satisfying these requirements.

This Standard has been revised to align with AS/NZS 3000:2018, and to include the following:

- (a) Additional tests for measurement of the resistance of the earth electrode and measurement of touch voltage.
- (b) Tests of the integrity of incoming neutral.

The major changes in this edition are as follows:

- (i) Increased guidance on selection and checking of test equipment.
- (ii) Most figures illustrating test procedures amended for increased clarity.
- (iii) Figures amended to reflect increasing use of residual current devices (RCDs).
- (iv) Test for de-energized added, to be carried out before all other testing.
- (v) Tests for polarity, phase rotation and correct circuit connections combined, because they are interrelated.
- (vi) Testing for correct installation and functioning of RCDs amended.

This Standard is accompanied by additional data in a ZIP file. The ZIP file contains editable PDF forms. The ZIP file may be obtained on purchase of the Standard in any format.

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

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Introduction

Application of typefaces

Four different typefaces are used in this Standard. Each of these has a specific purpose as follows:

Normal print indicates requirements that form the main part of a clause. It also indicates deemed to comply methods that satisfy the requirements. Normal print is used in the Appendices to present informative material for guidance only.

Italic print indicates exceptions or variations to requirements. Exceptions generally give specific examples where the requirements do not apply or where they are varied for certain applications. They may contain requirements. Examples are also presented in italic text.

Reduced normal print indicates Notes which give explanations and advice. They are preceded by “NOTE” in the manner used in previous editions.

Bold print indicates SAFETY WARNINGS.

It is important not to read text in any single typeface without consulting the preceding or following paragraphs, which may contain additional or modifying requirements.

Deemed to comply

The term “deemed to comply” means that a requirement can be met by following a specified Standard or method.

So, where an installation is carried out in accordance with the specified Standard or method, within the text of this Standard, the installation is “deemed to comply” with the requirements of this Standard.

Conformance to a deemed to comply Standard may exceed the minimum requirements of this Standard.

Notes

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard. Notes to text are informative and give explanations or advice. They do not form a mandatory part of this Standard.

Cross-references

Where reference to another clause has been made, such reference, unless otherwise stated, includes all appropriate subclauses and paragraphs of the clause or portion thereof referred to.

Provision for revision

This Standard is not intended to discourage invention or to exclude materials, equipment and methods that may be developed. Revisions will be made from time to time in view of such developments and Amendments to this edition will be made where essential.

NOTES

Australian/New Zealand Standard

Electrical installations — Verification by inspection and testing

Section 1 Scope and general

1.1 Scope

This Standard sets out some of the common inspection and test methods required to verify that a low voltage electrical installation, or part installation, complies with safety requirements.

This Standard illustrates testing procedures for an electrical installation connected to a Multiple Earth Neutral (MEN) (TN-C-S) system of earthing. The equipment and methods —

- (a) are not exclusive and other equipment and methods may be used; provided they give equally valid results; and
- (b) may be applied to types of low voltage installations other than MEN (TN-C-S); and
- (c) may be applied to work that affects only part of an installation, e.g. alterations or repairs.

Although verification of compliance refers to the completed work undertaken, it is reasonable to expect that the inspection and test methods set out in this Standard may be applied during the design, selection and installation phases of the work as a matter of sound practice. Records of the on-going inspection and testing would contribute to verification of the completed work.

This Standard describes alternate test methods for electrical installations that are either energized or de-energized. The user of this Standard is to determine the appropriate test methods.

1.2 Application

The principal application of this Standard is for verification of electrical installations used by electricity consumers.

This Standard may be applied through legislative requirements, made in each state and territory of Australia and in New Zealand, concerned with the verification of electrical installations. The Standard may also be applied in conjunction with any additional requirements, exemptions or restrictions in such legislation.

1.3 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this Standard:

NOTE Documents for informative purposes are listed in the Bibliography.

AS 61010.1, *Safety requirements for electrical equipment for measurement, control and laboratory use — Part 1: General requirements (IEC 61010-1:2001 MOD)*

AS/NZS 3000:2018, *Electrical installations (known as the Australian/New Zealand Wiring Rules)*

AS ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

IEC 61557 (series), *Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. — Equipment for testing, measuring or monitoring of protective measures*

1.4 Terms and definitions

For the purposes of this Standard the terms and definitions in AS/NZS 3000 and those below apply. Where an additional term is defined in a particular Section or Clause, the term takes the meaning defined in that Section or Clause.

1.4.1

competent person

person who has acquired, through education, training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the task required

1.4.2

de-energized

separated from all sources of supply, but not necessarily isolated, earthed or out of commission

1.4.3

earth fault-loop impedance

impedance of the earth fault-current loop (active-to-earth loop) starting and ending at the point-of-earth fault

1.4.4

energized

connected to a source of electrical supply

1.4.5

equipotential bonding

electrical connections intended to bring exposed conductive parts or extraneous conductive parts to the same or approximately the same potential, but not intended to carry current in normal service

1.4.6

exposed conductive part

conductive part of electrical equipment that —

- (a) can be touched with the standard test finger; and
- (b) is not a live part but can become live if basic insulation fails

Note 1 to entry: The specification of the standard test finger is given in AS/NZS 3100.

Exception: The term “exposed conductive part” does not apply to any of the following:

- (a) *Conductive parts within an enclosure where the parts cannot be touched unless a key or a tool is required to remove the covers of the enclosure.*
- (b) *Conductive parts within electrical equipment where the parts cannot be touched in normal use and during the movement of the electrical equipment, because of its configuration and size.*
- (c) *Conductive parts that are effectively and permanently separated from live parts by—*
 - (i) *double insulation; or*
 - (ii) *other conductive parts that are earthed.*
- (d) *Conductive parts that are in the form of nameplates, screw heads, covers and similar attachments that cannot become live in the event of failure of insulation of live parts because of the manner in which they are supported and fixed.*
- (e) *A removable or hinged conductive panel fitted to a switchboard or other enclosure containing conductors that are so located and/or restrained that, in the event of any conductor becoming detached from a terminal or mounting, the conductor is incapable of making contact with the panel.*

1.4.7**ingress protection (IP) classification**

classification of degrees of protection provided by enclosures for electrical equipment

Note 1 to entry: Refer to AS 60529 for information and requirements on IP classification.

1.4.8**insulated**

separated from adjacent conducting material by a non-conducting substance or airspace permanently providing resistance to the passage of current, or to disruptive discharges through or over the surface of the substance or space, to obviate danger of shock or injurious leakage of current

1.4.9**isolated**

separated from all possible sources of electrical energy (supply) and rendered incapable of being energized unintentionally

1.4.10**isolation (isolating function)**

function intended to cut off the supply from the whole installation, or a discrete section of it, by separating it from every source of electrical energy for reasons of safety

1.4.11**known earth**

earth point previously tested to confirm that it is connected to the installation earthing system

1.4.12**reporting**

providing a record of the results of inspection and testing to other parties

1.4.13**shall**

indicates a statement is mandatory

1.4.14**should**

indicates a recommendation

1.4.15**testing**

use of test instruments or test equipment by a *competent person* ([1.4.1](#))

1.4.16**verification**

provision of objective evidence that a given item fulfils specified requirements

[SOURCE: ISO/IEC 17025:2017, 3.8]

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

1.4.17**visual inspection**

inspection of an electrical installation and/or electrical equipment using vision

1.5 Safety

1.5.1 General

Electrical inspection and testing inherently involves a degree of hazard and shall be undertaken by a competent person. It is the responsibility of the person performing the inspection and tests to ensure that safe practices are used in the performance of all inspection and testing procedures.

This Standard describes tests methods both for situations where the circuit under test is energized, and where it is not. Working safely on de-energized circuits requires that the circuit under test be isolated.

Tests where the circuit under test is isolated minimize the risk of electric shock; however, some types of test can only be performed with supply connected and energized.

1.5.2 Work health and safety

Before commencing inspection and testing, a site-specific risk assessment is required to identify risks and establish control methods.

NOTE The risk assessment and resulting control measures should consider the following:

- (a) The age and condition of the equipment being tested that may expose persons to additional hazards.
- (b) Requirements of the Regulatory Authorities for the jurisdiction before the commencement of testing.
- (c) The safe work practices in health and safety legislation and as outlined in AS/NZS 4836.
- (d) Safety procedures for each test are described in [Section 4](#), Testing installations.
- (e) Use of personal protective equipment (PPE) appropriate and suitable for the inspection and testing task.
- (f) Risk of wearing conductive body adornments and devices.

Section 2 Test equipment

2.1 Equipment required

The following test instruments are required to carry out all the tests detailed in this Standard:

- (a) Voltage indicator.
- (b) Volt meter.
- (c) Low range ohmmeter.
- (d) Insulation resistance test instrument.
- (e) Instrument for measuring fault-loop impedance.
- (f) Instrument or device for initiating the operation of a RCD.

NOTE 1 Measuring the operation time of the RCD is not required by this Standard.

These instruments may be individual instruments designed for conducting just one type of test; or multi-function instruments capable of conducting a range of tests.

Where a test instrument assesses results as “pass” or “fail”; it is crucial that the parameters are correctly set up.

NOTE 2 Instruments with multiple functionality are often referred to as “installation testers”. Such instruments often have additional functions not required for testing electrical work; but useful for other testing purposes, such as diagnosing faults.

NOTE 3 If there is no setting that exactly matches the pass/fail criterion stipulated for the particular test procedure; the nearest setting on the “fail” side should be used. This is to ensure that the instrument does not provide false “pass” results.

Regardless of which type(s) of instruments are chosen, the user shall —

- (i) understand the use and capabilities of the instrument for each type of test;
- (ii) ensure that the instrument meets the requirements specified in [Clause 2.2.1](#); and
- (iii) ensure that the instrument is correctly set up.

For some tests, additional equipment will be required. For example, the following:

- (A) Test leads and probes.
- (B) Trailing leads.
- (C) Means of making temporary connection to mass of earth.
- (D) A range of resistors of known value.
- (E) Portable independent sources providing a 50 Hz supply.

2.2 Selection of test equipment

2.2.1 Equipment requirements

2.2.1.1 General

All test equipment shall be suitable for its intended purpose; in accordance with [Clause 2.2.2](#); with regard to the environment in which it is intended to be used, e.g. damp or hazardous areas.



Documents

Document Sharing Hub

Measuring equipment (meters) shall comply with the relevant requirements of AS 61010.1 or the IEC 61557 series or an equivalent Standard.

See [Appendix A](#) for additional information for selecting and using test equipment.

2.2.1.2 Meter error

Meters shall have a maximum inherent error of —

- (a) *for mechanical analogue meters* — 5 % full scale deflection; or
- (b) *for digital meters (including digital-analogue)* — 5 % of the value being measured.

NOTE See [Appendix A](#) for additional information.

2.2.1.3 Voltage ratings

Meters and leads shall have an appropriate voltage rating for the circuit under test.

Meters shall have an ability to withstand impulse voltages in accordance with [Table 2.1](#).

Table 2.1 — Impulse voltage and typical use

Impulse-voltage Category	Circuit voltage	Suitable for	Examples
I	ELV	Measurements on circuits not directly connected to an LV source of supply	Battery powered circuits, ELV lighting
II	LV	Measurements on equipment directly connected to an LV installation	Appliances
III	LV	Measurements performed on an LV installation	Final subcircuits; distribution boards; submains
IV	LV	Measurements performed at the source of an LV installation	Consumer mains and main switchboards
NOTE 1 Category I meters are not suitable for testing LV installations.			
NOTE 2 See Appendix A for additional information.			

2.2.1.4 Safe selection and use

Meters and leads shall be selected and adjusted for the electrical quantity and parameters to be measured.

On energized circuits, incorrect selection, adjustment and/or placement of test probes can result in damage and injury from excessive –

- (a) voltage being applied to the equipment; or
- (b) currents, up to the prospective fault current, flowing through the meter and test leads.

2.2.2 Requirements for specific types of test equipment

2.2.2.1 Voltage indicator

Voltage indicators are required to perform the following functions to —

- (a) confirm that no hazardous voltage is present; and
- (b) confirm the presence of voltage.

Non-contact and single-contact voltage indicators shall not be relied on for proving that no hazardous voltage is present, and that the wiring or fittings have been de-energized and/or isolated to a safe state. A dual-contact voltage indicator is required for this function.

NOTE When using a voltage meter, low-impedance meters are preferred as they draw current from the circuit under test, reducing the effects from circuit anomalies, for example, those due to capacitive effects or external mutual inducted current. Analogue voltmeters are a low-impedance device, and some digital meters have a selectable low input impedance function.

2.2.2.2 Low range ohmmeter

The tests specified in this Standard require the ability to accurately measure low values of resistance. Test instruments have inherent errors. It is essential that these errors are only a small fraction of the maximum permitted value.

The meter shall be either —

- (a) an analogue type meter with a range having full scale deflection of the needle of no more than $2\ \Omega$; or
- (b) a digital type or electronic-analogue meter giving readings, in ohms, to at least 2 decimal places.

Most insulation resistance meters have a suitable range.

NOTE See [Appendix A](#) for additional information.

2.2.2.3 Instrument for measuring insulation resistance

The meter shall have a nominal open-circuit terminal voltage in accordance with the following:

- (a) *For measurements on ELV circuits — 250 V d.c.*
- (b) *For LV circuits up to and including 500 V — 500 V d.c.*
- (c) *For circuits above 500 V and not exceeding 1 000 V — 1 000 V d.c.*

The insulation resistance meter used shall be able to maintain its terminal voltage within +20 % and –10 % of the nominal open-circuit terminal voltage, when measuring a resistance of $1\ \text{M}\Omega$ on the 250 V and 500 V ranges, and $10\ \text{M}\Omega$ on the 1 000 V range.

2.2.2.4 Instrument for measuring fault-loop impedance

The following instruments are required:

- (a) For measuring the active conductor and protective earth conductor (R_{ph} and R_e) loop values of a de-energized circuit, a low range ohmmeter, as specified in [Clause 2.2.2.2](#), is required.
- (b) For measuring earth fault-loop impedance on an energized circuit, an earth fault-loop impedance meter is required.

NOTE This type of meter can also be used for a number of other functions, including locating high-impedance faults in circuits, and verifying the prospective short-circuit current and prospective earth fault current.

2.2.2.5 Equipment for confirming correct operation of RCDs

The test equipment shall be capable of performing the following three functions:

- (a) Confirming the RCD has been correctly connected. This requires use of voltage and/or continuity test equipment.

- (b) Initiating operation of the RCD, by applying an appropriate residual current through the RCD sensing coil. This requires that the RCD be energized and a suitable residual current be applied. The value of the residual current shall be at least the RCD's rated residual current, and should not exceed 120 % of that value.

NOTE 1 A portable independent source providing 50 Hz supply will be needed for testing RCDs where normal supply is not available. See [Clause 2.2.2.6](#).

- (c) Confirming that operation of the RCD results in disconnection of the circuit(s) intended to be protected by the RCD. This requires the use of a dual-contact voltage indicator and/or ohmmeter.

NOTE 2 Testing advice of the RCD manufacturer should be followed.

NOTE 3 See [Appendix A](#) for additional information.

2.2.2.6 Portable independent source providing 50 Hz supply

The purpose of this equipment is to enable testing of RCDs in cases where normal supply is not available.

Suitable sources include —

- (a) a motor-generator set; or
(b) a battery-powered inverter with a nominally “pure sine wave” output.

The output of the source shall be sufficient to supply the required test current without causing voltage to drop.

NOTE Refer to [Appendix A](#) for additional information.

2.2.2.7 Test leads and probes

Test leads and probes shall be rated for the maximum voltage they are to be connected to.

Probes for making contact with live parts shall be suitable for the intended purpose and shrouding of the probes may be required.

Testing of multi-phase RCDs may be facilitated by use of a special test lead with a phase selection switch.

2.2.2.8 Trailing lead

Any suitable length of insulated conductor may be used. A dedicated lead, kept on a suitable reel, is recommended. The lead's conductor should be a flexible type, e.g. appliance wire.

For earth continuity testing, the resistance of the lead shall be known. The value should be recorded.

For confirming no hazardous voltage is present on earth-referenced systems; the lead should have a suitable terminal or clip to permit easy connection to the independent earth spike (see [Clause 2.2.2.9](#)).

NOTE Refer to [Appendix A](#) for additional information.

2.2.2.9 Means of making temporary connection to mass of earth

A suitable means is a metal spike capable of penetrating 150 mm into the ground and provided with a suitable means of connection for a test lead.

2.2.2.10 Resistors

Resistors, for checking polarity and phase rotation, should be selected such that —

- (a) each resistor is a different value; and
- (b) no combination of resistor values adds up to the value of any other resistor or combination.

Resistors for conducting routine checks of instrument accuracy should be selected to approximate typical values.

Resistors marked as having 5 % tolerance are preferred over those having 10 % tolerance.

NOTE Refer to [Appendix A](#) for additional information.

2.3 Test equipment checks

2.3.1 Basic functional checks before each use

Before carrying out any test the equipment should be checked to ensure that it is correctly set, functional and in good condition.

Contact probes and leads should be checked for damage to insulated parts, continuity and sound connections.

After each test, or group of tests, the pre-test checks should be undertaken again. This will confirm that the equipment has not developed a fault during the testing.

In summary, the process is:

PROVE operation of equipment → TEST circuit → PROVE operation of equipment

NOTE [Appendix A](#) provides guidance on pre-use checks for particular types of test equipment.

2.3.2 Periodic checks of accuracy

All test equipment shall be checked regularly, and particularly after extended periods of storage, to ensure that it remains operational and safe, and that internal batteries are adequately charged.

The interval between checks should be determined by the frequency of use. The interval shall not exceed 12 months.

Instrument accuracy may be confirmed by checking —

- (a) against a range of resistors of known values; or
- (b) against a circuit of known characteristics.

NOTE [Appendix A](#) includes guidance on periodic checks for particular types of test equipment.

2.3.3 Calibration

Full calibration by a test laboratory should be undertaken if routine checks indicate significant error in accuracy.

Laboratories that perform calibration tests outlined in this Standard shall meet the requirements of AS ISO/IEC 17025.

Section 3 Visual inspection

3.1 General

A visual inspection shall be performed when work on an electrical installation has been completed in order to verify that the work complies with the applicable requirements.

The visual inspection shall be carried out before, or in association with testing. Visual inspection should, where practicable, be completed before the relevant part of the electrical installation is placed in service.

Where the visual inspection of a part of the electrical installation is not practicable at the completion of the work, e.g. not accessible due to enclosure in the building structure, consideration should be given to inspecting that part during the course of the installation.

3.2 Safety requirements — Before visual inspection

Before the inspection, a risk assessment shall be undertaken to identify hazards and risks and establish the need for —

- (a) appropriate PPE;
- (b) appropriate equipment; and
- (c) safe access, where required.

NOTE Refer to AS/NZS 4836 for further guidance.

3.3 Check list

This clause provides a guide to the matters to be checked during the visual inspection.

The lists below are representative of items in an electrical installation that are the subject of visual inspection. They include but are not limited to the following:

- (a) *General:*
 - (i) Basic protection (protection against direct contact with live parts), e.g. insulation and enclosure.
 - (ii) Fault protection (protection against indirect contact with exposed conductive parts), e.g. by the use of automatic disconnection of supply, double insulation or isolating transformers.
 - (iii) Protection against hazardous parts, e.g. enclosure, guarding or screening of flammable materials, hot surfaces and parts that may cause physical injury.
 - (iv) Protection against spread of fire, e.g. penetration of fire barriers.
 - (v) General condition of the electrical equipment, e.g. signs of damage that could impair safe operation, disconnection of unused electrical equipment.
- (b) *Consumer mains:*
 - (i) Consumer mains wiring conductors shall be clearly identified to indicate their intended function.
 - (ii) Installation wiring systems conditions, e.g. underground systems — enclosure, depth of burial, mechanical protection. Aerial systems — mechanical protection, cables likely to be disturbed, support systems.

- (iii) Connection of wiring.
 - (iv) Protection against external influences.
 - (v) Arrangement.
- (c) *Switchboards:*
- (i) Location, e.g. access and egress.
 - (ii) Protective devices, e.g. selection and setting of adjustable protective devices for compliance with overcurrent protection, arc fault protection and discrimination requirements.
 - (iii) Isolating devices, e.g. main switches.
 - (iv) Connecting devices, e.g. neutral bars, earth bars and active links.
 - (v) Connection and fixing of wiring and switchgear.
 - (vi) Identification and labelling of electrical equipment.
 - (vii) Protection against external influences.
 - (viii) Construction (refer to applicable Standards).
 - (ix) Correct RCDs installed or alternate protection method.
- (d) *Wiring systems:*
- (i) Conductor size — coordination with protective devices.
 - (ii) Identification of cable cores.
 - (iii) Adequate support and fixing.
 - (iv) Connections and enclosures.
 - (v) Particular installation conditions, e.g. underground, aerial, safety services.
 - (vi) Segregation from other services and electrical installations.
 - (vii) Protection against external influences, e.g. enclosure.
- (e) *Electrical equipment:*
- (i) Isolation and switching devices for protection against injury from mechanical movement devices and motors.
 - (ii) Isolation and switching devices for protection against thermal effects, e.g. motors, room heaters, water heaters.
 - (iii) Switching devices for particular electrical equipment, e.g. socket-outlets, water heaters, etc.
 - (iv) Particular installation conditions, e.g. locations affected by water, explosive atmospheres, extra-low voltage, high voltage.
 - (v) Conformance with applicable Standards and the additional requirements as specified in the manufacturers' instructions.
 - (vi) Connection, support and fixing.

- (vii) Protection against external influences including ingress of moisture (IP rating) where required by any clause.
- (viii) Suitability for intended voltage, current and frequency.
- (f) *Earthing:*
 - (i) MEN (TN-C-S) connection (link).
 - (ii) Earth electrode.
 - (iii) Earthing conductors, e.g. size, identification.
 - (iv) Equipotential bonding conductors; e.g. size, identification.
 - (v) Connections, joints and terminations.
 - (vi) Protection against external influences.
 - (vii) Connection to earthing arrangements for other systems.
 - (viii) Creation of earthed situation that may require earthing of additional electrical equipment.

Section 4 Testing installations

4.1 General requirements

This Section provides the considerations, requirements, results and processes for the tests being conducted.

After completion of, or in association with, the visual inspection, tests shall be carried out in accordance with this Standard on the electrical installation to verify that it complies with the requirements of applicable Standards and that it is suitable for the use intended.

Testing shall be carried out in such a manner that the safety of the operator, other people in the vicinity, the installation being tested and test equipment are not placed at risk.

The test methods set out in this Standard are common test methods. Other methods are not precluded, provided that they give equally valid results.

Electrical installations can be configured in a variety of ways. The figures in this section show test methods as applied to typical installations. Minor variations may be needed to apply the same test procedure to an installation with a different configuration.

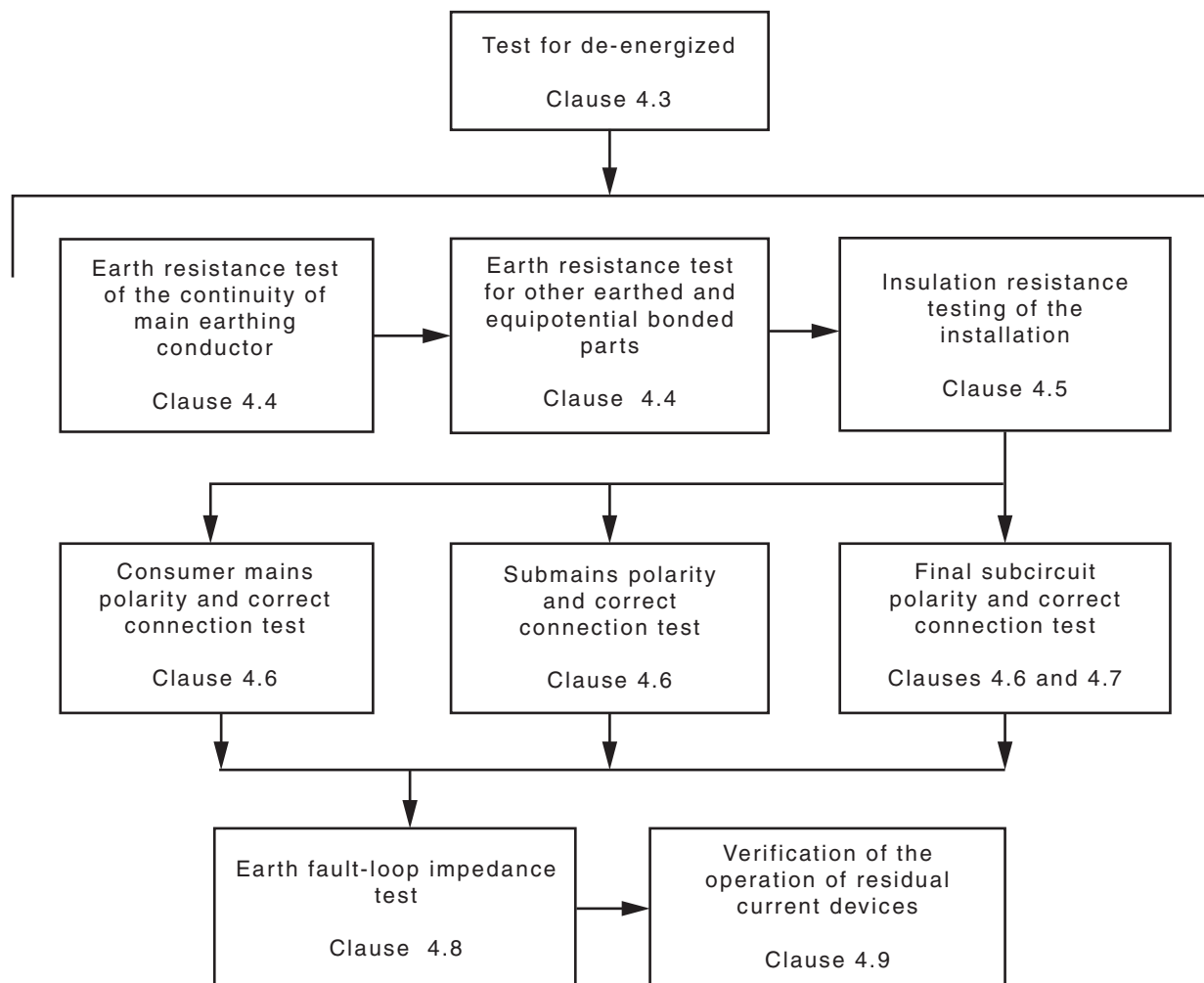
NOTE Placement of test probes may vary depending on the specific configuration of the circuit, particularly circuit protection devices.

4.2 Verification tests

4.2.1 Sequence of tests

[Figure 4.1](#) shows a preferred sequence for testing electrical installation work.

NOTE The order in which the various tests are carried out matters, because a fault found by a later test may have caused a misleading result in a different type of test carried out previously. For example, insulation resistance tests between live parts and earth cannot be relied on unless the integrity of the earthing system has first been proven.



NOTE The sequence of tests shown in this figure is recommended. Tests performed out of sequence may result in invalid results for subsequent tests.

Figure 4.1 — Sequence of verification tests

4.2.2 Test failures

If any part of the electrical installation fails a test, that test and any preceding tests that may have been influenced by the fault indicated shall be repeated after the fault has been rectified.

4.3 Test for de-energized

4.3.1 General

Before any electrical testing can be undertaken, the presence of any voltage shall be identified.

Irrespective of the type of tests (continuity, insulation resistance) being performed, a test to confirm whether any voltage is present on the circuit(s) under test shall be performed before any further actions.

Particular care is required where there may be multiple sources, for example:

- (a) Alternative or supplementary supplies.
- (b) Circuits with multiple switching paths.

Confirming the absence of supply voltage on active conductors is not sufficient.

WARNING: ALL ELECTRICAL CONDUCTORS, INCLUDING EARTHING CONDUCTORS, SHALL BE TREATED AS ENERGIZED UNTIL PROVEN DE-ENERGIZED.

NOTE 1 Even when all normal, alternative, and supplementary supplies to an installation have been isolated; faults in the supply network, or within another installation, can result in hazardous voltages being present. Common examples include the following:

- (i) Incorrect polarity of the incoming supply, resulting in the installation's earthing system being energized and isolation devices being ineffective.
- (ii) Faulty connections in PEN conductors of other installations supplied from same source, resulting in load current of the other installation being carried by the installation's earthing system and supply neutral.

NOTE 2 Caution is needed when disconnecting an MEN link or connections of the main earthing conductor, in case either is carrying current.

NOTE 3 Capacitive or induced voltage could influence test results.

4.3.2 Considerations

The correct selection of the type of voltage indicator and its operating condition to indicate the presence of voltage shall be verified before any testing is performed.

The test instrument shall be confirmed to be in a serviceable condition, safe to use and its operational settings understood by the person performing the test.

NOTE HB 187 provides an industry reference to assist in meter selection and use.

4.3.3 Requirements

Testing shall be carried out to ensure that all sources of supply have been isolated.

4.3.4 Results

The electrical installation shall be proven to be de-energized so work can progress safely.

4.3.5 Test procedure — Confirming isolation

4.3.5.1 Preparation

The immediate area and environment shall be assessed for the safety of personnel performing the tests.

Adequate lighting and free movement are essential when performing LV testing. Risk control methods established through the site risk assessment shall be followed.

4.3.5.2 Testing for de-energized

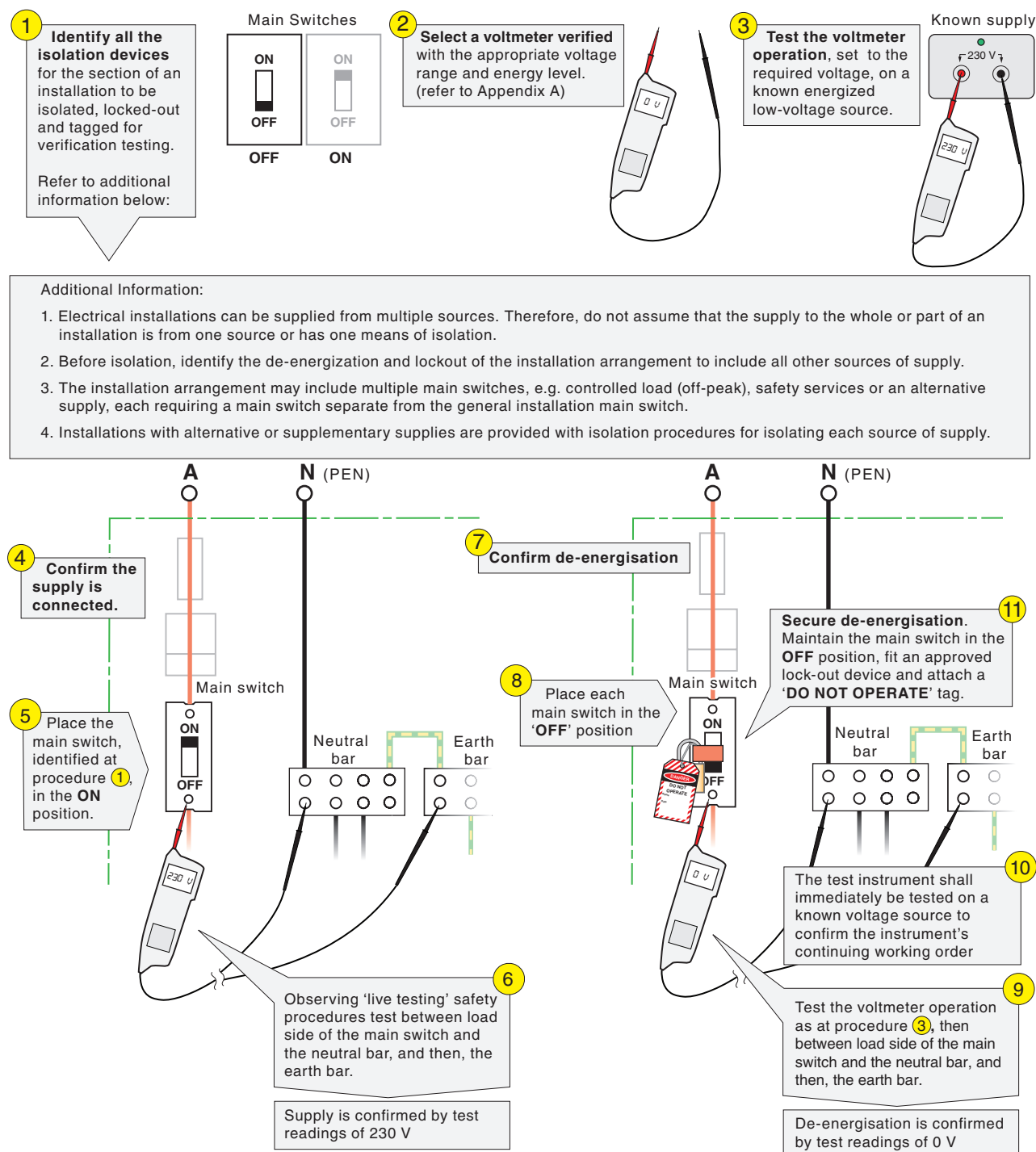
Testing for de-energized shall be undertaken as follows:

- (a) The test instrument shall be checked immediately before testing on a known voltage source to ensure operational condition.
- (b) Testing shall be performed (see [Figure 4.2](#)).
- (c) The test instrument shall immediately be tested on a known voltage source to confirm the instrument's continuing working order.

NOTE The confirmation of the instrument's ability to indicate voltage after the de-energized state is confirmed may require an alternative power supply.

4.3.5.3 Isolation

Where there is a requirement for continued de-energization, ensure the isolation device for each possible source is locked out and tagged or physically separated from the supply equipment so that the circuits under test cannot be energized unintentionally. See [Figure 4.2](#).



NOTE Numbers indicate the sequence of safety preparation, test preparation, tests and compliant results and reinstatement after completion.

Figure 4.2 — Confirm and secure isolation of energized installation

4.4 Earth continuity and resistance

4.4.1 General

Testing to prove the continuity of the earthing system (earth resistance of the main earthing conductor, protective earthing conductors, combined protective earthing and neutral (PEN) conductors and bonding conductors) shall be carried out to ensure that the earthing system has been installed in a manner that will cause circuit protective devices to operate if there is a fault between live parts, other than the neutral, and the mass of earth.

An effective earthing system will ensure that exposed conductive parts of electrical equipment do not reach dangerous voltages when such faults occur.

Where the touch potential exceeds 50 V a.c or 120 V ripple-free d.c., the circuit-protective device shall cause disconnection of supply within the required time.

4.4.2 Considerations

In some situations, such as the connection of equipotential bonding conductors to water piping or swimming pools, the terminations of conductors may not be accessible due to further building activities or enclosure.

If this is expected to occur, testing at the termination should be carried out at the time of initial connection or other convenient time when the termination is still accessible.

Where this is not practicable, the inaccessible connection may be proven by testing at a more convenient point on the parts which are to be earthed or bonded by the conductor.

NOTE 1 Where there is a possibility of a parallel connection between a protective earthing conductor and other conductive parts, e.g. a water heater, the protective earthing conductor may be disconnected from the electrical device and tested independently.

NOTE 2 [Tables 4.5](#) and [4.6](#) of this document are for miniature circuit breakers only. Where other than miniature circuit breakers are used as the protection device, the manufacturer's data shall be consulted to obtain the value of current (I_a) for calculating the resistance of the protective earthing conductor.

4.4.3 Requirements

Testing to prove the continuity of the earthing system includes the following:

- (a) Earth resistance of the main earthing conductor.
- (b) Protective earthing conductors.
- (c) Bonding conductors.

Where a PEN submain is installed to supply a separate MEN installation in an individual outbuilding, testing shall confirm that the earth terminal, point or bar of the sub-board is connected via the PEN conductor to the earth terminal, point or bar of the main switchboard.

The earthing system in a separate MEN installation shall be connected to the submain neutral conductor supplying the outbuilding. In this case, the submain neutral conductor supplying the outbuilding is a combined protective earthing and neutral (PEN) conductor.

4.4.4 Results

The resistance of protective earthing conductors shall be —

- (a) low enough to permit the passage of current necessary to operate the overcurrent protective device; and

(b) consistent with the length, cross-sectional area and type of conductor material.

The resistance of the main earthing conductor or any equipotential bonding conductor shall be not more than 0.5 Ω .

The resistance of the combined protective earthing and neutral (PEN) shall be low enough to permit the passage of current necessary to operate the circuit protective device.

NOTE 1 As described in [Clause 4.8](#) (EFLI), the maximum allowable resistance of the protective earthing conductor associated with any particular circuit depends on the type and rating of the protective device and the impedance of the live conductors that comprise the circuit in which the fault occurs.

NOTE 2 Maximum resistance values (R_e) for earthing conductors related to size of conductor and rating of R_e for earthing conductors are given in AS/NZS 3000 as a function of the rating of the associated overcurrent protective device. These values may be used when testing for earth continuity.

4.4.5 Procedures

4.4.5.1 Figures

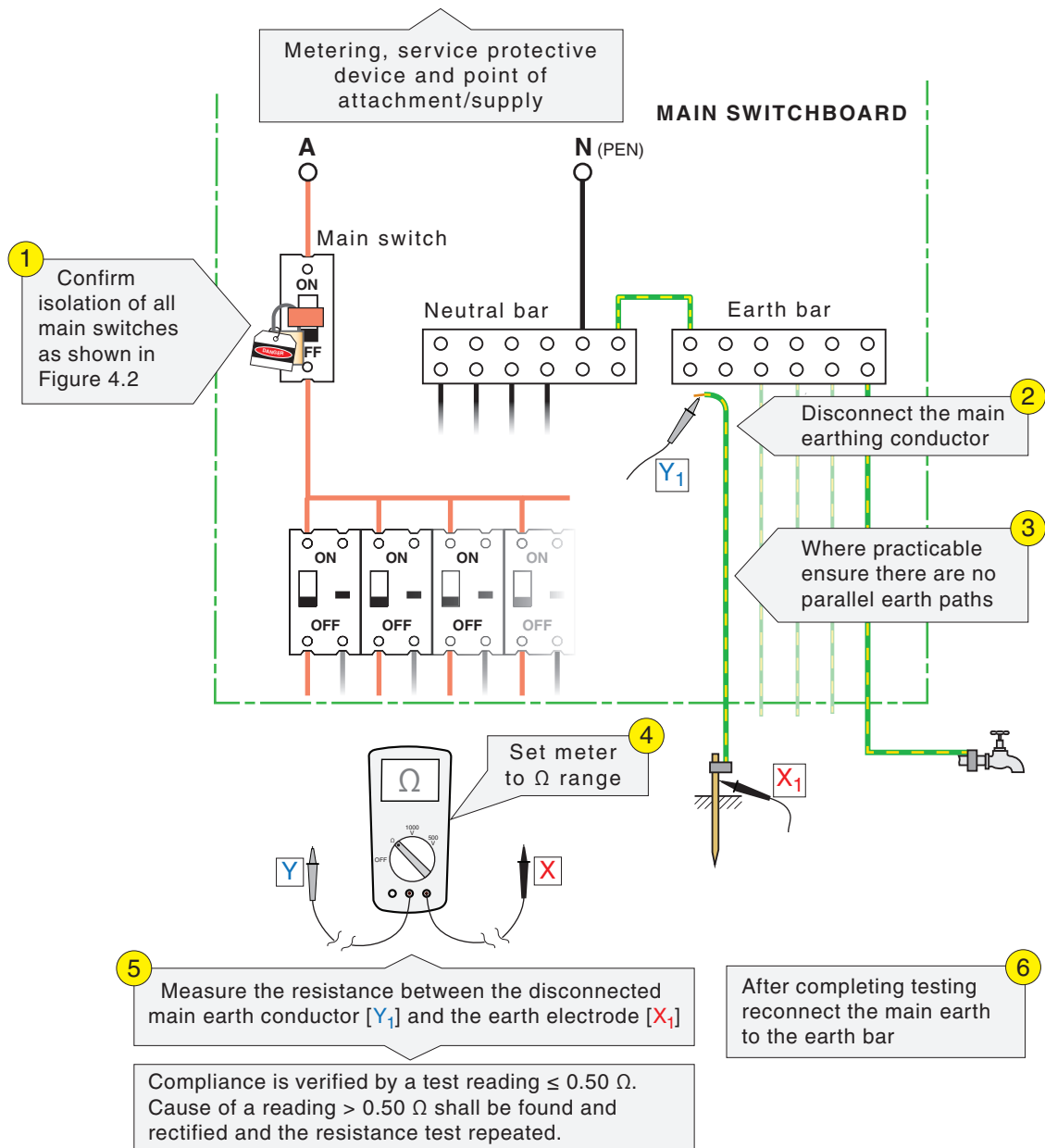
Tests for earth continuity and resistance are shown in [Table 4.1](#).

Table 4.1 — Earth continuity and resistance tests

Figure no.	Figure title
Figure 4.3	Resistance test of main earthing conductor – Installation isolated
Figure 4.4	Resistance test for protective earthing and equipotential bonding conductors — Circuit(s) isolated

4.4.5.2 Main earthing conductor

[Figure 4.3](#) shows a method of testing the continuity and resistance of the main earthing conductor.



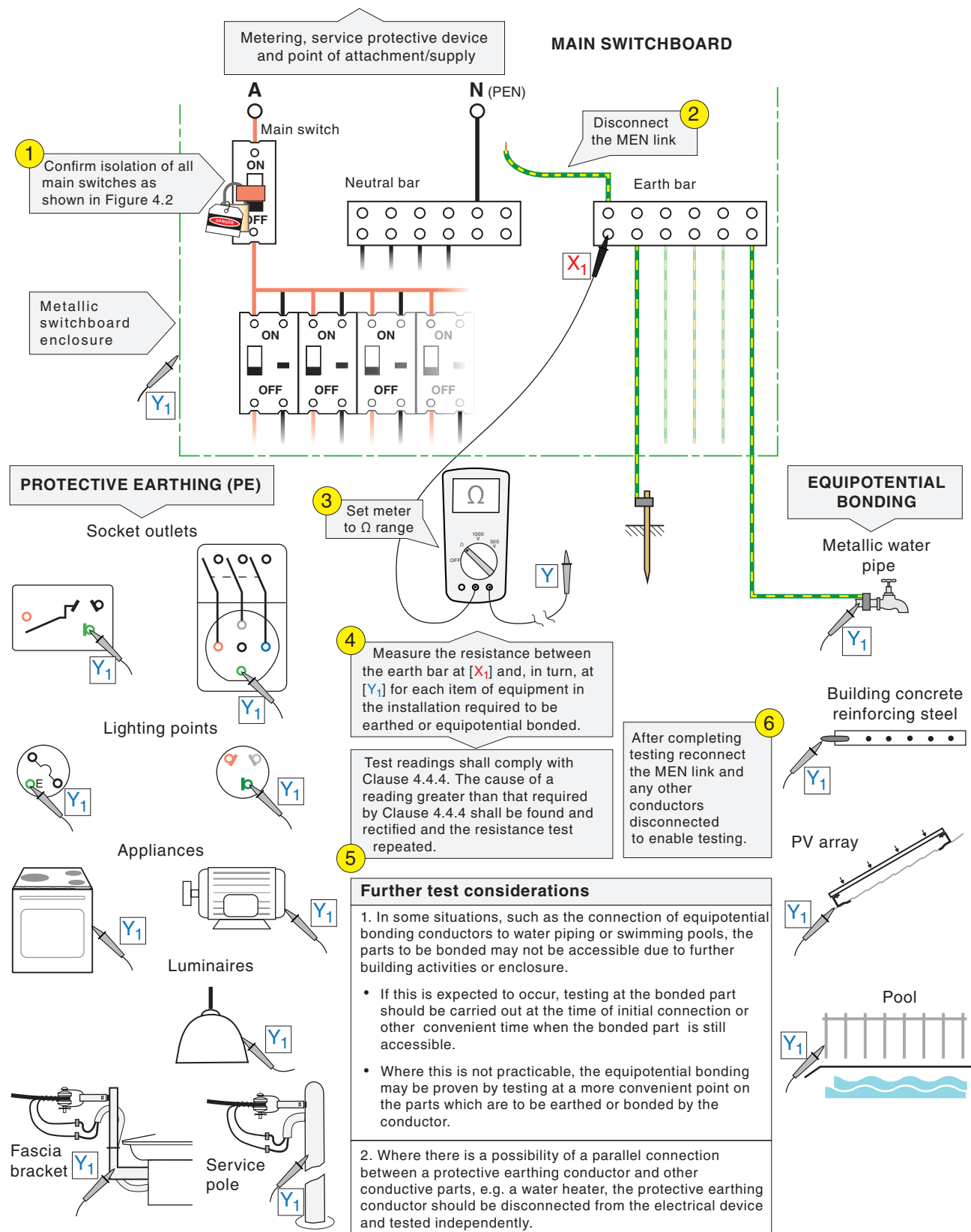
NOTE 1 Numbers indicate the sequence of safety preparation, test preparation, tests and compliant results and reinstatement after completion.

NOTE 2 When a trailing lead is used, the resistance of the trailing lead shall be considered.

Figure 4.3 — Resistance test of main earthing conductor — Installation isolated

4.4.5.3 Protective earthing and equipotential bonding conductors

[Figure 4.4](#) shows a method of testing the continuity and resistance of earthing and bonding conductors.



NOTE Numbers indicate the sequence of safety preparation, test preparation, tests and compliant results and reinstatement after completion.

Figure 4.4 — Resistance test for protective earthing and equipotential bonding conductors — Circuit(s) isolated

4.5 Insulation resistance

4.5.1 General

Insulation resistance testing shall be carried out to ensure that the insulation resistance between all live conductors and earth or, as the case may be, all live parts and earth, is adequate to ensure the integrity of the insulation. This testing is to prevent —

- (a) electric shock hazards from inadvertent contact;
- (b) fire hazards from short-circuits; and
- (c) equipment damage.

In addition, an insulation resistance test between all conductors is necessary for consumer mains and submains to minimize risk of injury or property damage because of insulation breakdown.

4.5.2 Considerations

The following matters shall be considered:

- (a) Care needs to be taken to ensure that the test equipment is not connected to energized parts. In most cases, main switches, circuit-breakers, residual current devices and fuses can be opened to isolate circuits.
- (b) Some connected equipment may be damaged by overvoltage. Manufacturer's instructions should be referred to. Examples include EMC filters, surge protection devices, and electronic equipment. Damage may be avoided by —
 - (i) connecting the live (active and neutral) conductors together and testing between all live conductors and earth; or
 - (ii) testing the equipment with a test voltage of 250 V.
- (c) Equipment connected to the circuit(s) under test may cause an unacceptably low result, so should be disconnected and tested separately. Examples include the following:
 - (i) Equipment connected to consumer mains; such as revenue metering or load control equipment.
 - (ii) Connections between neutral conductors and the earthing system; such as the incoming neutral of consumer mains, the installation's MEN link, outbuildings with neutral-earth (N-E) connections, and polarity sensing devices.
 - (iii) Equipment with functional earthing; such as some types of RCD
 - (iv) Sheathed heating elements.

NOTE For some equipment a different minimum insulation resistance may apply.
- (d) For final sub-circuits with separate neutral and protective earthing conductors, tests for insulation resistance to earth may be carried out either between earth and individual live conductors, or between earth and live conductors connected together.
- (e) All switch positions/combinations shall be tested, for example 2-way, intermediate and change-over switching configurations.
- (f) Parts of circuits on the load side of switching devices such as contactors and control devices shall be tested. This may require either testing those parts separately, or using bridging connections across the switching devices.

- (g) If the insulation resistance test is not satisfactory, earth continuity and resistance tests may need to be repeated after the fault is rectified.

4.5.3 Requirements

4.5.3.1 Preparation

All circuits, including consumer mains, sub-mains and final sub-circuits shall be proven de-energized and isolated before they are tested.

Testing shall be carried out with the neutral conductor(s) of the circuit(s) under test disconnected from the MEN system. Where applicable —

- (a) consumer mains shall not be connected to the distribution neutral conductor, and the installation MEN link shall be removed
- (b) outbuildings or other distribution boards that have additional MEN or N-E connections, such connections shall be disconnected before conducting the test.

Where an earth sheath return system is used, the neutral conductor shall not be connected to any active conductor for the purpose of the insulation resistance test.

If earthing arrangements for functional purposes are provided as part of the electrical installation, any connections to the protective earthing arrangement should be disconnected for the duration of this test.

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

4.5.3.2 Testing

The integrity of the insulation is stressed by applying a direct current at 500 V for low voltage circuits.

Exception 1: Where equipment, such as electromagnetic compatibility (EMC) filters, equipment containing surge protective devices connected to earth, or electronic equipment, is likely to be damaged by the test. Such equipment may be disconnected or switched off before carrying out the insulation resistance test on the circuit; or the test voltage for the particular circuit may be reduced to 250 V d.c. The insulation resistance test is performed between —

- (a) *each live conductor and each other live conductor of consumers mains and submains; and*
- (b) *all live (active and neutral) conductors and earth for consumers mains, submains and final sub-circuits; and*
- (c) *all live (active and neutral) conductive parts and earthed parts (earthing system) of equipment connected to the installation.*

Exception 2: Where connected equipment such as sheathed heating elements of appliances or an RCD with an FE connection is likely to influence the test, the equipment may be disconnected before carrying out the insulation resistance test on the circuit, and the equipment tested separately.

4.5.4 Results

The insulation resistance shall be not less than 1 MΩ.

Exception: Acceptable insulation resistance values for items likely to adversely affect test results are as follows:

- (a) *For sheathed heating elements of appliances, not less than 0.01 MΩ.*
- (b) *A value permitted in the Standard applicable to the electrical equipment.*

- (c) *For functional earth connections of RCD, not less than 0.05 MΩ, or as prescribed by the manufacturer.*

NOTE 1 For shorter cable runs, the insulation resistance should be significantly greater than 1 MΩ, e.g. for polymeric insulated cables up to 50 m a value in excess of 50 MΩ would be expected.

NOTE 2 Insulation resistance varies with insulation materials, and decreases with increased length and/or higher temperature.

NOTE 3 PVC insulated cables with a route length of 50 m can be expected to have insulation resistances of at least 20 MΩ at a temperature not exceeding 20 °C but only 6 MΩ at a temperature of 30 °C.

NOTE 4 XLPE insulated cables can be expected to have insulation resistance of at least 1500 MΩ for a route length of 50 m.

NOTE 5 The relevant regulatory authority or electricity distributor should be consulted regarding acceptable minimum insulation resistance values.

4.5.5 Procedures

4.5.5.1 Figures

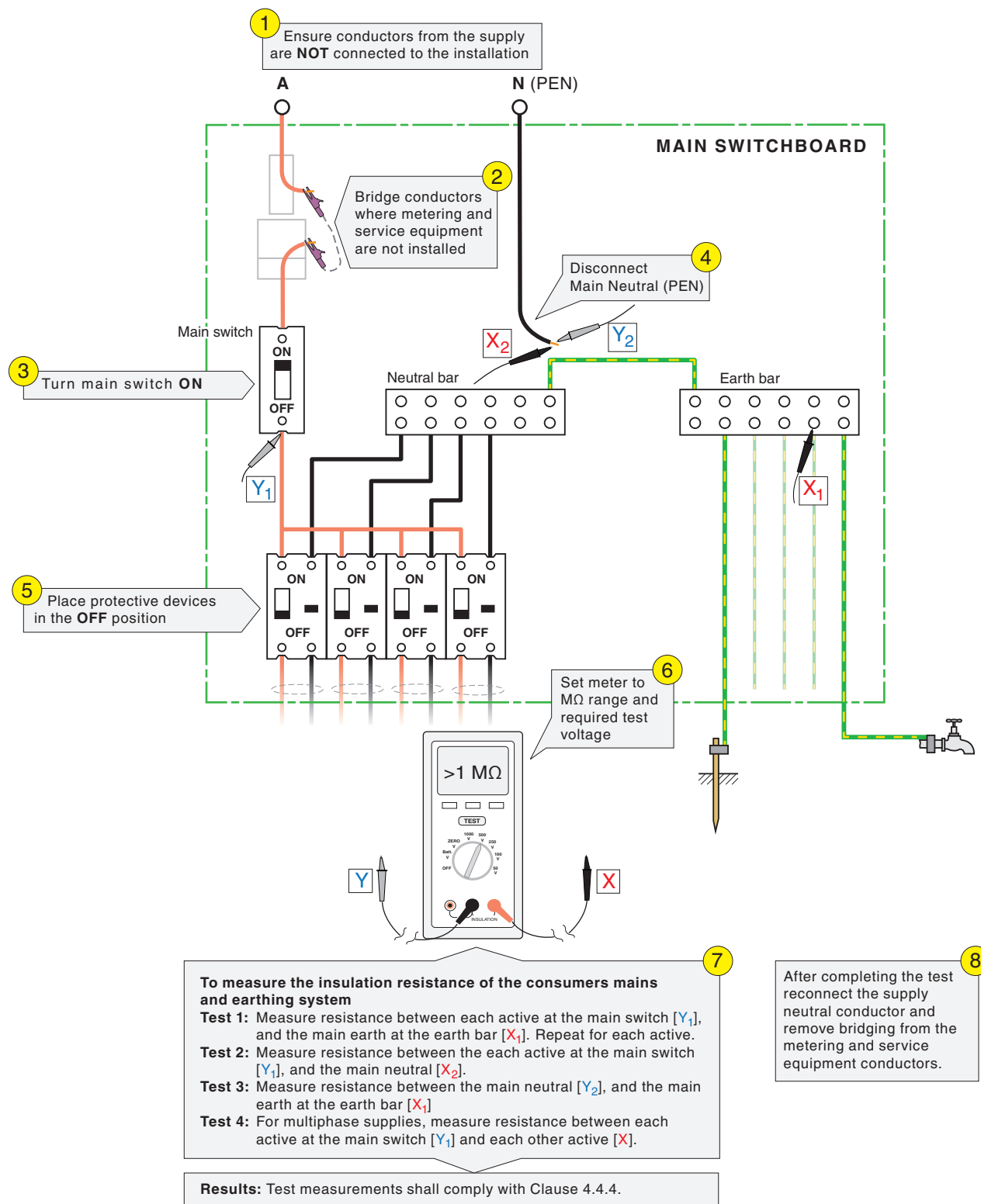
Tests for insulation resistance are shown in [Table 4.2](#).

Table 4.2 — Insulation resistance tests

Figure no.	Figure title
Figure 4.5	Insulation resistance test of consumer mains — Installation not connected to supply
Figure 4.6	Insulation resistance test of a submain or final subcircuit — Circuit isolated

4.5.5.2 Insulation resistance test of consumer mains

[Figure 4.5](#) shows a method of testing the insulation resistance of consumer mains when supply is not connected to the installation.



NOTE Numbers indicate the sequence of safety preparation, test preparation, tests and compliant results and reinstatement after completion.

Figure 4.5 — Insulation resistance test of consumer mains — Installation not connected to supply