When may an authorised officer enter an installation for the purpose of electrical inspection?

An **authorised officer may**, at any reasonable time, **enter** any place that the ... (a) **inspect** and test any **electrical** article or gas appliance or prototype of an **electrical** article or a gas appliance

2.May an authorised office insist that an authorised electrician show prove of their credentials?…….Yes

3.An authorised officer may require that anyone doing electrical work must prove that they are ……. ……. from doing electrical work by the Home Building act.
Competent / Fit and Proper person

4.With the written authority of the Director-General, an authorised officer may……. the place, …….. any documents and make copies of them or take extracts from them, if it is believed that documentary evidence relating to an installation exist in that place.

Enter, seize

5.May an authorised officer obtain a search warrant if required? ……..
Yes

6.A person must carry out electrical installation work in accordance with:-
……
……AS3000/ NSW Electrical Service Rule

7.The penalty for a second or subsequent offence by an individual carrying out electrical work that does not comply with the standards is
……
,7500 **penalty** units for a **second** or **subsequent offence**.

8.An owner or occupier of an electrical installation must ensure that the electrical installation is …… in accordance with the …… while the electrical installation remains connected to a source supply of electricity

cf 1946 No 13, s 29)

(1) A responsible person for an electrical installation in a place must, to the best of the person's ability and knowledge, ensure that such parts of the electrical installation as may be prescribed by the regulations are maintained in accordance with the regulations while the electrical installation remains connected to the source of the supply of electricity.

Electricity (Consumer Safety) Regulation 2006

Does this regulation cover generation and distribution of electricity?
No

Section 32 of the regulations sets out the …… and ……that were prescribed in section 31 (1) of the Act.
32 Standards and requirements for electrical installation work:
section 31 (1) of Act 22

What electrical installations or part installations may not be energised unless the service provider authorises it?
Clause 32
An electrical installation, or part of an electrical installation, must not be energised unless its safe operation and compliance with the Australian/New Zealand Wiring Rules have been established by a safety and compliance test.

Electrical installation work is required to be carried out in accordance with the……. and must also have regard for the …… …… ……
Electrical installation work is required to be carried out in accordance with the Australian/New Zealand Wiring Rules.
Note. Persons carrying out electrical installation work on electrical installations connected, or intended for connection, to a distribution system within the meaning of the *Electricity Supply Act 1995* should also have regard to the *New South Wales Service and Installation Rules* published by the Department of Energy, Utilities and Sustainability from time to time.

5.An electrical installation, or part of an electrical installation, must not be energised unless it's …… …… and …….. with the Australian/New Zealand Wiring Rules have been established by a ……and …….. test.

An electrical installation, or part of an electrical installation, must not be energised unless its safe operation and compliance with the Australian/New Zealand Wiring Rules have been established by a safety and compliance test.

6.A …….. electrical installation must not be energised unless the stand-alone power system to which it is to be connected complies with the requirements for such systems specified by the Australian Standard entitled AS 4509:1999*, Stand-alone power systems*, as in force from time to time,published by Standards Australia

A free-standing electrical installation must not be energised unless the stand-alone power system to which it is to be connected complies with the requirements for such systems specified by the Australian Standard entitled AS 4509:1999, *Stand-alone power systems*, as in force from time to time, published by Standards Australia.

7.Who may complete the required safety and compliance test on electrical installation?

……

33 Conduct of safety and compliance tests

(1) A safety and compliance test on electrical installation work on an electrical installation, or part of an electrical installation, must be carried out by a qualified person in accordance with the requirements of this clause after the completion of the work.

8.When must the safety and compliance test be completed?

……

Notification of results of safety and compliance tests

(1) **Notices relating to network connected electrical installations**

As soon as is reasonably practicable (but in any event no later than 14 days) after the completion of any safety and compliance test on an electrical installation, the results of the test are to be notified as follows:

(a) to the owner of the installation,

(b) in relation to an electrical installation that is connected, or is intended to be connected, to the distribution system of a distribution network service provider—to the distribution network service provider, but only if the electrical installation work concerned involves:

(i) a new electrical installation, or

(ii) any alterations or additions to an existing electrical installation that will require additional work to be done by or on behalf of the provider in relation to the network connection or metering arrangements for the installation, or

(iii) work on a switchboard or associated electrical

9.List the minimum tests that must be completed as part of the safety and compliance test of part or all of an installation.

(a)……

……

(b)……

……

(c)……

……

(d)……

A safety and compliance test on electrical installation work must verify that the work complies with the requirements of the Australian/New Zealand Wiring Rules, including in relation to (but not limited to) the following:

(a) continuity of the earthing system,

(b) insulation resistance,

(c) polarity,

(d) circuit connections.

10.What must be inspected as part of a safety compliance test?

……

(3) A safety and compliance test on electrical installation work must:
(a) include an inspection of switchboards and any other electrical equipment that is required by the Australian/New Zealand Wiring Rules, and
(b) ensure that the electrical equipment used is designed to enable the electrical installation concerned to function for the use intended.

11.The tester / inspector must ensure that the electrical equipment used is designed to enable the electrical installation concerned to:-

……

ensure that the electrical equipment used is designed to enable the electrical installation concerned to function for the use intended.

12……. …… ……., installed or replaced as part of electrical installation work, must be tested in accordance with the Australian/New Zealand Wiring Rules to determine whether they comply with the requirements of those Rules for such devices

All electrical wiring and equipment

13.Completion of the safety and compliance test must be notified within…… days.

14

14.Who must be notified of the completion of the compliance test for a building connected to the grid:-

a)……

b)……

c)……

34 Notification of results of safety and compliance tests

(1) **Notices relating to network connected electrical installations**

As soon as is reasonably practicable (but in any event no later than 14 days) after the completion of any safety and compliance test on an electrical installation, the results of the test are to be notified as follows:
(a) to the owner of the installation,
(b) in relation to an electrical installation that is connected, or is intended to be connected, to the distribution system of a distribution network service provider—to the distribution network service provider, but only if the electrical installation work concerned involves:
(i) a new electrical installation, or

(ii) any alterations or additions to an existing electrical installation that will require additional work to be done by or on behalf of the provider in relation to the network connection or metering arrangements for the installation,
or
(iii) work on a switchboard or associated electrical equipment (other than work to repair or replace equipment that does not alter the electrical loading, method of electrical protection, system of earthing or physical location of the switchboard or equipment being repaired or replaced)

15.Is it necessary to notify if the work is only replacement of existing faulty accessories? ……..
No

(iii) work on a switchboard or associated electrical equipment (other than work to repair or replace equipment that does not alter the electrical loading, method of electrical protection, system of earthing or physical location of the switchboard or equipment being repaired or replaced),

16.Is it necessary to notify if the work involves one additional circuit added to adistribution board? ……..
Yes
(iii) work on a switchboard or associated electrical equipment (other than work to repair or replace equipment that does not alter the electrical loading, method of electrical protection, system of earthing or physical location of the switchboard or equipment being repaired or replaced),

17.Who must be notified of the completion of the compliance test for an installation connected to a stand-alone power system:-

a)……

b)……

c)……
(c) in the case where the electrical installation work concerned involves the connection of the installation to a stand-alone power system—to the Director-General.

18.The notice must be in a form approved by the Director General and :-
……
……
Content of notice
The notice must:
(a) be in the form approved by the Director-General from time to time, and
(b) describe the electrical installation work done and identify the electrical installation concerned, and

19.The notice must specify:-

(i) ……

(ii) ……

(d) ……

(e) ……
specify:
(i) the name and authority number of each person who carried out, or supervised the carrying out of, the electrical installation work concerned, and
(ii) if applicable, the name and authority number of any person engaged by the owner or occupier of the installation (whether or not for fee or reward) to provide, or arrange for the provision of, the electrical installation work concerned (the ***responsible person***), and
(d) specify the name and authority number of the person who carried out the test (the ***tester***) and the date on which the test was carried out, and
(e) be signed by the tester and the responsible person (if any).

20.What happens if you fail to notify?
……
……

Offence: failure to give notice

If the results of the test are not notified in accordance with this clause, the responsible person (if any) for the electrical installation work or, if there is no responsible person, the tester, is guilty of an offence.
Maximum penalty: 40 penalty units (in the case of a corporation) and 20 penalty units (in any other case).

21.How long must the contractor keep a copy of the notice?
……
A person who notifies the results of a test for the purposes of this clause:
(a) must keep a copy of the notice for at least 5 years from when the notice was given, and
(b) if it relates to an electrical installation other than a free-standing electrical installation—must produce a copy of the notice to any of the following persons on demand made by them at any time during that 5-year period

22.Who may carry out a safety and compliance test?
……
……

Conduct of safety and compliance tests

(1) A safety and compliance test on electrical installation work on an electrical installation, or part of an electrical installation, must be carried out by a qualified person in accordance with the requirements of this clause after the completion of the work.

23.Maintenance of an installation must ensure:-

(i) ……

(ii) ……

(iii) ……

(iv) ……

(v) ……

36 Maintenance of electrical installations: section 32 of Act

For the purposes of section 32 (1) of the Act:
(a) all parts of an electrical installation are prescribed, and
(b) the following requirements apply to the maintenance of all parts of an electrical installation, that is, they must be maintained so as to ensure that:
(i) the safe and satisfactory operation of the installation is not impaired by interference, damage, ageing or wear,
(ii) the live parts of the installation remain properly insulated, or protected, against inadvertent contact with any person,
(iii) the earthing system for the installation operates effectively,
(iv) the installation is not used in a manner that exceeds the operating limits imposed by its design or installation,
(v) the installation does not become a significant potential cause of fire for the environment surrounding the installation.

Student Exercise 3

According to clause 8.2 of AS 3000 what are the major items that must be inspected?

a)……

b)……

c)……

d)……

e)……

f)……

8.2 VISUAL INSPECTION

8.2.1 General

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

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

Exception: Where the visual inspection of a part of the electrical installation is not practicable at the completion of the work, e.g. not accessible because

of enclosure in the building structure, consideration should be given to inspecting that part during the course of the installation.

8.2.2 Checklist

The following items shall be checked, where applicable during the visual inspection, to assess that the relevant requirements of this Standard are satisfied:

(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) Current-carrying capacity.

(ii) Voltage drop, e.g. size of conductors.

(iii) Underground installation conditions, e.g. enclosure, depth burial, mechanical protection.

of

(iv) Aerial installation conditions.

(v) Connection of wiring.

(vi) Protection against external influences.

(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.

(d) Wiring systems:
(i) Conductor size, e.g. current-carrying capacity and voltage drop.
(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. socketoutlets, water heaters, etc.
(iv) Particular installation conditions, e.g. locations affected by water, explosive atmospheres, extra-low voltage, high voltage.
(v) Compliance with required Standard.
(vi) Connection, support and fixing.
* (vii) Protection against external influences including ingress of moisture where required by any clause.
* (viii) Suitability for intended voltage, current and frequency.

1 An RCD is deemed suitable for operation under residual alternating current and residual pulsating direct current conditions if it is marked with one of the symbols cited Clause 2.6.2.2(b) to (e). If the marking is not clearly legible the RCD should be replaced prior to testing.

* 2 Appendix Q contains further guidance for DC circuits.

(f) Earthing:
(i) MEN connection.
(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.

1. The Electricity (Consumer Safety) Act 2004 states that an **authorised electrician** means a person who is authorised under the **Home Building Act 1989** to do electrical wiring work**.**
Who is an authorised electrician?
(look up http://www.legislation.nsw.gov.au,Home Building act 1989,Unqualified electrical wiring work)
……

2. Under what circumstances may an un-qualified person wire buildings?
……
35 Unqualified persons not to carry out safety and compliance tests
(1) A person must not carry out a safety and compliance test on an electrical installation if the person is not a qualified person.
Maximum penalty: 200 penalty units.
(2) A responsible person for electrical installation work must not cause or permit an employee, agent or contractor of the responsible person to carry out a safety and compliance test on the electrical installation concerned unless the employee, agent or contractor is a qualified person

3.To confirm the requirements of AS 3000 have been met, when should inspection and testing be carried out?
……
Clause ……..
Notification of results of safety and compliance tests
(1) **Notices relating to network connected electrical installations**
As soon as is reasonably practicable (but in any event no later than 14 days) after the completion of any safety and compliance test on an electrical installation, the results of the test are to be notified as follows:
(a) to the owner of the installation,

When inspecting switchboards, what must be considered in relation to protective devices?
(a) ……
(b) 8.3.3.1 Low voltage
(c) * Testing shall be carried out on parts of electrical installations
(d) designed to operate at low voltage as follows:
(e) (a) Continuity of the earthing system (earth resistance of the main
(f) earthing conductor, protective earthing conductors, PEN
(g) conductors and bonding conductors), in accordance with
(h) Clause 8.3.5.
(i)
(j) 5. What must be considered when inspecting the earthing system of an installation?
(k) ……
……

Earthing:
(i) MEN connection.
(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
(a) additional electrical equipment.
(b) 8.3.5 Continuity of the earthing system
(c) 8.3.5.1 General
(d) Testing to prove the continuity of the earthing system (earth resistance of
(e) the main earthing conductor, protective earthing conductors, combined
(f) protective earthing and neutral (PEN) conductors and bonding conductors)
(g) shall be carried out to ensure that the earthing system has been installed in
(h) a manner that will cause circuit protective devices to operate if there is a
(i) fault between live parts, other than the neutral, and the mass of earth.
(j) An effective earthing system will ensure that exposed conductive parts of
(k) electrical equipment do not reach dangerous voltages when such faults
(l) occur.
(m) * Where a PEN submain is installed in accordance with Clause 5.5.3.1(c),
(n) testing shall confirm that the earth terminal, point or bar of the sub-board is
(o) connected via the PEN conductor to the earth terminal, point or bar of the
(p) main switchboard.

Q

(q) 6. List the mandatory installation tests.

(r) a) .....

(s) b) .....

(t) c) .....

(u) d) .....

(v) e) .....

(w) f) .....

Testing shall be carried out on parts of electrical installations designed to operate at low voltage as follows:
(a) Continuity of the earthing system (earth resistance of the main earthing conductor, protective earthing conductors, PEN conductors and bonding conductors), in accordance with Clause 8.3.5.
(b) Insulation resistance, in accordance with Clause 8.3.6.
(c) Polarity, in accordance with Clause 8.3.7.

(d) Correct circuit connections, in accordance with Clause 8.3.8.
(e) Verification of impedance required for automatic disconnection of supply (earth fault-loop impedance), in accordance with Clause 8.3.9.

For a house in a underground residential development, who must be notified of the completion of the safety compliance test.

a) …….

b) …….

c) …….

How long have you got to notify of the completion of a safety compliance test?
……
14 days

How long have you got to notify of the completion of a safety compliance test?
……
14 days

9. If you fail to notify of the completion of a safety compliance test within the required time what may happen?
……
(4) **Offence: failure to give notice**
If the results of the test are not notified in accordance with this clause, the responsible person (if any) for the electrical installation work or, if there is no responsible person, the tester, is guilty of an offence.
Maximum penalty: 40 penalty units (in the case of a corporation) and 20 penalty units (in any other case).

10. May an apprentice carry out a safety and compliance tests:-

a) Un-supervised? …… No

b) Under supervision of a qualified supervisor? ……

Under supervision of a qualified supervisor? ……

In AS 3000 look up the meaning of:-
a) Exposed Conductive Part.

1.4.62 Exposed conductive part
A conductive part of electrical equipment that—
(a) can be touched with the standard test finger as specified in AS/NZS 3100; and
(b) is not a live part but can become live if basic insulation fails.

b) Extraneous Conductive Part.

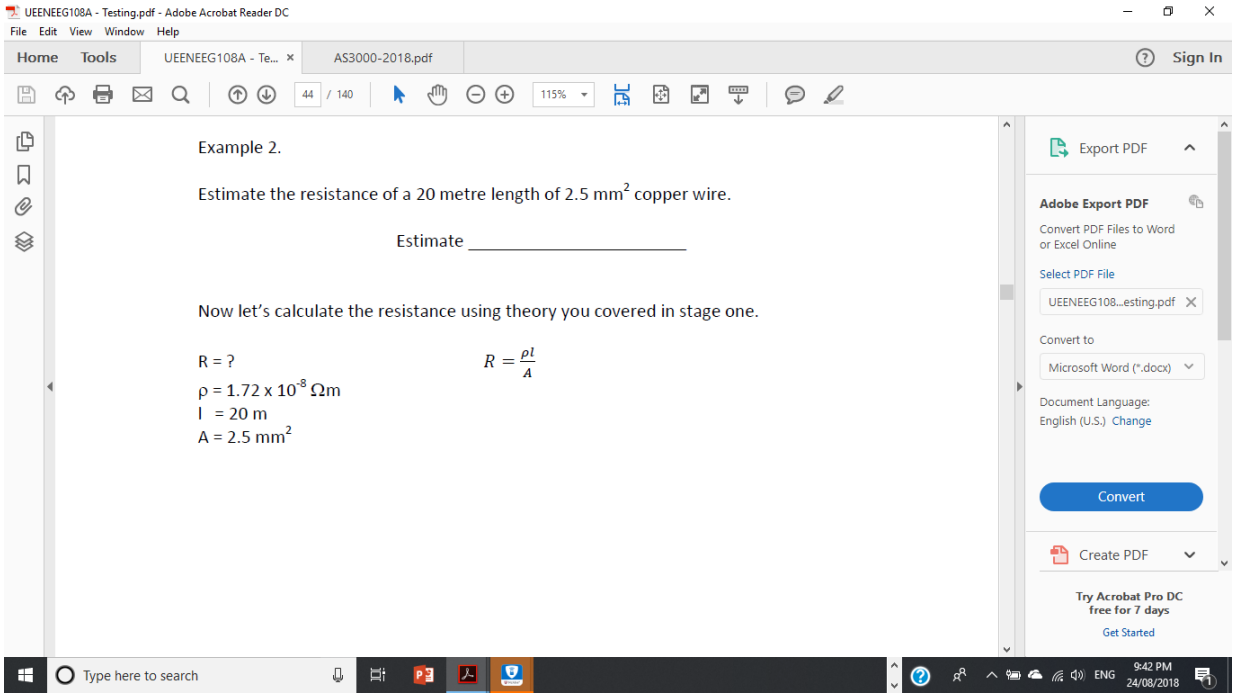
1.4.63 Extraneous conductive part
A conductive part that does not form part of an electrical installation but that may be at the electrical potential of a local earth.
NOTE: Examples of extraneous conductive parts include the following:
(a) Metal waste, water or gas pipe from outside.
(b) Cooling or heating system parts.
(c) Metal or reinforced concrete building components.
(d) Steel-framed structure.
(e) Floors and walls of reinforced concrete without further surface treatment.
(f) Tiled surfaces, conductive wall coverings.
(g) Conductive fittings in washrooms, bathrooms, lavatories, toilets, etc.
(h) Metallized papers.

c) Equipotential Bonding Conductor.

1.4.60 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.

d) Protective Earthing Conductor.

1.4.100 Protective earthing conductor
An earthing conductor, other than a main earthing conductor, intended to carry earth fault currents and connecting any portion of the earthing system to the portion of the electrical installation or electrical equipment required to be earthed, or to any other portion of the earthing system.
RCD [see Clause 1.4.102 Residual current device (RCD)].
Readily accessible (see Clause 1.4.3 Accessible, readily).



R = ? $R = \rho lA$
ρ = 1.72 x 10-8 Ωm
l = 20 m
A = 2.5 mm2

$$R = \frac{1.72 \times 10^{-8} \times 20}{2.5 \times 10^{-12}} = \text{ohm}$$

1.72 x 10-8

Question 2.
What would you think and do if in a house, you measured the resistance of a stove circuit's earth wire to be 0.8 Ω.
CB will not operate

Exercise 3. (Refer to your wiring rules)
a) What section of AS3000 deals with testing installations?

Section _____
Section 8
b) With reference to clause 8.3 of AS3000 what must be done before or concurrently with circuit testing.

.....
.....
.....
8.3.1 General
After completion of, or in association with, the visual inspection, tests shall be carried out in accordance with Clause 8.3.3 on the electrical

installation to verify that it complies with the requirements of this Standard and that it is suitable for the use intended.
If necessary, additional tests may be carried out.
8.3.2 Test methods
* AS/NZS 3017 sets out common test methods that may be used to verify by testing that a low voltage electrical installation complies with this Standard, and also includes minimum safety standards for test instruments.
* Testing shall be carried out in such a manner that the safety of the operator and other people in the vicinity, and test equipment is not placed at risk.

c) List the mandatory tests on an installation.

1. .....

2. .....

3. .....

4. .....

5. .....

6. .....

8.3.3 Mandatory tests
8.3.3.1 Low voltage
* Testing shall be carried out on parts of electrical installations designed to operate at low voltage as follows:
(a) Continuity of the earthing system (earth resistance of the main earthing conductor, protective earthing conductors, PEN conductors and bonding conductors), in accordance with Clause 8.3.5.
(b) Insulation resistance, in accordance with Clause 8.3.6.
(c) Polarity, in accordance with Clause 8.3.7.
(d) Correct circuit connections, in accordance with Clause 8.3.8.
(e) Verification of impedance required for automatic disconnection of supply (earth fault-loop impedance), in accordance with Clause 8.3.9.
(f) Operation of RCDs, in accordance with Clause 8.3.10.

d) Which electrical test is done first?

.....
.....
.....
.....

Earthing test

8.3.1 General

After completion of, or in association with, the visual inspection, tests shall be carried out in accordance with Clause 8.3.3 on the electrical installation to verify that it complies with the requirements of this Standard and that it is suitable for the use intended.

If necessary, additional tests may be carried out.

8.3.2 Test methods

* AS/NZS 3017 sets out common test methods that may be used to verify by testing that a low voltage electrical installation complies with this Standard, and also includes minimum safety standards for test instruments.

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

e) Clause 8.3.5 is entitled Continuity of The Earthing System. The term “continuity” implies a continuous circuit but does not specify a resistance value. In fact the installing electrician must measure the resistance of the wires with an …….. set to the lowest ohms range as very …….. values of resistance are expected. (Continuity buzzers and the like are not acceptable)

Megger/ low

8.3.5 Continuity of the earthing system

8.3.5.1 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 a PEN submain is installed in accordance with Clause 5.5.3.1(c), 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.

8.3.5.2 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 ohm

f) Clause 8.3.6 covers the expected results of the test. Although no specific value is given we expect the value to be consistent with the known resistance of certain size copper wire. The resistance of protective earthing conductors shall be:-

a.

……

……

b.

……

……

……

……

8.3.5.2 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, e.g. for a 100 metre length of 2.5mm^2 copper conductor, a resistance of 0.8 Ω could be expected.

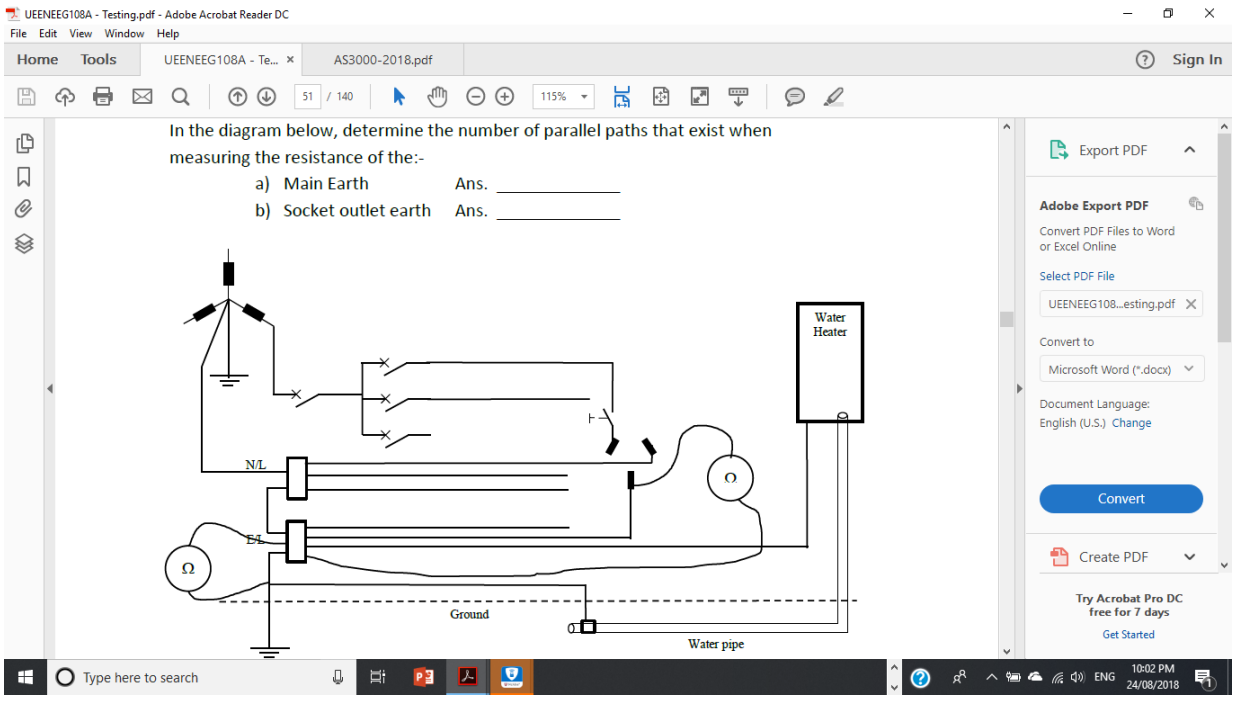
g) What is the stated maximum resistance of the main earthing conductor?

Clause …… Value …….

I don't know where they get this value from. It is very high given that main earth wires are usually short and of larger cross sectional area. The same value is given for equipotential bonding conductors.

8.3.5.2 Results

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



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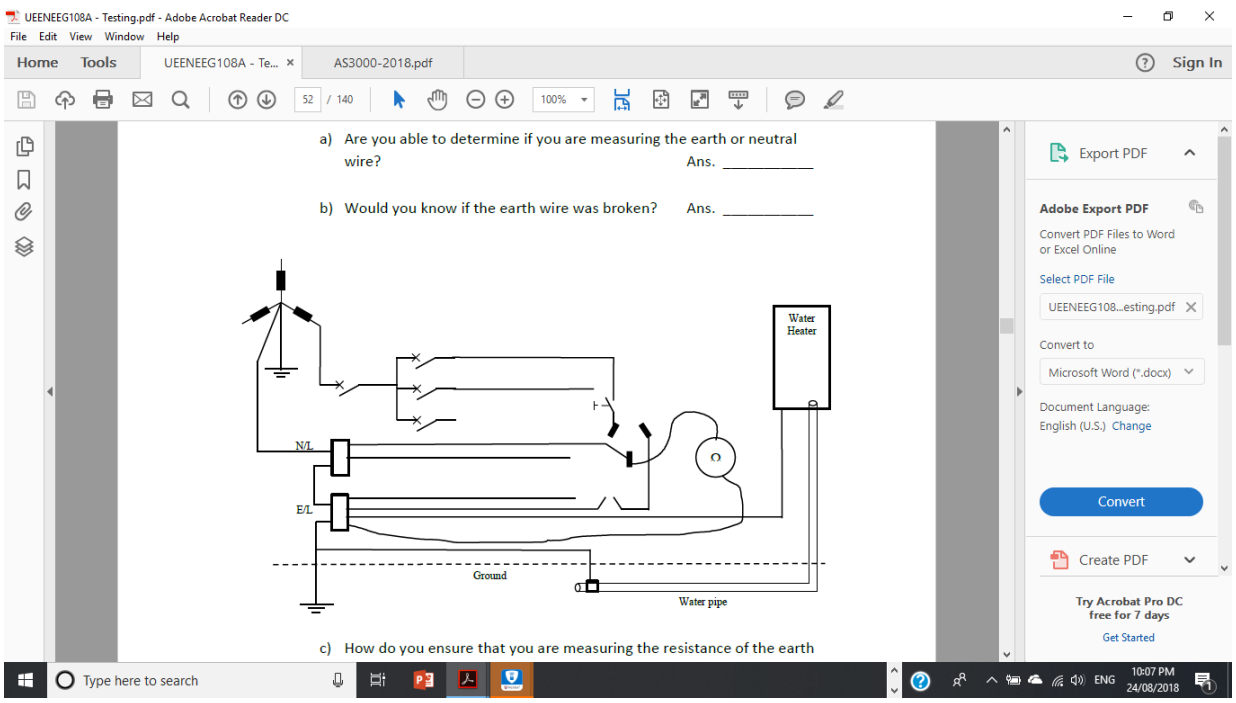


No / No

1. Which conductors in an installation must be tested for resistance to ensure the resistance is not too high?
Earth wire
.....
.....
.....
.....

2. Is it necessary to isolate and tag an energised installation prior to testing earth resistance? YES / NO

3.Which range should be selected when measuring the resistance of protective earths?

a) 1 MΩ
b) Lowest Ohms range.
c) Highest Ohms range.
d) 500 volt. (……..)

4.When measuring resistance with the leads shorted together with a digital Ohmmeter the expected result would be around:-

a) 1 MΩ
b) 50 Ω.
c) 0.5 Ω.
d) 0.2 Ω. (……..)

5.When measuring resistance with the leads shorted together with an analogue Ohmmeter the:-

a) Measured result should be 1 MΩ
b) Measured result should be infinite Ω.
c) Measured result should be 0.2 Ω.
d) Zero should be adjusted. (……..)

6.When measuring resistance with the leads apart the expected result would be around:-

a) 1 MΩ
b) infinite Ω.
c) 0.5 Ω.
d) 0.2 Ω. (……)

7. An effective earthing system will ensure that the _____ difference between conductive frames of electrical equipment will not reach a dangerous level for too long when earth faults occur.

resistance

8. Clause 8.3.5.2.(b) states that "The resistance of protective earthing conductors shall be consistent to the _____, cross sectional area and _____ of conductor material.

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

9. If 25 metres of 2.5 mm^2 copper conductor has a resistance of around 0.2 Ω.

25 metres of 4 mm^2 copper conductor would have a resistance of around:-
a) 0.1 Ω
b) 1 Ω
c) 10 Ω
d) 0.5 Ω

10. If 25 metres of 2.5 mm^2 copper conductor has a resistance of around 0.2 Ω.

25 metres of 1 mm^2 copper conductor would have a resistance of around:-
a) 0.1 Ω
b) 0.4 Ω
c) 4 Ω
d) 1.4 Ω

Page 65

STUDENT EXERCISE 1.
1. Which clause of AS 3000 deals with insulation resistance testing?

Clause ……

8.3.6 Insulation resistance

2. If you are about to pick up a live cable, how much insulation resistance would you like between your hand and the live wires?

……

The NIOSH states "Under dry conditions, the resistance offered by the human body may be as high as **100,000 ohms**. Wet or broken skin may drop the body's resistance to **1,000 ohms**,"

adding that "high-voltage electrical energy quickly breaks down human skin, reducing the human body's resistance to **500 ohms.**

3. Assuming you have a dry skin resistance of 10 kΩ and you picked up a live 230 Volt cable with an insulation resistance of 1 MΩ, how much current would flow through you to earth?

230/ 1.01 x 10^6 = 230 micro amp

4. How much current flow through your body for a few seconds does it take to kill you?
……

Any amount of current over 10 milliamps (0.01 amp) is capable of producing painful to severe shock, currents between 100 and 200 mA (0.1 to 0.2 amp) are lethal. Currents above 200 milliamps (0.2 amp), while producing severe burns and unconsciousness, do not usually cause death if the victim is given immediate attention. Resuscitation, consisting of artificial respiration, will usually revive the victim.

5. What is the minimum value of insulation resistance allowed by AS 3000 for general low voltage circuits?
……
8.3.6.3 Results

The insulation resistance between—

(a) the conductors of consumer mains and submains; and

(b) live and earthed parts of an electrical installation, or parts thereof,

including consumer mains and submains,

shall be not less than 1 Mohm.

6. What is the minimum value of insulation resistance allowed by AS 3000 for circuits that include heating elements?
……
……
8.3.6.3 Results

The insulation resistance between—

(a) the conductors of consumer mains and submains; and

(b) live and earthed parts of an electrical installation, or parts thereof,

including consumer mains and submains,

shall be not less than 1 M・.

* Exceptions:

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

1 For sheathed heating elements of appliances; not less than 0.01 Mohm

2 A value permitted in the Standard applicable to the electrical equipment.

3 For functional earth connections of RCDs; not less than 0.05 M・, or

as prescribed by the manufacturer

Why do the rules allow heating elements to have a lower insulation resistance value?

.....

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

8. What value of voltage must be used to conduct the insulation resistance test of a low voltage circuit and should you use AC or DC?

.....

.....

Clause .....

8.3.6.2 Method

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

Exceptions:

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.

9. Is the circuit insulation to be measured with appliances plugged in or unplugged?

.....

.....

Clause .....

7.4.8 Testing

7.4.8.1 General

In addition to the testing requirements of Section 8, the separation of each separated circuit (transformer secondary winding or isolated winding generator output) and the wiring to the socket-outlet shall be individually confirmed.

Separation shall be verified by a measurement of the insulation resistance between the separated circuit and—

(a) if a transformer is the source of the separated supply, the transformer

primary winding;

(b) any other wiring;

(c) any other separated circuit; and

(d) earth.

Insulation resistance values obtained shall be not less than 1 M · , when tested at a voltage of 500 V dc

10. Is it necessary to test insulation resistance between active and neutral of final sub circuits.

……

Clause ……

Yes

8.3.6 Insulation resistance

8.3.6.1 General

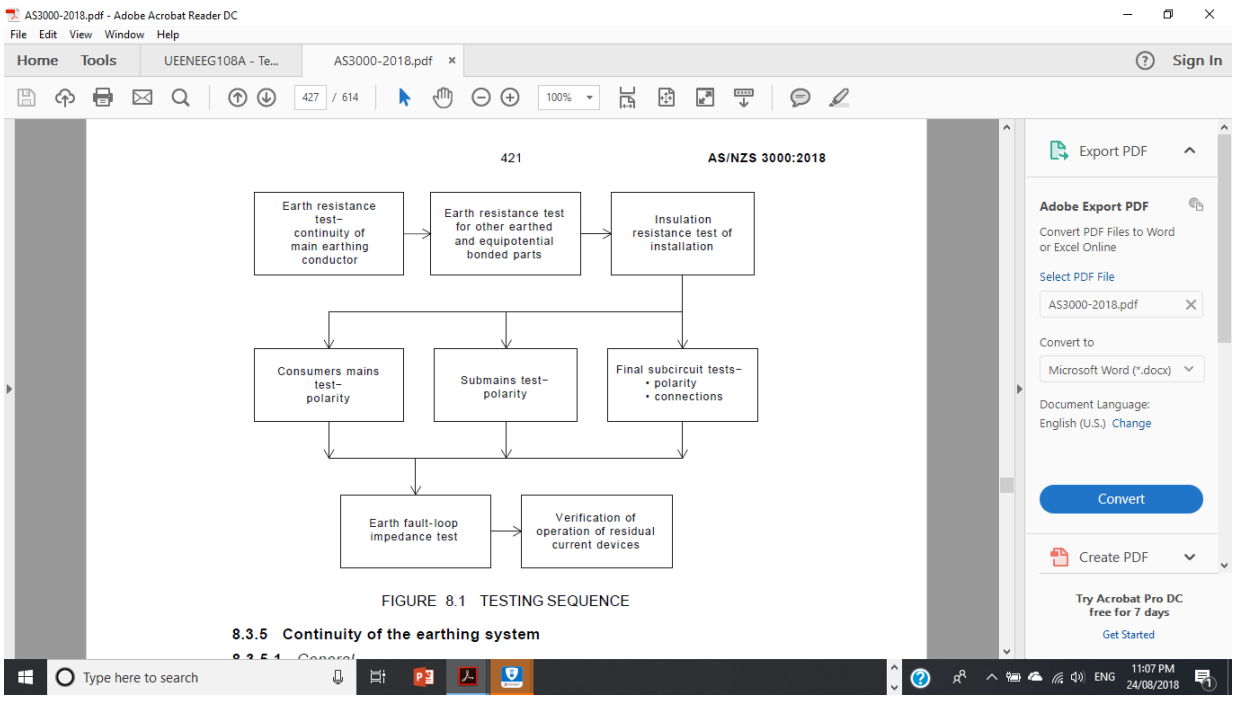
Insulation resistance testing shall be carried out to ensure that the insulation resistance between all live conductors and earth or, as the case may be, all live parts and earth, is adequate to ensure the integrity of the insulation. This testing is to prevent—

(a) electric shock hazards from inadvertent contact;

(b) fire hazards from short-circuits; and

(c) equipment damage.

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



11. What possible problems may occur if you test insulation resistance between active and neutral or between actives?

……

8.3.6.2 Method

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

Exceptions:

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.

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

For which electrical circuits is it a must to test insulation resistance between active and neutral as well as between actives?

……

……

Clause ……

8.3.6 Insulation resistance

8.3.6.1 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 conductors is necessary for consumer mains and submains to minimize risk of injury or property damage because of insulation breakdown

1. Does AS 3000 require that insulation resistance tests be made between live conductors for final sub-circuits?

……

……

Yes

Clause …….

Yes

8.3.6 Insulation resistance

8.3.6.1 General

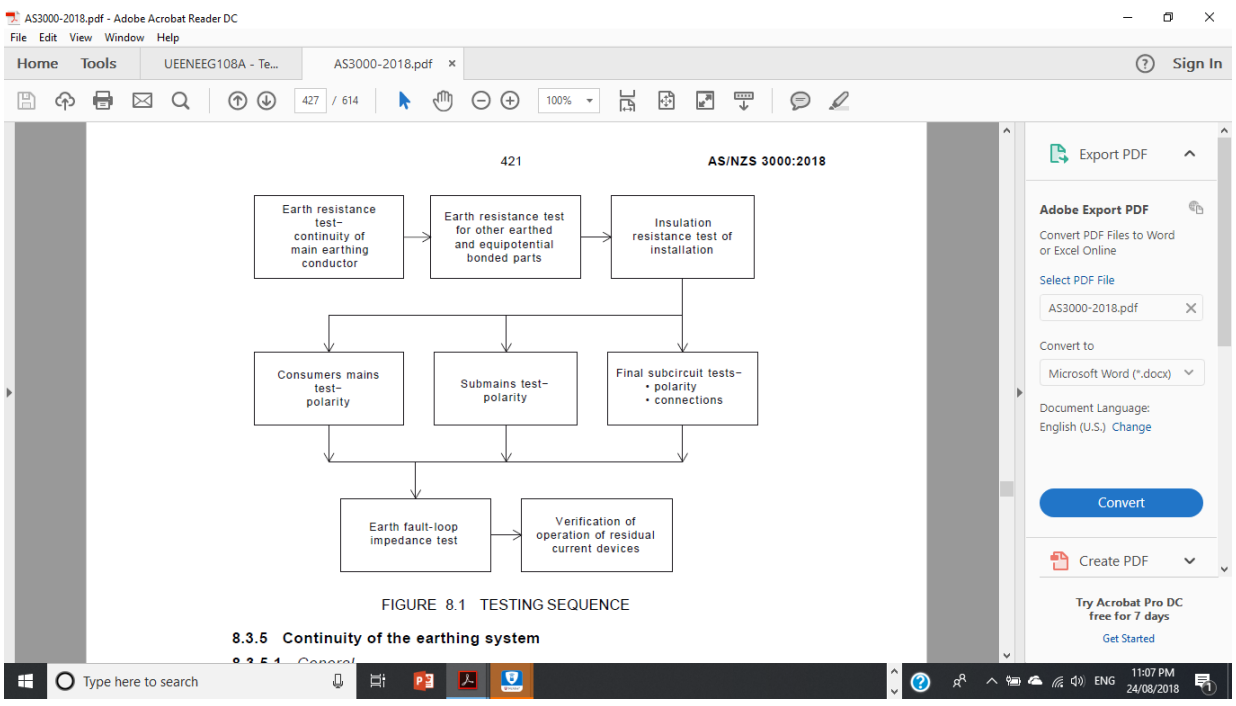
Insulation resistance testing shall be carried out to ensure that the insulation resistance between all live conductors and earth or, as the case may be, all live parts and earth, is adequate to ensure the integrity of the insulation. This testing is to prevent—

(a) electric shock hazards from inadvertent contact;

(b) fire hazards from short-circuits; and

(c) equipment damage.

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



2. Does AS 3000 require that insulation resistance tests be made between live conductors for sub-mains?

……
……

Clause ……

No

For final sub-circuits there is no need to test the insulation resistance between actives and neutral. In lieu of the IR test between A – N, the resistance between actives and neutral is measured on the Ohms range or on the 250 Volt range.

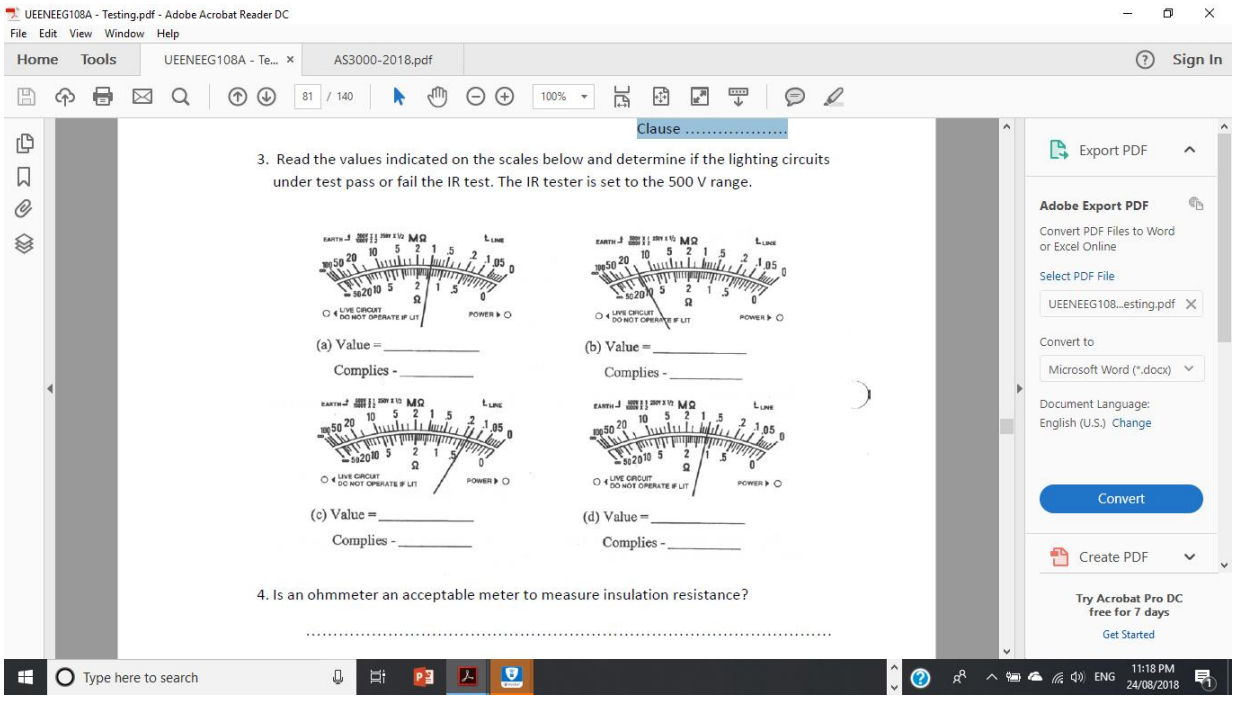
8.3.6.3 Results

The insulation resistance between—

(a) the conductors of consumer mains and submains; and

(b) live and earthed parts of an electrical installation, or parts thereof, including consumer mains and submains,

shall be not less than 1 MOhm



a- comply b -comply c- Not comply d- not comply

4. Is an ohmmeter an acceptable meter to measure insulation resistance?

.....

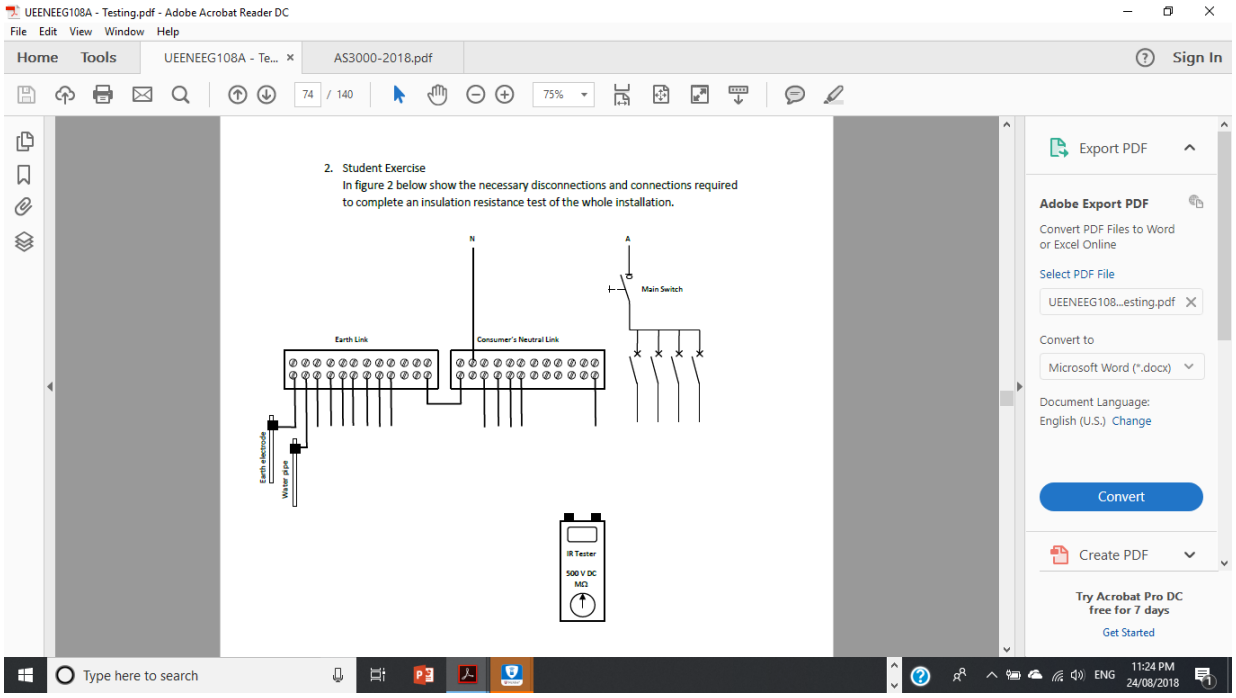
.....

Clause .....

No

8.3.6.2 Method

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



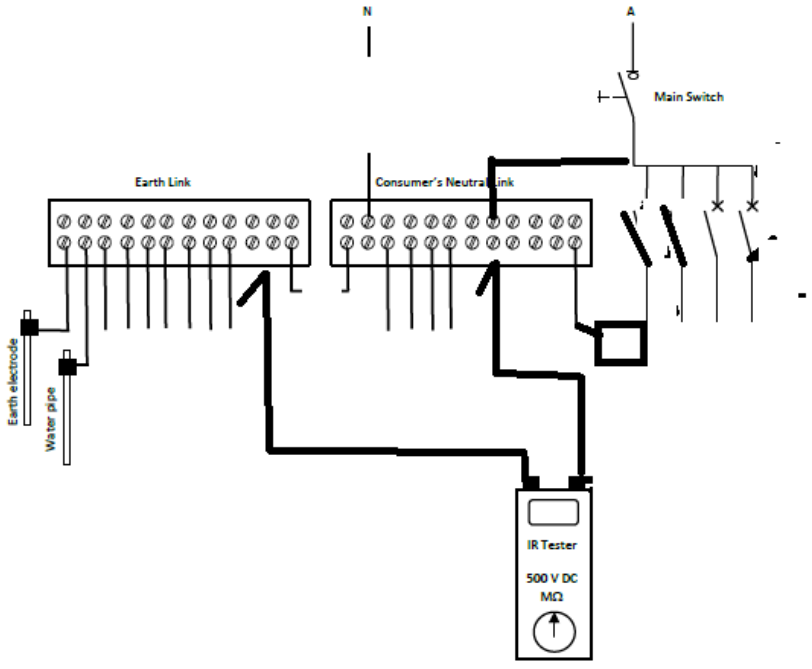
2. Disconnect MEN. Also consider all aspects mentioned in Test Considerations above.

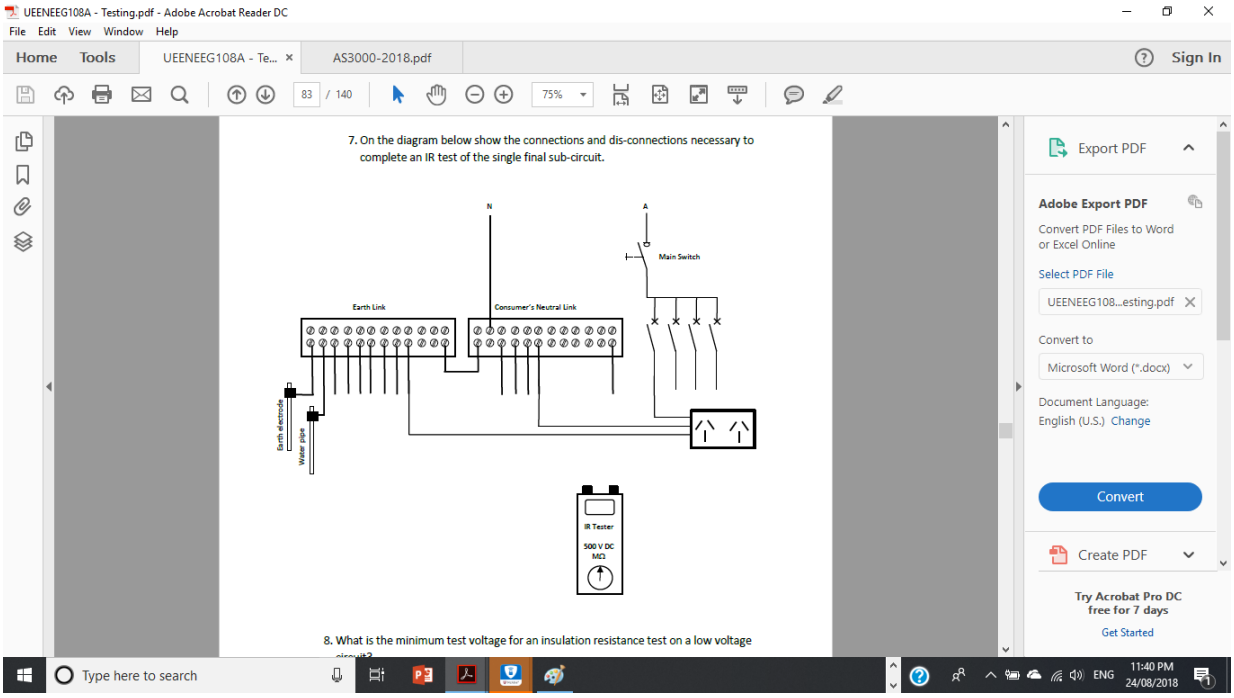
3. Bridge actives and neutral together by the use of fused bridging leads by bridging between the load side of main switch to consumer's neutral link. Repeat for each phase. (This procedure connects all live conductors together and ensures that 500 V DC will not be impressed across electronic devices normally connected between actives or between actives and neutral. The HRC fused bridging leads are used in case someone forgets to remove a bridge.)

4. All circuit breakers and RCDs must be closed. All fuses must be in.

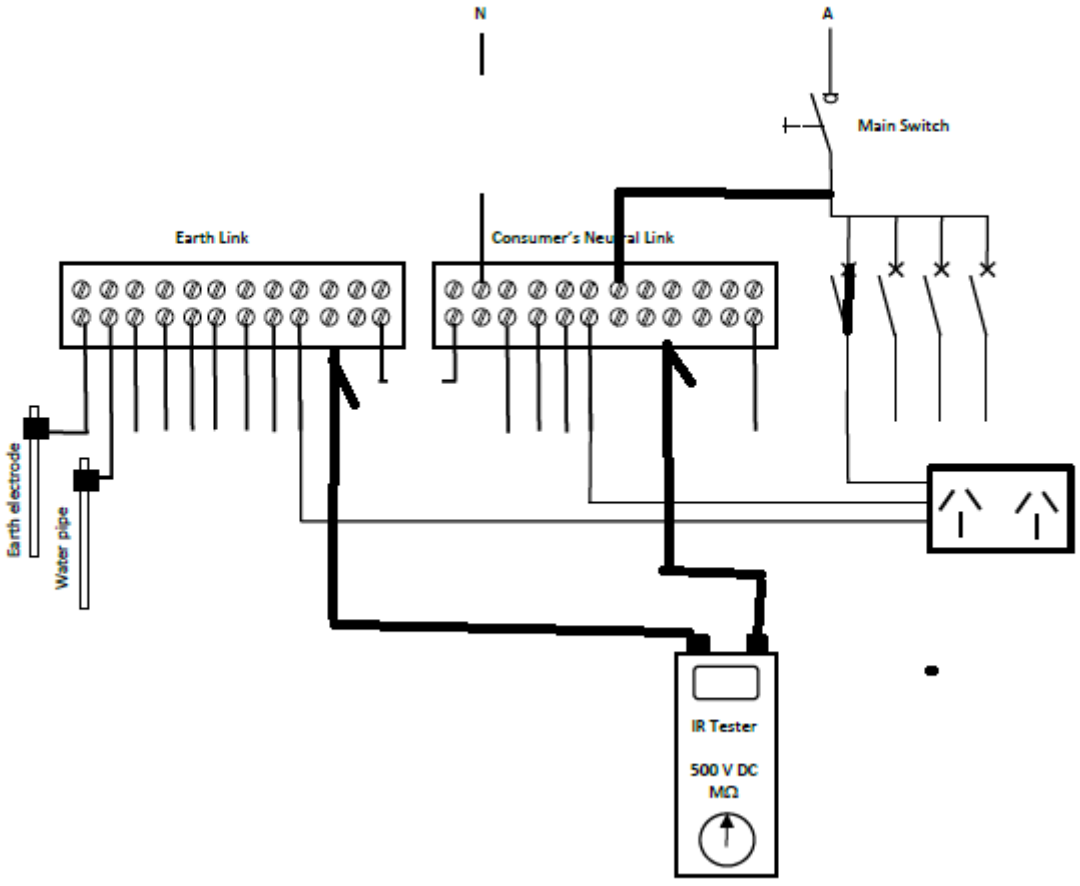
5. Sub-main switches, circuit breakers and RCDs in any distribution board will need to be closed to include the distribution board load in the IR test.

Now test the integrity of the insulation between all live conductors and earth of the whole installation in one go by connecting an IR tester at 500 V DC between the main earth and the consumer's neutral link.





All light and socket switches must be closed (on) and multiple switches (Two way & intermediate.) allowed for.



8.What is the minimum test voltage for an insulation resistance test on a low voltage circuit?

……

……

Clause …….

8.3.6.2 Method

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

Exceptions:

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.

9. If the measured result of an insulation resistance test of an entire installation is below 1 MΩ. What would you expect to be the most likely cause of the poor result?

……

3.11 AS 3000 clause 8.3.6.2 states that the minimum insulation resistance for the whole installation must not be less than 1MΩ. Usually even with sheathed heating elements included the insulation value obtained is well above 1MΩ. If so the installation passes the IR test. However if the measured value is below 1MΩ then the low reading is probably due to the sheathed heating elements. To isolate the sheathed elements from the test:-

a. Open the circuit breakers (or remove fuses) for all the stove and water heater circuits.

b. Remove the neutrals of all the stove and water heater circuits from the consumer's neutral link.

c. Now repeat the IR test on the installation and the sheathed element circuits separately. Insulation resistance for circuits supplying sheathed heating elements may be as low as 0.01MΩ.

If the installation still has an IR value below 1MΩ then each circuit must be checked individually by:-

d. Open circuit breaker (remove fuse) one circuit at a time and test. Leaving IR tester connected as before. If the short is between active or switch-wire and earth the fault will be found.

If the fault is still not found then there must be a short between neutral and earth. To find which neutral is shorted e. Remove one circuit neutral at a time and test as before. When the fault disappears you have found the neutral that the short is on.

10. Why is an insulation resistance test of an installation necessary?

……

An insulation resistance test is like a pressure test of the circuit insulation. We pump up the "electrical pressure" or voltage to 500 Volts which is around twice the normal operating phase voltage of a low voltage circuit. If any electrons leak from the live wires through the insulation or around the insulation to the frame of electrical equipment or to earth then that current is indicated by the meter movement. Although it is current that causes the needle to move the scale is graduated in Ohms. (R = V/I) The voltage is impressed between the live wires and the earth wires and as the only way current can flow is through the insulation the resistance measured is that of the insulation between the live wires and earth.

In general the standards are mostly concerned with earthed equipment becoming live and endangering the lives of people and livestock. So the IR test is done between live conductors and earth. It should be known that a neutral conductor is a live conductor. Also it should be known that some electronic equipment may be damaged by the higher than normal voltage (500 Volts) used during the IR test. To prevent this damage it is advised that you bridge the actives and neutral

conductors together and measure all live conductors to earth at one time. For final sub-circuits there is no need to test the insulation resistance between actives and neutral. In lieu of the IR test between A – N, the resistance between actives and neutral is measured on the Ohms range or on the 250 Volt range. This is called a short circuit test and is studied later.
However it is mandatory to measure the insulation resistance between actives and neutral of mains and sub-mains. It is advised that mains and sub-mains be completely isolated from supply and loads during the IR test.

11. What should be done with surge protection equipment for the IR test?
……

... Some brands will require power to be supplied **in** order for the **surge protection** to work (e.g. Arlec), as these particular **surge** boards will still pass both a 250V and 500V **Insulation Resistance test**

The Insulation Resistance test at 500V can cause an issue here. Most surge protected devices will have a threshold of approx 300V before they activate. As a result a 500V test voltage will see a very low resistance reading as the surge device will have shorted Live / Neutral to Earth. If your tester has the option, reduce the output test voltage to 250V. This will ensure the test does not activate the surge protection device. If you do not have this capability on your tester then we follow the IEE Code Of Practice For In Service Inspection and Testing recommendation to carry out a Protective Current Conductor Test (Class I) or Touch Current (Class II) in place of the Insulation Resistance Test

12. If RCDs are of the type that have functional earths (FE) What should be done with functional earths during an IR test?
……
……
……
……
Clause …….

8.3.6.2 Method
The integrity of the insulation is stressed by applying a direct current at 500 V for low voltage circuits.
Exceptions:
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.
2 Where connected equipment, such as sheathed heating elements of appliances or an RCD with an FE connection, is likely to influence the verification test, the equipment may be disconnected before carrying out the insulation resistance test on the circuit and the equipment tested separately.

13. The NSW Service & Installation Rules, clause 1.5.3.1 gives a value of 50 MΩ or greater for service mains which in most cases are also consumer's mains.

What does AS 3000 say about the expected insulation resistance of short lengths of polymeric consumer's mains?

……
……
……
……
Clause ……..

8.3.6.3 Results

NOTES:

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

14. Why is it necessary to disconnect the main neutral when insulation resistance testing a whole installation?

……
……
……
……
Clause ……..

In general the standards are mostly concerned with earthed equipment becoming live and endangering the lives of people and livestock. So the IR test is done between live conductors and earth. It should be known that a neutral conductor is a live conductor. Also it should be known that some electronic equipment may be damaged by the higher than normal voltage (500 Volts) used during the IR test. To prevent this damage it is advised that you bridge the actives and neutral conductors together and measure all live conductors to earth at one time. For final sub-circuits there is no need to test the insulation resistance between actives and neutral. In lieu of the IR test between A – N, the resistance between actives and neutral is measured on the Ohms range or on the 250 Volt range. This is called a short circuit test and is studied later.

15. What is the minimum allowable insulation resistance of a circuit supplying sheathed heating elements? …… Clause …….

8.3.6.3 Results

Exceptions:

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

1 For sheathed heating elements of appliances; not less than 0.01 Mohm

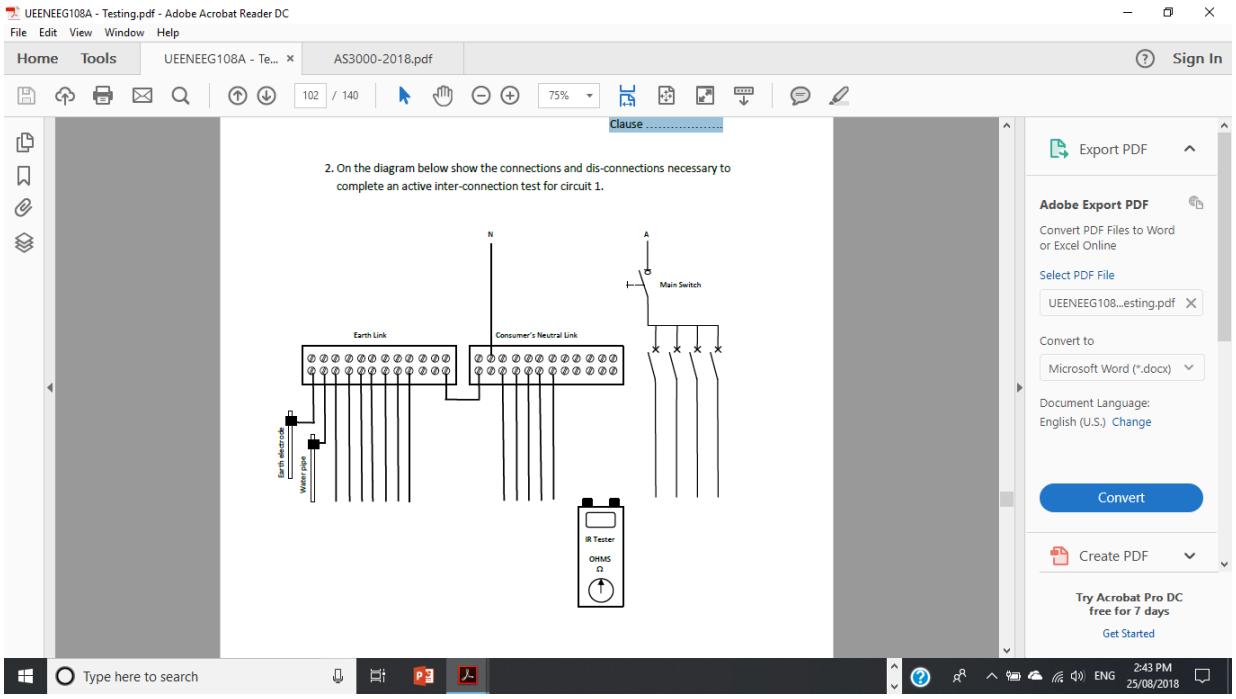
1. Which section of AS 3000 deals with testing for "correct circuit connections"?

……
Clause ……..

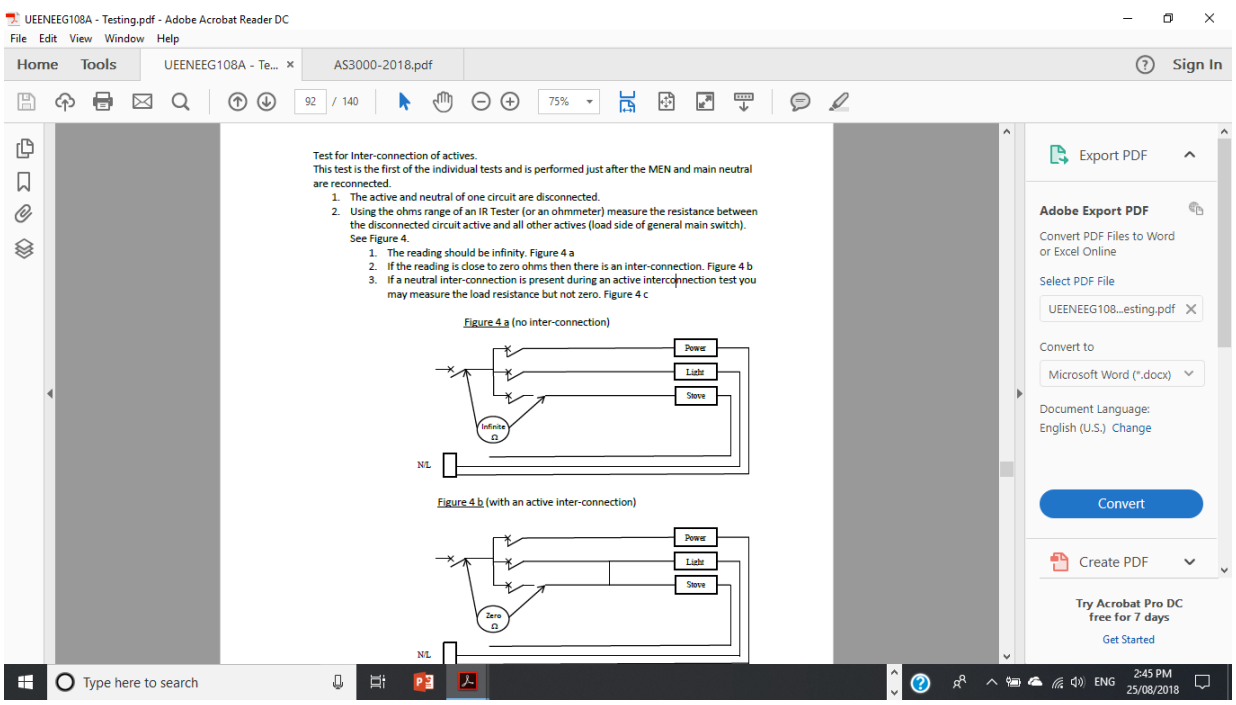
8.3.7 Polarity

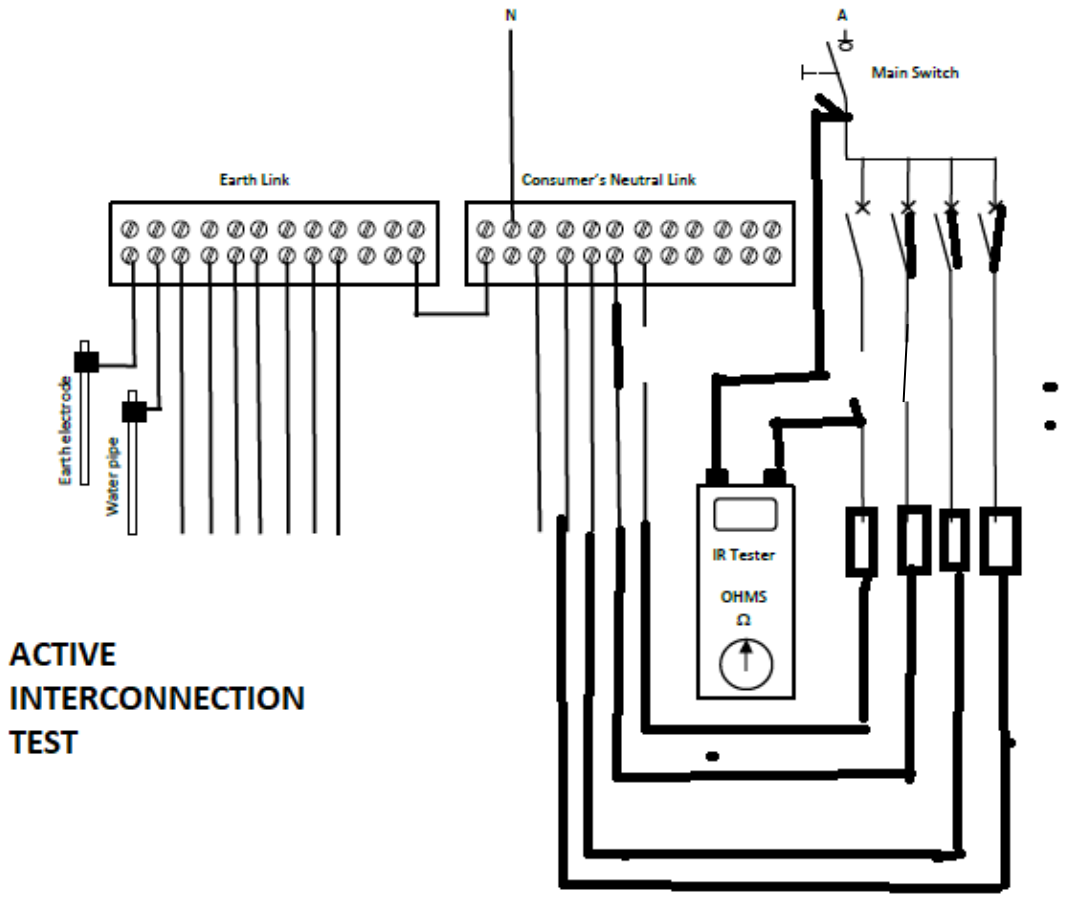
8.3.7.1 General

Polarity testing shall be carried out to ensure that no shock hazard arises from the incorrect connection of active, neutral and earthing conductors.



Test for Inter-connection of actives.
This test is the first of the individual tests and is performed just after the MEN and main neutral are reconnected.
1. The active and neutral of one circuit are disconnected.
2. Using the ohms range of an IR Tester (or an ohmmeter) measure the resistance between the disconnected circuit active and all other actives (load side of general main switch). See Figure 4.
1. The reading should be infinity. Figure 4 a
2. If the reading is close to zero ohms then there is an inter-connection. Figure 4 b
3. If a neutral inter-connection is present during an active interconnection test you may measure the load resistance but not zero. Figure 4 c





3. Tests for correct circuit connections are necessary to ensure that:-
(a)……
……
(b)……
……
Clause …….

8.3.8 Correct circuit connections

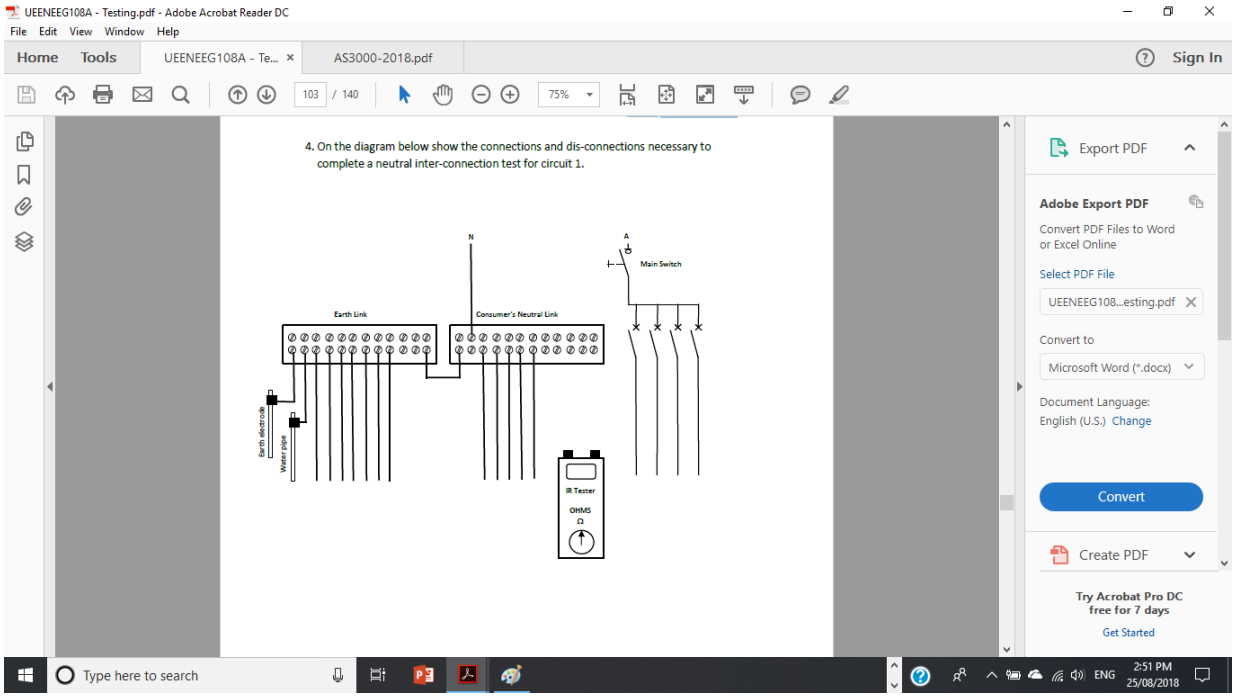
8.3.8.1 General

Testing for correct circuit connections shall be carried out to ensure the following:

(a) Protective earthing conductors do not normally carry current.

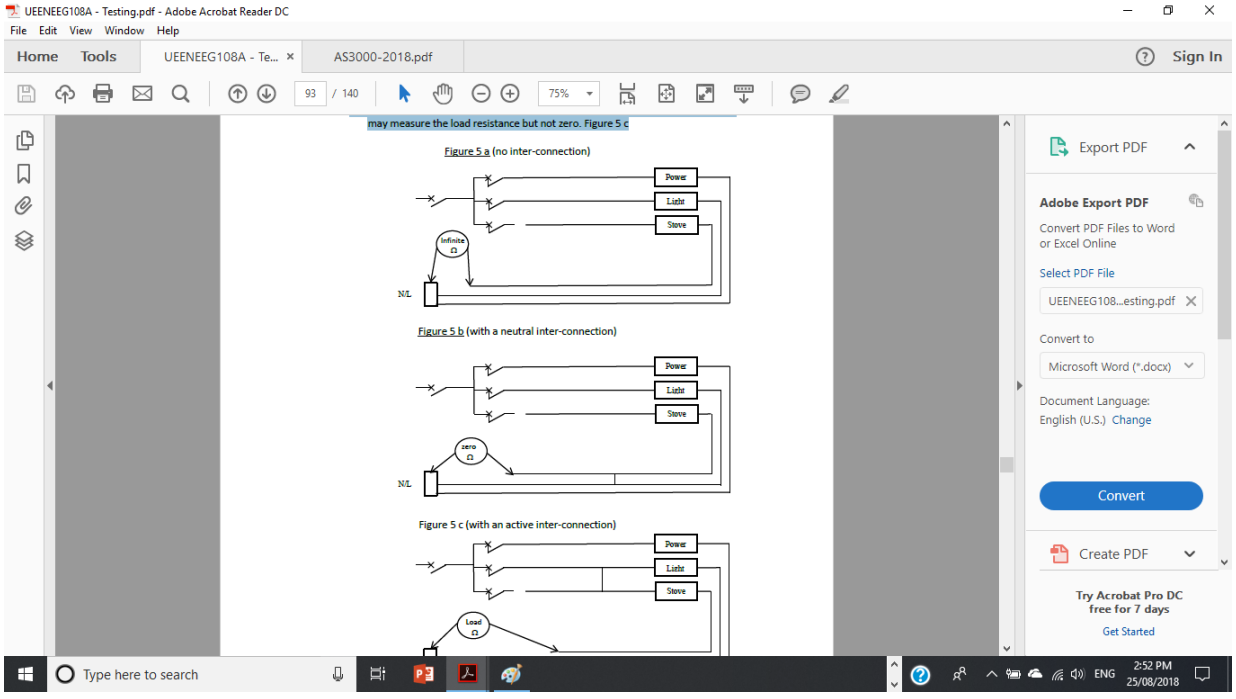
(b) No short-circuit exists.

NOTE: A short-circuit current flowing between live conductors or through part of the earthing system can cause considerable fire damage or personal injury, particularly in high current locations



Test for Inter-connection of neutrals.

1. The active and neutral of one circuit are disconnected.
2. Using the ohms range of an IR Tester or an ohmmeter measure the resistance between the disconnected circuit neutral and all other neutrals (neutral link). See Figure 5.
4. The reading should be infinity. Figure 5 a
5. If the reading is close to zero ohms then there is an inter-connection. Figure 5 b
6. If an active inter-connection is present during a neutral interconnection test you may measure the load resistance but not zero. Figure 5 c



5. According to AS3000, results of tests for correct circuit connection should prove that there are no:-

(a)……

……

(b)……

……

(c)……
……

Clause ……..

8.3.8.2 Results

The correct circuit connections testing shall show that the active, neutral and protective earthing conductors of each circuit are correctly connected so that none of the following conditions exists:

(a) Short-circuit between the conductors.

or

(b) Transposition of conductors that could result in the earthing system and any exposed conductive parts of the electrical installation becoming energized.

or

(c) Interconnection of conductors between different circuits.

NOTE: Any MEN or ESR connection is not considered as a short-circuit

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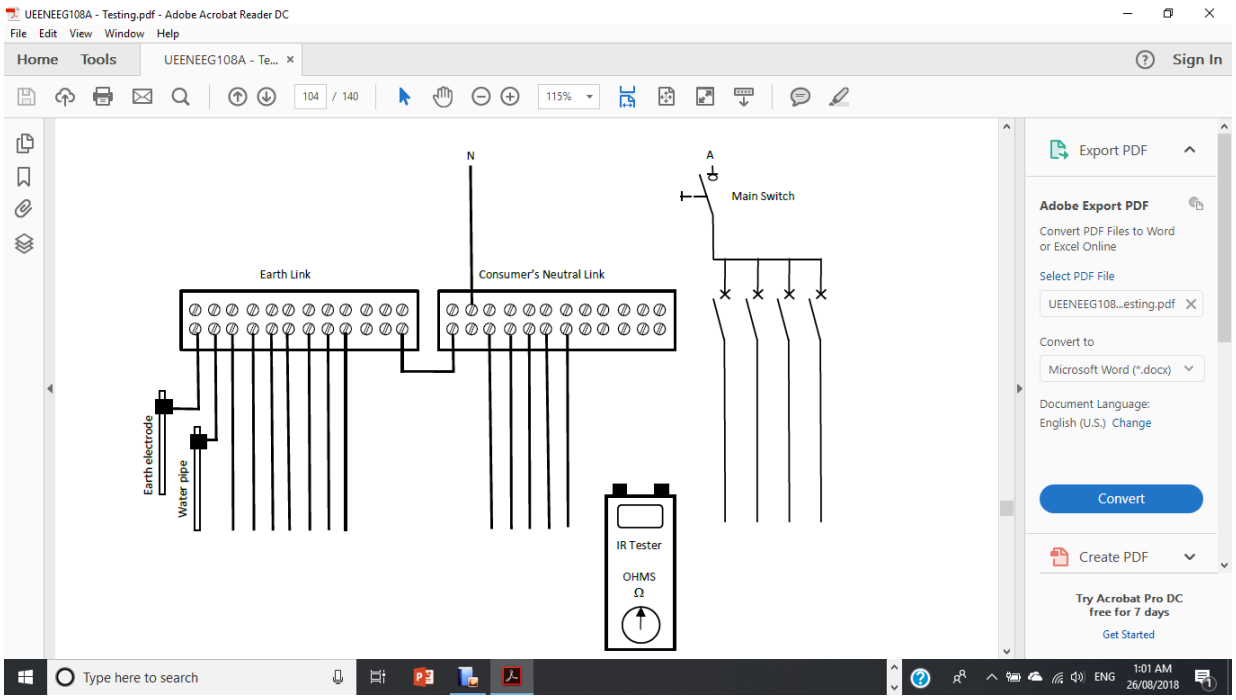
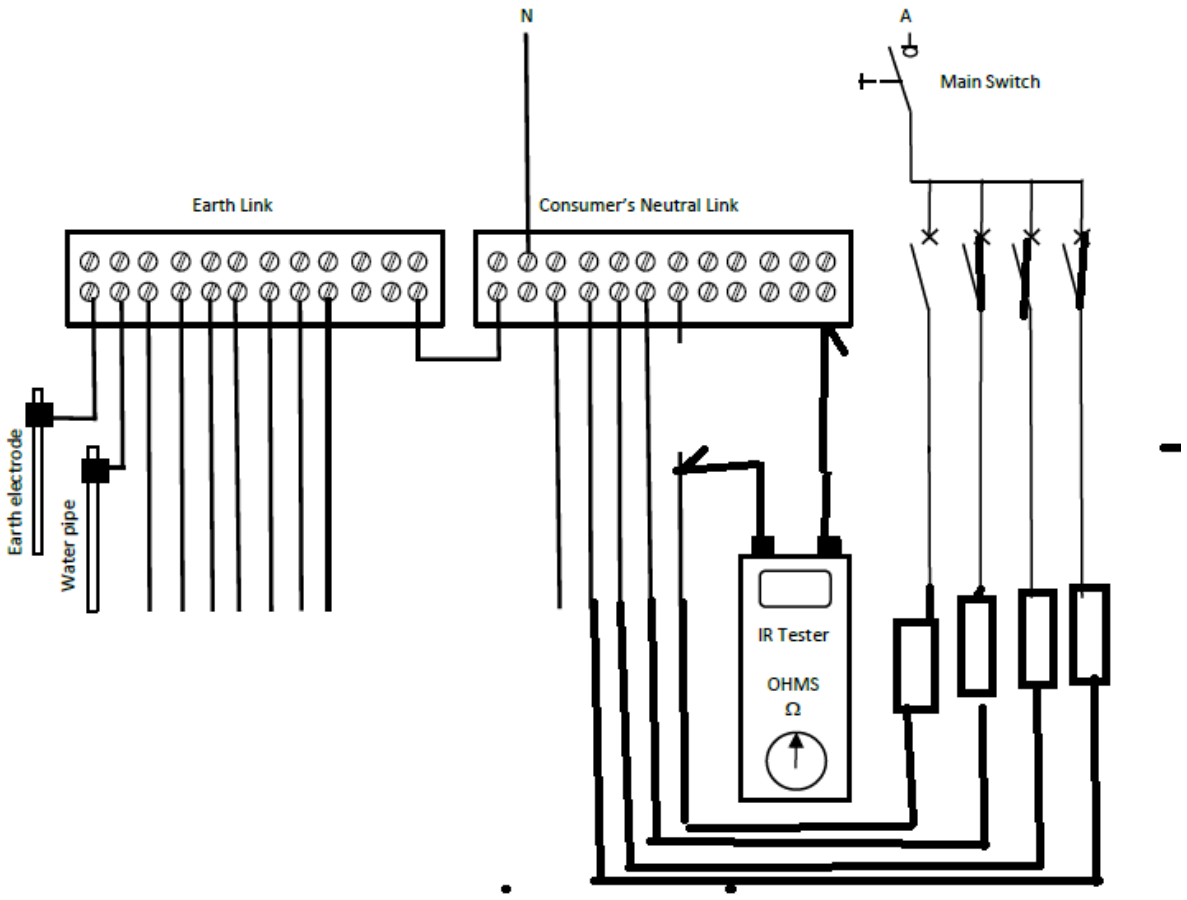
Q6





7. Describe the following incorrect connections:-

Incorrect polarity

……

……

Polarity testing shall be carried out to ensure that no shock hazard arises from the incorrect connection of active, neutral and earthing conductors.

This testing is to prevent—

(a) the transposition of active and neutral conductors of the consumer mains, or submains supplying an outbuilding having an MEN connection, resulting in the electrical installation earthing system becoming energized;

(b) combinations of incorrect active, neutral and earthing conductor connections resulting in the exposed conductive parts of the electrical installation becoming energized;

(c) the connection of switches or protective devices in neutral conductors, resulting in parts of appliances, such as heating elements and lampholders, remaining energized when the switches are in the 'OFF' position; and

(d) multiphase equipment, such as multiphase motors, and semiconductor-controlled equipment operating in an unpredictable manner.

Transposition

……
……

(b) Transposition of conductors that could result in the earthing system and any exposed conductive parts of the electrical installation becoming energized.

Inter-connection

……
……

(c) Interconnection of conductors between different circuits.

NOTE: Any MEN or ESR connection is not considered as a short-circuit.

Inter-mix

……
……

(a) there is no transposition of conductors that could result in the electrical equipment becoming unsafe when it is connected to supply, particularly where appliances are connected by socket-outlets;

8. What does a measurement of zero ohms indicate during an active inter-connection?

a) Load resistance.
b) Short circuit between active and neutral.
c) An active inter-connection.
d) A neutral inter-connection. (……)

9. What does a measurement of 7 ohms indicate during a short circuit test of final sub-circuit?

a) Load resistance.
b) Short circuit between active and neutral.
c) An active inter-connection.
d) A neutral inter-connection. (……)

10. What does a measurement of 7 ohms indicate during an active inter-connection?

a) Load resistance.
b) Short circuit between active and neutral.
c) An active inter-connection.
d) A neutral inter-connection. (……)

11. What does a measurement of infinite ohms indicate during an active inter-connection?

a) An active inter-connection.
b) Short circuit between active and neutral.
c) No active inter-connection.
d) A neutral inter-connection. (……)

12. What does a measurement of infinite ohms indicate during a short circuit test of final sub-circuit?

a) Load resistance.
b) Short circuit between active and neutral.
c) An active inter-connection.
d) No short circuit between active and neutral (……)

13. What does a measurement of infinite ohms indicate during a neutral inter-connection?

a) No active inter-connection.
b) Short circuit between active and neutral.
c) No neutral inter-connection.
d) A neutral inter-connection. (……)

14. What does a measurement of zero ohms indicate during a short circuit test of final sub-circuit?

a) Load resistance.
b) Short circuit between active and neutral.
c) An active inter-connection.
d) A neutral inter-connection.

15. What does a measurement of zero ohms indicate during an active inter-connection test?

a) Load resistance.
b) Short circuit between active and neutral.
c) An active inter-connection.
d) A neutral inter-connection.

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Student Exercise 1

i. Look up in AS 3000 the Requirements for isolating in alternating current systems.

Clause ……

2.3.2.1.2 Alternating current systems

Provisions for isolation of conductors in a.c. systems are as follows:

(a) Active conductors All active conductors of an a.c. circuit shall be capable of being isolated by a device for isolation.

(b) Neutral conductor:

(i) No switch or circuit-breaker shall be inserted in the neutral conductor—

(A) of consumer mains; or

(B) where the neutral conductor is used as a combined protective earthing and neutral (PEN) conductor for protective earthing of any portion of an electrical installation.

ii. Which conductors of an AC system must be able to be isolated?

…… Clause ……

2.3.2.2 Devices for isolation

2.3.2.2.1 General

* Devices for isolation shall effectively isolate all active conductors from the circuit.

iii. May a switch operate in the neutral of consumers mains?

…… Clause ……

2.3.2.1.2 Alternating current systems

Provisions for isolation of conductors in a.c. systems are as follows:

(a) Active conductors All active conductors of an a.c. circuit shall be capable of being isolated by a device for isolation.

(b) Neutral conductor:

(i) No switch or circuit-breaker shall be inserted in the neutral conductor—

(A) of consumer mains; or

(B) where the neutral conductor is used as a combined protective earthing and neutral (PEN) conductor for protective earthing of any portion of an electrical installation

iv. Under what conditions may a switch operate in the neutral of a final sub-circuit?

……

…… Clause ……

2.3.2.1.2 Alternating current systems

ii) A switch or circuit-breaker may operate in the neutral conductor of circuits other than those in Item (i) where—

(A) the neutral pole of a multi-pole switch or circuit-breaker, having an appropriate short-circuit breaking and making capacity, is linked and arranged to switch substantially together with all active poles; or

(B) the switch or circuit-breaker is linked with corresponding switches so that the neutral contact cannot remain open when the active contacts are closed

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Student Exercise 2.

i. Look up the clause of AS 3000 that covers polarization of socket outlets.

Clause ……

4.4.5 Polarization and phase sequence

Where socket-outlets of the same type form part of an electrical installation, the order of connection of the socket-outlets shall be the same.

All socket-outlets that accommodate three-pin/flat-pin plugs shall be connected so that, when viewed from the front of the socket-outlet, the order of connection commencing from the slot on the radial line shall be

earth, active, neutral in a clockwise direction.

ii. What do the rules say about the order of connection of socket outlets? Such as a number of three phase 10 Amp outlets.

……
……
…… Clause ……

4.4.2.2 Protection of socket-outlets

Socket-outlets shall be installed so that they will not be subjected to undue mechanical stress or damage in normal service.

In addition, the following applies:

(a) Where installed in a floor or other horizontal surface, socket-outlets shall be designed or arranged to prevent the accumulation of dust or water therein.

* NOTE: AS/NZS 3112 and AS/NZS 60884.1 contain requirements for socketoutlets intended to be mounted in a floor.

(b) Where installed within 75 mm of a floor, socket-outlets shall be installed so that any plug used with the socket-outlet is withdrawn in the horizontal plane.

Exception: This requirement does not apply to a socket-outlet that complies with Items (a) and (d).

(c) Socket-outlets shall be so installed that a plug is not likely to become loose or to malfunction because of gravity, vibration or the weight of the flexible cord or cable.

(d) Where installed in a location that is not readily accessible for the connection of a fixed or stationary appliance or a luminaire, the socket-outlet shall be securely fixed to a structure or support to ensure that no mechanical strain is placed on the installation wiring connections when inserting or removing a plug from the socket-outlet.

Exceptions: The socket-outlet need not be fixed in position where the installation meets the following conditions:

1 Cable connections are not subject to undue mechanical stress on any connection in accordance with Clause 3.7.2.6.

2 The wiring system, where likely to be disturbed, is supported in accordance with Clause 3.9.3.3.

3 The wiring system, where installed in a suspended ceiling, is supported in accordance with Clause 3.9.3.2.

iii. How is the polarization of single phase 10 Amp flat pin socket outlets described?

……
……
…… Clause ……

4.4.1.1.2 Socket-outlets—Alternative pin configurations

Socket-outlets with alternative pin configurations, e.g. UK, French, German and USA types, shall only be used under the following conditions:

(a) The socket-outlet shall be of the single set of apertures with an earthing contact and comply with the national Standard of the country, as shown in IEC/TR 60083. Single set of pin apertures of socketoutlets that accept multiple pin configurations shall not be used.

Exception: Shaver socket-outlets complying with AS/NZS 3194.

(b) The installation of the socket-outlet shall comply with Clause 4.4.4.

(c) The socket-outlet shall be rated at the voltage of the electrical installation, unless supplied at a lower voltage, in which case it may be rated at that lower voltage.

(d) Socket-outlets with alternative pin configurations normally supplying a voltage less than that of the electrical installation shall be supplied at that lower voltage.

(e) The socket-outlet shall have been tested to the equivalent of the requirements of the Standards listed in Clause 4.4.1.1.1, Items (a), (b), (c) and (d) above.

iv. Look up the clause of AS 3000 that covers lamp holders Edison screw.

Clause .....

4.5.1.2 Edison screw lamp holders

Every low voltage Edison screw lamp holder shall be connected to the supply so that, where a neutral conductor is required, it is connected to the outer contact.

Exception: This requirement need not apply where an Edison screw Lamp holder is incorporated in an appliance in a manner permitted by the AS/NZS 60335 series or the AS/NZS 3350 series, or the luminaire and the Lamp holder is provided with a shroud or skirt that prevents contact with the outer contact.

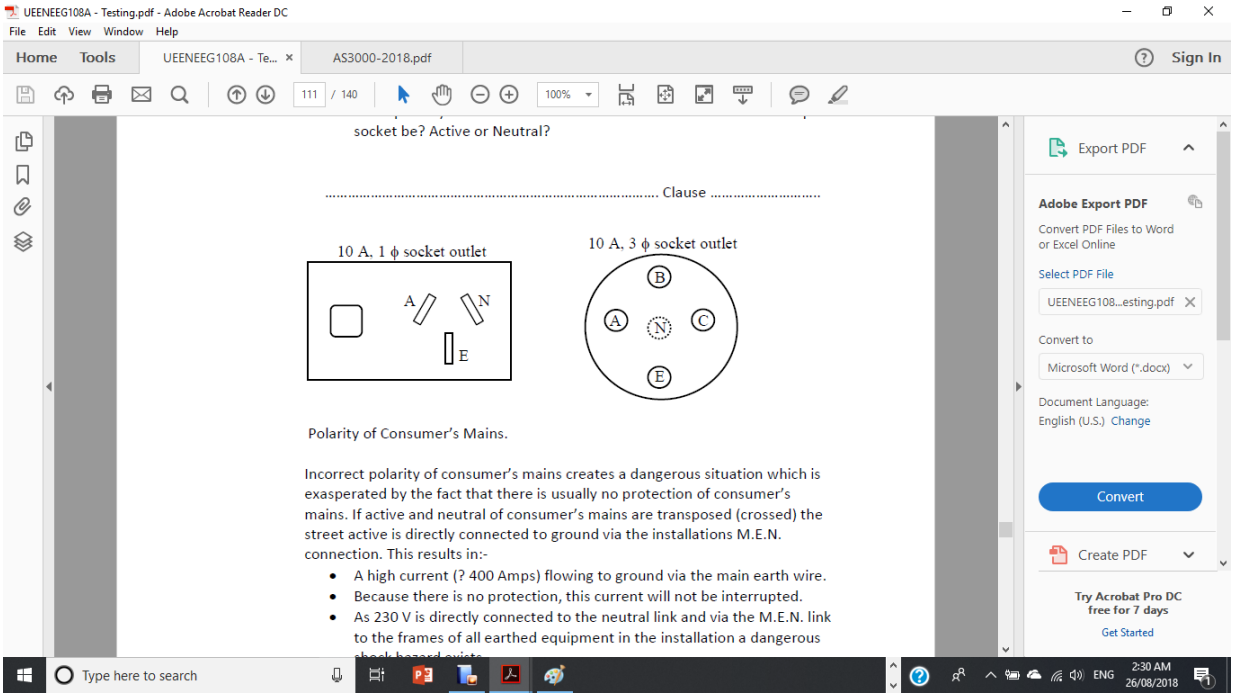
v. What polarity should the centre connection of an Edison screw lamp socket be? Active or Neutral?

..... Clause .....

Active

4.5.1.2 Edison screw lamp holders

Every low voltage Edison screw lamp holder shall be connected to the supply so that, where a neutral conductor is required, it is connected to the outer contact.



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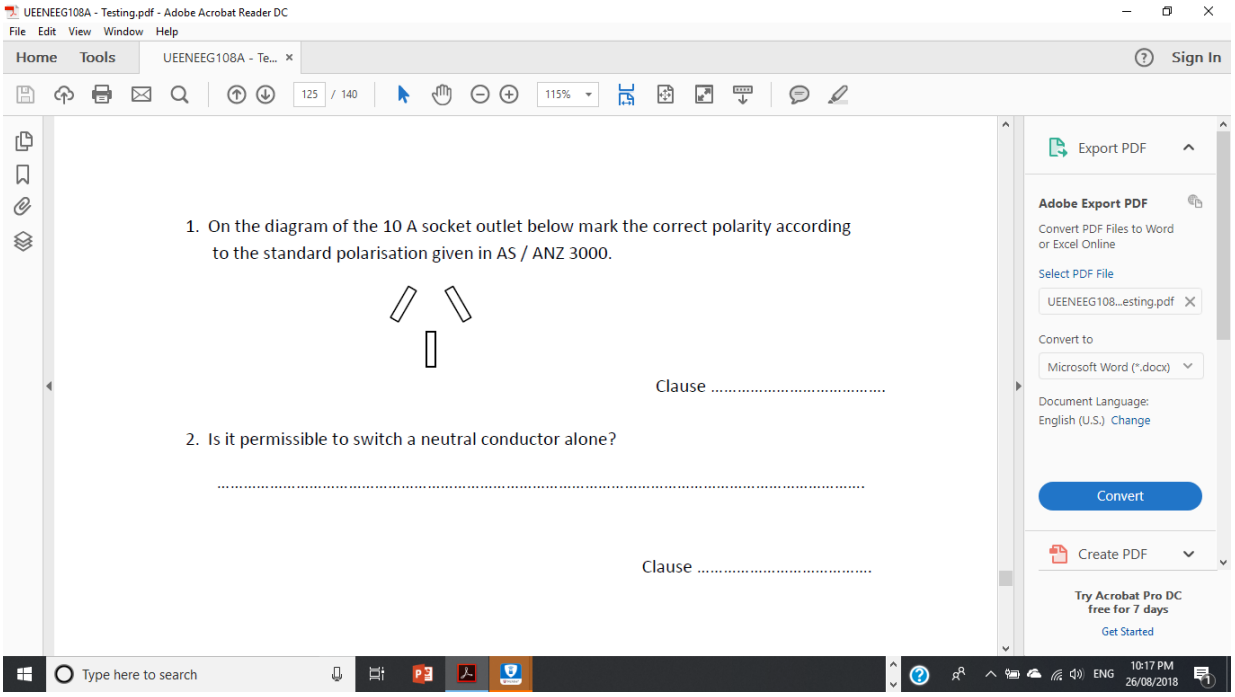


4.4.5 Polarization and phase sequence

Where socket-outlets of the same type form part of an electrical installation, the order of connection of the socket-outlets shall be the same.

All socket-outlets that accommodate three-pin/flat-pin plugs shall be connected so that, when viewed from the front of the socket-outlet, the order of connection commencing from the slot on the radial line shall be earth, active, neutral in a clockwise direction.

2.3.2.1.2 Alternating current systems

Provisions for isolation of conductors in a.c. systems are as follows:

(a) Active conductors All active conductors of an a.c. circuit shall be capable of being isolated by a device for isolation.
(b) Neutral conductor:
(i) No switch or circuit-breaker shall be inserted in the neutral conductor—
(A) of consumer mains; or
(B) where the neutral conductor is used as a combined protective earthing and neutral (PEN) conductor for protective earthing of any portion of an electrical installation

2.3.2.1.2 Alternating current systems
ii) A switch or circuit-breaker may operate in the neutral conductor of circuits other than those in Item (i) where—
(A) the neutral pole of a multi-pole switch or circuit-breaker, having an appropriate short-circuit breaking and making capacity, is linked and arranged to switch substantially together with all active poles; or
(B) the switch or circuit-breaker is linked with corresponding switches so that the neutral contact cannot remain open when the active contacts are closed

3. What must the polarity be of the thread section of an Edison screw lamp socket?
……
Clause ……

4.5.1.2 Edison screw lamp holders
Every low voltage Edison screw lamp holder shall be connected to the supply so that, where a neutral conductor is required, it is connected to the outer contact.

4. What must be done to eliminate parallel connection to load resistance when polarity testing a circuit with connected load?

……

1. The active and neutral of one circuit are disconnected.
2. Using the ohms range of an IR Tester (or an ohmmeter) measure the resistance between the disconnected circuit active and all other actives (load side of general main switch).

5. Why is polarity testing necessary?
……
Clause ……
8.3.7 Polarity

8.3.7.1 General

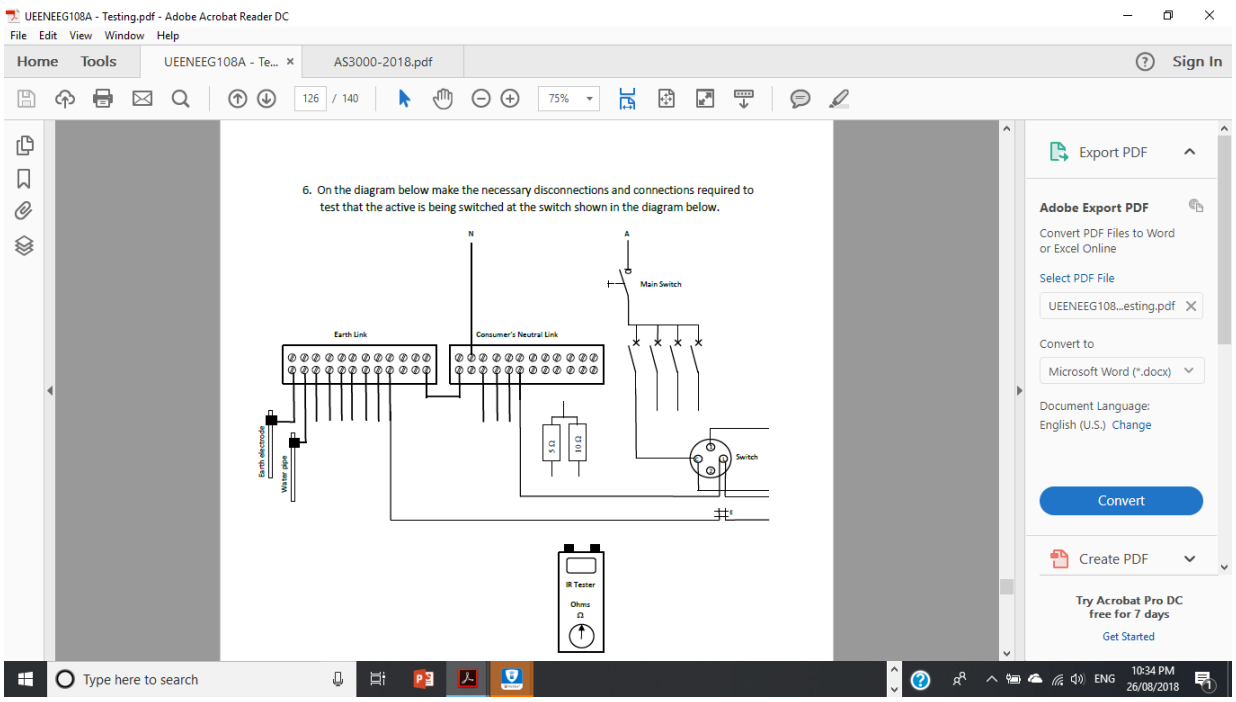
Polarity testing shall be carried out to ensure that no shock hazard arises from the incorrect connection of active, neutral and earthing conductors. This testing is to prevent—

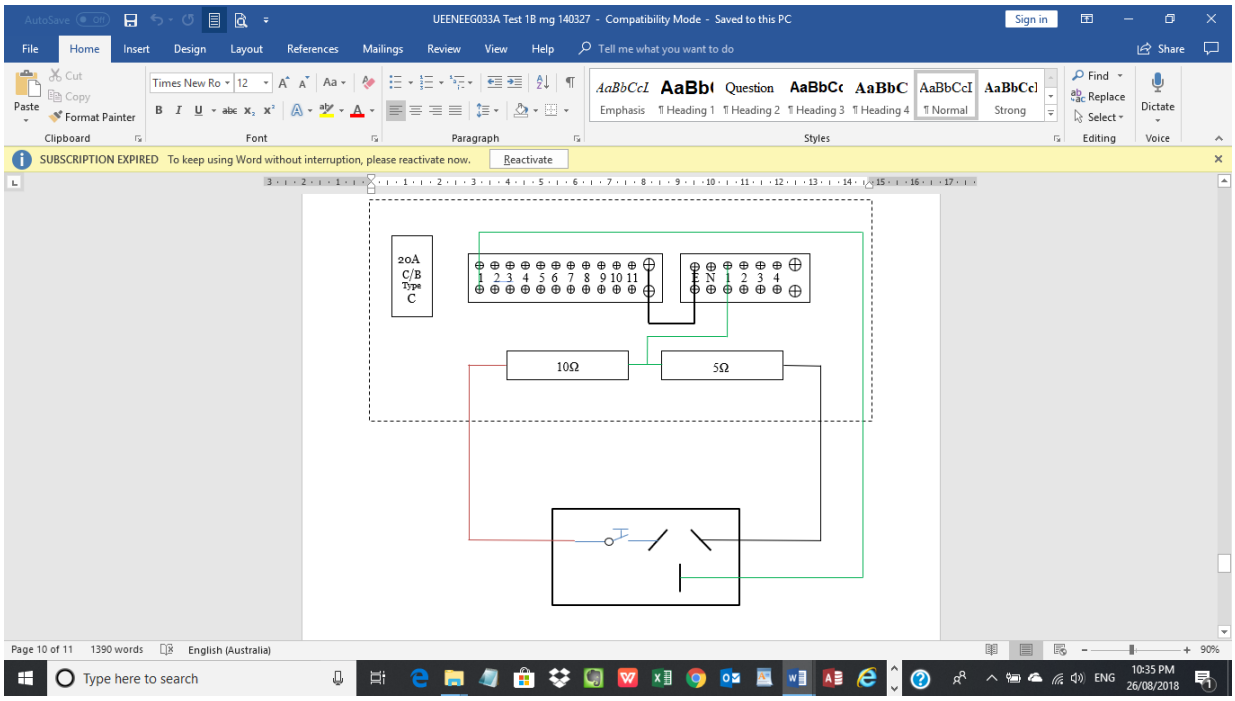
(a) the transposition of active and neutral conductors of the consumer mains, or submains supplying an outbuilding having an MEN connection, resulting in the electrical installation earthing system becoming energized;

(b) combinations of incorrect active, neutral and earthing conductor connections resulting in the exposed conductive parts of the electrical installation becoming energized;

(c) the connection of switches or protective devices in neutral conductors, resulting in parts of appliances, such as heating elements and lampholders, remaining energized when the switches are in the 'OFF' position; and

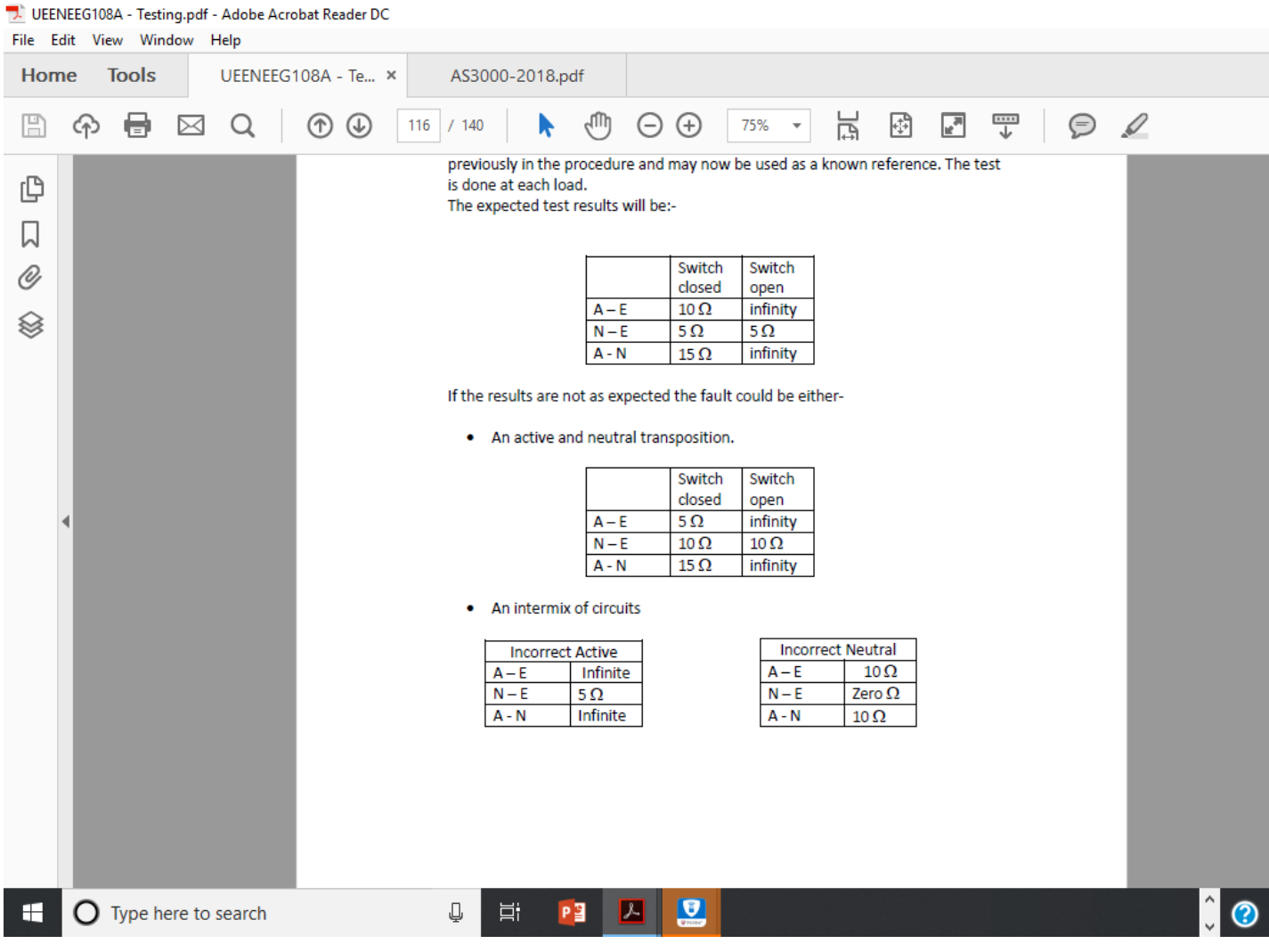
(d) multiphase equipment, such as multiphase motors, and semiconductor-controlled equipment operating in an unpredictable manner.





Determine the type of fault from these results of a polarity test on a socket outlet.
A – N = 10 Ohms
A – E = 10 Ohms
N – E = 0 Ohms

.....



	Switch closed	Switch open
A – E	10 Ω	infinity
N – E	5 Ω	5 Ω
A - N	15 Ω	infinity

	Switch closed	Switch open
A – E	5 Ω	infinity
N – E	10 Ω	10 Ω
A - N	15 Ω	infinity

Incorrect Active	
A – E	Infinite
N – E	5 Ω
A - N	Infinite

Incorrect Neutral	
A – E	10 Ω
N – E	Zero Ω
A - N	10 Ω

8. Is polarity testing mandatory?

……

Clause ……

Yes

8.3.7 Polarity

8.3.7.1 General

Polarity testing shall be carried out to ensure that no shock hazard arises from the incorrect connection of active, neutral and earthing conductors.

9. After testing how do you know that the circuit is safe, correctly wired and functioning as designed?

……

……

……

8.3.3.2 Extra-low voltage

Testing shall be carried out on parts of electrical installations designed to operate at extra-low voltage as follows:

(a) Continuity of the earthing system for PELV circuits in accordance with Clause 8.3.5.

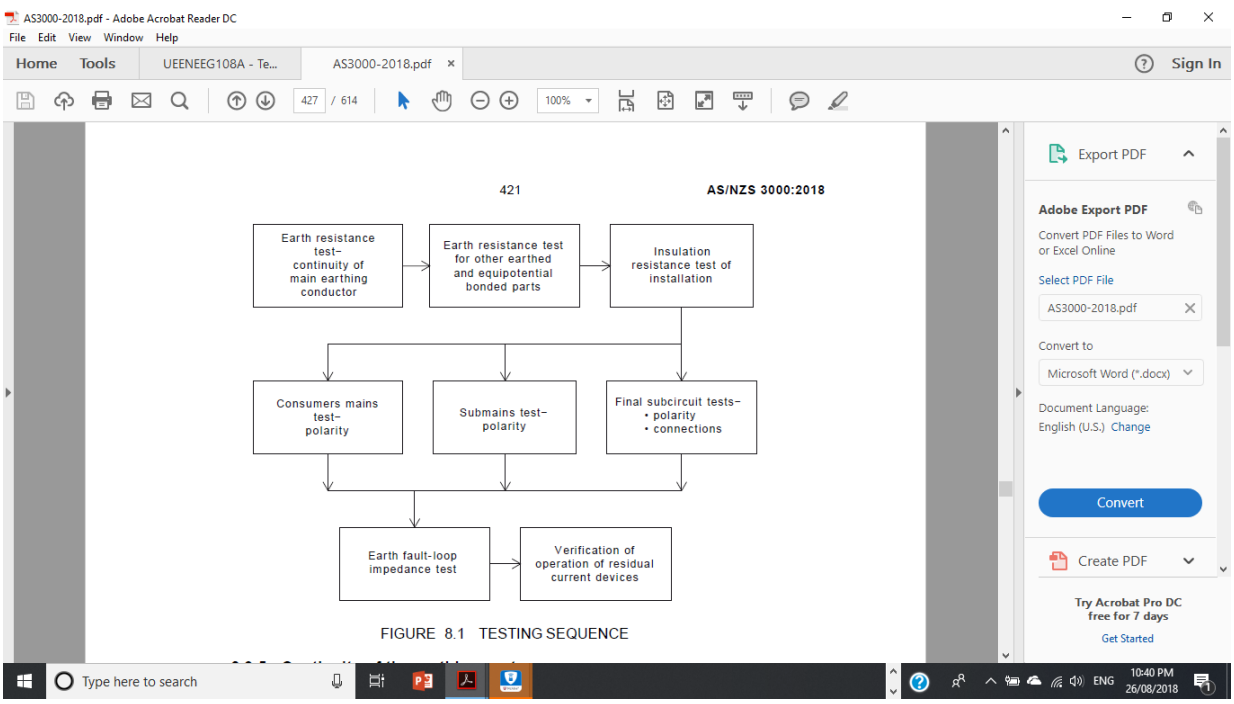
(b) Insulation resistance in accordance with Clause 7.5.12.

(c) Polarity for PELV circuits in accordance with Clause 8.3.7.

(d) Correct circuit connections in accordance with Clause 8.3.8.

8.3.3.3 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



10. If you have a room full of extra low voltage down lights what is the best way to test that active is being switched?

……

……

Polarity test procedure.

• Connect the dead test resistors. Red – Active, Black – Neutral and Green / Yellow – Earth.

• The following steps test Polarity, Transposition and intermix of circuits at the same time. (Inter-connection of neutral will also be detected but should have been picked up previously.)

• Go to each load point in the circuit and using the ohms range measure the resistance between: -

Active and Earth, should be 10 ohms. Operate switch to prove active is switched.

- Neutral and Earth, should be 5 ohms. Operate switch to prove neutral is not switched.
- Active and neutral, should be 15 ohms.

Note: If the results are not as expected one of the three faults above exists

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8.3.3 Mandatory tests

8.3.3.1 Low voltage

* Testing shall be carried out on parts of electrical installations designed to operate at low voltage as follows:

(a) Continuity of the earthing system (earth resistance of the main earthing conductor, protective earthing conductors, PEN conductors and bonding conductors), in accordance with Clause 8.3.5.

(b) Insulation resistance, in accordance with Clause 8.3.6.

(c) Polarity, in accordance with Clause 8.3.7.

(d) Correct circuit connections, in accordance with Clause 8.3.8.

(e) Verification of impedance required for automatic disconnection of supply (earth fault-loop impedance), in accordance with Clause 8.3.9.

(f) Operation of RCDs, in accordance with Clause 8.3.10.

Q1. Is fault loop impedance measurement a mandatory test?

……

Clause ……..

e) Verification of impedance required for automatic disconnection of supply (earth fault-loop impedance), in accordance with Clause 8.3.9.

Q2. Is testing the operation of RCDs mandatory?

……

Clause ……..

(f) Operation of RCDs, in accordance with Clause 8.3.10.

Q3. What clause covers the verification of earth fault loop impedance?

Clause ……..

8.3.9.2 Methods

8.3.9.2.1 General

One of the following methods (Clause 8.3.9.2.2 or 8.3.9.2.3) shall be used, depending on availability of supply.

8.3.9.2.2 Supply available

Where supply is available, the earth fault-loop impedance for each branch of each final subcircuit shall be determined using an earth fault-loop impedance tester at the socket-outlet furthest from the supply.

The MEN connection shall be left intact.

8.3.9.2.3 No supply available

Where no supply is available, the total resistance (R_{phe}) of the active and protective earthing conductors of the circuit shall be measured using an ohmmeter.

8.3.9.3 Results

The values obtained shall satisfy the requirements of Clause 5.7.4.

This requirement is deemed to be satisfied if—

(a) the earth fault-loop impedance, measured in accordance with Clause 8.3.9.2.2, does not exceed the value shown in Table 8.1 for the applicable type and rating of the protective device; or

(b) the total resistance (R_{phe}) of the of the active and protective earthing conductors, measured in accordance with Clause 8.3.9.2.3 does not exceed the value shown in Table 8.2 for the applicable circuit protection rating and required disconnection time.

Q4. What clause covers the operation of RCDs?

Clause .....

8.3.10 Operation of RCDs

* To verify that RCDs have been correctly installed, tests shall be performed on all RCDs.

* The function of the RCD shall be verified either by the operation of the integral test device, or by the use of special test equipment.

* In all cases, isolation of all switched poles shall be verified after the RCD has operated to disconnect the designated circuit.

* Isolation of all poles shall be verified by voltage tests or, after removing supply, by continuity checks through each pole.

Q5. Is it necessary to test RCDs if supply is not available?

.....

Clause .....

8.3.10 Operation of RCDs

Exception: In Australia, testing is not required if supply is not available

Refer to clause 8.3.10 of AS 3000

Q1. In Australia, where supply is available, the function of the RCD shall be verified by:-

……

……

8.3.10 Operation of RCDs

* To verify that RCDs have been correctly installed, tests shall be performed on all RCDs.

* The function of the RCD shall be verified either by the operation of the integral test device, or by the use of special test equipment.

* In all cases, isolation of all switched poles shall be verified after the RCD has operated to disconnect the designated circuit.

* Isolation of all poles shall be verified by voltage tests or, after removing supply, by continuity checks through each pole

NOTES:

1 Tripping the RCD by means of the integral test device establishes—

(a) the RCD is functioning correctly; and

(b) the integrity of the electrical and mechanical elements of the tripping device.

2 Operation of the integral test device does not provide a means of checking—

(a) the continuity of the main earthing conductor or the associated circuit protective earthing conductors;

(b) any earth electrode or other means of earthing; or

(c) any other part of the associated electrical installation earthing.

* 3 Guidance on the suitability of types of RCD is contained in Clause 2.6.2.2.

* 4 There is no requirement to test the operating time of RCDs. Operating time is a function of the type of RCD.

* 5 A suitable test could be performed using a test plug with a resistor between the active and earth pins.

Q2. Tripping the RCD by means of the integral test device establishes—

(a) ……

and

(b)……

……

1 Tripping the RCD by means of the integral test device establishes—

(a) the RCD is functioning correctly; and

(b) the integrity of the electrical and mechanical elements of the tripping device.

Q3. Operation of the integral test device does not provide a means of checking—

(a) the continuity of the main earthing conductor or the associated circuit

…… ; or

(b) …… or other means of earthing; or

(c) any other part of the associated …… .

2 Operation of the integral test device does not provide a means of checking—
(a) the continuity of the main earthing conductor or the associated circuit protective earthing conductors;
(b) any earth electrode or other means of earthing; or
(c) any other part of the associated electrical installation earthing

Q4. Using your acquired knowledge of installation testing, how is the integrity and compliance of the earthing system checked?

.....
.....

8.3.5 Continuity of the earthing system

8.3.5.1 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 a PEN submain is installed in accordance with Clause 5.5.3.1(c), 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.

Refer to clause 8.4 of AS 3000
Q4. In order to enable re-verification of the installation wiring in the future:-
The initial date of energising the installation should be available on-site, either by:-

.....

8.4 VERIFICATION RECORDS

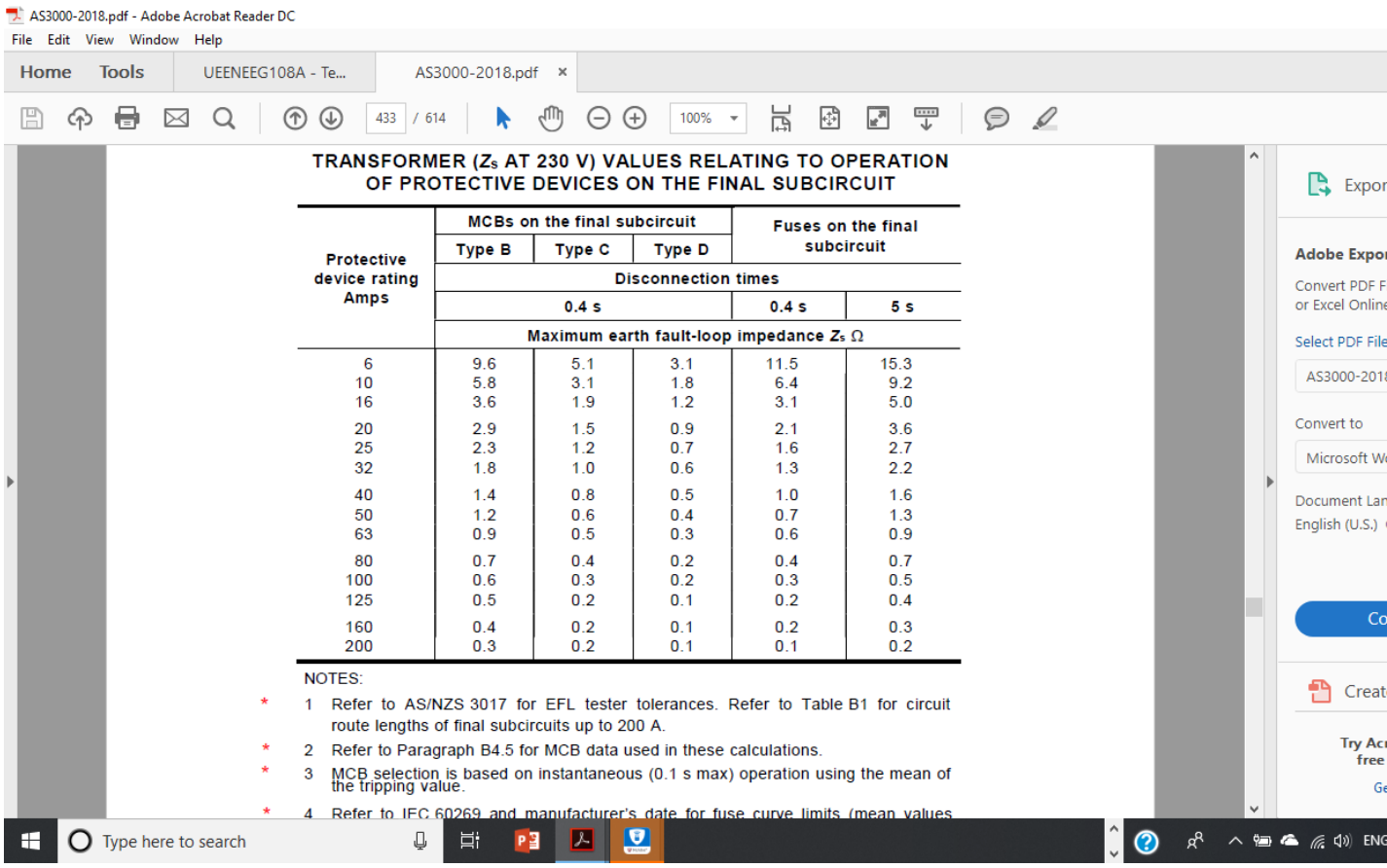
* The date of initial certification of an installation shall be available on-site, by permanent, indelible marking on or at the main switchboard.

NOTE: In order to enable reverification, it is necessary to know the details of the original verification. This will facilitate the operation of a reverification regime, when instituted.

Q1. Find the maximum wire resistance of active and earth allowable for a three phase circuit supplying a 20 A socket outlet with a D25 A circuit breaker, 4 mm^2 actives and a 2.5mm^2 earth wire.

Q2. Find the maximum resistance of the 1.5 mm^2 active and 1.5 mm^2 earth wires for a lighting circuit protected by a C16 A circuit breaker

Q3. Find the maximum resistance of the 1.5 mm^2 active and 1.5 mm^2 earth wires for a lighting circuit protected by a 16 A HRC fuse.



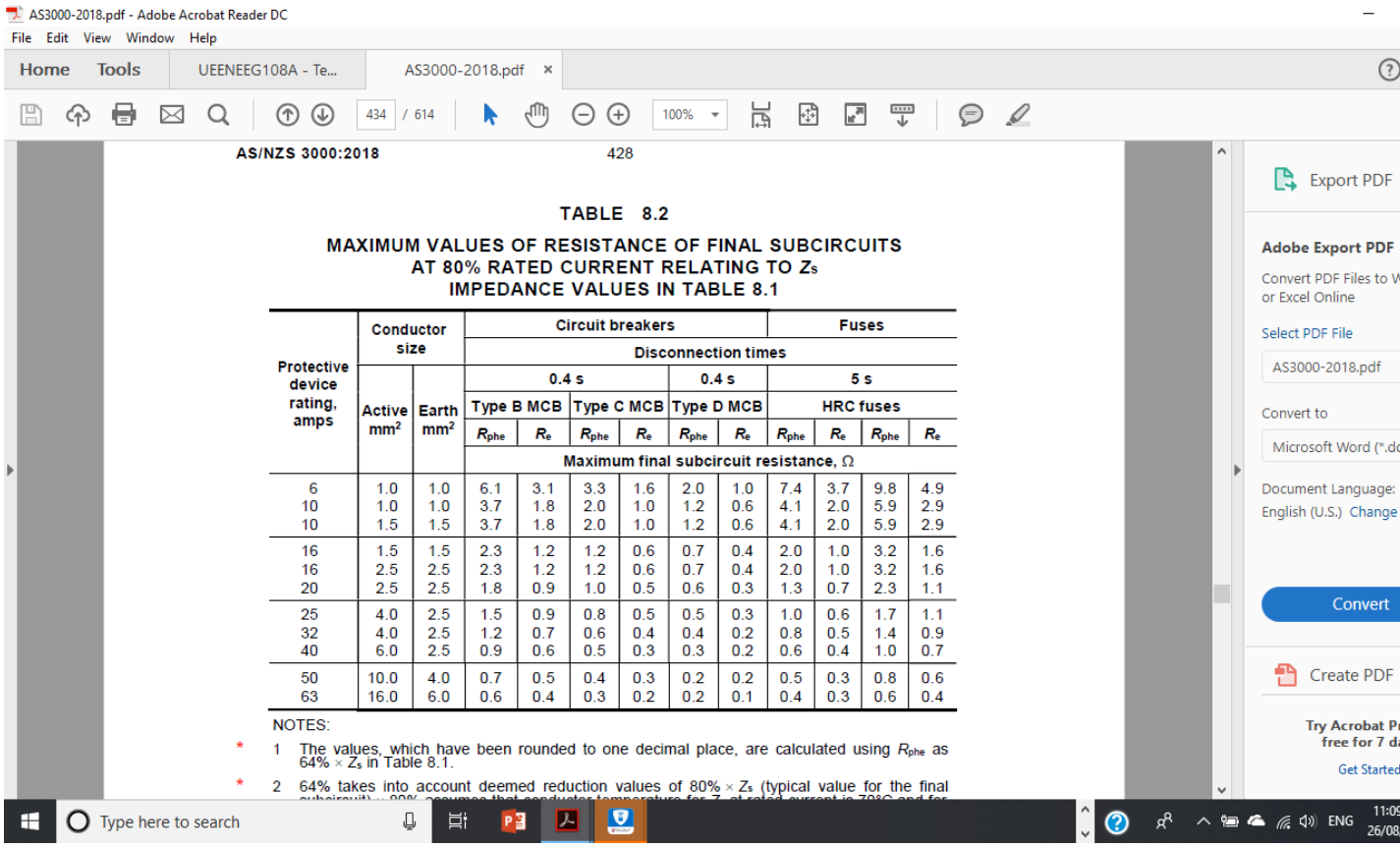


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TABLE 8.2

MAXIMUM VALUES OF RESISTANCE OF FINAL SUBCIRCUITS AT 80% RATED CURRENT RELATING TO Z_s IMPEDANCE VALUES IN TABLE 8.1

Protective device rating, amps	Conductor size		Circuit breakers						Fuses			
			Disconnection times									
			0.4 s				0.4 s		5 s			
	Active mm²	Earth mm²	Type B MCB		Type C MCB		Type D MCB		HRC fuses			
			R_{phe}	R_e	R_{phe}	R_e	R_{phe}	R_e	R_{phe}	R_e	R_{phe}	R_e
			Maximum final subcircuit resistance, Ω									
6	1.0	1.0	6.1	3.1	3.3	1.6	2.0	1.0	7.4	3.7	9.8	4.9
10	1.0	1.0	3.7	1.8	2.0	1.0	1.2	0.6	4.1	2.0	5.9	2.9
10	1.5	1.5	3.7	1.8	2.0	1.0	1.2	0.6	4.1	2.0	5.9	2.9
16	1.5	1.5	2.3	1.2	1.2	0.6	0.7	0.4	2.0	1.0	3.2	1.6
16	2.5	2.5	2.3	1.2	1.2	0.6	0.7	0.4	2.0	1.0	3.2	1.6
20	2.5	2.5	1.8	0.9	1.0	0.5	0.6	0.3	1.3	0.7	2.3	1.1
25	4.0	2.5	1.5	0.9	0.8	0.5	0.5	0.3	1.0	0.6	1.7	1.1
32	4.0	2.5	1.2	0.7	0.6	0.4	0.4	0.2	0.8	0.5	1.4	0.9
40	6.0	2.5	0.9	0.6	0.5	0.3	0.3	0.2	0.6	0.4	1.0	0.7
50	10.0	4.0	0.7	0.5	0.4	0.3	0.2	0.2	0.5	0.3	0.8	0.6
63	16.0	6.0	0.6	0.4	0.3	0.2	0.2	0.1	0.4	0.3	0.6	0.4

NOTES:

* 1 The values, which have been rounded to one decimal place, are calculated using R_{phe} as 64% × Z_s in Table 8.1.

* 2 64% takes into account deemed reduction values of 80% × Z_s (typical value for the final

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Examples.

E.g. 1.

A range circuit is protected by a 32 Amp HRC fuse. What is the maximum value of internal earth fault loop impedance?

(a) From table 8.1 obtain the maximum total earth fault loop impedance.

32 Amp 5 seconds = 2.19 Ohms.

(b) Determine maximum internal value of earth fault loop impedance.

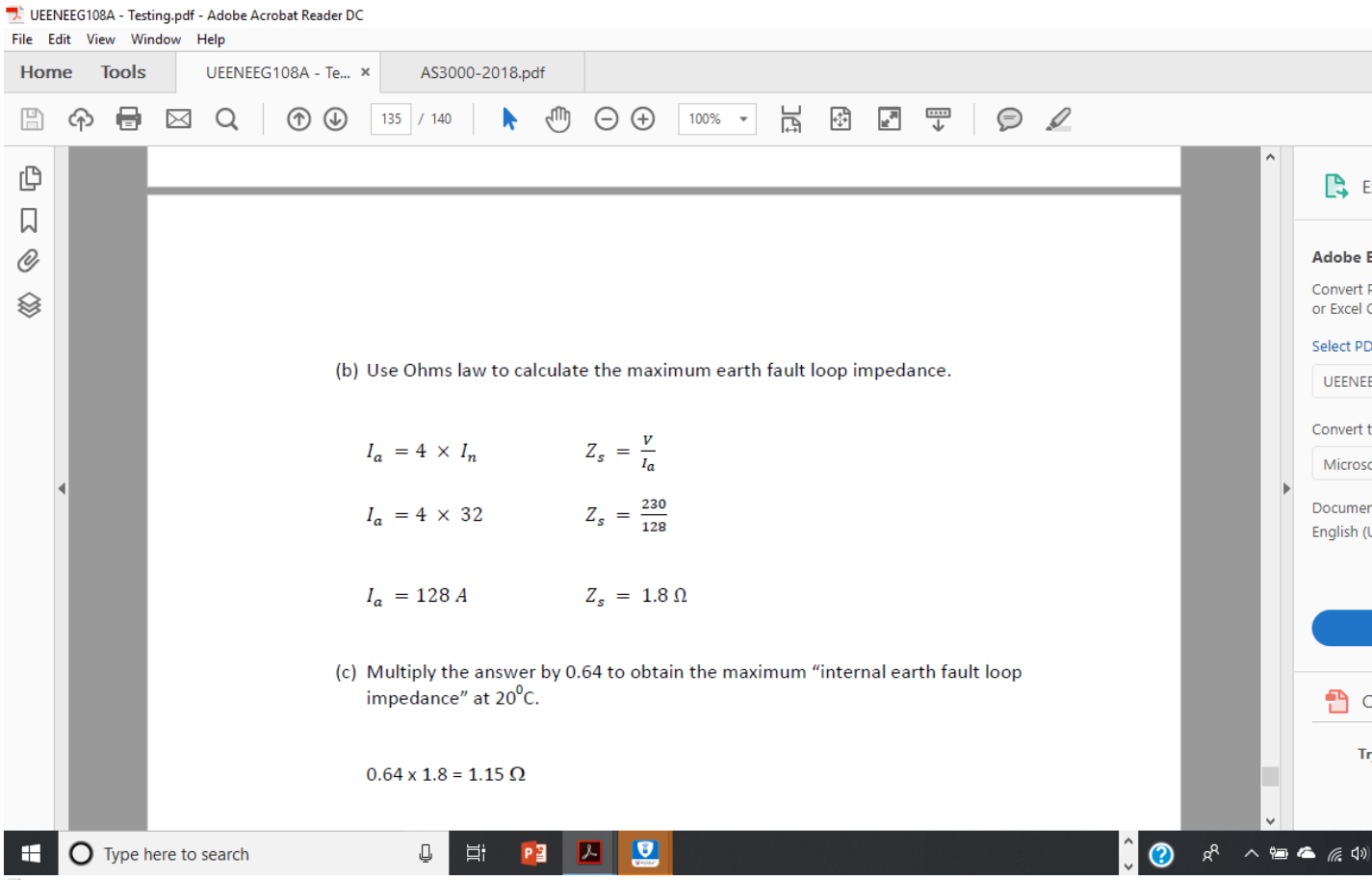
2.19 Ω x 0.64 = 1.4 Ω

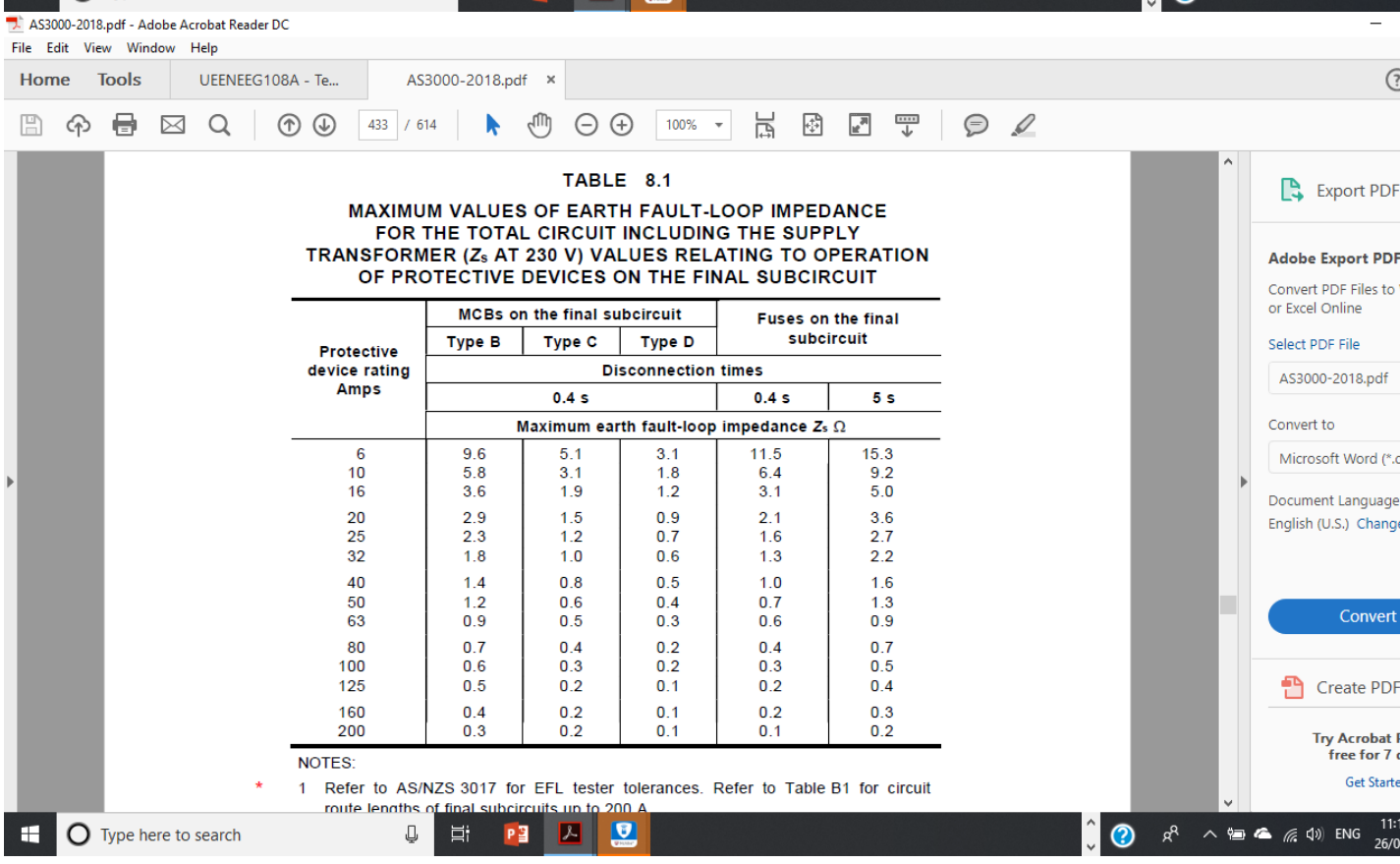
E.g. 2.

A range circuit is protected by a C32 Amp Clipsal circuit breaker. What is the maximum value of internal earth fault loop impedance?

(a) Read from the Clipsal miniature circuit breaker characteristic curve the multiple of rated current to trip the C/B in 5 seconds.

On average a value of 4 times is obtained





Do yourself

Student exercise 4.

Q1.

An air conditioner circuit is protected by a 25 Amp HRC fuse. What is the maximum value of internal earth fault loop impedance?

Q2.

An air conditioner circuit is protected by a C25 Amp Clipsal circuit breaker. What is the maximum value of internal earth fault loop impedance?

More accurate measurement of earth fault loop impedance.

1. If a high resistance is measured between active and earth during the polarity test this indicates a problem. To measure the wire resistance only remove the dead test resistors and short the active and earth wires of the circuit together at the switchboard. Go to the furthest end of the circuit and measure the resistance between active and earth. This will be the resistance of the wires only.

This method is only as accurate as the ohmmeter used and also only measures the final sub-circuit. Used in conjunction with table 8.2 as covered above a rough result is obtained that does the job most of the time.

2. A more accurate result can be obtained by testing with a dedicated Earth Fault Loop Impedance Tester. This instrument must connected to a live circuit and so limits the test to after supply is available. Basically it automatically takes a few readings and calculates the impedance.

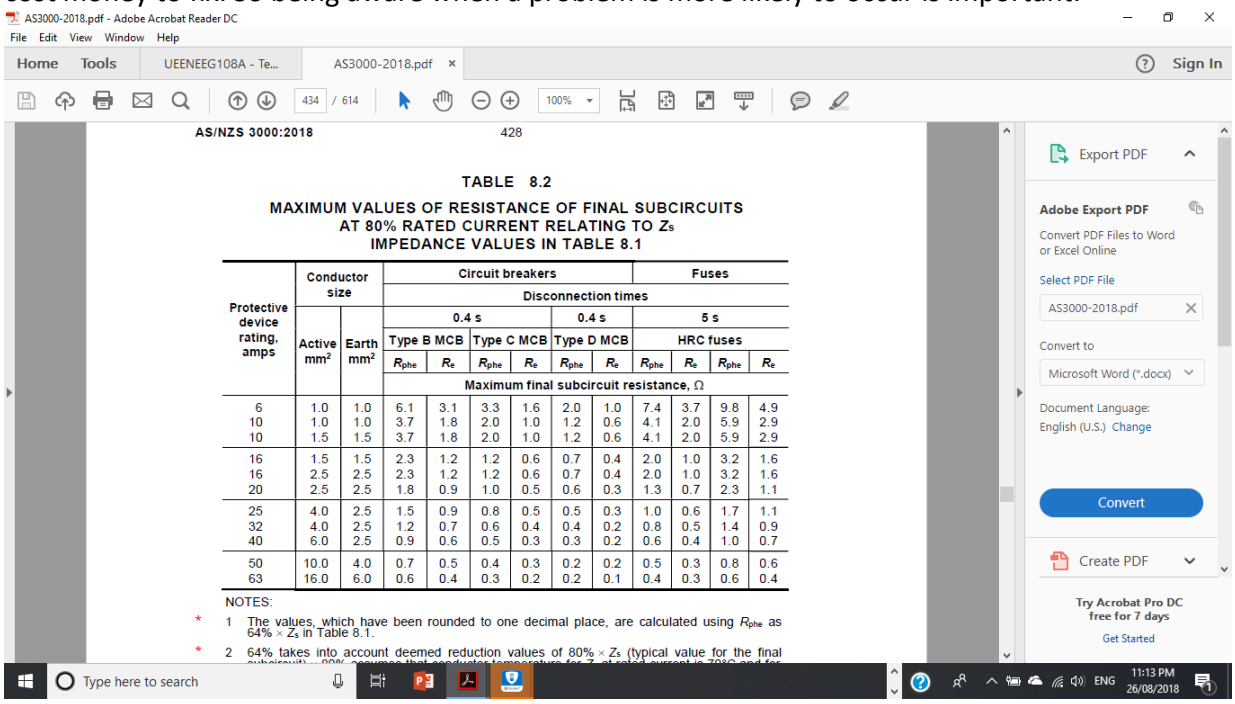
(a) Measures open circuit voltage of the circuit at the longest point of the circuit.

(b) Places a set current load on the circuit between active and earth and measures the circuit voltage on load.

(c) The difference in voltage divided by the set current equates to the Earth Fault Loop Impedance and is displayed on the register of the meter.

You could do this test yourself using a 10 Amp appliance and a digital voltmeter.

The live test is much better but can't be done until the job is finished. If a problem is found it will cost money to fix. So being aware when a problem is more likely to occur is important.



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			Disconnection times							
			0.4 s				0.4 s		5 s	
	Active mm²	Earth mm²	Type B MCB		Type C MCB		Type D MCB		HRC fuses	
			R_{phe}	R_e	R_{phe}	R_e	R_{phe}	R_e	R_{phe}	R_e	R_{phe}	R_e
			Maximum final subcircuit resistance, Ω							
6	1.0	1.0	6.1	3.1	3.3	1.6	2.0	1.0	7.4	3.7	9.8	4.9
10	1.0	1.0	3.7	1.8	2.0	1.0	1.2	0.6	4.1	2.0	5.9	2.9
10	1.5	1.5	3.7	1.8	2.0	1.0	1.2	0.6	4.1	2.0	5.9	2.9
16	1.5	1.5	2.3	1.2	1.2	0.6	0.7	0.4	2.0	1.0	3.2	1.6
16	2.5	2.5	2.3	1.2	1.2	0.6	0.7	0.4	2.0	1.0	3.2	1.6
20	2.5	2.5	1.8	0.9	1.0	0.5	0.6	0.3	1.3	0.7	2.3	1.1
25	4.0	2.5	1.5	0.9	0.8	0.5	0.5	0.3	1.0	0.6	1.7	1.1
32	4.0	2.5	1.2	0.7	0.6	0.4	0.4	0.2	0.8	0.5	1.4	0.9
40	6.0	2.5	0.9	0.6	0.5	0.3	0.3	0.2	0.6	0.4	1.0	0.7
50	10.0	4.0	0.7	0.5	0.4	0.3	0.2	0.2	0.5	0.3	0.8	0.6
63	16.0	6.0	0.6	0.4	0.3	0.2	0.2	0.1	0.4	0.3	0.6	0.4

NOTES:

* 1 The values, which have been rounded to one decimal place, are calculated using R_{phe} as 64% × Z_s in Table 8.1.

* 2 64% takes into account deemed reduction values of 80% × Z_s (typical value for the final