

- 2 *Overcurrent protective devices shall not be provided where the unexpected interruption of the supply could cause a greater danger than overcurrent.*

★ **4.12.5.2.2 RCDs**

The possible waveform of a fault current to earth can affect the operation of RCDs and shall be taken into account for the selection of the type of RCD.

Where an electricity converter includes an inverter, the RCD shall be of a type suitable for the waveform of the particular inverter, and in accordance with the inverter manufacturer's recommendations.

NOTE: Requirements for types of RCDs are set out in Clause 2.6.2.2.

**4.12.6 Earthing**

The output of an electricity converter shall be provided with the same type of earthing system used for the associated electrical installation.

Protective earthing conductors shall not be switched.

Provision shall be made to ensure that all necessary connections for protection, such as the MEN connection, remain intact when supply is available from the output of the system.

NOTE: See Clause 4.12.2 for information regarding Standards applicable to various devices.

**4.12.7 Neutral continuity**

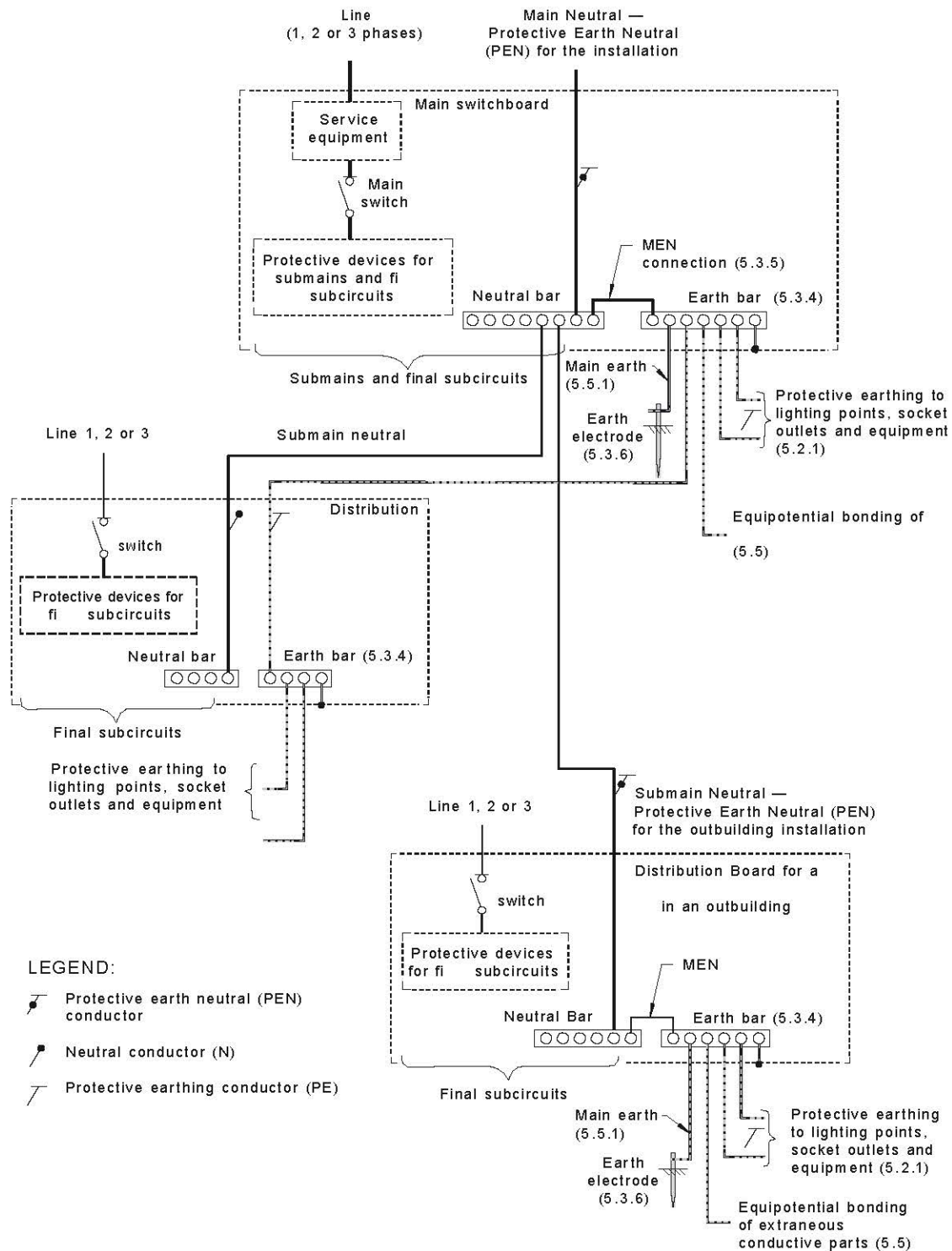
Electricity converters, particularly static converters, such as UPS, shall be arranged to ensure that the continuity of the neutral conductor to the load is not interrupted during bypass or maintenance switching.

**4.12.8 Electrical equipment connected to output**

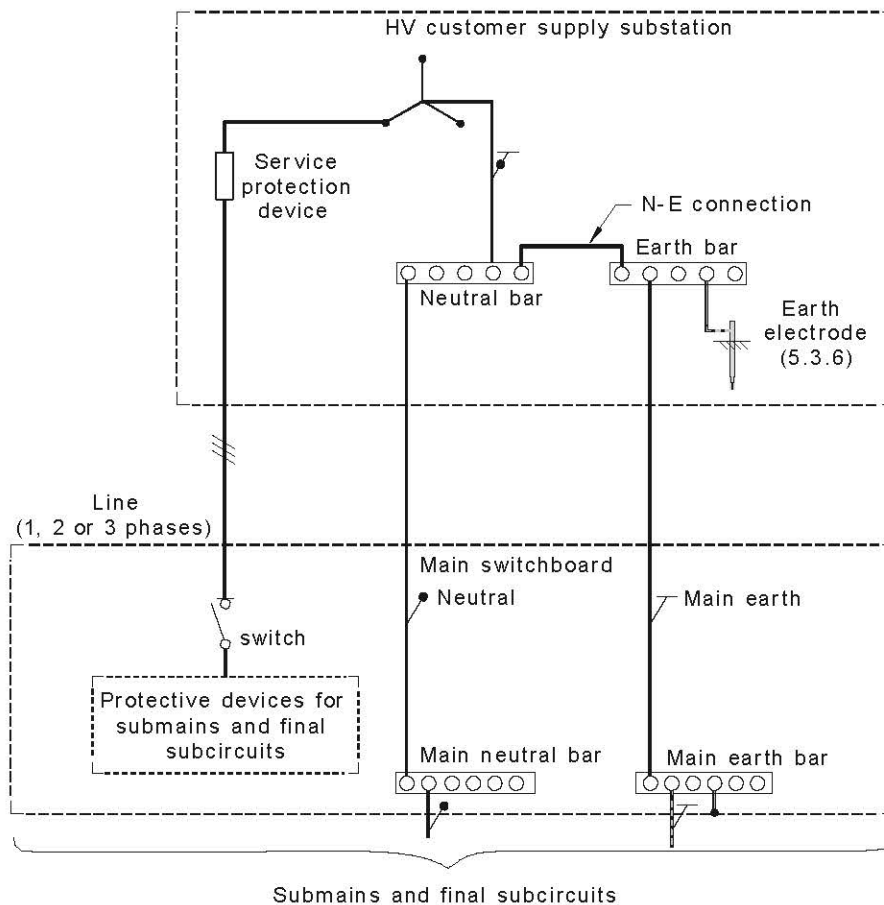
All electrical equipment connected to the output side of an electricity converter shall be suitable for the voltage, current and frequency of the output of the unit.

NOTES:

- 1 The values of current-carrying capacity and voltage drop specified in the AS/NZS 3008.1 series are only valid for conductors operating at 50 Hz.
- 2 For the type of RCD to be used where additional protection is required for circuits or equipment supplied by an electricity converter, refer to Clause 2.6.2.2.



**FIGURE 5.1 MULTIPLE EARTHED NEUTRAL (MEN) SYSTEM OF EARTHING—GENERAL ARRANGEMENT PEN DISTRIBUTION/TN-C-S**



## LEGEND:

⎓ Protective earth neutral (PEN) conductor

⋅ Neutral conductor (N)

⎓ Protective earthing conductor (PE)

NOTE: Symbols are explained in Appendix J.

FIGURE 5.2 ALTERNATIVE EARTHING ARRANGEMENT IN AN OWNER OR USER OPERATED SUPPLY SUBSTATION INSTALLATION

#### 5.1.4 Other earthing systems

Alternatives to the MEN system may be permitted, provided that the requirements of Part 1 of this Standard are satisfied, taking into account any effects on the distribution system supplying the installation.

*Examples:*

- 1 *Electrical installations and supply systems, in accordance with the descriptions and compliance conditions permitted by IEC 60364 series.*

- 2 *Electrical installations in surface mines complying with AS/NZS 3007 which permits the use of TN, TT and IT systems.*
- 3 *Existing installations may still remain connected under former direct earthing or voltage operated earth leakage circuit breaker (ELCB) systems permitted by superseded editions of this Standard.*
- 4 *Earthing/bonding arrangements for installations that are not supplied from a distribution system.*
- \* 5 *Electrical installations complying with IEC 60364 series which permits the use of TN, TT and IT systems as alternatives to the MEN system.*

## 5.2 EARTHING FUNCTIONS

### 5.2.1 Protective earthing

When a fault occurs between a live part and an exposed conductive part or parts of the protective earthing system, a prospective touch voltage may arise between simultaneously accessible conductive parts. Fault protection by means of automatic disconnection of supply is intended to limit this voltage.

Automatic disconnection is achieved by—

- (a) the provision of a protective earthing system in which exposed conductive parts are connected via conductors or similar medium to the earthed neutral of the distribution system; and
- (b) in the event of a fault current or excessive earth leakage current flowing in the protective earthing system, overcurrent or earth leakage current protective devices operate to disconnect the affected part of the installation within the specified maximum duration of the prospective touch voltage.

### 5.2.2 Functional earthing (FE)

Equipment may be required to be connected to the earthing system for purposes of correct operation rather than the safety conditions associated with protective earthing. In such cases, functional earthing conductors are not required to be selected and installed to withstand fault currents or to be identified in the same manner as a protective earthing conductor.

*Examples:*

- 1 *Functional earth (FE) connections fitted to certain types of RCDs to provide an earth for an alternative supply connection for the internal electronic circuit operation in the event of the incoming neutral connection becoming disconnected.*
- 2 *Conductors connecting cathodic protection systems or radio interference suppression devices to a separate earthing arrangement.*

- 3 *Where a 'clean earth' is specified for data or signalling purposes in a particular item of electrical equipment, the manufacturer of the electrical equipment should be consulted in order to confirm the necessary arrangements.*

Where required, for operational purposes, functional earth connections for data and signalling purposes should be insulated from all protective earthing connections and conductors and should only be connected together at one point, normally at the connection to the main earthing terminal/connection or bar.

Care needs to be exercised to avoid unintentional contact between the two earthing systems.

A conductor insulation colour for functional earth conductors has not been specified in this Standard. However, to ensure that functional earthing connections are made to the correct earthing system, a green or green/yellow conductor identification shall not be used.

In Australia, for telecommunication system earthing, see AS/CA S009 for the requirements for the colour and installation of a Telecommunications Reference Conductor. A

NOTE: Additional information on functional earthing is available in IEC 60364-4-44.

### 5.2.3 Earthing for combined protective and functional purposes

Where earthing for combined protective and functional purposes is required, the requirements for protective purposes shall prevail.

## 5.3 EARTHING SYSTEM PARTS

### 5.3.1 General

The protective earthing arrangement for an electrical installation providing protection by means of automatic disconnection of supply and connected to the MEN system of distribution shall include the following parts:

- (a) Protective earthing conductors connecting exposed conductive parts as required.
- (b) Main earthing conductor.
- (c) Main earthing terminal, connection or bar.
- (d) MEN connection between the main earthing terminal, connection or bar and the supply neutral bar.
- (e) Earth electrode.
- (f) Equipotential bonding of extraneous conductive and other parts as required.

NOTE: Examples of the parts of the MEN system of earthing are shown in Figures 5.1 and 5.2.

The parts of the earthing system shall comply with Clauses 5.3.2 to 5.3.7.



### 5.3.2 Earthing conductor material and type

#### 5.3.2.1 Conductor material

##### 5.3.2.1.1 Copper conductors

Copper earthing conductors shall be of high conductivity copper and shall be in the form of—

- (a) stranded conductors;
- (b) circular braided conductors; or
- (c) solid conductors having a cross-sectional area not less than 10 mm<sup>2</sup> and a thickness not less than 1.5 mm.

*Exceptions:*

- 1 *A smaller solid conductor may be used where permitted by a particular cable Standard.*
- 2 *This Clause need not apply where copper cable components, such as sheaths or screens, are deemed to be an earthing conductor in accordance with Clause 5.3.2.2.*

##### 5.3.2.1.2 Aluminium conductors

Aluminium conductors may be used as earthing conductors, provided that they comply with the following conditions:

- (a) Conductors of 10 mm<sup>2</sup> or less shall be solid conductors.
- (b) Minimum 16 mm<sup>2</sup> conductors shall be used for main earthing conductors.
- (c) Connection methods shall comply with Section 3 of this Standard.
- (d) Installation methods shall prevent corrosion of the conductor and connections.
- (e) Conductors shall not be installed underground or in damp situations.

*Exception: Aluminium earthing conductors may be installed underground or in damp situations where designed and suitable for such use.*

##### 5.3.2.1.3 Other materials

Materials other than copper or aluminium may be used as an earthing conductor. In such cases, the conductor resistance shall be not greater than that for a copper earthing conductor determined in accordance with Clause 5.3.3, and the degree of corrosion resistance shall not be inferior to other materials suitable for the purpose.

#### 5.3.2.2 Conductor type

Protective earthing conductors may include the following:

- (a) Earthing conductors that comply with Clause 5.3.2.1, separately installed.

- (b) Earthing conductors that comply with Clause 5.3.2.1, in a common enclosure with live conductors.
- (c) Earthing conductors in multi-core cables.
- (d) Busbars.

In addition, and subject to the special conditions of Clause 5.3.2.3, the following media may be regarded as a protective earthing conductor:

- (i) Conductive conduit, tube, pipe, trunking and similar wiring enclosures.
- (ii) Conductive sheaths, armours and screens of cables.
- (iii) Conductive framework used for mounting electrical equipment.
- (iv) Catenary wires for the support of cables.

Sprinkler pipes or pipes conveying gas, water, flammable liquid or other conductive non-electrical service enclosures shall not be used as an earthing medium.

NOTE: This requirement does not preclude the bonding of such conductive non-electrical service enclosures to conductive electrical service enclosures in accordance with Clause 5.6.

Main earthing conductors shall be of a type that complies with Clause 5.3.2.1.

#### **5.3.2.3 Special conditions**

The following conditions apply where the components in Clause 5.3.2.2(i), (ii), (iii) or (iv) are used for protective earthing:

- (a) *Conductive conduit, tube, pipe, trunking and similar wiring enclosures* May be regarded as a protective earthing conductor, provided that—
  - (i) the electrical equipment to be earthed is supplied by live conductors contained within the wiring enclosure; and
  - (ii) for screwed conductive wiring enclosures, the wiring enclosure is directly connected by conductive threads or locknuts to the electrical equipment to be earthed.
- (b) *Conductive sheaths, armours and screens of cables* May be regarded as a protective earthing conductor, provided that the electrical equipment to be earthed is supplied only by live conductors incorporated in the cable.

*Exception: This condition does not preclude the use of a MIMS cable sheath as a main earthing conductor, provided that any circuit-protective earthing conductors connected to the sheath are associated only with the circuits supplied through the MIMS cable.*

$K$  = factor dependent on the material of the protective earthing conductor, the insulation and other parts, and the initial and final temperatures

**NOTES:**

- 1 Values of  $K$  for protective earthing conductors in various conditions of service are given in the AS/NZS 3008.1 series, e.g. for copper conductors not laid up with other conductors, with PVC insulation  $K = 136$ , or for bare copper conductors  $K = 170$ .
- 2 Examples of the application of this equation are contained in the AS/NZS 3008.1 series.

If application of the equation produces non-standard sizes, conductors of the nearest higher standard cross-sectional area shall be used.

NOTE: Maximum permissible temperatures for joints should be considered (see the AS/NZS 3008.1 series).

**TABLE 5.1**  
**MINIMUM COPPER EARTHING CONDUCTOR SIZE**

Nominal size of active conductor mm <sup>2</sup>	Nominal size of copper earthing conductor, mm <sup>2</sup>	
	With copper active conductors	With aluminium active conductors
1	1*	—
1.5	1.5*	—
2.5	2.5	—
4	2.5	—
6	2.5	—
10	4	—
16	6	4
25	6	6
35	10	6
50	16	10
70	25	10
95	25	16
120	35	25
150	50	25
185	70	35
240	95	50
300	120	70
400	≥120†	≥95†
500	≥120†	≥95†
630	≥120†	≥120†
>630	≥25% of active size†	≥25% of active size†

\* These earthing conductors shall only be used where incorporated in a multi-core cable or flexible cord, other than a lift travelling cable, in accordance with Clause 5.3.3.4, Items (b) and (c).

† A larger earthing conductor may be required to satisfy Clause 5.3.3.1.1.



**TABLE 5.2**  
**ACCEPTABLE EARTH ELECTRODES**

Material	Surface treatment	Minimum dimensions	Minimum surface treatment thickness
Vertical electrodes			
Steel	Copper clad	Ø12 mm circular rod	250 µm
	Copper plated	Ø12 mm circular rod	250 µm
	Stainless (including clad with stainless)	Ø12 mm circular rod	500 µm
	Hot dipped galvanized	Ø16 mm circular rod	63 µm
	Hot dipped galvanized	Section with minimum cross-sectional area of 200 mm <sup>2</sup> and with no part less than 3 mm thick	63 µm
Non-ferrous (excluding aluminium)	Solid	12 mm	N/A
Horizontal (strip) electrodes			
Copper rod	Solid	Ø7 mm circular	N/A
Copper strip	Solid	25 mm × 1.6 mm	N/A
Copper pipe	Bare	Ø15 mm circular × 2.45 mm wall thickness	N/A
Copper cable	Bare	25 mm <sup>2</sup>	N/A
Steel pipe	Hot dipped galvanized	Ø20 mm circular × 3 mm wall thickness	63 µm
Steel strip	Hot dipped galvanized	40 mm × 3 mm	63 µm

### 5.3.6.3 Installation

Vertical-type earth electrodes shall be driven to a minimum depth of—

- (a) in Australia, 1.2 m; and
- (b) in New Zealand, 1.8 m.

**A**

**NZ**

Strip-type earth electrodes buried in a horizontal trench shall be laid at a depth having not less than 0.5 m cover and with a minimum horizontal length of—

- (i) in Australia, 3 m; and
- (ii) in New Zealand, 7.5 m.

**A**

**NZ**

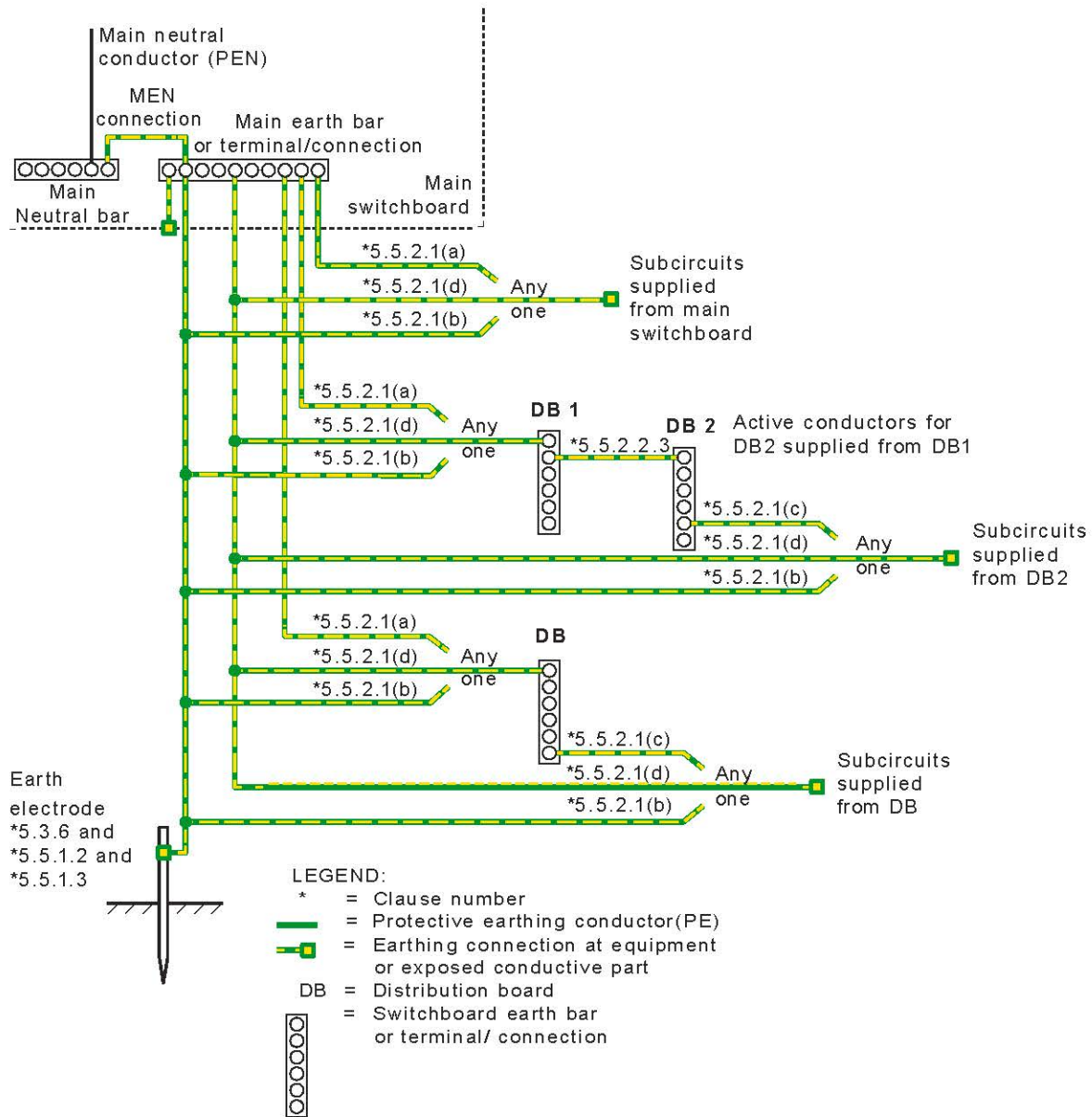


FIGURE 5.3 EXAMPLES OF EARTHING ARRANGEMENTS  
(CLAUSES 5.5.2.1 AND 5.5.2.2.3)

### 5.5.3 Particular methods of earthing

#### 5.5.3.1 Outbuildings

All parts of an electrical installation in or on an outbuilding that are required to be earthed in accordance with Clause 5.4 shall be earthed by one of the following methods:

- \* (a) *Individual outbuildings* The earthing system in an individual outbuilding shall be either—
  - (i) connected to a protective earthing conductor connected in accordance with Clause 5.5.2.1; or
  - (ii) connected as a separate MEN installation in accordance with Clauses 5.5.3.1(c) and 5.5.3.2.
- \* (b) *Combined outbuildings* The earthing system in a combined outbuilding shall be connected to a protective earthing conductor, connected in accordance with Clause 5.5.2.1, and shall not be connected as a separate MEN installation.
- (c) *Separate MEN installation* 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.

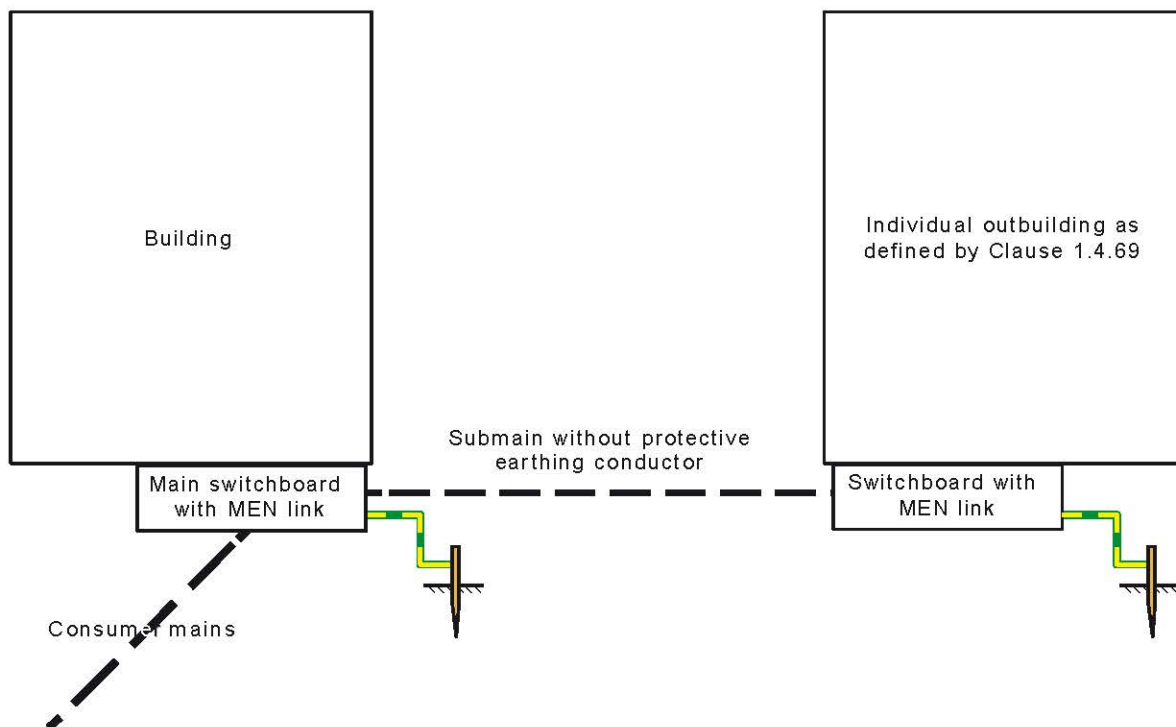
The electrical installation in the outbuilding shall be regarded as a separate electrical installation, and shall be earthed in accordance with other relevant Clauses of this Standard. The following requirements and recommendations also apply:

- (i) There shall be not more than one MEN connection in any one individual outbuilding.
- (ii) The distribution board in the outbuilding shall be regarded as a main switchboard for the purpose of effecting the MEN connection.
- (iii) The earthing conductor between the distribution board in the outbuilding and the earth electrode shall be regarded as a main earthing conductor for the purposes of earthing of the electrical installation in the outbuilding.
- (iv) The submain supplying the outbuilding shall be run either—
  - (A) directly from the main switchboard; or
  - (B) from the main switchboard via distribution boards in one or more other outbuildings, to one distribution board only in the outbuilding.

- (v) Where the combined protective earthing and neutral (PEN) conductor supplying the distribution board in the outbuilding runs from the main switchboard via distribution boards in one or more other outbuildings, the terminals on such distribution boards shall not be depended on for continuity of the combined protective earthing and neutral (PEN) conductor.
- (vi) The combined protective earthing and neutral (PEN) conductor supplying the distribution board in the outbuilding should not be connected in parallel, by means of earthing or equipotential bonding conductors, with conductive pipes or structural metal within the electrical installation.

**NOTES:**

- 1 Refer to Figures 5.4 and 5.5 for examples of earthing of individual and combined outbuildings.
- 2 Particular care is needed where conductive pipes and such items as telecommunication cable sheaths, covered walkways, etc. may be continuous between separate buildings and thus establish a parallel earth/neutral path.



NOTE: An individual outbuilding may also be earthed using a submain earth cable in lieu of its own MEN connection and earth electrode.

\* **FIGURE 5.4 EXAMPLE OF EARTHING OF AN INDIVIDUAL OUTBUILDING**  
[CLAUSE 5.5.3.1(a)]

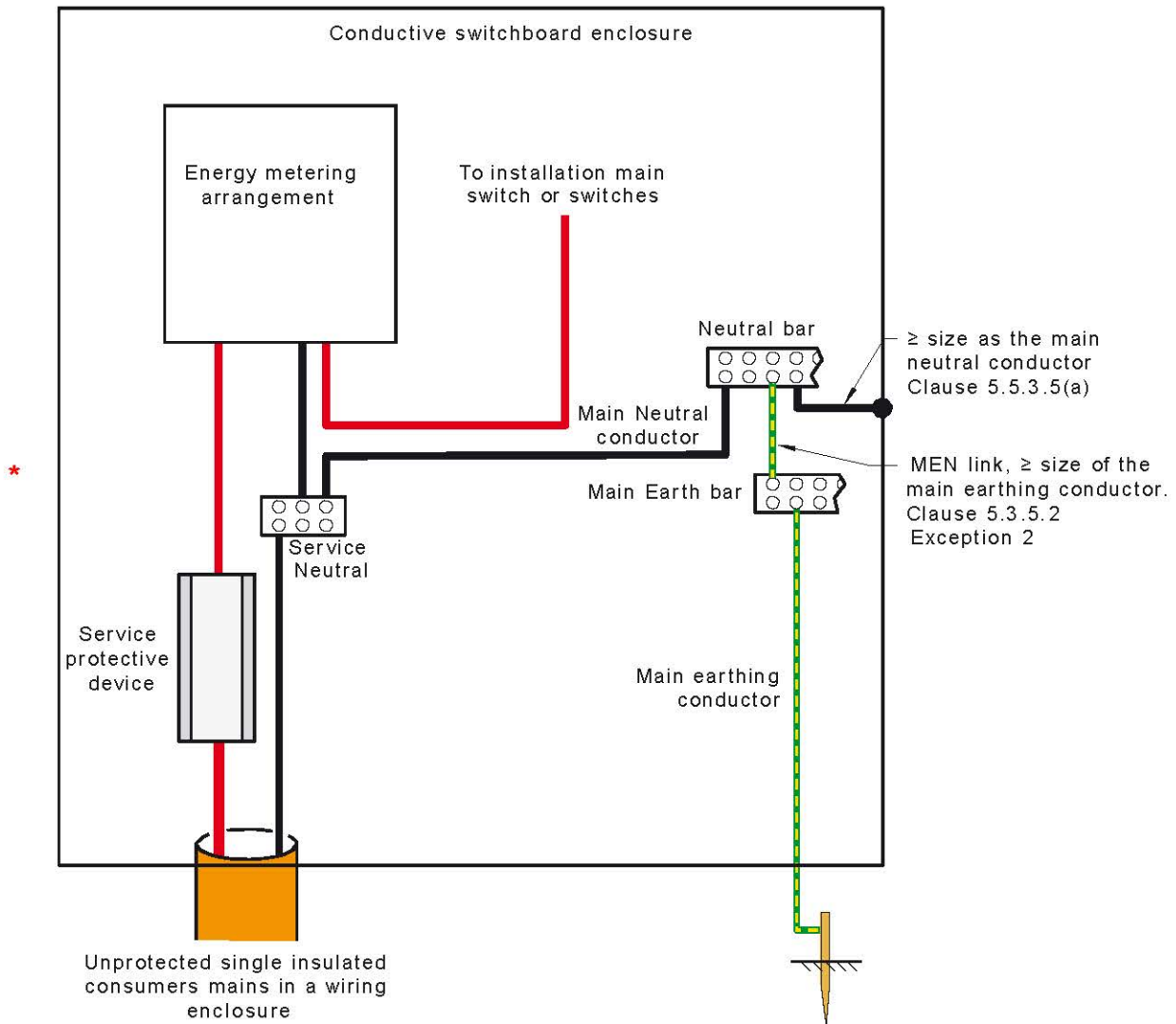


FIGURE 5.6(A) EARTHING ARRANGEMENT FOR CONDUCTIVE SWITCHBOARD ENCLOSURES ASSOCIATED WITH UNPROTECTED CONSUMER MAINS [CLAUSE 5.5.3.5(a)]

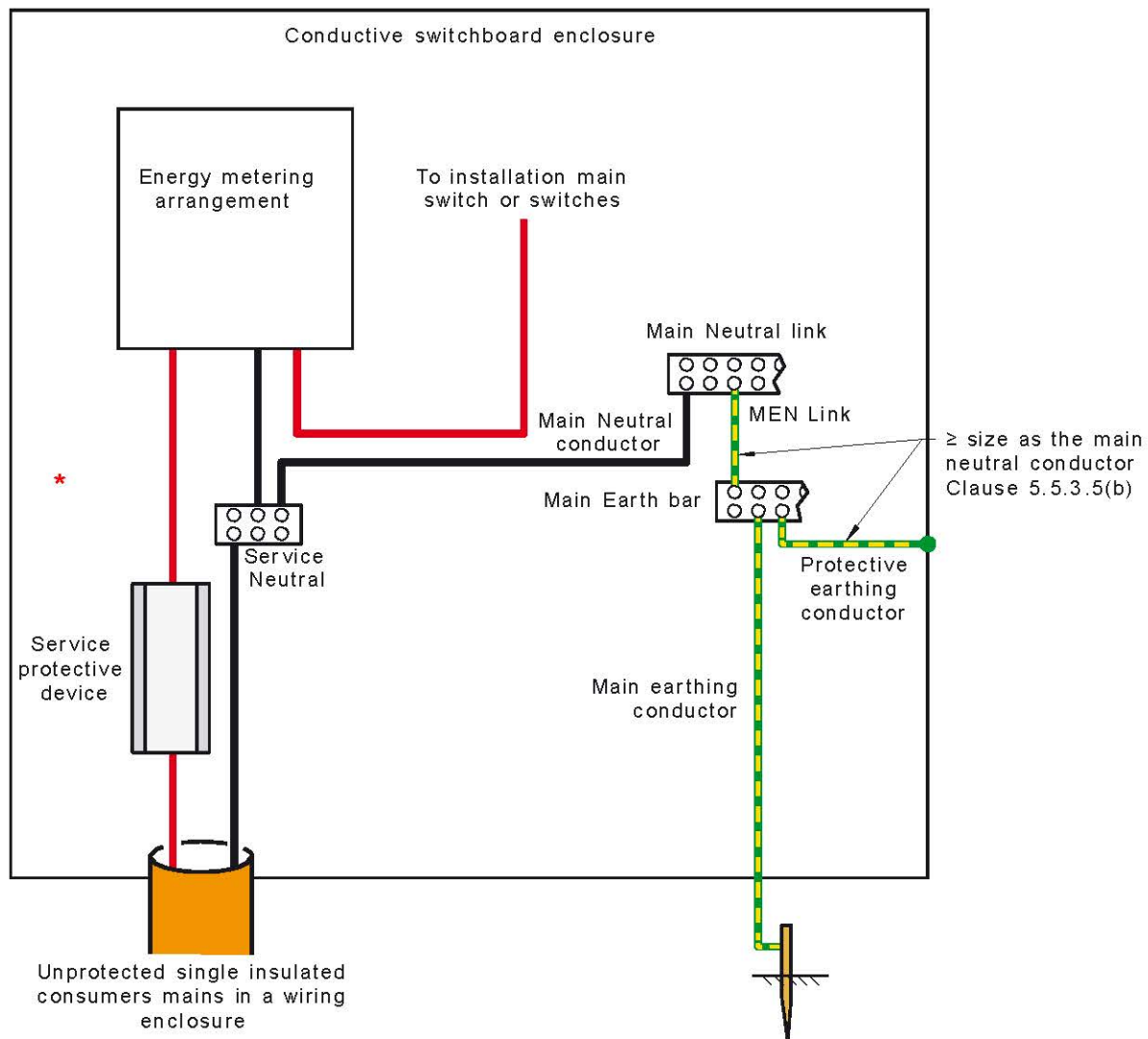


FIGURE 5.6(B) EARTHING ARRANGEMENT FOR CONDUCTIVE SWITCHBOARD ENCLOSURES ASSOCIATED WITH UNPROTECTED CONSUMER MAINS [CLAUSE 5.5.3.5(b)]