ISBN 978-0-626-34173-2

# SANS 10142-1:2017

Edition 2

## SOUTH AFRICAN NATIONAL STANDARD

# The wiring of premises

# Part 1: Low-voltage installations

**WARNING**
**This standard references other documents normatively.**

**Published by SABS Standards Division**
**1 Dr Lategan Road Groenkloof**
**⌧ Private Bag X191 Pretoria 0001**
**Tel: +27 12 428 7911 Fax: +27 12 344 1568**
**www.sabs.co.za**

**SANS 10142-1:2017**
Edition 2

**Table of changes**

| Change No. | Date | Scope |
|---|---|---|
| | | |

## Foreword

This South African standard was approved by National Committee SABS/TC 067/SC 06, *Electricity distribution systems and components – Installations*, in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This document was approved for publication in March 2017.

This document supersedes SANS 10142-1:2012 (edition 1.8).

**Compliance with this document cannot confer immunity from legal obligations.**

The test report in edition 1.8 may be used in parallel with the test report in edition 2.0 for a period of 12 months from the date of publication of edition 2.0.

With the first edition of this part of SANS 10142, the standard was subdivided and now consists of the following parts, under the general title *The wiring of premises:*

*Part 1: Low-voltage installations.*

*Part 2: Medium-voltage installations above 1 kV a.c. not exceeding 22 kV a.c. and up to and including 3 MVA installed capacity.*

Table 4.1 contains a list of the applicable standards for the components that may be installed in an electrical installation.

Information on national legislation that applies only in South Africa is given in text boxes in the introduction (see page 3).

To ensure that this part of SANS 10142 is always up to date, amendments will be introduced regularly. Each change made to the text as a result of an amendment is/will be indicated in the margin by the number of the amendment.

Annex I forms an integral part of this document. Annexes B, C, D, E, F, G, J, K, L, M, N, O and P are for information only.

## Introduction

In this edition an attempt has been made to move towards the IEC codes: extra low voltage (below 50 V) and d.c. applications (up to 1,5 kV) have been introduced as new requirements owing to the extensive usage of, and increased fire risk that result from, high load currents. This part of SANS 10142 does not intend to cover the LV control circuits of machinery or system components that are external circuits between separately installed parts of the machinery or system components.

This part of SANS 10142 includes certain provisions which are for information and guidance only. These provisions do not use the word "shall" and they can be found in the text, in the notes and in the informative annexes. Except in tables, notes are always for information only.
The aim of this part of SANS 10142 is to ensure that people, animals and property are protected from hazards that can arise from the operation of an electrical installation under both normal and fault conditions. An electrical installation has to provide protection against:

– shock current,

– overcurrent,

– fault current,

– overvoltage,

– undervoltage,

– excessive temperatures, and

– electric arcs.

If any of the above arises, the protection should automatically disconnect the supply or limit currents and voltages to safe values. In the case of undervoltage, the protection should ensure that dangerous situations, due to the loss and restoration of supply (for example, to a motor), or due to a drop in voltage, cannot occur.

This part of SANS 10142 is concerned with ensuring the basic safety of electrical installations. To ensure the protection of people, animals and property and the proper functioning of an installation, the designer of an electrical installation should be aware of:

a) the characteristics of the power supply,

b) the nature of the demand, and

c) the operating environment of each part of the installation.

It is especially important to be aware of the activities of occupants of a building. For example, the occupants might be engaged in wet processes or in the handling of flammable or explosive materials. These activities will influence the design of the installation. If a client wants more safety features for the installation than those prescribed in this part of SANS 10142, such features have to be included in the contract documentation.

The provisions of this part of SANS 10142 apply only to the selection and application of electrical equipment, appliances and accessories, which are part of the fixed electrical installation. They do not apply to the construction and safety of the equipment, appliances and accessories; those aspects are dealt with in other standards.

The Mine Health and Safety Act, 1996 (Act No. 29 of 1996), which is administered by the Chief Inspector of Mines of the Department of Minerals and Energy, requires that certain prescribed electrical installations on mines comply with the requirements of SANS 10142-1. It also requires that a competent person, as defined, will be responsible to ensure that those prescribed electrical installations are in accordance with the standard.

The Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) (OHS Act), which is administered by the Chief Inspector of Occupational Health and Safety of the Department of Labour, requires that electrical installations comply with the requirements of SANS 10142-1. It also requires that a registered person, as defined (master installation electrician, installation electrician or electrical tester for single phase), will issue a Certificate of Compliance together with a test report. The certificate shall be in the form of the Certificate of Compliance published in the Electrical Installation Regulations, 2012, and the test report shall be in the form of the test report in this part of SANS 10142 (see 8.7).

In terms of the OHS Act, the provisions of this part of SANS 10142 apply only from the point of control to the point of consumption.

Because this part of SANS 10142 is continually updated, problems can arise on which version of the standard will be applicable when a contract is signed. The date of approval of the latest revision or amendment of this part of SANS 10142 will be the implementation date of the revision or the amendment. The applicable version of this part of SANS 10142 is the one with the latest implementation date before the contract date. So contracts signed before the approval of an amendment shall be carried out in accordance with the provisions of the unamended standard. If an existing installation is extended or altered, such extension or alteration shall comply with the provisions of this part of SANS 10142 that were applicable at the time of the erection of the extension or alteration.

The edition of the standard that was applicable at the date of erection of an electrical installation is to be considered the edition defining the requirements applicable to that particular electrical installation.

## Contents

**Contents** *(continued)*

Page

**Contents** *(continued)*

**Contents** *(continued)*

**Contents** *(continued)*

**Contents** *(continued)*

**Contents** *(continued)*



**Contents** *(continued)*



**Contents** *(continued)*



**Contents** *(continued)*



**Contents** *(continued)*

**Contents** *(continued)*

**Contents** *(continued)*



**Contents** *(continued)*

**Contents** *(continued)*

**Contents** *(continued)*

**Contents** *(concluded)*

# The wiring of premises

## Part 1:
Low-voltage installations

## 1 Scope

### 1.1 Application of this part of SANS 10142

This part of SANS 10142 applies to electrical installations of

a) residential premises,

b) commercial premises,

c) public premises,

d) industrial premises,

e) prefabricated buildings,

f) fixed surface installations on mining properties,

g) construction and demolition site installations,

h) agricultural and horticultural premises,

i) caravan sites and similar sites,

j) marinas, pleasure craft and house boats,

k) medical locations,

l) exhibitions, fairs and other temporary installations,

m) extra low voltage lighting installations,

n) electrical installations for street lighting and street furniture, and

o) equipment enclosures (structures that provide physical and environmental protection for telecommunication equipment).

## 1.2 Aspects covered by this part of SANS 10142

This part of SANS 10142 covers

a) circuits supplied at nominal voltages up to and including 1 000 V a.c. or 1 500 V d.c. The standard frequency for a.c. is 50 Hz. The use of other frequencies for special purposes is not excluded,

b) circuits, other than the internal wiring of apparatus, that operate at voltages exceeding 1 000 V and are derived from an installation that has a voltage not exceeding 1 000 V a.c.,

c) any wiring systems and cables not specifically covered by the standards for appliances,

d) all consumer installations external to buildings,

e) fixed wiring in the power supply circuits for telecommunication equipment, signalling equipment, control equipment and the like (excluding internal wiring of apparatus),

f) the extension or alteration of the installation and also parts of the existing installation affected by the existing extension or alteration,

g) fixed wiring needed to connect the various units of complex machinery that are installed in separate locations,

h) equipment for which no standard is referenced ,

i) replacement or maintenance of components, and

j) earthing arrangements.

## 1.3 Where this part of SANS 10142 is not applicable

This part of SANS 10142 does not apply to

a) electric traction equipment,

b) automotive electrical equipment excluding the caravan part of a roving vehicle,

c) electrical installations on board ships,

d) electrical installations in aircraft,

e) electrical installations for underground and open cast mining operations,

f) telecommunication, television and radio circuits (excluding the power supply to such equipment),

g) lightning protection of buildings and structures, and

NOTE The installation of surge protection is not compulsory, but where it is installed, compliance with annex I is required.

h) extra low voltage control circuits between different parts of machinery or system components, forming a unit, that are separately installed and derived from an independent source or an isolating transformer (excluding ELV lighting circuits).

### 1.4 Electrical equipment

Electrical equipment is dealt with only as far as its selection and application in the installation are concerned. This also applies to assemblies of electrical equipment that comply with the relevant standards.

## 2 Normative references

The following referenced documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests.*

IEC 60695-2-10, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure.*

IEC 61557-8, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 8: Insulation monitoring devices for IT systems.*

IEC 62116, *Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures.*

SANS 164-0, *Plug and socket-outlet systems for household and similar purposes for use in South Africa – Part 0: General and safety requirements.*

SANS 164-1, *Plug and socket-outlet systems for household and similar purposes for use in South Africa – Part 1: Conventional system, 16 A 250 V a.c.*

SANS 164-2, *Plug and socket-outlet systems for household and similar purposes for use in South Africa – Part 2: IEC system, 16 A 250 V a.c.*

SANS 164-2-1, *Plug and socket-outlet systems for household and similar purposes for use in South Africa – Part 2-1: Partially dedicated system, 16 A 250 V a.c.*

SANS 164-2-2, *Plug and socket-outlet systems for household and similar purposes for use in South Africa – Part 2-2: Fully dedicated system, 16 A 250 V a.c.*

SANS 164-3, *Plug and socket-outlet systems for household and similar purposes for use in South Africa – Part 3: Conventional system, 6 A 250 V a.c.*

SANS 164-4, *Plug and socket-outlet systems for household and similar purposes for use in South Africa – Part 4: Dedicated system, 16 A 250 V a.c.*

SANS 164-5, *Plug and socket-outlet systems for household and similar purposes for use in South Africa – Part 5: Two-pole, non-rewirable plugs, 2,5 A 250 V a.c., with cord, for connection of class II equipment.*

SANS 164-6, *Plug and socket-outlet systems for household and similar purposes for use in South Africa – Part 6: Two-pole systems, 16 A 250 V a.c., for connection of class II equipment.*

SANS 337, Plugs and sockets outlets for use in the fixed installation of stoves.

SANS 529, *Heat-resisting wiring cables.*

SANS 556-1, *Low-voltage switchgear – Part 1: Circuit-breakers.*

SANS 556-2-2, *Low-voltage switchgear Part 2-2: Earth leakage switches*

SANS 780, *Distribution transformers.*

SANS 950, *Unplasticized polyvinyl chloride rigid conduit and fittings for use in electrical installations*.

SANS 1012, *Electric light dimmers.*

SANS 1019, *Standard voltages, currents and insulation levels for electricity supply.*

SANS 1063, *Earth rods, couplers and connections.*

SANS 1085, *Wall outlet boxes for the enclosure of electrical accessories.*

SANS 1195, *Busbars.*

SANS 1213, *Mechanical cable glands.*

SANS 1411-1, *Materials of insulated electric cables and flexible cords – Part 1: Conductors.*

SANS 1418-1, *Aerial bundled conductor systems – Part 1: Cores.*

SANS 1433-1, *Electrical terminals and connectors – Part 1: Terminal blocks having screw and screwless terminals.*

SANS 1433-2, *Electrical terminals and connectors – Part 2: Flat push-on connectors.*

SANS 1507-1, *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 1: General.*

SANS 1507-2, *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 2: Wiring cables.*

SANS 1507-3, *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 3: PVC distribution cables.*

SANS 1507-4, *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 4: XLPE distribution cables.*

SANS 1507-5, *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 5: Halogen-free distribution cables.*

SANS 1507-6, *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 6: Service cables.*

SANS 1524-1, *Electricity payment systems – Part 1: Payment meters.*

SANS 1574-3, *Electric flexible cables with solid extruded dielectric insulation – Part 3: PVC-insulated cables for industrial use.*

SANS 1574-5, *Electric flexible cables with solid extruded dielectric insulation – Part 5: Rubber-insulated cables for industrial use.*

SANS 1619, *Small power distribution units (ready-boards) for single-phase 230 V service connections.*

SANS 1777, *Photoelectric control units for lighting (PECUs).*

SANS 1799, *Watt-hour meters – AC electronic meters for active energy.*

SANS 1973-1, *Low-voltage switchgear and controlgear ASSEMBLIES – Part 1: Type-tested ASSEMBLIES with stated deviations and a rated short-circuit withstand strength above 10 kA.*

SANS 1973-3, *Low-voltage switchgear and controlgear ASSEMBLIES – Part 3: Safety of ASSEMBLIES with a rated prospective short-circuit current of up to and including 10 kA.*

SANS 1973-8, *Low-voltage switchgear and controlgear ASSEMBLIES – Part 8: Safety of minimally tested ASSEMBLIES (MTA) with a rated short-circuit current above 10 kA and a rated busbar current of up to and including 1 600 a.c. and d.c*.

SANS 10086-1, *The installation, inspection and maintenance of equipment used in explosives atmospheres – Part 1: Installations including surface installations on mines.*

SANS 10089-2, *The petroleum industry – Part 2: Electrical and other installations in the distribution and marketing sector.*

SANS 10108, *The classification of hazardous locations and the selection of equipment for use in such locations.*

SANS 10198-4, *The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 4: Current ratings.*

SANS 10198-10, *The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 10: Jointing and termination of paper-insulated cables.*

SANS 10198-11, *The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 11: Jointing and termination of screened polymeric-insulated cables.*

SANS 10198-14, *The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 14: Installation of aerial bundled conductor (ABC) cables.*

SANS 10199, *The design and installation of earth electrodes.*

SANS 10222-3, *Electrical security installations – Part 3: Electric security fences (non-lethal).*

SANS 10292, *Earthing of low-voltage (LV) distribution systems.*

SANS 10313, *Protection against lightning – Physical damage to structures and life hazard.*

SANS 60079-0/IEC 60079-0, *Explosive atmospheres – Part 0: Equipment - General requirements*.

SANS 60079-1/IEC 60079-1, *Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"*.

SANS 60079-14/IEC 60079-14, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*.

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

SANS 60269-1/IEC 60269-1, *Low-voltage fuses – Part 1: General requirements.*

SANS 60309-1/IEC 60309-1, *Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements.*

SANS 60309-2/IEC 60309-2, *Plugs, socket-outlets and couplers for industrial purposes – Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories.*

SANS 60364-7-712/IEC 60364-7-712, *Electrical installations of buildings – Part 7-712: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems*.

SANS 60439-1/IEC 60439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies.*

SANS 60439-2/IEC 60439-2, *Low-voltage switchgear and controlgear assemblies – Part 2: Particular requirements for busbar trunking systems (busways).*

SANS 60439-4/IEC 60439-4, *Low-voltage switchgear and controlgear assemblies – Part 4: Particular requirements for assemblies for construction sites (ACS).*

SANS 60439-5/IEC 60439-5, *Low-voltage switchgear and controlgear assemblies – Part 5: Particular requirements for assemblies for power distribution in public networks.*

SANS 60529/IEC 60529, *Degrees of protection provided by enclosures (IP Code).*

SANS 60570/IEC 60570, *Electrical supply track systems for luminaires.*

SANS 60598-2-18/IEC 60598-2-18, *Luminaires – Part 2: Particular requirements – Section 18: Luminaires for swimming pools and similar applications.*

SANS 60598-2-23/IEC 60598-2-23, *Luminaires – Part 2-23: Particular requirements – Extra low voltage lighting systems for filament lamps.*

SANS 60669-1/IEC 60669-1, *Switches for household and similar fixed-electrical installations – Part 1: General requirements.*

SANS 60669-2-1/IEC 60669-2-1, *Switches for household and similar fixed electrical installations – Part 2-1: Particular requirements – Electronic switches.*

SANS 60730-2-7/IEC 60730-2-7, *Automatic electrical controls for household and similar use – Part 2-7: Particular requirements for timers and time switches.*

SANS 60906-3/IEC 60906-3, *IEC system of plugs and socket-outlets for household and similar purposes – Part 3: SELV plugs and socket-outlets, 16 A 6 V, 12 V, 24 V, 48 V, a.c. and d.c.*

SANS 60947-2/IEC 60947-2, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers.*

SANS 60947-3/IEC 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units.*

SANS 60947-4-1/IEC 60947-4-1, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters.*

SANS 60947-4-2/IEC 60947-4-2, *Low-voltage switchgear and controlgear – Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers and starters.*

SANS 60947-4-3/IEC 60947-4-3, *Low-voltage switchgear and controlgear – Part 4-3: Contactors and motor-starters – AC semi-conductor controllers and contactors for non-motor loads.*

SANS 60947-5-1/IEC 60947-5-1, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices.*

SANS 60947-5-2/IEC 60947-5-2, *Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches.*

SANS 60947-5-5/IEC 60947-5-5, *Low-voltage switchgear and controlgear – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function.*

SANS 60947-6-1/IEC 60947-6-1, *Low-voltage switchgear and controlgear – Part 6-1: Multiple function equipment – Transfer switching equipment.*

SANS 60998-2-1/IEC 60998-2-1, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units.*

SANS 60998-2-2/IEC 60998-2-2, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units.*

SANS 61000-4-5/IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test.*

SANS 61000-4-7/IEC 61000-4-7, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto.*

SANS 61084-1/IEC 61084-1, *Cable trunking and ducting systems for electrical installations – Part 1: General requirements.*

SANS 61215/IEC 61215, *Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval.*

SANS 61238-1/IEC 61238-1, *Compression and mechanical connectors for power cables for rated voltages up to 30 kV ($U_m$ = 36 kV) – Part 1: Test methods and requirements.*

SANS 61347-2-2/IEC 61347-2-2, *Lamp controlgear – Part 2-2: Particular requirements for d.c. or a.c. supplied electronic step-down convertors for filament lamps.*

SANS 61386-1/IEC 61386-1, *Conduit systems for cable management – Part 1: General requirements.*

SANS 61386-21/IEC 61386-21, *Conduit systems for cable management – Part 21: Particular requirements – Rigid conduit systems.*

SANS 61386-22/IEC 61386-22, *Conduit systems for cable management – Part 22: Particular requirements – Pliable conduit systems.*

SANS 61386-23/IEC 61386-23, *Conduit systems for cable management – Part 23: Particular requirements – Flexible conduit systems.*

SANS 61558-1/IEC 61558-1, *Safety of power transformers, power supplies, reactors and similar products – Part 1: General requirements and tests.*

SANS 61558-2-2/IEC 61558-2-2, *Safety of power transformers, power supplies, reactors and similar products – Part 2-2: Particular requirements and tests for control transformers and power supplies incorporating control transformers.*

SANS 61558-2-4/IEC 61558-2-4, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V Part - 2-4: Particular requirements and tests for isolating transformers and power supply units incorporating isolating transformers*.

SANS 61558-2-5/IEC 61558-2-5, *Safety of transformers, reactors, power supply units and combinations thereof – Part 2-5: Particular requirements and test for transformers for shavers, power supply units for shavers and shaver supply units.*

SANS 61558-2-6/IEC 61558-2-6, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V – Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers.*

SANS 61558-2-15/IEC 61558-2-15, *Safety of transformers, reactors, power supply units and combinations thereof – Part 2-15: Particular requirements and tests for isolating transformers for the supply of medical locations.*

SANS 61643-11/IEC 61643-11, *Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power distribution systems – Requirements and test methods.*

SANS 61643-12/IEC 61643-12, *Low-voltage surge protective devices – Part 12: Surge protective devices connected to low-voltage power distribution systems – Selection and application principles.*

SANS 61646, *Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval*.

SANS 62040-1/IEC 62040-1, *Uninterruptible power systems (UPS) – Part 1: General and safety requirements for UPS*.

SANS 62053-11/IEC 62053-11, *Electricity metering equipment (a.c.) – Particular requirements – Part 11: Electromechanical meters for active energy (classes 0,5, 1 and 2).*

SANS 62053-21/IEC 62053-21, *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2).*

SANS 62103/IEC 62103, *Electronic equipment for use in power installations.*

SANS 62305-1/IEC 62305-1, *Protection against lightning – Part 1: General principles.*

SANS 62305-2/IEC 62305-2, *Protection against lightning – Part 2: Risk management.*

SANS 62305-3/IEC 62305-3, *Protection against lightning – Part 3: Physical damage to structures and life hazard.*

SANS 62305-4/IEC 62305-4, *Protection against lightning – Part 4: Electrical and electronic systems within structures.*

VC 8003, *Compulsory specification for manually operated switches for fixed installations*.

VC 8006, *Compulsory specification for safety of flexible cords for electrical appliances*.

VC 8008, *Compulsory specification for plugs, socket-outlets and socket-outlet adaptors*.

VC 8035, *Compulsory specification for earth leakage protection units*.

VC 8036, *Compulsory specification for circuit-breakers*.

VC 8075, *Compulsory specification for the safety of electric cables with extruded solid dielectric insulation for fixed installations*.

NOTE 1 Table 4.1 lists the standards applicable in this part of SANS 10142.

NOTE 2 When a standard has been amended or replaced, the superseded standard will remain in force.

a) for a period of one year from the date of publication of the amended or substitution standard, or

b) as determined in the amended or substitution standard, or

c) as provided for in a compulsory standard.

# 3 Definitions

For the purposes of this part of SANS 10142, the following definitions apply.

**3.1**
**acceptable**
acceptable to the regulator

**3.2**
**accessible**
not permanently closed in by the structure or surface(s) of the premises

**3.3**
**appliance**

**3.3.1**
**class I appliance**
appliance that has at least basic insulation throughout, and that is provided with an earthing terminal or earthing contact and is designed (in the case of single phase) for connection by means of a three-core flexible cord

**3.3.2**
**class II appliance**
appliance that has double insulation or reinforced insulation (or both) throughout, and that is without provision for earthing

**3.3.3**
**fixed appliance**
appliance that is fastened or otherwise secured at a specific location, and that would require the use of tools to be moved to another location

**3.3.4**
**portable appliance**
appliance that is moved in the course of normal operation

**3.3.5**
**stationary appliance**
appliance that is normally not moved or cannot easily be moved while in operation

**3.4**
**arm's reach**
volume that is limited by the relevant of the following distances measured from a surface expected to be occupied by persons (see annex A):

a) 2,5 m vertically upwards;

b) 1,25 m vertically downwards from the outer edge of the surface;

c) 1,25 m horizontally outwards from the outer edges of the surface; and

d) 0,75 m horizontally inwards from the outer edges of the surface and underneath the surface

**3.5**
**authorized**
authorized by the relevant Regulator

**3.6**
**bathroom**
room or part of a room that contains a bath, shower or spa (or any combination of these), each installed as a fixture (see figures 7.1.1 to 7.1.5)

**3.7**
**building element**
part of a premises such as a wall, floor, ceiling or partition

**3.8**
**cable**

**3.8.1**
**armoured cable**
cable that has a covering of metallic wires or galvanized steel wires or steeltape as a protection against mechanical damage

**3.8.2**
**flexible cable**
cable of which the conductors consist of strands of diameter not exceeding 0,51 mm and of which the insulation and covering are such that they afford flexibility and in which the nominal cross-sectional area of each conductor exceeds 4 $mm^2$

**3.8.3**
**flexible cord**
cable of which

a) the nominal cross-sectional area of each conductor does not exceed 4 mm², and

b) each conductor consists of strands of diameter less than 0,31 mm

**3.8.4**
**mineral-insulated metal-sheathed cable**
cable in which the conductors are insulated by a highly compressed, refractory, mineral insulating material, such as magnesia, and are contained in a solid-drawn hard-metal sheath

**3.8.5**
**multicore cable**
cable that contains at least two cores

**3.8.6**
**unarmoured metal-sheathed cable**
cable that has a sheath of metal to exclude moisture from the conductors and their insulation

**3.9**
**Certificate of Compliance**
**CoC**
certificate that is issued by a registered person in respect of an electrical installation or part of an electrical installation

**3.10**
**Chief Inspector**
Chief Inspector in terms of the relevant Health and Safety legislation

**3.11**
**circuit**

**3.11.1**
**Protected Extra Low Voltage (PELV) circuit**
extra low voltage (ELV) circuit with protective separation from other circuits and which, for functional reasons, may be earthed and/or the exposed conductive parts of which may be earthed

NOTE 1 PELV circuits are used where the circuits are earthed and SELV is not required.

NOTE 2 See 7.14.2 for additional safety precautions when SELV and PELV circuits are used in hazardous locations.

**3.11.2**
**Safety Extra Low Voltage (SELV) circuit**
extra low voltage (ELV) circuit with protective separation from other circuits, and which has no provision for earthing of the circuit or of the exposed conductive parts

**3.12**
**circuit-breaker**
mechanical switching device that is capable of making, carrying and breaking currents under normal circuit conditions and of making, carrying for a specified time, and automatically breaking currents under specified abnormal circuit conditions such as those of overcurrent (see also SANS 556-1)

NOTE See also multipole circuit-breaker (3.50).

**3.13**
**conductive part**

**3.13.1**
**exposed conductive part**
conductive part that

a) can easily be touched, and

b) is not a live part under normal conditions, but can become live under fault conditions

**3.13.2**
**extraneous conductive part**
conductive part that does not form part of the electrical installation

NOTE Examples of extraneous conductive parts are

a) structural metalwork of a building,

b) items such as heating tubes and non-electrical apparatus electrically connected to them such as radiators and gas-fired or coal-fired cooking appliances, and

c) floors or walls made of conductive material.

**3.14**
**conductor**

**3.14.1**
**aerial conductor**
conductor that is supported above the ground and that is (or its insulation is) exposed direct to the open air. (see also SANS 1418-1)

**3.14.2**
**bonding conductor**
conductor, including any clamp or terminal, that connects together exposed conductive parts (see 3.13.1), extraneous conductive parts (see 3.13.2) or both exposed and extraneous conductive parts, with the object of bringing such parts to the same electrical potential

**3.14.3**
**core**
single insulated conductor without protective covering

**3.14.4**
**earth continuity conductor**
earthing conductor
conductor, including any clamp or terminal, that connects the consumer's earth terminal to the exposed conductive parts of an installation for the purpose of earthing such parts and carrying fault currents

**3.14.5**
**functional bonding conductor**
conductor provided for functional equipotential bonding

**3.14.6**
**functional earthing conductor**
earthing conductor provided for functional earthing

**3.14.7**
**protective bonding conductor**
protective conductor (PE) provided for protective equipotential bonding

**3.14.8**
**protective conductor**
**PE**
conductor provided for purposes of safety (protection against electric shock) and that also connects the supply earth to the consumer's earth terminal

**3.14.9**
**protective earth and neutral conductor**
PEN conductor
conductor that forms part of a supply combining the functions of both protective earthing conductor and neutral conductor. The conductor is also connected to the other earth electrodes and exposed conductive parts of the low-voltage supply

**3.14.10**
**protective earthing conductor**
protective conductor provided for protective earthing

**3.15**
**conduit**
pipe, usually of diameter not exceeding 50 mm, that allows conductors and cables in electrical installations to be drawn in and to be replaced

**3.16**
**consumer**
person who is supplied (or who is to be supplied) with electricity by a supplier (see 3.77); or a person who supplies his own electricity

**3.17**
**consumer's earth terminal**
terminal that is effectively and permanently earthed and to which the earth continuity conductor of an installation is permanently connected

**3.18**
**contactor**
remote-controlled switching device that is capable of making, carrying and breaking currents under normal operating conditions, including overload

**3.19**
**convertor**
machine or device for converting one form of electrical power to a different form of electrical power

**3.20**
**cord**
see **flexible cord** (3.8.3)

**3.21**
**current**

**3.21.1**
**conditional short-circuit current**
the value of prospective current, which the equipment (when protected by a short-circuit protective device, as specified by the manufacturer) can withstand for the operating time of the device, under specified test conditions

**3.21.2**
**earth fault current**
fault current that flows to earth

**3.21.3**
**earth leakage current**
current that flows to earth in an electrically undamaged circuit

**3.21.4**
**fault current**
current that results from an insulation failure or from the bridging of insulation

**3.21.5**
**overcurrent**
current that exceeds the rated current

NOTE 1 Depending on its magnitude and duration, an overcurrent might or might not be harmful.

NOTE 2 In the case of conductors, the current-carrying capacity is deemed to be the rated current.

**3.21.6**
**overload current**
overcurrent that occurs in an electrically undamaged circuit

**3.21.7**
**prospective short-circuit current**
value of overcurrent at a given point in a circuit, which results from a fault of negligible impedance between live conductors that have a difference of potential under normal operating conditions, or between a live conductor and an exposed conductive part

**3.21.8**
**shock current**
current that passes through the body of a person or an animal and that has such a value (depending on frequency, harmonics and duration) that injury is likely to occur

**3.21.9**
**short-circuit current**
overcurrent that results from a fault of negligible impedance in a circuit

**3.22**
**discharge lamp**
lamp in which light (or radiant energy at a wavelength near that of the visible spectrum) is produced by the passage of an electric current through a vapour or gas

**3.23**
**discharge lighting**
lighting that is provided by luminaires in which discharge lamps are used

**3.24**
**disconnector**
mechanical switching device that

a) for reasons of safety, provides, in the open position, an isolating distance in accordance with specified requirements,

b) is capable of opening and closing a circuit either when negligible current is broken or made, or when no significant change in the voltage across the poles of the disconnector occurs, and

c) is capable of carrying currents under normal circuit conditions and of carrying, for a specified time, currents under specified abnormal circuit conditions such as those of short-circuit

NOTE A disconnector was known as an "off-load isolator".

**3.25**
**distribution board**
switchboard
switchgear and controlgear assembly
enclosure that contains electrical equipment for the distribution or control of electrical power from one or more incoming circuits to one or more outgoing circuits

**3.26**
**earthed**
so connected to the general mass of earth as to ensure, at all times, an immediate discharge of electrical energy without danger

**3.27**
**earth electrode**
one or more conductive parts that are embedded in the earth for the purpose of making effective electrical contact with the general mass of the earth

**3.28**
**earthing arrangement**

**3.28.1**
**earthing conductor**
conductor, including any clamp or terminal, by which the connection of the consumer's earth terminal or conductor to an earth electrode, or to the supplier's protective conductor, is made

**3.28.2**
**earthing terminal**
terminal fitted to equipment or to a device and intended for the electric connection with the earthing arrangement

**3.28.3**
**functional earthing**
earthing of a point or points in a system or in an installation or in equipment, which is necessary for purposes other than safety

**3.28.4**
**main earthing terminal**
busbar
terminal (or busbar) that is part of the earthing arrangement of an installation that enables the electric connection of a number of conductors for earthing purposes (see also 3.78)

**3.28.5**
**protective earthing**
earthing of a point or points in a system or in an installation or in equipment for purposes of safety

**3.29**
**earth leakage protection**
form of protection in which an earth leakage unit is used

**3.30**
**earth leakage unit**
device that is capable of detecting the flow of a specified or predetermined current from a circuit to earth, and of disconnecting, automatically and reliably, the affected circuit within a specified time when such current exceeds the specified or pre-determined value

**3.31**
**electrical consultant**
person who is registered in terms of the Engineering Profession Act, 2000 (Act 46 of 2000)

**3.32**
**electrical equipment**
item or any combination of items, including wireways, which is used for the generation, conversion (such as of voltage or frequency), transmission or distribution of electrical energy

**3.33**
**electrical installation**
machinery, in or on any premises, that is used for the transmission of electrical energy from a **point of control** (see 3.56) to a **point of consumption** (see 3.55) anywhere on the premises, including any article that forms part of such an installation, irrespective of whether or not it is part of the electrical circuit, but excluding

a) any machinery of the supplier that is related to the supply of electricity on the premises,

b) any machinery that is used for the transmission of electricity of which the voltage does not exceed 50 V, where such electricity is not derived from the main supply of a supplier, and

c) any machinery that transmits electrical energy in telecommunication, television or radio circuits

**3.34**
**electrode water heater**
device that is designed to heat water or other liquid by passing electricity between electrodes immersed in the water or liquid. The device may convert water to steam

NOTE A resistor that is in contact with liquid is, in effect, an electrode.

**3.35**
**enclosure**
part that provides protection of equipment against certain external influences and, in any direction, protection against direct contact

**3.36**
**equipotential bonding**

**3.36.1**
**equipotential bonding terminal**
terminal fitted to equipment or to a device and intended for the electric connection with the equipotential bonding system

**3.36.2**
**functional equipotential bonding**
equipotential bonding for purposes other than safety

**3.36.3**
**protective equipotential bonding**
equipotential bonding for purposes of safety

**3.37**
**fault free**
arrangement of conductors for which, under normal operating conditions, the occurrence of a short-circuit fault between phases or between phases and earth is only a remote possibility

**3.38**
**fire officer**
officer (or any person to whom such power has been duly delegated) who is appointed by a local authority to administer its bylaws (and any relevant statutory regulations) relating to fire protection

**3.39**
**flammable**
descriptive of a material that, when heated for 5 min in an oven at 300 °C (in the manner set out in an appropriate standard such as SANS 556-1), is capable of burning or of giving off vapours in sufficient quantity to ignite at a pilot flame

**3.40**
**flexible conduit**
tubing that is intended to house and to protect electric wiring and that is so designed that it is flexible

**3.41**
**flexible cord**
see 3.9.3

**3.42**
**fuse**
device that, by the melting of one or more of its specifically designed and dimensioned elements, opens the circuit in which it is inserted if the current that flows through it exceeds the rated current for a specified time (see also SANS 60269-1)

NOTE A fuse comprises all the parts that form the complete device.

**3.43**
**hazardous location**
location in which fire or explosion may occur owing to the presence of gases, vapours, dusts or fibres that, in the presence of air and in certain concentrations, are flammable or explosive

NOTE See SANS 10108 for the classification of hazardous locations.

**3.44**
**insulation**

**3.44.1**
**basic insulation**
insulation applied to live parts to provide basic protection against electric shock

NOTE Basic insulation does not include insulation used for functional purposes, for example, wire enamel.

**3.44.2**
**double insulation**
insulation that comprises both basic insulation and supplementary insulation. Usually indicated by the symbol ⧈

**3.44.3**
**reinforced insulation**
single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation

NOTE The term "insulation system" does not imply that the insulation is one homogeneous piece. It may comprise several layers that cannot be tested singly as supplementary or basic insulation.

**3.44.4**
**supplementary insulation**
independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of failure of the basic insulation

**3.45**
**lighting system**

**3.45.1**
**emergency lighting**
system that provides sufficient illumination to replace the existing safety and normal lighting system in the event of a power failure, so that people can evacuate a place of assembly

**3.45.2**
**normal lighting**
system that provides general illumination but does not necessarily provide illumination of exit routes

**3.45.3**
**safety lighting**
system that provides sufficient illumination to allow all the occupants of a place of assembly to see clearly enough during a performance to move around or to leave. Such a system includes illuminated exit signs that indicate the exit routes for all the occupants of a place of assembly (including areas such as projector rooms, control rooms and orchestra pits)

**3.46**
**live**
alive
at an electrical potential to earth

NOTE Live parts include the neutral conductor and conductive parts connected to it.

**3.47**
**local authority**
municipal council, borough council, town council, village council, village management board, town board, health board or any such institution

**3.48**
**luminaire**
appliance that distributes, filters or transforms the light transmitted from one or more lamps and that includes all the parts necessary for supporting, fixing and protecting the lamps but not the lamps themselves, and, when necessary, circuit auxiliaries together with the means for connecting them to the supply

NOTE A batten lamp holder or a lamp holder suspended by a flexible cord is a luminaire.

**3.49**
**marina**
fixed wharf, jetty, pier or floating pontoon arrangement capable of berthing or mooring more than one pleasure craft

**3.50**
**multipole circuit-breaker**
circuit-breaker in which all poles are mechanically connected together and that is suitable for making, carrying and breaking the currents in all the phase conductors or, if so required, in all the live conductors of a circuit

**3.51**
**new**
innovative
descriptive of a technique or item of equipment for use in an electrical installation where such technique or item of equipment does not fall within the scope of a standard (see 3.75).

**3.52**
**overcurrent protection (of a circuit)**
means of interrupting the current in a circuit when that current exceeds its rated value

NOTE See 6.10.1 for the use of fuses not being permitted as overcurrent protection in residential installations. **3.53**
**place of assembly**
theatre, cinema, church and any other place where people gather and where natural lighting is inadequate to allow for safe evacuation

NOTE Adjacent areas are treated as separate places of assembly.

**3.54**
**plug**
device that

a) has two or more metallic contacts in the form of pins,

b) is arranged for attachment to a flexible cord or cable, and

c) is intended for engagement with a socket-outlet (see 3.72)

**3.55**
**point of consumption**
point of outlet, or the supply terminal of machinery that is not connected to a point of outlet and that converts electrical energy to another form of energy, provided that in the case of machinery that has been installed for any specific purpose as a complete unit, the point of consumption is the supply terminals that have been provided on the unit of machinery for that purpose

**3.56**
**point of control**
point at which a consumer can, on or in any premises, switch off the electrical installation from the electricity supplied from the point of supply

**3.57**
**point of outlet**
termination of an electrical installation, which has been provided for connecting any electrical machinery without the use of a tool, provided that no connection to a busbar is deemed to be a point of outlet (see socket-outlet, 3.72)

**3.58**
**point of supply**
point at which a supplier supplies electricity to any premises

**3.59**
**pole**
portion of a switching device associated exclusively with one electrically separated conducting path of its main circuit and excluding those portions that provide a means for mounting and operating all poles together

NOTE A switching device is called single pole if it has only one pole. If it has more than one pole, it may be called multipole (two pole, three pole, etc.), provided that the poles are or can be coupled in such a manner as to operate together.

**3.60**
**portable water pump**
pump that can be easily moved from one place to another while connected to the supply

**3.61**
**premises**
place such as a site, building or structure, whether stationary or mobile, that can be electrically wired

**3.62**
**protected socket-outlet**
socket-outlet combined with, or adjacent to and protected by, a device that has either overload protection or overcurrent protection

**3.63**
**protective device**
unit that comprises one or more fuses or circuit-breakers

**3.64**
**protective screening**
separation from live parts by means of an interposed conductive screen, connected to earth by means of an external protective conductor

**3.65**
**protective separation**
separation between circuits by means of basic and supplementary protection (basic insulation plus supplementary insulation or protective screening) or by provision of equivalent protection (for example, reinforced insulation)

**3.66**
**residential installation**
electrical installation in a private dwelling or in an individual dwelling unit, including installations in flats, hotels, boarding houses or other residential institutions

**3.67**
**safety supply**
supply of electricity that is obtained from

a) the unearthed secondary circuit of an isolating transformer with limited output voltage, specified by the manufacturer, or

b) any other isolating device that provides equivalent safety and the same degree of separation between the primary and secondary circuits, or

c) an isolated generator or a battery that provides a non-earthed supply

**3.68**
**sauna**
enclosure in which heat is generated for therapeutic or recreational purposes and that is designed to accommodate one or more persons

**3.69**
**series-connected system**
cascaded system
protection system that allows for the installation of circuit-breakers that cannot necessarily be rated to handle the full prospective short-circuit current at their point of installation, provided that they are backed up by another fully rated circuit-breaker in a predetermined and tested coordination

**3.70**
**shaver supply unit**
accessory that embodies an isolating transformer with limited output and one or more socket-outlets that allow the use of only one plug at a time

**3.71**
**short-circuit protective device**
**SCPD**
device intended to protect a circuit or parts of a circuit against short-circuit currents by interrupting the current

**3.72**
**socket-outlet**
device that

a) has two or more metallic spring contacts designed to accept the corresponding pins of a plug (see 3.54),

b) is designed for fixing onto or into a building element (see 3.7) or other flat surface, and

c) is arranged for connection to the wiring of an installation

NOTE Single-phase socket-outlets that are rated in accordance with SANS 164-6 are used in residential and similar installations may be regarded as equivalent for the purposes of this part of SANS 10142 but, because it is intended that the standard rating will in due course be 16 A only, the use of socket-outlets rated at any value other than 16 A is not recommended, with the exception of two-contact socket-outlets (see 3.57)·

**3.73**
**spa**
container

a) in which water may be heated electrically or agitated electromechanically, or both,

b) that is designed to accommodate at least one person, and

c) the electrical equipment of which is permanently connected to the electricity supply

**3.74**
**specialized electrical installation**
electrical installation such as in

a) a hazardous location, as described in SANS 10108,

b) an explosive atmosphere, as described in SANS 10086-1,

c) the petroleum industry, as described in SANS 10089-2, and

d) a medical location, as described in 7.7 of this part of SANS 10142

**3.75**
**standard**
applicable compulsory standard or an applicable standard published by Standards South Africa, or by another standards body whose standards have been referred to in this part of SANS 10142

**3.76**
**stove coupler**
stove connection that complies with the requirements of SANS 60309-1, and of the dimensions as given in SANS 337

**3.77**
**supplier**
in relation to a particular installation, any local authority (see 3.47), statutory body or person who supplies, contracts or agrees to supply, electricity to that electrical installation

**3.78**
**supply earth terminal**
clamp or terminal at the point of supply to which the supply protective conductor is connected (see 3.28)

**3.79**
**switch**

NOTE A switch may also be capable of making, but not breaking, short-circuit currents.

**3.79.1**
**multipole switch**
switch in which all poles are mechanically coupled together and that is suitable for making, carrying and breaking the currents in all the phase conductors or, if so required, all the live conductors of a circuit

**3.79.2**
**switch-disconnector**
switch that, in the open position, satisfies the isolating requirements specified for a disconnector

NOTE A switch-disconnector was known as an "on-load isolator".

**3.80**
**terminal**
device in or on which conductors can be terminated and that provides substantial electrical connections and supports the terminations sturdily and safely, with a suitable cover, if necessary, to render it safe (see also SANS 1433-1 and SANS 1433-2)

**3.81**
**test report**
report (see 8.7) that is issued by a registered person in respect of an electrical installation or part of an electrical installation

**3.82**
**touch voltage**
$\boldsymbol{U}_{\mathrm{L}}$
voltage which, during an insulation fault, appears between simultaneously accessible parts

NOTE By convention, the term is used only in connection with protection against indirect contact.

**3.83**
**transformers**

**3.83.1**
**class I transformer**
transformer in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means, such as an earthing terminal, are provided for the connection of accessible conductive parts to the protective earthing conductor in the fixed wiring of the installation, so that accessible conductive parts cannot become live in the event of failure of the basic insulation

NOTE A class I transformer may have parts with double or reinforced insulation.

**3.83.2**
**class II transformer**
transformer in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as double insulation or reinforced insulation are provided, there being no provision for protective earthing or reliance upon installation conditions

**3.83.3**
**isolating transformer**
transformer with protective separation between the input and output windings, which are electrically separated in order to limit hazards due to accidental simultaneous contact with earth and live parts or with earth and metal parts that can become live in the event of an insulation fault

NOTE A class II isolating transformer has additional safety precautions such as double insulation or reinforced insulation and has no provision for earthing.

**3.83.4**
**safety isolating transformer**
isolating transformer designed to supply safety extra low voltage (SELV) or protected extra low voltage (PELV) circuits

**3.84**
**voltage**

**3.84.1**
**extra low voltage**
**ELV**
voltage that does not exceed 50 V a.c. or 120 V d.c.

**3.84.2**
**safety extra low voltage**
**SELV**
voltage that does not exceed 50 V a.c. or 120 V ripple-free d.c. between conductors, or between any conductor and earth, in a circuit which is isolated from the supply mains by means such as a safety isolating transformer

NOTE 1 Maximum voltage lower than 50 V a.c. or 120 V ripple-free d.c. may be specified in particular requirements, especially when direct contact with live parts is allowed.

NOTE 2 The voltage limit should not be exceeded at any load between full load and no load when the source is a safety isolating transformer.

NOTE 3 "Ripple-free" is conventionally defined as an r.m.s. ripple voltage that does not exceed 10 % of the d.c. component; the maximum peak value does not exceed 140 V for a nominal 120 V ripple-free d.c. system and 70 V for a nominal 60 V ripple-free d.c. system.

**3.84.3**
**low voltage**
**LV**
voltage that does not exceed 1 000 V a.c. or 1 500 V d.c, including ELV

**3.85**
**wireway**

NOTE A wireway can consist of one or more separate wireway channels, each of which is intended for different services such as installation wiring and telecommunication wiring.

**3.85.1**
**conduit**
see 3.15

**3.85.2**
**ducting**
closed enclosure that allows insulated conductors and cables in electrical installations to be drawn in and to be replaced.

**3.85.3**
**flexible conduit**
see 3.40

**3.85.4**
**trunking**
closed enclosure that comprises a base with a removable cover that is intended to completely surround insulated conductors and cables in electrical installations and accommodate other electrical equipment, for example, in the case of power skirting

# 4 Compliance

## 4.1 Applicable standards

**4.1.1** Table 4.1 gives a list of commodities and the applicable standards. The commodities given in column 1 shall comply with the applicable standards given in column 3.

**4.1.2** Each component used in a d.c. installation shall comply with the requirements for d.c. operation stipulated in the relevant standard.

**Table 4.1 — Applicable standards**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Commodity** | **Scope** | **Safety standard** | **Recommended performance standard** |
| Aerial bundled conductors | ≤ 1 000 V | SANS 1418-1 | |
| Busbars | Copper, aluminium or aluminium alloy (purity and dimensions only) | | SANS 1195 |
| Busbar trunking systems | All | SANS 60439-2 | |
| Cables (fixed extruded) | Fixed extruded insulation 300/500 V to 600/1 000 V | VC 8075[a] | |
| Cables (flexible) | Flexible, PVC or rubber insulated<br>≤ 600/1 000 V<br>Conductors ≤ 185 $mm^2$ | SANS 1574-3<br>SANS 1574-5 | |
| Cables (flexible cords) | Flexible cords<br>Conductors ≤ 4 $mm^2$ | VC 8006 | |
| Cables (heat-resisting) | Fixed, flexible, PVC or rubber insulated ≤ 600/1 000 V | SANS 1574-3<br>SANS 1574-5 | |
| Cables (single core, heat-resisting) | Single core; Cu; ≤ 300 V<br>Rated temperature ≤ 250 °C | SANS 529 | |
| Cable glands | Excluding<br>– entirely non-metallic<br>– for flameproof use | | SANS 1213 |
| Circuit-breakers | $I_n \leq 125$ A and $I_{cu} \leq 10$ kA | VC 8036 | |
| Circuit-breakers | $I_n \leq 125$ A and $I_{cu} > 10$ kA | SANS 556-1 | |
| Circuit-breakers | 125 A < $I_n$ | SANS 556-1 | |

**Table 4.1** *(continued)*

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Commodity** | **Scope** | **Safety standard** | **Recommended performance standard** |
| | | | |
| Circuit-breakers used as switch-disconnectors (isolators) | $I_n \leq 125$ A and $I_{cu} \leq 10$ kA | VC 8036[a] and SANS 60947-3, or<br>VC 8036[a] and SANS 60947-2 | |
| Circuit-breakers used as switch-disconnectors (isolators) | $I_n \leq 125$ A and $I_{cu} > 10$ kA | SANS 556-1 and SANS 60947-3, or<br>SANS 60947-2 and SANS 60947-3, or<br>SANS 60947-2 | |
| Circuit-breakers used as switch-disconnectors (isolators) | 125 A < $I_n \leq 1\,000$ A | SANS 556-1, and SANS 60947-3, or<br>SANS 60947-2 and SANS 60947-3, or<br>SANS 60947-2 | |
| Circuit-breakers used as switch-disconnectors (isolators) | 1 000 A < $I_n$ | SANS 556-1, or<br>SANS 60947-2 and SANS 60947-3, or<br>SANS 60947-2 | |
| Conduit | Conduit and fittings:<br><br>rigid<br>pliable<br>flexible<br><br>PVC rigid conduit and fittings: 20 mm to 63 mm dia.<br><br>Metal conduit: 20 mm to 50 mm dia. Metal fittings | | SANS 61386-1<br>SANS 61386-21<br>SANS 61386-22<br>SANS 61386-23<br><br><br>SANS 950 |

**Table 4.1** *(continued)*

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Commodity** | **Scope** | **Safety standard** | **Recommended performance standard** |
| Connectors (terminals) | Terminal blocks:<br>– clamping: ≤ 300 $mm^2$<br>– screw type: ≤ 35 $mm^2$<br>Flat push-on:<br>– 0,75 $mm^2$ to 10 $mm^2$<br>– ≤ 300 °C | | SANS 1433-1<br>IEC 60998-2-1<br>IEC 60998-2-2<br>SANS 1433-2 |
| Contactors, motor starters and overload relays | All | SANS 60947-4-1<br>SANS 60947-4-2<br>SANS 60947-4-3<br>UL 504 | |
| Disconnectors (non-trip) | ≤ 1 000 V a.c. or 1 500 V d.c. | SANS 60947-3 | |
| Distribution boards | ≤ 10 kA short-circuit current low-voltage switchgear and controlgear<br>Assemblies > 10 kA<br>For outdoor use and exposed to public<br>Assemblies for construction sites | SANS 1973-3<br>SANS 1973-1<br>SANS 1973-8<br>SANS 60439-5<br>SANS 60439-4 | |
| Earth leakage circuit-breakers (ELCBs) | $I_{\Delta n}$ ≤ 30 mA<br>≤ 500 V and ≤ 100 A | VC 8035 | |

**Table 4.1** *(continued)*

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Commodity** | **Scope** | **Safety standard** | **Recommended performance standard** |
| Earth leakage circuit-breakers (ELCBs) | $I_n \le 125$ A; $I_{\Delta n} > 30$ mA<br>≤ 500 V and ≤ 100 A | SANS 60947-2 | |
| Earth leakage circuit-breakers (ELCBs) | $I_n > 125$ A; $I_{\Delta n} > 30$ mA<br>≤ 1 000 V | SANS 60947-2 | |
| Earth leakage switches (ELSWs) | $I_{\Delta n} \le 30$ mA<br>≤ 500 V and ≤ 100 A | VC 8035 | |
| Earth leakage switches (ELSWs) | $I_{\Delta n} > 30$ mA<br>≤ 440 V and ≤ 125 A | SANS 556-2-2 | |
| Earth leakage circuit-breakers (ELCBs) used as switch-disconnectors (with isolation function) | $I_{\Delta n} \le 30$ mA<br>≤ 500 V and ≤ 100 A | VC 8035 and 7.2.7 of SANS 556-1:2012 | |
| Earth leakage circuit-breakers (ELCBs) used as switch-disconnectors (with isolation function) | $I_{\Delta n} > 30$ mA<br>≤ 500 V and ≤ 125 A | SANS 60947-2 and classified with isolation function | |
| Earth leakage circuit-breakers (ELCBs) used as switch-disconnectors (with isolation function) | $I_{\Delta n} > 30$ mA<br>≤ 1 000 V | SANS 60947-2 and classified with isolation function | |
| Earth leakage switches (ELSWs) used as switch-disconnectors (with isolation function) | $I_{\Delta n} \le 30$ mA<br>≤ 500 V and ≤ 100 A | VC 8035 plus 7.2.7 of SANS 556-1:2012 | |

**Table 4.1** *(continued)*

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Commodity** | **Scope** | **Safety standard** | **Recommended performance standard** |
| Earth leakage switches (ELSWs) used as switch-disconnectors (with isolation function) | $I_{\Delta n}$ > 30 mA<br>≤ 440 V and ≤ 125 A | SANS 556-2-2 | |
| Earth rods | All | | SANS 1063 |
| Earth wire | Bare copper | SANS 1411-1 | |
| Electrical and electronic equipment for use in installations | All | | SANS 62103 |
| Electricity dispensers (pre-payment meters) | All | | SANS 1524-1 |
| Emergency stop devices | With mechanical latching function | SANS 60947-5-5 | |
| Enclosures | IP ratings | | SANS 60529 |
| Ferrules and lugs | Ferrules and lugs for copper and aluminium conductors | | SANS 61238-1 |
| Fuses (low-voltage) | Rated voltage < 1 000 V a.c.<br>Breaking capacity at least 6 kA<br>Rated current < 1 250 A<br>Rated voltage < 690 V a.c. | SANS 60269-1 | |
| Light dimmers | For incandescent lamps<br><br>– electromechanical 250 V<br>– electronic – maximum of 3 kW | <br><br>SANS 1012<br>SANS 60669-2-1 and VC 8003 | |
| Luminaires | ELV systems<br>Pools and similar applications<br>Supply track systems | SANS 60598-2-23<br>SANS 60598-2-18<br>SANS 60570 | |

**Table 4.1** *(continued)*

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Commodity** | **Scope** | **Safety standard** | **Recommended performance standard** |
| Medical electrical equipment | General | | SANS 60601-1 |
| Medical monitoring devices | Medical IT systems | IEC 61557-8 | |
| Meter cabinets | For outdoor use and exposed to public | SANS 60439-5 | |
| Outlet boxes | All | | SANS 1085 |
| Proximity switches | Not with analogue outputs<br>< 250 V | | SANS 60947-5-2 |
| Push buttons, indicator lights, etc. | Electromechanical control circuit devices –<br>≤ 1 000 V | SANS 60947-5-1 | |
| Ready boards (SPDU) | Non-extendable and extendable – rated 230 V | SANS 1619 | |
| Shaver supply transformers (isolating transformers) | Input: 250 V a.c. supply<br>Output: 110/230 V a.c.<br>Isolating; 20 VA to 50 VA | SANS 61558-2-5 and VC 8055 | |
| Socket-outlets | 6 A, 3-pin, 250 V<br><br>16 A, 3-pin, 250 V<br><br>Dedicated 16 A, 3-pin, 250 V<br><br>Partially dedicated 16A 3 pin | VC 8008 and SANS 164-3<br><br>VC 8008 and one or both of SANS 164-1 or SANS 164-2<br><br>VC 8008 and SANS 164-4<br><br>SANS 164-2-1 | |

**Table 4.1** *(continued)*

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Commodity** | **Scope** | **Safety standard** | **Recommended performance standard** |
| | (SANS 164-2)<br><br>Fully dedicated 16A 3 pin (SANS 164-2).<br><br>IEC systems for SELV plugs and socket-outlets | <br><br>SANS 164-2-2<br><br>SANS 60906-3 | |
| Socket-outlets (industrial type) | ≤ 690 V; ≤ 250 A | SANS 60309-1 and SANS 60309-2 | |
| Stove coupler | All | SANS 337 | |
| Surge arresters for low-voltage systems | ≤ 1 000 V | SANS 61643-11 | |
| Switches (manually operated) | 50 V – 440 V; 63 A | VC 8003 | |
| Switches (photoelectric) | ≤ 1 800 VA; 230 V | VC 8003 (SANS 60669-2-1) | SANS 1777 |
| Switches and switch-disconnectors (non-trip) | ≤ 1 000 V a.c. or 1 500 V d.c. | SANS 60947-3 | |
| Switch-disconnectors (trip) | | | See circuit-breakers used as switch-disconnectors |
| Timer switches | All | VC 8003 (SANS 60669-2-1) | SANS 60730-2-7 |
| Transfer switches | < 1 000 V | SANS 60947-6-1 | |

**Table 4.1** *(concluded)*

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Commodity** | **Scope** | **Safety standard** | **Recommended performance standard** |
| Transformers (distribution) | ≤ 3 150 kVA<br>Maximum 36 kV | SANS 780 | |
| Transformers (isolating) | Test<br>Control<br>Separating (double-wound)<br>Shaver units<br>Safety isolating<br>Medical locations<br>Electronic convertors (for lamps) | SANS 61558-1<br>SANS 61558-2-2<br>SANS 61558-2-4<br>SANS 61558-2-5<br>SANS 61558-2-6<br>SANS 61558-2-15<br>SANS 61347-2-2 | |
| Uninterruptible power systems | All | | SANS 62040-1 |
| Watt-hour meters | Electromechanical induction type < 600 V<br>Electronic static for active energy < 600 V | | SANS 1799<br>SANS 62053-11<br>SANS 62053-21 |
| Wireways | Busways/busbar trunking<br>Cable trunking and ducting for electrical installations | | SANS 60439-2<br>SANS 61084-1 |
| NOTE For installation components see annex B. | | | |

## 4.2 Notices, labels and rating plates

Any notices, labels or rating plates that are required in terms of this part of SANS 10142 shall be durable and not removable except by determined and deliberate action. The inscriptions shall be legible and indelible. Details on the topics given in column 2 of table 4.2 can be found in the relevant subclauses in column 1.

**Table 4.2 — Notices, labels and rating plates**

| 1 | 2 |
|---|---|
| **Subclause** | **Topic** |
| 5.3.8(f) | Position of concealed distribution board |
| 6.6.1.1 | Switch-disconnectors for distribution boards and sub-distribution boards |
| 6.6.1.13 | Identification of ring circuits |
| 6.6.1.20 | Identification of incoming and outgoing circuits of distribution boards |
| 6.6.1.21 | Warning labels on distribution boards |
| 6.6.1.21(e) | Position of readily accessible earthing terminal for other services |
| 6.6.6.2(e) | Alterations or changes to a distribution board |
| 6.7.4(c) | Series-connected (cascaded) systems |
| 6.7.5.6 | Standard socket-outlets not on 30 mA earth leakage or with a rated tripping current higher than 30 mA. |
| 6.7.5.6 | Socket-outlets powered from a safety supply or on dimmer control |
| 6.8.2.2 | Circuit controlled by circuit-breaker |
| 6.8.2.3(b) | Load and line markings on circuit-breakers used as switches |
| 6.9.1.1 | Main switch-disconnectors in the case of multisupplies |
| 6.9.3.2 | Disconnecting devices with remote control |
| 6.9.3.3, NOTE 2 | Disconnecting devices other than switch-disconnectors |
| 6.10.4 | Maximum permissible current rating of fuse-protected circuits |
| 6.11.5 | Earthing terminal for other services |
| 6.14.1.7(a) | More than one phase or circuit in an enclosure |

**Table 4.2** *(concluded)*

| 1 | 2 |
|---|---|
| **Subclause** | **Topic** |
| 6.14.1.8 | More than one circuit brought into an enclosure |
| 6.15.1.2(a) | Voltage rating on socket-outlets if not standard voltage |
| 6.15.3(c)(5) | Maximum rating of back-up short-circuit protective device |
| 6.15.8 | Socket-outlets on ring circuits |
| 6.16.1.2(b) | Position of disconnecting device for remotely installed appliance |
| 7.4.2 | Supply from which equipment is supplied |
| 7.6.3.1 | Socket-outlets in caravan parks, mobile homes and marina sites |
| 7.8.3.1 | Each distribution circuit that supplies a temporary structure |
| 7.9.4.5 | Identification of a protective device not immediately evident |
| 7.10.1.6(b) | Socket-outlets supplied by a dimmer |
| 7.11.5 | Manual control of the emergency lighting supply |
| 7.12.2.1 | Main switch where an alternative supply is installed |
| 7.13.1 | High-voltage equipment |
| 7.13.3.2 | High-voltage signs |
| 7.13.7.1(a) | Enclosure of a step-up transformer for HV apparatus |
| 7.13.10.5(g), (h) | Fireman's switch |
| 7.13.11.2(b) | Terminations of conductors for HV circuits |
| 7.16.4.3 | Indication of neutral earthed distribution system |
| 7.16.4.4 | Prohibition of the removal of the combined neutral-earth connection inside distribution board |

# 5 Fundamental requirements

## 5.1 General

All commodities in an electrical installation shall be installed in accordance with the requirements in this part of SANS 10142 and with the manufacturer's instructions, where applicable.

NOTE 1 This clause contains the general safety principles applicable to electrical installations.

NOTE 2 The manufacturer's instructions may contain more stringent requirements.

## 5.2 Safety

### 5.2.1 Live parts

It shall not be possible to touch any live part within arm's reach with the standard test finger (see SANS 60529)

a) during normal operation, or

b) when a cover is removed, unless the cover is removed with the use of a tool or a key.

### 5.2.2 Temperature

**5.2.2.1** Unless otherwise permitted by an applicable standard (see 4.1 and table 4.1), electrical equipment shall be so designed, positioned and protected that accessible parts under normal operating conditions do not reach a temperature (safe touch temperature) that exceeds

a) 70 °C in the case of metallic parts, and

b) 90 °C in the case of non-metallic parts.

**5.2.2.2** If electrical equipment has to be mounted in a fire risk area or adjacent to flammable material, the equipment shall be

a) of, or enclosed by, thermally non-conductive non-flammable material, or

b) so designed or positioned (or both) that the flammable material is not subjected to any hazardous heating, or

c) so designed or positioned (or both) that any arc or sparks are contained within the enclosure.

### 5.2.3 Earth fault current protection

**5.2.3.1** A new electrical installation shall not be connected to the supply unless the supply includes a protective conductor. (See also 6.11 and 8.5.3.)

**5.2.3.2** People, animals and property shall be protected against harmful earth fault currents by protective measures such as

a) earthing and bonding,

b) electrical separation of circuits,

NOTE The expression "electrical separation of a circuit" means that the circuit is electrically isolated from other circuits in an installation. If an electrically separate circuit is short and is well protected against damage (for example, as in a shaver unit), it is unlikely that there will be faults on the circuit. However, if the circuit is long, the risk of one conductor faulting to earth increases. One fault will reduce the effectiveness of "electrical separation of a circuit" as a protective measure; a second fault can be dangerous. To be able to rely on "electrical separation of a circuit" as a protective measure for a long circuit, a specially designed device should be used to monitor the circuit, and, if a fault occurs, the device should disconnect the circuit or give an audible or a visible warning of the fault.

c) the use of an isolating transformer with an output of 50 V or less,

d) the use of electrical equipment that is double insulated, or

NOTE Electrical equipment that complies with an applicable standard (see 4.1 and table 4.1) and that bears the symbol ⧈ is deemed to be double insulated.

e) the use of earth leakage protection for socket-outlet circuits.

**5.2.3.3.** The rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ required to activate an earth leakage protection device shall not exceed 30 mA.

**5.2.3.4** Earth leakage protection shall not be used as an alternative protective measure to those given in 5.2.3.2(a) and 5.2.3.2(b). Earth leakage protection shall be considered an additional protective measure. (see also 6.7.5.)

**5.2.3.5** The protective measures described in 5.2.3.2(a) to 5.2.3.2(e) may be applied to a

a) complete installation,

b) part of an installation,

c) circuit, or

d) locality.

No protective measure shall interfere with the operation of any other protective measure.

#### 5.2.4 Positioning of equipment

Electrical equipment which, under normal conditions will be

a) exposed to flammable or explosive gas, vapour, dust or liquid, or to external influences such as direct sunlight, corrosive vapour or oil, or

b) in a hazardous location,

shall be so selected or enclosed that it is protected against harmful effects or it shall comply with the requirements of an applicable standard (or both).

#### 5.2.5 Marking of equipment

All equipment and circuits shall be labelled as required by this part of SANS 10142. (See also 4.2.).

### 5.3 Basic provisions

#### 5.3.1 Estimated load

The load of an installation shall be estimated to determine the type and capacity of the required electricity supply.

NOTE 1 Annex C gives an example of estimating the load for residential installations but the method is not to be regarded as an exact method.

NOTE 2 The supplier may have special requirements for large installations and for installations that need special consideration.

#### 5.3.2 Voltage drop

**5.3.2.1** When all conductors of an a.c. installation are carrying their maximum estimated load, the difference in voltage (the voltage drop) between the point of supply and any point of outlet or terminals of fixed appliances shall not exceed 5 % of the standard voltage or of the declared phase-to-neutral voltage (see also 6.2.7). In the case where reticulation is part of the electrical installation after the point of supply, the 5 % voltage drop shall be calculated to include the reticulation part of the installation (for example, in the case of a housing scheme where further submetering with a further point of control is installed for individual consumers).

**5.3.2.2** When all conductors of a d.c. installation are carrying their maximum estimated load, the difference in voltage (the voltage drop) between any point of supply and any point of consumption shall not exceed 5 % of the circuit nominal voltage or as determined by the specific equipment requirements.

### 5.3.3 Nominal cross-sectional area of conductors

The nominal cross-sectional area of a conductor shall be determined in accordance with the following safety considerations:

a) the conductor's maximum permissible continuous temperature;

b) the permissible voltage drop of an installation;

c) the electromechanical stresses and thermal effects that are likely to occur as a result of short-circuits;

d) the maximum impedance of the conductor with respect to the functioning of the short-circuit protection; and

e) mechanical stresses.

NOTE Nominal cross-sectional areas exceeding those necessary for safety may be required for practical operation.

### 5.3.4 Type of wiring and methods of installation

The type of wiring and methods of installation shall be determined after consideration of the following:

a) the location (also consider intentional or inadvertent damage);

b) the nature of the building elements for supporting the wiring;

c) the accessibility of the wiring to persons and livestock;

d) the voltage;

e) the electromechanical stresses and thermal effects likely to occur as a result of short-circuits; and

f) stresses imposed on the wiring during installation and in service.

#### 5.3.5 Protective equipment

Protective devices shall operate at currents and voltages and within periods of time that are related to the characteristics of the circuit that they serve. The type of protective device needed shall be determined in accordance with its respective function, that is to protect the circuit against one or more of the following:

a) overcurrent:

   1) overload current; and

   2) short-circuit current;

b) single phasing;

c) earth fault current;

d) overvoltage;

e) undervoltage;

f) incorrect phase rotation; and

g) fire risk.

#### 5.3.6 Emergency control

If, in dangerous situations, it is necessary to immediately interrupt the power supply, the interrupting device or devices in case of mains and alternative supplies, shall be installed such that all the devices shall

a) easily be recognized, and

b) effectively and quickly operated.

#### 5.3.7 Disconnecting devices

An installation shall have disconnecting devices that allow the installation to be disconnected for maintenance, testing, fault detection or repair. In the case of circuits or items of equipment, additional disconnecting devices could be required to allow disconnection for maintenance, testing, fault detection or repair of such circuits or equipment.

#### 5.3.8 Positioning and accessibility of electrical equipment

Electrical equipment shall be so positioned that

a) it does not impair the functioning or safety of other equipment,

b) it is readily accessible for installation, replacement, operation, testing, inspection, maintenance and repair (see 6.6.1.9 and 6.9.4 for the main switch). All parts of the installation shall be accessible without the need to enter any adjoining premises (for example, in an apartment building),

NOTE Common areas (such as passages and entrance halls) are not regarded as adjoining areas.

c) there is easy access to its location,

d) it is not likely to be physically damaged,

e) dust or moisture is not likely to accumulate on live or other parts and cause flashover, and

f) where the distribution board is concealed by a cupboard or other covering, the notice for live electrical apparatus referred to in annex N shall be in a conspicuous place indicating the position of the distribution board.

## 5.4 Characteristics

#### 5.4.1 General

The characteristics of the selected equipment shall be appropriate to the conditions and parameters on which the design of an installation is based.

#### 5.4.2 Voltage

The equipment shall be suitable for operation on the maximum steady (r.m.s.) voltage and overvoltage to which it is likely to be subjected. Equipment shall be rated in accordance with the intended application for use on one of the following voltages used in South Africa:

a) A.C. circuits:

   1) standard voltages of

      i) 230 V single-phase,

ii) 230/400 V three-phase four-wire, and

a tolerance of ± 10 % on these voltages.

NOTE For certain equipment it may be necessary to consider the lowest voltage that is likely to occur.

2) declared voltages of 525 V three-phase three-wire is a commonly used voltage and the tolerance is ± 5 %.

NOTE Declared voltage is the voltage declared by the manufacturer up to the maximum of 1 000 V.

b) D.C. circuits:

1) preferred voltages of

i) 12 V,

ii) 24 V,

iii) 48 V,

2) other voltages of

i) 60 V,

ii) 80 V,

iii) 110 V,

iv) 220 V,

v) 250 V,

vi) 500 V, and

the tolerances on the above d.c. voltages are determined by the application.

c) Voltages on control circuits should preferably not exceed 230 V a.c. or 110 V d.c.

#### 5.4.3 Current

The equipment shall be suitable for operation at the maximum steady (r.m.s.) current to which it is likely to be subjected. It shall also be able to carry the current that is likely to flow under abnormal conditions and for the period that the current is likely to flow.

NOTE The period that an abnormal current will flow is equal to the operating time of any protective device.

#### 5.4.4 Frequency

If the operation of the equipment is sensitive to frequency variations, the rated frequency of the equipment shall be such that the equipment operates safely when it is subjected to the frequency variations that are likely to occur in the circuit.

#### 5.4.5 Power

If the equipment is selected on the basis of its power characteristics, it shall be suitable for the duty demanded of it.

### 5.5 Prevention of harmful effects

#### 5.5.1 Prevention of mutually detrimental influence

An electrical installation shall be so arranged that there is minimal mutually detrimental influence between it and any other installation (including non-electrical installations) on the premises.

#### 5.5.2 Harmful effects by electrical equipment

Electrical equipment shall be so designed and arranged that any damage as a result of a fault be localized as much as possible. The equipment shall not have harmful effects on other equipment or on the power supply during normal service (including switching operations). Factors that can lead to harmful effects include

a) the power factor,

b) inrush current,

c) asymmetrical load, and

d) harmonics.

#### 5.5.3 Surge protection

Where a surge protection device is installed, it shall be installed after the main switch (see annex I).

### 5.6 Environmental conditions

**5.6.1** Electrical equipment shall be able to withstand the environmental conditions of the location in which it is installed. However, electrical equipment may be protected to allow its use in a particular environment for which it is not designed, provided that the environment shall allow for the normal heating and cooling of the equipment.

**5.6.2** This part of SANS 10142 applies to electrical installations located at altitudes not exceeding 2 000 m. In the absence of specific product information with regard to application at high altitudes, products should be derated as follows:

a) 1 % of the thermal current rating for every 500 m, or part thereof, exceeding an altitude of 2 000 m;

b) 1 % of the maximum voltage rating for every 100 m, or part thereof, exceeding an altitude of 2 000 m.

### 5.7 Medical locations

In medical locations it is necessary to ensure the safety of patients who could be subject to the application of medical electrical equipment. For every activity and function in a medical location, the particular requirements for safety have to be considered. In the majority of cases, safety can be achieved by ensuring the safety of the installation. The use of medical electrical equipment on patients while under intensive care (of clinical importance) has called for enhanced reliability and safety of electrical installations in hospitals by improving the safety and continuity of supplies (see 7.7).

### 5.8 Extra low voltage systems (SELV and PELV)

#### 5.8.1 Shock hazard protection by extra low voltage

**5.8.1.1** Protection by extra low voltage is a protective measure that consists of the following two different extra low voltage systems:

a) SELV (safety extra low voltage), an unearthed system; and

b) PELV (protected extra low voltage), an earthed system.

**5.8.1.2** The use of a SELV or PELV system is considered as a protective measure in all situations and the protection is provided by

a) the limitation of the voltage in the system to 50 V a.c. r.m.s. or 120 V ripple-free d.c.,

b) protective separation of the SELV or the PELV system from all circuits other than SELV and PELV circuits, and basic insulation between the SELV or the PELV system and other SELV or PELV systems, and

c) basic insulation between the SELV system and earth for the SELV systems only

NOTE 1 Typical applications are ELV lighting and emergency buttons in a bathroom.

NOTE 2 Additional safety precautions are required when SELV and PELV circuits are used in hazardous locations (see 7.14.2).

#### 5.8.2 Requirements for basic protection and fault protection

**5.8.2.1** Basic protection and fault protection are deemed to be provided when

a) the nominal voltage cannot exceed the upper limit of 50 V a.c. or 120 V d.c.,

b) the source of supply is one of the sources listed in 5.8.3, and

c) the conditions of 5.8.4 are fulfilled.

**5.8.2.2** If the system is supplied from a higher voltage system by equipment which does not provide at least simple separation between that system and the extra low voltage system, such as in auto-transformers, potentiometers, semiconductor devices, etc., the output circuit is deemed to be an extension of the input circuit and shall be protected by the protective measure applied to the input circuit.

NOTE In a d.c. system with batteries, the battery charging and floating voltages exceed the battery nominal voltage, depending on the type of battery. This does not require any protective provisions in addition to those specified in this clause. The charging voltage would normally not exceed a maximum value of 75 V a.c. or 150 V d.c.

### 5.8.3 Sources for SELV and PELV

#### 5.8.3.1 General sources

General sources that provide SELV and PELV are the following:

a) safety isolating transformers that comply with the requirements of SANS 61558-2-6;

b) sources that provide a degree of safety equivalent to that of the safety isolating transformer specified in (a) (for example, a motor generator with windings that provide equivalent isolation);

c) electrochemical sources (for example, a battery) or other sources independent of a higher voltage circuit (for example, a diesel-driven generator); and

d) certain electronic devices that comply with appropriate standards where provisions have been taken to ensure that, even in the case of an internal fault, the voltages at the outgoing terminals cannot exceed the values specified in 5.8.2. Higher voltages at the outgoing terminals are, however, permitted if it is ensured that, in the case of contact with a live part or in the event of a fault between a live part and an exposed conductive part, the voltages at the output terminals are immediately reduced to the values in 5.8.2 or less.

NOTE 1 Examples of such electronic devices include insulation testing equipment.

NOTE 2 Where higher voltages exist at the outgoing terminals, compliance with this clause may be assumed if the voltages at the outgoing terminals are within the limits specified in 5.8.2 when measured with a voltmeter that has an internal resistance of at least 3 000 Ω.

#### 5.8.3.2 Mobile sources

Mobile sources that provide SELV and PELV, for example, safety isolating transformers or motor generators, shall be selected or erected in accordance with the requirements for protection by using double or reinforced insulation.

### 5.8.4 Requirements for SELV and PELV circuits

**5.8.4.1** SELV and PELV circuits shall have

a) protective separation of live parts from the live parts of other circuits (except for other SELV and PELV circuits), which shall be provided by

   1) double insulation, or

2) reinforced insulation for the highest voltage present, or

3) basic insulation and protective screening according to the highest voltage present, and

b) basic insulation between live parts and the live parts of other SELV or PELV circuits.

**5.8.4.2** SELV circuits shall have basic insulation between live parts and earth not less than that provided between the input and the output windings of a safety isolating transformer.

NOTE The earthing of PELV circuits can be achieved by an appropriate connection to earth within the source itself.

**5.8.4.3** Protective separation of the wiring systems of SELV and PELV circuits from the live parts of other circuits can be achieved by one of the following arrangements:

a) SELV and PELV circuit conductors shall be enclosed in a non-metallic sheath or non-metallic enclosure in addition to basic insulation; or

b) SELV and PELV circuit conductors shall be separated from conductors of circuits at different voltages by an earthed metallic sheath or earthed metallic screen; or

c) circuits at different voltages can be contained in a multiconductor cable or other grouping of conductors if the SELV and PELV conductors are insulated for the highest voltage present.

**5.8.4.4** Plugs and socket-outlets for SELV and PELV systems shall comply with the following requirements:

a) plugs shall not be able to enter socket-outlets of other voltage systems;

b) socket-outlets shall not admit plugs of other voltage systems; and

c) socket-outlets in SELV systems shall not have a protective conductor.

**5.8.4.5** Live parts of SELV circuits shall not be connected to

a) earth, or

b) live parts that form part of other circuits, or

c) protective conductors that form part of other circuits.

**5.8.4.6** Exposed conductive parts of SELV circuits shall not be connected to

a) earth, or

b) protective conductors, or

c) exposed conductive parts of another circuit.

NOTE If the exposed conductive parts of SELV circuits are liable to come into contact, either fortuitously or intentionally, with the exposed conductive parts of other circuits, protection against electric shock no longer depends solely on protection by SELV, but also on the protective provisions to which the latter exposed conductive parts are subject.

**5.8.4.7** If the nominal voltage exceeds 25 V a.c. r.m.s. or 60 V ripple-free d.c. or if the equipment is immersed in a conductive liquid, basic protection shall be provided for SELV and PELV circuits by

a) insulation, or

b) barriers, or

c) enclosures.

**5.8.4.8** If the nominal voltage does not exceed 25 V a.c. r.m.s. or 60 V ripple-free d.c.

a) for SELV circuits, basic protection is generally not necessary under normal dry conditions, and

b) for PELV circuits, the exposed conductive parts or the live parts or both are connected by a protective conductor to the main earthing terminal.

**5.8.4.9** If the nominal voltage of the SELV or PELV system does not exceed 12 V a.c. r.m.s or 30 V ripple-free d.c., basic protection in all other cases is not necessary.

NOTE "Ripple-free" is conventionally defined for sinusoidal ripple voltage as a ripple content of not more than 10 % r.m.s.: the maximum peak value does not exceed 140 V for a nominal 120 V ripple-free d.c. system and 70 V for a nominal 60 V ripple-free d.c. system.

# 6 Installation requirements

## 6.1 General circuit arrangements

**6.1.1** In a multiphase installation, the circuits shall be so arranged that the total load is, as nearly as is practicable, balanced between the phases of the supply.

**6.1.2** A three-phase four-wire circuit that supplies only single-phase items of electrical equipment (that are connected between a phase conductor and the neutral conductor) may supply any number of points if

a) the circuit is protected by

   1) a multipole circuit-breaker, or

   2) single-phase protective devices with a multipole switch-disconnector on the supply side,

b) throughout the circuit, the neutral conductor has the same nominal cross-sectional area as the associated phase conductors,

c) tee-joints are accessible and the main neutral conductor remains unbroken when tee-joints are removed, and

d) the total load is, as nearly as is practicable, balanced over the three phases.

**6.1.3** Where it is required to separately control a part of an installation (such as fire services or emergency equipment), it shall be supplied by a separate dedicated circuit.

**6.1.4** All the conductors of any circuit shall originate at the same distribution board.

**6.1.5** A maximum of three conductors may be connected to any one terminal provided that the terminal has the correct rating.

**6.1.6** The neutral conductor shall not be connected direct to earth or to the earth continuity conductor on the load side of the point of control except as allowed in 7.16.4.

**6.1.7** If conductors that operate at different voltages run in the same wireway, the insulation of each conductor shall be able to withstand the highest conductor voltage in the wireway. Alternatively, the conductors shall be separated by a continuous barrier of insulating material or earthed metal.

**6.1.8** If a luminaire is used as a wireway (through-wiring),

a) there shall be a heat-resistant barrier between the ballast or transformer and the conductor; or

b) heat-resistant cable that complies with SANS 529 shall be used.

**6.1.9** The continuity of neutral and earth circuits shall be ensured at all times, and, except where the luminaire is used as a wireway for through-wiring, the continuity shall not be disturbed during repair, replacement or removal of any appliance.

**6.1.10** Conductors that form part of a d.c. installation shall not be run in the same wireway as conductors that form part of an a.c. installation.

**6.1.11** Flexible cords shall not be used as part of the electrical installation, except where

a) required by the relevant product solely for termination or connection of moving parts,

b) specified in the product standard,

c) used as single cores in conduits,

d) used in an authorized wiring system (see 3.5), or

e) needed for the connection of luminaires, provided that each connection is limited to one luminaire and to a maximum length of 3 m.

**6.1.12** Where flexible cords are used, the strands of the conductors shall be protected to prevent the strands from being cut off in terminations.

## 6.2 Current-carrying capacity of conductors and cables

### 6.2.1 General applications

NOTE The required size of conductor is determined by considering the required current-carrying capacity of the cable, the permitted voltage drop, requirements for overcurrent protection and short-time overcurrent rating.

**6.2.1.1** The nominal cross-sectional area of the conductors of a cable shall be such that the maximum estimated load to be carried by the conductors does not exceed their current-carrying capacity.

**6.2.1.2** The current-carrying capacity of each conductor in a circuit that comes from a distribution board shall be the same at each point in the circuit, but if the conductors of lowest current-carrying capacity are protected against overcurrent in accordance with 6.2.1.1,

a) the current-carrying capacity of conductors at one or more points in the circuit may be reduced;

b) one or more spurs that have conductors of reduced current-carrying capacity may be teed into a circuit; and

c) at one point only, a circuit may be split into two or more branches, each having conductors of reduced current-carrying capacity.

**6.2.1.3** Except in the case of a ring circuit, there shall be no branches, tee-offs or socket-outlets along parallel conductors and, where two or more conductors are connected in parallel, the conductors shall

a) have the same characteristics in respect of conductor material, nominal cross-sectional area, length and, where applicable, insulation and cable construction, and

b) follow the same route and have the same installation method(s).

### 6.2.2 Particular applications

#### 6.2.2.1 Motors

**6.2.2.1.1** The current-carrying capacity of the circuit conductors for a motor shall be at least equal to the full-load rated current of the motor. Possible increases in temperature owing to long or frequent starting shall be taken into consideration.

**6.2.2.1.2** In the case of a circuit that supplies two or more motors, the current-carrying capacity of the conductors shall be at least equal to the sum of the full-load rated current of the motors, but a lower current-carrying capacity may be used if there is cyclic loading.

#### 6.2.2.2 Discharge lighting

The nominal cross-sectional area of the neutral conductor in a three-phase circuit that supplies discharge lighting shall be at least equal to the nominal cross-sectional area of the associated phase conductor.

NOTE Without power-factor correction, a discharge lamp luminaire with magnetic ballast might have a current as much as 64 % higher than a power-factor corrected luminaire and would require bigger conductors and protection.

### 6.2.3 Basis of tabulated current-carrying capacity

**6.2.3.1** The current-carrying capacity of conductors and cables set out in this clause takes account of IEC standards, where applicable. For types of cable not covered in the relevant IEC publication (for example, armoured cables) the current-carrying capacity given in this clause is based on data provided by the Association of Electric Cable Manufacturers of South Africa.

**6.2.3.2** The tabulated current-carrying capacity (given in tables 6.2(a) to 6.9(b)) relates to continuous loading and is also known as the "full thermal current rating" of the cable, corresponding to the conductor operating temperature indicated in the headings to the tables concerned. This current-carrying capacity is intended to provide for a satisfactory life of conductors and insulation subject to the thermal effects of carrying current for sustained periods in normal service. A cable can be seriously damaged, leading to early failure, or its service life can be significantly reduced, if it is operated for any prolonged period at a temperature higher than the indicated value.

**6.2.3.3** In addition, there are other considerations that affect the choice of cross-sectional area of a conductor, such as the requirements for protection against electric shock, protection against thermal effects, overcurrent protection, voltage drop and limiting temperatures for terminals of equipment to which the conductors are connected.

**6.2.3.4** The tabulated current-carrying capacity (given in tables 6.2(a) to 6.9(b)) relates to a single circuit in the installation methods (shown in table 6.1), in an ambient air temperature of 30 °C. The current-carrying capacity (given in the said tables) for a.c. operation applies only to frequencies in the range 49 Hz to 61 Hz.

**6.2.3.5** In extreme cases, notably for large multicore cables, the reduction in current-carrying capacity of the cables (for example, balanced 400 Hz a.c. compared with the current-carrying capacity at 50 Hz), may be as much as 50 %.

**6.2.3.6** For small cables and flexible cords, such as may be used to supply individual tools, the difference between 50 Hz and the 400 Hz current-carrying capacities may be negligible.

### 6.2.4 Methods of cable installation

Table 6.1 lists the descriptions and the numbers of installation methods to be used for the determination of the current-carrying capacities of conductors in the selection of the appropriate cable size. The use of other methods is not precluded where a suitably qualified person has specified it.

For other conditions, appropriate correction factors shall be applied as described in 6.2.5.

### 6.2.5 Application of tables and correction factors for current-carrying capacity

**6.2.5.1** To determine the current-carrying capacity of a cable for a particular method of installation, multiply the value of current-carrying capacity obtained from tables 6.2(a) to 6.9(b) by the correction factors for each of the following, where applicable:

a) ambient temperature (see table 6.10);

b) grouping and number of cables on racks or trays (see table 6.14);

c) grouping and number of cables in a trench (see table 6.15);

d) grouping and number of cables buried directly in the ground (see tables 6.11, 6.12, 6.13 and 6.16);

e) neutral imbalance (see table 6.17);

f) harmonics (see table 6.18); and

g) direct solar radiation (see table 6.19).

**6.2.5.2** Once the current-carrying capacity has been determined, after all correction factors had been considered, carry out the load power factor and voltage drop calculations to determine whether the voltage drop will be within the allowed 5 %.

**6.2.6 Effective current-carrying capacity**

**6.2.6.1** The current-carrying capacity of a cable corresponds to the maximum current that can be carried in specified conditions without the conductors exceeding the permissible limit of steady state temperature for the type of insulation concerned.

**6.2.6.2** The value of a tabulated current represents the effective current-carrying capacity only where no correction factor is applicable. Otherwise the current-carrying capacity of a cable corresponds to the tabulated value multiplied by the appropriate correction factor or factors for ambient temperature, grouping, neutral imbalance, harmonics, thermal insulation and solar radiation, as applicable.

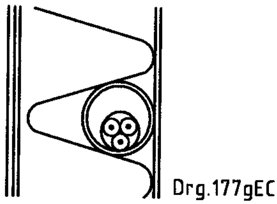
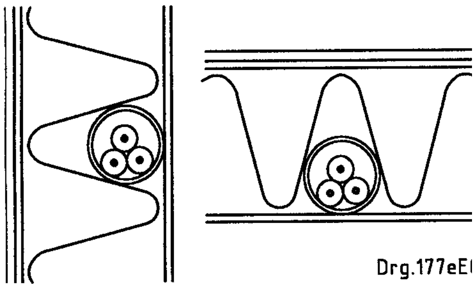
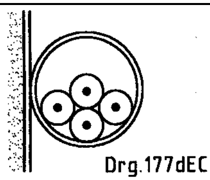
**6.2.6.3** Irrespective of the type of overcurrent protective device associated with the conductors concerned, the ambient temperature correction factors to be used when calculating current-carrying capacity (as opposed to those used when selecting cable sizes) are given in table 6.10.

**6.2.6.4** For the size and construction of a cable and for the conditions of use, other than those covered in this clause and the following tables, the current-carrying capacity shall be taken as that specified by the manufacturer or as given in SANS 10198-4.

**6.2.6.5** Conditions of installation for cables buried in the ground are given in tables 6.8, 6.11, 6.12, 6.13 and 6.16. For cables not covered, see SANS 10198-4.

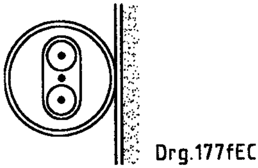
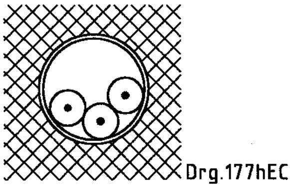
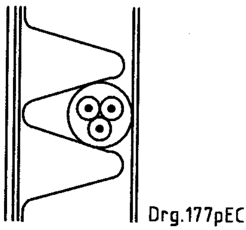
**6.2.6.6** Where CFL (compact fluorescent lamp) lighting is installed, the rating of the conductors shall be based on double the sum of the lamp load, in watts (see also 6.2.11.2.3 and 6.14).

## Table 6.1 — Schedule of description, examples and numbers of installation methods for cables

| 1 | 2 | 3 |
|---|---|---|
| **Description of installation method** | **Examples** | **Installation method** |
| **a) Cables in conduit** | | |
| Sheathed cables in conduit in a thermally insulating wall (otherwise as in footnote a) |   | Method 1 |
| Single-core non-sheathed cables in metallic or non-metallic conduit in a thermally insulating wall or above a thermally insulating ceiling, the conduit being in contact with a thermally conductive surface on one side[a] |   | Method 1 |
| Single-core non-sheathed cables in metallic or non-metallic conduit on a wall or ceiling |   | Method 2 |

[a] The wall is assumed to consist of an outer weatherproof skin, thermal insulation and an inner skin of plasterboard or wood-like material that have a thermal conductance not less than 10 W m$^2$K. The conduit is fixed so as to be close to, but not necessarily touching, the inner skin. Heat from the cables is assumed to escape through the inner skin only.

**Table 6.1** *(continued)*

| 1 | 2 | 3 |
|---|---|---|
| **Description of installation method** | **Examples** | **Installation method** |
| Multicore cables that have non-metallic sheaths, in metallic or non-metallic conduit on a wall or ceiling |   | Method 2 |
| Cables in conduit embedded in masonry, brick-work, concrete, plaster or the like (other than thermally insulating materials) |   | Method 2 |
| **b) Cables in building voids** | | |
| Sheathed cables installed direct in a thermally insulating wall or above a thermally insulating ceiling, the cable being in contact with a thermally conductive surface on one side (otherwise as in footnote a) |   | Method 1 |

[a] The wall is assumed to consist of an outer weatherproof skin, thermal insulation and an inner skin of plasterboard or wood-like material that have a thermal conductance not less than 10 W m$^2$K. The conduit is fixed so as to be close to, but not necessarily touching, the inner skin. Heat from the cables is assumed to escape through the inner skin only.

**Table 6.1** *(continued)*

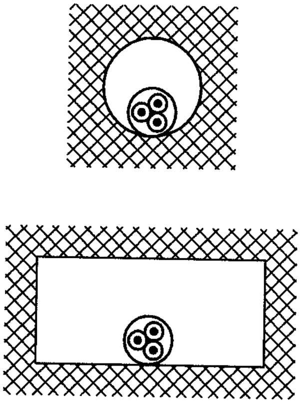
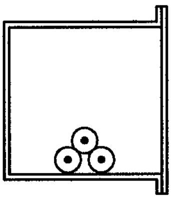
| 1 | 2 | 3 |
|---|---|---|
| **Description of installation method** | **Examples** | **Installation method** |
| Sheathed cables in ducts or voids formed by the building structure (other than thermally insulating materials) | <br>Drg.177qEC | Method 1<br><br>Where the cable has a diameter $D_e$ and the duct has a diameter not exceeding 5 $D_e$ or a perimeter not exceeding 20 $D_e$<br><br>Method 2<br><br>Where the duct has a diameter exceeding 5 $D_e$ or a perimeter exceeding 20 $D_e$<br><br>NOTE 1 Where the perimeter exceeds 60 $D_e$, installation methods 7 to 9, as appropriate, should be used.<br><br>NOTE 2 $D_e$ is the overall cable diameter. In the case of groups of cables, $D_e$ is the sum of the cable diameters. |
| **c) Cables in trunking** | | |
| Cables in trunking on a wall or suspended in the air | <br>Drg.177iEC | Method 2 |

**Table 6.1** *(continued)*

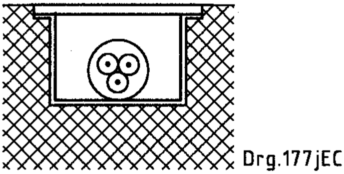
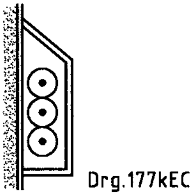
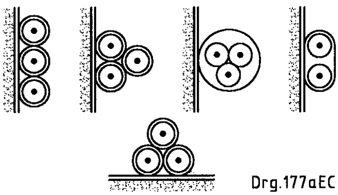
| 1 | 2 | 3 |
|---|---|---|
| **Description of installation method** | **Examples** | **Installation method** |
| Cables in flush floor trunking |  | Method 2 |
| Single-core cables in skirting or trunking |  | Method 2 |
| **d) Cables open and clipped direct** | | |
| Sheathed cables clipped direct to or lying on a non-metallic surface or bunched |  | Method 3 |

**Table 6.1** *(continued)*

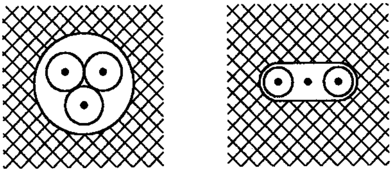
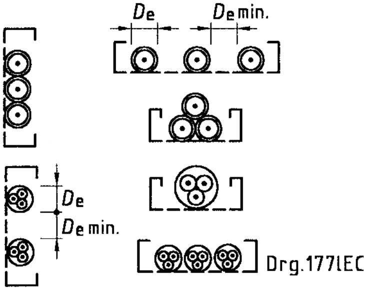
| 1 | 2 | 3 |
|---|---|---|
| **Description of installation method** | **Examples** | **Installation method** |
| **e) Cables embedded direct in building materials** | | |
| Sheathed cables embedded direct in masonry, brickwork, concrete, plaster or the like (other than thermally insulating materials) |   | Method 3 |
| **f) Cables on trays** | | |
| Sheathed cables on a perforated cable tray bunched and unenclosed. A perforated cable tray is considered as a tray in which the holes occupy at least 30 % of the surface area |   | Method 4 |

**Table 6.1** *(continued)*

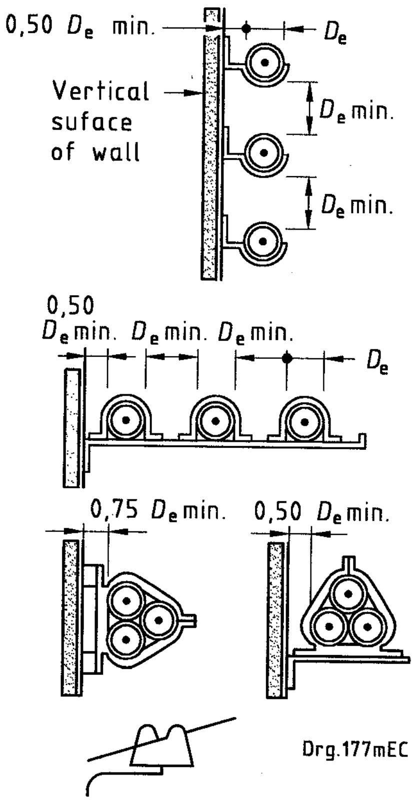
| 1 | 2 | 3 |
|---|---|---|
| **Description of installation method** | **Examples** | **Installation method** |
| **g) Cables in free air, on cleats, brackets or a ladder** | | |
| Sheathed single-core cables in free air (any supporting metalwork under the cables occupies less than 10 % of the plan area)<br><br>Two or three cables vertically one above the other, minimum distance between cable surfaces equal to the overall cable diameter ($D_e$); distance from the wall not less than 0,5 $D_e$<br><br>Two or three cables horizontally, with spacing as above<br><br>Three cables in trefoil, distance between wall and surface of nearest cable 0,5 $D_e$ or nearest cables 0,75 $D_e$<br><br>Insulated conductors on insulators |  | Method 5 |

**Table 6.1** *(continued)*

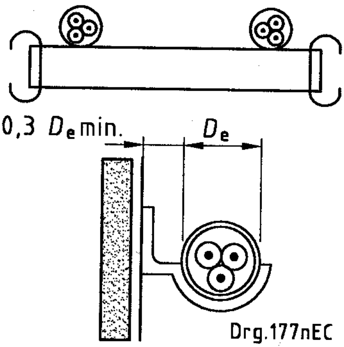
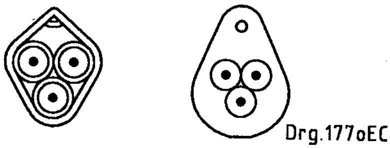
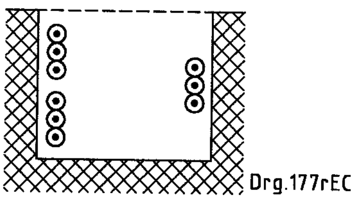
| 1 | 2 | 3 |
|---|---|---|
| **Description of installation method** | **Examples** | **Installation method** |
| Sheathed multicore cables on a ladder or brackets, separation exceeding 2 $D_e$<br><br>Sheathed multicore cables in free air; dis-tance between wall and cable surface not less than 0,3 $D_e$<br><br>Any supporting metal-work under the cables occupies less than 10 % of the plan area |  | Method 6 |
| Cables suspended from or incorporating a catenary wire |  | Method 5 or 6, as appropriate |
| **h) Cables in trenches** | | |
| Cables supported on the wall of an open or ventilated trench, with spacing as indicated for the appropriate installation methods in free air, on cleats, brackets or a ladder, as shown above |  | Method 5 or 6, as appropriate |

**Table 6.1** *(continued)*

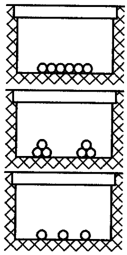
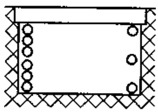
| 1 | 2 | | 3 |
|---|---|---|---|
| **Description of installation method** | **Examples** | | **Installation method** |
| Cables in enclosed trench 450 mm wide by 300 mm deep (minimum dimensions) including a cover of 100 mm | Two single-core cables with surfaces separated by a minimum of one cable diameter.<br><br>Three single-core cables in trefoil and touching throughout.<br><br>Multicore cables or groups of single-core cables with surfaces separated by a minimum of 50 mm. |  Drg.177sEC | Method 7<br><br>Use correction factors in table 6.15 |
| Cables in enclosed trench 450 mm wide by 600 mm deep (minimum dimensions) including a cover of 100 mm | Single-core cables arranged in flat groups of two or three on the vertical trench wall with surfaces separated by one diameter with a minimum distance of 50 mm between groups.<br><br>Multicore cables installed with surfaces separated by a minimum[b] of 75 mm.<br><br>All cables spaced at least 25 mm from the trench wall. |  Drg.177tEC | Method 8<br><br>Use correction factors in table 6.15 |
| [b] Larger spacing to be used where practicable. | | | |

**Table 6.1** *(continued)*

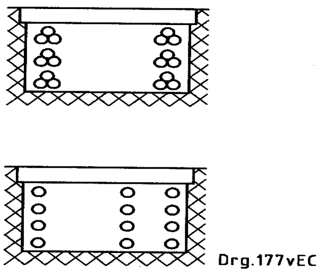
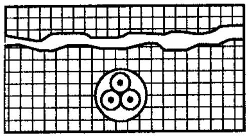
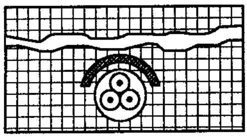
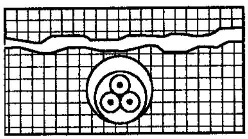
| 1 | 2 | | 3 |
|---|---|---|---|
| **Description of installation method** | **Examples** | | **Installation method** |
| Cables in enclosed trench 600 mm wide by 760 mm deep (minimum dimensions) including a cover of 100 mm | Single-core cables arranged in groups of two or three in flat formation with the surfaces separated by one diameter or in trefoil formation with cables touching. Groups separated by a minimum[b] of 50 mm either horizontally or vertically.<br><br>Multicore cables installed with surfaces separated by a minimum of 75 mm either horizontally or vertically.<br><br>All cables spaced at least 25 mm from the trench wall. |  | Method 9<br><br>Use correction factors in table 6.15 |
| [b] Larger spacing to be used where practicable. | | | |

**Table 6.1** *(concluded)*

| 1 | 2 | 3 |
|---|---|---|
| **Description of installation method** | **Examples** | **Installation method** |
| **i) Cables buried in the ground** | | |
| Single-core or multicore cables direct in the ground:<br>a) without added protection against mechanical damage[c] |  | |
| b) with added protection against mechanical damage[c] |  | Use ratings in table 6.8 and correction factors in tables 6.11 and 6.12 |
| c) in a pipe |  Drg.177cEC | |

[c] The inclusion of directly buried cables in this table is satisfactory when the soil thermal resistivity is in the order of 1,2 K m/W. In the case of lower soil resistivity, the current-carrying capacity for directly buried cables is appreciably higher than for cables in ducts.

**Table 6.2(a) — Single-core PVC insulated cables, unarmoured, with or without sheath (SANS 1507) Current-carrying capacity copper conductors**

Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** | **Installation method 1 (enclosed in conduit in thermally insulating wall, etc.)** | | **Installation method 2 (enclosed in conduit on a wall or in trunking, etc.)** | | **Installation method 3 (clipped direct)** | | **Installation method 4 (on a perforated cable tray, horizontal or vertical)** | | **Installation method 5 (in free air)** | | |
| | | | | | | | | | **Horizontal flat spaced** | **Vertical flat spaced** | **Trefoil** |
| | **Two cables, single-phase a.c. or d.c.** | **Three or four cables, three-phase a.c.** | **Two cables, single-phase a.c. or d.c.** | **Three or four cables, three-phase a.c.** | **Two cables, single-phase a.c. or d.c. (flat and touching)** | **Three or four cables, three-phase a.c. (flat and touching or trefoil)** | **Two cables, single-phase, d.c. (flat and touching)** | **Three or four cables, three-phase a.c. (flat and touching or trefoil)** | **Two cables, single-phase a.c. or d.c. or three cables, three-phase a.c.** | **Two cables, single-phase a.c. or d.c. or three cables, three-phase a.c.** | **Three cables, trefoil three-phase a.c.** |
| $mm^2$ | A | A | A | A | A | A | A | A | A | A | A |
| 1 | 11 | 10,5 | 13,5 | 12 | 15,5 | 14 | – | – | – | – | – |
| 1,5 | 14,5 | 13,5 | 17,5 | 15,5 | 20 | 18 | – | – | – | – | – |
| 2,5 | 19,5 | 18 | 24 | 21 | 27 | 25 | – | – | – | – | – |
| 4 | 26 | 24 | 32 | 28 | 37 | 33 | – | – | – | – | – |
| 6 | 34 | 31 | 41 | 36 | 47 | 43 | – | – | – | – | – |
| 10 | 46 | 42 | 57 | 50 | 65 | 59 | – | – | – | – | – |
| 16 | 61 | 56 | 76 | 68 | 87 | 79 | – | – | – | – | – |
| 25 | 80 | 73 | 101 | 89 | 114 | 104 | 126 | 112 | 146 | 130 | 110 |
| 35 | 99 | 89 | 125 | 110 | 141 | 129 | 156 | 141 | 181 | 162 | 137 |
| 50 | 119 | 108 | 151 | 134 | 182 | 167 | 191 | 172 | 219 | 197 | 167 |
| 70 | 151 | 136 | 192 | 171 | 234 | 214 | 246 | 223 | 281 | 254 | 216 |
| 95 | 182 | 164 | 232 | 207 | 284 | 261 | 300 | 273 | 341 | 311 | 264 |

**Table 6.2(a)** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** | **Installation method 1 (enclosed in conduit in thermally insulating wall, etc.)** | | **Installation method 2 (enclosed in conduit on a wall or in trunking, etc.)** | | **Installation method 3 (clipped direct)** | | **Installation method 4 (on a perforated cable tray, horizontal or vertical)** | | **Installation method 5 (in free air)** | | |
| | | | | | | | | | **Horizontal flat spaced** | **Vertical flat spaced** | **Trefoil** |
| | **Two cables, single-phase a.c. or d.c.** | **Three or four cables, three-phase a.c.** | **Two cables, single-phase a.c. or d.c.** | **Three or four cables, three-phase a.c.** | **Two cables, single-phase a.c. or d.c. (flat and touching)** | **Three or four cables, three-phase a.c. (flat and touching or trefoil)** | **Two cables, single-phase, d.c. (flat and touching)** | **Three or four cables, three-phase a.c. (flat and touching or trefoil)** | **Two cables, single-phase a.c. or d.c. or three cables, three-phase a.c.** | **Two cables, single-phase a.c. or d.c. or three cables, three-phase a.c.** | **Three cables, trefoil three-phase a.c.** |
| $mm^2$ | A | A | A | A | A | A | A | A | A | A | A |
| 120 | 210 | 188 | 269 | 239 | 330 | 303 | 349 | 318 | 396 | 362 | 308 |
| 150 | 240 | 216 | 300 | 262 | 381 | 349 | 404 | 369 | 456 | 419 | 356 |
| 185 | 273 | 245 | 341 | 296 | 436 | 400 | 463 | 424 | 521 | 480 | 409 |
| 240 | 320 | 286 | 400 | 346 | 515 | 472 | 549 | 504 | 615 | 569 | 485 |
| 300 | 367 | 328 | 458 | 394 | 594 | 545 | 635 | 584 | 709 | 659 | 561 |
| 400 | – | – | 546 | 467 | 694 | 634 | 732 | 679 | 852 | 795 | 656 |
| 500 | – | – | 626 | 533 | 792 | 723 | 835 | 778 | 982 | 920 | 749 |
| 630 | – | – | 720 | 611 | 904 | 826 | 953 | 892 | 1 138 | 1 070 | 855 |
| 800 | – | – | – | – | 1 030 | 943 | 1 086 | 1 020 | 1 265 | 1 188 | 971 |
| 1 000 | – | – | – | – | 1 154 | 1 058 | 1 216 | 1 149 | 1 420 | 1 337 | 1 079 |

## Table 6.2(b) — Single-core PVC insulated cables, unarmoured, with or without sheath (SANS 1507) Voltage drop (per ampere per metre) copper conductors

Conductor operating temperature: 70 °C

| 1 | 2 | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | | 9 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conductor cross-sectional area | Two cables d.c.a[a] | Two cables – Single-phase a.c.[a] | | | | | | | | | Three or four cables – Three-phase a.c. | | | | | | | | | | | |
| | | Installation Methods 1 and 2 (enclosed in conduit, etc. in or on a wall) | | | Installation Methods 3 and 4 (clipped direct or on trays, touching) | | | Installation Method 5 (spaced)[b] | | | Installation Methods 1 and 2 (enclosed in conduit, etc. in or on a wall) | | | Installation methods 3, 4 and 5 (in trefoil) | | | Installation Methods 3 and 4 (flat and touching) | | | Installation Method 5 (flat, spaced)[b] | | |
| mm² | mV/A/m | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | |
| 1 | 44 | 44 | | | 44 | | | 44 | | | 38 | | | 38 | | | 38 | | | 38 | | |
| 1,5 | 29 | 29 | | | 29 | | | 29 | | | 25 | | | 25 | | | 25 | | | 25 | | |
| 2,5 | 18 | 18 | | | 18 | | | 18 | | | 15 | | | 15 | | | 15 | | | 15 | | |
| 4 | 11 | 11 | | | 11 | | | 11 | | | 9,5 | | | 9,5 | | | 9,5 | | | 9,5 | | |
| 6 | 7,3 | 7,3 | | | 7,3 | | | 7,3 | | | 6,4 | | | 6,4 | | | 6,4 | | | 6,4 | | |
| 10 | 4,4 | 4,4 | | | 4,4 | | | 4,4 | | | 3,8 | | | 3,8 | | | 3,8 | | | 3,8 | | |
| 16 | 2,8 | 2,8 | | | 2,8 | | | 2,8 | | | 2,4 | | | 2,4 | | | 2,4 | | | 2,4 | | |
| | | r | x | z | r | x | z | r | x | z | r | x | z | r | x | z | r | x | z | r | x | z |
| 25 | 1,75 | 1,80 | 0,33 | 1,80 | 1,75 | 0,20 | 1,75 | 1,75 | 0,29 | 1,80 | 1,50 | 0,29 | 1,55 | 1,50 | 0,175 | 1,50 | 1,50 | 0,25 | 1,55 | 1,50 | 0,32 | 1,55 |
| 35 | 1,25 | 1,30 | 0,31 | 1,30 | 1,25 | 0,195 | 1,25 | 1,25 | 0,28 | 1,30 | 1,10 | 0,27 | 1,10 | 1,10 | 0,170 | 1,10 | 1,10 | 0,24 | 1,10 | 1,10 | 0,32 | 1,15 |
| 50 | 0,93 | 0,95 | 0,30 | 1,00 | 0,93 | 0,190 | 0,95 | 0,93 | 0,28 | 0,97 | 0,81 | 0,26 | 0,85 | 0,80 | 0,165 | 0,82 | 0,80 | 0,24 | 0,84 | 0,80 | 0,32 | 0,86 |
| 70 | 0,63 | 0,65 | 0,29 | 0,72 | 0,63 | 0,185 | 0,66 | 0,63 | 0,27 | 0,69 | 0,56 | 0,25 | 0,61 | 0,55 | 0,160 | 0,57 | 0,55 | 0,24 | 0,60 | 0,55 | 0,31 | 0,63 |
| 95 | 0,46 | 0,49 | 0,28 | 0,56 | 0,47 | 0,180 | 0,50 | 0,47 | 0,27 | 0,54 | 0,42 | 0,24 | 0,48 | 0,41 | 0,155 | 0,43 | 0,41 | 0,23 | 0,47 | 0,40 | 0,31 | 0,51 |

a In the case of single-phase circuits, the return path has been accounted for in the values given.

b Spacings larger than those specified in installation method 5 (see table 6.1) will result in larger voltage drop.

**Table 6.2(b)** *(concluded)*

| 1 | 2 | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | | 9 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** | **Two cables d.c.**[a] | **Two cables – Single-phase a.c.**[a] | | | | | | | | | **Three or four cables – Three-phase a.c.** | | | | | | | | | | | |
| | | **Installation Methods 1 and 2 (enclosed in conduit, etc. in or on a wall)** | | | **Installation Methods 3 and 4 (clipped direct or on trays, touching)** | | | **Installation method 5 (spaced)**[b] | | | **Installation methods 1 and 2 (enclosed in conduit, etc. in or on a wall)** | | | **Installation Methods 3, 4 and 5 (in trefoil)** | | | **Installation Methods 3 and 4 (flat and touching)** | | | **Installation Method 5 (flat, spaced)**[b] | | |
| $mm^2$ | mV/A/m | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | |
| | | r | x | z | r | x | z | r | x | z | r | x | z | r | x | z | r | x | z | r | x | z |
| 120 | 0,36 | 0,39 | 0,27 | 0,47 | 0,37 | 0,175 | 0,41 | 0,37 | 0,26 | 0,45 | 0,33 | 0,23 | 0,41 | 0,32 | 0,150 | 0,36 | 0,32 | 0,23 | 0,40 | 0,32 | 0,30 | 0,44 |
| 150 | 0,29 | 0,31 | 0,27 | 0,41 | 0,30 | 0,175 | 0,34 | 0,29 | 0,26 | 0,39 | 0,27 | 0,23 | 0,36 | 0,26 | 0,150 | 0,30 | 0,26 | 0,23 | 0,34 | 0,26 | 0,30 | 0,40 |
| 185 | 0,23 | 0,25 | 0,27 | 0,37 | 0,24 | 0,170 | 0,29 | 0,24 | 0,26 | 0,35 | 0,22 | 0,23 | 0,32 | 0,21 | 0,145 | 0,26 | 0,21 | 0,22 | 0,31 | 0,21 | 0,30 | 0,36 |
| 240 | 0,180 | 0,195 | 0,26 | 0,33 | 0,185 | 0,165 | 0,25 | 0,185 | 0,25 | 0,31 | 0,17 | 0,23 | 0,29 | 0,160 | 0,145 | 0,22 | 0,160 | 0,22 | 0,27 | 0,160 | 0,29 | 0,34 |
| 300 | 0,145 | 0,160 | 0,26 | 0,31 | 0,150 | 0,165 | 0,22 | 0,150 | 0,25 | 0,29 | 0,14 | 0,23 | 0,27 | 0,130 | 0,140 | 0,190 | 0,130 | 0,22 | 0,25 | 0,130 | 0,29 | 0,32 |
| 400 | 0,105 | 0,130 | 0,26 | 0,29 | 0,120 | 0,160 | 0,20 | 0,115 | 0,25 | 0,27 | 0,12 | 0,22 | 0,25 | 0,105 | 0,140 | 0,175 | 0,105 | 0,21 | 0,24 | 0,100 | 0,29 | 0,31 |
| 500 | 0,086 | 0,110 | 0,26 | 0,28 | 0,098 | 0,155 | 0,185 | 0,093 | 0,24 | 0,26 | 0,10 | 0,22 | 0,25 | 0,086 | 0,135 | 0,160 | 0,086 | 0,21 | 0,23 | 0,081 | 0,29 | 0,30 |
| 630 | 0,068 | 0,094 | 0,25 | 0,27 | 0,081 | 0,155 | 0,175 | 0,076 | 0,24 | 0,25 | 0,08 | 0,22 | 0,24 | 0,072 | 0,135 | 0,150 | 0,072 | 0,21 | 0,22 | 0,066 | 0,28 | 0,29 |
| 800 | 0,053 | – | – | – | 0,068 | 0,150 | 0,165 | 0,061 | 0,24 | 0,25 | – | – | – | 0,060 | 0,130 | 0,145 | 0,060 | 0,21 | 0,22 | 0,053 | 0,28 | 0,29 |
| 1 000 | 0,042 | – | – | – | 0,059 | 0,150 | 0,160 | 0,050 | 0,24 | 0,24 | – | – | – | 0,052 | 0,130 | 0,140 | 0,052 | 0,20 | 0,21 | 0,044 | 0,28 | 0,28 |

[a] In the case of single-phase circuits, the return path has been accounted for in the values given.

[b] Spacings larger than those specified in installation method 5 (see table 6.1) will result in larger voltage drop.

**Table 6.3(a) — Multicore PVC insulated cables, unarmoured, with or without protective conductor (SANS 1507)
Current-carrying capacity copper conductors**

Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** | **Installation method 1 (enclosed in an insulating wall, etc.)** | | **Installation method 2 (enclosed in conduit on a wall or ceiling, or in trunking)** | | **Installation method 3 (clipped direct)** | | **Installation method 4 (on a perforated cable tray), or installation method 6 (in free air)** | |
| | **One two-core cable, single-phase a.c. or d.c.** | **One three-core cable, or one four-core cable, three-phase a.c.** | **One two-core cable, single-phase a.c. or d.c.** | **One three-core cable, or one four-core cable, three-phase a.c.** | **One two-core cable, single-phase a.c. or d.c.** | **One three-core cable, or one four-core cable, three-phase a.c.** | **One two-core cable, single-phase a.c. or d.c.** | **One three-core cable, or one four-core cable, three-phase a.c.** |
| $mm^2$ | A | A | A | A | A | A | A | A |
| 1 | 11 | 10 | 13 | 11,5 | 15 | 13,5 | 17 | 14,5 |
| 1,5 | 14 | 13 | 16,5 | 15 | 19,5 | 17,5 | 22 | 18,5 |
| 2,5 | 18,5 | 17,5 | 23 | 20 | 27 | 24 | 30 | 25 |
| 4 | 25 | 23 | 30 | 27 | 36 | 32 | 40 | 34 |
| 6 | 32 | 29 | 38 | 34 | 46 | 41 | 51 | 43 |
| 10 | 43 | 39 | 52 | 46 | 63 | 57 | 70 | 60 |
| 16 | 57 | 52 | 69 | 62 | 85 | 76 | 94 | 80 |

**Table 6.3(a)** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** | **Installation method 1 (enclosed in an insulating wall, etc.)** | | **Installation method 2 (enclosed in conduit on a wall or ceiling, or in trunking)** | | **Installation method 3 (clipped direct)** | | **Installation method 4 (on a perforated cable tray), or installation method 6 (in free air)** | |
| | **One two-core cable, single-phase a.c. or d.c.** | **One three-core cable, or one four-core cable, three-phase a.c.** | **One two-core cable, single-phase a.c. or d.c.** | **One three-core cable, or one four-core cable, three-phase a.c.** | **One two-core cable, single-phase a.c. or d.c.** | **One three-core cable, or one four-core cable, three-phase a.c.** | **One two-core cable, single-phase a.c. or d.c.** | **One three-core cable, or one four-core cable, three-phase a.c.** |
| $mm^2$ | A | A | A | A | A | A | A | A |
| 25 | 75 | 68 | 90 | 80 | 112 | 96 | 119 | 101 |
| 35 | 92 | 83 | 111 | 99 | 138 | 119 | 148 | 126 |
| 50 | 110 | 99 | 133 | 118 | 168 | 144 | 180 | 153 |
| 70 | 139 | 125 | 168 | 149 | 213 | 184 | 232 | 196 |
| 95 | 167 | 150 | 201 | 179 | 258 | 223 | 282 | 238 |
| 120 | 192 | 172 | 232 | 206 | 299 | 259 | 328 | 276 |
| 150 | 219 | 196 | 258 | 225 | 344 | 299 | 379 | 319 |
| 185 | 248 | 223 | 294 | 255 | 392 | 341 | 434 | 364 |
| 240 | 291 | 261 | 344 | 297 | 461 | 403 | 514 | 430 |
| 300 | 334 | 298 | 394 | 339 | 530 | 464 | 593 | 497 |
| 400 | – | – | 470 | 402 | 634 | 557 | 715 | 597 |

**Table 6.3(b) — Multicore PVC insulated cables, unarmoured, with or without protective conductor (SANS 1507)
Voltage drop (per ampere per metre) copper conductors**

Conductor operating temperature: 70 °C

| 1 | 2 | 3 | | | 4 | | |
|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** mm² | **Two-core cable d.c.**[a] mV/A/m | **Two-core cable, single-phase a.c.**[a] mV/A/m | | | **Three-core or four-core cable, three-phase a.c.** mV/A/m | | |
| 1 | 44 | 44 | | | 38 | | |
| 1,5 | 29 | 29 | | | 25 | | |
| 2,5 | 18 | 18 | | | 15 | | |
| 4 | 11 | 11 | | | 9,5 | | |
| 6 | 7,3 | 7,3 | | | 6,4 | | |
| 10 | 4,4 | 4,4 | | | 3,8 | | |
| 16 | 2,8 | 2,8 | | | 2,4 | | |
| | | r | x | z | r | x | z |
| 25 | 1,75 | 1,75 | 0,170 | 1,75 | 1,50 | 0,145 | 1,50 |
| 35 | 1,25 | 1,25 | 0,165 | 1,25 | 1,10 | 0,145 | 1,10 |
| 50 | 0,93 | 0,93 | 0,165 | 0,94 | 0,80 | 0,140 | 0,81 |
| 70 | 0,63 | 0,63 | 0,160 | 0,65 | 0,55 | 0,140 | 0,57 |
| 95 | 0,46 | 0,47 | 0,155 | 0,50 | 0,41 | 0,135 | 0,43 |
| 120 | 0,36 | 0,38 | 0,155 | 0,41 | 0,33 | 0,135 | 0,35 |
| 150 | 0,29 | 0,30 | 0,155 | 0,34 | 0,26 | 0,130 | 0,29 |
| 185 | 0,23 | 0,25 | 0,150 | 0,29 | 0,21 | 0,130 | 0,25 |
| 240 | 0,180 | 0,190 | 0,150 | 0,24 | 0,165 | 0,130 | 0,21 |
| 300 | 0,145 | 0,155 | 0,145 | 0,21 | 0,135 | 0,130 | 0,185 |
| 400 | 0,105 | 0,155 | 0,145 | 0,185 | 0,100 | 0,125 | 0,160 |

[a] In the case of single-phase circuits, the return path has been accounted for in the values given.

**Table 6.4(a) — Multicore PVC insulated armoured cables (SANS 1507)**
**Current-carrying capacity copper conductors**

Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **Conductor cross-sectional area** | **Installation method 3 (clipped direct)** | | **Installation method 4 (on a perforated horizontal or vertical cable tray), or installation method 6 (in free air)** | |
| | **One two-core cable, single-phase a.c. or d.c.** | **One three-core or four-core cable, three-phase a.c.** | **One two-core cable, single-phase a.c. or d.c.** | **One three-core or four-core cable, three-phase a.c.** |
| $mm^2$ | A | A | A | A |
| 1,5 | 21 | 18 | 22 | 19 |
| 2,5 | 28 | 25 | 31 | 26 |
| 4 | 38 | 33 | 41 | 35 |
| 6 | 49 | 42 | 53 | 45 |
| 10 | 67 | 58 | 72 | 62 |
| 16 | 89 | 77 | 97 | 83 |
| 25 | 118 | 102 | 128 | 110 |
| 35 | 145 | 125 | 157 | 135 |
| 50 | 175 | 151 | 190 | 163 |
| 70 | 222 | 192 | 241 | 207 |
| 95 | 269 | 231 | 291 | 251 |
| 120 | 310 | 267 | 336 | 290 |
| 150 | 356 | 306 | 386 | 332 |
| 185 | 405 | 348 | 439 | 378 |
| 240 | 476 | 409 | 516 | 445 |
| 300 | 547 | 469 | 592 | 510 |
| 400 | 621 | 540 | 683 | 590 |

**Table 6.4(b) — Multicore PVC insulated armoured cables (SANS 1507) Voltage drop (per ampere per metre) copper conductors**

Conductor operating temperature: 70 °C

| 1 | 2 | 3 | | | 4 | | |
|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** mm² | **Two-core cable d.c.**[a] mV/A/m | **Two-core cable, single-phase a.c.**[a] mV/A/m | | | **Three-core or four-core cable, three-phase a.c.** mV/A/m | | |
| 1,5 | 29 | 29 | | | 25 | | |
| 2,5 | 18 | 18 | | | 15 | | |
| 4 | 11 | 11 | | | 9,5 | | |
| 6 | 7,3 | 7,3 | | | 6,4 | | |
| 10 | 4,4 | 4,4 | | | 3,8 | | |
| 16 | 2,8 | 2,8 | | | 2,4 | | |
| | | r | x | z | r | x | z |
| 25 | 1,75 | 1,75 | 0,170 | 1,75 | 1,50 | 0,145 | 1,50 |
| 35 | 1,25 | 1,25 | 0,165 | 1,25 | 1,10 | 0,145 | 1,10 |
| 50 | 0,93 | 0,93 | 0,165 | 0,94 | 0,80 | 0,140 | 0,81 |
| 70 | 0,63 | 0,63 | 0,160 | 0,65 | 0,55 | 0,140 | 0,57 |
| 95 | 0,46 | 0,47 | 0,155 | 0,50 | 0,41 | 0,135 | 0,43 |
| 120 | 0,36 | 0,38 | 0,155 | 0,41 | 0,33 | 0,135 | 0,35 |
| 150 | 0,29 | 0,30 | 0,155 | 0,34 | 0,26 | 0,130 | 0,29 |
| 185 | 0,23 | 0,25 | 0,150 | 0,29 | 0,21 | 0,130 | 0,25 |
| 240 | 0,180 | 0,190 | 0,150 | 0,24 | 0,165 | 0,130 | 0,21 |
| 300 | 0,145 | 0,155 | 0,145 | 0,21 | 0,135 | 0,130 | 0,185 |
| 400 | 0,105 | 0,115 | 0,145 | 0,185 | 0,100 | 0,125 | 0,160 |

[a] In the case of single-phase circuits, the return path has been accounted for in the values given.

**Table 6.5(a) — Single-core PVC insulated cables, unarmoured, with or without sheath (SANS 1507)**
**Current-carrying capacity aluminium conductors**

Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Conductor cross-sectional area | Installation method 1 (enclosed in conduit in thermally insulating wall, etc.) | | Installation method 2 (enclosed in conduit on a wall or in trunking, etc.) | | Installation method 3 (clipped direct) | | Installation method 4 (on a perforated cable tray, horizontal or vertical) | | Installation method 5 (in free air) | | |
| | | | | | | | | | Horizontal flat spaced | Vertical flat spaced | Trefoil |
| | Two cables, single-phase a.c. or d.c. | Three or four cables, three-phase a.c. | Two cables, single-phase a.c. or d.c. | Three or four cables, three-phase a.c. | Two cables, single-phase a.c. or d.c. (flat and touching) | Three or four cables, three-phase a.c. (flat and touching or trefoil) | Two cables, single-phase a.c. or d.c. (flat and touching) | Three or four cables, three-phase a.c. (flat and touching or trefoil) | Two cables, single-phase a.c. or d.c. or three cables, three-phase a.c. | Two cables, single-phase a.c. or d.c. or three cables, three-phase a.c. | Three cables, trefoil three-phase a.c. |
| $mm^2$ | A | A | A | A | A | A | A | A | A | A | A |
| 50 | 93 | 84 | 118 | 104 | 134 | 123 | 144 | 132 | 163 | 148 | 128 |
| 70 | 118 | 107 | 150 | 133 | 172 | 159 | 185 | 169 | 210 | 191 | 165 |
| 95 | 142 | 120 | 181 | 161 | 210 | 194 | 225 | 206 | 256 | 234 | 203 |
| 120 | 164 | 140 | 210 | 186 | 245 | 226 | 261 | 240 | 298 | 273 | 237 |
| 150 | 189 | 170 | 234 | 204 | 283 | 261 | 301 | 277 | 344 | 317 | 274 |
| 185 | 215 | 194 | 266 | 230 | 324 | 299 | 344 | 317 | 394 | 364 | 316 |
| 240 | 252 | 227 | 312 | 269 | 384 | 354 | 407 | 375 | 466 | 432 | 375 |
| 300 | 289 | 261 | 358 | 306 | 444 | 410 | 469 | 433 | 538 | 501 | 435 |
| 380 | – | – | 413 | 352 | 511 | 472 | 543 | 502 | 625 | 584 | 507 |
| 480 | – | – | 477 | 405 | 591 | 546 | 629 | 582 | 726 | 680 | 590 |
| 600 | – | – | 545 | 462 | 679 | 626 | 722 | 669 | 837 | 787 | 680 |
| 740 | – | – | – | – | 771 | 709 | 820 | 761 | 956 | 902 | 776 |
| 960 | – | – | – | – | 900 | 823 | 953 | 886 | 1 125 | 1 066 | 907 |
| 1 200 | – | – | – | – | 1 022 | 926 | 1 073 | 999 | 1 293 | 1 229 | 1 026 |

## Table 6.5(b) — Single-core PVC insulated cables, unarmoured, with or without sheath (SANS 1507) Voltage drop (per ampere per metre) aluminium conductors

Conductor operating temperature: 70 °C

| 1 | 2 | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | | 9 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conductor cross-sectional area | Two cables d.c.[a] | Two cables – Single-phase a.c.[a] | | | | | | | | | Three or four cables – Three-phase a.c. | | | | | | | | | | | |
| | | Installation methods 1 and 2 (enclosed in conduit, etc. in or on a wall) | | | Installation methods 3 and 4 (clipped direct or on trays, touching) | | | Installation method 5 (spaced)[b] | | | Installation methods 1 and 2 (enclosed in conduit, etc. in or on a wall) | | | Installation methods 3, 4 and 5 (in trefoil, touching) | | | Installation methods 3 and 4 (flat, touching) | | | Installation method 5 (flat, spaced)[b] | | |
| $mm^2$ | mV/A/m | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | | mV/A/m | | |
| | | r | x | z | r | x | z | r | x | z | r | x | z | r | x | z | r | x | z | r | x | z |
| 50 | 1,55 | 1,60 | 0,30 | 1,60 | 1,55 | 0,190 | 1,55 | 1,55 | 0,28 | 1,55 | 1,35 | 0,26 | 1,40 | 1,35 | 0,165 | 1,35 | 1,35 | 0,24 | 1,35 | 1,35 | 0,32 | 1,40 |
| 70 | 1,05 | 1,10 | 0,30 | 1,15 | 1,05 | 0,185 | 1,05 | 1,05 | 0,27 | 1,10 | 0,94 | 0,26 | 0,97 | 0,91 | 0,160 | 0,92 | 0,91 | 0,24 | 0,94 | 0,91 | 0,31 | 0,96 |
| 95 | 0,77 | 0,81 | 0,29 | 0,86 | 0,77 | 0,185 | 0,79 | 0,77 | 0,27 | 0,82 | 0,70 | 0,25 | 0,74 | 0,67 | 0,160 | 0,69 | 0,67 | 0,23 | 0,71 | 0,67 | 0,31 | 0,74 |
| 120 | 0,61 | 0,64 | 0,29 | 0,70 | 0,61 | 0,180 | 0,64 | 0,61 | 0,27 | 0,67 | 0,55 | 0,25 | 0,61 | 0,53 | 0,155 | 0,55 | 0,53 | 0,23 | 0,58 | 0,53 | 0,31 | 0,61 |
| 150 | 0,49 | 0,51 | 0,28 | 0,59 | 0,49 | 0,175 | 0,52 | 0,49 | 0,26 | 0,55 | 0,45 | 0,24 | 0,51 | 0,42 | 0,155 | 0,45 | 0,42 | 0,23 | 0,48 | 0,42 | 0,30 | 0,52 |
| 185 | 0,39 | 0,42 | 0,28 | 0,50 | 0,40 | 0,175 | 0,43 | 0,39 | 0,26 | 0,47 | 0,36 | 0,24 | 0,44 | 0,34 | 0,150 | 0,37 | 0,34 | 0,23 | 0,41 | 0,34 | 0,30 | 0,46 |
| 240 | 0,30 | 0,32 | 0,27 | 0,42 | 0,30 | 0,170 | 0,35 | 0,30 | 0,26 | 0,40 | 0,28 | 0,24 | 0,37 | 0,26 | 0,150 | 0,30 | 0,26 | 0,22 | 0,35 | 0,26 | 0,30 | 0,40 |
| 300 | 0,24 | 0,26 | 0,27 | 0,37 | 0,24 | 0,170 | 0,30 | 0,24 | 0,26 | 0,35 | 0,23 | 0,23 | 0,32 | 0,21 | 0,145 | 0,26 | 0,21 | 0,22 | 0,31 | 0,21 | 0,30 | 0,36 |
| 380 | 0,190 | 0,22 | 0,27 | 0,35 | 0,195 | 0,165 | 0,26 | 0,195 | 0,25 | 0,32 | 0,190 | 0,23 | 0,30 | 0,170 | 0,145 | 0,22 | 0,170 | 0,22 | 0,28 | 0,170 | 0,29 | 0,34 |
| 480 | 0,150 | 0,180 | 0,26 | 0,32 | 0,155 | 0,165 | 0,23 | 0,155 | 0,25 | 0,29 | 0,155 | 0,23 | 0,27 | 0,140 | 0,140 | 0,195 | 0,140 | 0,22 | 0,26 | 0,135 | 0,29 | 0,32 |
| 600 | 0,120 | 0,150 | 0,27 | 0,31 | 0,130 | 0,160 | 0,21 | 0,125 | 0,25 | 0,28 | 0,125 | 0,22 | 0,26 | 0,110 | 0,140 | 0,180 | 0,110 | 0,22 | 0,24 | 0,110 | 0,29 | 0,31 |
| 740 | 0,099 | – | – | – | 0,105 | 0,160 | 0,190 | 0,100 | 0,25 | 0,27 | – | – | – | 0,094 | 0,135 | 0,165 | 0,094 | 0,21 | 0,23 | 0,089 | 0,29 | 0,30 |
| 960 | 0,075 | – | – | – | 0,086 | 0,155 | 0,180 | 0,082 | 0,24 | 0,26 | – | – | – | 0,077 | 0,135 | 0,155 | 0,077 | 0,21 | 0,22 | 0,071 | 0,29 | 0,29 |
| 1 200 | 0,060 | – | – | – | 0,074 | 0,155 | 0,170 | 0,068 | 0,24 | 0,25 | – | – | – | 0,066 | 0,135 | 0,150 | 0,066 | 0,21 | 0,22 | 0,059 | 0,28 | 0,29 |

[a] In the case of single-phase circuits, the return path has been accounted for in the values given.

[b] Spacings larger than those specified in installation method 5 (see table 6.1) will result in larger voltage drop.

## Table 6.6(a) — Multicore PVC insulated cables, unarmoured (SANS 1507) Current-carrying capacity aluminium conductors

Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Conductor cross-sectional area | Installation method 1 (enclosed in an insulating wall, etc.) | | Installation method 2 (enclosed in conduit on a wall or ceiling, or in trunking) | | Installation method 3 (clipped direct) | | Installation method 4 (on a perforated cable tray), or installation method 6 (in free air) | |
| | One two-core cable, single-phase a.c. or d.c. | One three-core or four-core cable, three-phase a.c. | One two-core cable, single-phase a.c. or d.c. | One three-core or four-core cable, three-phase a.c. | One two-core cable, single-phase a.c. or d.c. | One three-core or four-core cable, three-phase a.c. | One two-core cable, single-phase a.c. or d.c. | One three-core or four-core cable, three-phase a.c. |
| $mm^2$ | A | A | A | A | A | A | A | A |
| 16 | 44 | 41 | 54 | 48 | 66 | 59 | 73 | 61 |
| 25 | 58 | 53 | 71 | 62 | 83 | 73 | 89 | 78 |
| 35 | 71 | 65 | 86 | 77 | 103 | 90 | 111 | 96 |
| 50 | 86 | 78 | 104 | 92 | 125 | 110 | 135 | 117 |
| 70 | 108 | 98 | 131 | 116 | 160 | 140 | 173 | 150 |
| 95 | 130 | 118 | 157 | 139 | 195 | 170 | 210 | 183 |
| 120 | – | 135 | – | 160 | – | 197 | – | 212 |
| 150 | – | 155 | – | 184 | – | 227 | – | 245 |
| 185 | – | 176 | – | 210 | – | 259 | – | 280 |
| 240 | – | 207 | – | 248 | – | 305 | – | 330 |
| 300 | – | 237 | – | 285 | – | 351 | – | 381 |

**Table 6.6(b) — Multicore PVC insulated cables, unarmoured (SANS 1507)**
**Voltage drop (per ampere per metre) aluminium conductors**

Conductor operating temperature: 70 °C

| 1 | 2 | 3 | | | 4 | | |
|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** mm² | **Two-core cable d.c.**[a] mV/A/m | **Two-core cable, single-phase a.c.**[a] mV/A/m | | | **Three-core or four-core cable, three-phase a.c.** mV/A/m | | |
| 16 | 4,5 | 4,5 | | | 3,9 | | |
| | | r | x | z | r | x | z |
| 25 | 2,9 | 2,9 | 0,175 | 2,9 | 2,5 | 0,150 | 2,5 |
| 35 | 2,1 | 2,1 | 0,170 | 2,1 | 1,80 | 0,150 | 1,80 |
| 50 | 1,55 | 1,55 | 0,170 | 1,55 | 1,35 | 0,145 | 1,35 |
| 70 | 1,05 | 1,05 | 0,165 | 1,05 | 0,90 | 0,140 | 0,92 |
| 95 | 0,77 | 0,77 | 0,160 | 0,79 | 0,67 | 0,140 | 0,68 |
| 120 | – | | – | | 0,53 | 0,135 | 0,55 |
| 150 | – | | – | | 0,42 | 0,135 | 0,44 |
| 185 | – | | – | | 0,34 | 0,135 | 0,37 |
| 240 | – | | – | | 0,26 | 0,130 | 0,30 |
| 300 | – | | – | | 0,21 | 0,130 | 0,25 |

[a] In the case of single-phase circuits, the return path has been accounted for in the values given.

**Table 6.7(a) — Multicore PVC insulated armoured cables (SANS 1507)
Current-carrying capacity aluminium conductors**

Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Conductor cross-sectional area | Installation method 3 (clipped direct) | | Installation method 4 (on a perforated cable tray), or installation method 6 (in free air) | |
| | One two-core cable, single-phase a.c. or d.c. | One three-core or four-core cable, three-phase a.c. | One two-core cable, single-phase a.c. or d.c. | One three-core or four-core cable, three-phase a.c. |
| $mm^2$ | A | A | A | A |
| 16 | 68 | 58 | 71 | 61 |
| 25 | 89 | 76 | 94 | 80 |
| 35 | 109 | 94 | 115 | 99 |
| 50 | 131 | 113 | 139 | 119 |
| 70 | 165 | 143 | 175 | 151 |
| 95 | 199 | 174 | 211 | 186 |
| 120 | – | 202 | – | 216 |
| 150 | – | 232 | – | 250 |
| 185 | – | 265 | – | 287 |
| 240 | – | 312 | – | 342 |
| 300 | – | 360 | – | 399 |

**Table 6.7(b) — Multicore PVC insulated armoured cables (SANS 1507)
Voltage drop (per ampere per metre) aluminium conductors**

Conductor operating temperature: 70 °C

| 1 | 2 | 3 | | | 4 | | |
|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** mm$^2$ | **Two-core cable d.c.**[a] mV/A/m | **Two-core cable, single-phase a.c.**[a] mV/A/m | | | **Three-core or four-core cable, three-phase a.c.** mV/A/m | | |
| 16 | 4,5 | 4,5 | | | 3,9 | | |
| | | r | x | z | r | x | z |
| 25 | 2,9 | 2,9 | 0,175 | 2,9 | 2,5 | 0,150 | 2,5 |
| 35 | 2,1 | 2,1 | 0,170 | 2,1 | 1,80 | 0,150 | 1,80 |
| 50 | 1,55 | 1,55 | 0,170 | 1,55 | 1,35 | 0,145 | 1,35 |
| 70 | 1,05 | 1,05 | 0,165 | 1,05 | 0,90 | 0,140 | 0,92 |
| 95 | 0,77 | 0,77 | 0,160 | 0,79 | 0,67 | 0,140 | 0,68 |
| 120 | – | | – | | 0,53 | 0,135 | 0,55 |
| 150 | – | | – | | 0,42 | 0,135 | 0,44 |
| 185 | – | | – | | 0,34 | 0,135 | 0,37 |
| 240 | – | | – | | 0,26 | 0,130 | 0,30 |
| 300 | – | | – | | 0,21 | 0,130 | 0,25 |

[a] In the case of single-phase circuits, the return path has been accounted for in the values given.

## Table 6.8 — Multicore PVC insulated armoured cables buried directly in the ground (SANS 1507) Current-carrying capacity

Soil temperature: 25 °C
Maximum conductor temperature: 70 °C

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **Nominal conductor size** mm² | **Standard rating[a] — Copper cables** A | | | |
| | **Cables buried in the ground** | | **Cables in pipes or ducts buried in the ground** | |
| | **Two-core** | **Three-core or four-core** | **Two-core** | **Three-core or four-core** |
| | **Cu** | **Cu** | **Cu** | **Cu** |
| 1,5 | 29 | 24 | 23 | 20 |
| 2,5 | 37 | 32 | 31 | 26 |
| 4 | 50 | 42 | 41 | 34 |
| 6 | 62 | 53 | 51 | 43 |
| 10 | 83 | 70 | 68 | 58 |
| 16 | 107 | 91 | 88 | 75 |
| 25 | 142 | 119 | 116 | 96 |
| 35 | 171 | 143 | 139 | 116 |
| 50 | 203 | 169 | 165 | 138 |
| 70 | 249 | 210 | 203 | 171 |
| 95 | 299 | 251 | 244 | 205 |
| 120 | 339 | 285 | 278 | 234 |
| 150 | 380 | 320 | 311 | 263 |
| 185 | 430 | 361 | 354 | 298 |
| 240 | 496 | 416 | 410 | 344 |
| 300 | 554 | 465 | 459 | 385 |
| 400 | 624 | 522 | 517 | 441 |

NOTE See table 6.4(b) for voltage drop.

[a] Standard conditions of installation:
Depth of burial 0,5 m;
Thermal resistivity of soil 1,2 K m/W; and
Each cable is thermally independent.

**Table 6.8** (*concluded*)

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Nominal conductor size<br><br>mm² | **Standard rating[a] — Aluminium cables**<br><br>A | | | |
| | **Al** | **Al** | **Al** | **Al** |
| 25 | 106 | 90 | 86 | 73 |
| 35 | 128 | 108 | 104 | 87 |
| 50 | 151 | 129 | 123 | 104 |
| 70 | 188 | 158 | 153 | 130 |
| 95 | 225 | 192 | 184 | 157 |
| 120 | – | 219 | – | 179 |
| 150 | – | 245 | – | 201 |
| 185 | – | 278 | – | 229 |
| 240 | – | 324 | – | 268 |
| 300 | – | 366 | – | 304 |
| 400 | – | – | – | – |

NOTE See table 6.7(b) for voltage drop.

[a] Standard conditions of installation:
Depth of burial 0,5 m;
Thermal resistivity of soil 1,2 K m/W; and
Each cable is thermally independent.

**Table 6.9(a) — 85 °C or 150 °C rubber-insulated and silicon-rubber-insulated flexible cables (SANS 1574-5)
Current-carrying capacity copper conductors**

Ambient temperature: 30 °C
Conductor operating temperature: 85 °C or 150 °C

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Conductor cross-sectional area**<br>$mm^2$ | **D.C. or single-phase a.c. (one two-core cable, with or without protective conductor)**<br>A | **Three-phase a.c. (one three-core, four-core or five-core cable)**<br>A | **Single-phase a.c. or d.c., two single-core cables, touching**<br>A |
| 4 | 41 | 36 | – |
| 6 | 53 | 47 | – |
| 10 | 73 | 64 | – |
| 16 | 99 | 86 | – |
| 25 | 131 | 114 | – |
| 35 | – | 140 | 192 |
| 50 | – | 170 | 240 |
| 70 | – | 216 | 297 |
| 95 | – | 262 | 354 |
| 400 | – | – | 885 |
| 500 | – | – | 1 017 |
| 630 | – | – | 1 190 |

**Table 6.9(a)** *(concluded)*

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Conductor cross-sectional area** | **D.C. or single-phase a.c. (one two-core cable, with or without protective conductor)** | **Three-phase a.c. (one three-core, four-core or five-core cable)** | **Single-phase a.c. or d.c., two single-core cables, touching** |
| $mm^2$ | A | A | A |
| 400 | – | – | 885 |
| 500 | – | – | 1 017 |
| 630 | – | – | 1 190 |

NOTE 1 The current ratings tabulated are for cables in free air but may also be used for cables resting on a surface. If the cable is to be wound on a drum on load the ratings should be reduced in accordance with note 2 below and for cables that may be covered, in accordance with note 4 below.

NOTE 2 The current ratings of flexible cables wound on reeling drums are to be reduced by the following correction factors:

a) Radial type drum

Ventilated :0,85
Non-ventilated : 0,75

b) Ventilated cylindrical type drum

One layer of cable : 0,85
Two layers of cable : 0,65
Three layers of cable : 0,45
Four layers of cable : 0,35

NOTE 3 A radial type drum is one where spiral layers of cable are accommodated between closely spaced flanges; if fitted with solid flanges the ratings given above should be reduced and the drum is described as non-ventilated. If the flanges have suitable apertures the drum is described as ventilated. A ventilated cylindrical type drum is one where layers of cable are accommodated between widely spaced flanges and the drum and end flanges have suitable ventilating apertures.

NOTE 4 Where cable may be covered over or coiled up whilst on load, or where the air movement over the cable is restricted, the current rating should be reduced. It is not possible to specify the amount of reduction but the table of rating factors for cables wound on reeling drums can be used as a guide (see note 2).

**Table 6.9(b) — 85 °C or 150 °C rubber-insulated and silicon-rubber -insulated flexible cables**
**Voltage drop (per ampere per metre) copper conductors (SANS 1574-5)**

| 1 | 2 | 3 | | | 4 | | | 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** | **One two-core or two single-core cables d.c.[a]** | **Two-core cable, single-phase a.c.[a]** | | | **Three-phase a.c. (one three-core, four-core or five-core cable)** | | | **Two single-core cables touching** | | |
| mm² | mV/A/m | mV/A/m | | | mV/A/m | | | **Single-phase a.c.[a b]** mV/A/m | | |
| 4 | 13 | 13 | | | 11 | | | – | | |
| 6 | 8,4 | 8,4 | | | 7,3 | | | – | | |
| 10 | 5,0 | 5,0 | | | 4,3 | | | – | | |
| 16 | 3,1 | 3,1 | | | 2,7 | | | – | | |
| | | r | x | z | r | x | z | r | x | z |
| 25 | 2,0 | | 0,175 | | 1,70 | 0,150 | 1,70 | – | – | – |
| 35 | 1,42 | | – | | 1,20 | 0,150 | 1,20 | 1,42 | 0,21 | 1,43 |
| 50 | 0,99 | 2,0 | – | 2,0 | 0,90 | 0,145 | 0,91 | 0,99 | 0,21 | 1,01 |
| 70 | 0,70 | | – | | 0,61 | 0,140 | 0,63 | 0,70 | 0,20 | 0,72 |
| 95 | 0,53 | | – | | 0,46 | 0,135 | 0,48 | 0,53 | 0,195 | 0,56 |

NOTE The voltage drop figures given above are based on a conductor operating temperature of 85 °C and are therefore not accurate when the operating temperature exceeds 85 °C. In the case of the 150 °C cables with a conductor temperature of 150 °C, the above resistive values should be increased by a factor of 1,2.

[a] in the case of a single-phase circuits, the return path has been accounted for in the values given.

[b] large voltage drop will results if the cables are spaced

**Table 6.9(b)** (*concluded*)

| 1 | 2 | 3 | | | 4 | | | 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** | **One two-core or two single-core cables d.c.**[a] | **Two-core cable, single-phase a.c.**[a] | | | **Three-phase a.c. (one three-core, four-core or five-core cable)** | | | **Two single-core cables touching** | | |
| | | | | | | | | **Single-phase a.c.**[a b] | | |
| mm² | mV/A/m | mV/A/m | | | mV/A/m | | | mV/A/m | | |
| 120 | 0,41 | | - | | 0,36 | 0,135 | 0,39 | 0,41 | 0,190 | 0,46 |
| 150 | 0,33 | | - | | 0,29 | 0,130 | 0,32 | 0,33 | 0,190 | 0,38 |
| 185 | 0,27 | | - | | 0,24 | 0,130 | 0,27 | 0,27 | 0,190 | 0,33 |
| 240 | 0,21 | | - | | 0,185 | 0,130 | 0,22 | 0,21 | 0,185 | 0,28 |
| 300 | 0,165 | | - | | 0,145 | 0,125 | 0,195 | 0,170 | 0,180 | 0,25 |
| 400 | 0,125 | | - | | - | - | - | 0,130 | 0,175 | 0,22 |
| 500 | 0,098 | | - | | - | - | - | 0,105 | 0,170 | 0,20 |
| 630 | 0,073 | | - | | - | - | - | 0,084 | 0,170 | 0,19 |

NOTE The voltage drop figures given above are based on a conductor operating temperature of 85 °C and are therefore not accurate when the operating temperature exceeds 85 °C. In the case of the 150 °C cables with a conductor temperature of 150 °C, the above resistive values should be increased by a factor of 1,2.

[a] in the case of a single-phase circuits, the return path has been accounted for in the values given.

[b] large voltage drop will results if the cables are spaced

### 6.2.7 Voltage drop

#### 6.2.7.1 Difference in voltage (voltage drop)

**6.2.7.1.1** When all conductors of an a.c. installation are carrying their design load, the difference in voltage (the voltage drop) between the point of supply and any point of outlet or terminals of fixed appliances shall not exceed 5 % of the standard or declared voltage. (See 5.3.2 and 5.4.2.)

In the case of a 230/400 V system, the voltage drop for single-phase circuits shall not exceed 11,5 V (5 % of 230 V) and the voltage drop for three-phase circuits shall not exceed 20 V (5 % of 400 V).

In the case of single-phase circuits derived from three-phase supplies with balanced loading, the phase-to-neutral voltage drop is calculated from three-phase values divided by $\sqrt{3}$ .

NOTE 1 If the phase-to-neutral voltage is not declared, the value can be calculated by dividing the phase-to-phase voltage by 1,73.

NOTE 2 In the case where reticulation is part of the electrical installation after the point of supply, the 5 % voltage drop should be calculated to include the reticulation part of the installation (for example, in the case of a housing scheme where submetering with a further point of control is installed for individual consumers) (see 5.3.2.1).

**6.2.7.1.2** When all conductors of a d.c. installation are carrying their maximum estimated load, the difference in voltage (the voltage drop) between any point of supply and any point of consumption shall not exceed 5 % of the circuit nominal voltage or shall comply with the requirements of the manufacturer of the equipment connected to the circuit.

#### 6.2.7.2 Tables of voltage drop

NOTE The values in the tables for a.c. operation apply only to frequencies in the range 49 Hz to 61 Hz. The values of voltage drop for cables that operate at higher frequencies may be substantially greater.

**6.2.7.2.1** In tables 6.2(b) to 6.9(b), values of voltage drop are given for a current of one ampere for a distance of 1 m along the route taken by the cables and represent the result of voltage drop in all the circuit conductors. The values of the voltage drop assume that the conductors are at their maximum permitted normal operating temperatures.

**6.2.7.2.2** For a given run of cable, to calculate the voltage drop (in millivolts), the tabulated value of voltage drop per ampere per metre for the cable concerned has to be multiplied by the length of the run in metres and by the current the cable is intended to carry, i.e. the design current of the circuit, in amperes. In the case of three-phase circuits, the tabulated mV/A/m values relate to the line voltage and balanced conditions have been assumed.

**6.2.7.2.3** In the case of cables that have conductors of cross-sectional area exceeding 16 mm$^2$, the impedance values are given as $(mV/A/m)_z$, together with the resistive component $(mV/A/m)_r$ and the reactive component $(mV/A/m)_x$. In the case of cables that have conductors of cross-sectional area 16 mm$^2$ or less, their inductances can be ignored and $(mV/A/m)_r$ values only are tabulated.

**6.2.7.2.4** The direct use of the tabulated $(mV/A/m)_r$ values or $(mV/A/m)_z$ values, as appropriate, can lead to pessimistically high calculated values of voltage drop or, in other words, to unnecessarily low values of permitted circuit lengths.

**6.2.7.2.5** For example, where the design current of a circuit is significantly less than the effective current-carrying capacity of the cable chosen, the actual voltage drop would be less than the calculated value because the conductor temperature (and hence its resistance) will be less than that on which the tabulated values were based.

**6.2.7.2.6** As regards power factor in a.c. circuits, the use of the tabulated mV/A/m values (for the larger cable sizes, the tabulated $(mV/A/m)_z$ values), to calculate the voltage drop is correct only when the phase angle of the cable equals that of the load. When the phase angle of the cable does not equal that of the load, the direct use of the tabulated mV/A/m values or $(mV/A/m)_z$ values leads to a calculated value of voltage drop higher than the actual value. In some cases it might be advantageous to take account of the power factor of the load when voltage drop is being calculated.

NOTE The voltage drop can also be calculated by using the alternate method given in D.2. Values in tables D.1 to D.3 are average values for the purpose of easy calculation and can differ from cable manufacturer's data.

### 6.2.7.3 Power factor corrections

**6.2.7.3.1** In the case of cables that have conductors of cross-sectional area 16 mm$^2$ or less, the approximate design value of mV/A/m is obtained by multiplying the tabulated value by the power factor of the load, cos Ø.

**6.2.7.3.2** In the case of cables that have conductors of cross-sectional area exceeding 16 $mm^2$, the approximate design value of mV/A/m is calculated by the following equation:

mV/A/m = cos Ø (tabulated $(mV/A/m)_r$) + sin Ø (tabulated $(mV/A/m)_x$)

**6.2.7.3.3** In the case of single-core cables in flat formation, the tabulated values apply to the outer cables and could underestimate the voltage drop between an outer cable and the centre cable for cross-sectional areas above 240 $mm^2$ and power factors exceeding 0,8.

### 6.2.8 Correction factors for ambient temperature

**6.2.8.1** The ambient temperature of a cable shall be taken as the temperature of the air that surrounds the cable under normal operating conditions. Allowances for heating caused by other heat sources within the building shall be included, but heating of the cable itself shall be ignored.

**6.2.8.2** If the ambient temperature varies along the cable route, the correction factor selected shall be the one appropriate to the part of the route where the most adverse conditions are created. From table 6.10, select the correction factor appropriate to the ambient temperature and to the type of cable.

**6.2.8.3** Where wiring systems are surrounded by thermal insulation, for example, above ceilings and wall cavities, the correction factor that corresponds to an ambient temperature of 60 °C shall be used (see table 6.10).

**6.2.8.4** Cables spaced up to 600 mm apart still have a thermal influence on one another when buried direct or in pipes in the ground. The soil temperature, thermal resistivity of the soil and the grouping of cables also affect the sustained current-carrying capacity of a cable (see tables 6.11, 6.12 and 6.13).

NOTE 1 The current-carrying capacity of a cable that is exposed to the direct rays of the sun could be considerably less than that determined in accordance with the above. (See also table 6.19.)

NOTE 2 The very high ambient temperatures that can occur in a roof space should be taken into consideration when the current-carrying capacity of a cable installed in such a situation is being determined.

**6.2.8.5** The sustained current-carrying capacity $I$ (A) of a cable buried directly in the ground can be calculated by the following equation:

$$I = I_s \times F_1 \times F_2 \times F_3 \times F_4 \text{ A}$$

where

$I_s$ is the standard rating, in amperes (A);

$F_1$ is the rating factor for depth of burial, given in table 6.16;

$F_2$ is the rating factor for soil temperature at depth of burial, given in table 6.11;

$F_3$ is the rating factor for thermal resistivity of soil, given in table 6.12;

$F_4$ is the rating factor for grouping of directly buried cables that are thermally interdependent, given in table 6.13.

**Table 6.10 — Correction factors for ambient temperature**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Ambient temperature** °C | **Type of insulation and operating temperature** | | |
| | **General purpose PVC 70 °C** | **Rubber 85 °C** | **Rubber 150 °C** |
| 10 | 1,22 | 1,18 | 1,0 |
| 15 | 1,17 | 1,14 | |
| 20 | 1,12 | 1,10 | |
| 25 | 1,06 | 1,05 | |
| 30 | 1,0 | 1,0 | |
| 35 | 0,94 | 0,95 | |
| 40 | 0,87 | 0,90 | |
| 45 | 0,79 | 0,85 | |
| 50 | 0,71 | 0,80 | |
| 55 | 0,61 | 0,74 | |
| 60 | 0,50 | 0,67 | |
| 65 | 0,35 | 0,60 | |
| 70 | – | 0,52 | |
| 75 | – | 0,43 | |
| 80 | – | 0,30 | |
| 85 | – | – | |
| 90 | – | – | 0,96 |
| 95 | – | – | 0,92 |
| 100 | – | – | 0,88 |
| 105 | – | – | 0,83 |
| 110 | – | – | 0,78 |
| 115 | – | – | 0,73 |
| 120 | – | – | 0,68 |
| 125 | – | – | 0,62 |
| 130 | – | – | 0,55 |
| 135 | – | – | 0,48 |
| 140 | – | – | 0,39 |
| 145 | – | – | 0,28 |

NOTE 1 Where a conductor operates at a temperature exceeding 70 °C it shall be ascertained that the equipment connected to the conductor is suitable for the conductor operating temperature.

NOTE 2 In the case of 150 °C cables, where the correction factors for ambient temperature are used, the conductor operating temperature may be up to 150 °C.

**Table 6.11 — Correction factors for soil temperature**

Maximum conductor temperature: 70 °C

| 1 | 2 |
|---|---|
| **Soil temperature** °C | **Correction factors for cables buried directly or buried in pipes in the ground** |
| 10 | 1,15 |
| 15 | 1,11 |
| 20 | 1,05 |
| 25 | 1,00 |
| 30 | 0,94 |
| 35 | 0,88 |
| 40 | 0,82 |

**Table 6.12 — Correction factors for thermal resistivity of soil**

| 1 | 2 | 3 |
|---|---|---|
| **Thermal resistivity of soil** K·m/W | **Correction factors** | |
| | **Cables buried directly in the ground** | **Cables installed in pipes buried in the ground** |
| 0,7 | 1,17 | 1,07 |
| 0,8 | 1,13 | 1,05 |
| 0,9 | 1,09 | 1,04 |
| 1,0 | 1,06 | 1,02 |
| 1,2 | 1,00 | 1,00 |
| 1,5 | 0,93 | 0,96 |
| 2,0 | 0,83 | 0,91 |
| 2,5 | 0,76 | 0,87 |
| 3,0 | 0,71 | 0,83 |
| 3,5 | 0,65 | 0,8 |
| 4,0 | 0,61 | 0,77 |
| NOTE The correction factors given have been averaged over the range of conductor sizes. Consult SANS 10198-4 if specific conductor size correction factors are required. | | |

## Table 6.13 — Correction factors for grouping of cables buried in the ground

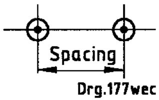
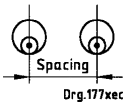
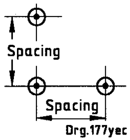
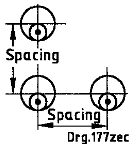
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cable or pipe arrangement** | **Number of cables in group** | **Correction factors** | | | | | | | | |
| | | **Cables buried directly in the ground** | | | | | **Cables installed in pipes in the ground** | | | |
| | | **Centre-line spacing**<br>mm | | | | | | | | |
| | | **Touching** | **150** | **300** | **450** | **600** | **Touching** | **300** | **450** | **600** |
| <br>**Horizontal spacing**<br> | 2 | 0,81 | 0,87 | 0,91 | 0,93 | 0,94 | 0,90 | 0,93 | 0,95 | 0,96 |
| | 3 | 0,70 | 0,78 | 0,84 | 0,87 | 0,90 | 0,82 | 0,87 | 0,90 | 0,93 |
| | 4 | 0,63 | 0,74 | 0,81 | 0,86 | 0,89 | 0,78 | 0,85 | 0,89 | 0,91 |
| | 5 | 0,59 | 0,70 | 0,78 | 0,83 | 0,87 | 0,75 | 0,82 | 0,87 | 0,90 |
| | 6 | 0,55 | 0,67 | 0,76 | 0,82 | 0,86 | 0,72 | 0,81 | 0,86 | 0,90 |
| | 7 | 0,52 | 0,65 | 0,75 | 0,81 | 0,86 | 0,70 | 0,80 | 0,86 | 0,89 |
| | 8 | 0,50 | 0,64 | 0,74 | 0,81 | 0,85 | 0,69 | 0,79 | 0,85 | 0,89 |
| | 9 | 0,48 | 0,63 | 0,74 | 0,80 | 0,85 | 0,68 | 0,78 | 0,84 | 0,88 |
| | 10 | 0,47 | 0,62 | 0,73 | 0,80 | 0,85 | 0,67 | 0,78 | 0,84 | 0,88 |
| | 11 | 0,45 | 0,61 | 0,72 | 0,80 | 0,84 | 0,66 | 0,77 | 0,84 | 0,88 |
| | 12 | 0,44 | 0,60 | 0,72 | 0,79 | 0,84 | 0,65 | 0,77 | 0,83 | 0,87 |

**Table 6.13** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cable or pipe arrangement** | **Number of cables in group** | **Correction factors** | | | | | | | | |
| | | **Cables buried directly in the ground** | | | | | **Cables installed in pipes in the ground** | | | |
| | | **Centre-line spacing**<br>mm | | | | | | | | |
| | | **Touching** | **150** | **300** | **450** | **600** | **Touching** | **300** | **450** | **600** |
| <br>**Horizontal and vertical arrangement and spacing**<br> | O<br>O O | 0,69 | 0,76 | 0,81 | 0,83 | 0,85 | 0,81 | 0,85 | 0,87 | 0,90 |
| | O O<br>O O | 0,62 | 0,71 | 0,76 | 0,79 | 0,81 | 0,76 | 0,81 | 0,83 | 0,86 |
| | O O O<br>O O O | 0,53 | 0,62 | 0,68 | 0,71 | 0,74 | 0,68 | 0,74 | 0,76 | 0,80 |
| | O O O<br>O O O<br>O O O | 0,44 | 0,53 | 0,58 | 0,61 | 0,64 | 0,59 | 0,64 | 0,67 | 0,71 |
| | O O O<br>O O O<br>O O O<br>O O O | 0,39 | 0,48 | 0,53 | 0,56 | 0,58 | 0,54 | 0,59 | 0,62 | 0,64 |

### 6.2.9 Correction factors for grouping and number of cables

#### 6.2.9.1 Groups that contain cables of the same size and load

The correction factors for grouping, as given in tables 6.14 or 6.15, are applicable to adjacent cables that are

a) in uniform groups (i.e. groups in which the cables are all single-core or all multicore), and

b) equally loaded (i.e. all the cables are loaded to their respective current-carrying capacities).

NOTE When the spacing between cables exceed twice the overall diameter of the cables, no correction factor for grouping need be applied except for cables buried directly in the ground.

#### 6.2.9.2 Correction factors for number of cables on racks or trays

NOTE Only the number of conductors that carry load current shall be considered in a circuit. Where it can be assumed that conductors in multiphase circuits carry balanced currents, the associated neutral conductor need not be taken into consideration. Therefore the tabulated current-carrying capacities for three conductors apply to conductors in a balanced three-phase and neutral circuit; under these conditions, a four-core cable is taken as having the same current-carrying capacity as a three-core cable, each phase conductor having the same nominal cross-sectional area.

**6.2.9.2.1** Where two or more conductors are connected in parallel in the same phase or pole of the system, measures shall be taken to ensure that the load current is shared equally between them.

**6.2.9.2.2** From table 6.1, select the installation method appropriate to the installation arrangement.

**Table 6.14 — Correction factors for groups of more than one circuit of single-core cable, or more than one multicore cable**

(To be applied to the corresponding current-carrying capacity for a single circuit in tables 6.1 to 6.6.)[a]

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Installation method** (see table 6.1) | | **Correction factors** | | | | | | | | | | | | | |
| | | **Number of circuits or multicore cables** | | | | | | | | | | | | | |
| | | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **12** | **14** | **16** | **18** | **20** |
| Enclosed (method 1 or 2) or bunched and clipped direct to a non-metallic surface (method 3) | | 0,80 | 0,70 | 0,65 | 0,60 | 0,57 | 0,54 | 0,52 | 0,50 | 0,48 | 0,45 | 0,43 | 0,41 | 0,39 | 0,38 |
| Single layer, clipped to a non-metallic surface (method 3) | Touching | 0,85 | 0,79 | 0,75 | 0,73 | 0,72 | 0,72 | 0,71 | 0,70 | – | – | – | – | – | – |
| | Spaced[b] | 0,94 | 0,90 | 0,90 | 0,90 | 0,90 | 0,90 | 0,90 | 0,90 | 0,90 | 0,90 | 0,90 | 0,90 | 0,90 | 0,90 |
| Single layer, multicore, on a perforated metal cable rack or tray, vertical or horizontal (method 4) **Single rack or tray** | Touching | 0,86 | 0,81 | 0,77 | 0,75 | 0,74 | 0,73 | 0,73 | 0,72 | 0,71 | 0,70 | – | – | – | – |
| | Spaced[b] | 0,91 | 0,89 | 0,88 | 0,87 | 0,87 | – | – | – | – | – | – | – | – | – |
| **Two racks or two trays** | Touching | 0,87 | 0,80 | 0,77 | 0,75 | 0,73 | 0,71 | 0,69 | 0,68 | – | – | – | – | – | – |
| | Spaced[b] | 0,99 | 0,96 | 0,92 | 0,89 | 0,87 | – | – | – | – | – | – | – | – | – |
| **Three racks or three trays** | Touching | 0,86 | 0,79 | 0,76 | 0,73 | 0,71 | 0,69 | 0,67 | 0,66 | – | – | – | – | – | – |
| | Spaced[b] | 0,98 | 0,95 | 0,91 | 0,88 | 0,85 | – | – | – | – | – | – | – | – | – |

[a] When cables that have different conductor operating temperatures are grouped together, the current rating shall be based on the lowest operating temperature of any cable in the group.

[b] Spaced by a clearance between adjacent surfaces of at least one cable diameter ($D_e$). Where the horizontal clearances between adjacent cables exceed 2 $D_e$, no correction factor need be applied.

**Table 6.14** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Installation method** (see table 6.1) | | **Correction factors** | | | | | | | | | | | | | |
| | | **Number of circuits or multicore cables** | | | | | | | | | | | | | |
| | | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **12** | **14** | **16** | **18** | **20** |
| Single layer, single-core, on a perforated metal cable rack and tray, touching (method 4) **Single rack or tray** | Horizontal | 0,90 | 0,85 | – | – | – | – | – | – | – | – | – | – | – | – |
| | Vertical | 0,85 | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **Two racks or two trays** | Horizontal | 0,87 | 0,81 | – | – | – | – | – | – | – | – | – | – | – | – |
| **Three racks or three trays** | Horizontal | 0,85 | 0,78 | – | – | – | – | – | – | – | – | – | – | – | – |
| Single layer, multicore, touching, on ladder supports (method 6) **Single rack or tray** | | 0,86 | 0,82 | 0,80 | 0,79 | 0,78 | 0,78 | 0,78 | 0,77 | – | – | – | – | – | – |
| **Two racks or two trays** | | 0,86 | 0,80 | 0,78 | 0,77 | 0,76 | 0,75 | 0,74 | 0,73 | – | – | – | – | – | – |
| **Three racks or three trays** | | 0,85 | 0,79 | 0,76 | 0,74 | 0,73 | 0,72 | 0,71 | 0,70 | – | – | – | – | – | – |

[a] When cables that have different conductor operating temperatures are grouped together, the current rating shall be based on the lowest operating temperature of any cable in the group.

[b] Spaced by a clearance between adjacent surfaces of at least one cable diameter ($D_e$). Where the horizontal clearances between adjacent cables exceed 2 $D_e$, no correction factor need be applied.

## Table 6.15 — Correction factors for cables installed in enclosed trenches
(installation methods 7, 8 and 9 (see table 6.1))[a]

The correction factors tabulated below relate to the disposition of cables illustrated in table 6.1 (cables in trenches) and are applicable to the current-carrying capacities of cables installed in accordance with installation methods 5 or 6 of table 6.1, as given in the relevant tables.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** mm$^2$ | **Correction factors** | | | | | | | | | |
| | **Installation method 7** | | | | **Installation method 8** | | | **Installation method 9** | | |
| | **Two single-core cables, or one three-core or four-core cable** | **Three single-core cables, or two two-core cables** | **Four single-core cables, or two three-core or four-core cables** | **Six single-core cables, four two-core cables, or three three-core or four-core cables** | **Six single-core cables, four two-core cables, or three three-core or four-core cables** | **Eight single-core cables, or four three-core or four-core cables** | **Twelve single-core cables, eight two-core cables, or six three-core or four-core cables** | **Twelve single-core cables, eight two-core cables or six three-core or four-core cables** | **Eighteen single-core cables, twelve two-core cables, or nine three-core or four-core cables** | **Twenty-four single-core cables, sixteen two-core cables, or twelve three-core or four-core cables** |
| 4 | 0,93 | 0,90 | 0,87 | 0,82 | 0,86 | 0,83 | 0,76 | 0,81 | 0,74 | 0,69 |
| 6 | 0,92 | 0,89 | 0,86 | 0,81 | 0,86 | 0,82 | 0,75 | 0,80 | 0,73 | 0,68 |
| 10 | 0,91 | 0,88 | 0,85 | 0,80 | 0,85 | 0,80 | 0,74 | 0,78 | 0,72 | 0,66 |
| 16 | 0,91 | 0,87 | 0,84 | 0,78 | 0,83 | 0,78 | 0,71 | 0,76 | 0,70 | 0,64 |
| 25 | 0,90 | 0,86 | 0,82 | 0,76 | 0,81 | 0,76 | 0,69 | 0,74 | 0,67 | 0,62 |
| 35 | 0,89 | 0,85 | 0,81 | 0,75 | 0,80 | 0,74 | 0,68 | 0,72 | 0,66 | 0,60 |
| 50 | 0,88 | 0,84 | 0,79 | 0,74 | 0,78 | 0,73 | 0,66 | 0,71 | 0,64 | 0,59 |
| 70 | 0,87 | 0,82 | 0,78 | 0,72 | 0,77 | 0,72 | 0,64 | 0,70 | 0,62 | 0,57 |
| 95 | 0,86 | 0,81 | 0,76 | 0,70 | 0,75 | 0,70 | 0,63 | 0,68 | 0,60 | 0,55 |

[a] When cables that have different conductor operating temperatures are grouped together, the current rating shall be based on the lowest operating temperature of any cable in the group.

**Table 6.15** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Conductor cross-sectional area** mm$^2$ | **Correction factors** | | | | | | | | | |
| | **Installation method 7** | | | | **Installation method 8** | | | **Installation method 9** | | |
| | **Two single-core cables, or one three-core or four-core cable** | **Three single-core cables, or two two-core cables** | **Four single-core cables, or two three-core or four-core cables** | **Six single-core cables, four two-core cables, or three three-core or four-core cables** | **Six single-core cables, four two-core cables, or three three-core or four-core cables** | **Eight single-core cables, or four three-core or four-core cables** | **Twelve single-core cables, eight two-core cables, or six three-core or four-core cables** | **Twelve single-core cables, eight two-core cables or six three-core or four-core cables** | **Eighteen single-core cables, twelve two-core cables, or nine three-core or four-core cables** | **Twenty-four single-core cables, sixteen two-core cables, or twelve three-core or four-core cables** |
| 120 | 0,85 | 0,80 | 0,75 | 0,69 | 0,73 | 0,68 | 0,61 | 0,66 | 0,58 | 0,53 |
| 150 | 0,84 | 0,78 | 0,74 | 0,67 | 0,72 | 0,67 | 0,59 | 0,64 | 0,57 | 0,51 |
| 185 | 0,83 | 0,77 | 0,73 | 0,65 | 0,70 | 0,65 | 0,58 | 0,63 | 0,55 | 0,49 |
| 240 | 0,82 | 0,76 | 0,71 | 0,63 | 0,69 | 0,63 | 0,56 | 0,61 | 0,53 | 0,48 |
| 300 | 0,81 | 0,74 | 0,69 | 0,62 | 0,68 | 0,62 | 0,54 | 0,59 | 0,52 | 0,46 |
| 400 | 0,80 | 0,73 | 0,67 | 0,59 | 0,66 | 0,60 | 0,52 | 0,57 | 0,50 | 0,44 |
| 500 | 0,78 | 0,72 | 0,66 | 0,58 | 0,64 | 0,58 | 0,51 | 0,56 | 0,48 | 0,43 |
| 630 | 0,77 | 0,71 | 0,65 | 0,56 | 0,63 | 0,57 | 0,49 | 0,54 | 0,47 | 0,41 |

[a] When cables that have different conductor operating temperatures are grouped together, the current rating shall be based on the lowest operating temperature of any cable in the group.

### 6.2.9.3 Groups that contain cables of different sizes

Tabulated group correction factors are applicable to groups that consist of similar, equally loaded cables. The calculation of correction factors for groups that contain different sizes of equally loaded insulated conductors or cables is dependent on the total number of cables and the different sizes in the group. Such factors cannot be tabulated but shall be calculated separately for each group. The method of calculation of such factors is beyond the scope of this standard. Examples of where such calculations might be advisable are given below.

The group correction factor *F* for a group that contains different sizes of insulated conductors or cables in conduits, cable trunking or cable ducting can be calculated as follows:

$$F = \frac{1}{\sqrt{n}}$$

where

*F* is the group correction factor;

*n* is the number of multicore cables or circuits in the group.

NOTE 1 A group that contains sizes of conductor that cover a range of more than three adjacent standard sizes can be considered a group that contains cables of different sizes. A group of similar cables where the range of conductor sizes in the group covers not more than three adjacent standard sizes, is taken to be a group that consists of cables of the same sizes and loads where the current-carrying capacity of all the cables is based on the same maximum permissible conductor temperature.

NOTE 2 Table 6.15 gives the correction factors to be applied to the tabulated current-carrying capacities of cables or circuits where the cables (circuits) are installed in enclosed trenches.

### 6.2.9.4 Groups of cables buried directly or installed in pipes buried in the ground

The number of cables, the grouping of the cables and the depth of the cables in the ground have a direct influence on the operating temperature of a cable (see tables 6.11, 6.12, 6.13 and 6.16).

**Table 6.16 — Correction factors for depth of cables buried in the ground**

| 1 | 2 | 3 |
|---|---|---|
| **Depth**<br>m | **Correction factors** | |
| | **Cables buried directly in the ground** | **Cables installed in pipes buried in the ground** |
| 0,5 | 1,0 | 1,0 |
| 0,6 | 0,98 | 0,99 |
| 0,8 | 0,96 | 0,98 |
| 1,0 | 0,94 | 0,96 |
| 1,25 | 0,92 | 0,95 |
| 1,5 | 0,9 | 0,94 |

### 6.2.10 Correction factors for neutral currents

**6.2.10.1** Where the neutral conductor carries current without a corresponding reduction in the load of the phase conductor, the current that flows in the neutral conductor shall be taken into account in ascertaining the rating of the circuit.

Select the appropriate correction factor from table 6.17.

NOTE Neutral current can be caused, for example, by

a) unbalanced circuit conditions, and

b) harmonic current in three-phase circuits.

**Table 6.17 — Correction factors for neutral imbalance**

| 1 | 2 |
|---|---|
| **Neutral current as percentage of phase current**<br>% | **Correction factors** |
| 0 | 1,00 |
| 25 | 0,97 |
| 50 | 0,94 |
| 75 | 0,90 |

**6.2.10.2** Irrespective of 6.2.10.1, the current-carrying capacity of a neutral conductor shall

a) in a single-phase circuit, be at least equal to that of the phase conductor,

b) in a multiphase circuit (when single-pole protective devices are used), be at least equal to that of the phase conductor,

c) in a multiphase circuit that uses a multipole protective device, be such that the neutral conductor can carry the maximum predictable out-of-balance current under normal operating conditions, and

d) in a three-phase circuit that supplies discharge lighting, the nominal cross-sectional area of the neutral shall be at least equal to the nominal cross-sectional area of the associated phase conductor.

**6.2.11 Correction factors for harmonic currents**

**6.2.11.1 Effects of harmonic currents on balanced three-phase systems**

**6.2.11.1.1** In the situation where current flows in the neutral of a balanced three-phase system, such neutral currents are due to the line current having a harmonic content that does not cancel in the neutral. The most significant harmonic which does not cancel in the neutral is usually the third harmonic. The magnitude of the neutral current due to the third harmonic may exceed the magnitude of power frequency phase current. The neutral current will then have a significant effect on the current-carrying capacity of cables in the circuit.

**6.2.11.1.2** The correction factors apply to balanced three-phase circuits; it is recognized that the situation is more onerous if only two of the three phases are loaded. In this situation the neutral conductor will carry the harmonic currents in addition to the unbalanced current; such a situation can lead to overloading of the neutral conductor.

**6.2.11.1.3** Equipment likely to cause significant harmonic currents is, for example, fluorescent lighting banks and d.c. power supplies such as those found in computers.

**6.2.11.1.4** The tabulated correction factors, when applied to the current-carrying capacity of the cable with three loaded conductors, will give the current-carrying capacity of a cable with four loaded conductors where the current in the fourth conductor is due to harmonics. The correction factors also take the heating effect of the harmonic current in the phase conductors into account.

**6.2.11.1.5** Further information on harmonic disturbances can be found in SANS 61000-4-7.

**6.2.11.2 Harmonic currents in four-core and five-core cables with four cores that carry current**

**6.2.11.2.1** Where the neutral conductor carries current without a corresponding reduction in the load of the phase conductor, the current that flows in the neutral conductor shall be taken into account in ascertaining the current-carrying capacity of the circuit.

**6.2.11.2.2** The correction factors given in table 6.18 only apply to cables where the neutral conductor is in a multicore cable and is of the same material and cross-sectional area as the phase conductor. The correction factors calculated were based on third harmonic currents. If more than 10 % of higher harmonics ($9^{th}$, $12^{th}$, etc.), are experienced, the lower correction factors are applicable. Where there is an unbalance between phases of more than 50 %, the lower correction factors may be applicable.

**6.2.11.2.3** Where the neutral current is expected to be higher than the phase current, the cable size shall be selected based on the neutral current (see 6.2.6.6).

**6.2.11.2.4** Where the cable size selection is based on a neutral current, which is not significantly higher than the phase current, it is necessary to reduce the tabulated current-carrying capacity for the three loaded conductors.

**6.2.11.2.5** If the neutral current is more than 135 % of the phase current and the cable size is selected based on the neutral current, the three phase conductors will not be fully loaded. The reduction in heat generated by the phase conductors offsets the heat generated by the neutral conductor to the extent that it is not necessary to apply any correction factor to the current-carrying capacity for three loaded conductors.

**Table 6.18 — Correction factors for harmonic currents in multiphase circuits with neutral conductor**

| 1 | 2 | 3 |
|---|---|---|
| **Third harmonic content of phase current**<br><br>% | **Correction factors** | |
| | **Size selection is based on phase current** | **Size selection is based on zero sequence current in the neutral** |
| 0 – 15<br>15 – 33<br>33 – 45<br>> 45 | 1,0<br>0,86<br>–<br>– | –<br>–<br>0,86<br>1,0 |
| Where CFL or LED lighting is installed, the rating of the conductors shall be based on double the sum of the rated input current to accommodate harmonic currents. If the rated input current is not available, then use double the lamp load(s) in watts, to accommodate harmonic currents. | | |
| NOTE 1 Where harmonic current is present, the cable size is selected on the basis of the zero sequence current in the neutral.<br><br>NOTE 2 See 6.2.11.2.4 and 6.2.11.2.5 for the rating of the neutral conductor in relation to the phase conductors in a three-phase circuit. | | |

### 6.2.12 Correction factors for direct solar radiation

Select the appropriate correction factor from table 6.19.

**Table 6.19 — Correction factors for direct solar radiation**

| 1 | 2 | 3 |
|---|---|---|
| **Cross-sectional area of conductor**<br><br>$mm^2$ | **Correction factors** | |
| | **Solar radiation** | |
| | **1 000 W/m$^2$ (coastal)** | **1 250 W/m$^2$ (highveld)** |
| 1,5 – 10 | 0,70 | 0,62 |
| 16 – 35 | 0,68 | 0,57 |
| 50 – 95 | 0,65 | 0,53 |
| 120 – 185 | 0,62 | 0,49 |
| 240 – 400 | 0,59 | 0,44 |
| NOTE For concentric (airdac) cables, see 6.2.13 (table 6.20). | | |

### 6.2.13 Single-phase concentric cables for aerial service connections

**6.2.13.1** Concentric and split concentric cables are single-phase XLPE insulated copper cables available in sizes 4 $mm^2$, 10 $mm^2$ and 16 $mm^2$ and are designed for aerial application, but may also be used underground. These cables are primarily used for the provision of an electricity supply from a distribution main or aerial bundled conductor (ABC) system to individual houses. For current ratings, see table 6.20.

**6.2.13.2** Split concentric cables are provided with an integral earthing conductor and can be used in single-phase circuits in an electrical installation.

**6.2.13.3** Concentric cables only contain a phase and concentric conductor to be used in combined neutral earth systems which does not make it suitable for circuits in an electrical installation except where a separate earthing conductor is installed.

**Table 6.20 — Current rating for concentric cables**

| 1 | 2 | 3 |
|---|---|---|
| **Conductor size** $mm^2$ | **Current rating at 30 °C** A | |
| | **In air (direct sunlight)** | **In ground** |
| 4 | 30 | 60 |
| 10 | 50 | 100 |
| 16 | 70 | 130 |

### 6.2.14 Aerial bundled conductors (ABC)

ABC cables consist of one to three XLPE insulated aluminium conductors wound around a central supporting core, which is also insulated.

These cables are intended for reticulation systems from which individual houses can be fed by concentric or split concentric service cables.

For current ratings see table 6.21 and for installation see SANS 10198-14.

ABC cables are intended to be suspended between structures and shall not be buried directly in the ground.

## Table 6.21 — Aerial bundled conductors (see SANS 1418-1)

**ABC shall not be buried directly in the ground.** (see the installation of ABC in SANS 10198-14.)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **Phase conductors** | | | | **50 Hz resistance at 90 °C** | **50 Hz impedance at 90 °C** | **Insulated neutral nominal diameter** | **Current rating** | **Short-circuit rating** | **Nominal bundle diameter** | **Voltage drop at full load** |
| | **Number of wires** | **Nominal strand diameter** | **Nominal insulation thickness** | **Nominal core diameter** | | | | | | | |
| | | mm | mm | mm | Ω/km | Ω/km | mm | A | kA | mm | mV/A/m |
| 35 × 3 + 54,6 | 7 | 7 ,00 | 1,60 | 10, 2 | 1,113 | 1,117 | 12,65 | 144 | 3,2 | 27,21 | 1,93 |
| 50 × 3 + 54,6 | 7 | 8,20 | 1,60 | 11,4 | 0,822 | 0,827 | 12,65 | 183 | 4,6 | 29,37 | 1,43 |
| 70 × 3 + 54,6 | 19 | 9,80 | 1,80 | 13,4 | 0,588 | 0,575 | 12,65 | 228 | 6,4 | 31,35 | 1,00 |
| 95 × 3 + 54,6 | 19 | 11,50 | 1,80 | 15,1 | 0,411 | 0,420 | 12,65 | 277 | 8,7 | 38,45 | 0,73 |
| 120 × 3 + 54,6 | 19 | 13,10 | 1,80 | 16,7 | 0,325 | 0,338 | 12,65 | 322 | 11,0 | 40,18 | 0,58 |
| 120 × 3 + 70 | 19 | 13,10 | 1,80 | 16,7 | 0,325 | 0,338 | 14,2 | 322 | 11,0 | 40,40 | 0,58 |

NOTE The following information is applicable:

| | | |
|---|---|---|
| Cable type | : | Supporting ABC to SANS 1418-1 |
| Wind | : | Still air |
| Air temperature | : | 35 °C |
| Maximum continuous conductor temperature | : | 90 °C |
| Maximum conductor temperature for 1 s | : | 250 °C |

## 6.3 Installation of conductors and cables

### 6.3.1 Materials

All conductors of nominal cross-sectional area less than 16 $mm^2$ shall be of annealed copper. In the following cases alternative material may also be used:

a) earth continuity conductors (see 6.12.1.9);

b) bonding conductors (see 6.13.1); and

c) aerial conductors (see 6.3.4).

### 6.3.2 Construction

**6.3.2.1** Conductors of nominal cross-sectional area exceeding 2,5 $mm^2$ shall be stranded, except in the following cases, where solid conductors may be used:

a) conductors of mineral-insulated metal-sheathed cables;

b) internal connections of distribution boards, switchgear and industrial controlgear;

c) busbars;

d) aerial conductors;

e) aluminium conductors of nominal cross-sectional area 16 $mm^2$ or more; and

f) copper conductors of nominal cross-sectional area 16 $mm^2$ or less that are used in multicore cables.

**6.3.2.2** Conductors shall be so insulated as to withstand the highest temperature and voltage to which they are likely to be exposed.

### 6.3.3 Identification

**6.3.3.1** A conductor shall be identifiable at its terminations unless its purpose is obvious.

**6.3.3.2** The means of identification for an a.c. circuit may be by colours or by numbers, as follows:

a) where colours are used

   1) a neutral conductor shall be identified by black only,

   2) an earth continuity conductor shall be identified by the bi-colour green/yellow only, or by being bare. Green/yellow insulated conductors shall **NOT** be used as live conductors under any circumstances,

   3) a phase conductor shall be identified by a colour other than green/yellow, green or black, and

      NOTE Welding cable manufactured to SANS 1576 should not be used in circuits above 100 V.

   4) the colours may be applied at the ends of the conductor (of a multicore cable) by means of durable colour marking (e.g. insulating sleeves or by electrical insulating tape wound more than once around the conductor), and

b) where numbers are used, "**0**" shall indicate the neutral conductor.

   NOTE Where the purpose or the function of a conductor is apparent, marking is not required.

**6.3.3.3** The means of identification for a d.c. circuit may be by colours or by symbols, as follows:

a) All equipotential bonding, earth continuity and protective earthing conductors shall be identified by the bi-colour green/yellow only, or by being bare.

b) Where colours are used

   1) the polarity of the positive conductor shall be identified by red only,

   2) the polarity of the negative conductor shall be identified by black or blue, and

3) the colours may be applied at the ends of a conductor by means of durable colour marking (e.g. insulating sleeves or by electrical insulating tape wound more than once around the conductor).

c) Where symbols are used

1) the polarity of the positive conductor shall be identified by the + symbol,

2) the polarity of the negative conductor shall be identified by the − symbol, and

3) the symbols shall be applied at the ends of the conductor. The symbols may be applied by means of printed adhesive tape or cable markers.

d) In an earthed d.c. installation, either the positive or the negative conductor may be earthed. The earthing system used in the installation shall be indicated by means of a notice placed at the d.c. supply.

e) Where an installation contains both a.c. and d.c. circuits and colour is used to identify the polarity of the d.c. conductors, polarity symbols described in (c) above shall be added at both ends of the d.c. conductors to distinguish them from the a.c. conductors.

**6.3.4 Aerial conductors**

**6.3.4.1** An aerial conductor shall be of

a) hard-drawn copper,

b) stranded aluminium, or

c) composite construction, such as steel-cored aluminium.

**6.3.4.2** A surge arrester should be installed at each end of each aerial conductor circuit in an installation (see 6.7.6).

The arrangement, support and, where required, insulation of an aerial conductor shall comply with the relevant statutory requirements.

### 6.3.5 Prefabricated wiring

**6.3.5.1** A prefabricated wiring system that is not wired on site shall allow for variation in building dimensions in such a way that the system, including the cables, is not subjected to any strain.

**6.3.5.2** A prefabricated wiring system, especially any exposed cable ends, shall be protected against damage both during and after installation.

### 6.3.6 PVC insulated multicore cables with a bare earthing conductor and round cable with metal stiffening

**6.3.6.1** The cables may be installed

a) on the surface,

b) under plaster,

c) under a raised floor,

d) in hollows (such as in walls and partitions) (no additional protection being needed),

e) in roof spaces,

f) direct in the ground (see 6.4.4.2, unarmoured buried cables),

g) outdoors or exposed to water (but unless the manufacturer proves that the cables can withstand ultraviolet radiation, the cable shall be out of sight of the sky), and

h) under screed if protected by an earth leakage protection device with a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA.

**6.3.6.2** These cables shall not be buried direct in concrete.

### 6.3.7 Joints and terminations

**6.3.7.1** Joints and terminations of cables, cores and conductors shall be made in accordance with manufacturers' instructions or the appropriate part of SANS 10198. Flexible cables shall only be joined using termination boxes, cable couplers or manufacturers' jointing kits. All joints shall be accessible, protected against strain, and protected in accordance with 5.2.1, except for joints made and sealed permanently and intended to be maintenance free.

**6.3.7.2** Joints and terminations shall not

a) adversely affect the current-carrying capacity, the insulation resist-ance or the earth continuity of the cable, core or conductor in which they are made,

b) be made in any connector, bend, elbow or tee-piece of a conduit,

c) allow the strands of a stranded conductor to spread, or

d) require strands of a stranded conductor to be cut away to allow connection of the conductors (for example, to terminals).

**6.3.7.3** Any armouring or sheathing shall be terminated in or on equipment. Armour wires shall be terminated by a clamp or gland in such a way that

a) pressure is not applied to insulating material, and

b) there is an earth tag washer (or similar) for connecting to the earth continuity conductor.

## 6.4 Positioning and fixing of cables

### 6.4.1 Positioning

A cable shall not be run

a) in the same trench or wireway as a supplier's cable, except with the supplier's permission,

b) in the same wireway as the cables or wires of telecommunication, radio and signalling circuits that are not covered by this part of SANS 10142,

c) where it is likely to be damaged by liquids such as oil, acid, acetone and alkali or by gases such as sulfur dioxide,

d) within 150 mm of hot services such as hot pipes and flues if the heat is likely to damage the cable, unless the cable is cooled or shielded from heat, or

e) in a position where it is likely to be damaged, unless it is mechanically protected.

### 6.4.2 Separation

Where cables and wiring have to be kept separate, as in 6.4.1(b), barriers shall be used at cross-overs, junctions and terminations. In service tunnels and large wireways, barriers need not be used if the circuits can be kept separate, even when the wiring is being worked on.

### 6.4.3 Fixing

**6.4.3.1** To avoid damage to the sheath of a cable, only appropriate cleats, saddles and clamps shall be used to fix a cable.

**6.4.3.2** Cables shall be fixed in such a way as to prevent strain on terminals or connectors.

**6.4.3.3** A cable shall not be bent more than is recommended by the cable manufacturer.

NOTE See annex E for information about bends in cables.

**6.4.3.4** If a cable is not run on racks or in pipes or ducts, it shall be firmly fixed to prevent sagging or creeping.

NOTE 1 PVC insulated multicore cables with a bare earthing conductor may be fixed using adhesives recommended by the cable manufacturer.

NOTE 2 A cable installed in the space above a ceiling and that runs on the ceiling need not be fixed except at the ends to prevent strain on the conductors or terminations.

NOTE 3 A cable can be damaged if it sags under its own weight.

**6.4.3.5** Each a.c. circuit shall be so arranged that

a) all live cores are in the same wireway,

b) when live single-core conductors go through electrically conductive material, measures shall be taken to minimize eddy current heating, and

c) when live single-core conductors go through magnetic material, measures shall be taken to avoid hysteresis losses.

### 6.4.4 Buried cables

**6.4.4.1** Unarmoured cables may be buried if they are insulated and sheathed.

**6.4.4.2** If unarmoured insulated cables are buried at a depth of

a) less than 0,5 m, they shall be enclosed in conduit or otherwise mechanically protected (for example, in the case of paving or concrete) (see also 6.5.), or protected by an earth leakage protection device with a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA, or

b) at least 0,5 m, the backfill around them shall not contain sharp objects and there shall be a marker tape that runs above the route of the cable, at a depth of between 0,3 m and 0,4 m.

**6.4.4.3** The armouring of armoured cables is considered to provide adequate mechanical protection in most circumstances except in the case of 6.4.1 (e).

### 6.4.5 Open wiring

NOTE Open wiring consists of single-core insulated conductors that operate at not more than 250 V to earth; however, this is not a recommended installation method for new installations.

**6.4.5.1** Open wiring shall not be installed

a) under thatched or wood-shingle roofs,

b) in parts of a roof space where the working height is less than 750 mm,

c) in roof spaces that are intended to be used (or are used) for storage, unless the wiring is suitably protected against mechanical damage,

d) within 1 m of a trap door unless the wiring is suitably protected against mechanical damage, or

e) where it will be in contact with flammable material.

**6.4.5.2** Each conductor of an open wiring system shall be visible where it is installed on, over, or next to beams that can be used for walking on, or it shall be suitably protected against mechanical damage.

**6.4.5.3** Conductors shall

a) be fixed at intervals not exceeding 1,5 m to building elements such as walls, rafters or purlins,

b) if there is no ceiling, be at least 3 m above floor level,

c) be supported within 600 mm of the point where they enter conduit or other building elements, and

d) be fixed in such a way that the fixing method does not impair the conductor insulation.

**6.4.5.4** Where conductors enter a conduit, the conductors shall not be strained. Metal conduit shall project enough to allow a bush and an earth clip to be fitted.

**6.4.5.5** Where the current-carrying capacity of conductors is impaired by thermal insulating material, the appropriate correction factors shall be applied.

### 6.4.6 Unarmoured cables

**6.4.6.1** Unarmoured single-core cables without a metal sheath shall only be used

a) in wireways (see 6.5),

b) for open wiring (see 6.4.5), and

c) for temporary wiring (see 7.8).

**6.4.6.2** Unarmoured multicore cables do not require additional mechanical protection if they are installed

a) under plaster in walls, or

b) under raised floors, in spaces above ceilings, in partitions or in wall cavities,

but only if they will not be damaged during installation.

**6.4.6.3** Unarmoured multicore cables need not be fixed in position in places such as in roof spaces above ceilings and where the cables are unlikely to be disturbed.

### 6.4.7 Copper braided cables

**6.4.7.1** The copper braiding of a cable shall be

a) earthed,

NOTE The braiding may be used as the earth continuity conductor.

b) bonded to any metal wireway in which it is run, and

c) connected to any metal enclosure or to the earthing terminals of the equipment that the cable supplies.

**6.4.7.2** Cables that have exposed copper braiding shall not be buried direct in concrete but may be buried in plaster made using Portland cement.

**6.4.7.3** Copper braided cables need not be fixed in position in places such as in roof spaces above ceilings and where the cables are unlikely to be disturbed.

### 6.4.8 Wiring through building elements

**6.4.8.1** If wiring has to pass right through a building element such as a floor, a wall, a partition, or a ceiling, conductors and busbars shall be in a non-flammable enclosure or wireway.

**6.4.8.2** If the building element is a fire break, the space around

a) a cable,

b) a wireway, or

c) the wiring in a wireway, if the internal cross-sectional area of the wireway exceeds 13 000 $mm^2$,

shall be completely filled with non-flammable material over the full thickness of the building element.

NOTE 1 Mineral wool is non-flammable.

NOTE 2 A local authority or fire officer could require extra safety measures to be taken.

## 6.5 Wireways

### 6.5.1 General

**6.5.1.1** When a wireway is installed

a) the wireway shall be installed such that safe maintenance is ensured;

b) joints other than expansion joints shall be at least as rigid as the wireway itself;

c) where flammable material is used for its construction, the electrical equipment mounted in or onto the wireway shall be protected by non-flammable material;

d) expansion joints shall protect the wiring at least as well as the rest of the wireway does;

e) all inspection joints and boxes shall be easily accessible, even if they are above ceilings or below floorboards;

f) all boxes and expansion joints that could be splashed with liquid shall have covers that prevent the liquid from entering the wireways;

g) it shall be able to withstand the environmental conditions in which it is installed;

h) any cable, other than a high-voltage cable for a discharge lamp installation, may be installed in the wireway, except in the case of 6.4.1(b);

i) no part of the wireway shall be flattened, split or damaged;

j) metal doors, covers or hinged panels shall be separately earthed where any electrical equipment is fitted to such doors, covers or panels;

k) where it is accessible to the public, protection shall be such that it is not possible to touch any live parts with either the standard jointed test finger or the 2,5 mm diameter 100 mm long rod (see SANS 60529). This protection also applies after opening any door or cover that can be opened without the use of a tool or key; and

l) cable entry points, exit points, and internal surfaces of the wireway shall not be able to damage the insulation of cables installed.

**6.5.1.2** The materials that come in contact with a wireway, such as the materials of

a) electrical equipment,

b) electrical fittings, and

c) lubricant used when cables are being drawn,

shall not react with the materials of the wireway, or with the cable insulation or sheath.

**6.5.1.3** Where a luminaire is used as a wireway (through-wiring), there shall be a heat-resistant barrier between the components that heat up and the conductor, unless heat-resistant cable is used.

**6.5.1.4** In the case of conduits,

a) all fittings other than bends and couplings shall be of the inspection type;

b) the inner radius of a bend in a conduit shall be at least three times the external diameter of the conduit;

c) bends shall not distort the internal shape of a conduit or open any weld; and

d) there shall be no openings in the side of a conduit for cables to enter or leave the conduit.

### 6.5.2 Rigid metallic wireways

#### 6.5.2.1 Fixing

Unless otherwise recommended by the manufacturer, a rigid metallic wireway shall

a) span not more than 2 m between supports, and

b) where it is accessible, be fixed at intervals not more than 3 m.

#### 6.5.2.2 Electrical continuity

All parts of rigid metallic wireways shall be bonded to earth.

#### 6.5.3 Rigid non-metallic wireways

##### 6.5.3.1 Fixing

Unless otherwise recommended by the manufacturer, a rigid non-metallic wireway shall

a) span not more than 1,5 m between supports, and

b) where it is accessible, be fixed at intervals not more than 3 m.

##### 6.5.3.2 Conditions of use

Rigid non-metallic conduit may be buried direct in the ground, without mechanical protection.

A rigid non-metallic wireway shall not be used

a) in a position where it is likely to be damaged, unless it is protected against damage, or

b) for cables that have a normal operating temperature that is higher than the highest operating temperature of the wireway.

#### 6.5.4 Flexible conduit

##### 6.5.4.1 Earthing

Metal flexible conduit, even if insulated, shall be connected to earth but shall not be used as an earth continuity conductor.

##### 6.5.4.2 Installation

Flexible conduit shall

a) use only appropriate glands and terminations,

b) not be so bent that it could open or be damaged when it is strained in normal use, and

c) not be buried in plaster, screed, or concrete, unless it has been designed for that purpose.

### 6.5.5 Multibore conduit

Multibore conduit shall comply with the applicable requirements for sheaths of single-core cables and shall only be used with appropriate terminations.

Conduit may be buried direct in the ground.

### 6.5.6 Maximum number of cables in a wireway

#### 6.5.6.1 General

The maximum number of cables permitted in a wireway shall be such as to allow the easy drawing-in and removal of cables without damage.

#### 6.5.6.2 Single-core cables in conduit

**6.5.6.2.1** The maximum number of single-core cables of a given nominal cross-sectional area that may be used in conduit shall be as given in table 6.22.

**Table 6.22 — Capacity of conduit for single-core cables**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Nominal cross-sectional area of conductors** mm² | **Number of cables that may be used in conduit** | | | | |
| | **Conduit diameter** mm | | | | |
| | **20** | **25** | **32** | **40** | **50** |
| 1 | 11 | 16 | - | - | - |
| 1,5 | 9 | 13 | - | - | - |
| 2,5 | 6 | 9 | 17 | - | - |
| 4 | 5 | 7 | 14 | - | - |
| 6 | 4 | 6 | 10 | 18 | - |
| 10 | 3 | 4 | 8 | 13 | - |
| 16 | - | 3 | 5 | 9 | - |
| 25 | - | 2 | 3 | 6 | 9 |
| 35 | - | - | 2 | 4 | 7 |
| 50 | - | - | - | 3 | 5 |
| 70 | - | - | - | 2 | 4 |

**6.5.6.2.2** To determine the size of conduit needed to accommodate conductors of different nominal cross-sectional areas, proceed as follows:

a) for each single-core cable and bare conductor, take the value of *C* from table 6.23, appropriate to the nominal cross-sectional area of each conductor;

b) add up all the values of *C* to give a value of *K*;

c) from table 6.24(a), select a conduit size that has a value of *K* at least equal to the value determined in (b) above. This conduit size will accommodate the conductors.

NOTE See annex F for worked examples of the above.

**Table 6.23 — Values of *C* for conductor nominal cross-sectional area**

| 1 | 2 |
|---|---|
| **Nominal cross-sectional area of conductor** mm² | **Value of *C*** |
| 1 | 8 |
| 1,5 | 10 |
| 2,5 | 14 |
| 4 | 17 |
| 6 | 22 |
| 10 | 30 |
| 16 | 42 |
| 25 | 65 |
| 35 | 84 |
| 50 | 118 |
| 70 | 152 |

**Table 6.24 — Values of *K* for conduit diameter**

| 1 | 2 |
|---|---|
| **Value of *K*** | **Conduit diameter** mm |
| 90<br>144 | 20<br>25 |
| 240<br>398<br>640 | 32<br>40<br>50 |

### 6.5.6.3 Multicore cables in wireways

To determine the size of wireway needed to accommodate cables of different sizes, add up the overall nominal cross-sectional area of each cable and ensure that this total area does not exceed the following percentages of cross-sectional area of the wireway:

a) 40 % for conduit;

b) 35 % for ducting; and

c) 45 % for trunking.

## 6.6 Distribution boards

NOTE This clause describes the minimum safety requirements for the construction and installation of distribution boards.

### 6.6.1 General

**6.6.1.1** Each distribution board shall be controlled by a switch-disconnector (see 6.9.4). The switch-disconnector shall:

a) be mounted in the distribution board or adjacent to the distribution board in the same room,

b) in the case of the main or first distribution board of an installation, be labelled as "main switch",

c) in the case of a sub-distribution board, be labelled as "sub-main switch" "or main switch" if the board is labelled "sub-board …",

d) in the case where an alternative supply is installed (emergency supply, uninterruptible power systems (UPS), etc.), be labelled as required in 7.12.2.1, and

e) have a danger notice on or near it. The danger notice shall give instructions that the switch-disconnector be switched off in the event of inadvertent contact or leakage.

**6.6.1.2** A distribution board shall comply with the requirements of clause 5.

**6.6.1.3** Each item of electrical equipment used in a distribution board shall comply with the requirements of clause 4.

**6.6.1.4** The distribution board shall be suitable for the environmental conditions in which it operates.

**6.6.1.5** Distribution boards shall be protected against corrosion.

**6.6.1.6** Any point of a distribution board that has to be reached during normal operation shall not exceed a height of 2,2 m above floor (or walking) level. However, the board may be mounted higher if it can be disconnected from the supply by a switch-disconnector that is less than 2,2 m above floor level. (See also 5.3.8(b)). Unless a residential distribution board is housed in an enclosure and direct access cannot be obtained by an infant, no part of an indoor distribution board shall be less than 1,2 m above the floor level and no part of an outdoor distribution board shall be less than 0,2 m above the ground level.

**6.6.1.7** A distribution board shall not be mounted

a) in a bathroom, except outside zone 3 and unless the enclosure provides an IP rating of IPX5 (see 7.1.4.3.6),

b) above a fixed cooking appliance or in a position where a cooking appliance could be put below it, unless the enclosure provides a degree of protection of at least IP44, or

c) within a radius of 1 m from a water tap or valve (in the same room), unless the enclosure provides a degree of protection of at least IP44.

**6.6.1.8** Wiring and feeder cables or tightening of connections shall not cause displacement of components.

**6.6.1.9** Distribution boards shall be so positioned and arranged as to ensure safe operation and maintenance (see 5.3.8).

**6.6.1.10** Text has been renumbered and moved to 6.6.2.6.

**6.6.1.11** If a conductor of cross-sectional area exceeding 4 $mm^2$ is used, it shall be so installed to allow any one neutral conductor to be disconnected without disturbing the connection of any other neutral conductor.

**6.6.1.12** A distribution board and the equipment mounted in or on it shall be so positioned and arranged that any conductor can easily be disconnected from the terminals.

**6.6.1.13** Both ends of the live conductors and of the neutral conductors of a ring circuit shall be crimped together. Ring circuits shall clearly and permanently be identified by either a notice or a tag.

**6.6.1.14** In a distribution board where the short-circuit rating exceeds 10 kA, the mechanical strength of the conductors installed between the busbars and the functional units shall be sufficient to withstand the short- circuit stresses which could occur. A conductor with a minimum cross-sectional area of 16 $mm^2$ shall be used if it cannot be shown by calculation or from the component manufacturer's information that a smaller conductor can be installed.

**6.6.1.15** Switchgear shall be fully rated for withstanding the prospective short-circuit current that could occur at that point in the system, unless series-connected (cascaded) systems are applied in accordance with 6.7.4.

**6.6.1.16** Where the prospective fault level of the supply cannot be determined, a fault current meter may be used (see 8.4.2).

**6.6.1.17** All disconnecting devices in a distribution board

a) shall be protected by a fully rated short-circuit protective device, and

b) when used in combination with a short-circuit protective device (see 6.7.4), shall have a conditional short-circuit current rating (see 3.21.1) appropriate to its condition of installation, but of not less than 2,5 kA.

**6.6.1.18** If an installation is likely to be extended, a distribution board with spare ways should be fitted.

**6.6.1.19** Each unoccupied opening of a distribution board shall be fitted with a blanking plate.

**6.6.1.20** Unless obvious, permanent labelling shall identify all incoming and outgoing circuits of the distribution board.

**6.6.1.21** The following warning labels shall be fitted to all distribution boards:

a) an indication of where the distribution board is fed from, except for single distribution board installations. (Where the supply is derived from sources other than the main supply, for example, generators or UPS, see 7.12.5.);

b) if the short-circuit rating exceeds 2,5 kA, the minimum fault current rating of switchgear that can be used;

c) in the case of series-connected (cascaded) systems, the warning label required by 6.7.4(c);

d) the current rating of the busbars shall be indicated where it exceeds 100 A; and

e) if the earthing terminal is installed, a label that indicates the position where the readily accessible earthing terminal for the bonding of other services is provided (see 6.11.5).

**6.6.1.22** The insulation-resistance test on wiring and components shall be performed in accordance with 8.6.8.

### 6.6.2 Busbars

**6.6.2.1** Unless fully tested in accordance with SANS 60439-1, the current density of copper busbars shall not exceed 2 A/mm$^2$ for currents ≤ 1 600 A, or 1,6 A/mm$^2$ for currents > 1 600 A.

**6.6.2.2** The size and design of the busbar system shall be appropriate to the prospective short-circuit current that could occur at the supply terminals of the distribution board.

**6.6.2.3** Where fishplates are used for busbar connections, the cross-sectional dimensions of the fishplates shall be similar to those of the busbar, and the overlap on each side shall be at least equal to the width of the busbar.

**6.6.2.4** Standard colour coding, i.e. red, yellow, blue, or numbering L1, L2 and L3, shall be used to identify phase busbars. Green/yellow shall be used for the earthing busbar and black for the neutral busbar.

**6.6.2.5** If colour is used for control wire coding, any colour may be used except green/yellow, green, or black.

**6.6.2.6** In the case of a multiphase distribution board, the neutral busbar shall be at least 50 % of the cross-sectional area of the phase busbar provided that only particular application conditions permit such reduction. (For harmonics, see 6.2.11.)

**6.6.2.7** The cross-sectional area of the earthing busbar (protective conductor) shall be not less than the appropriate value shown in table 6.24(b).

If the application of this table produces non-standard sizes, the nearest larger standard size shall be used.

**Table 6.25 — Cross-sectional area of protective conductors**

| 1 | 2 |
|---|---|
| **Cross-sectional area of phase conductors** ***S*** mm$^2$ | **Minimum cross-sectional area of the corresponding protective conductor** $S_p$ mm$^2$ |
| $S < 16$ | *S* |
| $16 < S \leq 35$ | 16 |
| $35 < S \leq 400$ | *S*/2 |
| $400 < S \leq 800$ | 200 |
| $S > 800$ | S/4 |

### 6.6.3 Factory built distribution boards with a short-circuit rating up to and including 10 kA

**6.6.3.1** Distribution boards shall comply with SANS 1973-3.

**6.6.3.2** Small power distribution units (SPDUs or ready boards) for single-phase 230 V service connections shall comply with SANS 1619.

### 6.6.4 Distribution boards built or modified on site with a short-circuit rating up to and including 10 kA

#### 6.6.4.1 General

A distribution board shall comply with 6.6.1, 6.6.2, 6.6.4.2 and 6.6.4.3.

#### 6.6.4.2 Design

Unless tested in accordance with SANS 60439-1, the minimum clearance between phases and between phase and earth shall be at least 8 mm. Equipment and components shall comply with the clearance distances given in the relevant product standards.

#### 6.6.4.3 Electrical integrity

Unless tested in accordance with SANS 60439-1, the minimum creepage distance between phases and between phase and earth shall be at least 16 mm. Equipment and components shall comply with the creepage distances given in the relevant product standards.

### 6.6.5 Factory built distribution boards with a short-circuit rating above 10 kA

Distribution boards that form part of a fixed electrical installation shall comply with SANS 1973-1 or SANS 1973-8.

### 6.6.6 Alterations/extensions to distribution boards with a short-circuit rating above 10 kA

**6.6.6.1** Alterations or extensions on site to distribution boards with a short-circuit withstand current above 10 kA shall comply with the requirements of 6.6.6.2, and where reports and similar documents are available, apply

a) the rules given in SANS 1973-1 for the maximum permissible deviations allowed for a PTTA, or

b) the rules for derivations from the minimally tested ASSEMBLY as in SANS 1973-8 or from an STA as in SANS 1973-1.

**6.6.6.2** When a distribution board is modified or extended, the following requirements shall apply:

a) the mechanical and electrical integrity of the distribution board shall not be infringed;

b) the integrity of the area in a distribution board or a section of a distribution board that comprises the conductors (including distribution busbars) between the main busbars and the supply side of functional units and the components included in these units, which is regarded as fault free on the basis of the reduced short-circuit stresses that occur on the load side of the prospective short-circuit protective device in each unit, is still applicable;

c) extensions to the busbar systems shall not adversely affect the electrical and mechanical performance of the complete busbar system;

d) components shall be selected for their suitability for application taking into account information available from the component manufacturers. It might be necessary to derate the components depending upon environment and application conditions;

**WARNING**
**Do not replace any component in the system with a component that is not of identical type and rating except when recommended by the manufacturer of the existing component, or the manufacturer of the distribution board, or a person competent to express an opinion on such replacement.**

e) any changed properties due to alteration or extension of the distribution board shall be marked indelibly on a supplementary nameplate; and

f) the required IP rating shall not be reduced.

### 6.6.7 Motor control

**6.6.7.1** Motor control that forms an integral part of a distribution board is deemed part of the fixed electrical installation and shall comply with the requirements of SANS 1973-1 or SANS 1973-3 or SANS 1973-8.

**6.6.7.2** Components for motor control as listed in table 6.25 shall comply with the standards as given in table 4.1.

**Table 6.26 — Compliance of motor control components**

| 1 | 2 |
|---|---|
| **Components** | **Applicable standards** |
| Circuit-breakers<br>Contactors<br>Disconnectors<br>Earth leakage units<br>Fuses and fuse holders<br>Motor-starters<br>Overload relays<br>Socket-outlets<br>Surge arresters<br>Switch-disconnectors<br>Switches<br>Transformers | See table 4.1 for details. |

## 6.7 Protection

### 6.7.1 Overcurrent protection

NOTE The term overcurrent protection includes both overload protection (see 6.7.2) and short-circuit protection (see 6.7.3).

**6.7.1.1** Each phase conductor of an installation, live (unearthed) conductor of an earthed d.c. system, and conductor in an unearthed d.c. installation shall be protected against overload and short-circuit currents by one or more protective device(s). Each protective device shall have a rated current that does not exceed the lowest of the current-carrying capacities of any of the conductors of the circuit and shall have a minimum short-circuit rating of 2,5 kA.

In a d.c. installation that has multiple sources of power, each source shall be protected individually. Protective devices shall be located as closely as possible to the source terminals, taking all other requirements (such as battery rooms) into account.

NOTE 1 An overcurrent protective device may be a circuit-breaker that interrupts the supply to all the phase conductors of a circuit.

NOTE 2 Protection against overload and short-circuit may be provided by separate devices or by a single device.

NOTE 3 Unless specified elsewhere in this part of SANS 10142 for a particular application, the protective device need not disconnect the neutral conductor.

NOTE 4 Where a control device (such as a home automation device) is installed, each circuit that feeds from such device needs an overcurrent protective device if not protected in the supply.

**6.7.1.2** To protect an installation or a live conductor against earth fault currents,

a) the nominal cross-sectional area of the earth continuity conductor shall have been determined in accordance with 6.12.1.1(d); or

b) suitable protection shall be installed; and

c) in the case of a TT supply system earthing (see J.2.3), where for practical reasons the supply to the installation cannot be automatically disconnected by an earth fault current of double the rated current (or higher) of the main protective device, as an alternative, an earth fault detection and disconnecting device can be installed at the point of control of the installation. The earth fault detection and disconnecting device shall be so installed that they operate at a current related to the earth loop impedance which will limit prospective touch voltages under short-circuit fault conditions to 25 V for a period not exceeding 5 s.

   NOTE 1 These requirements can easily be achieved by using an earth leakage device that has a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 300 mA. Devices provided with a time delay of for example, 0,1 s, will ensure discrimination with earth leakage protection devices in final circuits.

   NOTE 2 Separate earth fault protection could consist of sensitive earth leakage protection, which might not always be practicable where large currents are involved.

**6.7.1.3** Conductors that form part of an installation may be protected by the supplier's overcurrent protective device, provided that

a) the supplier agrees,

b) the supplier's protective device complies with clause 4,

c) the user has access to the device, and

d) such protective device complies with the requirements of 6.7.2.1.

### 6.7.2 Overload protection

**6.7.2.1** The rated current of the overload protective device shall not exceed the current-carrying capacity of the conductor it protects, except in the case of circuits in which the presence of overload protection could create a dangerous situation, such as in circuits for lifting magnets.

Except in the case of PVC insulated cables, no special provisions need be made for the short-time overcurrent rating of cables. In the absence of detailed operation data of the installation, the following currents shall not be exceeded in the case of the corresponding PVC insulated cable sizes (see table 6.26).

**Table 6.27 — Maximum protection rating for nominal cross-sectional area of small conductors**

| 1 | 2 |
|---|---|
| **Maximum protection rating** A | **Nominal cross-sectional area of conductor** $mm^2$ |
| 10 | 1 |
| 16 | 1,5 |
| 25 | 2,5 |

**6.7.2.2** Except as allowed in 6.7.2.3, an overload protective device shall be installed

a) along a conductor where the current capacity of the conductor is reduced,

b) where the thermal rating of a disconnecting device could be exceeded (summation of ratings), and

c) where the thermal rating of an earth leakage protection device not provided with integral overcurrent protection, could be exceeded.

**6.7.2.3** The overload protective device may be installed at any point in the conductor run that it protects, provided that

a) there is no branch circuit or socket-outlet between the point where there is a reduction in the conductor's current-carrying capacity and the point where the device is installed, and

b) the entire length of the conductor is protected against short-circuit, or

c) the conductor is

1) of length not exceeding 5 m,

2) so installed as to minimize the risk of overload or fault in its operating condition,

3) not near flammable materials, and

4) not likely to cause harm to a person in the event of a fault.

**6.7.2.4** Protective devices that have adjustable overload settings shall only be used if the means of adjustment is not accessible without the use of a tool and the adjustment can only be made by means of a tool.

**6.7.3 Short-circuit protection**

**6.7.3.1** At its point of installation, a short-circuit protective device shall be capable of breaking any overcurrent up to the value of the prospective short-circuit current (save as may be permitted under 6.7.4 pertaining to series-connected or cascaded systems.)

**6.7.3.2** Unless other means of short-circuit protection are used, a short-circuit protective device shall be installed at any point where there is a change in the characteristics of a conductor (such as a change in nominal cross-sectional area).

NOTE Safe short-circuit protection of PVC insulated copper cables will normally be ensured if the cross-sectional area of the conductor (in square millimetres) is at least numerically equal to the prospective short-circuit current (in kiloamperes). This is based on a maximum clearing time of less than one electrical cycle which is typical of LV short-circuit protective devices.

**6.7.3.3** With particular reference to socket-outlets and luminaire supplies, the cross-sectional area of PVC insulated conductors shall comply with the calculated prospective short-circuit current requirements (see also the note to 6.7.3.2) for all points of consumption that fall within the limits of 6.7.3.4.

**6.7.3.4** For the purpose of protection against short-circuit current in PVC insulated cables (of a cross-sectional area ≤ 4 $mm^2$), the first 5 m length in single-phase circuits and 10 m length in multiphase circuits are regarded as being fault free, however, the impedence of these concessionary lengths may not be included in determining the breaking capacity of upstream short-circuit protective devices.

### 6.7.4 Series-connected (cascaded) systems

NOTE A series-connected (cascaded) system is a protection system that allows for the installation of circuit-breakers which cannot necessarily be rated to handle the full prospective short-circuit current at their points of installation, provided that they are backed up by another fully rated circuit-breaker in a predetermined and tested coordination.

In a series-connected (cascaded) system, the following rules shall apply:

a) the combinations of circuit-breakers used shall comply with the requirements of A.6.2(a) and A.6.4 of SANS 60947-2:2014 or equivalent standard for coordinated back-up protection;

b) back-up circuit-breakers shall be fully rated to handle the maximum prospective short-circuit current at the point of installation; and

c) a warning label shall be fitted to every distribution board, switchboard, panelboard and the like where series-connected (cascaded) systems are used. The label shall include the following wording:

| **WARNING** |
|---|
| **This is a series-connected (cascaded) system. Except when recommended by the circuit-breaker manufacturer, do not replace any circuit-breaker in the system with a circuit-breaker that is not of identical type and rating.** |

### 6.7.5 Earth leakage protection

**6.7.5.1** Except as allowed in 6.7.5.5 and 7.10.1.6, non-auto-reclosing earth leakage protection shall be provided

a) in a new installation for circuits that supply SANS 164-1 or SANS 164-2 type socket-outlets,

b) in an existing installation for all the circuits that supply socket-outlets when any such circuit or circuits are rewired or extended.

NOTE It is recommended that earth leakage protection be installed in all circuits that supply socket-outlets in an existing installation.

c) in circuits supplying water heaters

**6.7.5.2** Industrial type single-phase and three-phase socket-outlets (including "welding" socket-outlets) shall comply with the requirements of SANS 60309-1 and SANS 60309-2 and, except as allowed in 6.7.5.5 and 7.10.1.6, shall have earth leakage protection if the circuit is intended to supply portable or stationary class I appliances.

**6.7.5.3** Earth leakage protection shall disconnect

a) both phase and neutral in a single-phase system, and

b) all three phases in a three-phase system.

When a single-phase socket-outlet is supplied from a three-phase earth leakage circuit-breaker, the earth leakage protection shall break both phase and neutral.

An earth leakage protection device that is used as a switch-disconnector (see 6.9.4) shall comply with the relevant requirements of the standard listed in table 4.1 for a device with isolation function.

**6.7.5.4** Unless allowed elsewhere in this part of SANS 10142 or for a special application, the rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ required to activate an earth leakage protection device shall not exceed 30 mA. It shall not be possible to desensitize an earth leakage protection device while the circuit in which it is installed is in service. However, this does not prevent the use of non-integral earth leakage protection devices when the rupturing capacity exceeds 2,5 kA.

**6.7.5.5** The following do not need earth leakage protection:

a) socket-outlets connected to a safety supply, but see 7.8.3.3 and 7.12;

b) a socket-outlet that complies with SANS 164-4 and that is intended only for the connection of an appliance for critical application (such as emergency lighting, a deep-freeze, a burglar alarm, data processing equipment, or life-supporting equipment);

c) circuits that supply fixed socket-outlets positioned out of normal reach, rated at less than 16 A and intended for the connection of luminaires (see 6.14.1.4); and

d) a stove coupler that complies with SANS 60309-1 and of dimensions as given in SANS 337 (see 6.15.1.1.5).

**6.7.5.6** A warning label shall be fitted to every socket-outlet circuit where

a) the rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ is higher than 30 mA, or

b) the socket-outlet circuit is powered from a safety supply, or

c) the socket-outlet circuit is on dimmer control,

indicating such tripping current, safety supply or dimmer control.

**6.7.5.7** An earth leakage protection device that is not provided with integral overcurrent protection

a) shall be protected by a fully rated short-circuit protective device, or

b) when used in combination with a short-circuit protective device, shall have a conditional short-circuit current rating (see 3.21.1) appropriate to its condition of installation, but of not less than 2,5 kA.

### 6.7.6 Surge protection

**6.7.6.1** Surge protective devices (SPDs) may be installed to protect an installation against transient overvoltages and surge currents such as those due to switching operations or those induced by atmospheric discharges (lightning).

NOTE SPDs installed for lightning protection will automatically cover switching surges.

**6.7.6.2** Where SPDs are to be installed in low-voltage installations, their selection, connection and application shall be in accordance with SANS 61643-12 and annex I.1.

NOTE A risk assessment analysis may be performed in accordance with SANS 62305-2 and annex I.2.

## 6.8 Circuit-breakers

### 6.8.1 Circuit-breakers used as main or local switch-disconnectors

A circuit-breaker that is used as a main or local switch-disconnector (see 6.9.4) shall comply with the relevant requirements of a standard given in clause 4 for switch-disconnectors, or, alternatively, a switch-disconnector shall be positioned on the supply side of the circuit-breaker.

### 6.8.2 Circuit-breakers used as switches

**6.8.2.1** A circuit-breaker that is used as a switch (for example, as a protective device for a socket-outlet) shall comply with the requirements of standards for both circuit-breakers and switches.

**6.8.2.2** Except for a circuit-breaker that is mounted next to the appliance or socket-outlet that it controls, each circuit-breaker shall be labelled to show which circuit or appliance it controls.

**6.8.2.3** Circuit-breakers, disconnectors and switch-disconnectors shall not be mounted upside down. Horizontal mounting is allowed unless specifically prohibited by the manufacturer.

Any deviation from the convention of connecting line to the top and load to the bottom of switchgear is not recommended. Reverse connection is allowed only if

a) it is specifically allowed by the manufacturer,

b) "load" and "line" are so marked that they are clearly visible during maintenance, and

c) any contradictory marking is not visible after installation.

## 6.9 Disconnecting devices

### 6.9.1 General

**6.9.1.1** Each installation shall have one disconnecting device to disconnect the entire installation, except in the case of multisupplies or more than one transformer supplying the installation where each supply shall have its own disconnecting device. There shall be a notice fixed next to each such disconnecting device indicating that the installation has more than one main switch-disconnector.

**6.9.1.2** If an installation consists of separate parts, each part shall be controlled by a sub-main switch-disconnector to disconnect

a) that part of the installation, or

b) individual circuits and appliances.

**6.9.1.3** A disconnecting device that is intended to disconnect equipment for repair, maintenance, or inspection shall have at least the safety isolating requirements of a switch-disconnector.

### 6.9.2 Disconnection of neutral conductors

**6.9.2.1** A neutral conductor shall not have a single-pole disconnecting device.

**6.9.2.2** In the case of a single-phase circuit, the disconnecting device shall disconnect live and neutral. In the case of a multiphase circuit, the disconnecting device shall disconnect all the phase conductors but need not disconnect the neutral conductor in an installation connected to a supply system in which the neutral conductor is earthed direct (see the TN system in annex J).

**6.9.2.3** A disconnecting device used in a supply system in which there is no direct connection between earth and any live conductor shall disconnect all the live conductors (see the TT and IT systems in annex J).

NOTE In a safety supply, none of the conductors are connected to earth, so any disconnecting device in such a circuit has to disconnect all the conductors.

### 6.9.3 Disconnecting devices for equipment

**6.9.3.1** An appliance or equipment that is not supplied from a socket-outlet, including equipment automatically or remote controlled, shall be capable of being disconnected from the supply by an easily accessible switch-disconnector. The disconnector shall be mounted (if not specified elsewhere in this part of SANS 10142, but excluding luminaire circuits) (see also 6.16.1.4)

a) within arm's reach from the terminals of the appliance, or

b) in a distribution board, if the device is capable of being locked in the open position.

The disconnector can control more than one appliance if the functions of the appliances are related. Where equipment which belongs to the supplier of electricity (such as meters or remote controlled load switching) is installed, the main switch may be regarded as the disconnecting device.

**6.9.3.2** All supply circuits to equipment and interconnected devices (such as appliances with remote control or alarm) shall be capable of being disconnected. Where more than one disconnecting device is used, each device shall have a notice fixed next to it, giving the location and function of the other disconnecting device.

**6.9.3.3** The disconnecting device shall be a switch-disconnector that disconnects all the phase conductors, however

a) a circuit-breaker may be used instead of a switch-disconnector if overcurrent protection is also required (see also 6.8.1.), or

b) another device may be used instead of a switch-disconnector, where specified in this part of SANS 10142 for a particular application.

NOTE 1 Any switch used to control an inductive load has to be suitable for that duty.

NOTE 2 Unless the device is a switch-disconnector, it shall be marked.

NOTE 3 The removal of a plug from a socket-outlet is a means of safe disconnection.

### 6.9.4 Main switch-disconnectors

The main switch-disconnector on each distribution board shall be easily accessible. (See also 6.6.1.1(b), 6.6.1.1(c), 6.6.1.6 and 6.6.1.9.) If, owing to the nature of the installation, it is necessary to be able to interrupt the supply immediately, the switch-disconnector shall be so installed that it can be rapidly identified and operated.

## 6.10 Fuses

**6.10.1** Fuses, other than fuses incorporated in an appliance or in a socket-outlet, shall not be installed in final circuits of a residential installation.

**6.10.2** Where fuses are installed, they shall, except as allowed in 6.10.3, be installed in a distribution board and shall not be of the rewirable type.

**6.10.3** Fuses that are not installed in a distribution board shall be

a) of the fully shrouded type, or

b) in a suitable protecting case, or

c) incorporated in an appliance or in a socket-outlet, or

d) incorporated in a switch or in controlgear.

**6.10.4** Fuse-protected circuits shall be marked with the maximum permissible current rating.

## 6.11 Consumer's earth terminal

**6.11.1** Each installation shall have a consumer's earth terminal (see 3.17) at or near the point where the supply cables to the installation enter the building or structure. All conductive parts that are to be earthed (see 6.12.3) shall be connected to a main earthing terminal (see 3.28.4), which shall be connected to the consumer's earth terminal. The consumer's earth terminal shall be earthed by connecting it to the supply earth terminal (see 3.78) or the protective conductor (see 3.14.8) and, if installed, the earth electrode. The effectiveness of the supplier's protective conductor shall be determined in accordance with 8.6.5.

**6.11.2** In every installation where main equipotential bonding is used, the following shall be connected to the main earthing terminal in the distribution board:

a) main equipotential bonding in accordance with 6.13;

b) earthing conductors;

c) bonding conductors, except for supplementary equipotential bonding conductors for medical locations in accordance with 7.7.4.6;

d) functional earthing conductors (for example, those given in annex K, if relevant);

e) conductive screens, sheaths or armouring of telecommunication cables or telecommunication equipment;

f) earthing conductors for overvoltage protective devices (including conductors of internal lightning protection systems);

g) earthing conductors of radio communication antenna systems; and

h) the earthing conductor of an earthed d.c. power supply system for information technology equipment.

NOTE The main earthing terminal of the building can generally be used for functional earthing purposes. (A foundation earth is regarded as the most effective earthing.)

**6.11.3** If, for practical reasons, the supply to the installation cannot be automatically disconnected by an earth fault current double the rated current (or higher) of the main protective device, as an alternative, an earth fault detection and disconnecting device may be installed at the supply of the installation. The earth fault detection and disconnecting device shall be so installed that it operates at a current related to the earth loop impedance which will limit prospective touch voltages under short-circuit fault conditions to 25 V for a period not exceeding 5 s. This alternative does not relieve the supplier from the responsibility of providing a supplier's earth terminal (see SANS 10292).

**6.11.4** Where conductors from more than one supply are connected to the main earthing terminal, each conductor connected to the main earthing terminal shall be able to be disconnected individually without having to disturb any of the other earthing conductors, irrespective of the number of supplies. All connections shall be disconnectable only by means of a tool, shall be mechanically sound, and shall ensure the maintenance of electrical continuity.

**6.11.5** A readily accessible earthing terminal may be provided for the bonding of other services such as a telephone, an audio or a video system, and the like, to a building. Where installed, such an earthing terminal shall be bonded to the consumer's earth terminal by a conductor of at least 6 $mm^2$ copper or equivalent, and shall be identified by the earth symbol ⏚

NOTE Providers of services other than the electrical power services should not access the distribution board or other parts of the electrical installation.

**6.11.6** Labels shall be fitted to all distribution boards where the readily accessible earthing terminal for the bonding of other services is provided (see 6.6.1.21).

## 6.12 Earthing

NOTE 1 This subclause addresses earthing arrangements, earth continuity conductors and equipotential bonding in order to ensure the safety of the electrical installation. Functional requirements for information technology installations are addressed in annex K. Earthing arrangements may be used jointly or separately for protective and functional purposes according to the requirements of the electrical installation. Requirements for protective purposes always take precedence.

NOTE 2 The requirements for earthing arrangements are intended to provide a connection to earth that

a) is reliable and suitable for the protective and functional requirements of the installation (for example, surge arresters, etc.),

b) can carry earth fault currents, protective conductor currents and leakage currents to earth without danger from thermal, thermomechanical and electromechanical stresses and from electric shock that arise from these currents, and

c) where relevant, is also suitable for functional requirements.

### 6.12.1 Earth continuity conductors

**6.12.1.1** An earth continuity conductor shall

a) consist of compatible conductors,

b) if it forms part of a cable other than a flexible cable, comply with the relevant requirements of the standard for the cable,

c) if it forms part of a flexible cable, be of the same material as, and have a nominal cross-sectional area at least equal to, that of the largest phase conductor,

d) if it does not form part of a cable or flexible cable, have a nominal cross-sectional area at least equal to that determined in accordance with table 6.27, as follows:

   1) from the row of table 6.27 that gives the rated current of the overcurrent protective device, select a "length of earth continuity conductor" that most closely exceeds the actual length of the circuit;

   2) from the head of the column that gives the selected "length of earth continuity conductor", read off the minimum nominal cross-sectional area of earth continuity conductor to be used; and

e) be able to carry the prospective fault current without excessive heating of the conductor, within the disconnecting time.

NOTE Where the armouring of a cable is used as the earth continuity path, the resistance of the earth continuity path shall not exceed the appropriate value given in table 8.1; it may be necessary to replace some of the steel wires with tinned copper ones or to use a supplementary earth continuity conductor.

**6.12.1.2** Earth continuity conductors shall be so arranged that they cannot be tampered with.

**6.12.1.3** A wireway shall not be used as an earth continuity conductor.

## Table 6.28 — Minimum size and maximum length of copper earth continuity conductors

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rated current of protective device** A | **Minimum nominal cross-sectional area of copper earth continuity conductors** mm² | | | | | | | | | | | | | |
| | **1** | **1,5** | **2,5** | **4** | **6** | **10** | **16** | **25** | **35** | **50** | **70** | **95** | **120** | **185** |
| | **Maximum length of earth continuity conductor** m | | | | | | | | | | | | | |
| 1 | 805 | 1 207 | – | - | - | - | - | - | - | - | - | - | - | - |
| 1,4 | 503 | 755 | 1 258 | - | - | - | - | - | - | - | - | - | - | - |
| 2,0 | 402 | 604 | 1 006 | - | - | - | - | - | - | - | - | - | - | - |
| 2,5 | 322 | 483 | 805 | 1 288 | - | - | - | - | - | - | - | - | - | - |
| 3,2 | 252 | 377 | 629 | 1 006 | - | - | - | - | - | - | - | - | - | - |
| 4,0 | 201 | 302 | 503 | 805 | 1 207 | - | - | - | - | - | - | - | - | - |
| 5,0 | 161 | 241 | 402 | 644 | 966 | - | - | - | - | - | - | - | - | - |
| 6,3 | 128 | 192 | 319 | 511 | 767 | - | - | - | - | - | - | - | - | - |
| 10,0 | 80 | 121 | 210 | 322 | 483 | 805 | - | - | - | - | - | - | - | - |
| 16 | 50 | 75 | 126 | 210 | 302 | 503 | 805 | - | - | - | - | - | - | - |
| 20 | - | 60 | 101 | 161 | 241 | 402 | 644 | - | - | - | - | - | - | - |
| 25 | - | - | 80 | 129 | 193 | 322 | 515 | - | - | - | - | - | - | - |
| 32 | - | - | 63 | 101 | 151 | 252 | 402 | 629 | - | - | - | - | - | - |
| 40 | - | - | - | 80 | 121 | 201 | 322 | 503 | 704 | - | - | - | - | - |
| 50 | - | - | - | 64 | 97 | 161 | 258 | 402 | 563 | - | - | - | - | - |
| 63 | - | - | - | - | 77 | 128 | 204 | 319 | 447 | 639 | - | - | - | - |
| 80 | - | - | - | - | 60 | 101 | 161 | 252 | 352 | 503 | 704 | - | - | - |

**Table 6.28** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rated current of protective device** | **Minimum nominal cross-sectional area of copper earth continuity conductors** mm$^2$ | | | | | | | | | | | | | |
| | **1** | **1,5** | **2,5** | **4** | **6** | **10** | **16** | **25** | **35** | **50** | **70** | **95** | **120** | **185** |
| A | **Maximum length of earth continuity conductor** m | | | | | | | | | | | | | |
| 100 | - | - | - | - | - | 80 | 129 | 201 | 282 | 402 | 563 | 765 | - | - |
| 125 | - | - | - | - | - | 64 | 103 | 161 | 225 | 322 | 451 | 612 | 773 | - |
| 160 | - | - | - | - | - | - | 80 | 126 | 176 | 252 | 352 | 478 | 604 | - |
| 200 | - | - | - | - | - | - | 64 | 101 | 141 | 201 | 282 | 382 | 483 | 744 |
| 250 | - | - | - | - | - | - | - | 80 | 113 | 161 | 225 | 306 | 386 | 596 |
| 315 | - | - | - | - | - | - | - | 64 | 89 | 128 | 179 | 243 | 307 | 473 |
| 400 | - | - | - | - | - | - | - | - | 70 | 101 | 141 | 191 | 241 | 372 |
| 500 | - | - | - | - | - | - | - | - | - | 80 | 113 | 153 | 193 | 298 |
| 630 | - | - | - | - | - | - | - | - | - | 64 | 89 | 121 | 153 | 236 |
| 800 | - | - | - | - | - | - | - | - | - | - | 70 | 96 | 121 | 186 |

NOTE 1 This table is not to be used to determine the maximum length of live conductors because the voltage drop may be excessive for the current that they carry.

NOTE 2 The values in the table are based on a fault current of 2,5 times the rated current of the protective device and a touch voltage of 30 V.

NOTE 3 This table applies to overcurrent protective devices and might not be appropriate to other types of protective device.

NOTE 4 If the full load current rating of the protective device is non-standard, the maximum length of the earth continuity conductor shall be taken as that applying to the next higher standard rating.

**6.12.1.4** An earth continuity conductor may have branch circuits provided that, when the resistance of the conductor is determined in accordance with 8.6.3, it complies with the appropriate value in table 8.1.

NOTE The information in 6.12.1.4 also applies to wire armouring if it is used as the earth continuity path; it may be necessary to replace some of the steel wires with tinned copper ones or to use a supplementary earth continuity conductor.

**6.12.1.5** Connections of earth continuity conductors shall not rely only on twisting of the conductor or strands of the conductor.

**6.12.1.6** A fuse or switching device shall not be fitted in an earth continuity conductor (joints which can only be disconnected by means of a tool may be provided for test purposes).

**6.12.1.7** Earth continuity conductors shall be suitably protected against mechanical damage, chemical or electrochemical deterioration, electrodynamic forces and thermodynamic forces.

**6.12.1.8** Where electrical monitoring of earthing is used, the operating coils shall not be inserted in protective conductors.

**6.12.1.9** An earth continuity conductor shall not be used to carry any current (other than fault currents). For equipment intended for permanent connection and with an earth continuity conductor current exceeding 10 mA, reinforced earth continuity conductors shall be designed as follows:

a) the earth continuity conductor shall have a cross-sectional area of at least 10 $mm^2$ Cu or 16 $mm^2$ Al through its total run; or

b) a second earth continuity conductor of at least the same cross-sectional area as required for protection against indirect contact shall be laid up to a point where the earth continuity conductor has a cross-sectional area of at least 10 $mm^2$ Cu or 16 $mm^2$ Al. This assumes that the appliance has a separate terminal for a second earth continuity conductor.

### 6.12.2 Earth electrodes

An earth electrode might be required for purposes such as antennas and surge voltage protection. Earth electrodes shall comply with the requirements of SANS 1063 and shall be installed in accordance with SANS 10199.

NOTE An earth electrode may have to be protected against electrolytic corrosion caused by stray currents, for example, from electrified railway lines.

### 6.12.3 Earthing of exposed conductive parts

**6.12.3.1** The following conductive parts shall be earthed:

a) all exposed conductive parts of an installation other than those described in 6.12.3.2;

   NOTE Metal enclosures on PVC conduit should be earthed if they can become live and can be touched.

b) all conductive cable sheaths and armouring, wireways and catenary wires;

c) the earthing terminal of a socket-outlet;

d) the secondary winding of a transformer if it is not a safety transformer;

e) earthing terminals of all permanently connected electrical equipment and appliances;

f) conductive parts of discharge luminaires and equipment that need special earthing arrangements; and

g) all class I equipment.

**6.12.3.2** The following conductive parts do not need to be earthed:

a) short unexposed lengths of metallic wireway used to protect wiring as it passes through a building element;

c) exposed conductive parts of fixed electrical equipment that are

   1) out of arm's reach from the floor (or walking) level,

   2) out of arm's reach from a structure that is bonded to earth, and

   3) not exposed to the weather or to the condensation, dripping, splashing or accumulation of water, and

   4) not touching a conductive surface;

c) conductive parts that cannot be touched by the standard test finger;

d) fixings such as cleats, clips, saddles and clamps;

e) equipment and appliances permanently connected to safety supplies;

f) small parts such as screws or nameplates that are isolated by insulating material;

g) structural steelwork, including items such as fire escapes and cat ladders; and

h) metallic fittings in bathrooms if they are isolated from earth (see 7.1.5).

**6.12.3.3** Metallic frames and metallic enclosures of electrical equipment shall be made electrically continuous.

### 6.12.4 Earthing of the neutral of combined sources

When an installation that has a common neutral is supplied from a combination of transformers and generators located near one another, the neutral terminal of each of these items shall be connected to a single neutral bar. This neutral bar shall be the only point at which the neutral of the installation is connected to the consumer's earth terminal except as in the case in 7.12.3.1.3 or 7.16.4.

## 6.13 Bonding

NOTE 1 The aim of bonding is to bring all the bonded parts to the same electrical potential.

NOTE 2 No external conductor is required if compliance with the requirements for continuity can be proved by the test in 8.6.2.

### 6.13.1 Bonding conductors

A bonding conductor shall

a) have a nominal cross-sectional area of at least 2,5 mm$^2$ copper or equivalent, and

b) be so arranged that it cannot be tampered with.

### 6.13.2 Parts to be bonded

#### 6.13.2.1 General

The parts given in 6.13.2.2 to 6.13.2.5 shall be bonded.

#### 6.13.2.2 Hot and cold water systems

Where the hot water system includes electric components and the water pipes are of conducting material, hot and cold water systems shall be bonded together and also be bonded to the earth continuity conductor system.

#### 6.13.2.3 Antennas

The conductive components of an antenna structure (including a satellite dish) may be bonded to the installation earthing system by means of a conductor of at least 2,5 $mm^2$ copper or equivalent.

#### 6.13.2.4 Roofs, gutters, down pipes and waste pipes

If a building is connected to an electricity supply, the roof(s), gutter(s), down pipe(s) and waste pipe(s) shall be bonded and earthed and the resistance of the earth continuity path shall not exceed 0,2 Ω, unless

a) the supply voltage does not exceed 50 V,

b) the supply uses an underground service connection,

c) the roof is made of, or covered with, non-conductive material,

d) the gutter(s), down pipe(s) and waste pipe(s) are of non-conductive material, or

e) the gutter(s) and down pipe(s) are attached to a metal roof that is covered with non-conductive material.

#### 6.13.2.5 Water pumps

All accessible extraneous conductive parts associated with a water pump motor shall be bonded to the earth continuity conductor. These parts include the suction pipe, delivery pipe and pump casing.

#### 6.13.2.6 Other services

Other services such as water, gas, etc. in conductive material, which enter the premises, shall be bonded to the readily accessible earthing terminal (see 6.11.5) by means of a conductor of cross-sectional area at least 2,5 $mm^2$ copper or equivalent.

NOTE 1 Providers of services other than the electrical power services should not access the distribution board or other parts of the electrical installation.

NOTE 2 Extraneous conductive parts of other services should not be used as an earth conductor.

## 6.14 Lighting

NOTE For extra low voltage lighting installations, see 7.9.

### 6.14.1 Lighting circuits

NOTE Where CFL lighting is installed, the rating of the conductors is based on double the sum of the lamp load, in watts (see 6.2.6.6 and 6.2.11.2.3).

**6.14.1.1** A single-phase circuit that supplies luminaires only can supply any number of luminaires.

NOTE Without power-factor correction, a discharge lamp luminaire with magnetic ballast might have a current as much as 64 % higher than that of a power-factor corrected luminaire and would require bigger conductors and protection.

**6.14.1.2** Each identified group of single-phase luminaires supplied from a multiphase supply that also feeds other luminaires, shall be controlled by a local multiphase disconnecting device.

NOTE The disconnecting device should disconnect all live conductors that feed the group of luminaires, including the neutral, in order that maintenance work can be carried out without switching off all the lights.

**6.14.1.3** A circuit that has two phase conductors and that supplies only luminaires that are connected between the phase conductors, may supply any number of points if

a) the circuit is controlled by a multipole switch-disconnector, and

b) any additional switches in the circuit are multipole switches.

**6.14.1.4** In a lighting circuit, a luminaire that is in a false ceiling or in a roof space 4 m above the floor where there is no ceiling, or in a floor cavity, or in a wall cavity, or in a similar position, may be fed from a socket-outlet which may be unswitched and not protected by earth leakage protection, provided that the socket-outlet

a) complies with SANS 164-3,

b) supplies one luminaire only, not exceeding the rating of the socket-outlet,

c) is accessible for maintenance purposes, and

d) is within 3 m of the luminaire that it supplies.

**6.14.1.5** A lighting circuit that incorporates 6 A socket-outlets socket-outlets in accordance with 6.14.1.4 shall be protected by a circuit-breaker of not exceeding 20 A.

**6.14.1.6** In a lighting circuit, a luminaire may be fed from a socket-outlet on a wall (that may be unswitched), provided that the socket-outlet

a) complies with SANS 164-3,

b) is protected by earth leakage protection,

c) supplies one luminaire only, not exceeding the rating of the socket-outlet, and

d) is within 3 m of the luminaire that it supplies.

At least one 16 A socket-outlet that complies with SANS 164-1 or SANS 164-2 (see 6.15.2.1) shall be installed in the same room.

**6.14.1.7** If more than one phase in a lighting circuit is brought into one enclosure for switching purposes,

a) labels (see 4.2) stating that the voltage between phase conductors could exceed 250 V shall be fixed in a visible position inside the enclosure (not on the cover plate); or

b) the phase terminals in the enclosure shall be separated by suitable barriers.

NOTE To avoid nuisance tripping where earth leakage protection is used, it is advisable to restrict the number of discharge luminaires on a circuit.

**6.14.1.8** If more than one circuit is brought into an enclosure, a warning label shall be fixed inside the enclosure.

**6.14.2 Luminaires**

**6.14.2.1** Surface-mounted luminaires shall be selected and installed such that thermal damage to the mounting surface is avoided.

**6.14.2.2** Ancillary equipment for luminaires (such as capacitors, chokes, resistors and transformers) shall be enclosed in

a) a luminaire, or

b) an enclosure that

   1) is non-flammable,

   2) is located as near to the lamp(s) as is practicable,

   3) is permanently installed,

   4) cannot be opened without the use of a tool, and

   5) is readily accessible.

**6.14.3 Suspended luminaires**

**6.14.3.1** The luminaire and pendant shall not rotate more than one complete revolution to prevent damage to the conductors.

**6.14.3.2** A luminaire pendant which is longer than 600 mm and not suitably stayed, shall have a flexible joint.

NOTE A rigid pendant is deemed to be suitably stayed if the lower end of the pendant cannot move horizontally by more than 25 mm per 500 mm (or part of 500 mm) length of the pendant.

**6.14.3.3** A suspended luminaire shall be out of arm's reach from the floor if the luminaire is installed in a

a) washroom,

b) change room,

c) laundry,

d) cupboard or other enclosure, or

e) position exposed to wind and the weather.

**6.14.3.4** A suspended luminaire that is likely to be exposed to wind shall be specially designed for such conditions and so installed that it cannot be damaged or come into contact with flammable material.

**6.14.3.5** The terminals of the flexible cord of a luminaire shall not carry any of the mass of the luminaire but the cord itself may carry the mass up to 1 kg. For luminaires with a mass of more than 1 kg, the number of strain elements indicated in table 6.28 shall be incorporated in the suspension to prevent the luminaire from falling.

The breaking strength of the strain elements of a luminaire shall be calculated on at least five times the load.

**Table 6.29 — Maximum mass of luminaire and supports**

| 1 | 2 |
|---|---|
| **Mass of luminaire**<br>kg | **Support (number of strain elements)** |
| < 1 | Flexible cord of luminaire |
| 1 – 10 | At least one strain element |
| > 10 | At least two strain elements |

**6.14.3.6** The connections between circuit conductors and luminaire conductors shall

a) allow enough slack immediately behind the base of the luminaire for easy handling, and

b) in the case of a pre-wired luminaire, be made using a connector.

NOTE PVC insulated conductors should not be used where the temperature of the conductor could exceed 70°°C, unless the conductors are shielded from heat sources.

### 6.14.4 Lamp holders

**6.14.4.1** A lamp holder shall be shrouded in insulating material or shall be earthed, unless it is simultaneously

a) out of arm's reach from the floor or walkway level,

b) out of arm's reach from a structure that is bonded to earth,

c) protected from the weather and the splashing, dripping, or accumulation of water, and

d) not touching a conductive surface.

**6.14.4.2** The outer contact of an Edison-screw type lamp holder shall be connected to the neutral conductor.

## 6.15 Socket-outlets

NOTE Earth leakage protection on socket-outlets is compulsory except where specified otherwise (see 6.7.5).

### 6.15.1 Construction

#### 6.15.1.1 Dimensions

**6.15.1.1.1** Except where otherwise specified in this part of SANS 10142, single-phase socket-outlets for general use (see also 6.14.1.4) shall

a) be of the two-pole and earthing contact type,

b) comply with SANS 164-0,

c) effective from January 2018 all socket-outlet points for new electrical installations shall include at least one socket-outlet complying with the dimensions of SANS 164-2. Socket-outlets points may also include socket-outlets complying with the dimentions of SANS 164-1.

**6.15.1.1.2** Socket-outlets intended for the connection of industrial type equipment such as welding machines, shall conform to the dimensions given in SANS 60309-1 and SANS 60309-2. NOVA and DIN socket-outlets may only be fitted as replacement of, and in extension to, an installation where such socket-outlets exist.

**6.15.1.1.3** Socket-outlets that supply caravans or boats shall conform to the dimensions given in SANS 164-1 and SANS 164-2.

**6.15.1.1.4** A socket-outlet that complies with SANS 164-4 may be used for the connection of appliances for critical application (such as emergency lighting, a deepfreeze, a burglar alarm, data-processing equipment, or life-supporting equipment).

NOTE 1 Dedicated socket-outlets are the only socket-outlets that need not be protected by earth leakage.

NOTE 2 The number of alternative socket-outlets is limited in the light of standardization.

**6.15.1.1.5** A stove coupler shall comply with the requirements of SANS 60309-1 and shall be of dimensions as given in SANS 337.

NOTE 1 Earth leakage protection is not required for the stove circuit when a stove coupler is used.

NOTE 2 For a three-phase coupler, the earth connection needs special consideration.

**6.15.1.1.6** A two-pole socket-outlet without earthing contact that has dimensions complying with SANS 164-2 or SANS 164-6 shall only be installed in a fixed installation when it is integrated with a socket-outlet complying with SANS 164-1 or SANS 164-2 with earthing contact in a multiple socket-outlet.

**6.15.1.2 Voltage**

Socket-outlets that supply voltages other than the standard voltage as defined in SANS 1019 shall

a) have the voltage marked on them in a position that is visible after installation,

b) be of a plug and socket system such that the socket-outlet cannot accept a plug in accordance with any part of SANS 164, and the plug cannot be plugged into a socket-outlet in accordance with any part of SANS 164, and

c) in the case of SELV (below 50 V), comply with SANS 60906-3.

#### 6.15.2 Rating

**6.15.2.1** Socket-outlets shall be rated in accordance with the intended load. Unless otherwise allowed in this part of SANS 10142, socket-outlets rated at less than 16 A shall not be used in an electrical installation.

**6.15.2.2** The anticipated load of a circuit that feeds socket-outlets shall not exceed 5 kW.

### 6.15.3 Single-phase circuits that only supply socket-outlets rated at 16 A

Single-phase circuits that only supply socket-outlets rated at not more than 16 A

a) shall have overcurrent protection;

b) shall use conductors that are rated at not less than 16 A; and

c) shall, if the circuit protection is rated at more than 20 A, use only protected socket-outlets, with, as far as is practicable, discrimination between the protective devices for the circuit and the protective devices associated with the socket-outlets. The protective device of a protected socket-outlet shall

   1) have a fixed rated current that does not exceed the rating of the socket-outlet,

   2) be mounted next to the socket-outlet that it protects,

   3) provide protection against overload currents,

   4) provide protection against short-circuit currents, unless short-circuit protection is provided by a separate device, for example on the distribution board,

   5) if it needs the protection of a back-up short-circuit device, be marked with the required or maximum rating of the back-up device,

   6) if it protects more than one socket-outlet, be so installed that all the socket-outlets are connected in parallel, have the same rated current, and are mounted next to the device, and

   7) if it is a circuit-breaker, comply with the requirements of 6.8.2.

NOTE In the interests of safety, the use of the building, the convenience of the occupants and the possibility of heating and cooling equipment being connected to socket-outlets, should be considered when the number and position of points of consumption are being determined.

### 6.15.4 Mixed loading of circuits

**6.15.4.1** Except as allowed in 6.15.4.2, 6.15.4.3 and 6.16.3.2.3, there shall be no mixed loading of circuits.

**6.15.4.2** Except as required in 6.16, a non-dedicated single-phase circuit that has overcurrent protection rated at not more than 20 A may supply a mixed load of a combination of any socket-outlets rated at not more than 16 A, luminaires and fixed appliances.

NOTE 1 The number of points need not be limited but the diversity of loads should be considered.

NOTE 2 Mixed circuits should be carefully considered since this may result in nuisance tripping.

**6.15.4.3** Socket-outlets rated at 16 A or more that are connected to circuits with mixed loading shall comply with the earth leakage requirements of 6.7.5.

NOTE 1 See 7.1 for the conditions under which a socket-outlet may be installed in a bathroom.

NOTE 2 See 6.16.1.6 for the conditions under which a socket-outlet may be used for the connection of fixed appliances.

### 6.15.5 Circuits that supply single-phase socket-outlets rated at more than 16 A, or that supply three-phase socket-outlets, or both

In a circuit that supplies single-phase socket-outlets rated at more than 16 A, or that supplies three-phase socket-outlets, or both, and that supplies more than one socket-outlet,

a) single-phase and three-phase socket-outlets may be supplied from the same circuit; and

b) the rating of the circuit protection shall not exceed 125 % of the rating of the lowest rated socket-outlet, or each socket-outlet that has a rating of less than that of the circuit protection shall be individually protected against overcurrent.

#### 6.15.6 Positioning of socket-outlets

**6.15.6.1** A socket-outlet that is exposed to the weather (or to the condensation, dripping, splashing or accumulation of water) shall have a rating of at least IP44 in accordance with SANS 60529. The rating applies whether a plug is in or out.

NOTE The IP ratings are explained in annex G.

**6.15.6.2** A floor-mounted socket-outlet (recessed or not) shall be so mounted that

a) the floor can be cleaned or washed without the insulation resistance of the installation being affected, and

b) there is no risk of live parts touching any floor covering used.

**6.15.6.3** A socket-outlet shall not be installed within a radius of 2 m of a water tap (in the same room) unless the socket-outlet

a) has earth leakage protection, or

b) is connected to a safety supply.

#### 6.15.7 Socket-outlet in d.c. circuit

A socket-outlet in a d.c. circuit shall be controlled by a switch that is fixed next to it.

#### 6.15.8 Socket-outlet in ring circuits

Each socket-outlet connected in a ring circuit shall be marked as such.

### 6.16 Fixed appliances

#### 6.16.1 General

NOTE The general requirements in 6.16.1.1 to 6.16.1.12 apply, except where otherwise required for specific cases.

**6.16.1.1** Fixed appliances do not form part of the electrical installation other than their positioning in relation to the supply and the wiring carried out between different parts of the appliances.

**6.16.1.2** The power supply to every fixed appliance, except luminaires, shall be supplied through

a) a disconnecting device that disconnects both live conductors in a single-phase supply and all phase conductors in a multiphase supply, or

b) a socket-outlet that is directly accessible at all times that any person is exposed to such appliance while the supply is on. In the case of a remotely installed appliance, the position of the disconnecting device shall be indicated by means of a notice in close proximity to or on the appliance.

**6.16.1.3** Where a fan or heater is included in a luminaire, the luminaire is regarded as a fixed appliance. If the luminaire circuit is protected by an earth leakage protection device that has a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA, a disconnector is not required (see 6.9.3.1).

**6.16.1.4** The disconnecting device shall be positioned

a) within 1,5 m from the appliance, or

b) in a distribution board (if the switch-disconnector is capable of being locked in the open position).

Even where a disconnecting device is on the appliance, a separate disconnecting device shall be provided in the fixed installation to allow for the total removal of the appliance.

NOTE A standard switch is not a switch-disconnector.

**6.16.1.5** A socket-outlet shall supply only one fixed appliance. The use of flexible cords of length exceeding 3 m is not recommended. The reason for this recommendation is an endeavour to ensure operation of the overcurrent protective device. (But see also 6.14.1.4 for luminaires.)

NOTE 1 Subclause 6.7.5 requires a socket-outlet to be protected by earth leakage protection.

NOTE 2 If an appliance is installed in a bathroom, see table 7.1 regarding earth leakage protection.

**6.16.1.6** Where a socket-outlet in accordance with SANS 164-1, SANS 164-2, SANS 164-3, or SANS 60309-1 and SANS 60309-2 is part of the appliance (built-in), the circuit shall be protected by overcurrent and earth leakage protection (see 6.15.) Socket-outlets in accordance with SANS 164-4 shall have overcurrent protection.

**6.16.1.7** Surface-mounted appliances shall be selected and installed in such a way that thermal damage to the mounting surface is avoided.

**6.16.1.8** Control components of fixed appliances that form part of the installation, including their input terminations and associated protective switchgear not mounted in the distribution board, shall be incorporated in a suitable enclosure(s) that comply with the requirements of 6.6.1 and 6.6.4, unless they are part of the appliance or self contained in their own enclosure. Enclosure(s) shall be

a) non-flammable,

b) located as near to the appliance(s) as is practicable,

c) permanently installed,

d) such that they cannot be opened without the use of a tool, and

e) readily accessible.

**6.16.1.9** The connections between circuit conductors and appliance conductors shall

a) allow enough slack immediately behind the base of the appliance for easy handling, and

b) in the case of a pre-wired appliance, be made using a connector.

NOTE PVC insulated conductors should not be used where the temperature of the conductor could exceed 70 °C, unless the conductors are shielded from heat sources.

**6.16.1.10** The wiring between different parts of a fixed appliance that are installed separately is part of the fixed installation, even where it is supplied from a socket-outlet, unless such wiring is less than 3 m in length.

Such wiring shall be protected by separate overload protection unless its current-carrying capacity is such that the circuit protection of the socket-outlet circuit will provide protection or that part of the appliance has built-in thermal overload protection.

NOTE Where the length of wiring exceeds 3 m, the impedance and the functioning of the protective devices need to be considered to satisfy the overcurrent protection requirements in this part of SANS 10142.

**6.16.1.11** Flexible conduit may be used for the final connection to a fixed or stationary appliance but may not be used as the final connection to a portable appliance, unless it has been authorized for this use.

**6.16.1.12** The earth continuity conductor shall be connected to the earthing terminal of fixed electrical appliances that

a) are exposed to the weather or to the condensation, dripping, splashing or accumulation of water, or

b) use water, such as cooking appliances, laundering and dishwashing machines, water heaters, garbage disposal units and air-conditioning equipment.

### 6.16.2 Water heaters

NOTE Water heaters include geysers, instantaneous water heaters including units for boiling water, heat pumps, solar systems, induction water heaters and the like (see also 6.16.1). electrode water heaters, steam generators and boilers are not included (refer to 6.16.7)

**6.16.2.1** All water heaters shall be bonded in accordance with 6.13 and shall be protected by earth leakage protection with $I_{\Delta n}$ not exceeding 30 mA.

NOTE To mitigate nuisance earth leakage tripping, an additional earth leakage may be provided.

**6.16.2.2** Dedicated circuits shall be provided for water heaters and there may be more than one water heater on each circuit.

### 6.16.3 Cooking appliances

NOTE Cooking appliances include built-in stoves, oven hobs, and the like (see also 6.16.1).

#### 6.16.3.1 Switch-disconnector

**6.16.3.1.1** The circuit that supplies a cooking appliance through fixed wiring, a stove coupler (see 6.16.3.3), or an industrial type socket-outlet (see SANS 60309-1), shall have a readily accessible switch-disconnector. The switch-disconnector may supply more than one appliance.

**6.16.3.1.2** A switch-disconnector for a cooking appliance(s) shall

a) be in the same room as the appliance(s),

b) be at a height above floor level of not less than 0,5 m and not more than 2,2 m,

c) preferably not be above the cooking appliance(s),

d) be within 3 m of the appliance(s), but within 0,5 m of the appliance(s) if the switch-disconnector's purpose is not clearly indicated, and

e) not be fixed to the appliance.

**6.16.3.2 Cooking appliance circuits**

**6.16.3.2.1** A dedicated circuit(s) shall be provided for cooking appliance(s) that are rated at more than 16 A.

**6.16.3.2.2** One circuit shall not supply more than one permanently connected cooking appliance, unless the appliances are in the same room.

**6.16.3.2.3** A cooking appliance circuit may also supply one socket-outlet if the rating of the socket-outlet does not exceed 16 A and if the following are all contained in one control unit (see also 6.15.4.1):

a) the socket-outlet;

b) an earth leakage protection device including overcurrent protection for protecting the socket-outlet; and

c) the switch-disconnector required for the cooking appliance (see 6.16.1).

NOTE The socket-outlet has to be protected against earth leakage so, unless the protection device (see (b) above) is in the control unit, the entire cooking appliance circuit has to be protected against earth leakage.

**6.16.3.2.4** If a cooking appliance is connected by means of a stove coupler (6.16.3.3.1(a)) or an industrial type socket-outlet (6.16.3.3.1(b)), the open end of the connector tube or socket-outlet shall point downwards.

#### 6.16.3.3 Stove connection

A stove designed to be a free-standing appliance rated above 16 A shall be connected through

a) a stove coupler which shall comply with SANS 60309-1 and of dimensions as given in SANS 337 (a maximum of 45 A single-phase and 16 A per phase for three phase), or

   NOTE 1 Earth leakage protection is not required for the stove circuit when a stove coupler is used.

   NOTE 2 For a three-phase coupler, the earth connection needs special consideration.

b) a socket-outlet that complies with SANS 60309-1 (industrial type) with 30 mA earth leakage protection, however, the use of industrial type socket-outlets is not recommended for stove connections.

### 6.16.4 Heaters, appliances for space heating and for cooling

NOTE 1 Heaters include towel rail and mirror heaters, hair and hand dryers, and the like (see also 6.16.1).

NOTE 2 Appliances for space heating include fixed heaters (including air conditioners), underfloor, undertile, undercarpet, underplaster heating, and the like (see also 6.16.1).

NOTE 3 Appliances for cooling include extraction and ventilation fans, fans combined with luminaires, air conditioning, refrigeration and freezer units, and the like (see also 6.16.1).

#### 6.16.4.1 Heating and cooling

**6.16.4.1.1** Dedicated circuits shall be provided for fixed space heating and cooling (air-conditioning units) that are rated at more than 16 A. There may be more than one unit on each circuit and the power supply to each unit shall be controlled by a switch-disconnector.

**6.16.4.1.2** A heater with exposed live parts shall be mounted out of arm's reach from a person standing on the floor or on the bath’s edge (see figure 7.1.1). For disconnection, see 6.16.1.4.

#### 6.16.4.2 Underfloor heating

**6.16.4.2.1** The circuit that supplies underfloor heating shall be protected by an earth leakage protection device that has a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA.

**6.16.4.2.2** The cables used to terminate underfloor heating shall be

a) metal sheathed, or

b) double insulated, or

c) cables with reinforced insulation.

**6.16.4.2.3** Heating elements installed above the screed under a wooden floor or under a carpet shall be covered by a metallic sheath (screened), which shall be connected to earth.

### 6.16.5 Motors

NOTE Motors include the motors in automatic doors and gates, garbage disposal units, pumps (pool, fountain, spa, etc.), and the like (see also 6.16.1).

#### 6.16.5.1 Motor protection and control

**6.16.5.1.1** In addition to the requirements of 6.7, the circuit that supplies a motor shall have overcurrent protection unless the motor

a) forms part of equipment that has built-in overcurrent protection, or

b) has an integral thermal protector with an accessible reset button, or

c) has an automatic resetting thermal protector and there is no likelihood of mechanical damage or of injury to persons when the motor restarts, or

d) is of a high impedance type that can stall without overheating (such as the motor of an electric clock).

**6.16.5.1.2** The overcurrent protective device shall

a) have a tripping value that is as near to the full load rated current of the motor as is practicable,

b) have sufficient time delay to allow the motor to start and accelerate under normal conditions,

c) prevent a multiphase motor from continuing to operate under load if single phasing occurs, and

d) in the case of an automatically controlled motor, have to be manually reset after operation before allowing automatic restarting of the motor.

**6.16.5.1.3** Any manually operated device used to control a motor shall be readily accessible to the person who operates it.

**6.16.5.1.4** Each motor shall be supplied by a manually operated disconnector or any other manually operated disconnecting arrangement such as a withdrawable circuit-breaker, a removable link, a fuse or by the removal of a plug from a socket-outlet, which provides at least the same isolating distance, for the sake of safety, as a disconnector that is

a) readily accessible and mounted on or next to the motor, or

b) visible from the motor, or

c) lockable in the open position, or

d) housed in a lockable enclosure other than a distribution board.

**6.16.5.2 Submersible motors and motors liable to flooding**

NOTE See 7.2.4.4 for pump motors used in pools, spas and fountains.

**6.16.5.2.1** A submersible motor shall

a) be supplied by suitable marine type flexible cable firmly attached to the motor,

b) use a cable gland that has an efficient water seal, and

c) be bonded to the earthing system of the installation.

NOTE A portable water pump can have a submersible motor.

**6.16.5.2.2** Conductive parts associated with a water pump (such as the suction pipe, the delivery pipe and the pump casing) shall be bonded to the earth continuity conductor. In the case of a submersible borehole motor, the bonding to the delivery pipe shall be made above ground and within 300 mm of the collar that supports the pipe.

#### 6.16.5.3 Motor starters

Except in the case of direct-on-line starting, a starter shall have an undervoltage release that opens the circuit if the supply voltage drops sufficiently to cause the motor to stop. When the supply voltage is restored to a value that would cause the motor to restart, and unexpected restarting could cause injury to the operator of the motor, the starter shall have a means of preventing the motor from restarting, whatever the type of starter.

#### 6.16.5.4 Water pump motors

All accessible extraneous conductive parts associated with a water pump motor shall be bonded to the earth continuity conductor. These parts include the suction pipe, the delivery pipe and the pump casing.

### 6.16.6 Electric fences

NOTE An electric fence is deemed to be a machine or an appliance and not part of the electrical installation. See separation of the high-voltage earth electrode of the fence energizer from the earthing system of the electrical installation. (See SANS 10222-3.)

### 6.16.7 Electrode water heaters, steam generators and boilers

NOTE See 6.16.1.

**6.16.7.1** An electrode water heater, steam generator or boiler shall be connected to the a.c. supply system only. The supply shall be controlled by a multipole circuit-breaker that disconnects all phase conductors and there shall be a switch-disconnector fitted close to, and visible from, the water heater, unless

a) the circuit-breaker is close to, and visible from, the water heater, or

b) a control switch for isolating the supply is positioned close to the water heater and indicating lights are visible from the control switch, one indicating light showing the closed position of the circuit-breaker and one indicating light showing the open position of the circuit-breaker.

**6.16.7.2** Each exposed conductive part shall be bonded to the cold-water inlet, and earthed.

**6.16.7.3** Earth leakage protection shall be provided for the circuit that supplies an electrode water heater, steam generator or boiler. This protection shall be set to operate in the event of a leakage current exceeding 10 % of the current consumed by the appliance under normal conditions of operation. The characteristics of the circuit and of the earth return path shall be such that the earth leakage device will operate before the potential between earth and the shell of the steam generator or boiler exceeds 50 V, including under short-circuit fault conditions.

#### 6.16.8 Electric vehicle charging stations

NOTE An electric vehicle charging station is deemed to be a machine or an appliance and not part of the electrical installation. (See SANS 62196 and SANS 61851 series.)

## 7 Special installations or locations

NOTE The general requirements of this part of SANS 10142 are applicable to all subclauses of this clause except where this clause modifies or replaces certain of the general requirements.

### 7.1 Bathrooms, showers and spas

NOTE The particular requirements of this subclause apply to bathtubs, shower basins and the surrounding zones where the risk of shock is increased by a reduction in body resistance and contact of the body with earth potential.

#### 7.1.1 General

**7.1.1.1** The requirements in this subclause do not apply to an enclosed prefabricated shower cabinet with its own shower basin and drainage system, except in the case of 7.1.4.3.4.

**7.1.1.2** The requirements relating to bathrooms shall apply to a spa installed indoors. If a spa is installed outdoors, the requirements relating to swimming pools shall apply (see 7.2).

**7.1.1.3** Electrical equipment, including appliances (although appliances are not covered by this part of SANS 10142), shall not be installed in a bathroom except under the conditions given in table 7.1. No electrical equipment shall be installed in zone 0 except in accordance with 7.1.3.2. (see also 7.1.4.4).

NOTE 1 A volume under a bath or indoor spa, which cannot be reached without the use of a tool to remove a cover, is not considered part of a bathroom.

NOTE 2 For locations that contain baths for medical treatment, special requirements might be necessary (see 7.7).

### 7.1.2 Zones

NOTE 1 For the purposes of this part of SANS 10142, bathrooms are divided into zones 0, 1, 2 and 3. The dimensions of the boundaries of these zones are measured taking account of the edge of the container, the walls and fixed partitions (see figures 7.1.1 to 7.1.5).

NOTE 2 Zones 0, 1 and 2 mentioned in 7.1.2.1, 7.1.2.2 and 7.1.2.3 bear no relationship to zones 0, 1, 2, 20, 21 and 22 mentioned in SANS 10108 for the classification of hazardous locations.

#### 7.1.2.1 Zone 0

Zone 0 is the interior of the bathtub or shower basin (the container).

#### 7.1.2.2 Zone 1

Zone 1 is limited by

a) the vertical plane circumscribing the outer edge or 0,20 m from the inner edge (where the ledge is too wide) of the bathtub, shower basin, or for a shower without a basin, by the vertical plane 0,60 m from the shower rose, and

b) the horizontal plane 2,5 m above the bathtub or shower floor.

#### 7.1.2.3 Zone 2

Zone 2 is limited by

a) the volume external to zone 1 and the parallel vertical plane 0,60 m external to zone 1, and

b) the floor and the horizontal plane 2,25 m above the floor.

#### 7.1.2.4 Zone 3

Zone 3 is limited by

a) the vertical plane external to zone 2 and the parallel vertical plane 2,40 m external to zone 2, and

b) the floor and the horizontal plane 2,25 m above the floor.

### 7.1.3 Protection for safety

NOTE For the protection of socket-outlets, see 7.1.4.3.1.

#### 7.1.3.1 Protection by safety extra low voltage (SELV)

Where safety extra low voltage is used, whatever the nominal voltage, protection against direct contact shall be provided by

a) barriers or enclosures that afford at least the degree of protection IP2X, or

b) insulation capable of withstanding a test voltage of 500 V for 1 min.

#### 7.1.3.2 Protection against electric shock

**7.1.3.2.1** In zone 0, only protection by safety extra low voltage at nominal voltage not exceeding 12 V is permitted, the safety source being installed outside zone 0.

**7.1.3.2.2** The measures of protection by means of obstacles and by placing equipment out of arm's reach are not permitted.

**7.1.3.2.3** The measures of protection by non-conducting location and earth-free equipotential bonding are not permitted.

#### 7.1.3.3 Supplementary equipotential bonding

All accessible conductive parts in zones 1, 2 and 3 that may become alive accidentally, though not normally forming part of the electrical circuit, shall be bonded with a local supplementary equipotential bonding conductor, except where the conductive parts are protected by insulating covering or is otherwise enclosed. The resistance of the earth continuity circuit to earth shall not exceed 0,2 Ω.

### 7.1.4 Selection and erection of electrical equipment

#### 7.1.4.1 Degrees of protection

Electrical equipment shall have at least the following degrees of protection against ingress of water:

a) in zone 0: IPX7;

b) in zone 1: IPX5;

c) in zone 2: IPX4;

d) in zone 3: IP21; and

e) outside zone 3 in the same room: IP21, except for a distribution board: IPX5 (see 7.1.4.3.6).

**7.1.4.2 Wiring systems**

**7.1.4.2.1** In zones 0, 1 and 2, wiring systems shall be limited to those necessary for the supply of appliances situated in these zones.

**7.1.4.2.2** Junction boxes are not permitted in zones 0, 1 and 2.

**7.1.4.3 Switchgear and controlgear**

**7.1.4.3.1** In zones 0, 1 and 2, no switchgear and accessories shall be installed except that emergency push buttons, which operate at a safety extra low voltage at nominal voltage not exceeding 12 V, are permitted in zones 1 and 2.

**7.1.4.3.2** Insulating cords of cord-operated switches are permitted in zones 1 and 2, provided that the cord-operated switch complies with the requirements for switches (see table 4.1).

**7.1.4.3.3** In zone 3, socket-outlets are permitted only if they are

a) supplied individually by an isolating transformer that complies with SANS 61558-2-6, or

b) supplied by safety extra low voltage (SELV) (see 5.8), or

c) protected by an earth leakage protection device with a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA.

**7.1.4.3.4** Any switches and socket-outlets shall be at a distance of at least 0,60 m from the door opening of the prefabricated shower cabinet (see figures 7.1.4 and 7.1.5).

**7.1.4.3.5** Where heating elements are installed in the water circulating system of a bath or a spa, the supply to the elements shall be interlocked with the circulating pump.

**7.1.4.3.6** If a distribution board is installed in a room that contains a fixed bath or a shower, it shall be outside zone 3 and the enclosure shall have a degree of protection of IPX5 (see 6.6.1.7(a)).

#### 7.1.4.4 Other fixed equipment and heated towel rails

NOTE Other fixed equipment includes heated tower rails and heating units embedded on the floor.

**7.1.4.4.1** except in the case of safety extra low voltage, subject to the conditions of 5.8, 7.1.3.2 and 7.9, the following requirements apply:

a) in zone 0, no fixed electrical equipment shall be installed;

b) in zone 1 and 2, only equipment as indicated in table 7.1 may be installed.

**7.1.4.4.2** Heating units embedded in the floor and intended for heating the location may be installed in zones 1, 2 or 3 provided

a) the heating elements are covered by a metallic sheath (screened), or

b) a metallic grid is installed above the heating elements, and

c) the sheath or grid is connected to the equipotential bonding specified in 7.1.3.3. Terminations shall comply with 6.16.4.2.

**Table 7.1 — Conditions under which electrical equipment may be installed in a bathroom**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Electrical equipment** | **Conditions that apply in** | | |
| | **Zone 1** | **Zone 2** | **Zone 3** |
| Distribution and control | X | X | Normal provisions of this part of SANS 10142 |
| Bell push | B1 and C1 | B1 and C1 | Normal provisions of this part of SANS 10142 |
| Socket-outlet | X | C2 | Normal provisions of this part of SANS 10142 |
| Wall switch | X | X | Normal provisions of this part of SANS 10142 |
| Pull switch | Normal provisions of this part of SANS 10142 | | |
| Distribution boards | X | X | X |
| Fixed appliances (including luminaires) | (A and B1) or (B2) | (A and B1) or (B2) | Normal provisions of this part of SANS 10142 |

The symbols used in this table are the following:

**A** denotes that earth leakage protection shall be provided;
**B1** denotes that the equipment shall be so enclosed in insulating material that it is not possible to touch current-carrying parts with the standard test finger;
**B2** denotes that class II appliances shall be used;
**C1** denotes that the equipment shall be supplied from a safety supply with a secondary voltage not exceeding 25 V;
**C2** denotes that the equipment shall be supplied from a safety supply that has a maximum rating of 50 VA. Shaver supply units shall comply with SANS 61558-2-5.
**X** denotes that the equipment shall not be installed.

### 7.1.5 Earthing

**7.1.5.1** Except in the case of isolated supplies, an earth continuity conductor shall be connected to the earthing terminal of class 1 fixed appliances in a bathroom.

**7.1.5.2** If the following are electrically isolated from earth, they need not be earthed:

a) metallic baths and basins;

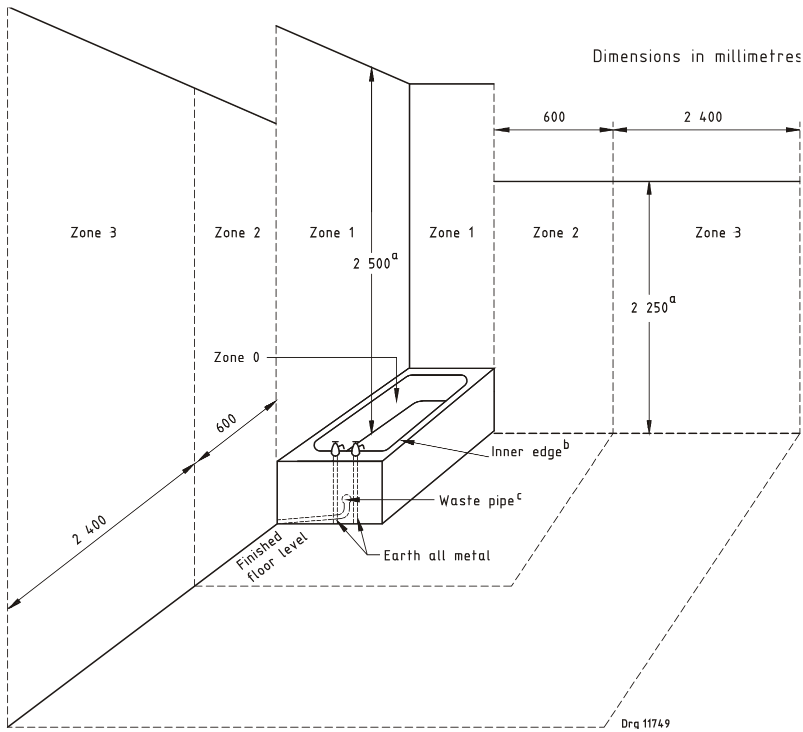
b) metallic waste fittings in baths or shower trays; and

c) other isolated metallic parts.

NOTE A bath or basin is said to be isolated from earth if the waste pipes are non-metallic and the taps are

a) wall mounted, or

b) bath or basin mounted and supplied by non-metallic piping.




NOTE A volume under a bath or spa that cannot be reached without the use of a tool to remove a cover is not considered part of a bathroom.

[a] Minimum height

[b] The inner edge of a bath, shower or spa is the upper inside edge of the container (zone 0) and does not include the ledge of the bath, shower or spa.

[c] Under certain conditions, waste pipes have to be earthed.

**Figure 7.1.1 — Illustration of zones in a bathroom**

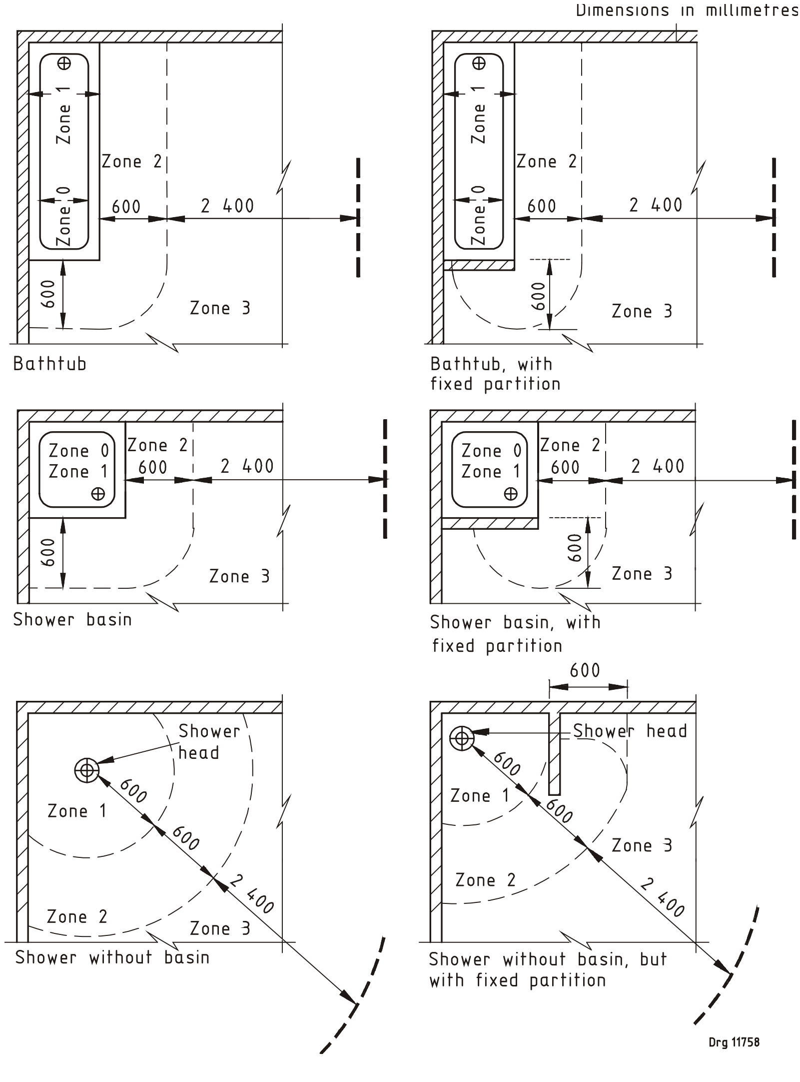



**Figure 7.1.2 — Plan of zone dimensions for bathrooms**

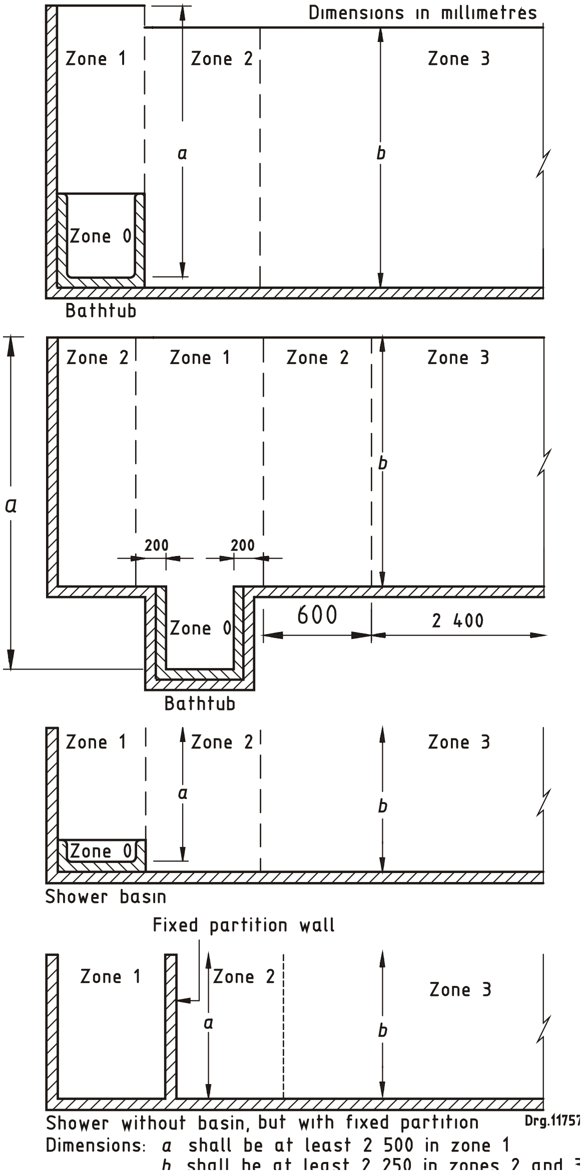



**Figure 7.1.3 — Elevation of zone dimensions for bathrooms**

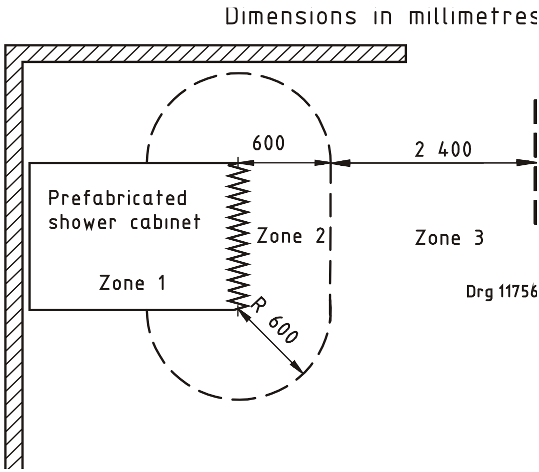



**Figure 7.1.4 — Plan of zone dimensions for a prefabricated shower cabinet**

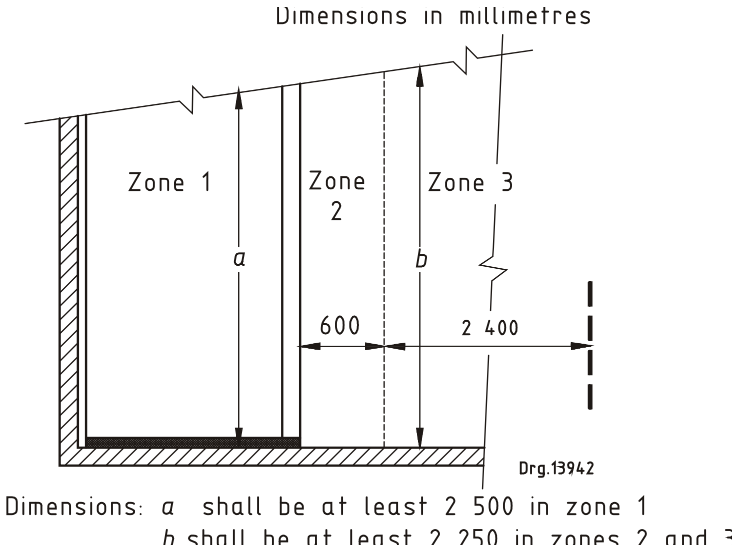



**Figure 7.1.5 — Elevation of zone dimensions for a prefabricated shower cabinet**

## 7.2 Swimming pools, paddling pools, ornamental pools, spas and fountains

### 7.2.1 General

**7.2.1.1** The particular requirements of this subclause apply to the basins of swimming pools, paddling pools, ornamental pools, outdoor spas and fountains. The requirements also apply to the surrounding zones of all these basins. In these areas, in normal use, the effect of electric shock is increased by a reduction in body resistance and contact of the body with earth potential.

**7.2.1.2** If a spa is installed as a fixed installation, all associated equipment (electrical and mechanical) shall be protected by a barrier.

NOTE 1 This subclause applies where people can touch electrical equipment in a swimming pool, paddling pool, ornamental pool, outdoor spa and a fountain. If a spa is installed indoors, the provisions relating to bathrooms shall apply.

NOTE 2 Special measures (such as equipotential bonding in the water of an ornamental pool) might be needed where motors are used.

NOTE 3 In the case of swimming pools for medical use, special requirements might be necessary (see 7.7).

### 7.2.2 Zones

#### 7.2.2.1 General

For the purposes of this part of SANS 10142, areas in and around swimming pools, paddling pools, ornamental pools, spas and fountains are divided into zones 0, 1, and 2. The boundaries of these zones are indicated in figures 7.2.1, 7.2.2 and 7.2.3 and requirements are based on the dimensions of the zones.

#### 7.2.2.2 Zone 0

Zone 0 is the interior of the basin including any recess(es) in the walls or floor, and of the basin for foot cleaning.

#### 7.2.2.3 Zone 1

**7.2.2.3.1** Zone 1 is limited by

a) zone 0,

b) a vertical plane 2 m from the rim of the basin,

c) the floor or the surface expected to be occupied by persons, and

d) the horizontal plane 2,5 m above the floor or the surface.

**7.2.2.3.2** When a swimming pool has a diving board, a springboard, starting blocks, a chute(s) or other components expected to be occupied by persons, zone 1 also comprises the zone being limited by

a) a vertical plane situated 1,5 m around the diving board, springboard, starting blocks, chute(s) and other components such as accessible sculptures and decorative basins, and

b) the horizontal plane 2,5 m above the highest surface intended to be occupied by persons.

**7.2.2.4 Zone 2**

**7.2.2.4.1** Zone 2 is limited by

a) the vertical plane external to zone 1 and a parallel plane 1,5 m from zone 1,

b) the floor or the surface intended to be occupied by persons, and

c) the horizontal plane 2,5 m above the floor or the surface.

**7.2.2.4.2** There is no zone 2 in the case of fountains.

**7.2.2.4.3** The dimensions are measured taking account of the edge of the container, the walls and fixed partitions (see figures 7.2.1, 7.2.2 and 7.2.3).

**7.2.3 Protection for safety** (excluding accessories)

NOTE The following requirements do not apply in the case of circuits not exceeding 12 V in zone 1.

**7.2.3.1 Protection by safety extra low voltage (SELV)**

Where SELV is used, whatever the nominal voltage, protection against direct contact shall be provided by

a) barriers or enclosures that provide a degree of protection of at least IP2X in accordance with SANS 60529; or

b) insulation that can withstand, without breakdown, a voltage of 500 V a.c. for 1 min.

NOTE The IP ratings are explained in annex G.

#### 7.2.3.2 Protection against electric shock

The only measure permitted for providing protection against electric shock in zone 0 is the use of a safety supply that operates at a nominal voltage not exceeding 12 V and that has its source outside the zone. The measures of protection by means of obstacles, placing equipment out of arm's reach, non-conducting locations or earth-free equipotential bonding to provide protection are not permitted.

#### 7.2.3.3 Supplementary equipotential bonding

All accessible conductive parts in zones 0, 1 and 2 that may become alive accidentally, though not normally forming part of the electrical circuit, shall be bonded with a local supplementary equipotential bonding conductor, except where the conductive parts are protected by insulating covering or is otherwise enclosed. The resistance of the earth continuity circuit to earth shall not exceed 0,2 Ω.

### 7.2.4 Selection and erection of electrical equipment

#### 7.2.4.1 Degrees of protection against ingress of water in installed electrical equipment

Electrical equipment shall have at least the following degrees of protection against ingress of water in accordance with SANS 60529:

a) in zone 0: IPX8;

b) in zone 1: IPX5;
IPX4 for swimming pools inside buildings which normally are not cleaned by means of jets;

c) in zone 2: IP22 for indoor locations;
IPX4 for outdoor locations;
IPX5 where water jets are likely to occur for cleaning purposes.

NOTE The IP ratings are explained in annex G.

**7.2.4.2 Wiring systems**

**7.2.4.2.1** Cables shall

a) comply with SANS 1507, and

b) not have exposed metal armouring.

**7.2.4.2.2** Wiring may consist of single-core cables in insulated conduits or of multicore cables with an insulating sheath.

**7.2.4.2.3** In zones 0, 1 and 2, wiring systems shall be limited to the wiring systems necessary for the supply of appliances situated in such zones. The shortest possible route shall be used.

**7.2.4.2.4** In a circuit in zone 0 or zone 1, there shall be

a) one appliance only,

b) no junction boxes for voltages exceeding 12 V, and

c) only conduits of insulating material.

**7.2.4.3 Switchgear and accessories**

**7.2.4.3.1** There shall be no switchgear or accessories in zones 0 and 1.

**7.2.4.3.2** In zone 2, any socket-outlet or switch shall be

a) supplied individually by a class II isolating transformer that is installed outside the zone and that operates at a nominal voltage not exceeding 50 V, or

b) protected by an earth leakage protection device that has a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA.

**7.2.4.4 Water pumps**

**7.2.4.4.1 Accessible extraneous conductive parts**

All accessible extraneous conductive parts associated with a water pump motor shall be bonded to the earth continuity conductor. These parts include the suction pipe, delivery pipe and pump casing.

**7.2.4.4.2 Submersible pumps**

**7.2.4.4.2.1** Unless otherwise authorized, a submersible pump shall be fed from

a) a circuit protected by an earth leakage protection device with a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA, or

b) a class II isolating transformer. The transformer shall have a maximum open-circuit voltage of

   1) 250 V single-phase or 440 V three-phase, if the pump is used in an ornamental pool or fountain, or

   2) 12 V, if used in other applications.

**7.2.4.4.2.2** If the supply cable has an earth continuity conductor, the conductor shall be connected to the installation earthing system. Any mechanical protection provided for the cable shall extend below the minimum water level. The cable shall be firmly fixed to the pump and there shall be an effective water seal.

**7.2.4.4.3 Non-submersible pumps**

**7.2.4.4.3.1** A motor for a non-submersible pump shall be fed from a safety supply or protected by an earth leakage protection device.

**7.2.4.4.3.2** There shall be bonding between

a) the pump casing,

b) the motor frame,

c) metal suction and delivery pipes at the pump, and

d) the earth continuity conductor.

**7.2.4.4.3.3** This bonding shall be visible.

**7.2.4.4.3.4** The pump and its associated equipment shall be kept dry and ventilated.

#### 7.2.4.4.4 Portable water pumps

The supply to a portable water pump that operates at a voltage of more than 50 V shall

a) be a safety supply, or

b) have earth leakage protection, or

c) have a safety arrangement that has been approved.

### 7.2.4.5 Luminaires

**7.2.4.5.1** A luminaire that is underwater, or within 2,5 m of the water surface, or so situated that a person has to go into the water to service it, shall be fed from a transformer that is out of arm's reach from zone 1 and

a) is a class II isolating transformer with a maximum output voltage of

   1) 250 V, if the luminaire is used in an ornamental pool or fountain, or

   2) 12 V, if the luminaire is used anywhere else, or

b) is an isolating transformer (see 3.83.3) (double-wound transformer)

   1) with a maximum output voltage of 12 V, and

   2) is protected by an earth leakage protection device that has a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA.

In the case of an ELV luminaire, the installation shall comply with 7.9.

**7.2.4.5.2** In the case of a luminaire mounted below or next to the water level of a pool,

a) the cable shall be in a non-metallic duct or conduit; and

b) armoured cable shall not be used.

**7.2.4.5.3** Underwater luminaires shall comply with SANS 60598-218.

### 7.2.4.6 Appliances

#### 7.2.4.6.1 Zone 0

Each appliance shall be supplied by a safety supply that operates at a nominal voltage not exceeding 12 V.

**7.2.4.6.2 Zone 1**

Each appliance shall

a) be supplied by a safety supply, or

b) if fixed, be of class II construction, or

c) shall be supplied by a circuit that is protected by an earth leakage protection device that is out of arm's reach from zone 1.

**7.2.4.6.3 Zone 2**

Unless supplied by a safety supply, each appliance shall be

a) of class II construction, or

b) of class I construction and protected by an earth leakage protection device that has a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA, or

c) supplied by an isolating transformer.

**7.2.4.7 Heating units**

**7.2.4.7.1** Unless the heating unit operates from a safety supply, any heating unit embedded in the floor of zone 1 or zone 2 shall be covered with

a) an earthed metallic grid, or

b) an earthed metallic sheath,

connected to supplementary equipotential bonding (see 7.2.3.3).

**7.2.4.7.2** A fixed water heater for a swimming pool or spa shall be installed

a) in the same way as a non-submersible pump,

b) in the water circulating system and not in the swimming pool itself, and

c) with the supply to the elements and the circulating pump interlocked.

### 7.2.4.8 Other equipment

An item of equipment other than a pump and a luminaire shall not be used unless it and its method of installation have been authorized.

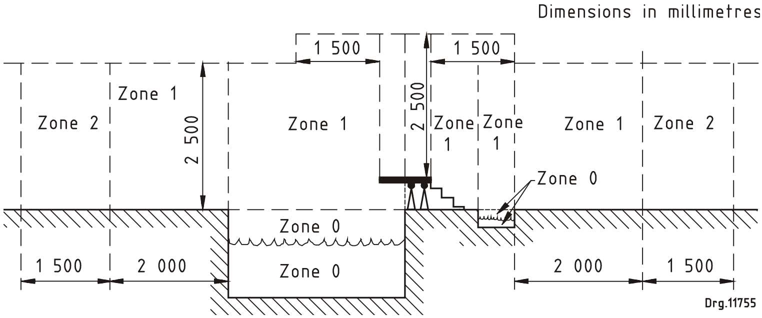



**Figure 7.2.1 — Elevation of zone dimensions for swimming pools and paddling pools**

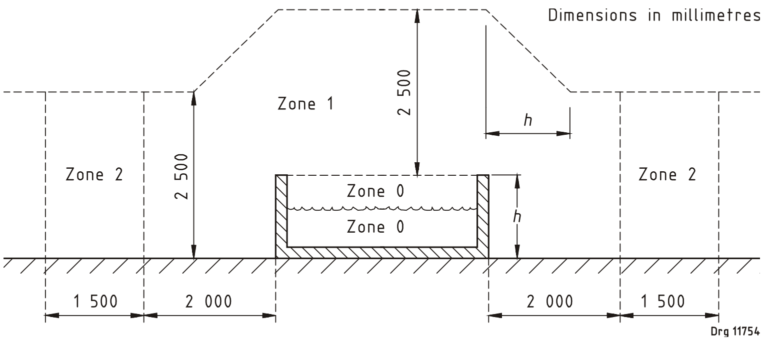



**Figure 7.2.2 — Elevation of zone dimensions for above ground pools**

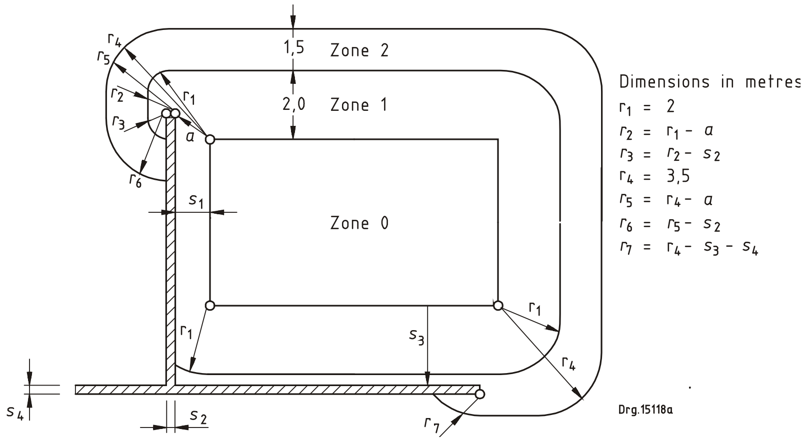



**Figure 7.2.3 — Plan of zone dimensions for swimming pools and paddling pools with fixed partitions**

## 7.3 Saunas

NOTE The particular requirements of this subclause apply to locations in which sauna heating equipment is installed and is exclusively reserved for such use.

### 7.3.1 Zones

For the purposes of this part of SANS 10142, saunas are divided into zones 1, 2, 3 and 4. The boundaries of these zones are indicated in figure 7.3.1.

### 7.3.2 Protection for safety

**7.3.2.1** Protection against direct contact shall be provided by

a) barriers or enclosures that provide a degree of protection of at least IP2X in accordance with SANS 60529, or

b) insulation that can withstand, without breakdown, a voltage of 500 V for 1 min.

**7.3.2.2** The measures of protection by means of obstacles, placing equipment out of arm's reach, non-conducting locations and earth-free equipotential bonding to provide protection are not permitted.

### 7.3.3 Selection and erection of electrical equipment

#### 7.3.3.1 Degree of protection

The equipment shall have a degree of protection of at least IP24.

NOTE The IP ratings are explained in annex G.

#### 7.3.3.2 Wiring systems

Cables shall comply with SANS 1507 and, if surface mounted, shall not

a) have exposed metal armouring or braiding, and

b) be installed in a non-metallic wireway.

#### 7.3.3.3 Switchgear

Switchgear not built into the sauna heater shall be placed outside the enclosure of the location.

Socket-outlets shall not be installed in the sauna.

A temperature-limiting device shall be installed, capable of disconnecting the supply to the sauna heater when the temperature measured in zone 4 exceeds 140 °C.

A luminaire shall only be installed in zone 3 and the light switch shall be outside the enclosure.

#### 7.3.3.4 Other fixed equipment

Conditions for the installation of equipment in a sauna shall be as follows:

a) in zone 1: only equipment that belongs to the sauna heater shall be installed;

b) in zone 2: there is no special requirement concerning the heat resistance of equipment;

c) in zone 3: the equipment shall withstand a minimum temperature of 125 °C and the insulation of wires shall withstand a minimum temperature of 170 °C;

d) in zone 4: only control devices of sauna heaters (thermostats and thermal cut-outs) and wiring belonging to those devices shall be installed. Heat resistance shall be as required for zone 3.

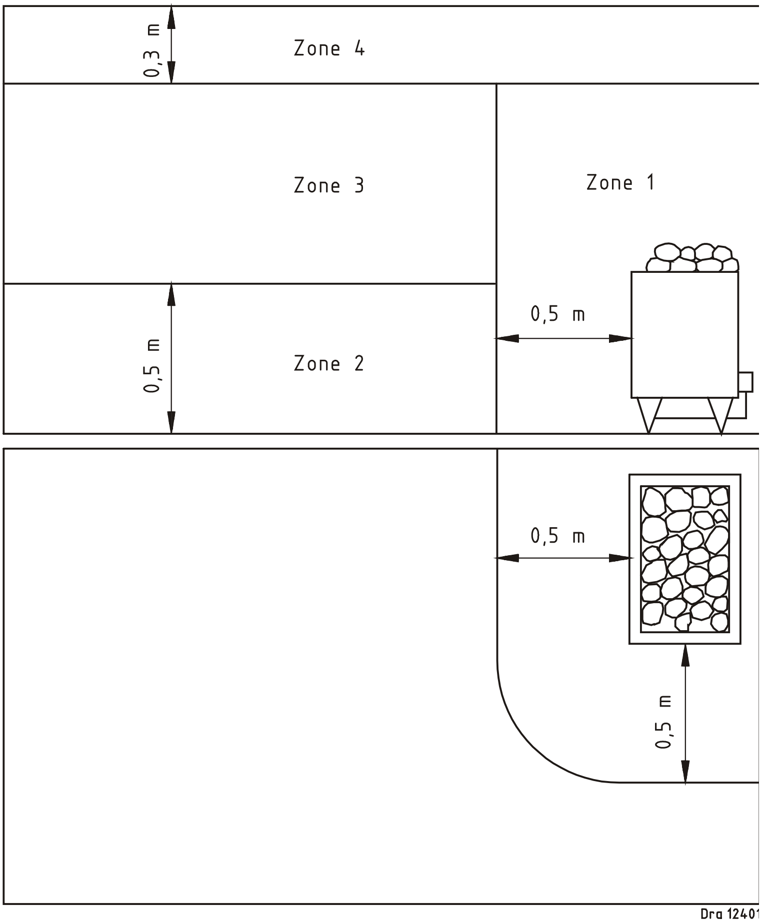



**Figure 7.3.1 — Zones in saunas**

## 7.4 Construction and demolition site installations

### 7.4.1 General

The special requirements of this subclause apply to temporary installations provided for building construction sites, work of repair, alterations, extension or demolition of existing buildings, earthwork, public engineering and similar work.

Parts of buildings which undergo structural alterations such as extension, major repair, or demolition, are considered to be construction sites during the relevant period of work, to the extent that the work necessitates the provision of a temporary installation.

Where alterations to existing buildings are undertaken, that part of the installation shall comply with the additional requirements of this sub-clause. This might necessitate the temporary installation of an additional distribution board.

### 7.4.2 Supply

Equipment shall be identified with the particular supply from which it is energized, and shall contain only components connected to one and the same installation, except for control or signalling circuits and input from standby supplies.

### 7.4.3 Protection

Socket-outlets shall be protected by earth leakage protection devices that have a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA.

Except for emergency lighting all final circuits for lighting shall be additionally protected by an earth leakage protection device with a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA.

### 7.4.4 Installation

**7.4.4.1** Assemblies, fixed equipment and other equipment installed shall have a degree of protection of at least IP32.

NOTE Environmental conditions such as excessive dust, wet conditions, heat, etc. should be considered.

**7.4.4.2** Wiring shall be so arranged that no strain be placed on the terminations of conductors unless they are specially designed for this purpose.

**7.4.4.3** To avoid damage, cables should not be run across site roads or walkways. Where this is necessary, special protection against mechanical damage and contact with construction plant shall be provided.

**7.4.4.4** Armoured cables or cables protected against mechanical damage shall be used wherever there is a risk of mechanical damage.

Unarmoured single-core cables are permitted where they cannot be subjected to mechanical damage and are out of arm's reach.

Uninsulated live conductors are not permitted.

**7.4.4.5** Mixed loading of circuits is not permitted.

**7.4.4.6** All electric motors shall be provided with an effective means of isolation of all poles and such means shall be adjacent to the motor.

### 7.4.5 Luminaires

Luminaires mounted below 2,5 m from floor level or otherwise accessible to accidental contact shall be firmly and adequately fixed, and so sited or guarded as to prevent risk of injury to persons or ignition of materials.

### 7.4.6 Distribution boards

**7.4.6.1** All distribution boards shall comply with SANS 60439-4.

**7.4.6.2** Automatic supply disconnection of cables, which are intended to supply sub-distribution boards or loads, shall be provided at the origin by additional earth leakage protection devices with a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 500 mA. These devices can provide a delay by using a device for discrimination with earth leakage devices that protect final circuits.

NOTE The recommendation for additional protection relates to the increased risk of damage to cables in temporary locations.

**7.4.6.3** The number of sub-distribution boards and circuits required shall be determined by the size of the site and the demand for power.

**7.4.6.4** A circuit-breaker rated in accordance with the anticipated diverse load, and with a symmetrical short-circuit breaking capacity commensurate with the prospective symmetrical fault current shall be installed at the source end. Rating and timing shall be set to provide protection but avoiding spurious trips caused, for example, by sub-transient inrush currents on motor starting.

**7.4.6.5** The metalwork shall be protected against corrosion and the damage expected under site conditions. The final finish shall be orange.

**7.4.6.6** Isolating devices shall be suitable for securing in the off position (for example, a padlock or location inside a lockable enclosure).

**7.4.6.7** The distribution board shall contain

a) one or more multi-element robust LED indicator lamps per phase to show that the board is alive. HRC fuses or correctly rated circuit-breakers within the board shall protect these lamps,

b) where required, four-pin (three-phase and earth) welding socket-outlets, typically 63 A rating, each of which shall be protected by a circuit-breaker and 30 mA earth leakage protection,

c) where required, three-pin (phase neutral and earth) welding socket-outlets rated at 32 A with associated circuit-breakers and 30 mA earth leakage protection. This shall particularly be provided for portable single-phase welding sets, and

d) switched socket-outlets (16 A), connected in pairs to individual single-pole 20 A combined circuit-breakers and 30 mA earth leakage protection of sufficient number.

**7.4.6.8** The circuit-breakers and associated earth leakage relays referred to in 7.4.6.7(b), (c) and (d) shall be provided as combined units to reduce the possibility of the sensors being bypassed.

**7.4.6.9** A sufficient number of the different types of socket-outlets to suit the circumstances shall be installed.

**7.4.6.10** When live single-core conductors go through

a) electrically conductive material, measures shall be taken to minimize eddy current heating, or

b) magnetic material, measures shall be taken to avoid hysteresis losses.

**7.4.6.11** The cabinet size shall allow the door to be comfortably closed with the largest plugs inserted in the socket-outlets. The bending radius of the trailing cable shall be safe and grommetted slots shall be provided on the return lip of the door.

## 7.5 Agricultural and horticultural locations

NOTE 1 Agricultural locations are rooms or areas where livestock are kept and include kennels, SPCA premises, stables for cattle, pigs, horses, sheep, game and goats, and chicken-houses and the like including adjacent rooms (e.g. feed-processing locations, milking machine locations, milk-storage rooms).

NOTE 2 Horticultural locations are greenhouses, nurseries and the like.

### 7.5.1 General

**7.5.1.1** The design of an installation for agricultural and horticultural locations should make particular allowances for the environmental conditions and the need for earthing and bonding.

**7.5.1.2** In agricultural and horticultural locations, socket-outlets shall be mounted at least 1 m above the floor level.

**7.5.1.3** Except for wireways, all electrical equipment shall be inaccessible to, or protected from, livestock. Cables shall be mechanically protected (kick pipes) for at least 1,5 m above the floor level.

**7.5.1.4** Where animals are fed and where vermin is likely to be, wireways shall be vermin-proof and barriers shall be installed to prevent vermin passage should they enter the wireway. PVC wireways and PVC insulated conductors shall not be accessible.

**7.5.1.5** Suspended electrical equipment (for example, luminaires, heaters, etc.), including the cables themselves, shall be so supported that conductors or cables are not strained. In the case where such suspended equipment is less than 1,5 m above the floor, it shall have a rating of IP35.

**7.5.1.6** Cattle feed dust is explosive and areas where such dust is generated are classified as hazardous areas. The electrical installation in these areas shall comply with 7.14.

### 7.5.2 Supplementary equipotential bonding

In locations used for animals, supplementary equipotential bonding shall connect all exposed conductive parts and extraneous conductive parts, which can be touched simultaneously, to the protective conductor of the installation. If a metallic grid is laid in the floor, it shall be connected to the local supplementary bonding.

### 7.5.3 Protection

Automatic supply disconnection of circuits that supply agricultural and horticultural locations shall be provided at the origin of the circuit by an earth leakage protection device that has a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 300 mA. These devices can provide a delay by using a device for discrimination with earth leakage devices that protect final circuits such as socket-outlets.

### 7.5.4 Soil heating

Soil heating equipment shall

a) be supplied by a safety supply, or

b) have earth leakage protection.

## 7.6 Caravan parks, mobile homes and marinas

### 7.6.1 General

This subclause covers the supply to and the installation of socket-outlets in caravan parks, mobile home sites and marinas.

### 7.6.2 Reticulation

**7.6.2.1** The reticulation throughout an installation shall only use

a) underground cables, or

b) aerial bundled conductors (ABC) except for marinas, or

c) other authorized methods.

**7.6.2.2** Underground wiring systems shall be buried at at least 500 mm and, unless provided with additional mechanical protection, shall be placed outside any caravan pitch or outside any area where tent pegs or ground anchors may be driven.

**7.6.2.3** Poles, other supports and the conductors for overhead wiring shall be located or protected so that they are unlikely to be damaged by vehicle or craft movement.

**7.6.2.4** Overhead conductors shall be at a height above ground not less than 4 m.

**7.6.2.5** The load on a circuit shall be estimated by multiplying the sum of the ratings of the socket-outlets on the circuit by 0,75, unless more accurate design information is available.

**7.6.3 Socket-outlets**

**7.6.3.1** Each socket-outlet or group of socket-outlets shall have a notice fixed next to it stating the following:

a) the supply voltage;

b) whether the supply is a.c. or d.c.; and

c) the maximum rated load, in amperes.

**7.6.3.2** Each socket-outlet shall be protected by its own circuit-breaker.

**7.6.4 Caravan sites**

**7.6.4.1** The socket-outlets that supply caravans shall

a) be 230 V single-phase or 400 V three-phase a.c.,

b) comply with SANS 60309-1 and SANS 60309-2 and have a six o'clock earthing position,

c) be so arranged that one socket-outlet serves one caravan site,

d) be so arranged that not more than six socket-outlets are grouped together (to reduce nuisance tripping of earth leakage protection),

e) have a distribution housing for each (group of) socket-outlet(s), the housing providing a degree of protection of at least IP44 in accordance with SANS 60529. This degree of protection shall not be reduced when a plug is inserted, and

   NOTE The IP ratings are explained in annex G.

f) unless the supply is a safety supply, be protected at each distribution housing by an earth leakage protection device that has a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA.

**7.6.4.2** Each socket-outlet shall be protected by its own circuit-breaker.

**7.6.4.3** A socket-outlet shall be

a) within 25 m of the caravan that it is to supply, and

b) mounted at least 1 m above ground.

**7.6.5 Mobile home sites**

**7.6.5.1** The earth continuity conductor in a supply to a mobile home shall be

a) a core of the supply cable,

b) terminated in the distribution board of the mobile home, and

c) bonded to the earthing terminal on the chassis of the mobile home.

**7.6.5.2** All supply conductors shall be terminated in the distribution board of a mobile home.

**7.6.6 Marinas**

**7.6.6.1** Supply cables that are installed on pontoons shall be protected from the effects of changes in water level. Aluminium cables, including ABC, shall not be used.

**7.6.6.2** Where distribution boards and their associated socket-outlets are mounted on floating installations or jetties, they shall be fixed not less than 1 m above the walkway. This distance may be reduced to not less than 300 mm if appropriate additional measures against splashing are taken.

**7.6.6.3** Socket-outlets or groups of socket-outlets intended for use on the same walkway or jetty shall be connected to the same phase unless fed from isolating transformers.

**7.6.6.4** A socket-outlet shall be

a) within 25 m of the boat or craft that it is to supply, and

b) protected against the action of tides or waves at a mooring point.

**7.6.6.5** The socket-outlets that supply boats shall

a) comply with SANS 60309-1 and SANS 60309-2 and have a six o'clock earthing position,

b) be so arranged that one socket-outlet serves one mooring point,

c) be so arranged that not more than six socket-outlets are grouped together (to reduce nuisance tripping of earth leakage protection),

d) have a distribution housing for each (group of) socket-outlet(s), the housing providing a degree of protection of at least IP66 in accordance with SANS 60529. This degree of protection shall not be reduced when a plug is inserted, and

e) be protected at each distribution housing by an earth leakage protection device that has a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA, unless the supply is a safety supply.

## 7.7 Medical locations

### 7.7.1 General

The particular requirements given in this subclause apply to electrical installations in medical locations to ensure the safety of patients and medical staff. These requirements mainly refer to hospitals, private clinics, medical and dental practices, health care centres, dedicated medical rooms in the workplace and veterinary clinics. The requirements do not apply to medical electrical equipment.

Where a change of utilization of the location has occurred, it will be necessary to modify the existing electrical installation in accordance with the requirements. Special care should be taken where intracardiac procedures are performed in existing installations. Where applicable, the requirements shall also be adhered to in veterinary clinics.

NOTE For medical electrical equipment, see SANS 60601-1.

### 7.7.2 Terminology for medical locations

**7.7.2.1 applied part:** part of medical electrical equipment which in normal use

a) for the equipment to perform its function, necessarily comes into physical contact with the patient, or can be brought into contact with the patient, or

b) needs to be touched by the patient.

**7.7.2.2 main distribution board:** distribution board in the building that fulfils all the functions of a main distribution board for the supply area assigned to it and where the voltage drop is measured for operating the safety services.

**7.7.2.3 medical electrical equipment:** electrical equipment provided with not more than one connection to a particular supply mains and intended to diagnose, treat, or monitor a patient under medical supervision and to perform one or more of the following functions:

a) make physical or electrical contact with the patient;

b) transfer energy to or from the patient; or

c) detect such energy transfer to or from the patient.

The equipment includes those accessories as defined by the manufacturer, which are necessary to enable normal use of the equipment.

**7.7.2.4 medical electrical system:** combination of more than one item of medical electrical equipment and other non-medical equipment that have a specified function, and are interconnected by

a) coupling, or

b) a multiple portable socket-outlet, or

c) both coupling and a multiple portable socket-outlet.

NOTE The system includes those accessories that are needed for operating the system and that should be specified by the manufacturer.

**7.7.2.5 medical location:** location intended for the purposes of diagnoses, treatment (including cosmetic treatment), monitoring and care of patients.

NOTE To ensure protection of patients from possible electrical hazards, additional protective measures need to be applied in medical locations. The type and description of these hazards can vary according to the treatment being administered. The manner in which a room is to be used necessitates some division into different groups for differing medical procedures.

**7.7.2.5.1 group 0 location:** medical location where no applied part is intended to be used.

NOTE No additional requirements are listed and the normal requirements for an electrical installation apply.

**7.7.2.5.2 group 1 location:** medical location where applied parts are intended to be used

a) externally, or

b) to any part of the body, but not to the heart.

**7.7.2.5.3 group 2 location:** medical location where applied parts are intended to be used in applications such as in an intracardiac procedure, in an operation (in an operating theatre), and in vital treatment where discontinuity (failure) of the supply can cause danger to life.

NOTE An intracardiac procedure is a procedure whereby an electrical conductor is placed within the cardiac zone of a patient or is likely to come into contact with the heart, such conductor being accessible outside the patient's body. In this context, an electrical conductor includes insulated wires such as cardiac pacing electrodes or intracardiac ECG electrodes, or insulated tubes filled with conducting fluids.

**7.7.2.5 patient:** living being (person or animal) undergoing medical or dental investigation or treatment.

NOTE The person under treatment for cosmetic purposes may be considered, as far as these requirements are concerned, a patient.

**7.7.2.6 patient environment in an allocated medical location:** volume in which intentional or unintentional contact between patient and parts of a medical electrical system or other persons touching parts of the system can occur (see figure 7.7.1).

NOTE The patient environment applies when the patient's position is pre-determined; if not, all possible positions of the patient should be considered.

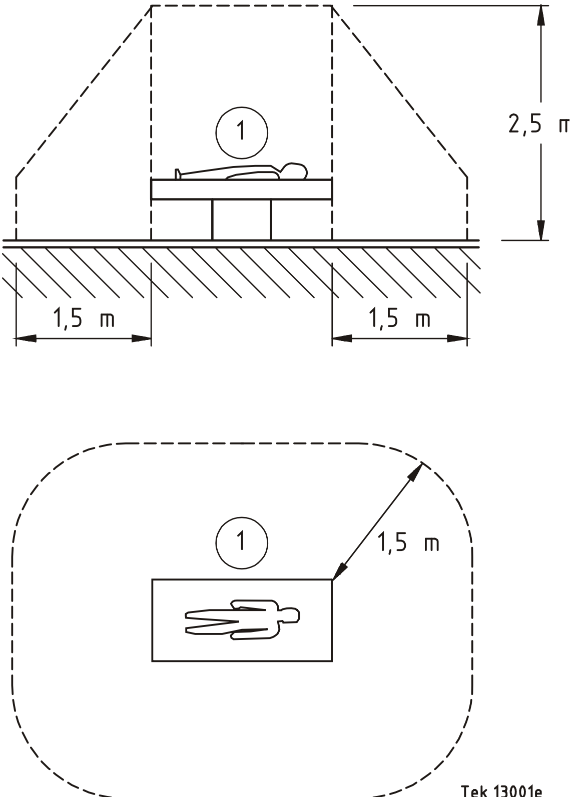



**Figure 7.7.1 — Patient environment in a medical location**

**7.7.2.7 touch voltage $U_L$:** voltage which, during an insulation fault, appears between simultaneously accessible parts (see 3.82).

NOTE By convention, the term "touch voltage" is used only in connection with protection against indirect contact.

**7.7.2.8 medical IT system**: electricity supply to patient environments in an allocated medical location where the supply is isolated from the earth and from the electricity supply to other areas of the medical location.

### 7.7.3 Assessment of general characteristics

#### 7.7.3.1 Classification

The classification of medical locations into groups (see table L.2 in annex L) shall be made in agreement with the medical staff, the health organization or the body responsible for the safety of the patients in accordance with the national, regional or local rules. In order to determine the classification of a certain medical location, it is necessary that the medical staff or the responsible body indicate which medical procedures will take place in the location. Based on the intended use, the appropriate classification for this location shall be determined. Classification of a medical location shall be related to the type of contact between applied parts and the patient and to the purpose for which the location will be used. Applied parts shall comply with the relevant standard for such medical electrical equipment.

#### 7.7.3.2 Power supply

In medical locations the distribution system shall be designed and installed to facilitate the automatic changeover from the main distribution network to the safety power supply source that feeds essential loads (see 7.7.5.6).

### 7.7.4 Protection for safety

#### 7.7.4.1 Protection against electrical shock

##### 7.7.4.1.1 Protection against both direct and indirect contact

When using SELV or PELV circuits (or both) in groups 1 and 2 medical locations, the nominal voltage applied to current-using equipment shall not exceed 25 V r.m.s. a.c. or 60 V ripple-free d.c. Protection by insulation of live parts and barriers or enclosures is essential.

Exposed conductive parts of equipment shall be connected to the equipotential bonding conductor (for example, the operating theatre luminaire).

##### 7.7.4.1.2 Protection against electric shock in normal use

Only protection by insulation of live parts or protection by barriers or enclosures is permitted.

Protection by obstacles or by placing out of arm's reach is not permitted.

**7.7.4.2 Protection against indirect contact**

Protection by automatic disconnection of supply, by electrical separation, or by the use of class II equipment (or by having equivalent insulation) may be used, except as given in 7.7.4.3, 7.7.4.4 and 7.7.4.5.

**7.7.4.3 Protection by automatic disconnection of supply**

In groups 1 and 2 medical locations, where automatic disconnection of supply is applicable, the conventional touch voltage $U_L$ shall not exceed 25 V and disconnection time shall not exceed 0,2 s.

NOTE Disconnection of supply for overload and short-circuit conditions can be achieved by different design methods within the procedures of the general rules in order to comply with the required safety level.

**7.7.4.4 TN systems**

**7.7.4.4.1** In groups 1 and 2 medical locations, the maximum disconnection time shall not exceed 0,2 s for all circuits and final circuits that supply fixed equipment.

**7.7.4.4.2** In group 1 medical locations, final circuits for socket-outlets up to 16 A shall be protected by earth leakage protection devices with a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA.

**7.7.4.4.3** In group 2 medical locations, protection by automatic disconnection of the supply by means of earth leakage protection devices that have a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA shall only be used on the following circuits:

a) circuits for X-ray units;

b) circuits for large equipment with a rated power exceeding 5 kVA;

c) circuits for non-critical electrical equipment (non-life-support); and

d) circuits for the supply of operating tables (alternative to medical IT systems of electricity supply).

**7.7.4.4.4** Care shall be taken to ensure that simultaneous use of many items of such equipment connected to the same circuit cannot cause unwanted tripping of the earth leakage device.

**7.7.4.5 Medical IT system of supply (isolated system) (insulation monitoring)**

**7.7.4.5.1** In group 2 medical locations, the medical IT system of electricity supply shall be used for circuits that supply medical electrical equipment and systems intended for life support or surgical applications and other electrical equipment located in the patient environment, excluding equipment listed in 7.7.4.4.

**7.7.4.5.2** In the case of each group 2 medical location, at least one separate medical IT system of electricity supply is necessary. The medical IT system shall be equipped with an insulation-monitoring device that

a) has an internal impedance of at least 100 kΩ;

b) has a test voltage not exceeding 25 V d.c.;

c) is of a current, even under fault conditions, not exceeding 1 mA d.c.; and

d) shall indicate, at the latest, when the insulation resistance has decreased to 5 kΩ. A test device shall be provided to test this facility to ensure that the alarm (audible and visual) (see 7.7.4.5.4) operates when the insulation resistance reaches 5 kΩ.

**7.7.4.5.3** An overload and high-temperature-monitoring device for the medical IT system transformer is recommended.

**7.7.4.5.4** For each medical IT supply system, an audible and visual alarm system shall be arranged in a suitable place such that it can be permanently monitored by the medical staff. The alarm system shall incorporate the following components:

a) a green signal lamp to indicate normal operation;

b) a yellow or red signal lamp that signals when the minimum value set for the insulation resistance is reached. It shall not be possible for this light to be cancelled and disconnected; and

c) an audible alarm that sounds when the minimum value set for the insulation resistance is reached. The audible signal may be silenced.

The visual signal shall revert to green and the audible alarm shall be automatically reset on the removal of the fault condition.

### 7.7.4.6 Supplementary equipotential bonding

**7.7.4.6.1** In each group 1 and group 2 medical location, insulated supplementary equipotential bonding conductors shall be installed and connected to the equipotential busbar for the purpose of equalizing potential differences between the following parts located in the patient environment:

a) protective conductors;

b) extraneous conductive parts;

c) screening against electrical interference fields;

d) connection to screening floor grids, if any; and

e) patient earth.

NOTE Fixed conductive non-electrical operating theatre tables should be connected to the equipotential bonding conductor unless they are intended to be isolated from earth.

**7.7.4.6.2** In group 2 medical locations, the resistance of the conductors (including the resistance of the connections) between the equipotential bonding busbar and the terminals for the protective conductor of socket-outlets of fixed equipment, or of any extraneous conductive parts shall not exceed 0,2 Ω.

NOTE This resistive value can also be determined by the use of a suitable cross-sectional area of the conductor.

**7.7.4.6.3** The equipotential bonding busbar shall be located in or near the medical location. In each distribution board or in its proximity, an equipotential bonding busbar shall be provided to which the equipotential bonding conductors and protective conductor shall be connected. Connections shall be so arranged that they are clearly visible and can be disconnected individually. Each equipotential bonding busbar shall be connected to the consumer's earth terminal (main earthing terminal) with a separate insulated earthing conductor. Table 7.2 gives the minimum size of the earthing conductor for the corresponding phase conductors.

**Table 7.2 — Minimum cross-sectional area of earthing (PE) conductor for the corresponding phase conductor**

| 1 | 2 |
|---|---|
| **Size of phase conductor** mm² | **Minimum size of PE conductor** mm² |
| < 16 | Same as phase conductor |
| 16 – 35 | 16 |
| > 35 | 50 % of the phase conductor |

### 7.7.5 Selection and erection of electrical equipment

#### 7.7.5.1 Operational conditions

##### 7.7.5.1.1 Wiring systems

Any wiring system in group 2 medical locations shall be exclusive for the use of equipment and fittings in that location. All protective conductors shall be insulated conductors.

##### 7.7.5.1.2 Transformers for medical IT system of supply

Transformers shall be installed in close proximity to, inside or outside, the medical location, but shall be placed in a cabinet or enclosure, if necessary, to prevent unintentional contact with live parts.

The nominal voltage $U_n$ on the secondary side of transformers for medical IT supply systems shall be not more than 250 V a.c.

##### 7.7.5.1.3 Medical IT systems of supply for group 2 medical locations

**7.7.5.1.3.1** Transformers shall comply with SANS 61558-2-15.

**7.7.5.1.3.2** The leakage current of the output winding to earth and the leakage current of the enclosure, when measured in the no-load condition and the transformer supplied at rated voltage and rated frequency, shall generally not exceed 0,5 mA.

**7.7.5.1.3.3** Single-phase transformers shall be used to form the medical IT supply systems for portable and fixed equipment and the rated output shall be at least 0,5 kVA and shall not exceed 10 kVA.

**7.7.5.1.3.4** Three-phase supplies shall not be used in medical IT systems.

**7.7.5.1.3.5** When coding of insulated conductors is done by colour, the colours red, white and blue for live conductors and green for the earth conductor shall be used.

**7.7.5.1.3.6** Because an isolating transformer output has no neutral, steps shall be taken to prevent any extraneous earth paths such as metal wireways and other services.

NOTE See 7.7.6 for tests and verification, and the additional test report for a medical location.

### 7.7.5.2 External influences

NOTE 1 Where appropriate, attention should be given to the prevention of electromagnetic interference.

NOTE 2 Requirements for electrical equipment for use in conjunction with flammable gasses and vapours are given in SANS 10108 (for medical electrical equipment, see SANS 60601-1).

NOTE 3 Prevention of the build-up of static electricity is recommended.

Where hazardous conditions can occur (for example, in the presence of flammable gases and vapours), special precautions are required (see 7.14).

### 7.7.5.3 Diagrams, documentation and operating instructions

Plans of the electrical installation together with records, diagrams and modifications thereto, and also instructions for operation and maintenance, shall be provided for the user. The relevant documents are in particular

a) block diagrams showing the distribution system of the normal power supply and power supply for safety services in a single-line representation. These diagrams shall contain information on the location of the sub-distribution boards in the building,

b) block diagrams showing switchgear, controlgear and distribution boards in a single-line representation of the locations of the main and sub-distribution boards, and

c) schematic diagrams of insulation-monitoring systems.

**7.7.5.4 Switchgear and controlgear**

Overcurrent protection shall be provided by circuit-breakers which, on the occurrence of such overcurrent, shall disconnect all live poles simultaneously. They shall be set to discriminate against upstream protective devices in relation to short-circuits.

**7.7.5.5 Other equipment**

**7.7.5.5.1 Lighting circuits**

In groups 1 and 2 medical locations, the luminaires shall be connected to at least two circuits, one of which shall be connected to a safety service.

In escape routes alternate luminaires shall be connected to the safety services (see 7.7.5.6.2.4).

**7.7.5.5.2 Socket-outlet circuits in group 2 medical locations**

**7.7.5.5.2.1** At each patient's place of treatment, for example, at bed heads, the configuration of socket-outlets shall be as follows:

a) either a minimum of two separate circuits that feed socket-outlets shall be installed; or

b) each socket-outlet shall be individually protected against overcurrent.

**7.7.5.5.2.2** Within the patient environment (see figure 7.7.1),

a) for patient application, only a medical IT system shall be installed;

b) socket-outlets on the TN system shall only be permitted if they are not compatible with the socket-outlets on the medical IT system.

**7.7.5.5.2.3** Only one item of electromedical equipment shall be supplied from each point of outlet.

**7.7.5.5.2.4** Unless an accessible switch-disconnector is mounted on the equipment, the switch-disconnector at the point of outlet shall be within easy reach of the operator of the equipment.

**7.7.5.5.3 Socket-outlets**

**7.7.5.5.3.1** In a group 1 medical location, a minimum of two socket-outlets per patient environment area shall be installed.

**7.7.5.5.3.2** In a group 2 medical location, a minimum of four socket-outlets per patient environment shall be installed.

**7.7.5.5.3.3** Wherever socket-outlets in a medical location are connected on the medical IT system, each socket-outlet shall be clearly and permanently marked to indicate that the socket-outlet is for medical equipment only (on the medical IT system). Socket-outlets on the TN system in such locations shall be clearly and permanently marked for general use (on the TN system).

**7.7.5.6 Safety services**

NOTE In practical terms, safety services in medical locations are synonymous with emergency services. For a classification of safety services for medical locations, see annex L.

**7.7.5.6.1 General requirements for safety power supply sources of groups 1 and 2 medical locations**

**7.7.5.6.1.1** In medical locations, a power supply for safety services is required, which shall be energized in the case of a failure of the normal power supply source, to feed the equipment stated in 7.7.5.6.2.1 and 7.7.5.6.2.2 with electrical energy for a definite period of time within a predetermined changeover period.

**7.7.5.6.1.2** If the voltage at the main distribution board drops at one of several line conductors by more than 10 % of the nominal voltage, a safety power supply source shall assume the supply automatically.

The supply transfer should be achieved with a delay to cater for auto-reclosure of circuit-breakers of incoming supplies (short-time interruptions).

**7.7.5.6.1.3** Interconnecting cables between the individual components and sub-assemblies of safety power sources shall comply with 7.7.5.1.1.

**7.7.5.6.2 Power supply sources**

**7.7.5.6.2.1 Power supply sources with a changeover period of up to 0,5 s**

In the event of a voltage failure of one or more line conductors at the distribution board, a special safety power supply source capable of maintaining luminaires of operating theatres and other essential life-supporting and monitoring equipment for a minimum period of 3 h, is required. The safety power supply shall restore the supply within a changeover period not exceeding 0,5 s.

**7.7.5.6.2.2 Safety power supply sources with a changeover period of up to 30 s**

When the voltage of one or more line conductors at the main distribution board for the safety services has decreased by more than 10 % of the nominal supply voltage for a duration exceeding 3 s, equipment stated in 7.7.5.6.2.4 and 7.7.5.6.2.5 shall be connected within ≤ 30 s to a safety power supply source capable of maintaining the equipment for a minimum period of 24 h.

NOTE The duration of 24 h can be reduced to 3 h if the medical requirements and utilization of the location facilitates the treatment/examination, and any evacuation of the building can be completed in the reduced time duration.

**7.7.5.6.2.3 Power supply sources with a changeover period that can exceed 30 s**

Equipment other than that given in 7.7.5.6.2.4 and 7.7.5.6.2.5, which is required for the maintenance of hospital services, may be connected either automatically or manually to a power supply source capable of maintaining the equipment for a minimum period of 24 h. This equipment may include, for example,

a) sterilization equipment,

b) necessary building services, including air conditioning, heating, ventilation, and waste disposal systems,

c) cooling equipment,

d) cooking equipment, and

e) storage battery chargers.

**7.7.5.6.2.4 Power supply sources for lighting**

In the event of a power failure, the changeover period to the safety power supply source shall not exceed 30 s and the necessary minimum luminance shall be provided from a safety power supply source to the following locations:

a) escape routes;

NOTE The values for minimum luminance are required by national regulations.

b) lighting of exit signs;

c) locations for switchgear and controlgear for emergency alternate supply and for main distribution boards for normal power supply and for safety power supply services;

d) rooms in which essential services are intended. In each room at least one luminaire shall be supplied from the safety power supply source;

e) rooms of group 1 medical locations. In each room at least one luminaire shall be supplied from the safety power supply source; and

f) rooms of group 2 medical locations. A minimum of 50 % of the lighting shall be supplied from the safety power supply source.

#### 7.7.5.6.2.5 Power supply sources for other services

Other services that require a safety power supply with a changeover period not exceeding 30 s include the following:

a) selected lifts for firemen;

b) ventilating systems for smoke extraction;

c) paging systems and nurse call systems;

d) medical electrical equipment used in group 2 medical locations that serves surgical and other measures of vital importance;

e) electrical equipment for medical gas supply that includes compressed air, vacuum, anaesthetics exhaustion and also their monitoring devices; and

f) fire detection, fire alarms and fire extinguishing systems.

NOTE 1 This list is not exhaustive.

NOTE 2 The responsible authority should define medical electrical equipment that requires a safety power supply.

### 7.7.6 Verification

The instructions for tests and verification given in (a) to (e) apply to the electrical safety of the installation in compliance with the requirements of this part of SANS 10142 and also to the functions and performance of safety devices. The tests shall be carried out before commissioning, after alterations or repairs, and before recommissioning. In each case, the date and result of the test, the measurement or verification shall be recorded (see 8.7):

a) test the functioning of the insulation-monitoring devices of IT systems and the audible and visual alarm systems;

b) verify the integrity of the components required in 7.7.4.6.3 for equipotential bonding;

c) take measurements to verify that the supplementary equipotential bonding is in accordance with 7.7.4.6.1 and 7.7.4.6.2;

d) measure the leakage current of the output circuit and of the enclosure of medical IT transformers in the no-load condition (see 7.7.5.1.3); and

e) verify compliance with the requirements of 7.7.5.6 for safety power supply services.

## 7.8 Temporary installations

### 7.8.1 General

NOTE Temporary wiring is wiring for installations used for activities such as temporary amusement parks, fêtes, fairs, marquee, voting stations, exhibitions, shows and flea markets. Construction and demolition sites are not included (see 7.4).

**7.8.1.1** Control and protective switchgear shall be placed in closed cabinets, which can only be opened by the use of a key, or a tool, except for the equipment designed and intended to be operated by uninstructed persons.

**7.8.1.2** The electrical installation shall be inspected and tested (see 8.1.4) and a test report issued, together with a CoC, by the registered person each time after the electrical installation has been assembled on a new site.

### 7.8.2 Supplementary equipotential bonding

**7.8.2.1** In locations used for animals, supplementary equipotential bonding shall connect all exposed conductive parts and extraneous conductive parts, which can be touched simultaneously, and the protective conductor of the installation.

**7.8.2.2** If a metallic grid is laid in the floor, it shall be connected to the local supplementary bonding required for locations where animals are kept (see 7.5.2).

**7.8.3 Isolation**

**7.8.3.1** Every separate temporary structure (indoor or outdoor) such as a vehicle, a stand, or a unit, intended to be occupied by one specific user and each distribution circuit that supplies such installation shall be provided with its own readily accessible and properly identifiable means of isolation.

**7.8.3.2** Automatic supply disconnection of cables, which is intended to supply temporary structures, shall be provided at the origin of the cables to each sub-distribution board by earth leakage protection devices with a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 300 mA. These devices can provide a delay by using a device for discrimination with earth leakage protection devices that protect final circuits.

**7.8.3.3** Except for emergency lighting, all final circuits for lighting and socket-outlets shall be additionally protected by earth leakage protection devices with a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA.

NOTE Discharge lighting shall be connected to single-phase circuits to avoid nuisance tripping of the earth leakage protection device.

**7.8.3.4** Insulation piercing lamp holders shall not be used unless the cables and lamp holders are compatible.

**7.8.4 Wiring systems**

**7.8.4.1** Cables shall be selected or protected to withstand likely mechanical damage.

**7.8.4.2** Where cables are to be reused or repositioned, flexible cables should be used.

**7.8.4.3** Conductors shall be copper and have a minimum cross-sectional area of 1,5 mm².

**7.8.4.4** Uninsulated live conductors are not permitted.

**7.8.4.5** Unarmoured single-core cables are permitted where they are out of arm's reach and will not be subjected to mechanical damage.

### 7.8.5 Electrical connections

**7.8.5.1** Joints in cables shall be avoided, however if required, they shall be made in an enclosure that affords a degree of protection not less than IP4X.

**7.8.5.2** Where strain can be transmitted to terminals, cable anchorage shall be provided.

**7.8.5.3** Where non-standard socket-outlets are used as connectors to connect different parts of the distribution system of a temporary installation, and if it is not possible to plug a standard plug into such a connector, sensitive earth leakage protection need not be installed for such parts.

### 7.8.6 Socket-outlets and plugs

**7.8.6.1** An adequate number of socket-outlets shall be installed to safely comply with the user's requirements.

**7.8.6.2** Floor-mounted socket-outlets shall be adequately protected from accidental ingress of water.

### 7.8.7 Heat generation

Lighting equipment such as incandescent lamps, spotlights and small projectors, low-voltage lights and other equipment or appliances with high temperature surfaces shall be suitably guarded and installed, and located well away from combustible material to prevent contact.

### 7.8.8 Motors

All electric motors shall be provided with an effective means of isolation of all poles and such means shall be adjacent to the motor. Any motor which is automatically or remotely controlled and which is not continuously supervised shall be fitted with a manually reset protective device to protect the motor from excessive temperatures.

## 7.9 Extra low voltage lighting installations

### 7.9.1 General

NOTE The general requirements of this part of SANS 10142 are applicable to all subclauses of this subclause (7.9), except where this subclause modifies or replaces certain of the general requirements.

**7.9.1.1** The particular requirements in this subclause apply to extra low voltage lighting installations supplied from sources with a maximum rated voltage of 50 V a.c. or 120 V d.c.

**7.9.1.2** For extra low voltage lighting installations only SELV shall be applied.

**7.9.1.3** The following components of SELV lighting installations shall not be installed unless they comply with the appropriate standards:

a) safety isolating transformers (wire wound) shall comply with SANS 61558-2-6;

b) convertors (electronic power supply units) shall comply with SANS 61347-2-2;

c) supply track systems for luminaires shall comply with SANS 60570; and

d) bare wire extra low voltage lighting systems shall comply with SANS 60598-2-23.

**7.9.1.4** The rated output current of the SELV source (transformer or convertor) shall not exceed 25 A.

**7.9.1.5** The secondary circuits of more than one transformer shall not be connected in parallel.

**7.9.1.6** The fixed secondary circuit of a transformer or a convertor connected to a socket-outlet (see 6.14.1.4 and 6.16.1.11) is part of the electrical installation.

**7.9.1.7** Metallic structural parts of buildings, for example, pipe systems or parts of furniture, shall not be used as live conductors.

#### 7.9.2 Wiring systems

#### 7.9.2.1 Current-carrying capacity

**7.9.2.1.1** In an extra low voltage lighting circuit, conductors with the appropriate steady state current rating shall be used to allow for the high currents usually associated with extra low voltage types of light.

**7.9.2.1.2** The sum of the current ratings of the secondary circuits shall not exceed 125 % of the transformer rating.

#### 7.9.2.2 Length of circuit and size of conductor

**7.9.2.2.1** Since voltage drop has an adverse effect on light output, the recommended maximum length of the SELV circuit between the source and the load and the minimum conductor size for the circuit are given in table 7.3 for different loads and voltages.

NOTE 1 It is recommended that each extra low voltage light be supplied by its own SELV source (transformer or convertor).

NOTE 2 The conductor size can be reduced when a ring circuit is used.

NOTE 3 The manufacturer's instructions may contain more stringent requirements for the length of the circuit between the ELV source and the lamp.

**7.9.2.2.2** The size of the SELV circuit conductors shall be not less than 1,5 $mm^2$.

**Table 7.3 — The recommended length of a SELV circuit between the source and the load and the minimum size of SELV conductors for different lighting loads and voltages**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Single circuit lighting load** | **Length of circuit between the source and the load** | | | | | | | |
| | **Up to 1,5 m** | | **Up to 2,5 m** | | **Up to 5 m** | | **Up to 10 m** | |
| | **Minimum conductor size** mm² | | | | | | | |
| | **Different circuit voltages** | | | | | | | |
| VA | **12 V** | **24 V** | **12 V** | **24 V** | **12 V** | **24 V** | **12 V** | **24 V** |
| 20 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 4 | 1,5 |
| 40 | 1,5 | 1,5 | 1,5 | 1,5 | 2,5 | 1,5 | 6 | 2,5 |
| 50 | 1,5 | 1,5 | 1,5 | 1,5 | 4 | 2,5 | 6 | 4 |
| 60 | 1,5 | 1,5 | 2,5 | 1,5 | 4 | 2,5 | 10 | 4 |
| 75 | 1,5 | 1,5 | 2,5 | 1,5 | 6 | 2,5 | 10 | 6 |
| 80 | 1,5 | 1,5 | 2,5 | 1,5 | 6 | 4 | 10 | 6 |
| 100 | 2,5 | 1,5 | 4 | 2,5 | 6 | 4 | – | 6 |
| 120 | 2,5 | 1,5 | 4 | 2,5 | 10 | 4 | – | 10 |
| 140 | 4 | 1,5 | 6 | 2,5 | 10 | 6 | – | 10 |
| 150 | 4 | 1,5 | 6 | 2,5 | 10 | 6 | – | 10 |
| 160 | 4 | 1,5 | 6 | 2,5 | 10 | 6 | – | 10 |

**Table 7.3** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Single circuit lighting load** | **Length of circuit between the source and the load** | | | | | | | |
| | **Up to 1,5 m** | | **Up to 2,5 m** | | **Up to 5 m** | | **Up to 10 m** | |
| | **Minimum conductor size** mm² | | | | | | | |
| | **Different circuit voltages** | | | | | | | |
| VA | **12 V** | **24 V** | **12 V** | **24 V** | **12 V** | **24 V** | **12 V** | **24 V** |
| 180 | 4 | 2,5 | 6 | 4 | – | 6 | – | – |
| 200 | 4 | 2,5 | 10 | 4 | – | 10 | – | – |
| 250 | 6 | 2,5 | 10 | 4 | – | 10 | – | – |
| 300 | 6 | 4 | 10 | 6 | – | 10 | – | – |
| NOTE These values include the voltage drop calculations and have taken the length of both supply and return conductors of the circuit into account. | | | | | | | | |

#### 7.9.2.3 Voltage drop in consumers' installations

In extra low voltage lighting installations particular attention shall be given to the voltage drop requirements (see 6.2.7) because voltage drop has an adverse effect on light output.

#### 7.9.2.4 Bare conductors

**7.9.2.4.1** Bare conductors may only be used in an extra low voltage lighting installation system if

a) the nominal voltage does not exceed 25 V a.c. or 60 V d.c.,

b) the wiring system is made up of compatible components and complies as a complete unit with SANS 60598-2-23, and

c) the conductors are at least 1 m from the thatch under a thatched roof.

**7.9.2.4.2** If both circuit conductors are uninsulated and supplied from a convertor that complies with SANS 61347-2-2, the power of the convertor shall not exceed 200 VA.

### 7.9.3 Protection

#### 7.9.3.1 Protection against both direct and indirect contact

**7.9.3.1.1** Components shall be mounted in an enclosure, ventilated where necessary, unless they are suitably designed and include provision for the termination of conductors to and from the component and for the mounting of protective devices (see 6.4.3.2 and 6.16.1.5).

**7.9.3.1.2** Terminations and connections of conductors shall be made by screw terminals or screwless clamping devices that comply with SANS 60998-2-1 or SANS 60998-2-2, respectively.

#### 7.9.3.2 Protection against overcurrent

**7.9.3.2.1** When selecting the protective device and conductor size for the primary circuit, account shall be taken of the magnetizing current (in-rush current) of the transformer.

**7.9.3.2.2** Except as allowed in 7.9.3.2.4, each secondary circuit of a safety extra low voltage (SELV) supply source (transformer or convertor) shall have overcurrent protection (see 6.7.1 and 6.7.2). The overcurrent protection may be either by a common protective device, or a protective device for each SELV circuit.

NOTE A circuit-breaker installed in the secondary circuit is not regarded as a distribution board and may be installed in an accessible position in the roof space.

**7.9.3.2.3** A protective device shall be readily accessible unless it is built into the supply source and is of the automatic resetting type.

**7.9.3.2.4** Secondary overcurrent protection is not required where the maximum output of the SELV transformer is 50 VA, the secondary circuit conductor is at least 1,5 mm$^2$, not exceeding a length of 2,5 m, and at least one conductor and its terminals are insulated to prevent a short circuit.

**7.9.3.3 Protection against fire risk**

**7.9.3.3.1 Mounting of luminaires**

**7.9.3.3.1.1** For the selection of luminaires with regard to their thermal effect on the surroundings, the following features shall be taken into account:

a) the maximum permissible power dissipated by the lamps;

b) fire resistance of adjacent material

   1) at the point of installation; and

   2) in the thermally affected areas; and

c) minimum distance to combustible materials, including materials in the path of a spotlight beam.

**7.9.3.3.1.2** Depending on the fire resistance of the material at the point of installation and in thermally affected areas, the manufacturer's installation instructions shall be followed. Marked luminaires shall be selected and installed according to the marking instructions.

**7.9.3.3.1.3** At least 200 mm of the conductors leading from an ELV lamp holder shall be 180 °C (class H) flexible conductors such as silicon-rubber-insulated conductors. The lamp holder shall also be suitable for an operating temperature of at least 180 °C.

**7.9.3.3.1.4** The ELV power source shall not be installed above the lamp or within 200 mm from the lamp to any side unless a heat barrier is installed between the lamp and the power source.

#### 7.9.3.3.2 Fire risk by short circuit

At least one conductor and its terminals, for the part of the circuit between the transformer and the protective device, shall be insulated to prevent a short circuit.

### 7.9.4 Position of components

**7.9.4.1** Primary terminals of the supply source shall be in an enclosure.

**7.9.4.2** Cables shall be fixed in such a way as to prevent strain on the terminals or connectors.

**7.9.4.3** Any SELV sources with a mass of more than 1 kg shall be fixed.

**7.9.4.4** Transformers, protective devices or similar equipment, which are mounted above ceilings or in a similar place, shall, as far as is reasonably practicable, be mounted on a fixed part of the building such as a beam.

**7.9.4.5** If the identification of a protective device for a circuit is not immediately evident, a sign or diagram (label) close to the protective device shall identify the circuit and its purpose.

## 7.10 Stage and theatre equipment

### 7.10.1 General equipment and wiring

**7.10.1.1** Resistors and dimmers that generate heat shall be supported on, and, where necessary, enclosed in, non-flammable material. Ventilation shall be used to prevent them from overheating.

**7.10.1.2** Equipment that generates heat in excess of the safe touch temperature (see 5.2.2) shall be inaccessible to the public.

**7.10.1.3** See 7.13.7.2 concerning autotransformers.

**7.10.1.4** Arc lamps, other than those in projectors, shall be controlled by a multipole switch mounted on the frame that supports them.

**7.10.1.5** Flexible cables shall be used to supply equipment that is permanently installed but movable, such as swivelling projection lamps and movable frames for lighting equipment (battens).

**7.10.1.6** Socket-outlet circuits supplied from a dimmer in any theatre, cinema or similar place of assembly do not need earth leakage protection, provided that

a) the circuits are derived from a safety supply, and

b) the socket-outlets are marked to indicate that they are on dimmer control.

**7.10.2 Stage equipment**

**7.10.2.1** Cables for stage equipment shall be insulated with material that is suitable for exposure to the high operating temperatures of such equipment.

**7.10.2.2** Suspended electrical equipment, including the cables themselves, shall be so supported that the conductors or cables are not strained.

**7.10.2.3** All stage luminaires that retract into recesses that close, shall automatically switch off as they retract (see also 6.14.3).

## 7.11 Safety and emergency lighting

**7.11.1** Normal, safety and emergency lighting systems shall be independent of outdoor lighting systems.

**7.11.2** The electrical equipment of an emergency lighting system shall be independent of the electrical equipment and circuit of the normal lighting system.

**7.11.3** Normal and safety lighting systems may share a source of supply, but an emergency lighting system shall have an independent source of supply.

**7.11.4** If the source of supply uses batteries that emit explosive fumes or gases (or both), it shall be installed in a room that

a) is designed to accommodate the source of supply and the batteries,

b) has adequate ventilation to the outside, and

c) when required (see SANS 10108), contains explosion-proof electrical equipment (see 7.14).

**7.11.5** Where the emergency supply is provided from a central power system, an emergency lighting supply circuit shall have a clearly identified manual control for use if the automatic control fails to operate. All controls of emergency lighting shall be inaccessible to the general public.

**7.11.6** Exit signs shall be illuminated by the safety and emergency lighting systems.

**7.11.7** An exit sign or an emergency luminaire that contains its own battery shall have continuous supply to the battery charging equipment.

## 7.12 Alternative supplies

NOTE Alternative supplies include but are not limited to low-voltage generating sets, photovoltaic (PV) installations, gas generators, diesel generators, wind turbines and hydropower plant.

### 7.12.1 General

**7.12.1.1** Subclause 7.12 applies to an installation that incorporates alternative supplies intended to supply, either continuously or occasionally, all or part of the installation with the following supply arrangements:

a) supply to an installation or part of an installation which is not connected to the main supply of a supplier;

b) supply to an installation or part of an installation as an alternative to the main supply of a supplier; and

c) appropriate combinations of the above.

NOTE 1 Requirements of the supplier should be ascertained before any alternate supply is installed in an installation connected to the main supply of a supplier.

NOTE 2 This part of SANS 10142 does not cover the generation plant, integration and synchronising requirements of an alternative supply operating in parallel with the main supply to an installation.

**7.12.1.2** Subclause 7.12 covers, but is not limited to, the following:

a) alternate supply that consist of a combination of an internal combustion engine or a turbine, hydro plant, wind energy recovery installation or any similar source of mechanical energy and an alternator or a d.c. generator;

b) rotary UPS (uninterruptible power supply) systems that consist of a combination of an electric motor and an alternator, with batteries as a standby power source for the electric motor, or with an internal combustion engine, gas or turbine as a standby power source for the alternator; and

c) static UPS systems that consist of static inverters with batteries as the standby power source (with or without bypass facilities).

d) installations similar to those in 7.12.1.2(c), but sourcing energy from photovoltaics or other sources.

### 7.12.2 Requirements for alternative sources of supply

**7.12.2.1** Where any form of alternative supply (emergency supply, UPS, other static inverters, or wind turbine inverter generators), is connected to an electrical installation, a notice to this effect shall be displayed at the main switch of the installation, and where such supply

a) supplies power only to certain circuits in a distribution board, a power-on indicator (visible or audible) shall be provided on each such distribution board as well as a notice indicating that the standby power main switch shall also be switched off in an emergency,

b) only supplies a part of the electrical installation, the notice shall also be displayed on each distribution board in that part of the installation (see 6.6.1.1(d)).

All forms of alternative devices such as invertors shall comply with the requirements of 6.16.1.

**7.12.2.2** The means of excitation and commutation shall be appropriate for the intended use of the alternative supply and the safety and proper functioning of other sources of supply shall not be impaired by the generating plant.

**7.12.2.3** The prospective short-circuit current and prospective earth fault current shall be assessed for each source of supply or combination of sources, which can operate independently of other sources or combinations. The short-circuit rating of protective devices within the installation and, where appropriate, connected to the main supply, shall not be exceeded for any of the intended methods of operation of the sources.

**7.12.2.4** Where the alternative supply is intended to provide a supply to an installation that is not connected to the main supply, or to provide a supply as a switched alternative to the main supply, the capacity and operating characteristics of the alternative supply shall be such that danger or damage to equipment does not arise after the connection or disconnection of any intended load as a result of the deviation of the voltage or frequency from the standard range. Means shall be provided to automatically disconnect such parts of the installation, as may be necessary if the capacity of the alternative supply is exceeded.

**7.12.2.5** Where an alternative supply is provided to an installation or part of an installation as a switched alternative to the main supply, the change-over switching device shall disconnect the main supply before the alternative supply is switched in. The change-over switching device shall be interlocked in such a way that the main supply and the alternative supply cannot be connected to the installation or part of the installation at the same time.

**7.12.2.6** Except where otherwise permitted in this part of SANS 10142, where a socket-outlet is installed in a circuit on standby power, such circuit shall be protected by an earth leakage protection device with a rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ not exceeding 30 mA.

**7.12.2.7** A 230 V generator with a V-O-V earth connection (centre tap on winding which is earthed), shall not be connected to a fixed electrical installation.

NOTE Such a generator may be used as a free-standing unit to provide power to specific appliances.

### 7.12.3 Earthing requirements and earth leakage protection

#### 7.12.3.1 Neutral bar earthing

**7.12.3.1.1** Protection in accordance with the requirements of 6.7 shall be provided for the electrical installation in such a manner as to ensure correct operation of the protection devices, irrespective of the source of supply or combination of sources of supply. Operation of the protection devices shall not rely upon the connection to the earthed point of the main supply when the generator is operated as a switched alternative to the main supply.

Where there is no existing earth electrode installed in the electrical installation, a suitable earth electrode may be installed in accordance with SANS 10199. When installed, the electrode shall be bonded to the consumer's earth terminal and to the earthing point on the alternate supply by a conductor of at least half the cross-section of that of the phase conductor, but not less than 6 $mm^2$ copper, or equivalent. This also applies to a single-phase supply (see also 5.2.3.1).

NOTE 1 In a TN system earthing of electricity supply, an earth electrode is normally not required in an electrical installation.

NOTE 2 Protection of photovoltaics should be by means of lightning protection device (LPD) or surge protective device (SPD).

**7.12.3.1.2** In an installation that is supplied from a combination of transformers and alternative supplies located near to each other, the neutral points of each of these items shall be connected to a single earthed neutral bar (see P.1). This earthed neutral bar shall be the only point at which the neutral of the installation is earthed. Any earth leakage device shall be positioned in such a way as to avoid incorrect operation due to the existence of any parallel neutral/earth path.

**7.12.3.1.3** Where alternative supplies are installed remotely from the installation, or from one another, and where it is not possible to make use of a single neutral bar which is earthed, the neutral of each unit shall be earthed at the unit and these points shall be bonded to the consumer's earth terminal (see 6.12.4). The supply from each unit which supplies the installation or part of the installation, shall be switched by means of a switch that breaks all live conductors operating substantially together (see P.2 and P.4), to disconnect the earthed neutral point from the installation neutral when the alternative supply is not connected (see also 6.1.6).

**7.12.3.1.4** Where only part of an installation is switched to the alternative supply in the same distribution board, the neutral bar shall be split (see figures P.2 and P.3).

**7.12.4 Additional requirements for installations that incorporate electrical supply derived from static inverters used with uninterruptible power supply (UPS) equipment and photovoltaic installations off-grid or on-grid**

**7.12.4.1** The output of such unit shall be fitted with overcurrent protection devices designed to disconnect the output of the unit in the case of overcurrent or earth faults that occur. The earth loop impedance, including the internal impedance of the unit, shall comply with the requirements of 8.6.5.

**7.12.4.2** Where a common neutral and a bypass switch are used, the part of the installation supplied by the alternative supply shall be provided with earth leakage protection when required in 6.7.5. (See figure P.3.) (See also 6.7.5.5(a) for exclusion relating to safety supplies.)

### 7.12.5 Protection against overcurrent

#### 7.12.5.1 Overcurrent protection

**7.12.5.1.1** Overcurrent protection and isolation shall be located as near as possible to the output terminals of each alternative supply unit, except where the cable connecting the unit to the distribution board is mechanically protected and is regarded to be within the fault-free zone of the distribution board where protection is installed. The circuit-breaker magnetic characteristic shall have a low threshold value in view of the high impedance in the case of a generator or of the current-limiting characteristics in the case of a static inverter UPS. Downstream coordination shall take this into account. To be consistent with the rest of this part of SANS 10142, overcurrent protection is required for the protection of the conductors, but might also provide protection to the alternative supply unit.

**7.12.5.1.2** Where an alternate supply system is intended to operate in parallel with the main supply or where two or more alternate supply system may operate in parallel, circulating harmonic currents shall be limited so that the thermal rating of conductors is not exceeded. The effects of circulating harmonic currents can be limited by

a) the selection of alternate supply system with compensated windings,

b) the provision of suitable impedance in the connection to alternate supply system generator star position,

c) the provision of switches which interrupt the circulatory circuit but are interlocked so that at all times protection is not impaired,

d) the provision of filtering equipment, and

e) other suitable means.

#### 7.12.5.2 DC conductors and battery protection methods

Colour coding for AC/DC solar/photovoltaic installations shall be in accordance with the requirements given in 6.3.3.3.

NOTE DC circuits may be identified by means of colours or symbols.

**7.12.6 Additional requirements for installations where the alternate supply system provides a supply as a switched alternative to the main supply (standby systems and UPS systems that incorporate bypass switching)**

**7.12.6.1** Precautions that comply with the requirements of 6.9 and 6.16 for disconnection shall be taken, so that the alternate supply system cannot unintentionally operate in parallel with the main supply where the supply to the electrical installation is supplied by a supplier.

NOTE 1 Suitable precautions can include

a) an electrical, mechanical or electromechanical interlock between the operating mechanisms or control circuits of the changeover switching devices, or

b) a system of locks with a single transferable key, or

c) a three position break-before-make changeover switch, or

d) an automatic changeover switching device with suitable interlock, or

e) other means that provide equivalent security of operation, or

f) an inverter (if it complies with IEC 62116).

NOTE 2 All the protection measures for alternate supply in accordance with this standard still apply.

**7.12.6.2** The control panel may be either set mounted or be a free standing cabinet. In either instance the cabinet shall be considered a control assembly (see 6.6.7).

**7.12.7 Additional requirements for photovoltaic (PV) and similar installations that provide a supply as an alternative to the main supply**

**7.12.7.1** The photovoltaic installation shall comply with SANS 60364-7-712 and the solar panels shall comply with SANS 61215 (for poly and mono crystalline) or SANS 61646 (for thin-film).

**7.12.7.2** The DC component of the installation shall comply with 7.15.

**7.12.7.3** The rated voltage of each circuit shall be clearly indicated at all ends of the circuit.

In the case of combined circuits, every circuit shall be easily identifiable.

Where single core conductors are used, such conductors for each circuit shall be tied together at intervals to ensure identification, unless another suitable arrangement is employed.

**7.12.7.4** Precautions regarding parallel operation as prescribed in 7.12.6.1, and overcurrent protection as prescribed in 7.12.4.1 shall be provided.

**7.12.7.5** In addition it shall be recognised that the supply from each inverter, battery arrangement and PV panel (or identified clustered group), constitutes a supply, and requires arrangements similar to point of supply, which shall include switch-disconnection arrangements and shall comply with 7.12.5.

**7.12.7.6** If applicable, all exposed conductive parts may require earthing as prescribed in 6.12.3.

## 7.13 High-voltage (HV) apparatus

NOTE 1 HV apparatus includes signs, electrostatic particle precipitation and the like. This subclause covers circuits (other than the internal wiring of apparatus) that operate at voltages exceeding 1 000 V and are derived from an installation of voltage not exceeding 1 000 V a.c.

NOTE 2 A voltage exceeding 1 000 V which is stepped up in a power installation is covered in SANS 10142-2.

### 7.13.1 Rating plates

Each transformer, reactor, voltage regulator, induction coil, capacitor, rectifier and convertor shall have a rating plate securely fixed to it. The rating plate shall give the rated power and the rated voltages.

### 7.13.2 Enclosures

All accessible live parts of high-voltage apparatus shall be enclosed by earthed metal or by non-flammable material. The covers of an enclosure shall only be removable with the use of a tool (see 6.14.2.2).

The minimum clearances in table 7.4 shall be complied with.

**Table 7.4 — Minimum clearances in air for high-voltage apparatus**

| 1 | 2 | 3 |
|---|---|---|
| **Nominal voltage of system** $U_n$ kV (r.m.s) | **Minimum clearance phase-to-earth and phase-to-phase** mm | **Minimum safety clearance (encroached on by person with or without object)** mm |
| 3,3 | 120 | 150 |
| 6,6 | 120 | 150 |
| 11 | 160 | 200 |
| 22 | 220 | 320 |
| 33 | 320 | 430 |

### 7.13.3 High-voltage signs

**7.13.3.1** A high-voltage sign and its equipment shall be supported by non-flammable supports.

**7.13.3.2** A notice that shows that a sign uses high voltages shall be fixed

a) next to the high-voltage sign, and

b) in full view.

### 7.13.4 Outdoor oil-filled equipment

The possibility of the spread of fire from inside, or close to, oil-filled equipment, to any part of a building or to flammable material shall be limited by the use of an appropriate combination of

a) space separation,

b) fire-resistant barriers,

c) enclosures, and

d) other safeguards.

Any fire-resistant barrier shall have a fire-resistance rating of at least 120 min and shall be at least 300 mm taller than the body of the equipment.

#### 7.13.5 Indoor oil-filled equipment

Indoor oil-filled equipment shall be positioned in a chamber that

a) is ventilated independently of the normal building ventilation, and

b) has an oil enclosure or drain that prevents any spilt oil from reaching a part of the building that is not designed to accommodate the spill. The enclosure or drain shall be such as to satisfy the fire officer.

NOTE Metal-clad indoor oil-filled equipment with an oil capacity of 200 L or less and with no exposed conductors need not be installed in a special chamber if the equipment is situated over a sump or drain of adequate capacity.

#### 7.13.6 Equipment filled with non-combustible dielectric

Equipment that is filled with a dielectric that is non-flammable in air shall be

a) fitted with a relief valve that is ducted to the outside of the building, or

b) installed in a chamber that is ventilated direct to the outside of the building.

#### 7.13.7 Transformers

##### 7.13.7.1 Step-up transformers

If a step-up transformer is used to raise the voltage of the supply (for example, for high-voltage signs but excluding voltages stepped up in a power installation),

a) the transformer shall be in a suitably labelled enclosure;

b) except as permitted in 7.13.7.2 for autotransformers, the primary and secondary windings shall be separate throughout;

c) the circuit that supplies the transformer shall have a multipole switch-disconnector that disconnects all the phase and neutral conductors of the supply; and

d) the equipment shall be so arranged that the length of high-voltage wiring is reduced as much as possible.

#### 7.13.7.2 Autotransformers

**7.13.7.2.1** An autotransformer that has an open-circuit voltage of less than 50 V or more than 1 000 V shall not be used except in connection with discharge lighting equipment.

**7.13.7.2.2** In the case of an autotransformer, the common terminal shall be connected to the neutral conductor.

#### 7.13.7.3 Convertors

A convertor shall have separate windings with insulation levels equivalent to those of a safety transformer.

### 7.13.8 Capacitors

Capacitors shall

a) be enclosed in insulating material or in earthed metal, and

b) have means to ensure that they are automatically discharged to less than 50 V within 1 min when they are disconnected from the supply.

NOTE 1 Appropriate means of discharging include connection to a load and using a resistance connected across the poles of the capacitor.

NOTE 2 Capacitors have to be treated with caution; care should be taken in ensuring that they are discharged before their associated live parts are handled.

### 7.13.9 Switch-disconnectors

A switch-disconnector shall be provided to allow disconnection of the supply. It shall be

a) so interlocked that it is not possible to gain access to the high-voltage apparatus without automatic disconnection of the supply, or

b) easily accessible, as close as possible to the high-voltage apparatus, and lockable.

Lockable switch-disconnectors in an installation shall be individually keyed.

### 7.13.10 Fireman's switch

**7.13.10.1** Each interior high-voltage installation that runs unattended (such as a window display) and each exterior high-voltage installation shall have a fireman's switch.

NOTE 1 A high-voltage sign in a closed market or arcade is deemed to be an exterior installation, but an installation in a permanent exhibition centre is deemed to be an interior installation.

NOTE 2 A portable high-voltage sign that

a) has a rated input not exceeding 100 W, and

b) is supplied from a socket-outlet that has a local means of isolation need not be regarded as being an interior high-voltage installation.

**7.13.10.2** A fireman's switch shall comply with the requirements for switch-disconnectors of SANS 60947-3.

**7.13.10.3** A fireman's switch shall isolate all live poles of the supply to a high-voltage sign. If the isolation is remote controlled, failure of the power supply to the remote control equipment shall cause the circuit to open automatically.

**7.13.10.4** A fireman's switch shall be so designed that a catch prevents the switch from being accidentally or inadvertently returned to the closed position.

**7.13.10.5** A fireman's switch shall

a) be in a red-coloured enclosure,

b) be switched off when the lever is at the top,

c) have the closed and open positions marked with lettering that can be clearly seen by a person (who has normal eyesight) standing on the ground,

d) be fixed in a clearly visible position that can easily be reached by firemen,

e) unless otherwise permitted by a fire officer, be about 2,75 m above ground level,

f) for interior signs, be at the main entrance of the building or structure or in another position acceptable to the fire officer,

g) in the case of an exterior sign, be next to the sign (but, if the switch controls more than one sign, the switch shall be next to one of the signs and there shall be a notice under each of the other signs to show where the fireman's switch can be found. Another arrangement may be used if acceptable to the fire officer), and

h) if there is more than one switch in a building or structure, be marked to indicate which sign(s) (or part of the building) it controls.

### 7.13.11 Conductors for high-voltage circuits

**7.13.11.1** The high-voltage circuit from a transformer to electrical equipment shall use conductors that are

a) insulated to withstand the rated voltage and rated current of the circuit, and

b) armoured or suitably enclosed.

**7.13.11.2** Cables for circuits that operate at voltages exceeding 1 000 V shall

a) not be run in the same channel of a wireway as cables for circuits that operate at a voltage of less than 1 000 V,

b) be identifiable at their terminations, and

c) be fixed at the appropriate spacings given in table 7.5.

**Table 7.5 — Spacing of supports for high-voltage cables in HV signs**

| 1 | 2 | 3 |
|---|---|---|
| **Type of cable** | **Maximum spacing of supports**<br>mm | |
| | **Horizontal** | **Vertical** |
| Insulated or insulated-and-braided cables | 600 | 750 |
| Metal-sheathed unarmoured cables | 750 | 1 250 |
| Armoured or metal-sheathed and armoured cables | 1 000 | 1 500 |

## 7.14 Hazardous locations

**7.14.1** The class of a hazardous location shall be determined before the installation is designed. The classification of hazardous locations for the purpose of electrical installation work shall be carried out by a person who is competent to express an opinion on such locations. The appropriate electrical equipment shall be installed in accordance with a standard adopted by the appropriate statutory authority.

**7.14.2** The installation shall comply with the appropriate of the following:

a) SANS 10108 (which deals with the definitions for the terms used, the classification of hazardous locations, the selection of equipment for use in such locations and the methods of protection);

b) SANS 10086-1 (which deals with the installation and maintenance of electrical equipment used in explosive atmospheres); and

c) SANS 10089-2 (which deals with the classification of areas for the petroleum industry).

**7.14.3** The classification of the location and the selection of equipment permitted (such as flameproof, explosion proof and intrinsically safe equipment) shall be in accordance with SANS 10108. The installation of electrical equipment in explosive atmospheres and in the petroleum industry shall be in accordance with SANS 10086-1 and SANS 10089-2 respectively.

NOTE Examples of hazardous locations are

a) petrol pumps,

b) spray painting booths,

c) areas for the storage, mixing and use of flammable fuels, paints or solvents,

d) grain silos and flour mills,

e) coal storage facilities,

f) wine cellars,

g) areas for the storage and filling of LPG cylinders,

h) battery charging locations, and

I) sewage plant.

## 7.15 D.C. installations

NOTE such as telecommunication installations and the like.

### 7.15.1 Selection of equipment and circuits

**7.15.1.1** All equipment and protection devices in d.c. installations shall be specified to operate on the specific d.c. voltages and shall be suitably rated.

**7.15.1.2** Where batteries are used, protection devices and conductors suitable for the short-circuit current rating of the batteries shall be selected.

**7.15.1.3** The live polarity is the polarity that is not connected to earth (positive on a negative-earth system, or negative on a positive-earth system); the earth or "O V" polarity is the polarity that is connected to earth.

**7.15.1.4** The polarities shall be clearly marked with ⏚ and **+** or **−**.

### 7.15.2 Earthing

Earthing and bonding of power supply circuits for d.c. installations shall comply with the following requirements:

a) the "O V" (earth) polarity of each d.c. power system of a telecommunication system shall be bonded with a solid connection to an earthing terminal at the point of supply of the d.c. power plant, which shall be the main earthing terminal;

b) if an earth electrode is required, it shall comply with the requirements of SANS 1063, be installed in accordance with SANS 10199 and be bonded to the main earthing terminal of the electrical installation;

c) the main earthing terminal shall be bonded to the consumer's earth terminal (see also 6.11);

d) the common bonding network shall be bonded to the main earthing terminal at least at one point;

e) all accessible conductive parts of the installation (rectifier cabinets, equipment racks and cabinets, enclosures, grids, wire-ways, etc.) shall be bonded to the common bonding network; and

f) the d.c. return path in its entire length shall be capable of carrying overcurrents in the case of a fault between a live power conductor of the secondary supply and the common bonding network;

NOTE 1 Earthing of telecommunication installations is multifunctional and used for the following purposes:

a) electrical protection;

b) protection against lightning and surges;

c) to provide a reference plane for signalling; and

d) to comply with EMC requirements.

NOTE 2 The earthing practices in telecommunication d.c. power systems deviate significantly from the earthing standards given in this part of SANS 10142. Main points of deviation are

a) the multiple earthing or bonding connections to current-carrying conductors at points beyond the point of control, and

b) the current that flows in the protective earth bonding conductors, and in all metallic parts bonded to the system. Correct sizing of power conductors generally minimizes this.

### 7.15.3 Overcurrent protection

An overcurrent protective device shall be installed at both ends of the conductor between the live terminals of the battery and the battery charger and as close as practically possible to the terminals. For overcurrent protection of other circuits, see 6.7.1.

### 7.15.4 Disconnection (see also 6.9)

**7.15.4.1** In an earthed d.c. installation where one of the polarities is connected to earth, all switch-disconnectors and protective devices shall break the live polarity only. The return circuit shall not be disconnected or broken.

**7.15.4.2** Each group of telecommunication equipment, racks or cabinets shall have a disconnecting device to disconnect the d.c. power supply to the entire group. The disconnecting device shall be mounted

a) within arm's reach from the terminals of the racks or cabinets, or

b) in a distribution board, if the devices are capable of being locked in the open position.

**7.15.4.3** The d.c. power supply to every telecommunication equipment rack or cabinet shall be controlled by its own switch-disconnector. Where the disconnecting device is on the rack or cabinet, a separate disconnecting device shall be mounted in the fixed installation to allow for the total removal of the rack or cabinet.

### 7.15.5 Distribution boards (see also 6.6)

The provisions of 6.6 shall apply.

## 7.16 Distribution systems as part of an electrical installation
(Secondary supply network or distribution system)

NOTE 1 This clause applies only to the distribution systems of electrical installations that form part of an installation where electricity is distributed by a landlord, body corporate or home owners' association in the case of housing complexes, and a landlord or centre management in the case of industrial or commercial premises, or similar.

NOTE 2 Generally bulk electricity is purchased from the supplier and distributed via this distribution system to the points of control of such installations where users can switch off the power. The consumption of each end user is metered by the landlord, body corporate, home owners' association or management, as the case may be, who then charges each user.

### 7.16.1 General

The distribution system is that part of the installation between the point of control connected to the point of supply where electricity is supplied by the supply authority, and the point of control of any particular electrical installation connected thereto, whether it is a specific user or a communal installation, where the user of that particular installation can switch it off.

### 7.16.2 Distribution system cabling

Only cables of the following types may be used in the distribution system:

a) multicore PVC insulated armoured cables, that comply with SANS 1507,

b) aerial bundled conductors (ABC) that comply with SANS 1418-1, and are installed in accordance with the requirements in 6.2.14, or

c) split concentric cables that comply with, and are installed in accordance with, the requirements in 6.2.13. Single-phase split-concentric cables may only be used for final service connections.

### 7.16.3 Voltage drop

The designer of the distribution system shall select the components in order to ensure a minimum voltage drop over the system, which will allow for the voltage drop over the entire installation, which is the distribution system and any user's individual electrical installation connected to the system, not to exceed the 5 % of the circuit nominal voltage (see 6.2.7).

### 7.16.4 Neutral earthing

**7.16.4.1** Whereas TN-C systems may be implemented along the distribution system backbone, the individual service connections at every distribution kiosk shall be TN-S.

**7.16.4.2** From the point of supply to each user or part of a communal installation, the neutral and earth conductors shall be separate conductors.

**7.16.4.3** Wherever the neutral is connected to the earth, a warning notice shall be fitted to the outside of each distribution kiosk in the distribution system, indicating "Neutral earthed inside".

**7.16.4.4** A clear notice shall be fitted at the combined neutral-earth connection inside each distribution kiosk in the distribution system, that prohibits the removal of this connection while the supply is alive, or might become alive.

**7.16.4.5** The neutral shall not be earthed beyond any earth leakage unit.

**7.16.4.6** A TN-S system shall not be converted to a TN-C system.

#### 7.16.5 Service connections

**7.16.5.1** Service connections shall only be made in a suitable distribution board, or kiosk, that complies with SANS 1973-1, SANS 1973-3 or SANS 60439-5.

**7.16.5.2** Each service connection, whether it is to a specific user or part of a communal installation, shall be individually controlled by a suitably rated multi-pole protective device that interrupts all live conductors (neutral and live) for single phase and at least all three phases for three-phase connections.

**7.16.5.3** Each particular electrical installation shall be supplied by an individual service connection and cable connected to its point of control.

## 8 Verification and certification

NOTE In South Africa, it is a statutory requirement that every user or lessor of an electrical installation shall have a valid Certificate of Compliance (CoC) for every such installation. A CoC will only be valid when it is accompanied by a test report in the format of the test report in 8.7.

### 8.1 Responsibility (see 8.7, section 5 of the test report)

#### 8.1.1 Design

Section 5.1 of the test report provides for the designer of the electrical installation to verify that the design complies with the requirements of this part of SANS 10142.

NOTE See SANS 10142-2 where part of an electrical installation is above 1 000 V.

#### 8.1.2 Material specification/procurement

Section 5.2 of the test report provides for the specifier/procurer to verify that the equipment specified/procured is in compliance with the requirements of this part of SANS 10142.

#### 8.1.3 Construction

Section 5.3 of the test report provides for the installer of the electrical installation to verify that the installation was constructed in accordance with the requirements of this part of SANS 10142.

NOTE In South Africa, it is a statutory requirement that an approved Inspection Authority (AIA), or a defined competent person, or a person registered in the professional category in terms of the Engineering Profession Act, 2000 (Act 46 of 2000), ensures compliance from commencement to commissioning of an electrical installation where the intention is to supply five or more users from a new point of supply (Regulation 5(6) of the Electrical Installation Regulations, 2009, of the Occupational Health and Safety Act).

#### 8.1.4 Inspection and tests

Section 5.4 of the test report provides for the person who carried out the inspection and testing of the electrical installation as given in 8.5 and 8.6, if the results are acceptable, to verify that the installation complies with the requirements of this part of SANS 10142.

NOTE 1 If the test report covers an installation in South Africa that existed before the publication of this part of SANS 10142 and extensions made since then, sections 5.1 to 5.3 will cover the new extensions only and, in section 5.4, both blocks that refer to installations which existed before and after the publication of this part of SANS 10142 should be marked.

NOTE 2 Under certain circumstances, the same person could be responsible for the entire installation and the same signature can appear up to four times on the report. If no signature appears in any of sections 5.1 to 5.3 of the test report, the signatory of section 5.4 takes that responsibility.

### 8.2 Installation characteristics (section 2 of the test report)

Section 2 of the test report gives certain characteristics of the installation that are relevant to subsequent inspection and testing. Further details of the information needed to complete section 2 of the test report are given in 8.3 and 8.4.

### 8.3 Electricity supply system (see section 2 of the test report and annex J)

**8.4 Prospective short-circuit current** (see section 2 of the test report and 6.7.3).

**8.4.1** Obtain the estimated prospective short-circuit current (PSCC) at the point of supply or control from the supplier of electricity.

NOTE In the case of existing installations, determine whether the transformer capacity has been changed, since such change can affect the PSCC and thus the required kA rating of the switchgear.

**8.4.2** In the case of supply systems rated at not more than 250 V to earth, measure the PSCC at the point of control with a commercially available instrument (fault current meter). Before any instrument is connected, confirm that the instrument is rated for the applicable current rating, in particular where the current rating at the main switch disconnector exceeds 100 A or the PSCC is expected to exceed 10 kA.

NOTE 1 Do not measure three-phase PSCC if the meter is not specifically designed for that purpose or for the capacity of supply (or both). In a balanced three-phase system, the three-phase value can be estimated by multiplying the single-phase value by 1.73.

NOTE 2 Ensure that the instrument connections do not add impedance to the circuit measured.

**CAUTION Verify the suitability and accuracy of the PSCC instrument with the manufacturer.**

**8.4.3** Information on three-phase PSCC can also be obtained from graphs, tables and computer programs, suppliers of equipment, or can be calculated using the following formula:

$$\text{PSCC} = \frac{V}{\sqrt{3} \times Z_{\text{total}}}$$

where

$V$ is the phase-to-phase voltage, in volts;

$Z_{\text{total}}$ is the total impedance of the upstream network, in ohms (Ω) (including, for example, the source transformer impedance and the impedance of a phase conductor).

**8.4.4** The source transformer impedance can be calculated using the following formula:

$$Z_{\text{transformer}} = \frac{V^2}{P \times 10^3} \times \frac{Z_{\%}}{100}$$

where

| | |
|---|---|
| $Z_{\text{transformer}}$ | is the source transformer impedance, in ohms (Ω); |
| $P$ | is the power of the transformer, in kilovolt-amperes (kVA); |
| $Z_{\%}$ | is the rated short-circuit impedance voltage of the transformer, expressed in percentage (%). |

**8.4.5 A.C. circuits**

In a.c. circuits the impedance of a phase conductor can be calculated using the following formula:

$$Z_{\text{conductor}} = \frac{L\sqrt{R^2 + X^2}}{1\,000}$$

where

| | |
|---|---|
| $Z_{\text{conductor}}$ | is the impedance of the phase conductor, in ohms (Ω); |
| $L$ | is the length of the cable, in metres (m); |
| $R$ | is the conductor resistance, in ohms per kilometre (Ω/km) (see table D.1); |
| $X$ | is the conductor reactance, in ohms per kilometre (Ω/km) (see table D.1). |

NOTE This calculation gives practical and conservative results.

**8.4.6 D.C. circuits**

**8.4.6.1** In d.c. installations where a back-up source of power is provided (such as a battery), all sources shall be taken into account when calculating the prospective short-circuit current (PSCC).

**8.4.6.2** Obtain the estimated prospective short-circuit current of the rectifiers and d.c. generators from the suppliers of the equipment.

**8.4.6.3** The prospective short-circuit current of batteries in ampere (A) can be calculated using the following formula:

$$\text{PSCC} = \frac{E_B}{R_{BBr}}$$

where

$E_B$ is the open-circuit voltage of the batteries; if this information is not known, then use

$E_B = 1{,}05 \times U_{NB}$ V (where $U_{NB} = 2{,}0$ V/cell);

$R_{BBr}$ is the total resistance of the upstream network, in ohms (Ω), including the internal resistance of the battery and the resistance of the conductors;

$R_{BBr} = 0{,}9 \times R_B + R_{BL} + R_y$ Ω (see figure 8.1);

$R_B$ is the internal resistance of the battery;

$R_{BL}$ is the resistance of the battery connections;

$R_y$ is the resistance of the conductors.

NOTE The internal resistance of the battery can be obtained from the manufacturer's data.

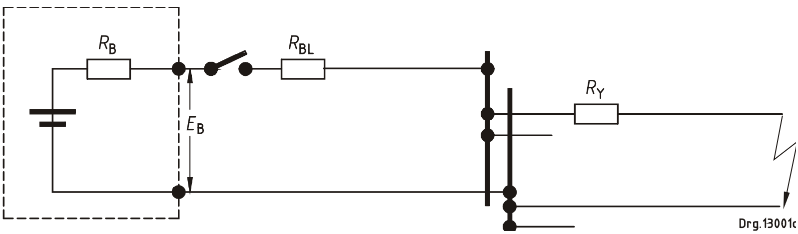



**Figure 8.1 — Resistance components in a battery power source circuit**

**8.4.6.4** Alternatively the estimated PSCC at the battery terminals, as supplied by the manufacturer of the battery, may be used.

## 8.5 Inspection

**8.5.1** Normally, inspection precedes testing and should be done with the installation isolated. Inspect the installation to confirm that equipment has been selected and installed in accordance with this part of SANS 10142 and that equipment is not damaged so as to impair its safety.

**8.5.2** Complete the inspection table in the test report by confirming the statements with "Yes" in the appropriate block. "No" answers to any of the statements will prevent the issuing of the report.

**8.5.3** During the inspection, confirm that

1) accessible components are correctly selected,

2) all protective devices are of the correct rating,

3) all protective devices are capable of withstanding the prospective short-circuit current,

4) conductors are of the correct rating and current-carrying capacity for the protective devices and connected load,

| |
|---|
| **Pay attention to voltage rating, voltage drop, current-carrying capacity and short-circuit capacity**. |

5) components have been correctly installed, and are accessible where necessary,

6) disconnecting devices (isolators) are correctly located and that all switchgear switches the phase conductors,

7) different circuits are separated electrically. Circuits for control communication, security, detection, safety and the like, should be electrically separated and, where specified, physically separated,

8) connections of conductors and earthing and bonding are mechanically sound,

9) connections of conductors and earthing and bonding are electrically continuous,

10) circuits, fuses, switching devices, terminals, earth leakage units, circuit-breakers and distribution boards are correctly and permanently identified, marked or labelled,

**Pay attention to installations where circuit-breakers are used in series-connected (cascaded) systems.**

11) the integrity of the fire barrier has been maintained where an electrical system passes through a fire barrier,

12) safety lighting, emergency lighting and safety signs function correctly,

13)(a) in the case of new installations, or additions or alterations to existing installations, the new, added or altered installation complies with this part of SANS 10142, or

13(b) in the case of installations that existed before the publication of this edition of this part of SANS 10142, the installation complies with the general safety principles of this edition of this part of SANS 10142 and is reasonably safe,

NOTE Indicate (a) or (b) or (a) and (b) on the test report.

14) where an alternative supply is installed, it complies with all the requirements in 7.12, and

15) the position of the readily accessible earthing terminal for the earth connection of other services made by installers of such services (see 6.11.5) is indicated on all distribution boards (see 6.6.1.21(e)).

## 8.6 Testing

**Certain tests shall not be carried out in hazardous locations. Due to the characteristics of the intrinsic safety features of equipment, such equipment can be damaged by certain tests. Certain tests might be impractical in existing installations already under power.**

### 8.6.1 General

NOTE Conduct all tests and complete a copy of Section 4: Tests for each distribution board and supply (normal and alternative supplies).

Additional tests may be required for large installations and where alternative supplies are installed.

For the testing of installations that are fully or partially in hazardous or specialized locations, see the relevant standards, and complete the additional report(s) (see 8.7 for medical locations and for hazardous locations).

For cases where multiple tests are required, record the worst-case measurement on the test report.

In the case of failure in any test, the test shall be repeated after the fault has been rectified. Other tests that might have been influenced by the fault shall also be repeated.

Measuring instruments shall be accurate to within 5 % or better.

### 8.6.2 Continuity of bonding

Test the continuity of the bonding between the consumer's earth terminal and all exposed conductive parts using a supply that has a no-load d.c. or a.c. voltage of 4 V to 24 V, and a current of at least 0,2 A. In each case, the resistance shall not exceed 0,2 Ω.

### 8.6.3 Resistance of earth continuity conductor

Use a resistance meter to measure the resistance of the earth continuity conductors between the consumer's earth terminal and the earthing terminals of all points of consumption and switches. The values shall not exceed those given in table 8.1.

**Table 8.1 — Maximum resistance of earth continuity conductor**

| 1 | 2 |
|---|---|
| **Rated current of protective device** | **Maximum resistance of earth continuity path** |
| A | Ω |
| 6,3 | 1,7 |
| 10 | 1,1 |
| 16 | 0,70 |
| 20 | 0,55 |
| 25 | 0,53 |
| 32 | 0,41 |
| 40 | 0,33 |
| 50 | 0,26 |
| 63 | 0,24 |
| 80 | 0,19 |
| 100 | 0,14 |
| 125 | 0,12 |
| 160 | 0,096 |
| 200 | 0,077 |
| 250 | 0,062 |
| 315 | 0,049 |

**All socket-outlets shall be tested by inserting a plug and including the resistance of the earth pin in the measurements.**

### 8.6.4 Continuity of ring circuits

Remove both ends of each live conductor, separate them and test the circuit for continuity. Ensure that the two ends of the live conductor are connected to the same terminal after the test (see 6.6.1.13).

### 8.6.5 Earth fault loop impedance at the main switch

**8.6.5.1** At the main switch, the impedance shall be such that an earth fault current double the rated current (or higher) of the main protective device automatically disconnects the supply to the installation. Table 8.2 indicates the earth fault loop circuits for different distribution systems.

**Table 8.2 — Earth fault loop circuits for different distribution systems**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Electricity supply system earthing** | **Earth fault loop circuit** | | | | |
| | **Source** | **Phase** | **PEN** | **PE** | **Return through earth (soil)** |
| TN-C-S (Figure J.2.1) | **X** | **X** | **X** | | |
| TN-S (Figure J.2.2) | **X** | **X** | | **X** | |
| TT (Figure J.2.3) | **X** | **X** | | | **X** |
| NOTE 1 The items marked X form the loop for the particular supply system earthing.<br><br>NOTE 2 The TT system relies on a low-impedance earth both at the source transformer and at every consumer's installation. This system is impractical in most parts of Southern Africa due to high soil resistivity and conductor losses. It has the added disadvantage that the loss of earth connection is not inherently self-monitoring. The system is not recommended for use in South Africa. | | | | | |

**8.6.5.2** If, for practical reasons, the requirement in 8.6.5.1 cannot be complied with, as an alternative, an earth fault detection and disconnecting device may be installed at the supply to the installation. The earth fault detection and disconnecting device should be so installed that it operates at a current related to the earth fault loop impedance which will limit touch voltages to 25 V under short-circuit fault conditions for a period not exceeding 5 s.

### 8.6.6 Elevated voltage on supply neutral

With the main switch off, measure the voltage between the supply neutral and any earth external to the installation. Notify the supplier if the reading exceeds 25 V.

Disconnect the installation and notify the supplier (see annex H) if the reading exceeds 50 V.

### 8.6.7 Earth resistance

**8.6.7.1** Earth resistance can be determined in accordance with SANS 10199. Where the supplier does not provide an earthing terminal or where an alternative supply is installed, the efficiency of the earthing system can be confirmed by this test in SANS 10199.

**8.6.7.2** Where the supplier provides an earthing terminal, this test is optional.

### 8.6.8 Insulation resistance

NOTE 1 Before power is connected to any new or altered circuit, the test for insulation resistance should be carried out to ensure there is no short-circuit or high impedance faults in the installation, and that it is safe to energize.

NOTE 2 In the case of existing installations where the power may not be switched off from certain circuits in order to carry out this test, the fact that the circuits are subject to the supply voltage can be regarded as evident that the insulation resistance is compliant.

**WARNING: Special precautions are required for medical locations and in hazardous locations (see 7.7 and 7.14).**

**8.6.8.1** When carrying out insulation-resistance tests,

a) use an a.c. or d.c. voltage of at least twice the nominal voltage, with a minimum of 500 V,

   NOTE The working voltage is taken as the maximum of the voltages measured

   a) in the case of a.c., between each phase conductor and either the neutral or the earthing conductor, and

   b) in the case of d.c., between positive and negative conductors.

b) ensure that all fuses are in place and switches and circuit-breakers are in the closed positions. Loads may be disconnected.

   NOTE To prevent damage, ensure that voltage-sensitive electronic equipment such as dimmer switches, touch switches, time delay devices, power controllers, electronic starters for fluorescent lamps, earth leakage units, surge arresters and certain appliances are disconnected so that they are not subjected to the test voltage.

**8.6.8.2** The insulation resistance, measured as follows, shall be at least 1,0 MΩ:

a) to measure the insulation resistance to earth, apply the test voltage between the earth continuity conductor and the whole system of live conductors, or any section of it; and

b) to measure the insulation resistance between the conductors, apply the test voltage

   1) between the phase conductors, and, when relevant,

   2) between the phase conductors and the neutral conductor.

**8.6.8.3** When there are sub-distribution boards and the total insulation resistance is less than 1,0 MΩ, the insulation-resistance test may be carried out by

a) isolating and testing the wiring between the main supply and the sub-distribution boards, and

b) testing, as a separate section, each sub-distribution board connected to all the circuits that it feeds, but the insulation resistance in each section shall be at least 1,0 MΩ.

### 8.6.9 Voltage, main distribution board — no load

With all load switched off, measure the voltage at the point of control. Notify the supplier (see annex H) if the voltage is outside the standard voltage limits (see 5.4.2).

### 8.6.10 Voltage, main distribution board — on load

Switch on the maximum available load (see 8.6.11) and measure the voltage at the point of control. Notify the supplier (see annex H) if the voltage is outside the regulatory limits (see 5.4.2).

### 8.6.11 Voltage at available load

Select the circuit and point of consumption where the worst voltage drop condition is expected. Switch on the maximum available load, but at least 50 % of the circuit load and not less than 2 A, and measure the voltage at that point of consumption. Record the value on the test report. The voltage drop from the point of supply to the point of consumption shall not exceed 5 % (see annex D).

### 8.6.12 Operation of earth leakage units

Ensure that earth leakage protection is installed in each circuit that is required to be so protected. At various points of outlet and for each phase conductor of the outlet, pass an a.c. leakage current equal to the rated earth leakage tripping current (rated residual current) $I_{\Delta n}$ through a resistance connected between a phase conductor and the earth continuity conductor. The circuit is protected if the earth leakage unit trips.

Repeat the test with a leakage current at 50 % of the rated earth leakage tripping current (rated residual current) $I_{\Delta n}$. The earth leakage unit shall not trip.

NOTE This test can be carried out only after power is available at the point of supply.

#### 8.6.13 Earth leakage test button

Press the test button to see that the unit trips.

NOTE The test is intended to check whether the earth leakage unit is operating correctly, not to check its sensitivity.

#### 8.6.14 Polarity at points of consumption

Ensure that

a) all single-pole switching devices, fuses and circuit-breakers have been connected in the phase conductor,

b) the phase terminals in fixed appliances and in all single-phase socket-outlets have been connected to the phase conductor,

c) the centre contact of each Edison-screw lamp holder is connected to the phase conductor, and

d) phase rotation and identification is maintained for three-phase systems on the supply sides of all distribution boards.

#### 8.6.15 Switching devices

Ensure that when switching devices are operated, the circuit is interrupted as intended.

### 8.7 Test reports

The following test reports are applicable:

a) Test report for all electrical installations.

   NOTE this report may be supplemented with the additional report for a medical location.

b) Additional test report for a medical location.

c) Inspection and test report for electrical installations in hazardous locations.

## Test report for all electrical installations

| | | |
|---|---|---|
| **CERTIFICATE OF COMPLIANCE (CoC) NO.** | **Date of issue:** | |
| **Additional pages added** | ☐ **Yes** | ☐ **No** |

**TEST REPORT**
**for ELECTRICAL INSTALLATIONS**
**to SANS 10142-1**

NOTE 1 In terms of South African legislation, the user or lessor is responsible for the safety of the electrical installation

NOTE 2 This report covers only the part of the installation described in section 3.
NOTE 3 This report covers the circuits for fixed appliances, but does not cover the actual appliances, for example stoves, geysers, air conditioning and refrigeration plant and lights.
NOTE 4 Medical and hazardous locations require additional test reports (see 8.7).
NOTE 5 Enter the required information or tick the appropriate block.

**SECTION 1 – LOCATION** (Only required if not provided on Certificate of Compliance)

Physical address: ..............................................................................................................................................................................
Name of building: ..............................................................................................................................................................................

## Test report *(continued)*

**SECTION 2 – INSTALLATION**

Existing certificate: ☐ No. ☐ Yes Date issued: Number:

☐ **Existing installation** ☐ **Alteration/extension** ☐ **New installation** ☐ **Temporary installation**

Type of installation: ☐ Residential ☐ Commercial ☐ Industrial ☐ Common area for multiple users (Sectional title)

☐ Other Describe ..........................................................

**Type of electricity supply system:**
☐ TN-S ☐ TN-C-S ☐ TN-C ☐ TT ☐ IT

Supply earth terminal provided: ☐ Yes ☐ No

**Characteristics of supply:**

| | | | | |
|---|---|---|---|---|
| Voltage: | ☐ 230 V | ☐ 400 V | ☐ 525 V | ☐ Other:............ V |
| Number of phases: | ☐ One | ☐ Two | ☐ Three | |
| Phase rotation | ☐ Clockwise | ☐ Anticlockwise | | |
| Frequency: | ☐ 50 Hz | ☐ Other:……….. | ☐ d.c. | |

Prospective short-circuit current at point of control (PSCC): ………..kA
How determined? ☐ Calculated ☐ Measured ☐ From supplier

**Main switch type:**
☐ Switch disconnector (on-load isolator) ☐ Fuse switch ☐ Circuit-breaker
☐ Earth leakage circuit-breaker ☐ Earth leakage switch disconnector
Number of poles: …. Current rating: ……A Short-circuit/withstand rating: ………..kA

Rated earth leakage tripping current $I_{\Delta n}$: ☐ 30 mA ☐ Other ………..mA
Surge protection (see 6.7.6 and annex I): ☐ Yes ☐ No
Is alternative power supply installed? (See 7.12.) ☐ Yes ☐ No
Is any part of the installation a specialized electrical installation? ☐ Yes ☐ No
If yes, complete additional test reports (see 8.7)
Is any part of the installation at a voltage above 1 kV? ☐ Yes ☐ No
If yes, competent person to approve design and complete additional test reports (see 8.5.3 and SANS 10142-2)
Is this installation one of five or more on the same new supply? ☐ Yes ☐ No
If yes, name of the competent person who supervised the installation (see 8.1.3): ...................................

**Test report** *(continued)*

**SECTION 3 – DESCRIPTION OF INSTALLATION COVERED BY THIS REPORT**
(Add additional pages, specification references or drawings (layout of installation on premises), etc., where applicable)
.................................................................................................................................................................................................
.................................................................................................................................................................................................
.................................................................................................................................................................................................

**NUMBER OF CIRCUITS OR POINTS COVERED BY THIS REPORT**

| Circuits | Existing installation | | | | | New/altered/temporary installation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Main distribution board | Sub-distribution boards | | | | Main distribution board | Sub-distribution boards | | | |
| Lighting circuits | | | | | | | | | | |
| Lighting points | | | | | | | | | | |
| Socket-outlet circuits | | | | | | | | | | |
| Sockets-outlets | | | | | | | | | | |
| Three-phase socket-outlet circuits | | | | | | | | | | |
| Three-phase socket-outlets | | | | | | | | | | |
| Socket-outlets for critical application circuits | | | | | | | | | | |
| Socket-outlets for critical applications | | | | | | | | | | |
| Mixed circuits (number of) | | | | | | | | | | |
| Motor circuits | | | | | | | | | | |
| Control circuits | | | | | | | | | | |
| Air-conditioning circuits | | | | | | | | | | |
| Motor-controlled assembly circuits | | | | | | | | | | |

**Test report** *(continued)*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Transformer circuits: | Lighting | | | | | | | | | | |
| | Bell | | | | | | | | | | |
| | Other | | | | | | | | | | |
| Heating circuits | | | | | | | | | | | |
| Fan circuits | | | | | | | | | | | |
| Elevator/escalator circuits | | | | | | | | | | | |
| Signage circuits | | | | | | | | | | | |
| Fixed appliance circuits: | Cooking | | | | | | | | | | |
| | Geyser | | | | | | | | | | |
| | Pool pump | | | | | | | | | | |
| | Borehole pump | | | | | | | | | | |
| | Other | | | | | | | | | | |
| Earth leakage: | Main switch | | | | | | | | | | |
| | Only socket-outlets | | | | | | | | | | |
| Overhead busbars | | | | | | | | | | | |
| Alternative power supply connections | | | | | | | | | | | |
| Other circuits | | | | | | | | | | | |

**Test report** *(continued)*

| SECTION 4 – INSPECTION AND TESTS (new and existing installations) / Additional tests added | ☐ Yes ☐ No | ☐ N/A |
|---|---|---|
| **Inspection**<br>NOTE Answer "Yes" or "N/A". The report shall not be issued if any "No" answers appear. | **Existing installation** | **New/altered/ temporary installation** |
| 1 Accessible components are correctly selected | | |
| 2 All protective devices are of correct rating | | |
| 3 All protective devices are capable of withstanding the prospective fault level | | |
| 4 Conductors are of the correct rating and current-carrying capacity for the protective devices and connected load | | |
| 5 Components have been correctly installed | | |
| 6 Disconnecting devices are correctly located and all switchgear switches the phase conductors | | |
| 7 Different circuits are separated electrically | | |
| 8 Connection of conductors and earthing and bonding are mechanically sound | | |
| 9 Connection of conductors and earthing and bonding are electrically continuous | | |
| 10 Circuits, fuses, switches, terminals, earth leakage units, circuit-breakers, distribution boards are correctly and permanently marked or labelled | | |
| 11 Where an electrical circuit passes through a fire barrier, the integrity of the fire barrier has been maintained | | |
| 12 Safety and emergency lighting and signs are functioning correctly | | |
| 13(a) In the case of new installations, or additions or alterations to existing installations, the new, added or altered installation complies with this part of SANS 10142,<br>**or**<br>13(b) In the case of installations that existed before the publication of this edition of SANS 10142, the installation complies with the general safety requirements in this edition of this part of SANS 10142 and is reasonably safe<br><br>NOTE 1 Confirm (a) or (b) or (a) and (b) on the test report.<br><br>NOTE 2 Confirm N/A in the case of (a) or (b), where applicable. | | |
| 14 Where an alternative supply is installed, it complies with the requirements in respect of connections, change-over switch and indicator. | | |
| 15 The position of the readily accessible earthing terminal for earth connections of other services by installers of such services (see 6.11.5) is indicated on the distribution board (see 6.6.1.21(e) | | |

## **Test report** *(continued)*

| **Tests**<br>**Carry out all the tests for the main distribution board.**<br>**Also conduct all tests and complete copies of the tests for each distribution board and for each supply (normal and alternative supplies), and attach as annexes to this report.** | **Units** | **Instrument** | **Reading/result** | |
|---|---|---|---|---|
| | | | **Existing installation** | **New/altered/ temporary installation** |
| 1 Continuity of bonding | Ω | | | |
| 2 Resistance of earth continuity conductor | Ω | | | |
| 3 Continuity of ring circuits (if applicable) | – | | | |
| 4 Earth loop impedance test: | Ω | | | |
| 5 Prospective short-circuit current | | | | |
| Indicate: .....kA ☐Calculated ☐ Measured ☐From supplier | | | | |
| 6 Elevated voltage between incoming neutral and external earth (ground) | V | | | |
| 7 Earth resistance at electrode (if required) | Ω | | | |
| 8 Insulation resistance | MΩ | | | |
| 9 Voltage at main distribution board with no load for each phase to neutral | V | | For | each |
| 10 Voltage at main distribution board with load (as calculated for full load) for each phase to neutral | V | | For | each |
| 11 Voltage at available load (worst condition as calculated for full load) for each phase to neutral | V | | | |
| 12 Operation of all earth leakage units | mA | | | |
| 13 Operation of all earth leakage test buttons | – | | correct ☐ | correct ☐ |

| | | | | | | |
|---|---|---|---|---|---|---|
| 14 Polarity of points of consumption | – | | correct | | correct | |
| 15 Phase rotation at points of consumption for three-phase systems | – | | correct | | correct | |
| 16 All switching devices, make-and-break circuits | – | | correct | | correct | |

Comments: ..............................................................................................................................................................

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

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

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

Comments on parts of the installation not covered by this report: ..............................................................................................

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

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

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

## Test report *(continued)*

**SECTION 5 – RESPONSIBILITY**

NOTE For existing installations, complete only 5.4. For new/altered/temporary installations, if no signature appears in 5.1 to 5.3, the signatory of 5.4 takes responsibility. Where there are five or more installations on the same supply, a competent person signs 5.5.

**5.1 DESIGN.** I, being the person responsible for the DESIGN of the electrical installation, particulars of which are described in section 3 of this form, CERTIFY that the work for which I have been responsible, is to the best of my knowledge and belief in accordance with the relevant legislation. The extent of my liability is limited to the installation described in section 3 of this form.

For the DESIGN of the installation:

Name (in block letters): ....................................................................

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

Signature: ...................................

Profession Registration No.(where applicable): ………………………………

Position: ...............................................................................................

Address: ...............................................................................................

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

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

Date: …………………………………………………………………

**5.2 MATERIAL SPECIFICATION/PROCUREMENT**. I/We, being the person(s) responsible for the MATERIAL SPECIFICATION/PROCUREMENT for the electrical installation, particulars of which are described in section 3 of this form, CERTIFY that the equipment that I/we have procured, is to the best of my/our knowledge and belief in accordance with the relevant legislation. The extent of liability of the signatory is limited to the installation described in section 3 of this form.

For the MATERIAL SPECIFICATION/PROCUREMENT

Name (in block letters): ............................................................

For and on behalf of:................................................................

Signature: ..........................................................................

Date: ..........................................................................

Position: ... ........................................................................... ..

Address: ...............................................................................

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

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

## Test report *(continued)*

**5.3 CONSTRUCTION**. I/We, being the person(s) responsible for the CONSTRUCTION of the electrical installation, particulars of which are described in section 3 of this form, CERTIFY that the work for which I/we have been responsible, is to the best of my/our knowledge and belief in accordance with the relevant legislation. The extent of liability of the signatory is limited to the installation described in section 3 of this form.

For the CONSTRUCTION of the installation:

Name (in block letters): ......................................................................... .......... Date of registration: ………………………...

Electrical Contractor's Registration Number: ……………………………………… Expiry date of registration: …………………

or

Employer name: ……………………………………………………………………… Employee no.: …………………………..

For and on behalf of contractor: .........................................................................

Signature: ............................................................................... Date: ……………………………………

**5.4 INSPECTION AND TESTS.** I, being the person responsible for the INSPECTION AND TESTING of the electrical installation, particulars of which are described in section 3 of this form, CERTIFY that the inspection and testing were done in accordance with this part of SANS 10142, that the results obtained and reflected on this report are correct, and indicate

☐ (for installation work performed since the publication of this part of SANS 10142), compliance with this standard, or

☐ (for an installation that existed before the publication of this part of SANS 10142), that the installation complies with the general safety principles of this standard and is reasonably safe.

The extent of my liability is limited to the installation described in section 3 of this form.

Name of registered person: ……………………………………….
(in block letters) Registration certificate No.: ...........................................................

Type of registration: ☐ Master installation electrician ☐ Installation electrician ☐ Single-phase tester

Signature: ......................................................................................... Date: ……………………………………………………………

Tel. No.: ..........................................................................................

## Test report *(concluded)*

**5.5 COMPLIANCE OF INSTALLATION FROM COMMENCEMENT TO COMMISSIONING.**
(This part is only required in case of a new point of supply which is intended to supply five or more users)

I.......................................................................... being the person responsible to ensure that the electrical installation, particulars of which are described in section 3 of this form and which is intended to supply one of five or more users from the same new point of supply, CERTIFY that the installation was done in accordance with SANS 10142-1.

| | | |
|---|---|---|
| ☐ An Approved Inspection Authority for electrical installations | Chief Inspector's registration No.: ................................................................ | |
| ☐ A competent person as defined | Indicate competency: .................................................................................. | |
| ☐ A professionally registered person | Category of professional registration: ...................................................... | Registration No.: .............................. |
| Name (in block letters): ..........................................................................<br>Signature: ..........................................................................................<br>Date: ................................................................................................. | Address: ...............................................................................................<br>...............................................................................................................<br>............................................................................................................... | |

## Additional test report for a medical location (see 7.7)

**Additional test report for a medical location**
(To be attached to the test report and the Certificate of Compliance)

| | |
|---|---|
| **CERTIFICATE OF COMPLIANCE (CoC) NO.:** | **Date of issue:** |

**1 Classification of a medical location**

Medical location group: ........................................................................................................ Date:..................................

List of hazardous substances:

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

Gas group: .................................. Max. permissible temp.: _______ Zone(s): .................................................
T1 to T6

Classified by (signature): ...................................................... Print name: ........................................ Position: ..........................

Accepted by (signature): ...................................................... Print name: ........................................ Position: ..........................

**2 Visual inspections**

| | **Item(s)** | **Yes** | **No** |
|---|---|---|---|
| 2.1 | Classification of medical locations correct (see annex L) | | |
| 2.2 | Classification of medical location group correct (see annex L) | | |
| 2.3 | Labelling of distribution boards | | |
| 2.4 | Safety transformer(s) installed Capacity ______ kW | | |
| 2.5 | Medical IT system | | |
| 2.6 | Supply: | | |
| | Normal | | |
| | Safety | | |
| | Emergency | | |
| 2.7 | Emergency power supplies – automatic changeover installed | | |

## Additional test report for a medical location *(concluded)*

| | **Item(s)** | Yes | No |
|---|---|---|---|
| 2.8 | Bonding (separate insulated earth conductors) | | |
| 2.9 | Insulation-monitoring devices for IT systems | | |
| | Visual | | |
| | Audible | | |
| 2.10 | Lighting circuits – safety lighting | | |
| 2.11 | Socket-outlets – labelling | | |
| 2.12 | Explosive risks | | |
| 2.13 | Documentation | | |
| **3 Measurements and tests** | | **Results** | |
| 3.1 | Verify the integrity of safety services | | |
| 3.2 | Medical IT transformer(s) leakage current in no-load condition (by measurement) of: | | |
| | the output circuit | | |
| | the enclosure | | |
| 3.3 | Functioning of: | | |
| | emergency power supply (2.7) | | |
| | safety lighting (2.10) | | |
| 3.4 | Safety transformer no-load leakage current mA | | |
| 3.5 | Verify compliance of the supplementary equipotential bonding (by measurements) | | |
| 3.6 | Verify the integrity of the facilities required for equipotential bonding | | |
| 3.7 | Functioning of: visual alarm system | | |
| | audible alarm system | | |
| Name of Master Installation Electrician: | Identification No.: | Signature: | |

## Inspection and test report for electrical installations in hazardous locations

| | | |
|---|---|---|
| **INSPECTION AND TEST REPORT FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS IN ACCORDANCE WITH SANS 10142-1, SANS 10108 AND SANS 60079 SERIES, SANS 10086-1** | **COC No.:** | |
| | **Date of issue:** | |

***(Print test report on white paper only)***

**NOTE 1** In terms of South African legislation, the user or lessor is responsible for the safety of the electrical installation.
**NOTE 2** This report covers only that part of the installation described in Section 3.
**NOTE 3** This report covers the circuits to all machinery (including the equipment installation, selection and environment in hazardous locations only)
**NOTE 4** Enter the required information or tick the appropriate block.

**SECTION 1 – LOCATION**

Name of company: ……………………………………………………………………………………………………………………

Name of building/Plant: ……………………………………………………………………………………………

| | |
|---|---|
| Technical Identification: ……………………………………………… | Other names or numbers:…………………... |
| Description: ……………………………………...……...……...… | ………………………………………………… |
| ……………………………………………………………...……...…… | ………………………………………………… |
| ……………………………………………………………………………… | ………………………………………………… |

**SECTION 2 – INSTALLATION**

Existing Certificate: ☐ Yes ☐ No Date issued: ………………………………………
Number: ………………………………………

| | | | |
|---|---|---|---|
| ☐ Existing installation | ☐ Alteration/Extension | ☐ New installation | ☐ Temporary installation |

**Type of electricity supply system (See SANS 60079-14)**:

| | | | |
|---|---|---|---|
| ☐ TN-S | ☐ TN-C-S | ☐ TT | ☐ IT |

| | | | |
|---|---|---|---|
| Supply earth terminal provided? | ☐ Yes | ☐ No | |

**Estimated year of installation**: ………………………………………………………………………………

**Characteristics of supply**: ……………………………………………………………………………………

| | | | | | | |
|---|---|---|---|---|---|---|
| Voltage | ☐ 230 V | | ☐ 400 V | ☐ 525 V | | ☐ Other: ………………… |
| Number of phases | ☐ One | ☐ Two | ☐ Three | Phase rotation | ☐ Clockwise | ☐ Anticlockwise |
| Frequency | ☐ 50 Hz | | ☐ Other: …………………… | | | |

## Inspection and test report for electrical installations in hazardous locations *(continued)*

| | | | | | |
|---|---|---|---|---|---|
| **Main switch type**: | | | | | |
| ☐ Switch disconnector (on load isolator) | | ☐ Fuse switch | | ☐ Circuit breaker | |
| ☐ Earth Leakage switch disconnector | | ☐ Earth Leakage Circuit Breaker (ELCB) | | | |
| Number of poles | | Current rating | A | Short circuit withstand rating | kA |
| Rated earth leakage withstand rating / IΔn | 15 – 30mA | | Other :………………………… mA | | |
| Surge protection required (see 5.4.3, 6.7.6 and Annex I1)? | ☐ Yes | ☐ No | ☐ Reason ……………………………… | | |
| Is alternative power supply installed (see 7.12)? | ☐ Yes | | ☐ No | | |

## Inspection and test report for electrical installations in hazardous locations *(continued)*

| | | |
|---|---|---|
| **INSPECTION AND TEST REPORT FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS IN ACCORDANCE WITH SANS 10142-1, SANS 10108 AND SANS 60079 SERIES, SANS 10086-1** | **COC No.:** | |
| | **Date of issue:** | |

| **SECTION 3 – DESCRIPTION OF INSTALLATION COVERED BY THIS CERTIFICATE (Add additional pages or specifications references, where applicable)** | | |
|---|---|---|
| **Machinery/Equipment** | **Quantity** | **Comments/Attachments** <br> **(e.g. initial inspection report in accordance with section 4.2 below** |
| **Example**: 525 Volt – Ex ec 3 phase induction motor | One | Attachment 1: Initial inspection report, IA certificate, QC8 |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

## Inspection and test report for electrical installations in hazardous locations *(continued)*

| | | |
|---|---|---|
| **INSPECTION AND TEST REPORT FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS IN ACCORDANCE WITH SANS 10142-1, SANS 10108 AND SANS 60079 SERIES, SANS 10086-1** | **COC No.:** | |
| | **Date of issue:** | |

**SECTION 4 (*continued*) – INSPECTION FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS (Additional certificate)**

**4.1 Classification of hazardous location(s)**

| | | | |
|---|---|---|---|
| Hazardous Area Location (Description) | | Date | |
| Drawing number/s | | | |
| List of flammable/ combustible substance/s | | | |

| | | | | | |
|---|---|---|---|---|---|
| Dust Group | | Max. permissible temp.: (T1 to T6) | | Zones(s) | |
| Gas Group | | Max. permissible temp. :(T1 to T6) | | Zones(s) | |

| | | | |
|---|---|---|---|
| Classified by (Print name) | | Position | |

**4.2 Initial detailed inspection of Ex equipment**

**Before commissioning of the equipment, an initial detailed inspection schedule shall be completed for the different protection types, for all equipment installed in hazardous locations in accordance with SANS 60079-14 and SANS 60079-17.**

**4.3 Additional certificate for visual inspection**

**NOTE Answer "Yes" or "N/A". The report shall not be issued if any "No" answers appear.**

| No. | Item(s) | Yes | No |
|---|---|---|---|
| 1 | Has all explosion-protected equipment been correctly selected against the area classification stated above? | | |
| 2 | Has all explosion-protected equipment been correctly installed? | | |
| 3 | Has all explosion-protected equipment been correctly certified and documented? | | |
| 4 | Has all explosion-protected equipment been correctly labelled and marked? | | |
| 5 | Has the electrical equipment been so selected that its maximum surface temperature will not reach the ignition temperature of any gas, vapour or dust which may be present? | | |
| 6 | Has all equipment been correctly protected against overload, overheating and incendive sparking? | | |
| 7 | Have all unused cores in multi-core cables been either connected to earth or insulated by means of terminations suitable for the type of protection in accordance with SANS 60079-14? | | |
| 8 | Have all electrical multi stranded wire connections been crimped in accordance with SANS 60079-14? | | |
| 9 | Has the electrical equipment been so selected or installed (or both) that it is protected against external influences (e.g. pressure, chemical, mechanical and electrical conditions, vibration, thermal ability, | | |

## Inspection and test report for electrical installations in hazardous locations *(continued)*

| | | | |
|---|---|---|---|
| **INSPECTION AND TEST REPORT FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS IN ACCORDANCE WITH SANS 10142-1, SANS 10108 AND SANS 60079 SERIES, SANS 10086-1** | | **COC No.:** | |
| | | **Date of issue:** | |
| **SECTION 4 (*continued*) – INSPECTION FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS (Additional certificate)** | | | |
| **4.1 Classification of hazardous location(s)** | | | |
| | humidity, corrosion) which could adversely affect the explosion protection)? | | |
| 10 | Have sufficient earthing and bonding been done to all explosion-protected equipment, exposed and extraneous mental parts and structures in the hazardous area to prevent intensive sparking caused by static electricity, stray currents and lightning? (See SANS 60079-14) | | |
| 11 | Have all earth connections been secured against self-loosening and steps been taken to minimise the risk of corrosion which may reduce the effectiveness of connection in accordance with SANS 60079-14? | | |
| 12 | Are all openings in walls for cables and conduits between different hazardous areas and between hazardous and non-hazardous areas adequately sealed in accordance with SANS 60079-14? | | |
| 13 | Have all cable systems and accessories been so installed, as far as is practicable, in positions that will prevent them being exposed to mechanical damage, to corrosion or chemical influences (for example solvents), to the effects of heat and to the effects of UV radiation? | | |

## Inspection and test report for electrical installations in hazardous locations *(continued)*

| | | | |
|---|---|---|---|
| **INSPECTION AND TEST REPORT FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS IN ACCORDANCE WITH SANS 10142-1, SANS 10108 AND SANS 60079 SERIES, SANS 10086-1** | | **COC No.:** | |
| | | **Date of issue:** | |
| **SECTION 4 (*continued*) – INSPECTION FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS (Additional certificate)** | | | |
| **4.3. Additional certificate for visual inspection *(continued)*** <br><br> **NOTE Answer "Yes" or "N/A". The report shall not be issued if any "No" answers appear.** | | | |
| No. | Item(s) | Yes | No |
| 14 | Have barrier glands been installed in flameproof equipment with a volume greater than 2 Litres? | | |
| 15 | Is area protection against corrosion of flameproof joints being maintained in accordance with the manufacturer's documentation? The use of gaskets is only permissible when specified in the manufacturer's documentation (Flameproof joints shall not be painted)? | | |
| 16 | Are all motors supplied at varying frequency and voltage by a converter supply? Have they been type-tested for this duty as a unit in association with the converter specified in the descriptive documents according to SANS 60079-0, and with the protective device provided, or direct temperature control by embedded temperature sensors specified in the motor documentation, or other effective measures for limiting the surface temperature of the motor housing being used? | | |
| 17 | Has the cable armour been bonded to the equipotential bonding system via the cable entry devices or equivalent, at each end of the cable run? | | |
| 18 | Does the installed equipment comply with the special conditions of use as in accordance with the IA certificate? | | |
| 19 | Are all protective devices capable of withstanding the prospective fault level? | | |
| 20 | Are conductors of the correct rating and current-carrying capacity for the protective devices and connected load? | | |
| 21 | Are all disconnecting devices correctly located and can they switch the phase conductors? | | |
| 22 | Have different circuits been separated electrically? | | |
| 23 | Is the connection of conductors, earthing and bonding mechanically sound and electrically continuous? | | |
| 24 | Have circuits, fuses, switches, terminals, earth-leakage units, circuit-breakers, and distribution boards been correctly and permanently marked or labelled? | | |
| 25 | Is the integrity being maintained where an electrical circuit passes through a fire barrier? | | |
| 26 | Are safety and emergency lighting and signs functioning correctly? | | |
| 27 | **(a)** In the case of new installations, or additions or alterations to existing installations, the new, added or altered installation complies with this part of SANS 10142. | | |
| | **(b)** In the case of installations that existed before the publication of this edition of SANS 10142, the installation complies with the general safety requirements in this edition of this part of SANS 10142 and is reasonably safe. | | |

## Inspection and test report for electrical installations in hazardous locations *(continued)*

| | | | |
|---|---|---|---|
| **INSPECTION AND TEST REPORT FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS IN ACCORDANCE WITH SANS 10142-1, SANS 10108 AND SANS 60079 SERIES, SANS 10086-1** | | **COC No.:** | |
| | | **Date of issue:** | |
| **SECTION 4 (*continued*) – INSPECTION FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS (Additional certificate)** | | | |
| | NOTE 1 Confirm (a) or (b) or (a) and (b) on the test report.<br>NOTE 2 Confirm N/A in the case of (a) or (b), where applicable. | | |
| 28 | Where an alternative supply is installed, does it comply with the requirements in respect of connections, change-over switch and indicator? | | |
| 29 | Is the position of the readily-accessible earthing terminal for earth connections of other services by installers of such services (see 6.11.5) indicated on the distribution board (see 6.6.1.21(e))? | | |
| Comments: | | | |
| | | | |
| | | | |
| | | | |
| | | | |

## Inspection and test report for electrical installations in hazardous locations *(continued)*

| | | | | |
|---|---|---|---|---|
| **INSPECTION AND TEST REPORT FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS IN ACCORDANCE WITH SANS 10142-1, SANS 10108 AND SANS 60079 SERIES, SANS 10086-1** | | | **COC No.:** | |
| | | | **Date of issue:** | |
| **SECTION 5 – TESTS (new and existing installations)** | | | | |
| NOTE Carry out all the tests for the main distribution board. Also conduct all tests and complete copies of the tests for each distribution board and for each supply (normal and alternative supplies), and attach as annexes to this report. | | | | |

| | | Unit/s | Instrument | Reading/result |
|---|---|---|---|---|
| 1 | Continuity of bonding | Ω | | |
| 2 | Resistance of earth continuity conductor | Ω | | |
| 3 | Continuity of ring circuits (if applicable) | – | | |
| 4 | Earth loop impedance test: at main switch | Ω | | |
| 5 | Prospective short-circuit current at point of control (PSCC) for distribution boards<br>Indicate: Calculated [ ] Measured [ ] From supplier [ ] | kA | | |
| 6 | Elevated voltage between incoming neutral and external earth (ground) | V | | |
| 7 | Earth resistance (if required) | Ω | | |
| 8 | Insulation resistance | MΩ | | |
| 9 | Voltage at main distribution board with no load for each phase to neutral | V | | R Y B |
| 10 | Voltage at main distribution board with load (as calculated for full load) for each phase to neutral | V | | R Y B |
| 11 | Voltage at available load (worst condition as calculated for full load) for each phase to neutral | V | | R Y B |
| 12 | Operation of earth leakage units | mA | | Correct |
| 13 | Operation of earth leakage test buttons | – | Test button | Correct |
| 14 | Polarity of points of consumption | – | | Correct |
| 15 | Phase rotation at points of consumption for three-phase systems | – | | |
| 16 | All switching devices, make-and-break circuits | – | Function test | Correct |
| Comments: | | | | |
| | | | | |
| Comments on parts of the installation not covered by this report: | | | | |

## Inspection and test report for electrical installations in hazardous locations *(continued)*

| | | |
|---|---|---|
| **INSPECTION AND TEST REPORT FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS IN ACCORDANCE WITH SANS 10142-1, SANS 10108 AND SANS 60079 SERIES, SANS 10086-1** | **COC No.:** | |
| | **Date of issue:** | |
| **SECTION 6 – INFORMATION SKETCHES/DIAGRAMS** | | |
| **This page is intentionally left open. It is provided for the registered person to include DB line diagrams, cable reticulation diagrams, fault level calculations, or a sketch of the original or additional installation, to assist in determining the extent of the original/extended or altered installation or both.**<br>Note Record drawing number and revision on this page, if available. | | |
| | | |

## Inspection and test report for electrical installations in hazardous locations *(continued)*

| | | |
|---|---|---|
| **INSPECTION AND TEST REPORT FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS IN ACCORDANCE WITH SANS 10142-1, SANS 10108 AND SANS 60079 SERIES, SANS 10086-1** | **COC No.:** | |
| | **Date of issue:** | |

**SECTION 7 – RESPONSIBILITY**

**NOTE For existing installations, complete only 7.4. For new/altered/temporary installations, if no signature appears in 7.1 to 7.3, the signatory of 7.4 takes responsibility.**

**7.1 DESIGN**. I/We, being the person(s) responsible for the DESIGN of the electrical installation, particulars of which are described in section 3 of this form, CERTIFY that the work, for which I/we have been responsible, is to the best of my/our knowledge and belief in accordance with the relevant legislation. The extent of liability of the signatory is limited to the installation described in section 3 of this form.
**For the DESIGN of the installation**:

Name (in block letters): ……………………………………………… Position: …………………………………

Professional Registration No: ………………………………………………………………

For and on behalf of company: ………………………………………… CIPC No: ………………………………………

Address: ……………………………………………………………………… Email: ……………………………………………

Signature: ……………………………….. Tel/Cell No.: …………………………… Date: ……………………………………

**7.2 MATERIAL SPECIFICATION/ PROCUREMENT**. I/We, being the person(s) responsible for the MATERIAL SPECIFICATION/ PROCUREMENT for the electrical installation, particulars of which are described in section 3 of this form, CERTIFY that the equipment that I/we have procured is to the best of my/our knowledge and belief in accordance with the relevant legislation. The extent and liability of the signatory is limited to the installation described in section 3 of this form.
**For the MATERIAL SPECIFICATION/ PROCUREMENT**:

Name (in block letters): ………………………………………………… Position: ……………………………………………

Professional Registration No.: ………………………………………………………………

For and on behalf of company ……………………………………………… CIPC No.: ………………………………………

Address: ……………………………………………………………………… Email: ………………………………………………

Signature: ……………………………………….. Tel/Cell No.: ……………………… Date: …………………………………

## Inspection and test report for electrical installations in hazardous locations *(continued)*

**7.3 CONSTRUCTION.** I/We, being the person(s) responsible for the CONSTRUCTION of the electrical installation, particulars of which are described in section 3 of this form, CERTIFY that the work for which I/we have procured is to the best of my/our knowledge and belief in accordance with the relevant legislation. The extent and liability of the signatory is limited to the installation described in section 3 of this form.
**For the MATERIAL SPECIFICATION/ PROCUREMENT**:

Name (in block letters): ……………………………………………… Position: ………………………………………………

For and on behalf of company: …………………………………………… CIPC No: …………………………………………

Address: ………………………………………………………………… Email: ………………………………………………

Contractors registration No. with the Chief Inspector/ECB: …………………………………………………..…………………

Date of current registration with DOL: ………………………………………….. Tel/Cell No.: ………………………………

Signature: ………………………………………………………………………….Date: ………………………………………

## Inspection and test report for electrical installations in hazardous locations *(concluded)*

| | | |
|---|---|---|
| **INSPECTION AND TEST REPORT FOR ELECTRICAL INSTALLATIONS IN HAZARDOUS LOCATIONS IN ACCORDANCE WITH SANS 10142-1, SANS 10108 AND SANS 60079 SERIES, SANS 10086-1** | **COC No.:** | |
| | **Date of issue:** | |

**SECTION 7 – RESPONSIBILITY *(continued)***

**NOTE For existing installations, complete only 7.4. For new/altered/temporary installations, if no signature appears in 7.1 to 7.3, the signatory of 7.4 takes responsibility.**

**7.4 INSPECTION AND TESTS.** I/We, being the person(s) responsible for the INSPECTION AND TESTING of the electrical installation, particulars of which are described in section 3 of this form, CERTIFY that the inspection and testing were done in accordance with SANS 10142-1, SANS 10108 and SANS 60079 series, that the results given are correct and indicate

☐ (for installation work performed since the publication of this part of the requirements of 7.14 of SANS 10142-1), or

☐ (for an installation existing before publication of this part of SANS 10142),

that the hazardous installation complies with the general safety principles of SANS 10142-1 and is reasonably safe.

The extent of liability of the signatory is limited to the installation described in section 3 of this form.

Name of registered person: ………………………………………………….. Identification No.: …………………..........…

MIE Registration No.: …………………...................…………. DOL Annual Registration Date: ………………….................

DOL Registration No.: ……………………………………………. COC number: …………………………………………......

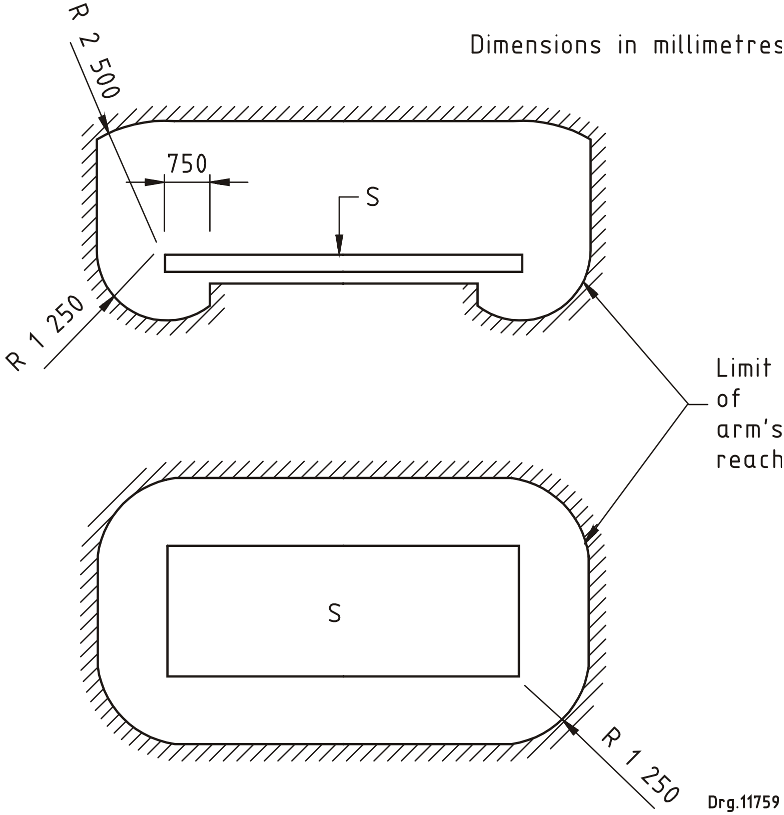
For and on behalf of company: ……………………………… Email: ……………………….. Address: ………....................

Signature: ……………………………………………………………… Date: ……………………………………………………

Recipient Name: …………………….. Date: ……………………….. Signature: ……………………

# Annex A
(informative)

## Limits of arm's reach




S is the surface expected to be occupied by persons.

**Figure A.1 — Limits of arm's reach**

# Annex B
(informative)

## Installation components

### B.1 Installation components — Standards for service connections

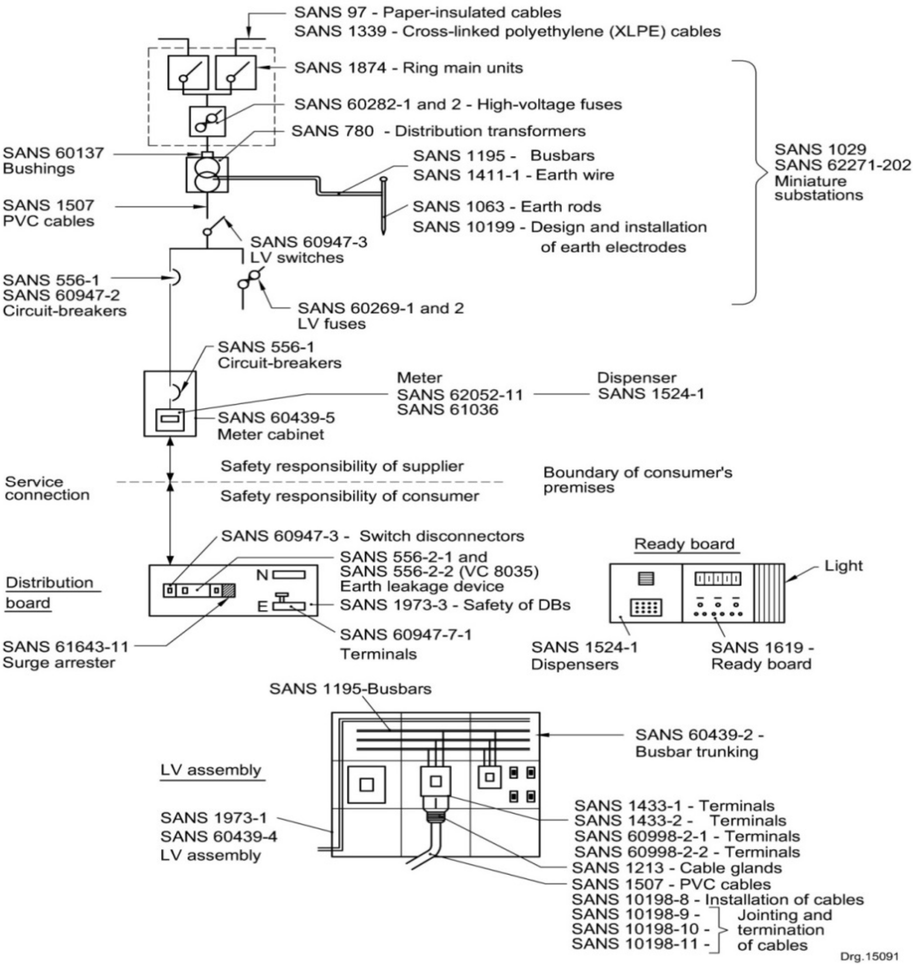



**Figure B.1 — Installation components up to the main distribution board**
(see table 4.1 — High-voltage equipment not included)

## B.2 Installation components — Standards for fixed electrical installations

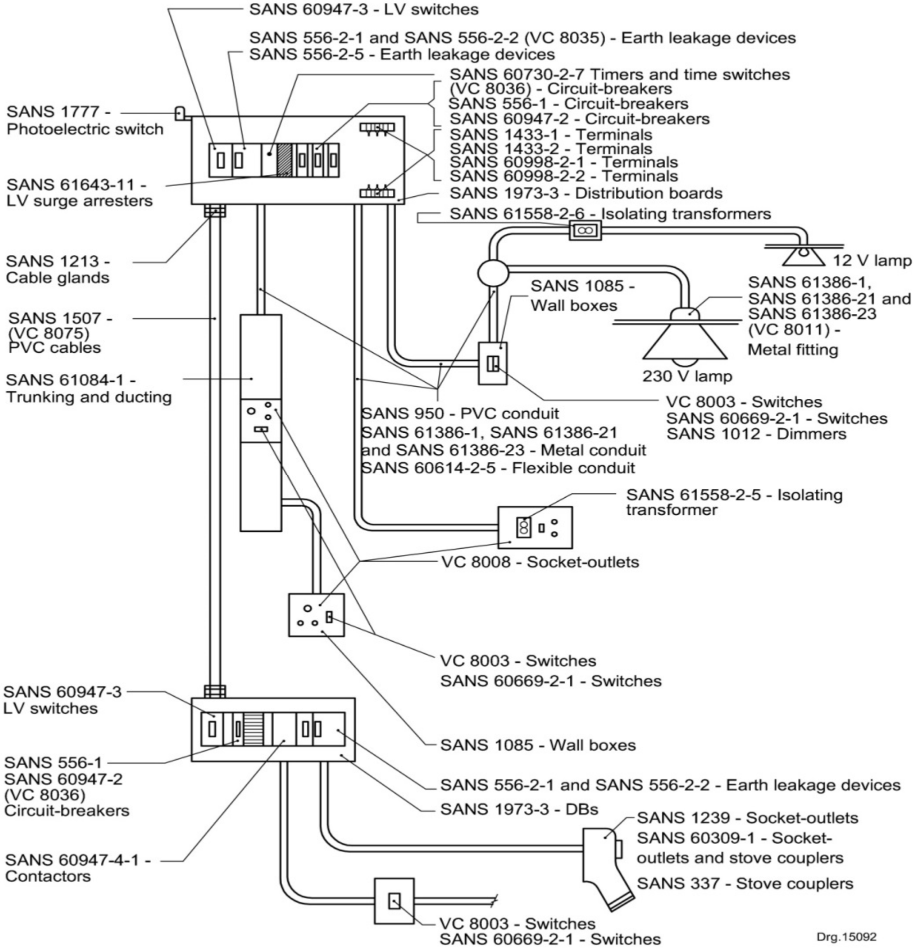



**Figure B.2 — Installation components from the point of control to the point of consumption**
(see table 4.-1)

# Annex C
(informative)

# Example of assessing estimated load for residential type installations

## C.1 Estimated load

The estimated load of an installation for a private residence or a flat can be assessed by calculating the connected load in accordance with C.2 and applying the diversity factors given in C.3. If electrical energy is used for more than one purpose, obtain the estimated load by adding together the estimated loads for each purpose.

NOTE The above applies to installations that do not need special consideration.

## C.2 Connected load

**C.2.1** The connected load can be determined by adding together the load, in kilowatts, of all

a) power-consuming equipment that is connected in the installation, and

b) equipment that could be connected to the installation by using the means provided.

**C.2.2** The value of the connected load can be estimated by using the following values:

a) for each lamp, at least 60 W;

b) for socket-outlets, 5 kW for the first 100 m² (under cover) and 1 kW for each additional 100 m² or part of 100 m²; and

c) for water heaters and all other equipment, the total rated load.

## C.3 Diversity factors

NOTE The diversity factors given in (a) to (c) below are examples only; the values are not to be regarded as the only ones that can be used.

The appropriate of the following diversity factors can be applied to the connected load to assess the estimated load:

a) for appliances:

1) lighting, heating, cooking and socket-outlet loads : 0,50;

2) water heater loads and all motor loads : 1,00;

b) for blocks or groups of housing units:

| | | | |
|---|---|---|---|
| 1 unit per phase | : 1,00 | 9 units per phase | : 0,46 |
| 2 units per phase | : 0,72 | 10 units per phase | : 0,45 |
| 3 units per phase | : 0,62 | 15 units per phase | : 0,42 |
| 4 units per phase | : 0,57 | 20 units per phase | : 0,40 |
| 5 units per phase | : 0,53 | 30 units per phase | : 0,38 |
| 6 units per phase | : 0,50 | 40 units per phase | : 0,37 |
| 7 units per phase | : 0,48 | 50 units per phase | : 0,36 |
| 8 units per phase | : 0,47 | 100 units per phase | : 0,34 |

c) for elevators:

| | |
|---|---|
| 1 elevator | : 1,00 |
| 2 elevators | : 0,75 |
| 3 or more elevators | : 0,60 |

# Annex D
(informative)

# Calculation of voltage drop

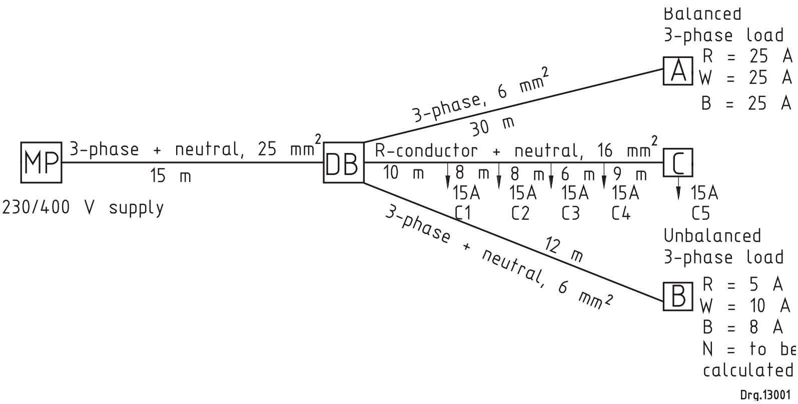
## D.1 The calculation of voltage drop

### D.1.1 Example of determining the voltage drop due to specific loads by using the tables 6.2 to 6.9

Calculate the voltage drop at each point of consumption indicated in figure D.1 and determine if the cable selection is correct.

Assume the following case:

Multicore armoured PVC insulated cables are installed and buried directly in the ground. The following example assumes that the cables stated will result in a total voltage drop of less than 5 %.




MP is the meter point
DB is the distribution board
A is a balanced three-phase load (point of consumption)
B is an unbalanced three-phase load (point of consumption)
C is a single-phase circuit feeding different loads at different points
(Maximum loads are indicated at each point of consumption – C1 to C5)

NOTE 1 All conductors are copper.

NOTE 2 Phase and neutral conductors have the same nominal cross-sectional area.

NOTE 3 All circuits are fully loaded and at unity power factor to represent the worst-case voltage drop.

NOTE 4 In the case of single-phase circuits, the return path has been accounted for in the values given in tables 6.2(b), 6.3(b), 6.4(b), 6.5(b), 6.6(b), 6.7(b) and 6.9(b).

NOTE 5 The effect of voltage drop due to harmonic current has not been considered.

**Figure D.1 — Example of voltage drop calculation for a cable installation with specific loads**

### D.1.2 Circuit DB/A

Consider the 25 A balanced load:

From table 6.8 (current-carrying capacity for PVC insulated armoured copper cables buried in the ground), the 6 $mm^2$ cable selection is in order.

From table 6.4(b) (voltage drop), for a 6 $mm^2$ three-core cable, the voltage drop is 6,4 mV/A/m.

Calculate the cable voltage drop per phase:

Voltage drop = mV/A/m × A × m
= $(6,4 \times 10^{-3}) \times 25 \times 30$
= 4,8 V

### D.1.3 Circuit DB/B

**D.1.3.1** Calculate the voltage drop for each current-carrying conductor.

**D.1.3.2** Calculate voltage drop per phase.

From table 6.4(b) (voltage drop), for a 6 $mm^2$ four-core cable, the voltage drop is 6,4 mV/A/m. Due to the unbalanced load, treat each phase as a single-phase circuit.

| | | |
|---|---|---|
| Red phase | = $(6,4 \times 10^{-3}) \times 5 \times 12$ | = 0,384 V |
| White phase | = $(6,4 \times 10^{-3}) \times 10 \times 12$ | = 0,768 V |
| Blue phase | = $(6,4 \times 10^{-3}) \times 8 \times 12$ | = 0,614 V |

The voltage drop DB to B (worst case in the white phase) = 0,768 V
The voltage drop DB to B in the red phase = 0,384 V

**D.1.3.3** Calculate the neutral current:

$$I = \sqrt{[R^2 + W^2 + B^2] - [(RW) + (RB) + (BW)]}$$

$$= \sqrt{[5^2 + 10^2 + 8^2] - [(5 \times 10) + (5 \times 8) + (10 \times 8)]}$$

$$= \sqrt{[25 + 100 + 64] - [50 + 40 + 80]}$$

$= \sqrt{189 - 170}$

$= \sqrt{19}$

$= 4,4$ A

## D.1.4 Circuit DB/C

Selected cable voltage drop to be repeated for each load point from the previous load point.

From table 6.4(b) (voltage drop), for a 16 mm$^2$ two-core cable single-phase a.c., the voltage drop is 2,8 mV/A/m

DB to C1 voltage drop = $(2,8 \times 10^{-3}) \times (5 \times 15) \times 10$ = 2,10 V
C1 to C2 voltage drop = $(2,8 \times 10^{-3}) \times (4 \times 15) \times 8$ = 1,34 V
C2 to C3 voltage drop = $(2,8 \times 10^{-3}) \times (3 \times 15) \times 8$ = 1,01 V
C3 to C4 voltage drop = $(2,8 \times 10^{-3}) \times (2 \times 15) \times 6$ = 0,50 V
C4 to C5 voltage drop = $(2,8 \times 10^{-3}) \times (1 \times 15) \times 9$ = 0,38 V
Total voltage drop DB to C5 (red phase) = 5,33 V [1]

Consider the total load at DB of the three loads (A + B + C)

| | | |
|---|---|---|
| Red phase | = 25 + 5 + (5 × 15) | = 105 A |
| White phase | = 25 + 10 + 0 | = 35 A |
| Blue phase | = 25 + 8 + 0 | = 33 A |
| Neutral | = 0 + 4,4 + (5 × 15) | = 79,4 A |

## D.1.5 Circuit MP/DB

Assume that it is a balanced three-phase load and the current in all phases is equal to the highest of the three unbalanced phases. Consider the worst case, which is the red phase for the circuit MP/DB.

From table 6.4(b) (voltage drop), for a 25 mm$^2$ four-core cable the voltage drop is 1,5 mV/A/m

Voltage drop = mV × A × m
= $(1,5 \times 10^{-3}) \times 105 \times 15$ = 2,363 V

$$\text{Voltage drop for red phase} = \frac{2{,}363}{\sqrt{3}}$$

$$= 1{,}364 \text{ V} \qquad [2]$$

NOTE For phase-to-neutral voltage drop, see 6.2.7.1.1.

Because the voltage drop will be across both the phase and neutral in the single-phase circuit, both these shall be considered.

The maximum voltage drop (worst case) for the red circuit [(1)] + [(2)]

= 5,33 + 1,364
= 6,694 V

### D.1.6 Total circuit

A maximum of 5 % of 230 V or 11,5 V is allowed in the single-phase circuit. The cable selection was correct.

NOTE The 25 $mm^2$ cable size cannot be reduced as the maximum rating of a 16 $mm^2$ cable is 91 A and the load in the red phase is 105 A.

**Table D.1 — Impedance of 600/1 000 V conductors that comply with SANS 1507**

Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Nominal cross-sectional area of conductor** mm² | **Conductor resistance *R* for a.c. circuits** Ω/km | | **Conductor reactance *X* for a.c. circuits** Ω/km | | **Conductor resistance *R* for d.c. circuits** Ω/km | |
| | **Material of conductor** | | | | | |
| | **Copper Cu** | **Aluminium Al** | **Copper Cu** | **Aluminium Al** | **Copper Cu** | **Aluminium Al** |
| 1 | 21,9 | 36,0 | 0,107 | 0,107 | 21,9 | 36,0 |
| 1,5 | 14,6 | 24,0 | 0,100 | 0,100 | 14,6 | 24,0 |
| 2,5 | 8,7 | 14,4 | 0,095 | 0,095 | 8,7 | 14,4 |
| 4 | 5,5 | 9,0 | 0,093 | 0,093 | 5,5 | 9,0 |
| 6 | 3,6 | 6,0 | 0,090 | 0,090 | 3,6 | 6,0 |
| 10 | 2,2 | 3,6 | 0,084 | 0,084 | 2,2 | 3,6 |
| 16 | 1,4 | 2,3 | 0,080 | 0,080 | 1,4 | 2,2 |
| 25 | 0,88 | 1,44 | 0,079 | 0,079 | 0,87 | 1,44 |
| 35 | 0,63 | 1,03 | 0,076 | 0,076 | 0,62 | 1,03 |
| 50 | 0,44 | 0,72 | 0,076 | 0,076 | 0,44 | 0,72 |
| 70 | 0,31 | 0,52 | 0,074 | 0,074 | 0,31 | 0,51 |
| 95 | 0,23 | 0,38 | 0,073 | 0,073 | 0,23 | 0,38 |
| 120 | 0,18 | 0,30 | 0,072 | 0,072 | 0,18 | 0,30 |
| 150 | 0,15 | 0,24 | 0,072 | 0,072 | 0,15 | 0,24 |
| 185 | 0,12 | 0,20 | 0,072 | 0,072 | 0,12 | 0,19 |
| 240 | 0,095 | 0,156 | 0,072 | 0,072 | 0,091 | 0,150 |
| 300 | 0,077 | 0,127 | 0,071 | 0,071 | 0,073 | 0,120 |
| 400 | 0,060 | 0,099 | 0,071 | 0,071 | 0,055 | 0,090 |
| 500 | 0,050 | 0,083 | 0,070 | 0,070 | 0,044 | 0,072 |
| 630 | 0,043 | 0,071 | 0,069 | 0,069 | 0,035 | 0,057 |
| 800 | 0,037 | 0,061 | 0,058 | 0,058 | 0,027 | 0,045 |
| 1 000 | 0,033 | 0,054 | 0,049 | 0,049 | 0,022 | 0,036 |

## D.2 Alternative calculation of voltage drop

**D.2.1** The resistance and reactance values for copper and aluminium conductors of various cross-sectional areas listed in table D.1 can be used in the following formulae to calculate the voltage drop. Alternatively, the maximum length of a circuit before the permissible voltage drop would be reached can be calculated. Examples of calculated maximum current lengths are given in table D.2. The values in tables D.1, D.2 and D.3 are average values for the purpose of easy calculations and can differ from the values determined by using the tables in clause 6 or from cable manufacturers' data.

**D.2.2** In the case of the pure resistive load, the circuit voltage drop can be calculated from the following formula:

$$V_d = \frac{F_v \times I \times R \times L}{1\,000}$$

where

$V_d$ is the voltage drop, in volts (V);

$F_v$ is the multiplication factor determined from table D.3;

$I$ is the current, in amperes (A);

$R$ is the resistance, in ohms per kilometre (Ω/km);

$L$ is the length, in metres (m).

**D.2.3** In the case of a load with impedance, the circuit voltage drop can be calculated from the following formula:

$$V_d = \frac{F_v \times I \times (R \cos Ø + X \sin Ø) \times L}{1\,000}$$

The phase angle Ø of the load is determined by power factor = cos Ø.

**D.2.4** The voltage drop for a given current at unity power factor will in most cases represent the worst-case voltage drop.

**D.2.5** The voltage drop of single-core cables can be improved by using a trefoil configuration.

**D.2.6** The reactance (*X*) values for trefoil cables can be obtained from cable manufacturers.

**WARNING Use only for maximum lengths. For current-carrying capacity of cables and conductors, see 6.2.**

**Table D.2(a) — Maximum lengths, in metres, of copper cables/circuits at a given circuit-breaker current rating for single phase ($F_V$ = 2)**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| **Nominal cross-sectional area** mm² | **Circuit-breaker current rating** A | | | | | | | | |
| | **10** | **15** | **20** | **25** | **30** | **40** | **50** | **60** | **80** |
| 1 | 26 | – | – | – | – | – | – | – | – |
| 1,5 | 39 | 26 | – | – | – | – | – | – | – |
| 2,5 | 66 | 44 | 33 | 26 | – | – | – | – | – |
| 4 | 104 | 69 | 52 | 41 | 34 | – | – | – | – |
| 6 | 159 | 106 | 79 | 63 | 53 | 39 | – | – | – |
| 10 | 261 | 174 | 130 | 104 | 87 | 65 | 52 | 43 | – |
| 16 | 410 | 273 | 205 | 164 | 136 | 102 | 82 | 68 | 51 |

NOTE 1 Power factor is unity.

NOTE 2 Maximum permissible voltage drop between phases and neutral if full circuit-breaker loading is 5 % of 230 V, i.e. 11,5 V.

NOTE 3 Only popular circuit-breaker ratings have been selected.

**Table D.2(b) — Maximum lengths, in metres, of copper cables/circuits at a given circuit-breaker current rating for three-phase ($F_V$ = 1 balanced)**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nominal cross-sectional area** mm² | **Circuit-breaker current rating** A | | | | | | | | | | | | | | | | |
| | **10** | **15** | **20** | **25** | **30** | **40** | **50** | **60** | **80** | **100** | **125** | **150** | **200** | **225** | **250** | **300** | **350** |
| 1 | 52 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 1,5 | 78 | 52 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 2,5 | 132 | 88 | 66 | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 4 | 209 | 139 | 104 | 83 | 69 | – | – | – | – | – | – | – | – | – | – | – | – |
| 6 | 319 | 212 | 159 | 127 | 106 | 79 | – | – | – | – | – | – | – | – | – | – | – |
| 10 | 522 | 348 | 261 | 209 | 174 | 130 | 104 | – | – | – | – | – | – | – | – | – | – |
| 16 | – | 547 | 410 | 328 | 273 | 205 | 164 | 136 | – | – | – | – | – | – | – | – | – |
| 25 | – | – | 660 | 528 | 440 | 330 | 264 | 220 | 165 | – | – | – | – | – | – | – | – |
| 35 | – | – | – | 741 | 618 | 463 | 370 | 309 | 231 | 185 | – | – | – | – | – | – | – |
| 50 | – | – | – | – | – | 653 | 522 | 435 | 326 | 261 | 209 | 174 | – | – | – | – | – |
| 70 | – | – | – | – | – | – | 741 | 618 | 463 | 370 | 296 | 247 | – | – | – | – | – |
| 95 | – | – | – | – | – | – | – | – | 625 | 500 | 400 | 333 | 250 | 222 | – | – | – |
| 120 | – | – | – | – | – | – | – | – | 798 | 638 | 511 | 425 | 319 | 283 | 255 | – | – |
| 150 | – | – | – | – | – | – | – | – | – | 766 | 613 | 511 | 383 | 340 | 306 | 255 | – |
| 185 | – | – | – | – | – | – | – | – | – | – | 766 | 638 | 479 | 425 | 383 | 319 | 273 |

**Table D.3 — Multiplication factor $F_V$ for the relevant circuit conditions**

| 1 | 2 |
|---|---|
| **Type of supply and mode connection of load** | **Multiplication factor $F_V$** |
| Direct current load across two conductors | 2 |
| Single-phase load between phase and neutral | 2 |
| Single-phase load between two phases only | 2 |
| Balanced three-phase load on all three phases, neutral unconnected | 1 |
| Three identical single-phase loads, one between each phase and connected neutral | 1 |
| Unbalanced loads between all three phases and connected neutral: | |
| a) unbalanced < 75 % | 1 |
| b) unbalanced > 75 % | 2 |
| Unbalanced loads between all three phases, neutral unconnected: | |
| a) unbalanced < 75 % | 1 |
| b) unbalanced > 75 % | 1,2 |
| NOTE If the voltage drop values are calculated using tables 6.2(b), 6.3(b), 6.4(b), 6.5(b), 6.6(b), 6.7(b) and 6.9(b), the multiplication factor $F_v$ is not applicable. | |

# Annex E
(informative)

## Recommended bending of cables

The values of radius of curvature given in table E.1 should be exceeded wherever possible.

**Table E.1 — Minimum radius of curvature of cables**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Type of cable** | **Type of sheathing** | **Diameter of cable** mm | **Minimum radius of curvature** |
| PVC insulated, that complies with relevant requirements of SANS 1507 | Unsheathed | *d* ≤ 10<br>10 < *d* ≤ 25<br>25 < *d* ≤ 40<br>40 < *d* | 3*d*<br>4*d*<br>6*d*<br>8*d* |
| | Sheathed but unarmoured | | 8*d* |
| | Armoured | – | 10*d* |
| Paper-insulated | Lead sheathed | – | 15*d* |
| NOTE *d* is the overall diameter of the cable. | | | |

# Annex F
(informative)

# Examples of determining the conduit size required for single-core cables of different sizes

## F.1 Procedure

**F.1.1** For each single-core cable and bare conductor, take a value of *C* from table 6.23 (see 6.5.6.2.2), appropriate to the nominal cross-sectional area of each conductor.

**F.1.2** Add up all the values of *C*.

**F.1.3** From table 6.24(a) (see 6.5.6.2.2) select a conduit size that has a value of *K* at least equal to the value determined by adding all the values of *C*.

## F.2 Example 1

Two single-phase loads are to be supplied through a conduit,

a) one circuit has single-core cables of nominal cross-sectional area 4 $mm^2$,

b) the other circuit has cables of 2,5 $mm^2$, and

c) each circuit has an earth continuity conductor of nominal *cross-sectional area 2,5* $mm^2$.

What size of conduit should be used?

**Table F.1 — Calculation of *C* values for cables in conduit — example 1**

| 1 | 2 | 3 |
|---|---|---|
| **Cables to run in conduit (insulated or bare)** | **Values of *C* from table 6.23** | |
| | **Per cable** | **Total per cable size** |
| 2 × 4 mm² cables | 17 | 34 |
| 2 × 2,5 mm² cables | 14 | 28 |
| 2 × 2,5 mm² conductors | 14 | 28 |
| **Total for conduit** | | Total = 90 |

From table 6.24(a), a value of 90 for *K* indicates that a conduit of size 20 mm will accept the cables.

## F.3 Example 2

A conduit has to accommodate

a) four single-core cables, each of nominal cross-sectional area 10 mm² to supply a three-phase and neutral load,

b) one earth continuity conductor of nominal cross-sectional area 6 mm², and

c) four control cables, each of nominal cross-sectional area 1 mm².

What size of conduit should be used?

**Table F.2 — Calculation of *C* values for cables in conduit — example 2**

| 1 | 2 | 3 |
|---|---|---|
| **Cables to run in conduit (insulated or bare)** | **Values of *C* from table 6.23** | |
| | **Per cable** | **Total per cable size** |
| 4 × 10 mm² cables | 30 | 120 |
| 1 × 6 mm² conductor | 22 | 22 |
| 4 × 1 mm² cables | 8 | 32 |
| **Total for conduit** | | Total = 174 |

From table 6.24(a)

a) the value of *K* for a 25 mm conduit is 144, which is too small, and

b) the value of *K* for a 32 mm conduit is 240, indicating that a 32 mm conduit should be used.

# Annex G
(informative)

## Explanation of IP ratings

The table below is an extract from SANS 60529.

The IP ratings consist of the letters IP followed by two characteristic numerals. The first characteristic numeral relates to protection against the penetration of solid objects, the second numeral relates to protection against penetration of liquid. The use of X as a first or second characteristic numeral in the text of this part of SANS 10142 indicates that there is no requirement for that characteristic numeral.

## Table G.1 — International protection ratings — IP ratings

<table>
<tr><td>1</td><td>2</td><td colspan="2">3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td colspan="4">First characteristic numeral</td><td colspan="3">Second characteristic numeral</td></tr>
<tr><td colspan="2">Protection against solid foreign objects</td><td colspan="2" rowspan="2">Meaning for the protection of persons against access to hazardous parts with</td><td colspan="2">Protection against harmful ingress of water</td><td rowspan="2">Meaning for the protection against water</td></tr>
<tr><td>IP</td><td>Tests</td><td>IP</td><td>Tests</td></tr>
<tr><td>0</td><td>No protection</td><td colspan="2">Non-protected</td><td>0</td><td>No protection</td><td>Non-protected</td></tr>
<tr><td>1</td><td>Full penetration of 50 mm diameter of sphere not allowed. Contact with hazardous parts not permitted.</td><td colspan="2">Back of hand</td><td>1</td><td>Protected against vertically falling drops of water</td><td>Vertical dripping</td></tr>
<tr><td>2</td><td>Full penetration of 12,5 mm diameter of sphere not allowed. The jointed test finger shall have adequate clearance from hazardous parts</td><td colspan="2">Finger</td><td>2</td><td>Protected against vertically falling drops of water with enclosure tilted 15 ° from the vertical</td><td>Dripping up to 15 ° from the vertical</td></tr>
<tr><td>3</td><td>The access probe of 2,5 mm diameter shall not penetrate</td><td colspan="2">Tool</td><td>3</td><td>Protected against sprays to 60 ° from the vertical</td><td>Limited spraying</td></tr>
<tr><td>4</td><td>The access probe of 1,0 mm diameter shall not penetrate</td><td colspan="2">Wire</td><td>4</td><td>Protected against water splashed from all directions – limited ingress permitted</td><td>Splashing from all directions</td></tr>
<tr><td>5</td><td>Limited ingress of dust permitted (no harmful deposit)</td><td>Dust-protected</td><td rowspan="2">Wire</td><td>5</td><td>Protected against low-pressure jets of water from all directions – limited ingress permitted</td><td>Hosing jets from all directions</td></tr>
<tr><td>6</td><td>No ingress of dust</td><td>Dust-tight</td><td>6</td><td>Protected against strong jets of water, e.g. for use on ship decks – limited ingress permitted.</td><td>Strong hosing jets from all directions</td></tr>
<tr><td></td><td></td><td colspan="2"></td><td>7</td><td>Protected against the effects of immersion between 150 mm and 1 m</td><td>Temporary immersion</td></tr>
<tr><td></td><td></td><td colspan="2"></td><td>8</td><td>Protected against long periods of immersion under pressure > 1 m</td><td>Continuous immersion</td></tr>
</table>

# Annex H
(informative)

## Notification of a potential danger
(see 8.6.6 and 8.6.10)

To: .....................................................

..................................................... (The supplier)

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

From: .....................................................

..................................................... (The registered person)

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

During an inspection in terms of SANS 10142-1, *The wiring of premises – Part 1*: *Low-voltage installations,* performed at stand

No.: .....................................................

situated at .............................................

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

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

I, .........................................................., Registration No.: ...........

found the following potential danger:

❑...Elevated voltage on neutral of ................................................ V,

❑...Voltage not within limits ......................................................... V,

❑...Other .......................................................................................

Signed: ..................................................... Date: ...........................

# Annex I
(normative where surge protection
is required or installed (see 6.7.6))

# Surge protective devices (SPDs) into low-voltage systems in order to protect the installation

## I.1 Installation of urge protective devices (SPDs) into low-voltage systems in order to protect the installation

### I.1.1 Surge protection

**I.1.1.1** Surge protective devices (SPDs) are used to protect, under specified conditions, electrical systems, components and equipment against various transient overvoltages and surge currents such as lightning and switching surges. The selection, connection and application of SPDs installed in low-voltage installations shall be in accordance with this annex.

**I.1.1.2** SPDs shall be selected according to environmental conditions and the acceptable failure rate of components, equipment and SPDs.

NOTE 1 These minimum requirements do not apply to structures that require lightning protection in accordance with SANS 10313.

NOTE 2 The type and class of SPD to be incorporated in the lightning protection design will depend on the risk assessment and protection level. (For the risk assessment analyses, see SANS 62305-2 and annex I.2.)

NOTE 3 Consult with the SPD manufacturer on the selection and application of his product.

### I.1.2 Surge protective devices

**I.1.2.1** Surge protective devices shall be installed at least in the main distribution board of an electrical installation.

**I.1.2.2** Where installed, the following minimum requirements for SPDs shall apply to buildings and structures that require protection against transient overvoltages and surge currents from switching operations or from induced atmospheric discharges:

a) SPDs shall comply with the requirements of SANS 61643-11;

b) SPDs in the main distribution board shall be at least class II devices;

NOTE Due to the length of conductors and the exposure to induced surges, additional SPDs may be installed in accordance with the manufacturer's specifications.

c) Except for voltage switching (gapped) type, it is recommended that all class II voltage-limiting SPDs be equipped with thermal disconnecting mechanisms and visual indication that shows end of life;

d) The following minimum ratings shall apply to

1) class II SPDs:

| | |
|---|---|
| nominal discharge current | $I_n \geq 5$ kA (min.) 8/20 μs wave form, |
| maximum discharge current | $I_{max} \geq 2 \times I_n$ (min.) 8/20 μs wave form, |
| voltage protection level at $I_n$ | $U_p \leq 1,5$ kV (max.) for 230 V systems; |

2) class III SPDs:

| | |
|---|---|
| peak open-circuit voltage | $U_{OC} \geq 3$ kV (min.) 1,2/50 μs wave form, |
| voltage protection level | $U_p \leq 1,5$ kV (max.) for 230 V systems. |

NOTE Class III SPDs can only be used in coordination with class II type SPD devices.

**I.1.2.3** Class III SPDs without internal disconnecting mechanisms shall only be used in circuits that are supervised by earth leakage devices or protected by suitable disconnecting mechanisms.

NOTE Earth leakage devices will not protect SPDs connected between line and neutral.

### I.1.3 Modes of protection and installation

**I.1.3.1** When the components and electrical systems to be protected have sufficient overvoltage withstand capability or are located close to the main distribution board, one SPD set might be sufficient. In this case the SPD set should be installed as close as possible to the origin of the installation. The SPD should have sufficient surge withstand capability for this location.

**I.1.3.2** Figures I.1.1, I.1.2 and I.1.3 indicate the different modes of installation that might be used for the protection of different LV systems (see also table I.1.1).

NOTE 1 The efficacy of surge protection and the susceptibility to damage by temporary overvoltage (TOV) are illustrated in annex I.3 as a guide to the choice of protection.

NOTE 2 The number of modes of installation and protection depends on

a) the type of equipment to be protected,

b) the circuit configuration (for example, if the equipment is connected to earth, line- to-earth or neutral-to-earth protection might not be necessary),

c) the impulse withstand voltage of the equipment according to each mode of protection,

d) the electrical system structure and earthing, and characteristics of the incoming surges (for example, protection between phase/neutral and PE conductor or between phase and neutral are generally sufficient). (Protection between phase and phase is not generally used.)

**Table I.1.1 — Modes of installation for the protection of various LV supply systems**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **SPD between** | **TT** | **TN-C** | **TN C-S** | **TN-S** | **IT** |
| Line and neutral | X | | X | X | X[a] |
| Line and PE | X | | X | X | X |
| Line and PEN | | X | | | |
| Neutral and PE | X | | X | X | X[a] |
| Line to line | X | X | X | X | X |
| [a] When the neutral is distributed. | | | | | |

**I.1.3.3** When more than one SPD is connected on the same conductor, coordination between them shall be ensured.

**I.1.3.4** The following connection types are applicable:

a) connection type 1: SPDs are connected between each line conductor and the main protective conductor and between the neutral conductor and the main protective conductor;

b) connection type 2: SPDs are connected between each line conductor and the neutral conductor and between the neutral conductor and the main protective conductor.

**I.1.3.5 Installation methods**

**I.1.3.5.2** The bonding bridge across SPDs shall be located as close to the SPDs as possible (see figures I.1.1, I.1.2 and I.1.3).

NOTE A bridge that clamps direct into the SPD should be used in preference to hard wiring.

**I.1.3.5.3** The distance across the SPDs, including connection cables, from the live conductors to the consumer's earth terminal, shall preferably be 0,5 m or less in order to keep the overall inductive voltage drop due to surge current as low as possible.

**I.1.3.5.4** The cross-sectional area of the bonding conductor

a) for connection type 1, from the SPD's bonding bridge to the consumer's earth terminal (E) shall be equal to that of the phase conductor up to the maximum size specified by the manufacturer but not less than 6 $mm^2$,

b) for connection type 2, from the SPD's bonding bridge to the neutral conductor and from the SPD between the neutral conductor and the consumer's earth terminal (E), shall be equal to that of the phase conductor up to the maximum size specified by the manufacturer but not less than 6 $mm^2$.

NOTE In general a 16 $mm^2$ copper conductor is used, unless otherwise specified by the manufacturer of the SPD.

**I.1.3.5.5** SPDs shall be installed after the point of control. Where the point of control is an earth leakage unit, it might cause nuisance tripping in some instances.

**I.1.3.5.6** To provide for accumulated surges where an SPD is installed in more than one phase

a) for connection type 1, the nominal discharge current $I_n$ for the SPD shall be not less than 5 kA 8/20 for each mode of protection (see figures I.1.1 and I.1.2),

b) for connection type 2, the nominal discharge current $I_n$ for the SPD connected between the neutral conductor and the PE shall be not less than 20 kA 8/20 for three-phase systems and 10 kA 8/20 for single-phase systems (see figure I.1.3).

**I.1.3.5.7** Where the distance between the PEN connection at the point of control and the consumer's earth terminal (E) (see (a) to (b), (6,1) and (6,2) in figures I.1.1, I.1.2 and I.1.3) is less than 5 m, the installation of the SPD between neutral and the consumer's earth terminal (E) may be omitted.

## I.1.4 Selection of SPDs with regard to temporary overvoltages (TOVs)

**I.1.4.1** SPDs shall comply with the relevant requirements and pass the test for TOVs in SANS 61643-11. (See also annex I.2 and annex I.3.)

**I.1.4.2** SPDs connected to the PE shall fail safely in the case of TOVs due to earth faults in the high-voltage system, and pass the test in SANS 61643-11. (See also annex I.2 and annex I.3.)

NOTE The loss of neutral is not covered by these requirements and currently there is no specific test in SANS 61643-11. SPDs are expected to fail safely.

## I.1.5 Protection against overcurrent and consequences of an SPD failure

**I.1.5.1** Protection against SPD short-circuits shall be provided by overcurrent protective devices that are selected according to the SPD manufacturer's instructions.

**I.1.5.2** The cross-sectional area of the conductors that connect the overcurrent protective devices to the line conductors shall be rated according to the maximum possible short-circuit current.

## I.1.6 Power and telecommunication lines

Power and telecommunication lines should enter a building or structure in close proximity and NOT on opposite sides of the building or structure.

NOTE For total protection, the installer of any conductive service that enters or leaves a building or a structure should install SPDs on such service and bond it to the readily accessible earth terminal (see 6.13.2.6).

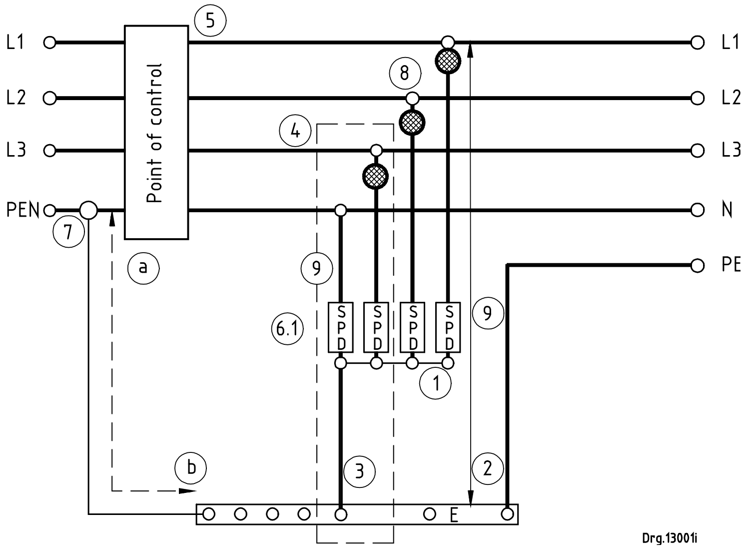



**Figure I.1.1 — Installation mode of SPDs — Connection type 1 for TN-C-S supply systems**

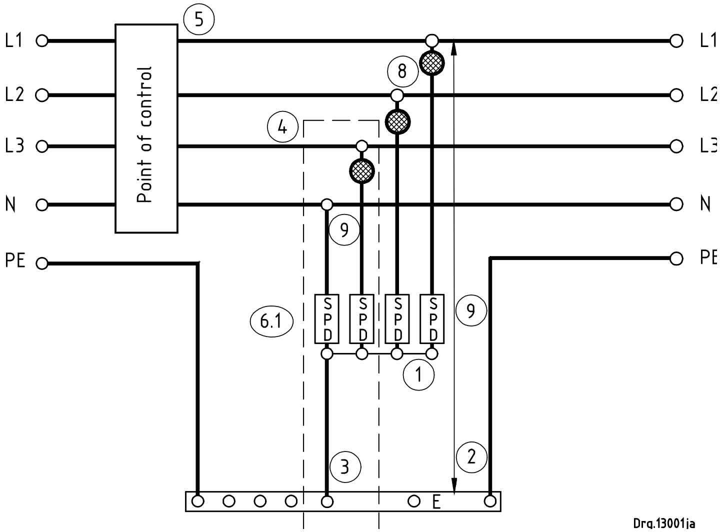
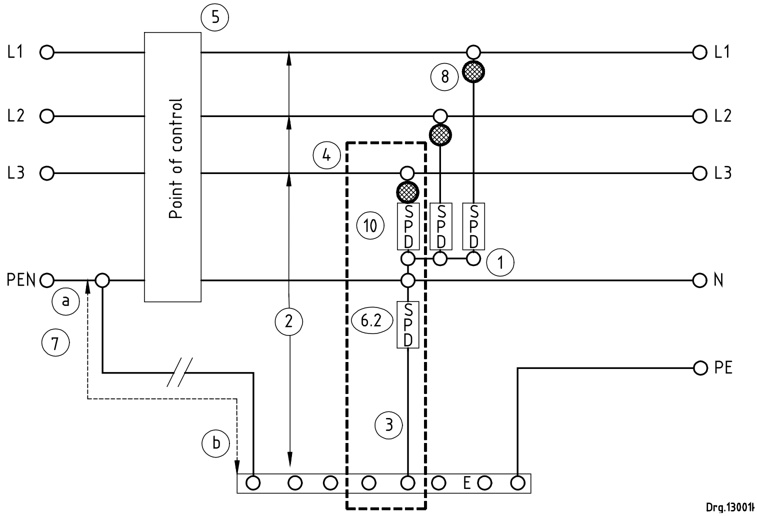



**Figure I.1.2 — Installation mode of SPDs — Connection type 1 for TN-S supply systems**




NOTE This mode of installation is suitable for TT, TN-C, TN-C-S and TN-S types of electricity supply systems (see annex J). This figure illustrates a TN-C-S supply system.

**Figure I.1.3 — Installation mode of SPDs — Connection type 2**

**Legend for figures I.1.1, I.1.2 and I.1.3**

(1) The bonding bridge on SPDs.

(2) The distance across the SPDs, including connections, cables and the SPDs, from the live conductors to the consumer's earth terminal (E), (preferably 0,5 m or less). See L.1.3.5.3.

(3) The bonding conductor between the SPD bonding bridge and the consumer's earth terminal (E) for connection type 1 or between the SPD from neutral earth and the consumer's earth terminal (E) for connection type 2.

(4) The designated area indicates a single-phase installation.

(5) SPDs installed after the point of control.

(6,1) Connection type 1 configuration in figures I.1.1 and I.1.2.

(6,2) Connection type 2 configuration in figure I.1.3.

(7) The distance (a) to (b) between the PEN connection at the point of control and the consumer's earth terminal (E).

(8) Overcurrent protective device (see I.1.5).

(9) SPDs between live and neutral in series (figures L.1.1 and L.1.2 – connection type 1).

(10) SPDs between live and neutral direct (figure I.1.3 – connection type 2).

## I.1.7 Voltage protection levels

According to the requirements for insulation coordination in power installations (see IEC 60664-1) and the surge immunity of equipment to be protected, it is necessary to keep the voltage protection levels of the SPDs below or equal to the maximum value of the surge immunity level of the equipment. If the immunity against damage is not known, component immunity levels given in SANS 61000-4-5 shall be used.

## I.1.8 Overvoltage categories

Table I.1.2 lists impulse withstand voltage levels divided into categories with overvoltage limits listed for standard 230/400 V three-phase four-wire systems as in IEC 60664-1.

**Table I.1.2 — Impulse withstand categories for overvoltage limits**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **Voltage line to neutral derived from nominal voltages a.c. or d.c. up to and including** | **Rated impulse voltage** | | | |
| | **Overvoltage category** | | | |
| **V** | **I** | **II** | **III** | **IV** |
| 50 | 330 | 500 | 800 | 1 500 |
| 100 | 500 | 800 | 1 500 | 2 500 |
| 150 | 800 | 1 500 | 2 500 | 4 000 |
| 300 | 1 500 | 2 500 | 4 000 | 6 000 |
| 600 | 2 500 | 4 000 | 6 000 | 8 000 |
| 1 000 | 4 000 | 6 000 | 8 000 | 12 000 |

The overvoltage categories given in this table are

category I — which includes equipment such as pluggable devices with electronic circuits,

category II — which includes equipment supplied from a fixed installation, such as pumps, motors and other appliances,

category III — which includes equipment in fixed installations, such as distribution boards and motor control centres, and

category IV — which includes equipment at the origin of the installation (point of control), such as electricity meters and primary overcurrent protective equipment.

## I.2 Guide to the risk assessment for the installation of SPDs

### I.2.1 General

**I.2.1.1** As indicated in annex I.1, the type and class of SPD to be incorporated in the surge protection design will depend on the risk assessment and protection level for the installation.

**I.2.1.2** The lightning protection systems (LPSs) explained in (a) to (c) apply in the case of structures that require lightning protection as determined by the risk analyses in SANS 10313.

a) Complete lightning protection system (LPS)

The complete system used to protect a space against the effects of lightning consists of both external (structural protection) and internal (electrical equipment) lightning protection systems. Both systems shall be implemented in totality in order to comply with SANS 10313.

b) External structural LPS

The external LPS consists of an air-termination system, down conductors, and an earth electrode system.

c) Internal LPS

The internal LPS consists of all measures additional to those required for an external lightning protection system, and is intended to reduce the electromagnetic effects of lightning currents within the space to be protected. It includes equipotential bonding at each lightning protection zone (LPZ) boundary, interface that utilizes bonding conductors, and surge protective devices (SPDs).

**I.2.1.3** This annex indicates the outcomes and conclusions of the research analysis conducted by a research team from the University of the Witwatersrand under the direction of a SABS technical committee. It presents a guide to the proposed application of and requirements for the installation of SPDs.

## I.2.2 Guidelines for the installation of SPDs

Two general South African guidelines for the installation of SPDs in fixed installations are proposed. These guidelines are in accordance with SANS 62305-2, and have been based on two separate risk criteria:

a) **risk analysis type $R_4$ (economic loss) that yields a monetary saving for each scenario**

   This saving indicates a method to gauge whether protection measures that could be justified would result in an annual saving or a loss.

b) **risk analysis type $R_1$ (risk to human life) for which IEC provides a tolerable risk level of $1 \times 10^{-5}$**

   This value relates to 1 in 100 000 "man years" or 10 deaths per million people and was used as a decision indicator for risk $R_1$.

## I.2.3 The risk analysis performed for risk $R_4$ (economic loss)

**I.2.3.1** The risk analysis performed for risk $R_4$ provides a quick reference as to the need for the application of surge protection. It does not indicate the necessity for the mandatory application of surge protection.

**I.2.3.2** The *net present value* for the amount that would be lost per year for each structure type has been assessed. These values are shown in tables I.2.1 and I.2.2. They give an indication to the owner of the structure of the amount that could be spent on protection measures which would result in a saving to the owner. The amount of loss will therefore determine which protection measures will be adopted, i.e. whether SPDs will be mounted in the distribution board alone or together with point of use devices.

**I.2.3.3** Tables I.2.1 and I.2.2 cover the risk of economic loss ($R_4$) for structures found in towns and cities where the exposure levels are often lower (suburban)), and formal structures in low-cost high-density dwellings found both in rural and urban areas (townships), respectively. The first column represents the cost of the electrical system in the structure including that of the fixed installation and of any attached devices or appliances. The calculated values in Rand represent the present value of the cost of loss of the electrical system over a set period of five or 10 years with a fixed interest of 6 %, which is shown in the final column.

**Table I.2.1 — Suburban structure – Present values of loss**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Cost of system** | **Lightning ground flash density** | | | | | **Period and interest** |
| | **1** | **4** | **7** | **10** | **13** | |
| R 20 000 | R 45 | R 181 | R 316 | R 452 | R 587 | Five years at 6 % |
| R 50 000 | R 113 | R 452 | R 790 | R 1 129 | R 1 468 | |
| R 90 000 | R 203 | R 813 | R 1 423 | R 2 032 | R 2 642 | |
| R 20 000 | R 79 | R 316 | R 552 | R 789 | R 1 026 | Ten years at 6 % |
| R 50 000 | R 197 | R 789 | R 1 381 | R 1 973 | R 2 565 | |
| R 90 000 | R 355 | R 1 420 | R 2 486 | R 3 551 | R 4 616 | |

**Table I.2.2 — Township structure – Present values of loss**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Cost of system** | **Lightning ground flash density** | | | | | **Period and interest** |
| | **1** | **4** | **7** | **10** | **13** | |
| R 5 000 | R 12 | R 50 | R 87 | R 124 | R 161 | Five years at 6 % |
| R 10 000 | R 25 | R 99 | R 174 | R 248 | R 323 | |
| R 20 000 | R 37 | R 149 | R 261 | R 373 | R 484 | |
| R 35 000 | R 50 | R 199 | R 348 | R 497 | R 646 | |
| R 5 000 | R 22 | R 87 | R 152 | R 217 | R 282 | Ten years at 6 % |
| R 10 000 | R 43 | R 174 | R 304 | R 434 | R 564 | |
| R 20 000 | R 65 | R 260 | R 456 | R 651 | R 846 | |
| R 35 000 | R 87 | R 347 | R 608 | R 868 | R 1 128 | |

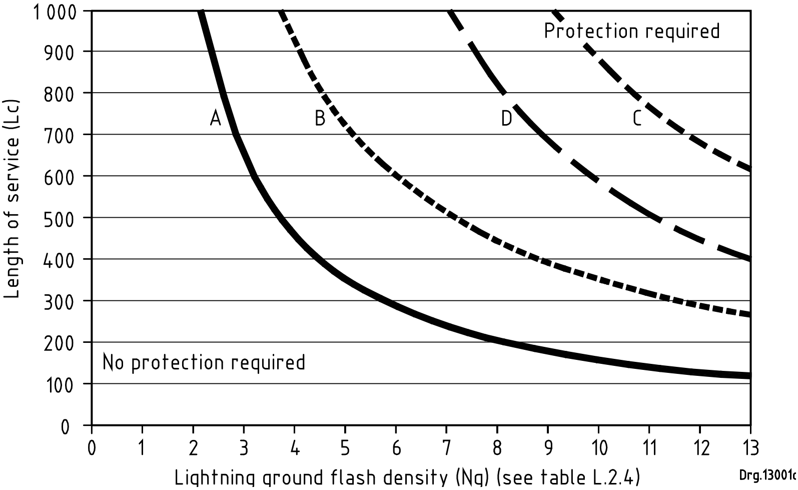
## I.2.4 The risk analysis performed for risk $R_1$ (risk to loss of life)

**I.2.4.1** The risk analysis performed for risk $R_1$ provides the graph in figure I.2.1 that shows trend lines for the different types of structure.

**I.2.4.2** It should be noted that areas to the left of each curve in figure I.2.1 indicate an acceptable risk. Areas to the right of each curve indicate those conditions that represent an unacceptable risk. (See table I.2.3 for examples for determining the need to install SPDs.)

**I.2.4.3** The curves in figure I.2.1 represent the limits at which surge protection measures should be installed. To the left of the curve protection is not required and to the right of the curve protection should be installed.

**I.2.4.4** The vertical scale of figure I.2.1 (Lc) is defined as the total length of service (MV plus LV) to the structure based on the last utility protection and earthing point (in metres).




**Legend**

**Curve A** represents the level at which protection should be installed for urban informal structures and for township structures.

**Curve B** represents the level at which protection should be installed for suburban structures.

**Curve C** represents the level at which protection should be installed for suburban structures that have a single buried service of length Lc entering the structure.

**Curve D** represents a suburban structure that has a varying buried service (Lc) connected to an overhead service of not more than 200 m in length.

**Figure I.2.1 — Risk to loss of human life $10^{-5}$ – Risk boundaries for different structures and service layouts**

**Table I.2.3 — Examples for determining the need to install SPDs**

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Example** | **City** | **Structure type** | **Curve (from figure I.2.1)** | **Ground flash density ($N_g$)[a]** | **SPD required for Lc[b] greater than**<br>m |
| 1 | Bloemfontein | Informal/Township | A | 5,2 | 350 |
| 2 | Bloemfontein | Suburban | B | 5,2 | 690 |
| 3 | Bloemfontein | Suburban (buried) | C | 5,2 | – |
| 4 | Bloemfontein | Suburban (buried and overhead) | D | 5,2 | – |
| | | | | | |
| 5 | Cape Town | Informal/Township | A | 0,3 | – |
| 6 | Cape Town | Suburban | B | 0,3 | – |
| 7 | Cape Town | Suburban (buried) | C | 0,3 | – |
| 8 | Cape Town | Suburban (buried and overhead) | D | 0,3 | – |
| | | | | | |
| 9 | Durban | Informal/Township | A | 4,4 | 400 |
| 10 | Durban | Suburban | B | 4,4 | 800 |
| 11 | Durban | Suburban (buried) | C | 4,4 | – |
| 12 | Durban | Suburban (buried and overhead) | D | 4,4 | – |
| | | | | | |
| 13 | East London | Informal/Township | A | 1,6 | – |
| 14 | East London | Suburban | B | 1,6 | – |
| 15 | East London | Suburban (buried) | C | 1,6 | – |
| 16 | East London | Suburban (buried and overhead) | D | 1,6 | – |

**Table I.2.3** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Example** | **City** | **Structure type** | **Curve (from figure I.2.1)** | **Ground flash density ($N_g$)[a]** | **SPD required for Lc[b] greater than**<br>m |
| 17 | Johannesburg | Informal/Township | A | 7,5 | 210 |
| 18 | Johannesburg | Suburban | B | 7,5 | 460 |
| 19 | Johannesburg | Suburban (buried) | C | 7,5 | 900 |
| 20 | Johannesburg | Suburban (buried and overhead) | D | 7,5 | – |
| | | | | | |
| 21 | Piet Retief | Informal/Township | A | 11,7 | 130 |
| 22 | Piet Retief | Suburban | B | 11,7 | 290 |
| 23 | Piet Retief | Suburban (buried) | C | 11,7 | 470 |
| 24 | Piet Retief | Suburban (buried and overhead) | D | 11,7 | 700 |
| | | | | | |
| 25 | Port Elizabeth | Informal/Township | A | 0,9 | – |
| 26 | Port Elizabeth | Suburban | B | 0,9 | – |
| 27 | Port Elizabeth | Suburban (buried) | C | 0,9 | – |
| 28 | Port Elizabeth | Suburban (buried and overhead) | D | 0,9 | – |
| | | | | | |
| 29 | Pretoria | Informal/Township | A | 7,5 | 210 |
| 30 | Pretoria | Suburban | B | 7,5 | 460 |
| 31 | Pretoria | Suburban (buried) | C | 7,5 | 900 |
| 32 | Pretoria | Suburban (buried and overhead) | D | 7,5 | – |

[a] $N_g$ is the lightning ground flash density in table I.2.4.

[b] Lc is the length of service in figure I.2.1 (see I.2.4.4).

## Table I.2.4 — Lightning ground flash density $N_g$

(NOTE For specific areas contact the South African Weather Bureau)
(Current research indicates higher values)

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Town** | **$N_g$** | **Town** | **$N_g$** | **Town** | **$N_g$** |
| Aberdeen | 2.4 | George | 0.2 | Murraysburg | 3.4 |
| Albertinia | 0.2 | Georgedale | 5.4 | Nelspruit | 8.0 |
| Alexandria | 0.7 | Germiston | 12.2 | Noupoort | 4.4 |
| Aliwal North | 6.5 | Giant's Castle | 8.3 | Ohrigstad | 5.4 |
| Aranos | 0.8 | Golden Gate | 9.1 | Oudtshoorn | 0.3 |
| Aroab | 1.7 | Graaff-Reinet | 2.4 | Paarl | 0.1 |
| Barberton | 7.9 | Grabouw | 0.1 | Petrus Steyn | 9.0 |
| Beaufort West | 1.9 | Grahamstown | 1.0 | Piet Retief | 15.2 |
| Bela Bela | 7.3 | Greytown | 6.3 | Pietermaritzburg | 5.4 |
| Belfast | 10.9 | Groblersdal | 6.3 | Piketberg | 0.1 |
| Benoni | 11.5 | Harding | 3.5 | Polokwane | 4.5 |
| Bergville | 11.2 | Harrismith | 8.3 | Pongola | 7.4 |
| Bethal | 12.7 | Heidelberg (GAU) | 10.9 | Port Alfred | 0.9 |
| Bethlehem | 7.2 | Heidelberg (WC) | 0.1 | Port Elizabeth | 0.5 |
| Bethulie | 6.0 | Heilbron | 8.7 | Potchefstroom | 9.5 |
| Bloemfontein | 8.1 | Hermanus | 0.1 | Pretoria | 10.5 |
| Bloemhof | 7.5 | Hluhluwe | 4.1 | Prieska | 3.3 |
| Blyderivierspoort (MPU) | 5.2 | Hoedspruit | 3.3 | Prins Albert | 0.7 |
| Boksburg | 12.2 | Humansdorp | 0.4 | Queenstown | 5.7 |
| Brakpan | 10.0 | Irene | 9.9 | Reddersburg | 8.2 |
| Brandvlei | 1.3 | Jagersfontein | 6.6 | Richards Bay | 2.1 |
| Brits | 9.4 | Johannesburg | 11.7 | Richmond (KZN) | 3.5 |
| Bultfontein | 7.9 | Jozini | 5.8 | Riversdale | 0.1 |
| Burgersdorp | 4.7 | Keetmanshoop | 0.7 | Roedtan | 6.7 |
| Butterworth | 2.8 | Keiskammahoek | 2.0 | Rustenburg | 9.2 |
| Cala | 6.2 | Kempton Park | 12.6 | Sabie | 6.1 |
| Caledon | 0.2 | Kimberley | 7.0 | Satara | 2.5 |
| Calvinia | 0.8 | King William's Town | 1.1 | Schweizer-Reneke | 8.2 |
| Cape Town | 0.1 | Klerksdorp | 8.3 | Scottburgh | 2.8 |
| Carletonville | 11.0 | Knysna | 0.2 | Senekal | 8.3 |
| Carnavon | 2.2 | Komatipoort | 3.3 | Sishen | 4.4 |
| Carolina | 14.7 | Kroonstad | 8.3 | Skukuza | 2.6 |
| Cathcart | 3.8 | Krugersdorp | 12.6 | Somerset East | 1.5 |
| Cedara | 5.8 | Kuruman | 4.8 | Springbok | 1.0 |
| Ceres | 0.1 | Ladismith (WC) | 0.4 | Springs | 10.0 |
| Christiana | 6.3 | Ladybrand | 8.0 | Standerton | 11.8 |

**Table I.2.4** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **Town** | **$N_g$** | **Town** | **$N_g$** | **Town** | **$N_g$** |
| Colenso | 10.2 | Ladysmith KZN) | 10.6 | Stanger | 2.9 |
| Colesberg | 5.2 | Laingsburg | 0.7 | Stellenbosch | 0.1 |
| Cradock | 3.3 | Lichtenburg | 8.3 | Steytlerville | 1.3 |
| De Aar | 3.3 | Loskop (FS) | 9.1 | Sutherland | 1.3 |
| Dealesville | 8.5 | Loskop (KZN) | 11.5 | Tarkastad | 4.1 |
| Delareyville | 7.2 | Loskop (WC) | 3.5 | Thabazimbi | 5.9 |
| Donnybrook | 6.2 | Lydenburg | 9.3 | Theunissen | 7.1 |
| Doornfontein (FS) | 6.9 | Machadodorp | 12.7 | Touws River | 0.5 |
| Doornfontein (LIM) | 5.2 | Mafikeng | 6.2 | Tzaneen | 4.0 |
| Doornfontein (NW) | 6.1 | Makhado | 3.2 | Umtata | 3.5 |
| Dordrecht | 6.8 | Malmesbury | 0.1 | Uniondale | 0.5 |
| Douglas | 4.8 | Mandini | 3.5 | Upington | 2.6 |
| Dundee | 12.9 | Margate | 2.2 | Utrecht | 10.1 |
| Durban | 5.4 | Marikana | 9.3 | Ventersdorp | 8.0 |
| East London | 1.0 | Matatiele | 5.5 | Vereeniging | 11.9 |
| Edenvale | 11.7 | Middelburg (EC) | 4.1 | Victoria West | 3.2 |
| Elliot | 5.6 | Middelburg (MP) | 12.9 | Villiersdorp | 0.1 |
| Empangeni | 2.3 | Modimolle | 6.7 | Vredendal | 0.4 |
| Ermelo | 12.8 | Mokopane | 5.6 | Vryburg | 6.0 |
| Eshowe | 3.4 | Molteno | 4.7 | Vryheid | 14.1 |
| Evander | 13.6 | Montagu | 0.1 | Welkom | 6.7 |
| Flagstaff | 3.9 | Mooi River | 8.3 | Willowmore | 1.1 |
| Fort Beaufort | 2.1 | Mookgopong | 6.9 | Witbank | 12.1 |
| Fraserburg | 2.2 | Mossel Bay | 0.1 | Zeerust | 6.7 |

## I.3 An analysis of both the efficacy of surge protection and the susceptibility to damage by temporary overvoltage (TOV), comparing the installation modes and protection levels/failure modes of SPDs in figures I.1.1 and I.1.2 (connection type 1) with the installation modes and protection levels/failure modes in figure I.1.3 (connection type 2)

**Table I.3.1 — An analysis of the efficacy of surge protection and the susceptibility to damage by TOV**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Item** | **Installation mode and protection level/failure mode** | **System** | **Connection type 1 figures I.1.1 and I.1.2** | | **Connection type 2 figure I.1.3** | | **Notes** |
| | | | **Number of SPDs damaged** | **SPDs** | **Number of SPDs damaged** | **SPDs** | |
| 1 | L to E protection | | | 1 series<br>= 1 × 1 500 V[a] | | 2 series<br>= 2 × 1 500 V | Common mode |
| 2 | L to N protection | | | 2 series<br>= 2 × 1 500 V | | 1 × series<br>= 1 × 1 500 V[a] | Differential mode |
| 3 | L to L protection | | | 2 × series<br>= 2 × 1 500 V | | 2 × series<br>= 2 × 1 500 V | Differential mode |
| 4 | N to PE protection | | | 1 × series<br>= 1 × 1 500 V[a] | | 1 series<br>= 1 × 1 500 V[a] | Common mode |
| | | | | | | | |
| 5 | Lost neutral TOV L-N | TN-S | | 2 × 275 V withstand[b] | 3 | 1 × 275 V withstand[c] | |
| 6 | Lost neutral TOV L-PE | TN-S | | 1 × 275 V withstand[b] | | 2 × 275 V withstand[b] | Star point reference through PE |
| 7 | Lost neutral TOV N-PE | TN-S | 1 | 1 × 275 V withstand[c] | 1 (High cost) | 1 × 275 V withstand[c] | |

**Table I.3.1** *(continued)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Item** | **Installation mode and protection level/failure mode** | **System** | **Connection type 1 figures I.1.1 and I.1.2** | | **Connection type 2 figure I.1.3** | | **Notes** |
| | | | **Number of SPDs damaged** | **SPDs** | **Number of SPDs damaged** | **SPDs** | |
| 8 | Lost PEN TOV L-N | TN-C-S | | 2 × 275 V withstand[b] | 3 | 1 × 275 V withstand[c] | |
| 9 | Lost PEN TOV L-PE | TN-C-S | 3 | 1 × 275 V withstand[c] | | 1 × 275 V withstand[c] | N and PE are common (SPD bridged) |
| 10 | Lost PEN TOV N-PE | TN-C-S | | Zero volts due to N-PE bridge[b] | | Zero volts due to N-PE bridge [b] | |
| | | | | | | | |
| 11 | Lost neutral TOV L-N | TT | | 2 × 275 V withstand[b] | 3 | 1 × 275 V withstand[c] | |
| 12 | Lost neutral TOV L-PE | TT | 3 | 1 × 275 V withstand[c] | | 2 × 275 V withstand[b] | |
| 13 | Lost neutral TOV N-PE | TT | 1 | 1 × 275 V withstand[c] | 1 (High cost) | 1 × 275 V withstand[c] | |
| | | | | | | | |
| | **Influence of an HV fault to earth on the LV system** | | | | | | |
| 14 | HV-earth TOV L-N | TN-S | | No TOV on SPDs[b] | | No TOV on SPDs[b] | |
| 15 | HV-earth TOV L-PE | TN-S | | No TOV on SPDs[b] | | No TOV on SPDs[b] | |
| 16 | HV-earth TOV N-PE | TN-S | | No TOV on SPDs[b] | | No TOV on SPDs[b] | |

**Table I.3.1** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| Item | Installation mode and protection level/failure mode | System | Connection type 1 figures I.1.1 and I.1.2 | | Connection type 2 figure I.1.3 | | Notes |
| | | | Number of SPDs damaged | SPDs | Number of SPDs damaged | SPDs | |
| 17 | HV-earth TOV L-N | TN-C-S | | No TOV on SPDs[b] | | No TOV on SPDs[b] | |
| 18 | HV-earth TOV L-PE | TN-C-S | | No TOV on SPDs[b] | | No TOV on SPDs[b] | |
| 19 | HV-earth TOV N-PE | TN-C-S | | No TOV on SPDs[b] | | No TOV on SPDs[b] | |
| | | | | | | | |
| 20 | HV-earth TOV L-N | TT | | No TOV on SPDs[b] | | No TOV on SPDs[b] | |
| 21 | HV-earth TOV L-PE | TT | 3 | SPD stressed at *U*o + 1 200 V[d] | | No TOV on SPDs[b] | |
| 22 | HV-earth TOV N-PE | TT | 1 | SPD stressed at 1 200 V[d] | 1 (High cost) | SPD stressed at 1 200V [d] | |

NOTE 1 Abbreviations used in this table are

HV High voltage
TOV Temporary overvoltage
E Earth
L Live
N Neutral
PE Protective conductor
PEN Protective earth and neutral conductor

NOTE 2 For TN-C-S, TN-S and TT systems, see annex J.

[a] Best surge protection.

[b] Safe under TOV conditions.

[c] SPD failure due to lost N or PEN.

[d] SPD failure due to HV to earth fault.

**Table I.3.2 — Summary of the information given in table I.3.1**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Protection level/ failure mode** | **System** | **Connection type 1, figures I.1.1 and I.1.2** | **Connection type 2, figure I.1.3** |
| Lost N or PEN (items 5 to 13) | TN-S | Lowest TOV damage, in Rands[a] | Highest TOV damage, in Rands[c] |
| Lost N or PEN | TN-C-S | Same TOV damage incidence[b] | Same TOV damage incidence[b] |
| Lost N or PEN | TT | Lower TOV damage, in Rands[a] | Highest TOV damage, in Rands[c] |
| HV earth fault (items 14 to 22) | TN-S | No SPD damage[a] | No SPD damage[a] |
| HV earth fault | TN-C-S | No SPD damage[a] | No SPD damage[a] |
| HV earth fault | TT | Four low-cost SPDs damaged[b] | One high-cost SPD damaged[b] |
| Common mode (items 1 to 4) | | Best protection[a] | Worst protection[c] |
| Differential mode | | Worst protection[c] | Best protection[a] |

[a] Best choice.

[b] Similar choice.

[c] Worst choice.

# Annex J
(informative)

# Electricity supply systems

NOTE See section 2 of the test report (see 8.7).

## J.1 System earthing identification code

The first letter of the identification code denotes the relationship of the source of energy to earth:

**T** one or more parts are connected direct to earth; and

**I** all live parts are isolated from earth or one point is connected to earth through impedance.

The second letter of the identification code denotes the relationship of the exposed conductive parts of the consumer's installation to earth:

**T** the exposed conductive parts of the consumer's electrical installation are connected direct to earth, independently of the earthing of any point of the source of energy; and

**N** the exposed conductive parts of the consumer's electrical installation are connected direct to the source earth, which, in the case of an a.c. system, is usually the transformer neutral point.

The designation TN is further subdivided depending on the arrangement of the neutral and protective conductors. A further letter or letters denotes such arrangement, as follows:

**C** the neutral and protective functions on the incoming supply and in the consumer's electrical installation are combined in a single conductor;

**S** the neutral and protective functions on the incoming supply and in the consumer's electrical installation are provided by separate conductors; and

**C-S** the neutral and protective functions on the incoming supply are combined in a single conductor and in the consumer's electrical installation are serviced by separate conductors.

The common types of system earthing using these identification codes are described in M.2. TN-C-S and TN-S system earthing for electricity supply systems (see figures J.2.1 and J.2.2) are prescribed for use in South Africa. Except for medical locations as described in clause 7.7, only TN-S system earthing shall be used in an electrical installation beyond the point of control.

## J.2 Types of LV system earthing

NOTE The point of supply on the figures could be at the point of control or further upstream, depending on the point determined by the supplier of electricity.

### J.2.1 TN-C-S system earthing

The usual form of a TN-C-S system earthing is as shown in figure J.2.1, where the supply is TN-C and the arrangement in the consumer's installation is TN-C-S.

All exposed conductive parts of a consumer's installation are connected to the PEN (protective earth and neutral) conductor via the supply earth terminal.

NOTE 1 This is one of the preferred methods of low-voltage system earthing.

NOTE 2 The integrity of the PEN conductor is of paramount importance. With an open circuit in the PEN conductor, dangerous voltages can appear at the supply earth terminal, which might not be prevented by multiple-point earthing of the PEN conductor.

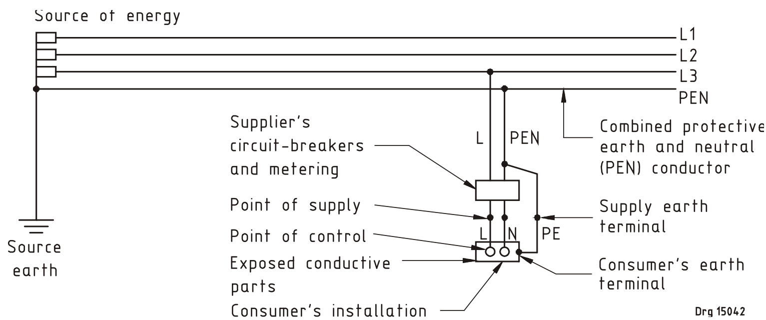



**Figure J.2.1 — TN-C-S system earthing**

**Neutral and protective functions combined in a single conductor between the source of energy and the point of supply and separated in the consumer's installation**

### J.2.2 TN-S system earthing

The protective conductor (PE), which is connected to the source earth, is either a separate conductor or the armour of the cable if the resistance of the armouring is such that the earth fault loop impedance complies with the requirements of 8.6.5.

All exposed conductive parts of a consumer's installation are connected to this protective conductor via the supply earth terminal.

NOTE This is one of the preferred methods of low-voltage system earthing.

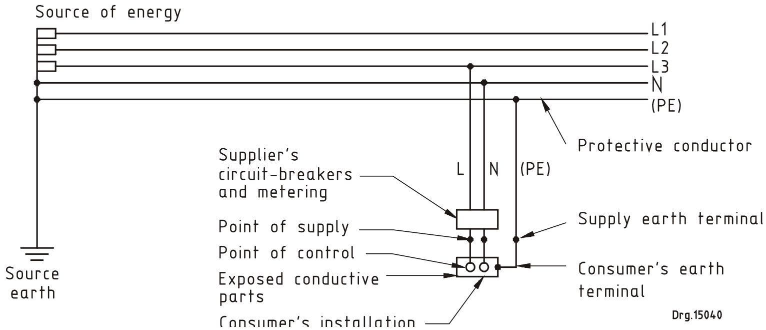



**Figure J.2.2 — TN-S system earthing**

**Separate neutral and protective conductors throughout the system earthing**

### J.2.3 TT system earthing

All exposed conductive parts of a consumer's installation are connected to a consumer's earth electrode which is electrically independent of the source earth.

NOTE This system relies on a low-impedance earth both at the source transformer and at every consumer's installation. The system is impractical in most parts of South Africa owing to high soil resistivity and earthing conductor losses. It has the added disadvantage that the loss of earth connection is not inherently self-monitoring. It is not considered further in this part of SANS 10142.

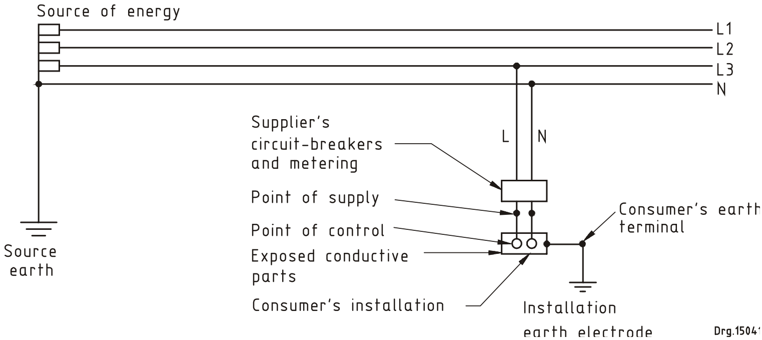



**Figure J.2.3 — TT system earthing**

**The general mass of earth is the only earth return path to the source earth**

## J.2.4 IT system earthing

The source of energy is either connected to earth through a deliberate introduced high earthing impedance or it is isolated from earth (typically more than 1 000 Ω).

All exposed conductive parts of a consumer's installation are connected to an earth electrode.

NOTE This is a special application usually found in an isolated source/load situation, such as on ships, in continuous process plants and in hospitals (see 7.7 for medical locations). It is not considered further in this part of SANS 10142, except for medical locations.

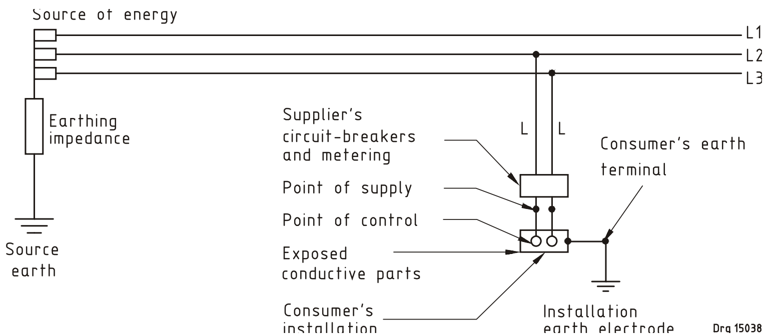



**Figure J.2.4 — IT system earthing**

## J.2.5 TN-C system earthing

All exposed conductive parts of a consumer's installation are connected to the PEN conductor.

NOTE This system is not allowed, because this part of SANS 10142 stipulates that a separate earth and neutral be run to each appliance beyond the point of supply. The loss of the PEN conductor can result in the appliance's becoming live and earth leakage protection might not operate. This system is not approved for use in South Africa. If such a system is identified, it should be converted to a prescribed system in consultation with the supply authority.

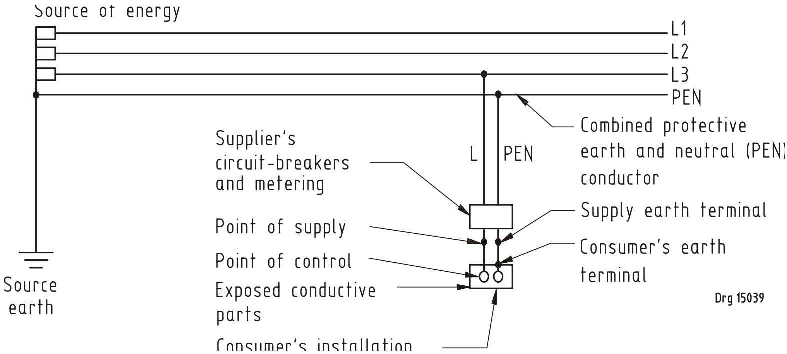



**Figure J.2.5 — TN-C system earthing**

**Neutral and protective functions combined in a single conductor throughout the system earthing**

# Annex K
(informative)

# Earthing arrangements and equipotential bonding of information technology installations for functional purposes

## K.1 General

**K.1.1** This annex provides functional provisions for earthing and equipotential bonding for information technology installations and similar equipment that require interconnections for data transmission purposes and other electronic equipment that is susceptible to interference.

**K.1.2** Information technology equipment includes all forms of electrical and electronic business equipment and telecommunications equipment.

NOTE For more information regarding the term "information technology equipment", see the scope of SANS 60950-11.

**K.1.3** Examples of equipment and installations to which this annex can apply are

a) telecommunication and data communication or data processing equipment, or installations that use signalling with earth return in internal connections and external connections to a building,

b) d.c. power supply networks that serve information technology equipment inside a building,

c) private automatic branch exchange (PABX) equipment or installations,

d) local area networks (LAN),

e) fire alarm systems and intruder alarm systems,

f) building management services, for example, direct digital control systems, and

g) systems for computer-aided manufacturing (CAM) and other computer-aided services.

**K.1.4** Throughout this annex the term "functional" refers to the use of earthing and equipotential bonding for signalling and electromagnetic compatibility (EMC) purposes.

NOTE 1 This annex does not consider the possible influence of lightning.

NOTE 2 SELV circuits, as defined in SANS 60950-1, are earthed and they are considered as PELV circuits.

## K.2 Earthing busbar

### K.2.1 Functional purposes

Where an earthing busbar is required for functional purposes, the main earthing terminal of the building can be extended using an earthing busbar so that information technology installations can be connected to the earthing busbar by the shortest practical route from any point in the building. Where the earthing busbar is erected to support the equipotential bonding system of a significant information technology installation in a building, it may be installed as a closed ring.

NOTE 1 The earthing busbar may be bare or insulated.

NOTE 2 The earthing busbar is preferably to be installed so that it is accessible throughout its length, for example, on the surface of the trunking. To prevent corrosion, it might be necessary to insulate bare conductors at supports and where they pass through walls.

### K.2.2 Cross-sectional area of the earthing busbar

The effectiveness of the earthing busbar depends on the routing and the impedance of the conductor employed. For large installations, a copper conductor of cross-sectional area 50 mm² is a good compromise between material cost and impedance. Where the earthing busbar is used as part of a d.c. return current path, its cross-sectional area shall be dimensioned according to the expected d.c. return currents.

NOTE The following d.c. return currents and coordinated cross-sectional areas may be considered for copper:

| | | |
|---|---|---|
| < 200 A | : | 50 mm² |
| 200 A to 999 A | : | 70 mm² |
| 1 000 A to 2 000 A | : | 95 mm² |
| > 2 000 A | : | 120 mm² |

### K.2.3 Connections to the earthing busbar

The following conductors may be connected to the earthing busbar:

a) conductive screens, sheaths or armouring of telecommunication cables or telecommunication equipment;

b) earthing conductors for overvoltage protective devices;

c) earthing conductors of radio communication antenna systems;

d) the earthing conductor of an earthed d.c. power supply system for information technology equipment;

e) functional earthing conductors; and

f) conductors of lightning protection systems.

## K.3 Equipotential bonding arrangements for functional purposes

**K.3.1** Where an equipotential bonding arrangement is used for functional purposes, it may include cable sheaths and building metalwork such as water pipes and cable ducts.

**K.3.2** The integration of structural steel and steel reinforcement of buildings into an equipotential bonding system can be advantageous. Then reinforcement rods should be welded together and connected to the earthing bus conductor. If welding is not allowed for structural reasons, clamps may be used or additional steel rods should be incorporated which are welded together at joints and bonded to the reinforcement rods by means of binding wire.

**K.3.3** The requirements for equipotential bonding for functional purposes (for example, cross-sectional area, shape, position) depend upon the frequency range of the information technology system, the prevailing electromagnetic environment, and the immunity/frequency characteristics of the equipment.

NOTE During a short-circuit to earth, overcurrents can occur in conductive signal connections between equipment.

## K.4 Functional earthing conductors

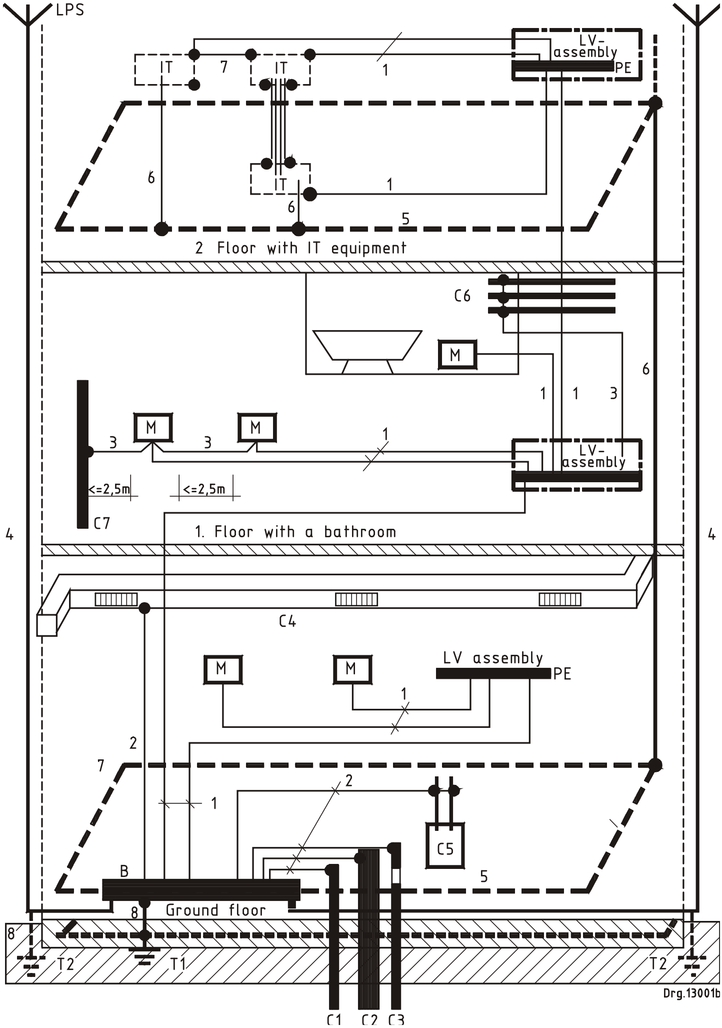
### K.4.1 Provision for functional earthing

Functional earthing may be provided by using the protective conductor of the supply circuit for the information technology equipment or by a separate dedicated conductor.

### K.4.2 Cross-sectional area

The cross-sectional area of earthing conductors shall take account of possible fault currents which can flow and the relevant data shall be obtained from the equipment manufacturer.

The earthing arrangement is illustrated in figure K.1.




**Legend**

**B** Main earthing terminal or main earthing busbar
Terminal or busbar, which is part of the earthing arrangement of an installation and enables the electric connection of a number of conductors for earthing purposes.

**C** Extraneous conductive part
Conductive part that does not form part of the electrical installation and is liable to introduce an electric potential, generally the electric potential of a local earth.

- C1 water pipe (metal – from outside)
- C2 waste-water pipe (metal – from outside)
- C3 gas pipe with insulating piece (metal – from outside)
- C4 air conditioning
- C5 heating system
- C6 water pipe (metal – for example, in a bathroom)
- C7 extraneous conductive part within arm's reach of exposed conductive parts

**M** Exposed conductive part
Part of equipment which can be touched and which is not normally live, but can become live when basic insulation fails.

**T** Earth electrode
Conductive part, which may be embedded in a specific conductive medium, for example, concrete or coke, in electric contact with the earth.

- T1 foundation earth
- T2 earth electrode for lightning protection system (LPS), if necessary

**1** Protective conductor
Conductor provided for purposes of safety, for example, protection against electric shock.

**2** Protective bonding conductor
Protective conductor provided for protective equipotential bonding.

**3** Protective bonding conductor for supplementary bonding

**4** Down conductor of a lightning protection system (LPS)

**5** Earthing busbar

**6** Functional earthing conductor
Earthing conductor provided for functional earthing.

**7** Functional bonding conductor
Conductor provided for functional equipotential bonding.

**8** Earthing conductor
Conductor which provides a conductive path, or part of the conductive path, between a given point in a system or in an installation or in equipment and an earth electrode.

An earthing conductor is the conductor which connects the earth electrode to a point on the common equipotential bonding system, usually the main earthing terminal or the earthing busbar.

**Figure K.1 — Illustration of protective and functional earthing and equipotential bonding for information technology equipment**

# Annex L
(informative)

# Classification of safety services necessary for medical locations

## L.1 Classification of safety services

NOTE Safety services in medical locations are synonymous with emergency services.

**Table L.1 — Safety service classes and security of supply**

| 1 | 2 |
|---|---|
| **Safety service class** | **Security of supply** |
| Class 0<br>(No break) | Automatic supply available at no break |
| Class 0,15<br>(Very short break) | Automatic supply available within 0,15 s |
| Class 0,5<br>(Short break) | Automatic supply available within 0,5 s |
| Class 30<br>(Medium break) | Automatic supply available within 30 s |
| Class > 30<br>(Long break) | Automatic supply available in more than 30 s |

## L.2 Examples for the allocation of medical location group and classification of safety service classes for medical locations

A list that shows the assigned groups of medical location is impracticable, since the use for locations (rooms) will differ from one country to another and even within a country. Table L.2 is provided as a guide.

**Table L.2 — List of examples for allocation of medical location group and classification of safety service classes**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| | **Medical location** | **Medical location group** | | | **Safety service class** | |
| | | **0** | **1** | **2** | **≤ 0,5** | **> 0,5 ≤ 30** |
| 1 | Massage room | X | X | | | X |
| 2 | Bedrooms | | X | | | X |
| 3 | Delivery room | | X | | X | X |
| 4 | ECG, EEG, EHG room | | X | | | X |
| 5 | Endoscopic room | | X[a] | | | X[a] |
| 6 | Examination or treatment room | | X | | | X |
| 7 | Urology room | | X[a] | | | X |
| 8 | Radiological diagnostic and radio therapy room, other than mentioned under 21 | | X | | | X |
| 9 | Hydrotherapy room | | X | | | X |
| 10 | Physiotherapy room | | X | | | X |
| 11 | Anaesthetic room | | | X | X | X |
| 12 | Operating theatre | | | X | X | X |
| 13 | Operating preparation room | | X | X | X | X |
| 14 | Operating plaster room | | X | X | X | X |
| 15 | Operating recovery room | | X | X | X | X |
| 16 | Heart catheterization room | | | X | X | X |
| 17 | Intensive care room | | | X | X | X |
| 18 | Angiographic examination room | | | X | X | X |
| 19 | Haemodialysis room | | X | | | X |
| 20 | Magnetic resonant imaging (MRI) | | X | | | X |
| 21 | Nuclear medicine | | X | | | X |
| 22 | Premature baby room | | | X | X | X |
| [a] The room is not an operating theatre. | | | | | | |

## L.3 Explanations of the terms listed in table L.2 for medical locations

1. Massage room.

2. General ward (bedrooms).

   Room or room group in which patients are accommodated for the duration of their stay in a hospital, or in any other medical establishment.

3. Delivery room.

   Room in which actual birth takes place.

4. Electrocardiography room (ECG), electroencephalography room (EEG), electrohysterography room (EHG).

5. Endoscopic room.

   Room intended for the application of endoscopic methods for the examination of organs through natural or artificial orifices.

   Examples of endoscopic methods are bronchoscopic, laryngoscopic, cystoscopic, gastroscopic and similar methods performed, if necessary, under anaesthesia.

6. Examination or treatment room.

7. Urology room (not being an operating theatre).

   Room in which diagnostic or therapeutic procedures are performed on the urogenital tract when medical electrical equipment is used, such as X-ray equipment, endoscopic equipment and high-frequency surgery equipment.

8. Radiological diagnostic and radio therapy room

   Radiological diagnostic room.

   Room intended for the use of ionizing radiation for the display of internal structures of the body by means of radiography or fluoroscopy, or for the use of radioactive isotopes, or for other diagnostic purposes.

Radio therapy room.

Room intended for the use of ionizing radiation to obtain therapeutic effects.

9. Hydrotherapy room.

Room in which patients are treated by hydrotherapeutic methods. Examples of such methods are therapeutic treatments with water, brine, mud, slime, clay, steam, sand, water with gases, brine with gases, inhalation therapy, electrotherapy in water (with or without additions), massage thermotherapy and thermotherapy in water (with or without additions).

Swimming pools for general use and normal bathrooms are not considered hydrotherapy rooms.

10. Physiotherapy room.

Room in which patients are treated by physiotherapeutic methods.

11. Anaesthetic room.

Room in which general inhalation anaesthetics (gas) are intended to be administered.

NOTE Anaesthetic rooms comprise, for example, the actual operating theatre, operating preparation room, operating plaster room and room(s) for surgeries.

12. Operating theatre.

Room in which surgical operations are performed.

13. Operating preparation room.

Room in which patients are prepared for an operation, for example, by administering anaesthetics.

NOTE Such a room belongs to the operating room group and is usually spatially connected to it.

14. Operating plaster room.

Room in which plaster of Paris or similar dressings are applied while anaesthesia is maintained.

NOTE Such a room belongs to the operating room group and is usually spatially connected to it.

15. Operating recovery room.

    Room in which the patient under observation recovers from the influence of anaesthesia.

    NOTE Such a room is usually very close to the operating room group but not necessarily part of it.

16. Heart catheterization room.

    Room intended for the examination of the heart using catheters. Examples of applied procedures are measurement of action potentials of the haemodynamics of the heart, drawing of blood samples, injection of contrast agents, or application of stimulants.

17. Intensive care rooms.

    Room in which bed patients are monitored independently of an operation by means of medical electrical equipment. Body actions may be stimulated if required.

18. Angiographic examination room.

    Room intended for displaying arteries or veins, etc. with contrast media.

19. Haemodialysis room.

    Room intended for the connection of patients to medical electrical equipment in order to detoxicate their blood.

20. Magnetic resonant imaging (MRI).

21. Nuclear medicine.

22. Premature baby room.

## Annex M
(informative)

# Authority for issuing a test report and a Certificate of Compliance

| | | | |
|---|---|---|---|
| **Type of Installation** | **Single-phase** | – **Two-phase**<br>– **Three-phase**<br>– **DC** | **Specialized installations (hazardous, medical, explosive, petroleum, etc.)** |
| **May be installed by** | electrical contractor<br>or<br>any person[a] | electrical contractor, or<br>any person under control of<br>– installation electrician, or<br>– master installation electrician | electrical contractor, or<br>any person under control of<br>– master installation electrician |
| **Test report and Certificate of Compliance may be issued only by** | – electrical tester for single phase, or<br>– installation electrician, or<br>– master installation electrician | – installation electrician or<br>– master installation electrician | – master installation electrician |

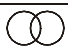
[a] Any person who undertakes to perform electrical installation work on behalf of any other person, but excluding an employee of such first-mentioned person, is legally required to register as an electrical contractor.

# Annex N
(informative)

## IEC symbols associated with switchgear

The following symbols are associated with switchgear. The marking of switchgear with these symbols is voluntary, except if prescribed in the product or in any mandatory specification.

**Table N.1 — IEC symbols for switchgear**

| 1 | 2 |
|---|---|
| Symbol | Description |
|  | General symbol for switch |
|  | Disconnector (off-load isolator) provisionally used for other switchgear which has isolation properties |
|  | Switch-disconnector (on-load isolator) |
|  | Circuit-breaker |
|  | Circuit-breaker, suitable for isolation |
| 2,5 kA<br>or<br>2 500 | Short-circuit rating (kA or A respectively) |
|  | Live electrical apparatus |
|  | Transformers |

Drg.14808z

# Annex O
(informative)

## Example of the application of correction factors for harmonic currents

Consider a three-phase circuit with a design load of 39 A to be installed using a four-core PVC insulated cable clipped to a wall, installation method 3 (see table 6.1).

In table 6.3(a), a 6 mm² cable with copper conductors has a current-carrying capacity of 41 A and hence is suitable if harmonic currents are not present in the circuit.

If 20 % third harmonic current is present, a correction factor of 0,86 (see table 6.18) is applied and the design load becomes

$$\frac{39}{0{,}86} = 45\ \text{A}$$

For this load a 10 mm² cable is suitable.

If 40 % third harmonic current is present, the cable selection is based on the zero sequence current in the neutral, which is

$$39 \times 0{,}4 \times 3 = 46{,}8\ \text{A}$$

and the correction factor of 0,86 (see table 6.18) is applied, leading to a design load of

$$\frac{46{,}8}{0{,}86} = 54{,}4\ \text{A}$$

For this load a 10 mm² cable is suitable.

If 50 % third harmonic current is present, the cable size is again selected on the basis of the zero sequence current in the neutral, which is

$$39 \times 0{,}5 \times 3 = 58{,}5\ \text{A}$$

In this case the rating factor is 1 and a 16 mm² cable is suitable.

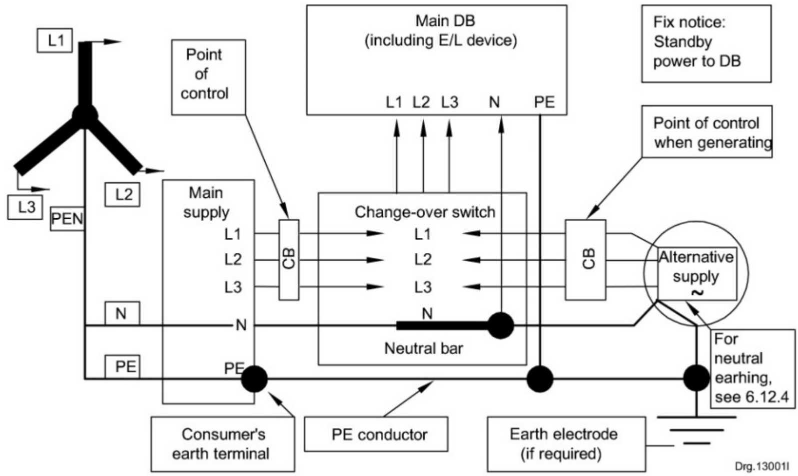
All the cable selections in this annex are based on the current-carrying capacity of the cable only. Voltage drop and other aspects of design (such as other correction factors) have not been considered.

NOTE Where harmonic current is present, the cable size is selected on the basis of the zero sequence current in the neutral.

# Annex P
(informative)

# Examples of emergency power installation configuration

## P.1 Change-over switch connection where standby power feeds in at main supply




**Key**

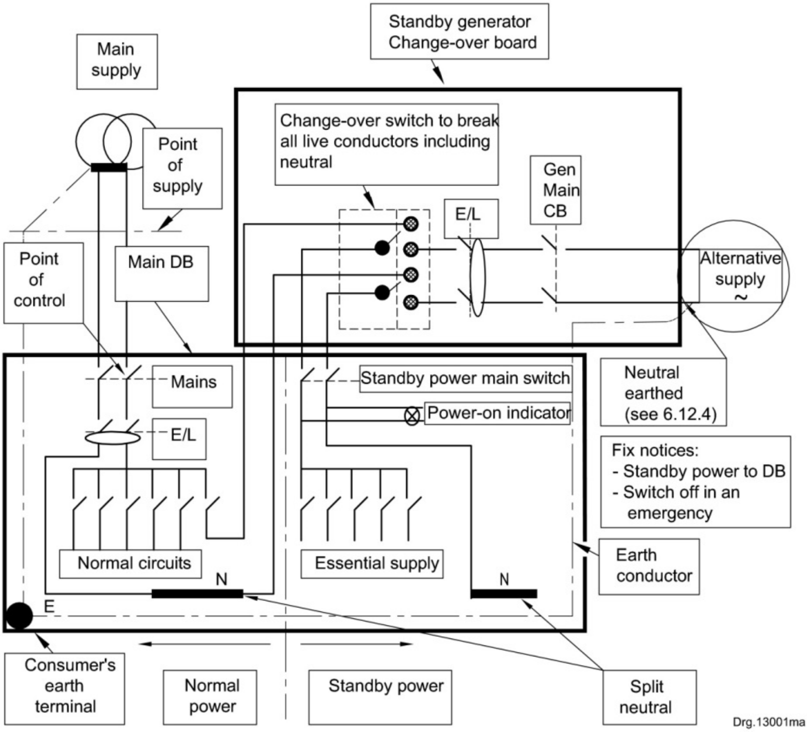
| | | | |
|---|---|---|---|
| CB | circuit-breaker | E/L | earth leakage |
| DB | distribution board | | |

NOTE 1 A three-pole change-over switch may be used where the supply is from a TN system of supply and the standby power is connected at the main supply.

NOTE 2 It may be necessary to break the neutral when neutral currents are present in the utility supply.

**Figure P.1 — Change-over switch connection where standby power feeds in at main supply**

## P.2 Change-over switch connection where a standby power generator feeds into a section of the main distribution board




**Key**

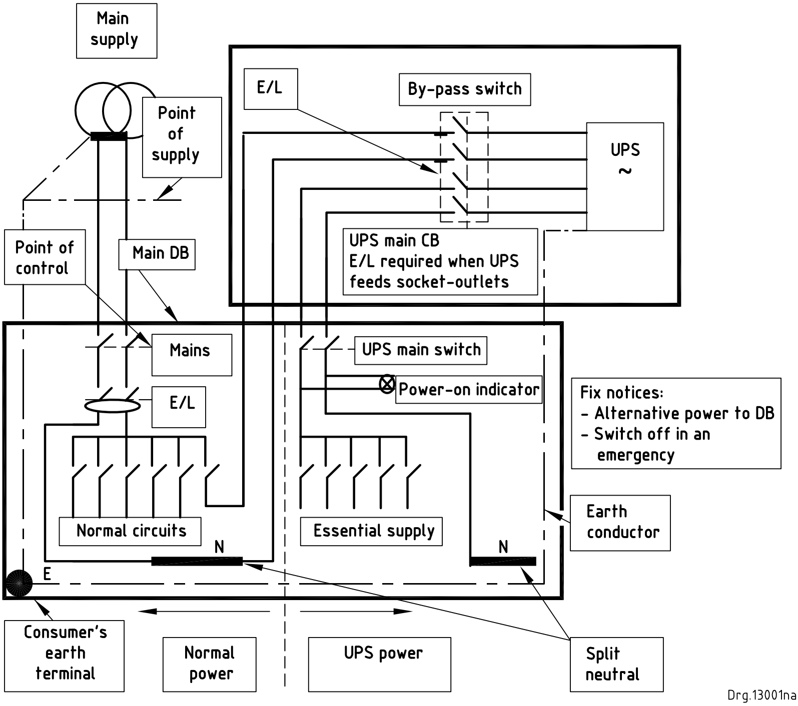
| | | | |
|---|---|---|---|
| CB | circuit-breaker | E/L | earth leakage |
| DB | distribution board | | |

NOTE See the split neutral bars.

The main switch may be an E/L device.

**Figure P.2 — Change-over switch connection where a standby power generator feeds into a section of the main distribution board**

## P.3 Connection where UPS power feeds into a section of the main distribution board




**Key**

| | |
|---|---|
| CB | circuit-breaker |
| DB | distribution board |
| E/L | earth leakage |

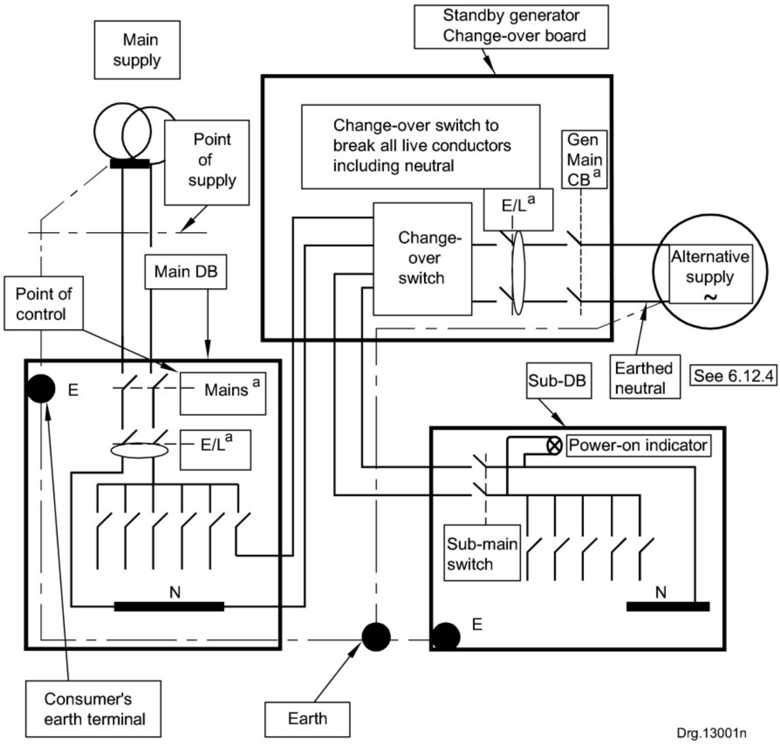
NOTE See the split neutral bars.

The main switch may be an E/L device.

**Figure P.3 — Connection where UPS power feeds into a section of the main distribution board**

## P.4 Change-over switch connection where standby power feeds in after the main distribution board (point of supply) into a sub-distribution board




[a] The main circuit-breaker may be an earth leakage device with isolation function.

**Figure P.4 — Change-over switch connection where standby power feeds in after the main distribution board (point of supply) into a sub-distribution board**

## Bibliography

SANS 1576, *Electric cables – Single core arc welding cable*.

SANS 60079 (all parts), *Explosive atmospheres*.

SANS 60601-1/IEC 60601-1, *Medical electrical equipment – Part 1: General requirements for basic safety and essential performance.*

SANS 60950-1/IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements.*

IEC 60998-2-1, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units*.

IEC 60998-2-2, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units*.

SANS 61851 (all parts), *Electric vehicle conductive charging system*.

SANS 62196 (all parts), *Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles*.

## SABS – Standards Division

The objective of the SABS Standards Division is to develop, promote and maintain South African National Standards. This objective is incorporated in the Standards Act, 2008 (Act No. 8 of 2008).

### Amendments and Revisions

South African National Standards are updated by amendment or revision. Users of South African National Standards should ensure that they possess the latest amendments or editions.

The SABS continuously strives to improve the quality of its products and services and would therefore be grateful if anyone finding an inaccuracy or ambiguity while using this standard would inform the secretary of the technical committee responsible, the identity of which can be found in the foreword.

The SABS offers an individual notification service, which ensures that subscribers automatically receive notification regarding amendments and revisions to South African National Standards.
Tel: +27 (0) 12 428 6883 Fax: +27 (0) 12 428 6928 E-mail: sales@sabs.co.za

### Buying Standards

Contact the Sales Office for South African and international standards, which are available in both electronic and hard copy format.
Tel: +27 (0) 12 428 6883 Fax: +27 (0) 12 428 6928 E-mail: sales@sabs.co.za
South African National Standards are also available online from the SABS website http://www.sabs.co.za

### Information on Standards

The Standards Information Centre provides a wide range of standards-related information on both national and international standards. The Centre also offers an individual updating service called INFOPLUS, which ensures that subscribers automatically receive notification regarding amendments to, and revisions of, international standards.
Tel: +27 (0) 12 428 7911 / 0861 27 7227 Fax: +27 (0) 12 428 6928 E-mail: info@sabs.co.za