ISBN xxx-x-xxx-xxxxx-x

SANS 10142-1-2:201X

Edition 1
Any reference to SABS xxxx is deemed
to be a reference to this standard
(Government Notice No. 1373 of 8 November 2002)

DRAFT:
SOUTH AFRICAN NATIONAL STANDARD

The wiring of premises

Part 1-2: Specific requirements for embedded generation installations connected to the low voltage distribution Network in South Africa

WARNING
This document references other documents normatively.

Published by

Table of Changes

Change No	Date	Scope

Acknowledgements

We would like to thank the Council for Scientific and Industrial Research (CSIR), POWER Engineers and Route63 Training for their assistance in the development of this standard.

Foreword

Electrical Networks worldwide are experiencing higher distributed generation penetration levels. In order to maintain a safe and reliable Network, the South African standard SANS 10142-1-2 was developed.

SANS 10142-1-2 is the first of a series of standards being developed concerning embedded generation installations. The titles of the additional documents in the series will follow.

This first publication of SANS 10142-1-2 builds on SANS 10142-1, the South African Low Voltage Wiring Code.

The aim of SANS 10142-1-2 is to ensure safe operation of embedded generation installations and the electrical Network it is connected to under both normal and fault conditions.

Contents

List of Tables

List of Figures

List of Certificates

1. Scope

1.1 Application of this Part of SANS 10142-1-2

SANS 10142-1-2 applies to Embedded Generation Installations utilizing the following technologies:
a) Energy Storage Systems;
b) Inverter-Based Generation;
c) Synchronous Generators;
d) Asynchronous / Induction Generators;
that are connected to a Point of Utility Supply.

NOTE: This standard takes precedence over all other wiring and / or installation standards for Embedded Generation Installations.

1.2 Aspects Covered by this Part of SANS 10142-1-2

SANS 10142-1-2 covers the following:
a) The requirements for Embedded Generation Installations up to and including 1500V DC and 1000V AC (solar PV systems at 1500V is the maximum power point voltage value at STC);
b) The installation requirements for Embedded Generation Installations up to all points of supply within a single installation;
c) Any wiring systems and cables not specifically covered by the standards for appliances;
d) The extension or alteration of the installation, as well as parts of the existing installation, affected by an Embedded Generation Installation.

NOTE: Installers are advised to consult the NRS 097 series documents to correctly apply this standard.

1.3 Where this Part of SANS 10142-1-2 is Not Applicable

SANS 10142-1-2 does not apply to:
a) Utility-scale Embedded Generation Installations;
b) Installations that are not connected to the grid;
c) DC installations.

1.4 Electrical Equipment

Requirements of SANS 10142-1, Section 1.4 applies.

2. Normative References

Requirements of SANS 10142-1, Section 2, Normative References applies.

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 60364-7-712:2002 - Electrical Installations of buildings - Part 7-712: Requirements for special installations or locations - Solar photovoltaic (PV) power supply systems.

IEC 60891, Photovoltaic devices - Procedures for temperature and irradiance corrections to measured I-V characteristics

IEC 60904-1, Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics

IEC 60904-10, Photovoltaic devices - Part 10: Methods of linearity measurement

IEC 60904-1-1, Photovoltaic devices - Part 1-1: Measurement of current-voltage characteristics of multi-junction photovoltaic (PV) devices

IEC 60904-2, Photovoltaic devices - Part 2: Requirements for photovoltaic reference devices

IEC 60904-2, Photovoltaic devices – Part 2: Requirements for photovoltaic reference devices

IEC 60904-3, Photovoltaic devices - Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data

IEC 60904-3, Photovoltaic devices - Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data

IEC 60904-4, Photovoltaic devices - Part 4: Reference solar devices - Procedures for establishing calibration traceability

IEC 60904-5, Photovoltaic devices - Part 5: Determination of the equivalent cell temperature (ECT) of photovoltaic (PV) devices by the open-circuit voltage method

IEC 60904-7, Photovoltaic devices - Part 7: Computation of the spectral mismatch correction for measurements of photovoltaic devices

IEC 60904-8, Photovoltaic devices - Part 8: Measurement of spectral responsivity of a photovoltaic (PV) device

IEC 60904-8-1, Photovoltaic devices - Part 8-1: Measurement of spectral responsivity of multi-junction photovoltaic (PV) devices

IEC 60904-9, Photovoltaic devices - Part 9: Solar simulator performance requirements

IEC 61215-1, Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1: Test requirements

IEC 61215-1-1, Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules

IEC 61215-1-2, Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules

IEC 61215-1-3, Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules

IEC 61215-1-4, Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-4: Special requirements for testing of thin-film Cu(In,GA)(S,Se)2 based photovoltaic (PV) modules

IEC 61215-2, Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 2: Test procedures

IEC TS 61312-3, Protection against lightning electromagnetic impulse – Part 3: Requirements of surge protective devices (SPDs).

IEC 61683, Photovoltaic systems - Power conditioners - Procedure for measuring efficiency

IEC 61701, Salt mist corrosion testing of photovoltaic (PV) modules

IEC 61724-1, Photovoltaic system performance - Part 1: Monitoring

IEC 61725, Analytical expression for daily solar profiles

IEC 61727, Photovoltaic (PV) systems - Characteristics of the utility interface

IEC 61727:2004 - Photovoltaic (PV) systems - Characteristics of the utility interface

IEC 61730-1, Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction

IEC 61730-2, Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing

IEC 61730-2, Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing

IEC 61829, Photovoltaic (PV) array - On-site measurement of current-voltage characteristics

IEC 61853-1, Photovoltaic (PV) module performance testing and energy rating - Part 1: Irradiance and temperature performance measurements and power rating

IEC 61853-2, Photovoltaic (PV) module performance testing and energy rating - Part 2: Spectral responsivity, incidence angle and module operating temperature measurements

IEC 62093, Balance-of-system components for photovoltaic systems - Design qualification natural environments

IEC 62108, Concentrator photovoltaic (CPV) modules and assemblies - Design qualification and type approval

IEC 62108, Concentrator photovoltaic (CPV) modules and assemblies - Design qualification and type approval

IEC 62109-1, Safety of power converters for use in photovoltaic power systems - Part 1: General requirements

IEC 62109-1:2010 - Safety of power converters for use in photovoltaic power systems - Part 1: General requirements.

IEC 62109-2, Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters
IEC 62109-2: 2011 - Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters.

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

IEC 62116:2014 - Utility-interconnected photovoltaic inverters - Test procedure of islanding prevention measures.

IEC 62124, Photovoltaic (PV) stand alone systems - Design verification

IEC 62253, Photovoltaic pumping systems - Design qualification and performance measurements

IEC 62446-1, Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 1: Grid connected systems - Documentation, commissioning tests and inspection

IEC 62509, Battery charge controllers for photovoltaic systems - Performance and functioning

IEC 62548, Photovoltaic (PV) arrays - Design requirements

IEC 62670-1, Photovoltaic concentrators (CPV) - Performance testing - Part 1: Standard conditions

IEC 62670-2, Photovoltaic concentrators (CPV) - Performance testing - Part 2: Energy measurement

IEC 62670-3, Photovoltaic concentrators (CPV) - Performance testing - Part 3: Performance measurements and power rating

IEC 62716 / COR1, Corrigendum 1 - Photovoltaic (PV) modules - Ammonia corrosion testing

IEC 62716, Photovoltaic (PV) modules - Ammonia corrosion testing

IEC 62759-1, Photovoltaic (PV) modules - Transportation testing - Part 1: Transportation and shipping of module package units

IEC 62788-1-2, Measurement procedures for materials used in photovoltaic modules - Part 1-2: Encapsulants - Measurement of volume resistivity of photovoltaic encapsulants and other polymeric materials

IEC 62788-1-4, Measurement procedures for materials used in photovoltaic modules - Part 1-4: Encapsulants - Measurement of optical transmittance and calculation of the solar-weighted photon transmittance, yellowness index, and UV cut-off wavelength

IEC 62788-1-5 / COR1, Corrigendum 1 - Measurement procedures for materials used in photovoltaic modules - Part 1-5: Encapsulants - Measurement of change in linear dimensions of sheet encapsulation material resulting from applied thermal conditions

IEC 62788-1-5, Measurement procedures for materials used in photovoltaic modules - Part 1-5: Encapsulants - Measurement of change in linear dimensions of sheet encapsulation material resulting from applied thermal conditions

IEC 62788-1-6, Measurement procedures for materials used in photovoltaic modules - Part 1-6: Encapsulants - Test methods for determining the degree of cure in Ethylene-Vinyl Acetate

IEC 62790, Junction boxes for photovoltaic modules - Safety requirements and tests

IEC 62817 + AMD1, Photovoltaic systems - Design qualification of solar trackers

IEC 62817, Amendment 1 - Photovoltaic systems - Design qualification of solar trackers

IEC 62817, Photovoltaic systems - Design qualification of solar trackers

IEC 62852, Connectors for DC-application in photovoltaic systems - Safety requirements and tests

IEC 62894 / AMD1, Amendment 1 - Photovoltaic inverters - Data sheet and name plate

IEC 62894 + AMD1, Photovoltaic inverters - Data sheet and name plate

IEC 62894, Photovoltaic inverters - Data sheet and name plate

IEC 62920, Photovoltaic power generating systems - EMC requirements and test methods for power conversion equipment

IEC 62925, Concentrator photovoltaic (CPV) modules - Thermal cycling test to differentiate increased thermal fatigue durability

IEC 62979, Photovoltaic modules - Bypass diode - Thermal runaway test

IEC PAS 62257-10, Recommendations for renewable energy and hybrid systems for rural electrification - Part 10: Silicon solar module visual inspection guide

IEC TS 61312-3, Protection against lightning electromagnetic impulse – Part 3: Requirements of surge protective devices (SPDs).

IEC TS 61724-2, Photovoltaic system performance - Part 2: Capacity evaluation method

IEC TS 61724-3, Photovoltaic system performance - Part 3: Energy evaluation method

IEC TS 61836 RLV, Solar photovoltaic energy systems - Terms, definitions and symbols

IEC TS 61836, Solar photovoltaic energy systems - Terms, definitions and symbols

IEC TS 62257-1, Recommendations for renewable energy and hybrid systems for rural electrification - Part 1: General introduction to IEC 62257 series and rural electrification

IEC TS 62257-12-1, Recommendations for renewable energy and hybrid systems for rural electrification - Part 12-1: Selection of lamps and lighting appliances for off-grid electricity systems

IEC TS 62257-12-1, Recommendations for renewable energy and hybrid systems for rural electrification – Part 12-1: Selection of self-ballasted lamps (CFL) for rural electrification systems and recommendations for household lighting equipment.

IEC TS 62257-1-X:2015, Recommendations for renewable energy and hybrid systems for rural electrification – Part 3: Project development and management

IEC TS 62257-2, Recommendations for renewable energy and hybrid systems for rural electrification - Part 2: From requirements to a range of electrification systems

IEC TS 62257-2:2015, Recommendations for renewable energy and hybrid systems for rural electrification – Part 1: General introduction to IEC 62257 series and rural electrification

IEC TS 62257-2:2015, Recommendations for renewable energy and hybrid systems for rural electrification – Part 2: From requirements to a range of electrification systems

IEC TS 62257-3, Recommendations for renewable energy and hybrid systems for rural electrification - Part 3: Project development and management
IEC TS 62257-4, Recommendations for renewable energy and hybrid systems for rural electrification - Part 4: System selection and design

IEC TS 62257-4:2015, Recommendations for renewable energy and hybrid systems for rural electrification – Part 4: System selection and design

IEC TS 62257-5, Recommendations for renewable energy and hybrid systems for rural electrification - Part 5: Protection against electrical hazards

IEC TS 62257-5:2015, Recommendations for renewable energy and hybrid systems for rural electrification – Part 5: Protection against electrical hazards

IEC TS 62257-6, Recommendations for renewable energy and hybrid systems for rural electrification - Part 6: Acceptance, operation, maintenance and replacement

IEC TS 62257-6:2015, Recommendations for renewable energy and hybrid systems for rural electrification – Part 6: Acceptance, operation, maintenance and replacement

IEC TS 62257-7, Recommendations for renewable energy and hybrid systems for rural electrification – Part 7: Generators

IEC TS 62257-7, Recommendations for small renewable energy and hybrid systems for rural electrification - Part 7: Generators

IEC TS 62257-7-1, Recommendations for renewable energy and hybrid systems for rural electrification – Part 7-1: Generators – Photovoltaic arrays

IEC TS 62257-7-1, Recommendations for small renewable energy and hybrid systems for rural electrification - Part 7-1: Generators - Photovoltaic generators

IEC TS 62257-7-1-X, Recommendations for renewable energy and hybrid systems for rural electrification – Part 7-1-X: Generator set – Selection of generator sets for rural electrification systems

IEC TS 62257-7-3, Recommendations for small renewable energy and hybrid systems for rural electrification - Part 7-3: Generator set - Selection of generator sets for rural electrification systems

IEC TS 62257-8-1, Recommendations for small renewable energy and hybrid systems for rural electrification - Part 8-1: Selection of batteries and battery management systems for stand-alone electrification systems - Specific case of automotive flooded lead-acid batteries available in developing countries

IEC TS 62257-8-1:2007, Recommendations for renewable energy and hybrid systems for rural electrification – Part 8-1: Selection of batteries and battery management systems for standalone electrification systems – Specific case of automotive flooded lead-acid batteries available in developing countries

IEC TS 62257-9-1, Recommendations for renewable energy and hybrid systems for rural electrification - Part 9-1: Integrated systems - Micropower systems

IEC TS 62257-9-1, Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-1: Micropower systems

IEC TS 62257-9-1-X, Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-1-X: Integrated system – User interface

IEC TS 62257-9-2, Recommendations for renewable energy and hybrid systems for rural electrification - Part 9-2: Integrated systems – Microgrids

IEC TS 62257-9-2, Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-2: Microgrids

IEC TS 62257-9-3, Recommendations for renewable energy and hybrid systems for rural electrification - Part 9-3: Integrated systems - User interface

IEC TS 62257-9-4, Recommendations for renewable energy and hybrid systems for rural electrification - Part 9-4: Integrated systems - User installation

IEC TS 62257-9-5, Recommendations for renewable energy and hybrid systems for rural electrification - Part 9-5: Integrated systems - Selection of stand-alone lighting kits for rural electrification

IEC TS 62257-9-6, Recommendations for small renewable energy and hybrid systems for rural electrification - Part 9-6: Integrated system - Selection of Photovoltaic Individual Electrification Systems (PV-IES)

IEC TS 62446-3, Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 3: Photovoltaic modules and plants - Outdoor infrared thermography
IEC TS 62548, Photovoltaic (PV) arrays - Design requirements.

IEC TS 62727, Photovoltaic systems - Specification for solar trackers

IEC TS 62782, Photovoltaic (PV) modules - Cyclic (dynamic) mechanical load testing

IEC TS 62788-2, Measurement procedures for materials used in photovoltaic modules - Part 2: Polymeric materials - Frontsheets and backsheets

IEC TS 62789, Photovoltaic concentrator cell documentation

IEC TS 62804-1, Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation - Part 1: Crystalline silicon

IEC TS 62910, Utility-interconnected photovoltaic inverters - Test procedure for low voltage ride-through measurements

IEC TS 62916, Photovoltaic modules - Bypass diode electrostatic discharge susceptibility testing

IEC TS 62941, Terrestrial photovoltaic (PV) modules - Guideline for increased confidence in PV module design qualification and type approval

NRS 097-2-1, Grid interconnection of Embedded Generation, Part 2: Small Scale Embedded Generation, Section 1, Utility interface.

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 apparatus for use in such locations.

SANS 10198-10 (SABS 0198-10), 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 (SABS 0198-11), 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 (SABS 0198-14), 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 10198-4, The selection, handling and installation of electric power cables of rating not exceeding 33 kV – Part 4: Current ratings.

SANS 10199, The design and installation of earth electrodes.

SANS 10222-1-3, Electrical security installations – Part 3: Electric security fences (non-lethal).

SANS 10292 (SABS 0292), Earthing of low-voltage (LV) distribution systems.

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

SANS 1063, Earth rods, couplers and connections.

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

SANS 1186-1, Symbolic safety signs, Part 1: Standard signs and general requirements

SANS 1195, Busbars.

SANS 1213, Mechanical cable glands.

SANS 1239, Plugs, socket-outlets and couplers for industrial purposes.

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

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 1473-1, Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested, partially type-tested and specially tested assemblies with a rated short-circuit withstand strength above 10 kA

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 152 (SABS 152), Low-voltage air-break switches, air-break disconnectors, air-break Switch Disconnectors, and fuse-combination units.

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

SANS 156, Moulded-case circuit-breakers.

SANS 1574-3, Electric flexible cores, cords and cables with solid extruded dielectric insulation – Part 3: PVC-insulated cores and cables.

SANS 1574-5, Electric flexible cores, cords and cables with solid extruded dielectric insulation – Part 5: Rubber-insulated cores and cables.

SANS 1607 (SABS 1607), Electromechanical watt-hour meters. (Superseded by SANS 62053-11.)

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

SANS 1765, Low-voltage switchgear and controlgear assemblies (distribution boards) with a rated short-circuit withstand strength up to and including 10 kA.

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 shortcircuit 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 AC and DC

SANS 529, Heat-resisting wiring cables.

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

SANS 60034, Rotating electrical machines

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 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 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, AC and DC

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

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

SANS 60947-4-1 / IEC 60947-4-1, Low-voltage switchgear and control

SANS 60947-4-3 / IEC 60947-4-3, Low-voltage switchgear and control gear – Part 4-3: Contactors and motor-starters – A.C. semiconductor controllers and contactors for non-motor loads.

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

SANS 60947-5-1 / IEC 60947-5-1, Low-voltage switchgear and control gear – 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 control gear – Part 5-2: Control circuit devices and switching elements –Proximity switches.

SANS 60947-5-5 / IEC 60947-5-5, Low-voltage switchgear and control gear – 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 control gear – Part 6-1: Multiple function equipment –Transfer switching equipment.

SANS 60950 / IEC 60950, Safety of information technology equipment. (Superseded by SANS 60950-1).

SANS 60950-1 / IEC 60950-1, Information technology equipment – Safety – Part 1: General requirements.

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 inter-harmonics measurements and instrumentation, for power supply systems and equipment connected thereto. A

SANS 61008-1 / IEC 61008-1, Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules.

SANS 61036 / IEC 61036, Alternating current static watt-hour meters for active energy (classes 1 and 2). (Superseded by SANS 62053-21.)

SANS 61084-1 / IEC 61084-1, Cable trunking and ducting systems for Electrical Installations – Part 1: General requirements.

SANS 61140, Protection against electric shock – Common aspects for installations and equipment.

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

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

SANS 61439, Low-voltage switchgear and controlgear assemblies.

SANS 767-1, Earth leakage protection units – Part 1: Fixed earth leakage protection circuit-breakers.

SANS 780, Distribution transformers.

SANS 950, Unplasticized polyvinyl chloride rigid conduit and fittings for use in Electrical Installations.

South African Grid Connection Code for Renewable Power Plants (RPPs) Connected to the Electricity Transmission System (TS) or the Distribution System (DS) in South Africa (NOTE: Other parts of the grid code may also be applicable.)

3. Definitions, Abbreviations and Terms

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

3.1 Definitions

3.1.1 Alternative Supply

Any other form of power supply other than power supplied by the utility, including UPS, solar PV, Batteries and other power sources.

3.1.2 Air Change

Replacing the air within a certain are with uncontaminated / pure clear air.

3.1.3 Air Mass

Length of path through the earth's atmosphere traversed by the direct solar beam, expressed as a multiple of the path traversed to a point at sea level with the sun directly overhead.

NOTE: The air mass index is 1,0 at sea level with cloudless sky when the sun is directly overhead and the local air pressure equals P0. Standard test conditions use an AM of 1,5.
[IEC 61836, ed. 2.0 (2007-12)]

3.1.4 Asynchronous / Induction Generator

An induction machine, when driven above synchronous speed by an external source of mechanical power, used to convert mechanical power to electric power.

NOTE: Induction generators may draw reactive power from the Low Voltage (LV) Distribution Network.

3.1.5 Battery-Connected Inverter

An inverter that converts battery-supplied DC input to AC output.

3.1.6 Bonding (Equipotential)

Provision of electric connections between conductive parts intended to achieve equipotentiality. Also see SANS 10142-1, definition 3.14.2.
[SOURCE: IEV 195-01-10]

3.1.7 Customer

See “Consumer”, Section 3.1.8 of this standard.

3.1.8 Consumer

A person who is supplied (or who is to be supplied) with electricity by a Supplier (see 3.1.59), or a person who supplies his / her own electricity.

3.1.9 Current-Carrying Capacity (CCC)

Maximum electrical current that can be carried continuously by a conductor, under specified conditions, without causing objectable degradation of electrical and mechanical properties of the product.
[IEC 60194, ed. 6.0 (2015-04)]

3.1.10 Customer Network

An Electrical Installation downstream of the electricity consumption meter, usually on the Customer premises.

3.1.11 DC Systems

DC Systems in this document refers to DC equipment of the Embedded Generation Installation, see Section 3.1.16.

3.1.12 Dead

Means at or about zero potential and isolated from any live system.

3.1.13 Disconnection Device / Disconnector

A 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”.

3.1.14 Earthing

See SANS 10142-1, definitions 3.26, 3.27 and 3.28.

3.1.15 Electrical Installation

Machinery, in or on any premises, that is used for the transmission of electrical energy from a point of control to a point of consumption 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 50V, 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.

[SANS 10142-1]

3.1.16 Embedded Generation Installation (EGI)

A legal entity that operates or desires to operate any generating plant that is or shall be connected to the Network Service Provider’s Network. This definition includes all types of connected generation, including co-generators and renewables. Alternatively, the item of generating plant that is or shall be connected to the Network Service Provider’s Network.

3.1.17 Embedded Generator

One or more energy generation sources that includes the energy conversion device (devices), the Static Power Converter (converters), if applicable, the control and protection gear within a Customer’s Network that operate in synchronism with the utility’s supply.

NOTE 1: Examples of energy conversion devices are photovoltaic modules, fuel cells, induction generators or synchronous generators.

NOTE 2: Embedded generation is also referred to as “distributed” or “dispersed generation” in other documents.

NOTE 3: The embedded generator may include storage devices, such as lead-acid batteries in which case the size of the generator is limited to the maximum change in active power flow at the point of supply for a generator trip (or rapid reduction in output) when generating at full active power output. [NRS 097]

3.1.18 Extra Low Voltage (ELV)

Voltage that does not exceed 50V AC or 120V DC

3.1.19 Functional Earthing

Earthing of a point in a system or in an installation or in equipment, which is necessary for the proper function, but does not form part of the protection against electric shock.
[IEC 60598-1, ed. 8.0 (2014-05)]

3.1.20 Grid

Particular installations, substations, lines or cables for the transmission and distribution of electricity. Also known as electrical network.
[IEC 61850-80-3, ed. 1.0 (2015-11)]

3.1.21 Grid-Tied Inverter

An inverter that synchronises and operates in parallel with a power supply, in most cases the Utility Supply.

3.1.22 High Voltage (HV)

The set of nominal voltage levels greater than 44 000V and up to and including 220 000V.
[SANS 1019].

3.1.23 Inverter

A devise that generally converts DC input to AC output.
[IEC 61800-7-202, ed. 2.0 (2015-11)]

3.1.24 Island

The opening of a circuit breaker or circuit breakers resulting in the severance of the synchronous connection between the Network Service Provider’s Network and the Embedded Generator, or between the Network Service Provider’s Network and another section of the Network Service Provider’s Network containing a Synchronised generator.
[Eskom 240-61268576]

3.1.25 Lightning Protection System (LPS)

The complete system used to reduce physical damage due to lightning flashes to a structure.
[SANS / IEC 62305-3]

3.1.26 Live

Means electrically charged.

3.1.27 Local Authority

Municipal council, borough council, town council, village council, village management board, town board, health board or any such institution.

3.1.28 Loss-of-Grid

A condition in which supply from the Network Service Provider's Network is interrupted.

3.1.29 Loss-of-Grid Protection

A single or series of protection elements designed to detect a loss-of-grid condition and disconnect the Network Service Provider's Network from the embedded generator installation's Network to prevent the embedded generator from energising a portion of the Network Service Provider's Network.

3.1.30 Low Voltage (LV)

Nominal voltage levels up to and including 1 000V. [SANS 1019]

NOTE: For the purposes of this specification, the focus is on systems connecting to 230 V AC for single phase, 460 V AC line-to-line for dual phase and 400V AC line-to-line for three-phase.

3.1.31 Main Supply

The electricity supply point that is supplied by a distribution licensee connected to the greater South African power grid, e.g., Eskom or municipalities.

3.1.32 Medium Voltage (MV)

The set of nominal voltage levels greater than 1 000V and up to and including 44 000V. [SANS 1019]

3.1.33 Network Service Provider (NSP)

A legal entity that is licensed to provide network services through the ownership and maintenance of an electricity network.

See Section 3.1.66, "Utility".

3.1.34 Owner

The person that owns an Embedded Generation Installation, be it a legal person or a natural person.

3.1.35 Point of Control

The point at which an Electrical Installation on or in any premises can be switched off by a user or lessor from the electricity supplied from the Point of Supply, or the point at which a particular part of an Electrical Installation on or in any premises can be switched off where different users occupy different portions of such premises.

3.1.36 Point of Generator Connection (PGC)

A Point of Supply (see Section 3.1.39) where an Embedded Generator is connected.

3.1.37 Point of Source Isolation

The point on or in any premises where the embedded generation supply source is isolated from the Utility supply source.

3.1.38 Point of Source Separation

The point on or in any premises where the embedded generation supply source is disconnected from the Utility supply source.

3.1.39 Point of Supply

The point at which electricity is supplied to any premises by a Supplier.

NOTE 1: An embedded system may contain more than one Point of Supply.

NOTE 2: The Point of Supply electrically closest to the Utility shall be referred to as the Point of Utility Supply throughout this document.

3.1.40 Point of Utility Supply

The Point of Supply electrically closest to the Utility.

Also see “Main Supply”.

3.1.41 Power Conversion Equipment (PCE)

An electrical device converting one kind of electrical power from a voltage or current source into another kind of electrical power with respect to voltage, current and frequency.

NOTE: Examples include AC-DC converters, DC-AC inverters, DC-DC charge controllers, frequency converters, etc.
[IEC 62109-1, ed. 1.0 (2010-04)]

3.1.42 PV Array

a) A mechanically integrated assembly of modules or panels and support structure that forms a DC electricity-producing unit.

An array does not include foundation, tracking apparatus, thermal control, and other such components.

b) A mechanically and electrically integrated assembly of PV modules, and other necessary components, to form a DC power supply unit

NOTE: A PV array may consist of a single PV module, a single PV string, or several parallel-connected strings, or several parallel-connected PV Sub-Arrays and their associated electrical components. Two or more PV arrays, which are not interconnected in parallel on the generation side of the power conditioning unit, shall be considered as independent PV arrays.
[IEC 61850-7-420, ed. 1.0 (2009-03)]

3.1.43 PV Sub-Array

The portion of an array that can be considered as a unit.
[IEC 62257-1, ed. 3.0 (2015-10)]

3.1.44 Residual Current Device (RCD)

Mechanical Switching Device or association of devices designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions.
[IEC 62873-2, ed. 1.0 (2016-09)]

3.1.45 Residual Current Monitoring (RCM)

Device or association of devices which monitors the residual current in an Electrical Installation, and which indicates a fault when the residual current exceeds the operating value of the device or when a defined step change is detected.

3.1.46 Protected Extra Low Voltage (PELV) Circuit

An 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 circuits are earthed and SELV is not required.

NOTE 2: See SANS 10142-1, Section 7.14.2 for additional safety precautions when SELV and PELV circuits are used in hazardous locations.

3.1.47 Protective Earth

Earthing of a point or points in a system or in an installation or in equipment for the purposes of safety.

3.1.48 Renewable Power Plant (RPP)

A unit or a system of generating units producing electricity based on a primary renewable energy source e.g. wind, sun, water, biomass, etc. A RPP can use different kinds of primary energy sources. If a RPP consists of a homogenous type of generating units it can be named as follows [RSA Grid Code Requirements for Renewable Power Plants]:

3.1.48.1 PV Power Plant (PVPP)

A single photovoltaic panel or a group of several photovoltaic panels with associated equipment operating as a power plant.

3.1.48.2 Concentrated Solar Power Plant (CSPP)

A group of aggregates to concentrate the solar radiation and convert the concentrated power to drive a turbine or a group of several turbines with associated equipment operating as a power plant.

3.1.48.3 Small Hydro Power Plant (SHPP)

A single hydraulic driven turbine or a group of several hydraulic driven turbines with associated equipment operating as a power plant.

3.1.48.4 Landfill Gas Power Plant (LGPP)

A single turbine or a group of several turbines driven by landfill gas with associated equipment operating as a power plant.

3.1.48.5 Biomass Power Plant (BMPP)

A single turbine or a group of several turbines driven by biomass as fuel with associated equipment operating as a power plant.

3.1.48.6 Biogas Power Plant (BGPP)

A single turbine or a group of several turbines driven by biogas as fuel with associated equipment operating as a power plant.

3.1.48.7 Wind Power Plant (WPP)

A single turbine or a group of several turbines driven by wind as fuel with associated equipment operating as a power plant. This is also referred to as a wind energy facility (WEF).

3.1.49 Power Factor (PF)

Ratio of the R.M.S. value of the active power to the apparent power, measured over the same integrating period.

NOTE: Active power is measured in watts and apparent power in volt-amperes.

3.1.50 Prevention of Islanding

See Section 3.1.29, “Loss-of-Grid Protection”.

3.1.51 Reference Current

I_{ref}
Value of the R.M.S. input current of the equipment determined according and used to establish emission limits.
[IEC 61000-3-12]

3.1.52 Rated Current of the Equipment

I_{equ}
input current of the piece of equipment as declared by the manufacturer and marked as such on the rating plate of the piece of equipment or stated in the product documents.
[IEC 61000-3-12]

3.1.53 Safety Extra Low Voltage Circuit

An ELV circuit with protective separation from other circuits, and which has no provision for earthing of the circuit or of the exposed conductive parts.
[SANS 10142-1]

3.1.54 Standard Test Conditions

Reference values of in-plane irradiance (1 000 W/m²), PV cell junction temperature, (25 °C), and air mass (AM=1,5) to be used during the testing of any PV device.
[IEC 60269-6, ed. 1.0 (2010-09)]

3.1.55 Simple Separation

Galvanic separation between circuits or between a circuit and earth by means of basic insulation.

3.1.56 Embedded Generator Categories

Renewable Power Plants are grouped into the following three categories [RSA Grid Code Requirements for Renewable Power Plants]: Category A: 0 – 1 MVA (only LV connected RPPs). Typically called small or micro turbines. This category shall further be divided into 3 sub-categories:

a) Category A1: 0 kVA ≤ x ≤ 13.8 kVA;
b) Category A2: 13.8 kVA < x < 100 kVA;
c) Category A3: 100 kVA ≤ x < 1 MVA.

3.1.57 Static Power Converter

Power electronic device that converts variable DC or AC to grid compatible AC either synchronously (able to operate in stand-alone mode) or asynchronously (requires utility interconnection).

3.1.58 Synchronous Generator

Type of rotating electrical generator that operates at a speed which is directly related to system frequency and is capable of operating in isolation from other generating plants

3.1.59 Supplier

In relation to a particular installation, any Local Authority (see Section 3.1.27), statutory body or person who supplies, contracts or agrees to supply, electricity to that Electrical Installation.

3.1.60 Surge Protective Device (SPD)

A device that contains at least one (1) nonlinear component that is intended to limit surge voltages and divert surge currents.
[SANS 61643-12]

3.1.61 Synch-Check (Synchro-Check)

A relay / function that electrically determines if the difference in voltage magnitude, frequency and phase angle falls within allowable limits.

3.1.62 Synchronising

The process of manually (synchroscope) or automatically (synchronising unit) controlling generation equipment to attain the conditions where the voltage magnitudes, frequency and phase angle differences, of two independent electrical systems, fall within allowable limits so as to initiate an interconnection between the two electrical systems.

3.1.63 Switching Device

A device designed to make or break the current in one or more electric circuit(s).

3.1.64 Switch Disconnector

Switch which, in the open position, satisfies the isolating requirements specified for a disconnector.

NOTE: A Switch Disconnector was known as an "on-load isolator".
[SANS 10142-1]

3.1.65 Transformerless (TL) Inverter

An inverter that does not have a large low-frequency (50Hz) transformer. These inverters may have a small high-frequency transformer before the final conversion to a 50Hz AC output or no galvanic isolation.

3.1.66 Uninterruptible Power Supply System (UPS)

Power system that comprises a synchronous static power converter, a charger, switchgear, control circuitry and a means of energy storage (e.g. batteries) for maintaining continuity of electricity supply to a load in the case of a disruption of power supply from an electricity distribution network.

3.1.67 Utility

See Section 3.1.59, Supplier, and Section, 3.1.33, Network Service Provider (NSP).

3.2 Abbreviations

AC: Alternating Current

BGPP: Biogas Power Plant

BMPP: Biomass Power Plant

COC: Certificate of Compliance

CSPP: Concentrated Solar Power Plant

CT: Current Transformer

CCC: Current-Carrying Capacity

DC: Direct Current

DoE: Department of Energy
EG: Embedded Generator (includes Co-Generator)
ELV: Extra Low Voltage
EMC: Electromagnetic Compatibility
EMS: Energy Management System
HV: High Voltage
I_B: Rating of the main battery overcurrent protective device
I_{equ}: Equivalent current
I_{ref}: Reference current
I_{SC}: Short-circuit current
LGPP: Landfill Gas Power Plant
LV: Low Voltage
MV: Medium Voltage
NEC/R: Neutral Earthing Compensator with Resistor
NERSA: National Energy Regulator of South Africa
NSP: Network Service Provider
p.u.: per unit
PCE: Power Conversion Equipment
PELV: Protected Extra Low Voltage
PF: Power Factor
PGC: Point of Generator Connection
Pu: per unit
PID: Potential-Induced Degradation
PV: Photovoltaic
PVPP: Photovoltaic Power Plant
RCD Residual Current Device
RCM Residual Current Monitoring
RMS: Root Mean Square
RPP: Renewable Power Plant
S_{SC}: Short-circuit power of the source or fault level
SELV: Safety Extra Low Voltage
SHPP: Small Hydro Power Plant
SO: System Operator
SSEG: Small Scale Embedded Generator
STC: Standard Test Conditions
TL: Transformerless
TS: Transmission System
UPS: Uninterruptible Power Supply

WPP: Wind Power Plant

4. Compliance

4.1 Applicable Standards

4.1.1 Table 4-2: Applicable Standards gives a list of components and applicable standards. The components given in Column 1 shall comply with the applicable standards given in Column 3.

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

4.1.3 Standards listed in Table 4.1 of SANS 10142-1 shall also be applicable.

4.2 Safety

4.2.1 General

4.2.1.1 Safety in terms of the Operational Health and Safety (OHS) Act applies to both people and the Embedded Generation Installation (EGI).

4.2.1.2 The safe operation of machinery in South Africa is governed by the OSH Act and the associated regulations, including the following:

a) Occupational Health and Safety Act, 1993;
b) Occupational Health and Safety Act, 1993, Electrical Machinery Regulations, 2011, Government Notice Department of Labour No. R. 250 25 March 2011;
c) Occupational Health and Safety Act, 1993, Electrical Installation Regulations, 2009, Government Notice Department of Labour No. R. 242 6 March 2009;
d) SANS 10142-1, The wiring of premises, Part 1: Low-voltage installations.

4.2.1.3 Owners of EGIs need to ensure that the installation complies with the relevant aspects of the law, regulations and standards.

4.2.1.4 In terms of South African legislation, the user or lessor is responsible for the safety of the Electrical Installation. [SANS 10142-1]

4.2.2 Utility Approval

4.2.2.1 An EGI shall not be connected to a Point of Utility Supply unless the necessary approval has been obtained from the Utility.

4.2.2.2 Owners of EGIs need to ensure that the necessary approval is obtained from the Utility.

4.2.2.3 Additional requirements may be applicable to the EGI. It the responsibility of the owner to ensure that all requirements be adhered to, e.g.:

a) Grid code requirements, as published by NERSA;
b) License and registration requirements, as published by the Department of Energy (DoE) and as applied by NERSA;
c) The OHS Act, Machinery Installation Regulations and Electricity Installation Regulations;
d) Utility-specific requirements related to capacity.

4.3 Marking of Equipment

4.3.1 All equipment and circuits shall be labelled as required by SANS 10142-1 (see SANS 10142-1, Section 5.2.5) and by this part of SANS 10142 (see Section 5.3.1: Notices, Labels and Rating Plates).

4.4 Registered Person

4.4.1 A person as defined in terms of regulation 11 (1) of the Electrical Installation Regulations, promulgated under Government Notice R.2270 of 11 October 1985, with the exception of an electrical tester for single phase, may sign-off the Certificate of Compliance (CoC) of an EGI.

4.5 Basic Compliance Provisions

Requirements of SANS 10142-1, Section 5.3 applies.

4.5.1 Generator Categories by Capacity

4.5.1.1 For this part of SANS 10142, EGIs are categorized by generating capacity as shown in the following table.

Table 4-1: Embedded Generator Installation Categories by Capacity

Category	Embedded Generator Installation Size
Category A1	0 < x ≤ 13.8kVA
Category A2	13.8kVA < x < 100kVA
Category A3	100kVA < 1 MVA

4.5.2 Protective Equipment

4.5.2.1 Requirements of SANS 10142-1, Section 5.3.5 applies.

4.5.2.2 In addition to the requirements of SANS 10142-1, Section 5.3.5, the following shall also apply:

a) Loss-of-grid;
b) Out-of-sync energizing.

4.6 Characteristics

4.6.1 Requirements of SANS 10142-1, Section 5.4.1 applies.

Table 4-2: Applicable Standards

Component	Scope	Safety Standard	Applicable Performance Standard
Accumulators for use in PV systems	Safety. Test requirements and procedures	BS EN 50315-1	
Accumulators for use in PV systems	Performance. Test requirements and procedures		BS EN 50315-2
Conduit	Conduit and fittings: rigid pliable flexible PVC rigid conduit and fittings: 20 mm to 63 mm dia. Metal conduit: 20 mm to 50 mm dia. Metal fittings		 SANS 61386-1 SANS 61386-21 SANS 61386-22 SANS 61386-23 SANS 950
DC Cables			
DC Combiner Boxes	Class Ratings Boxes and enclosures for electrical accessories. Special Installations or locations		SANS 61439-2 SANS 60670 SANS 60364-7-712 Ed2
DC Circuit Breakers	≤ 1 000 V AC or 1 500 V DC	SANS 60947-2	
DC Fuses	Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems, ≤1 500 V DC	SANS 60269-6	
Earth wire	Bare copper	SANS 1411-1	
Enclosures	IP ratings		SANS 60529
Inverter	Safety of power converters for use in photovoltaic power systems	IEC 62109-2 IEC 62109-1	
PV Modules - Crystalline	Design qualification and type approval		SANS 61215

Component	Scope	Safety Standard	Applicable Performance Standard
PV Modules – Thin Film	Design qualification and type approval		SANS 61646
PV Modules – Ammonia Corrosion	Photovoltaic (PV) modules - Ammonia corrosion testing		IEC 62716
PV Modules – Salt mist Corrosion	Salt mist corrosion testing of photovoltaic (PV) module		IEC 61701
PV Modules - Safety	Photovoltaic (PV) module safety qualification	SANS 61730	
Disconnectors (non-trip)	≤ 1 000 V AC or 1 500 V DC	SANS 60947-1 SANS 60947-3	
PV Connectors	≤ 1 500 V DC and ≤ 125A	IEC 62852:2014	
RCM	Residual current monitors for household and similar uses		IEC 62020
RCD	Residual current operated circuit-breakers without integral overcurrent protection		SANS 61008-1
Switches and switch disconnectors (non-trip)	≤ 1 000 V AC or 1 500 V DC	SANS 60947-3	
Surge arresters for low-voltage systems	≤ 1 000 V	SANS 61643-11	

5. Installation Requirements

Requirements of SANS 10142-1, Section 6 applies.

5.1 General Circuit Arrangements

See Annexure I: Example General Circuit Arrangements, for examples based on Section 5.2, Interface Point Requirements.

5.2 Interface Point Requirements

The interface points identified below can be arranged in any manner in which it complies with the associated definition.

Every EGI shall have a single line diagram depicting, as a minimum, all interface points listed below.

NOTE: See Annexure H: Interface Point Requirements – Additional, for supporting normative information.

5.2.1 Point of Utility Supply

In the electrical system, the Point of Utility Supply designates the point of ownership and responsibility between the Customer and the Utility.

5.2.1.1 Disconnection Device

a) Typically, the Disconnection Device(s) associated with the Point of Utility Supply is the responsibility of the Utility. In the case where it is agreed between the Owner and the Utility that the Disconnection Device(s) are the responsibility of the Owner, the disconnection device(s) shall conform to the Utility's requirements.

b) In the case where reverse energy flow is anticipated, the Disconnection Device selected shall be capable of normal operation in either current direction.

c) In the absence of specific Utility requirements, the Disconnection Device(s) shall conform to the requirements set out in Section 5.3.2, Disconnection Devices – AC.

d) This Disconnection Device shall be lockable and accessible to the Utility, which is typically located outside of the Owner's property.

5.2.1.2 Responsibility for Electrical Installations

a) Refer to the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), Electrical Installation Regulations – Responsibility for Electrical Installations.

5.2.1.3 Labelling

a) The Point of Utility Supply is to be labelled as stipulated in Section 5.3.1, Notices, Labels and Rating Plates.

5.2.2 Point of Control

The Point of Control serves as the main isolation point between the Utility's Network and the Customer Distribution Network.

This point is Consumer-controlled.

5.2.2.1 Labelling

a) The Point of Control is to be labelled as required in Section 5.3.1, Notices, Labels and Rating Plates.

5.2.3 Point of Source Isolation

With the connection of an EGI, two electricity sources are present. The Point of Source Isolation isolates the two sources and ensure save working conditions. One of the following two configurations shall be implemented.

5.2.3.1 Dead Grid Safety Lock

a) The Dead Grid Safety Lock (DGSL) is a device that ensures the safety of Utility staff in the presence of Embedded Generation on Low Voltage feeders. The DGSL will ensure that it is not possible for an EGI to energize a portion of the Utility's network and therefore create a hazard to the workers on the utility network.

b) The DGSL include isolators, auxiliary circuit protection (for the relay circuit and the surge arresters as and when required), surge arresters, protective earths.

c) See Section 5.3.7, Protection and Control – AC, for detailed requirements.

5.2.3.2 Accessible Disconnection Device

a) The Disconnection Device associated with the Point of Isolation shall have an isolating function as described in SANS 60947-1: Low-Voltage Switchgear and Control Gear – General Rules.

b) In the case where reverse energy flow is possible, the Disconnection Device selected shall be capable of normal operation in either current direction.

c) This Disconnection Device shall be lockable and accessible to the Utility, which is typically located outside of the Owner's property.

d) The Disconnection Device(s) shall conform to the requirements of Section 5.3.2, Disconnection Devices – AC.

e) See Section 5.3.7, Protection and Control – AC, for detailed requirements.

5.2.3.3 Labelling

a) The Point of Source Isolation is to be labelled as required in Section 5.3.1, Notices, Labels and Rating Plates.

5.2.4 Point of Source Separation

The portion disconnected from the Utility-connected supply may include Customer loads within his / her Network.

5.2.4.1 Protection and Control

a) A Disconnection Device or Switch-Disconnection Device associated with the Point of Source Separation shall disconnect the EGI from the Utility.

b) The Network and system grid protection device(s), e.g., a relay, for the Point of Source Separation Disconnection Device shall be type-tested and certified on its own.

c) See Section 5.3.7, Protection and Control – AC, for detailed requirements.

5.2.4.2 Labelling

a) The Point of Source Separation is to be labelled as required in Section 5.3.1, Notices, Labels and Rating Plates.

5.2.5 Point of Generator Connection (PGC)

The Point of Generator Connection (PGC) serves as the point across which a generator is synchronised to the Utility and / or other generators, or where an islanded bus is powered. The PGC serves as the point where the embedded generator(s) disconnect from the rest of the electrical Network.

The PGC cannot be installed downstream to an earth leakage device.

By definition, a PGC is regarded as a Point of Supply.

5.2.5.1 Disconnection Device

a) Each individual embedded generator shall have its own dedicated Disconnection Device associated with its PGC.

b) The PGC Disconnection Device shall not be of a standard load plug-type installation.

c) The PGC Disconnection Device(s) shall conform to the requirements of Section 5.3.2, Disconnection Devices – AC.

5.2.5.2 Protection and Control

a) See Section 5.3.7, Protection and Control – AC, for detailed requirements.

5.2.5.3 Labelling

a) The Point of Generator Connection is to be labelled as required in Section 5.3.1, Notices, Labels and Rating Plates.

5.2.6 Distribution Boards

Requirements of SANS 10142-1, Section 6.6 applies.

All distribution boards associated with an interface point shall have the EGI single line diagram (as per Section 5.2, Interface Point Requirements, displayed.

If a single distribution board has both AC and DC, the AC and DC sections shall be mechanically separated and clearly marked to distinguish between AC and DC.

5.3 Integrated Systems Requirements

5.3.1 Notices, Labels and Rating Plates

All 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.

All notices, labels or rating plates that are required shall be in accordance to SANS 10142-1, Table 4.2: Notices, Labels and Rating Plates.

All symbols shall be in accordance with SANS 1186-1: Symbolic Safety Signs – Standard Signs and General Requirements.

NOTE 1: Notices and labels conforming to UL Standard 969 shall be acceptable as an alternative to that of SANS 1186-1, Section 5.

NOTE 2: Notices and labels that are placed indoors are exempt from SANS 1186-1, Section 5.

NOTE 3: See Annexure D: Labels and Markings, and Annexure E: Labels and Markings – Photovoltaic Installations, for additional normative requirements.

5.3.1.1 Interface Point(s)

a) As a minimum requirement, the interface point shall comply with Annexure D: Labels and Markings and the topics given in Column 2 of Table 5-1: Notices, Labels and Rating Plates of this section. Details of the topics can be found in the relevant sub-clauses in Column 1.

b) Sub-clauses in Column 1 of Table 5-1: Notices, Labels and Rating Plates below refers to SANS 10142-1.

Table 5-1: Notices, Labels and Rating Plates

1	2
Sub-clause	**Topic**
6.6.1.1	Switch Disconnectors for distribution boards and sub-distribution boards.
6.6.1.20	Identification of incoming and outgoing circuits of distribution boards.
6.6.1.21	Warning labels on distribution boards.
6.9.1.1	Main Switch Disconnectors in the case of multi-supplies.
7.4.2	Supply from which equipment is supplied.
7.12.2.1	Main switch where an alternative supply is installed.

5.3.1.2 Facility Identification

A label indicating that an Embedded Generation Installation (EGI) is installed on the premises shall be located at the entrance of the premises as per Annexure D: Labels and Markings.

5.3.1.3 Inverter-Based Generation / Solar Photovoltaic Installations

a) As a minimum, the labelling on the DC side of the EGI shall comply with Annexure E: Labels and Markings – Photovoltaic Installations.

5.3.2 Disconnection Devices – AC

Disconnecting Devices within the installation shall conform to the following:

a) SANS 10142-1, Section 5.3.5: Protective Equipment;
b) SANS 10142-1, Section 5.3.7: Disconnecting Devices;
c) SANS 10142-1, Section 6.9.4: Main Switch Disconnectors;
d) SANS 60947-2: Low-Voltage Switchgear and Control Gear – Circuit Breaker.

5.3.3 Disconnection Devices – DC

Disconnecting Devices within the installation shall conform to the following:

a) SANS 10142-1, Section 5.3.5: Protective Equipment;
b) SANS 10142-1, Section 5.3.7: Basic Provisions – Disconnecting Devices;
c) SANS 10142-1, Section 6.9.1: Disconnecting Devices – General;
d) SANS 10142-1, Section 6.9.4: Disconnecting Devices – Main Switch Disconnectors.

Sub-main disconnectors used for separate parts of the installation shall be clearly marked as "do not open under load". See Annexure E: Labels and Markings – Photovoltaic Installations.

5.3.4 Earthing

5.3.4.1 General

a) Requirements of SANS 10142-1, Section 6.12 applies for AC installations.

b) In the event of a new EGI, the requirements of SANS 10142-1 shall be followed to determine the appropriate earthing system on the AC side of the installation.

5.3.4.2 Inverter-Based Generation Earthing

a) Earthing is the practice of providing a low impedance path to earth for safety purposes. This requires an earth rod at the installation or at the supply.

b) The most common method of system earthing on the DC side of the installation is floating, i.e., neither the positive nor the negative terminal of the DC source is earthed. However, a Protective Earth connection shall be implemented for exposed metallic parts in all installations.

c) Earthing of one (1) of the live (current-carrying) conductors on the DC side of the installation is permitted, if there is at least Simple Separation between the AC side and the DC side of the installation. This is referred to as Functional Earthing.

d) Alternative (functional) DC earthing systems are provided in Annexure F: Earthing.

NOTE 1: The main reason that Functional Earthing is not recommended, is that when one (1) of the current-carrying conductors are earthed, a single earth fault will enable a fault current to flow, whereas a floating DC system requires two (2) earth faults before the fault current will flow.

NOTE 2: Alternative earthing systems may require additional protection devices.

e) Earthing Cables Sizes

The cross-sectional area of earthing and bonding cables of the DC installation shall be of equivalent cross-sectional area as both the positive and negative live (current carrying) conductors.

However, the cable shall have a minimum cross-sectional area of 4mm^2.

f) Requirements for Functional Earthing

A system with Functional Earthing of one (1) of the current carrying conductors shall be specified to meet the following requirements:

- Connecting one (1) of the current carrying conductors to a functional earth shall only be done where the system includes at least simple (galvanic) separation between the AC and DC sides of the installation. Simple Separation can be provided by a transformer within the inverter or by using a separate external transformer.
- The inverter shall be compatible with having one (1) of the current-carrying conductors connected to a functional earth.
- The functional earth connection shall be at one (1) point only and physically be as close as possible to the DC terminals of the inverter (or within the inverter).
- The functional earth connection shall be connected to the Point of Utility Supply earthing terminal.

Where a separate functional earth connection is provided:

- It shall be connected to any suitable earthing terminal, such as the building's main earthing terminal, or an earthing terminal within the device that provides the DC isolation fault detection (typically the inverter);
- The cable shall be laid (installed) in parallel to, and in as close contact as is possible, with the DC array cables;

NOTE: The array frame earthing connection may be prone to corrosion – see section on corrosion below.

g) Earth Fault Prevention and Management

For systems with more than two (2) solar PV strings, the following are required:

- A means shall be provided to isolate the different strings from each other under load.

NOTE 1: This is to ensure that circulating currents due to two (2) or more simultaneous earth faults can be cleared.

The inverter manufacturer's installation instructions, provided that they are in accordance with IEC 62109-2, shall be followed. See Section 6.2.4, Insulation Fault Protection, for further details.

NOTE 2: These instructions typically include reference to additional equipment that may be required, e.g., external isolation transformers, Residual Current Devices (RCDs) on either the DC or AC side, array Functional Earthing (grounding) allowance, solar PV array insulation resistance monitoring.

NOTE 3: Potential-Induced Degradation (PID) protection and thin film technologies require external RCDs to determine DC leakage.

Metal conduit installed in areas where temperature variations and wind loading can cause significant movement of the conduit, e.g., on rooftops, metal screw connections and not compression fittings shall be used.

h) Minimising Induced Lightning Surges

To protect DC systems against the effect of induced voltage surges, the following wiring measures shall be adopted:

- DC cable runs shall be kept as short as is practical;
- Positive and negative cables shall be run alongside one another to prevent the formation of loops;
- PV array bonding conductors shall be run alongside the PV array live conductors.

i) Corrosion

The array frame earthing connection may be prone to corrosion, especially under the following conditions:

- if there are dissimilar metals (for example, copper and aluminium);
- if a transformerless inverter is used due to small DC leakage currents;
- in corrosive environments (such as coastal, industrial).

Any connections with earth on the DC side of the installation shall be electrically connected so as to avoid corrosion of the solar PV panel frames and related structures.

When designing an earth connection to the array frame, methods to minimise the effects of corrosion include:

- use of stainless steel crimped lugs between cable and frame;
- use of bimetallic washers between crimped lugs and array frame;
- if the joint includes more than one type of metal, it should be sealed to prevent ingress of water using a suitable weatherproof coating or taping system.

5.3.4.3 Energy Storage Systems

a) Earthing Cables Sizes

The cross-sectional area of earthing and bonding cables of the DC installation shall be of an equivalent cross-sectional area as both the positive and negative live (current-carrying) conductors.

NOTE 1: The conductor size may be significantly larger for energy storage systems than for solar PV systems.

NOTE 2: Further requirements may exist that is not covered by this edition of the standard and that will be expanded upon in a following edition.

5.3.4.4 Synchronous Machines

a) This section to be expanded upon in a following edition.

5.3.4.5 Asynchronous Machines

a) This section to be expanded upon in a following edition.

5.3.5 Bonding

5.3.5.1 General

a) Bonding is the practice of providing electrical connections to structures, housings, etc., in order to ensure that dangerous voltages do not develop between them. These structures, housings, etc., are typically bonded to earth for safety purposes.

b) Requirements of SANS 10142-1, Section 6.13 applies for AC installations.

c) Extraneous metal parts that may become energised must be bonded.

d) Where protective bonding conductors are installed, they shall be parallel to, and in as close contact as is possible, with the DC and AC cables and accessories.

e) In addition to SANS 10142-1, Section 6.13.2, the following parts of the installation shall be bonded.

5.3.5.2 Inverter-Based Generation Earthing

a) PV Modules

The frames of all PV modules must be bonded to earth for all installations.

b) PV Mounting Structures

The mounting structures of all PV modules must be bonded and earthed for all installations.

Bonding resistance of the earth continuity path between PV modules / frames shall not exceed 0.2Ω. [SANS 10142-1:2017 8.6.2]

The connection to the array frame shall be in line with the manufacturer's instructions, and shall be designed and constructed to minimize the effects of corrosion. This shall include selection of materials and components that minimize the effect of galvanic corrosion. Plated or un-plated copper tubular cable lugs shall not be used for connection onto aluminium rails.

The cable shall link to each electro-mechanically interconnected array block (typically a row of modules on a pair of aluminium mounting rails) such that all parts of the solar PV array frame are connected to earth.

c) Conduits

Where conduit is used for DC cables, it shall be metal conduit. Conduit shall be bonded at all junctions to ensure electrical continuity of the conduit. The metal conduit shall be bonded to earth at a suitable location.

5.3.6 Lightning Protection

EGI Categories A1 and A2 (as per Section 4.5.1: Generator Categories by Capacity) are exempt from installing any external lightning protection systems.

A risk assessment, according to SANS 10313, shall be performed for EGI Category A3 (as per Section 4.5.1, Generator Categories by Capacity). If the risk profile shows a high risk, a full lightning protection system must be installed for the EGI.

5.3.6.1 Lightning Protection System (LPS)

a) The requirements of SANS 10313 apply.

5.3.6.2 External Lightning Protection System

a) The requirements of SANS 10313:2012 apply.

b) Air-Termination Systems

If an air-termination system is installed to protect the EGI, it shall conform to SANS 62305-3, Section 5.2, and SANS 62305-3, Annexure A.

c) Down-Conductor Systems

To protect the EGI structure, down-conductors shall be installed and arranged in such a way that, from the point of strike to earth:

- several parallel current paths exist;
- the lengths of the current paths are kept to a minimum;
- equipotential bonding to conducting parts of the structure is performed according to the requirements of SANS 62305-3, Section 6.2.

The number of down-conductors shall not be less than two (2) and shall be distributed around the perimeter of the structure to be protected from lightning surges, subject to architectural and practical constraints.

The down-conductors shall be installed according to the requirements of SANS 62305-3, Section 5.3.4.

d) Earth-Termination Systems

A single, integrated structure earth-termination system shall be installed according to the requirements of SANS 62305-3, Section 5.4.

In general, a low earthing resistance of lower than 10Ω is recommended, when measured at low frequency.

Earth-termination systems shall be bonded in accordance with the requirements of SANS 62305-3, Section 6.2.

e) Construction and Installation

All components and materials used in the Lightning Protection System (LPS) shall be installed according to the requirements of SANS 62305-3, Section 5.5 and Section 5.6.

5.3.6.3 Internal Lightning Protection Systems

a) The requirements of SANS 10313:2012 apply.

b) Dangerous sparking between different parts shall be avoided by means of lightning equipotential bonding or electrical insulation between the LPS and the structural metal parts.

c) Lightning Equipotential Bonding

Lightning equipotential bonding shall be installed according to the requirements of SANS 62305-3, Section 6.2.

The minimum values of the cross-section of the bonding conductors connecting the different bonding bars, and of the conductors connecting the bars to the earth-termination system, are listed in Table 8 of SANS 62305-3 and below.

Table 5-2: Minimum Values of Cross-Section of Bonding Conductors Connecting Different Bonding Bars, and of Conductors Connecting the Bars to Earth-Termination System

Class of LPS	Material	Cross-Section (mm^2)
I to IV	Copper	16
	Aluminium	25
	Steel	50

The minimum values of the cross-section of the bonding conductors that connect the internal metal installations to the bonding bars are listed in SANS 62305-3, Table 9 and below:

Table 5-3: Minimum Values of Cross-Section of Bonding Conductors that Connect the Internal Metal Installations to Bonding Bars

Class of LPS	Material	Cross-Section (mm^2)
I to IV	Copper	6
	Aluminium	10
	Steel	16

d) Electrical Insulation of External Lightning Protection Systems

An electrically-insulated LPS shall be installed according to the requirements of SANS 62305-3, Section 6.3.

e) Surge Protection

Surge Protective Devices (SPDs) shall be installed to protect an installation against transient over-voltages and surge currents, such as those caused by switching operations or those induced by atmospheric discharges (lightning).

Their selection, connection and application shall be in accordance with SANS 61643-12 and SANS 10142-1, Annexure I.1

See Section 5.3.4.2, Inverter-Based Generator Earthing, for requirements regarding the installation of surge protection on inverter-based generation.

NOTE: SPDs installed for lightning protection will automatically address protection against switching surges.

5.3.6.4 Maintenance and Inspection of Lightning Protection Systems

a) The requirements of SANS 10313:2012 apply.

5.3.6.5 Protection Measures Against Injury to Living Beings Due to Touch and Step Voltages

a) The requirements of SANS 10313:2012 apply.

5.3.6.6 Installation of Earth Rods and Electrodes

a) The requirements of SANS 10313:2012 apply.

5.3.7 Protection and Control – AC

All requirements of SANS 10142-1, Section 6.7 are applicable to the EGI from the Point of Supply to the Point of Generator Connection.

Special requirements pertaining to protection and control are detailed in the following sections.

5.3.7.1 General

a) It is the responsibility of the Owner to enquire about the operating conditions of the Utility Network, e.g., fault level increases for the foreseeable future.

b) The Switching Device associated with each interface point shall be able to operate under all operating conditions of the Utility Network, such as current, voltage and frequency fluctuations.

c) A failure within an interface point switching or control device(s) shall lead to the disconnection of the EGI from the Utility supply. The failure condition shall be indicated.

d) Disconnection Devices which have adjustable set points shall have a notice warning against unauthorised altering of settings. Altering of settings which have an impact on the safe operation of the EGI shall only be done by qualified personnel.

e) For the respective installation points, the breaking capacity of a Disconnection Device shall be rated in accordance with SANS 60947-2: Low-voltage switchgear and control gear – Circuit breaker.

f) The prospective short-circuit current and prospective earth fault current shall be assessed for each source of supply and / or each combination of sources, which can operate independently of other sources, or in combination with other sources. The short-circuit rating, as stipulated by the manufacturer, of the Protection and / or the Disconnection Device(s) within the Embedded

Generation installation shall not be exceeded for any method of operation of the sources. [SANS 10142-1, Section 7.12.2.3]

NOTE: See Annexure C: Fault Level Assessment.

5.3.7.2 Current-Related Faults

a) Unless explicitly excluded, all parts of SANS 10142-1 that are related to overcurrent and short circuit protection applies to the EGI.

b) Overcurrent protective devices shall be rated for the prospective short circuit current at the point of installation.

c) Overcurrent protective devices shall be selected, or the settings thereof shall be applied, after a grading exercise has been performed.

d) Where applicable, cascading of overcurrent protective devises shall be in accordance with SANS 10142-1, Section 6.7.4.

e) Short circuit characteristics of Embedded Generators in Categories A2 and A3 (as per Section 4.5.1, Generator Categories by Capacity) shall be provided to the Utility.

f) Typical protection elements for current protection are listed in Table 5-4: Typical Protection Requirements – Interface Points per category.

5.3.7.3 Phase and Earth Fault Protection

a) The EGI shall have protective devices to detect and isolate faults occurring either in the EGI or on the Utility Network. The EGI must be able to detect the following scenarios and isolate itself from the Utility when any of the following occur:
   - Short circuit between phases and earth;
   - Short circuit between phases;
   - Loss of any phase.

5.3.7.4 Loss-of-Grid and Prevention of Islanding

a) The EGI shall disconnect from the Utility when the Utility is Dead (Loss-Of-Grid), as measured at the Point of Utility Supply.

b) The EGI shall not be able to connect to the Utility if the Utility is Dead (loss-of-grid), as measured at the Point of Utility Supply.

c) The separation of the EGI from the Utility shall take place at the Point of Source Separation within two (2) seconds from detection of loss-of-grid or as per the requirements of the Utility. [NRS 097-2-1, Section 4.2.2.4.4]

d) In order to detect an Islanding condition, the EGI shall make use of active or passive Islanding detection methods, such as rate-of-change-of-frequency and voltage vector shift detection.

NOTE 1: Voltage measurements taken on the Utility side at the Point of Source Separation will be sufficient.

NOTE 2: Loss-of-Grid Protection for non-inverter-based generation may require specialist design, specification, installation and commissioning.

5.3.7.5 Equipment Protection – Operation Interlock Requirements

a) The following minimum interlocks are to ensure the safe operation of the EGI.

b) Unless explicitly excluded, interlock requirements shall be governed by automated means.

c) The EGI shall not be able to connect to the Utility if the Utility is Dead (loss-of-grid), as measured at the Point of Utility Supply – this can be achieved by adhering to clause e below.

d) It shall not be possible for the Disconnection Device associated with the Point of Control to be closed whilst the EGI side of the said Disconnection Device is Live.

e) The Disconnection Device associated with the Point of Source Separation and / or Point of Generator Connection, as applicable, shall only reconnect the EGI Network to the rest of the Owner's distribution Network, or to the Utility's Network, in the following cases:
- EGI side Live: By ensuring that the EGI and the Utility side of the Disconnection Device (Utility Network voltage and generator voltage) are in sync. Sync checks shall only be performed by a dedicated automated device – manual synchronizing is not permitted;
- EGI side Dead: On confirmation that the Utility Network is disconnected from the Owner's Network. This can be achieved by ensuring that the Point of Control is open. This confirmation shall only be performed by a dedicated automated device.

5.3.7.6 Equipment Protection – Operation Control Requirements

a) The following minimum controls are required to ensure the safe operation of the EGI.

b) Unless explicitly excluded, control requirements shall be governed by automated means.

c) The Disconnection Device associated with the Point of Source Separation shall open within two (2) seconds, in the event of loss-of-grid. [NRS 097-2-1, Section 4.2.2.4.4]

d) The Disconnection Device associated with the Point of Source Separation shall open in the event of the conditions listed in Table 5-4: Typical Protection Requirements – Interface Points.

e) The Disconnection Device associated with the Point of Generator Connection shall open in the event of the conditions listed in Table 5-4: Typical Protection Requirements – Interface Points.

Table 5-4: Typical Protection Requirements – Interface Points

ANSI Code	Description	Embedded Generator Category			Point of Source Separation	Point of Generator Connection
		A1 0 kVA ≤ x ≤ 13.8 kVA	A2 13.8 < x < 100 kVA	A3 100 kVA ≤ x < 1 MVA		
59	Overvoltage	x	x	x		x
27	Under-voltage	x	x	x	x	x
81O/U	Over/Under frequency	x	x	x	x	x
67/67N	Directional Overcurrent			x		x
51V	Time over-current, voltage restraint –optional to prevent nuisance trips)			x		x

ANSI Code	Description	Embedded Generator Category			Point of Source Separation	Point of Generator Connection
		A1 **0 kVA ≤ x ≤ 13.8 kVA**	**A2** **13.8 < x < 100 kVA**	**A3** **100 kVA ≤ x < 1 MVA**		
51G	Ground overcurrent	x	x	x		x
46	Negative phase sequence overcurrent			x		x
25	Synchronization check				x[1]	x
58	DC injection threshold exceeded (Photovoltaic generators)	x	x	x		x

NOTE: If the Point of Source Separation and Point of Generator Connection are not combined, only one (1) of the two (2) points need to perform sync checks, as stipulated above.

5.3.8 Protection and Control – DC

Requirements pertaining to protection and control on the DC side of the EGI with an open circuit voltage (Voc), which does not exceed 1500V d.c, including Extra Low Voltage (ELV), are detailed in the following sections.

Any device used for protection and/or control on the DC side of an EGI shall be rated for DC

5.3.8.1 Current-Related Faults

a) Overcurrent protective devices shall be rated for the prospective short circuit- or fault current at the point of installation.

b) Overcurrent protective devices shall be rated for reverse currents in cases where multiple DC sources are connected in parallel.

c) Overcurrent protective devices shall be able to manage the maximum possible load.

d) Overcurrent protective devices shall be selected, or the settings thereof shall be applied, after a grading exercise has been performed.

NOTE: Prospective short circuit current requirements and calculations for DC can be obtained from SANS 10142-1, Section 8.4.6.

5.3.8.2 Over- and Under-Voltage Protection

a) To prevent overvoltage damage, all DC components used in an EGI, e.g., cabling, connectors, fuses, fuse holders, surge arrestors, PV modules, combiner boxes and disconnection devices, shall be rated for the maximum potential voltage.

b) The maximum voltage value ($V_{DC\text{-}MAX}$) is the highest voltage value between all the DC sources and shall be calculated as follows: [IET Code of Practice for Grid Connected Solar PV Systems]

Maximum Voltage (VDC-max) = V_{OC_STC} (Solar PV) x 1.15

or

Maximum Voltage (VDC-max) = V_{OC} (Nominal Battery voltage) x 1.25

c) For under-voltage, minimum operating voltage of all Power Conversion Equipment (PCE) shall be taken into consideration.

NOTE: The correction factor of 1.15 is for temperatures of -9ºC to -12ºC, and irradiation of 1000W/m². [IEC 62548:2016-7.2]

5.3.8.3 Over– and Under–Voltage Control

a) Overvoltage control devices shall be capable of automatically managing overvoltage conditions at the DC terminals of the PCE.

b) Under-voltage control devices shall be capable of automatically managing under voltage conditions at the point of installation.

5.3.8.4 DC Source-to-Earth Fault Protection

a) DC-to-earth fault protection shall be provided to monitor, detect, indicate and / or isolate a positive or negative (conductors) to earth fault.

5.3.8.5 Reverse Polarity Prevention

a) The DC cabling shall be colour-coded and labelled, as required by SANS 10142-1, Section 6.3.3.3.

b) When connecting DC components, measurements shall be taken to confirm correct polarity.

5.3.8.6 Surge Protection

a) At least one (1) set of Surge Protection Devices (SPDs) shall be installed on the DC side of the EGI, as close as is possible to the power converter equipment.

b) See Section 5.3.6.3, Internal Lightning Protection Systems, for more detailed requirements.

6. Specific Embedded Generation Requirements

This section sets forth requirements for specific embedded generation technologies and their applications.

6.1 Electrical Energy Storage Systems

Requirements for grid-connected energy storage systems, used to store excess energy, to limit electricity export to the grid and / or to provide back-up power, are covered in this section.

Battery charging locations are seen as a hazardous location, as stated in SANS 10142-1, Section 7.14.3.

NOTE: Energy storage includes batteries and supercapacitors.

6.1.1 Installation Requirements

In addition to SANS 6285-1 and 2, the following general measures shall be observed where a battery is installed:

a) The battery shall be installed in an enclosure or location, making provision for passive ventilation, preventing thermal build up and taking into account the possible corrosion due to acid. Access shall be restricted to authorised personnel only, whilst allowing suitable access for maintenance;
b) Battery enclosures / rooms shall be provided with sufficient ventilation by calculating the battery system's expected gassing rate, ensuring that there is two (2) air changes per hour and preventing 1% hydrogen concentration in the air of the battery enclosure / room (the exact amount of ventilation can be calculated and / or provided the by battery Supplier – also see SANS 62458-2, Section 7.2);
c) The battery shall be mounted on a structure (floor / wall) that is able to withstand the weight of the battery system;
d) The battery terminals shall be protected to prevent accidental short-circuiting;
e) Devices that could form a spark, such as overcurrent protective devices and isolators, shall be located outside of the battery enclosures (if used) and in a ventilated zone (as explained within this section) away from areas where there could be a build-up of explosive gasses;
f) Battery enclosures and containment shall be corrosion resistant;
g) Any electrical cable, connectors, electronic devices or other components within a battery enclosure shall be corrosion resistant. Otherwise, these parts shall be located outside of the battery enclosures and in a ventilated zone;
h) The installation location shall be selected to suit the operating temperature range of the battery, as specified by the manufacturer. Insulation and / or thermal control shall be provided when temperatures are higher than required by Supplier. Also see SANS 62485, Section 11.
i) The battery installation location shall be selected with consideration to fire escape routes and exits;
j) Appropriate safety signs, as indicated by the battery's installations manual, shall be fixed on the battery enclosure / room entrance, whichever is seen first;
k) Strain on battery terminals need to be minimised according to SANS 10142-1, Section 7.9.4.2;
l) The correct torque rating shall be applied when fixing cables to the batteries;
m) The voltage drop between the charger and energy storage shall be addressed by adjusting the charging configuration or including a voltage correcting sensor.

6.1.2 Battery-Connected Inverter

The inverter connected to batteries shall be rated for the maximum potential load, which can be determined by load calculations and / or metering.

NOTE 1: Only inverters rated for battery use shall be installed when connecting battery systems.

NOTE 2: To ensure the continuous operation of a battery-connected inverter, power loss due to conversion losses, temperature, power factor and other factors should be taken into consideration when sizing the inverter.

6.1.3 Battery Charger or Charge Controller

The battery charger or charge controller shall be sized according to the battery Supplier's specifications. Battery charging requirements for the specific type of battery should also be considered, especially thermal runaway requirements.

6.1.4 Protection

See Section 6.1.1, Installation Requirements.

6.1.4.1 Overcurrent Protection – Batteries

a) An overcurrent protective device, rated for I_B, shall be installed on the positive output terminal of the battery. This device shall:
   - be rated for DC operation;
   - have a voltage rating of at least 1.25 x the nominal battery voltage;
   - have an interrupt rating that is higher than the battery's rated short-circuit current;
   - have an interrupt rating of ≤1.25 x of the maximum possible load; and
   - not cause any open arc when operating.

b) The overcurrent protective device shall be installed in such a way that the cable between the battery terminal and the protective device is kept as short as is practically possible.

c) The positive and negative cables between the battery and the overcurrent protective device shall be separated.

NOTE 1: The designer of the battery system / EGI needs to be aware of possible short-circuit risks.

NOTE 2: Prospective short circuit current calculations for the battery can be obtained from SANS 10142-1, Section 8.4.6.3.

NOTE 3: I_B = rating of the main battery overcurrent protective device.

6.1.4.2 Current-Carrying Capacity (CCC) of Conductors and Cables – DC

a) Where a battery is coupled on the DC side of the PV system and there is a possibility for fault currents to flow from the battery into the DC side of the PV system, all parts of that circuit (such as cables, connectors and isolators) shall have a current rating greater than I_B or another upstream device. [IET Code of Practice for Grid Connected PV Systems, Section 5]

NOTE: I_B = rating of the main battery overcurrent protective device.

6.1.4.3 Voltage Rating

a) Where a battery is coupled to the DC side of the EGI, all parts of that circuit (such as cables, connectors and isolators) shall have a voltage rating of at least 1.25 x the nominal battery voltage or the maximum open-circuit array voltage, as calculated in Section 5.3.8.2 of this standard, whichever is greater.

NOTE: The inverter switching impact on actual live-to-earth voltage should be taken into account, specifically single-phase inverters.

6.1.4.4 Protection Against Gassing

When determining the location of the protective device(s), any gasses emitted by the battery need to be taken into consideration. The safety distance of 1.2m from the source of gas and any possible spark source shall be achieved for vented batteries. Alternatively, the exact safety distance can be calculated using the equation provided in SANS 62458-2, Section 7.7 (see figure below).

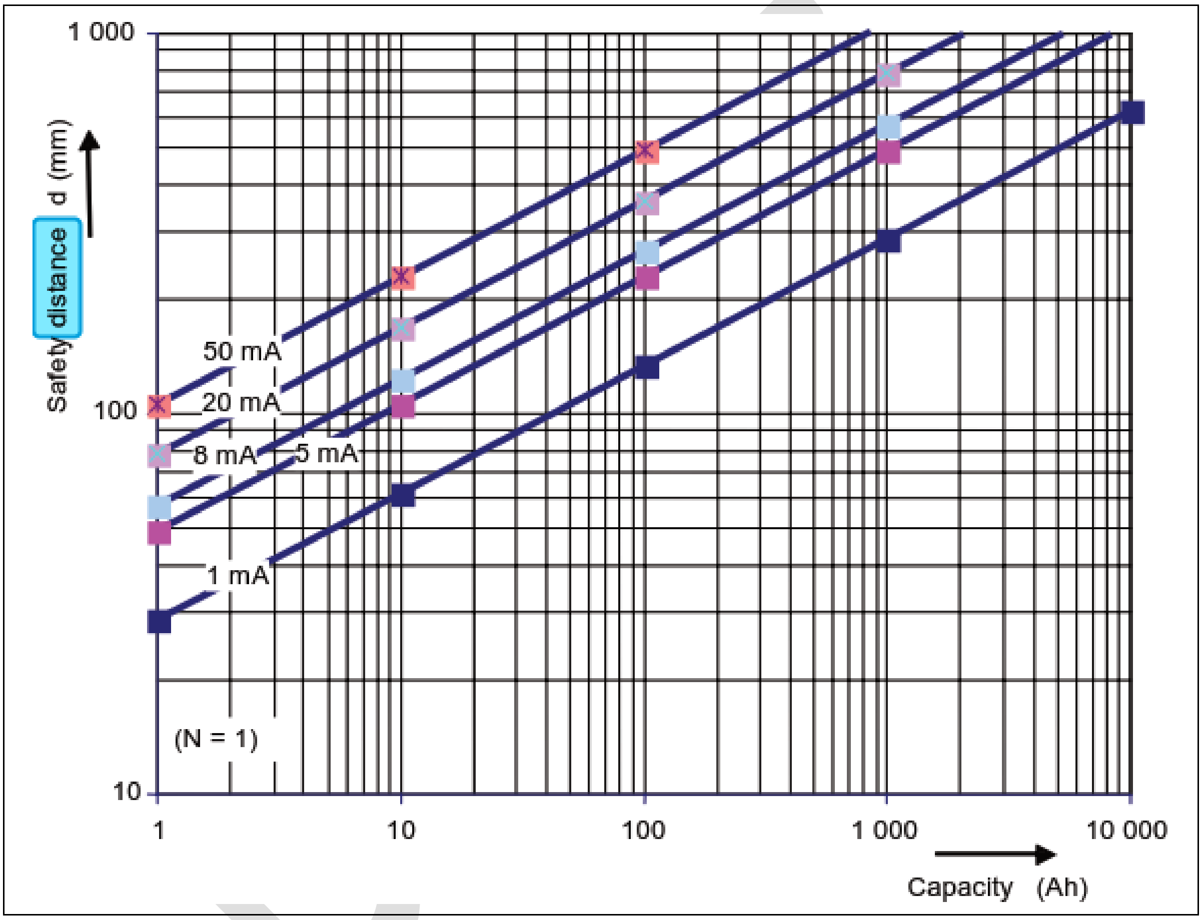


Figure 6-1: SANS 62458-2, Section 7.7, Figure B.1 – Safety Distance as a Function of the Rated Capacity for Various Charge Currents (mA / Ah)

6.1.5 Disconnectors and Circuit Breakers – DC

At least one lockable, visible open DC disconnect is required on the external DC conductors between the storage system and the inverter / charger. [NEC 690.71(H)]

6.1.5.1 Isolation and Switching – Batteries

a) An isolator shall be installed on the output terminals of the battery. This device shall:
- interrupt both positive and negative cables;
- be rated for DC operation;
- have a voltage rating of at least 1.25 x the nominal battery voltage; and
- have an interrupt rating that is higher than the battery's rated short-circuit current.

b) The isolator shall be installed such that the cable between the battery terminals and the isolator is kept as short as is practicable.

NOTE: The battery main overcurrent protective device can also provide the means for isolation, provided that it is rated as an isolation device and meets the requirements of the battery isolator, as listed in this section.

6.1.5.2 Operating Control Requirements – Battery Systems

a) Where a system is designed to operate in Islanded mode, an isolator shall be installed that:
   - isolates the grid before Islanded operation can commence;
   - isolates all phases and neutrals before Islanded operation can commence; and
   - is interlocked with the neutral-earth switch.

b) Where a system is designed to operate in Islanded mode, a neutral-earth switch shall be installed that forms a neutral-to-earth bond for the duration of the islanding operation only.

6.1.6 Other Technologies

Manufacturer specifications need to be adhered to for the design and installation of storage technologies not specifically addressed in this standard.

Other storage technology requirements will be addressed in future editions.

6.2 Inverter-Based Generation

The requirements in this section apply to generation systems that make use of power inverters which forms part of an EGI, with specific focus on PV installation.

NOTE: Future editions will consider other inverter-based technologies.

6.2.1 Voltage and Current Ratings

The PV string or array shall be designed to suit the input range of the inverter and / or charge controller it will be connected to.

The maximum voltage value (VDC-max) shall be calculated as follows: [NEC 690.8(A) (1)]

$$\text{Voltage (VDC\_max)} = V_{OC\_STC} \times 1.15$$

The continuous or maximum current, Imax, is defined as 1.25 multiplied by Isc of the string.

$$\text{Current (IDC\_max)} = I_{SC\_STC} \times 1.25$$

For under-voltage, minimum operating voltage shall be taken into consideration.

NOTE: The correction factor of 1.15 is for temperatures of -9 ºC to -12ºC, and irradiation of 1000W/m². [IEC 62548:2016-7.2]

6.2.2 Overcurrent Protection

This section relates to a system where the solar PV array provides the only source of fault current. For systems with batteries, refer to Section 6.1.2 of this standard.

Overcurrent protection is not required for a PV string or for PV array cables when the continuous current-carrying capacity of the cables are equal to, or greater than, 1.56 x $I_{SC\ STC}$ of the relevant PV string or array. [NEC 690.9(A)]

Overcurrent protection is not required for the PV main cable, if the continuous current-carrying capacity is equal to, or greater than, 1.56 x $I_{SC\ STC}$ of the entire connected PV generator.

Where the overcurrent protection device is a fuse, it shall be of a type gPV, in accordance with SANS 60269-6.

Where the overcurrent protection device is a circuit breaker, it shall comply with SANS 60947-2.

The overcurrent protective device shall be rated for the maximum system voltage, as calculated in Section 5.3.8.2, Over- and Under-Voltage Protection.

Overcurrent protective devices are only required in one (1) of the active conductors:

a) Unless the string cables are laid next to PV Sub-Array / array cables, without any physical barrier providing separating them, in which case an overcurrent protection device is required in both the positive and negative conductor;
b) Where overcurrent protection is used in only one (1) conductor, the overcurrent protection shall be installed in the same polarity cable throughout the whole system, e.g., on the positive cables for both the string and the PV Sub-Array.

Where a battery is coupled on the DC side of the PV system:

a) String overcurrent protective devices shall be installed to protect the PV modules where: Imax < IB (or another upstream device);
b) Overcurrent protective devices shall be installed to protect a circuit where the rating of any part of that circuit (cables, connectors, isolators etc.) is less than I_B or another upstream device.

NOTE 1: I_B = rating of the main battery overcurrent protective device.

NOTE 2: I_{SC_STC} = the short-circuit current at Standard Test Conditions.

NOTE 3: These requirements are only relevant for the protection of cables. Refer to the manufacturer’s instructions for the protection of the solar PV modules.

NOTE 4: Where string cables are laid next to PV Sub-Array / array cables without any physical barrier separating them, the possibility exists that a fault can occur directly between the two (2) cables, without any reference to earth. In these circumstances, overcurrent protection in both positive and negative cables may be required.

6.2.3 Reverse Current Protection

Reverse current protection shall be installed when three (3) or more strings are combined / paralleled together.

Reverse current protection can be achieved with DC fuses. The fuse shall be rated to equal or greater than 1.56 x $I_{SC\ STC}$ [NEC 690.8(B)(1)(a)]. The applicable temperature correction factor shall be implemented (see Section 5.6, Environmental Conditions, of this standard). [NEC 690.8(B)(1)(c)]

Fuses can be installed in the inverter or in the DC-combiner boxes.

Fuses shall not be removed on load. A Switch Disconnector shall be installed to enable isolation of the fuse.

DC fuses shall be installed on both the positive and negative conductors, as both cables would be subjected to damage during a fault condition.

In order to ensure that voltage requirements of fuses are met, the highest expected string voltage shall be multiplied by a factor of 1.2. [NEC 690.7]

NOTE: Switchgear devices, such as circuit-breakers or fuses on the DC side of the EGI, do not protect against electric shock, as there is no automatic disconnection from the power supply.

6.2.4 Insulation Fault Protection

The inverter shall:

a) be able to measure and monitor insulation resistance using Residual Current Monitoring (RCM); [IEC 62020]
b) have an integrated RCD, which shall conform to SANS 61008-1.

For separate devices (e.g., the RCD or RCM not integrated into the inverter), the insulation resistance measurement shall be done according to IEC 61557-2.

RCM devices shall be certified according to IEC 62020.

NOTE: Potential-Induced Degradation (PID) protection and thin film technologies require external RCDs to determine DC leakage.

6.2.4.1 Earthing Insulation Resistance

a) All solar PV systems with a floating generator, i.e., not one (1) of the DC conductors are earthed, shall have a system that measures the insulation resistance from the solar PV array to earth.

b) Measurements shall be performed by the inverter before the start of operation and at least once in every 24-hour period. An alarm needs to indicate to the user if the fault threshold is exceeded.

c) The earth insulation fault thresholds shall be determined according to the following table:

Table 6-1: Earth Insulation Fault Thresholds

System Size (kW)	Minimum Resistance
≤20	30kΩ
>20 to ≤30	20kΩ
>30 to ≤50	15kΩ
>50 to ≤100	10kΩ
>100 to ≤200	7kΩ
>200 to ≤400	4kΩ
≥400	3kΩ

NOTE 1: Naturally occurring leakage currents are largely determined by the size of the solar PV array, i.e., the larger the surface area, the lower the insulation resistance.

6.2.5 Earthing and Bonding Arrangements

For earthing and bonding arrangements, refer to Section 5.3.4, Earthing, and Section 5.3.5, Bonding, respectively.

6.2.5.1 Protection for Systems with Functional Earth

a) Refer to Section 5.3.4, Earthing.

b) A functional earth connection shall either be via a resistor, or via an overcurrent protective device.

c) Where the connection is through a resistor, the resistance value shall be selected so as to limit the maximum fault current to below the applicable value according to the following table.

Table 6-2: Earth Fault Overcurrent Protective Device Rating

PV Array Power (kWp)	Rated Current
0 – 25	≤1A
>25 – 50	≤2A
>50 – 100	≤3A
>100 – 250	≤4A
>250	≤5A

d) Where the connection is through an overcurrent protective device, requirements as stipulated in Section 6.1.2, Battery-Connected Inverter, shall apply.

e) Overcurrent protective devices shall be installed in all unearthed conductors.

f) The system shall incorporate measures for insulation monitoring, as stipulated in Section 6.2.4, Insulation Fault Protection, which shall trigger the earth fault alarm when the functional earth interrupter operates.

NOTE 1: Simple Separation can be provided by a transformer within the inverter, or by a separate external transformer.

NOTE 2: The resistance value can be calculated using Ohm's law and the array open circuit voltage.

6.2.6 Surge Protection

To protect DC systems against the effect of induced voltage surges, the following wiring measures shall be adopted:
a) DC cable runs shall be kept as short as is practically possible;
b) Positive and negative cables shall be run alongside each other, to prevent the formation of induction loops;
c) PV array bonding conductors shall be run alongside the PV array conductors; and
d) Where a system features longer DC cables (e.g. >50m), consideration shall be given to the use of screened / armoured cables, or to installing the cable in earthed, metal conduit / trunking.

See Section 5.3.8, Protection and Control – DC, for detailed requirements.

6.2.7 Isolation and Switching

Isolation shall be provided for the inverter on both the DC and AC side.

The solar PV array shall be equipped with devices for isolation and switching.

PV strings and PV sub-arrays shall have accessible means of isolation.

PV arrays shall have accessible Switch Disconnectors.

All Switch Disconnectors shall be selected and erected to comply with the following requirements:
a) It shall not have exposed live metal parts in connected or disconnected states;
b) It shall be DC rated at the calculated maximum voltage and current, as calculated in Section 5.3.8.2, Over- and Under-Voltage Protection;
c) It shall be rated to interrupt the current in either direction, and shall be able to isolate all live conductors during source isolation and / or breaking a fault condition.

The DC Switch Disconnector shall comply with SANS 60947-1 and 3, and SANS 60947-2, when circuit breakers are used.

NOTE 1: Devices must be able to interrupt current in either direction, as fault currents can flow in either direction in a PV array.

6.2.7.1 Location of the Switch Disconnector for Inverters

a) The Switch Disconnector shall be located such that maintenance of the inverter (e.g., the replacing of modules and fans, or the cleaning of filters) is possible without risk of electrical hazards.

b) The Switch Disconnector may form part of the inverter enclosure.

c) For multiple DC inputs, these requirements apply to each input.

6.2.7.2 Devices for Isolation within the PV Array

a) Devices shall be approved in accordance with the following table.

Table 6-3: Disconnection Device Requirements in PV Array Installations

Circuit of Part of Circuit	Means of Isolation	Requirement
Array	Means of isolation offering load breaking capabilities.*	Required

* Where a Switch Disconnector is used, it may provide the isolation function.

b) Means of isolation that are not capable of breaking load current shall be marked to indicate that they are no-load break devices and shall be accessible only by means of a tool or a key.

c) Where multiple PV Sub-Array Disconnection Devices are installed <2m to the inverter and in line of sight, a PV array cable needs to be provided. In such cases, there is no need for a PV array load-breaking switch. In this scenario, the switches for the PV Sub-Arrays shall all be load-breaking switches.

d) Where multiple Disconnection Devices are required to isolate the inverter, a warning sign shall indicate the need to isolate multiple supplies. See Annexure E: Labels and Markings – Photovoltaic Installations.

6.2.7.3 Electrical Connectors – DC

a) Male and female connectors shall be of the same type from the same manufacturer. [SANS 60364-7-712.526.1]

b) Connectors shall comply with the following requirements:

- Be rated for DC use, as per IEC 62852;
- Have a voltage rating equal to or greater than the open circuit maximum voltage, as calculated per Section 5.3.8, Protection and Control – DC;
- Be protected from contact with live parts in connected and disconnected states (e.g. can be shrouded);
- Have a current rating equal to or greater than the Current-Carrying Capacity (CCC) for the circuit to which they are fitted;
- Be sized according to the cable to which it is connected;
- Require a deliberate force to disconnect;
- If accessible by untrained people, then shall be of a lockable type, where two (2) independent actions are required to disconnect;
- Have a temperature rating suitable for the installation location;
- If multi-polar, polarity shall be indicated;
- Comply with Class II of electrical safety (as per SANS 61140);
- If exposed to the environment, be rated for outdoor use, be UV resistant and have at least an IP65 rating;
- Shall be installed in such a way to minimise mechanical strain on the connectors (e.g., by supporting the cable on either side of the connector);
- Standard (load) plugs, e.g., wall sockets, that are typically used for the connection of household equipment to Low Voltage AC power shall not be used in PV arrays.

6.2.8 AC / DC Wiring

Where a system features DC cables longer than 50m, the cables shall be installed in earthed metal conduit or using armoured cable.

When determining the wiring sizes for inverter-based generation, the following sections apply.

6.2.8.1 Current-Carrying Capacity of Conductors and Cables – AC

a) All conductors carrying AC current shall adhere to SANS 10142-1, Section 6.2.

NOTE 1: SANS 10142-1, Section 6.2 should be read in conjunction with Table 2 of NRS 097-2-3 (*Look-up values for a dedicated LV feeder maximum generator sizes (kVA) as a function of PVC copper cable size and distance*).

NOTE 2: Table 2 of NRS 097-2-3 serves as a guide only. Additional factors, such as Network short circuits, should also be considered when choosing an AC conductor.

6.2.8.2 Current-Carrying Capacity of Conductors and Cables – DC

a) The ambient temperature for cables subjected to direct heating below the PV modules shall be considered to be at least 70ºC. [SANS 60364-7-712]

b) Cable sizes for PV string, PV Sub-Array and PV array cables shall be determined by the minimum current rating of the cables (i.e., the maximum output from the module(s), I_{max} = 1.25 x I_{sc}), overcurrent protection ratings (where in use), the voltage drop and the prospective short-circuit current. The largest cable size obtained from these criteria shall be applied.

c) The CCC of the conductor shall be calculated to include any relevant de-rating factors (such as installation method and grouping), as indicated in SANS 10198-4.

d) In some PV module technologies, Isc is higher than the nominal-rated value during the first weeks or months of operation. In other technologies, I_{sc} increases over time (also known as soaking in). This shall be considered when establishing cable ratings.

e) DC cables shall be selected and erected so as to minimise the risk of earth faults and short-circuits, which can be achieved by using reinforced or double insulated cables.

Table 6-4: Solar PV Cable Current Rating [EUCASOLAR PV1-F]

Conductor Size mm²	Current Rating in Amps (A)			
	60º in Air	Single Cable on Surface	Two (2) Cables in Contact on Surface	90º in Air
2.5	41	-	-	21
4	55	52	44	27
6	70	67	57	34
10	98	93	79	48
16	132	125	107	63

Table 6-5: Solar PV Cable Temperature Derating [EUCASOLAR PV1-F]

Ambient Temperature ºC	Derating Factor
10	1.0
20	
30	
40	
50	
60	
70	0.91
80	0.82
90	0.71
100	0.58
110	0.41

f) For group / bundling derating factors, IEC 60364-5-52, Table A.52-17 shall apply (similar to AC derating for grouping / bundling of cables).

NOTE 1: The installer shall obtain the Isc of the technology used from the Supplier or PV module manufacturer.

g) Where an inverter or charge controller is capable of providing back-feed current into the array under fault conditions, the value of the back-feed current shall be taken into account in all calculations of the circuit current ratings.

NOTE 2: The value of the back-feed current provided by the inverter or charge controlled can be obtained from the manufacturer.

6.2.9 DC Combiner Boxes

DC combiner boxes shall be required when PV Sub-Arrays are combined, or where overcurrent protection and / or switch disconnection devices are used.

6.2.9.1 Component Requirements

a) Where protective measures used on the DC side is double or reinforced insulation, combiner boxes shall be selected according to Class II or equivalent insulation, as per SANS 61140.

b) Combiner boxes shall comply with SANS 61439-2. Alternatively, in the event of household or similar solutions only, combiner boxes may comply with SANS 60670 (relevant parts).

c) Switchgear assemblies shall comply with SANS 61439 (relevant parts).

6.2.9.2 Accessibility

a) Combiner boxes that contain overcurrent and / or Switching Devices shall be accessible for inspection, maintenance and / or repairs without necessitating the dismantling of the structural parts (such as cupboards, benches or the like).

b) Combiner boxes shall be accessible from ground level, i.e., no ladder or scaffolding is required to reach the boxes.

6.2.9.3 Wiring in Combiner Boxes

a) All cable entries shall maintain the IP rating of the enclosure.

b) Where conductors enter a combiner box without a conduit, a tension relief arrangement shall be used to avoid cable disconnection inside the box.

NOTE 1: Using a gland-connector could serve as a tension relief arrangement.

NOTE 2: Water condensation inside combiner boxes can be a problem in some locations – in these cases, provision should be made to drain water build-up.

6.2.10 Inverters

The requirements stipulated in this clause apply to current-controlled / current source type inverters, including micro, string and centralised inverters.

6.2.10.1 Inverter Requirements

a) Inverters shall be certified and operate according to SANS 62109-1, IEC 62109-2 and NRS 097-2-1. These functions shall include, but are not limited to, the following:
   - Synchronizing the inverter’s output voltage and frequency with the AC mains or grid;
   - Monitoring the grid and switching off, or disconnecting, if the voltage or frequency is outside allowable limits, or there is a loss-of-mains;
   - Ensuring that the output waveform is within specified harmonic and flicker limits;
   - Monitoring faults on the DC side (earth and insolation faults).

6.2.10.2 Inverter-Sizing

a) The permissible ratio between the inverter and the PV array, i.e., the sizing factor) shall be applied according to the inverter manufacturer’s specifications, without exceeding the input voltage or other limited parameters of the inverter.

b) An inverter shall be suitable for the maximum voltage calculated for the circuit to which it connects (see section 5.3.7.3 of this standard).

NOTE 1: The PV module voltage output may be significantly higher than the nominal V_{OC} during low temperature conditions.

c) For shared LV feeders, the inverter output shall be balanced across phases, according to NRS 097-2-3 and the South African grid code.

d) Power factor shall be set to ‘unity’, unless otherwise required by the Utility or another legal authority.

NOTE 2: Under-sizing inverters in PV plants may be useful in cases where conditions are not ideal for the PV array to achieve nominal-rated power output (e.g., high temperature conditions, partial shading, or modules installed in a sub-optimal manner).

NOTE 3: In most cases, the inverter can sustain damage if the voltage output of the PV array is higher than the maximum-rated input.

6.2.10.3 Inverters with Optimisers

a) When used, optimisers shall be compatible with the applicable inverter and PV array circuit, and protection shall be adapted according to the output provided.

6.2.10.4 Installation Requirements

a) The inverter system shall be installed according to SANS 10142-1 and the manufacturer’s specifications.

b) The following parameters shall be addressed for application:
- IP rating;
- Temperature ratings;
- Ventilation requirements;
- Proximity;
- Ease of access.

c) The installer shall confirm that the system size is approved by the NSP.

6.2.11 Solar PV Module Access, Installation and Spacing Requirements

6.2.11.1 General

a) General requirements regarding the installation of solar PV modules are listed in this section. The EGI installer shall ensure that:
- The PV modules are secured to an applicable structure, considering wind speed and added load (in cases of rooftop installations);
- Provide walkways between modules for maintenance and inspection;
- Install Fall Arrest systems for rooftop installations;
- Certification for salt mist corrosion resistance (IEC 61701) shall be considered for PV modules used in coastal areas or for maritime application;
- Certification as per IEC 62716 shall be considered for modules installed in wet, highly-corrosive and / or agricultural atmospheres.

6.2.11.2 Solar PV Modules Application and Safety Classes

a) Application Class A: General access, hazardous voltage, hazardous power applications: [SANS 61730]
- Modules rated for use in this application class may be used in systems operating at greater than 50V DC or 240 Wp, where general contact access is anticipated;
- Modules qualified for safety through SANS 61730 and SANS 61730-2, and within this application class, are considered to meet the requirements for safety Class II;
- Safety Class II shall:
  a) Have insulation comprising of basic protection and supplementary insulation as a precaution for fault protection or, alternatively, reinforced insulation that provides both basic and supplementary insulation (compliant to double insulation principles);
  b) Have accessible conductive parts separated from hazardous live parts by double or reinforced insulation, or be constructed in such a way as to provide similar protection.

b) Application Class B: Restricted access, hazardous voltage, hazardous power applications: [SANS 61730]

NOTE: Application of Class B which requires safety Class 0 equipment is not covered in this standard.

c) Application Class C: Limited voltage, limited power applications: [SANS 61730]
- Class C is not relevant to EGIs within this standard due to the voltage and power limitation of this application, but could be relevant for small standalone PV systems.

Table 6-6: Application of Equipment in a Low Voltage Installation [as per SANS 61140, Table 3]

Class of Equipment	Equipment Marking or Instructions	Symbol	Conditions for Connection of the Equipment to the Installation
Class 0	Not covered in this standard.	NA	Not covered in this standard.
Class I	Marking of the protective bonding terminal with the graphical symbol of IEC 60417-5019, or the letters ‘PE’, or the colour-combination green-yellow.		Connect this terminal to the protective-equipotential-bonding system of the installation.
Class II	Marking with the graphical symbol of IEC 60417-5172.		No reliance on installation protective measures.
Class III	Marking with the graphical symbol of IEC 60417-5180.		Connect only to SELV or PELV systems.

6.2.12 Safe Operating Control Requirements

The DC side of the EGI, as well as the required control configuration, shall be in place and operating according to specification, prior to connecting to the AC side.

To ensure that the string is correctly connected and configured, the string voltage shall be compared to the rated voltage of one (1) module, multiplied with the number of modules.

If more than one (1) string of the same size is installed, the voltage output of each string shall also be compared with one another.

If the voltages in either scenario do not correspond, corrections to the modules and / or cabling shall be implemented to achieve the correct voltage output.

Inverters should ideally have internal polarity checking, prior to generating.

6.2.12.1 Cross-Connection of PV Arrays or PV Sub-Arrays

a) For PV installations, each PV array shall have its own dedicated inverter.

6.3 Synchronous Machines

Machines which will not be embedded in the installation (alternative power and not connected to the Utility, e.g., an alternative back-up generator), shall adhere to the requirements of SANS 10142-1, and are therefore not included in this section.

Rotating machines shall comply with SANS 60034 / IEC 60034.

Further to the requirements of Section 5.3, Integrated Systems Requirements, synchronous machines shall adhere to the requirements set forth in the following sub-sections.

NOTE 1: Typically, these requirements are fulfilled by the manufacturer. However, the onus rests on the EGI installer to ensure compliance.

NOTE 2: NRS 097-2-3 provides further requirements and guidelines regarding small scale embedded generation.

6.3.1 Current-Carrying Capacity of Conductors and Cables

All conductors carrying AC current shall adhere to SANS 10142-1, Section 6.2.

NOTE 1: SANS 10142-1, Section 6.2 should be read in conjunction with Table 2 of NRS 097-2-3, (*Look-up values for a dedicated LV feeder maximum generator sizes (kVA) as a function of PVC copper cable size and distance*).

NOTE 2: Table 2 of NRS 097-2-3 serves as a guide only. Additional factors, such as Network short circuits, should also be considered when selecting AC cables.

6.3.2 Synchronization

Synchronous generators shall synchronize with the Utility Network before parallel connection is established.

Automatic synchronization equipment shall be the only method of synchronization.

Synchronization is typically performed at the Point of Generator Coupling.

NOTE: The Utility may have minimum voltage stable time requirements before synchronising. As such, the EGI should consult local requirements.

6.3.3 Equipment Protection

6.3.3.1 Voltage

a) Voltage protection elements will typically be performed at the Point of Generator Coupling.

b) To adhere to the requirements of NRS 097, voltage measurements taken at the generator terminals and Point of Generator Coupling will generally be sufficient for the overvoltage protection elements' pick-up settings. If the expected voltage drop across the cable that connects the Embedded Generator to the Point of Utility Supply is too high, under-voltage settings might have to be adjusted accordingly.

6.3.3.2 Current-Related

a) Requirements of Section 5.3.7.2, Current-Related Faults, and Section 5.3.7.3, Phase and Earth Fault Protection, apply.

b) The fault level at the Point of Utility Connection is to be determined, taking the Embedded Generator into account. Should the fault level be unobtainable, the following guide shall be followed:
   - To limit fault contribution into the Utility's Network, the Embedded Generator's fault contribution shall be limited to eight (8) times the rated current for synchronous generators. [NRS 097-2-3, Section A7.2]

All equipment within the EGI shall be suitably rated for the respective point of installation.

6.3.4 Equipment Protection Device(s)

The primary equipment protection device shall make use of active protection.

Passive protection devices shall not be used as a means of primary generator protection.

All protective apparatuses at the interface points shall be type-tested.

6.4 Asynchronous Machines

Further to the requirements of Section 5.3, Integrated Systems Requirements, asynchronous machines shall adhere to the requirements set forth in the following sub-sections.

Rotating machines shall comply with SANS 60034 / IEC 60034.

NOTE: Typically, these requirements are fulfilled by the manufacturer. However, the onus rests on the EGI installer to ensure compliance.

6.4.1 Current-Carrying Capacity of Conductors and Cables

All conductors carrying AC current shall adhere to SANS 10142-1, Section 6.2.

NOTE 1: SANS 10142-1, Section 6.2 should be read in conjunction with Table 2 of NRS 097-2-3 (*Look-up values for a dedicated LV feeder maximum generator sizes (kVA) as a function of PVC copper cable size and distance)*.

NOTE 2: Table 2 of NRS 097-2-3 serves as a guide only. Additional factors, such as Network short circuits, should also be considered when selecting AC cables.

6.4.1.1 Equipment Protection

a) Voltage

Voltage protection elements will typically be performed at the Point of Generator Coupling.

To adhere to the requirements of NRS 097-2-1, voltage measurements taken at the generator terminals and Point of Generator Coupling will generally be sufficient for the overvoltage protection elements' pick-up settings. If the expected voltage drop across the cable that connects the Embedded Generator to the Point of Utility Supply is too high, under-voltage settings might have to be adjusted accordingly.

b) Current-Related

The requirements of Section 5.3.7.2, Current-Related Faults, and Section 5.3.7.3, Phase and Earth Fault Protection, apply.

The fault level at the Point of Utility Connection is to be determined, taking the Embedded Generator into account. Should the fault level be unobtainable, the following guide shall be followed:

- To limit fault contribution into the Utility's Network, the Embedded Generator's fault contribution shall be limited to six (6) times the rated current for asynchronous generators. [NRS 097-2-3, Section A7.2]

All equipment within the installation shall be suitably rated for the respective point of installation.

6.4.1.2 Equipment Protection Device(s)

a) The primary equipment protection device shall make use of active protection.

b) Passive protection devices shall not be used as a means of primary generator protection.

c) All protective apparatuses at the interface points shall be type-tested.

7. Additional Utility, Regulatory or Legal Requirements for Embedded Generation Installations

7.1 Grid Code Requirements

The Grid Connection Code for Renewable Power Plants (RPPs) Connected to the Electricity Transmission System (TS) or the Distribution System (DS) in South Africa (the grid code) provides the minimum technical requirements for renewable generation. Other chapters of this grid code may also contain requirements for Embedded Generators.

The latest revision of the grid code should be consulted to ascertain any additional requirements.

Certain larger installations (review the grid code) may have additional requirements, such as:

a) An automatic synch-check relay (if the generator is synchronous or self-commutated) or open transition transfer switch;
b) The Embedded Generation Installation (EGI) must have the ability to provide power factor support;
c) Network and voltage stability functions may be required.

NOTE: Power factor support should be agreed upon between the EGI and the Network Service Provider (NSP), and should be documented and provided as part of obtaining a Certificate of Compliance (CoC).

7.2 Regulatory Requirements (DoE and NERSA)

The requirement for registration or licensing need to be ascertained at the time of installation.

Generation licenses may be obtained from NERSA.

7.3 Utility Requirements

The Utility has an application and approval process. This process is two-fold, namely:

a) To ensure that the Network integrity is maintained, e.g., the application of NRS 097-2-3 or more detailed Network studies;
b) To ensure that relevant information regarding Embedded Generators are captured in line with their licensee requirements, as specified by NERSA and / or the Department of Energy (DoE).

7.4 Additional Requirements for Non-Inverter-Based Generation

7.4.1 General

All generating units shall comply with all applicable standards.

Fault currents of the system must be recalculated to include the proposed EGI, and all equipment must be rated to the increased fault current.

Where applicable, neighbouring installations need to be informed of the EGI and be refurbished where an increase in fault level requires this.

Protection coordination and settings shall be agreed with the utility.

The embedded generation installation is solely responsible for proper synchronization of its generator with the Network Service Provider.

7.4.2 Synchronous Machines

The EGI circuit breakers shall be three-phase or single-phase devices, with electronic control.

The generator's excitation system shall conform to the field voltage versus time criteria, specified in the most recent version.

7.4.3 Induction Machines

This section to be expanded upon in a following edition.

7.5 Additional Requirements for Inverter-Based Generation

This section to be expanded upon in a following edition.

7.6 Additional Requirements for Electric Energy Storage Systems

Safe installation of battery energy storage systems includes dedicated areas with adequate ventilation.

7.7 Additional Requirements for Notices and Labels

The Utility will require labels to be affixed at relevant Network points when Embedded Generators are installed.

NOTE: This is to ensure that Utility staff is aware of the presence of the EGI, e.g., to ensure safe work procedures in the presence of Embedded Generators.

7.8 Additional Requirements for Protection and Control

This section to be expanded upon in a following edition.

7.9 Additional Requirements for Earthing System

Hybrid systems and off-grid systems require their own earthing rods.

8. Verification and Certification

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 as per SANS 10142-1.

Every user or lessor of an Embedded Generation Installation (EGI) shall have a valid CoC for every such installation. A CoC will only be valid when it is accompanied by a test report in the format as specified in Section 8.4 of this standard.

8.1 Inspection

The inspection criteria stated in SANS 10142-1, Section 8.5 shall apply.

In addition, the following shall be inspected.

NOTE: Confirm that all Switch Disconnectors or emergency Switch Disconnectors are in the open position or disconnected prior to inspection.

Table 8-1: Inspection Requirements

Component / Section	Requirement
DC System General	1. General check to confirm that the system complies with relevant standards. 2. The PV modules and their mounting structures are mechanically sound. 3. Components have been selected and installed to suit the environmental conditions. 4. Roof and building penetrations are weatherproof (where applicable).
DC System – Protection Against Electrical Shock	5. Verification of protective measures against electrical shock. 6. Parts have been selected and installed so as to minimize the risk of earth faults and short-circuits.
DC System – Protection Against Bridging of Insulation	7. Identification if the inverter has at least Simple Separation. 8. Identification of any Functional Earthing (only applicable to EGIs with Simple Separation). 9. Presence of earth insulation resistance detection and an alarm system (if not part of the inverter). 10. Presence of earth residual current monitoring detection and an alarm system (if not part of the inverter).
DC system – Protection Against Overcurrent	11. Overcurrent protection device(s) > possible reverse current. 12. String wires / cables are sized appropriately for prospective short circuit currents. 13. String / array overcurrent protective devices have been correctly specified and installed.
DC System – Earthing and Bonding	14. Check functional earth connections. 15. Check that functional earth fault interrupters are fitted (where required). 16. Check earthing and / or equipotential bonding.
DC System – Lightning and Overvoltage	17. Verify that circuit loops are minimised. 18. Measures, such as SPDs, are in place to protect long cables. 19. SPDs, where fitted, have been suitably selected and erected.

Component / Section	Requirement
DC System – Equipment Selection and Erection	20. All DC components are rated for DC, as well as for maximum expected voltage and current. 21. Cables have been selected and installed to suit environmental conditions. 22. The DC cables are correctly colour-coded, marked and / or labelled. 23. String / array isolation and disconnection devices are correctly specified and located. 24. Cables are correctly terminated to the cable connectors, at the combiner boxes, termination boxes, etc. 25. Male and female cable connectors are of the same type and compatible. 26. The DC circuits are electrically separated from the AC circuits.
Control Systems	27. The control devices are in place and communication protocols are established, such as grid feedback limiters. NOTE: May need DC connection to inspect.
AC System	28. Isolating disconnector(s) are installed on AC and DC of inverter. 29. Isolators are correctly connected. 30. Inverter parameters are correctly specified. 31. The inverter(s) are set up for the correct grid code (i.e., South Africa / NRS 097-2-1). 32. RCDs have been correctly selected and installed (where fitted).
Labelling	33. All parts are correctly labelled. 34. All labels are suitably durable. 35. Schematics and other signs are suitably displayed.

8.2 Maintenance

Maintenance for the EGI shall be required when there is a fault condition, an alarm or when an error message has been triggered, the system performs poorly or when a scheduled service is required.

The Customer shall be responsible for ensuring the safety of the EGI by, inter alia, ensuring that maintenance is performed.

8.2.1 Planned Maintenance

EGI systems shall have planned maintenance to ensure the safety of the installation.

The following maintenance requirements can be used as a guideline:

Table 8-2: Maintenance Requirements

Routine	Component / Section	Actions
Daily	Inverter	In operation without fault indication / alarm. (Customer)
Weekly to Monthly Monthly	Earthing and bonding	Check if earthing and bonding cables are in place. (EGI Installer)

Routine	Component / Section	Actions
	Yield / performance check	Check, note and compare metered values regularly. (Customer)
Every 3 to 6 Months	Module surfaces	Ensure all modules are properly fastened. Are any modules under tension (possibly due to roof structure bending / deformation)? (EGI Installer)
Every 3 to 6 Months Every 3 to 4 Years	PV array circuit boxes	Have moisture and / or insects penetrated combiner boxes (mainly outdoors)? Check all accessible fuses. (EGI Installer)
	Surge arrestors	**Check after thunderstorms.** Surge arrestors are intact. (Is the indicator showing white or red?) (Customer/EGI Installer)
	Cables	Check for broken / damaged insulation or other damage. Check all connections. (EGI Installer)
	Recommission – Repeat all measurements for commissioning	Should be done by EGI installer.
Every 3 to 4 Years Troubleshooting	Inverters located outdoors	Examination by installer to see moisture penetration inside of inverter.
	Modules	Characteristics curve measurement, thermographic analysis and / or functional analysis by EGI Installer/expert.
Troubleshooting Daily	PV module combiner boxes	Check string fuses (EGI Installer)
	AC protection devices	Check circuit-breakers, AC fuses and RCDs. (Customer/EGI installer)
	Inverter	In operation without fault indication / alarm. (Customer)

8.2.2 Corrective Maintenance

When an EGI needs maintenance for inspection, cleaning purposes or due to a fault condition, the following shall be adhered to:

a) Take note of and interpret alarms / indicators accordingly;
b) The EGI shall be isolated on both the AC and DC side;
c) Lockout the DC side disconnection and mark it with a maintenance notice;
d) PV strings / arrays shall only be isolated if one of the following can be achieved:

e) The installer can confirm that the string / array is not under load, i.e., no current flowing;
f) Each string / array can be disconnected with its own Switch Disconnector; or
g) It is night time.

8.3 Testing

8.3.1 General

Requirements of SANS 10142-1, Section 8.6 apply.

8.3.2 Point of Source Separation

A loss-of-grid event must be simulated to verify that the Disconnection Device associated with the Point of Source Separation opens within the designated time period. [NRS 097-2-1, Section 4.2.2.4.4]

8.3.3 Point of Generation Connection

A synchronizing event must be simulated to verify that the Disconnection Device associated with the point of generation connection can be successfully synchronised with the grid.

8.3.4 Dead Bus Verification

A dead bus verification event must be simulated to ensure that it is not possible, whilst the grid is Dead, for the EGI to energize the Utility's Point of Supply (Point of Utility Coupling).

8.3.5 Earthing

Requirements of SANS 10142-1, Section 8.6 apply.

8.3.6 Bonding

Requirements of SANS 10142-1, Section 8.6 apply.

8.3.7 Specific Embedded Generation Requirements

NOTE: It is recommended that the EGI designer does basic power quality measurements (such as power factor, harmonic content and load balancing in cases of three-phase supply) of the present Utility power supply prior to the installation. Identified issues can then be addressed and / or measurements can be compared during the realisation and operation of the EGI.

8.3.7.1 Energy Storage Systems

a) This section to be expanded upon in a following edition.

8.3.7.2 Inverter-Based Generation

a) Requirements as per IEC 62446 (Grid Connected Systems – Documentation, Commissioning Tests and Inspection) apply.

8.3.7.3 Synchronous Machines

a) This section to be expanded upon in a following edition.

8.3.7.4 Asynchronous Machines

a) This section to be expanded upon in a following edition.

8.4 Test Reports

The following test reports are applicable:
a) A test report for all Electrical Installations (CoC), as per SANS 10142-1.

b) An additional test for specific embedded generation requirements will be performed as per SANS 10142-1-2.

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 10142-1-2

NOTE 1: In terms of South African legislation, the user or lessor is responsible for the safety of the embedded generation installation

NOTE 2: This report covers the circuits for fixed appliances, but does not cover the actual appliances, for example generator, inverter, Photovoltaic panel, and lights.

NOTE 3: 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 the building: ....

SECTION 2 – DESCRIPTION OF ELECTRICAL INSTALLATION						
Existing certificate of compliance:	☐ Yes	☐ No	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 embedded generation installation:		☐ Inverter based generation	☐ Synchronous machines	☐ Asynchronous machines		
		☐ Other	Specify:			
Size of embedded generation installation:		kVA	Category:	☐ A1	☐ A2	☐ A3
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:	☐ DC			
Prospective short-circuit current at point of control (PSCC):			kA			
How determined?	☐ Calculated	☐ Measured	☐ From Supplier			

NOTE: See Section 6.

SECTION 2 – DESCRIPTION OF ELECTRICAL INSTALLATION (Continued)				
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:		☐ Yes	☐ No	
Is alternative power supply installed?		☐ Yes	☐ No	
Is any part of the installation a specialized Electrical Installation?		☐ Yes	☐ No	If yes, complete additional test reports
Is any part of the installation at a voltage above $1kV_{AC}$?		☐ Yes	☐ No	If yes, competent person to approve design and complete additional test reports (see 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:

SECTION 3 – DESCRIPTION OF INSTALLATION COVERED BY THIS REPORT												
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				

SECTION 4 – INSPECTION AND TESTS (new and existing installations)		
Inspection 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 can withstand 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 and / or labelled.		
10.1 Point of Utility Supply correctly labelled.		
10.2 Point of Control correctly labelled.		
10.3 Point of Source Isolation correctly labelled.		
10.4 Point of Source Separation correctly labelled.		
10.5 Point of Generator Connection correctly labelled.		
11. Where an electrical circuit passes through a fire barrier, the integrity of the fire barrier is 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.		

or 13(b) In the case of installations that existed before the publication of this edition of SANS 10142-1-2, the installation complies with the general safety requirements stipulated in this edition of this part of SANS 10142-1-2 and is reasonably safe. NOTE 1: Confirm (a) or (b), or (a) and (b) on the test report. 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 is indicated on the distribution board.		
16. Lightning protection risk assessment is required. (If yes, attach SANS 10313 risk assessment report under Section 6 of this report).		
17. Closing on dead bus protection and control function tested.		
18. Anti–islanding protection and control function tested.		
19. Synchronisation protection and control function tested (if applicable).		
20. Single line diagram displayed in relevant distribution boards.		
21. Structural requirements, as per SANS 10400, related to the EGI identified and addressed		
22. Additional Utility requirements for EGIs are identified and addressed		
23. The local authority has been notified of the EGI (If yes, provide notification number) (As per Annex 4 OHS Act)		

<table>
<tr><td colspan="11">SECTION 4 – INSPECTION AND TESTS (new and existing installations)</td></tr>
<tr><td colspan="5" rowspan="2">Tests
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.</td><td rowspan="2">Units</td><td rowspan="2">Instrument</td><td colspan="4">Reading / Result</td></tr>
<tr><td colspan="2">Existing Installation</td><td colspan="2">New / Altered / Temporary Installation</td></tr>
<tr><td colspan="5">1 Continuity of bonding.</td><td>Ω</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">2 Resistance of earth continuity conductor.</td><td>Ω</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">3 Continuity of ring circuits (if applicable).</td><td>-</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">4 Earth loop impedance test.</td><td>Ω</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">4 Neutral loop impedance test.</td><td>Ω</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">5 Prospective short-circuit current at point of control.</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Indicate:</td><td>kA</td><td>☐ Calculated</td><td>☐ Measured</td><td>☐ From Supplier</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">6 Elevated voltage between incoming neutral and external earth (ground).</td><td>V</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">7 Earth resistance at electrode (if required).</td><td>Ω</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">8 Insulation resistance.</td><td>MΩ</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">9 Voltage at main distribution board with no load for each phase to neutral.</td><td>V</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">10 Voltage at main distribution board with load (as calculated for full load) for each phase to neutral.</td><td>V</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">11 Voltage at available load (worst condition as calculated for full load) for each phase to neutral.</td><td>V</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">12 Operation of all earth leakage units.</td><td>mA</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">13 Operation of all earth leakage test buttons.</td><td>-</td><td></td><td>Correct</td><td></td><td>Correct</td><td></td></tr>
<tr><td colspan="5">14 Polarity of points of consumption.</td><td>-</td><td></td><td>Correct</td><td></td><td>Correct</td><td></td></tr>
<tr><td colspan="5">15 Phase rotation at points of consumption for three-phase systems.</td><td>-</td><td></td><td>Correct</td><td></td><td>Correct</td><td></td></tr>
<tr><td colspan="5">16 All Switching Devices, make-and-break circuits.</td><td>-</td><td></td><td>Correct</td><td></td><td>Correct</td><td></td></tr>
<tr><td colspan="5">17. Islanding condition – time to disconnect.</td><td>s</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
</table>

SECTION 5 – RESPONSIBILITY	
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): .... Date:	Position: .... Address: ....
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): .... Signature: .... Profession Registration No. (where applicable): .... Date:	Position: .... Address: ....

SECTION 5 – RESPONSIBILITY	
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): .... Signature: ………………………………………………………………………. Profession Registration No. (where applicable): .... Date: …………………………………………………………………..…………	Position: ……………………………………………………………………………… Address: ……………………………………………………………………………… ....
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 compliance with this standard, or 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: .... Tel. No.: .... Date: ……	

<table>
<tr><td colspan="3">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.</td></tr>
<tr><td>An Approved Inspection Authority for Electrical Installations.</td><td colspan="2">Chief Inspector's registration No.:</td></tr>
<tr><td>A competent person as defined.</td><td colspan="2">Indicate competency:</td></tr>
<tr><td>A professionally registered person.</td><td>Category of professional registration:</td><td>Registration No.:</td></tr>
<tr><td>Name (in block letters): ....

Signature: ....
Date: ....</td><td colspan="2">Address: ....
....
....
....</td></tr>
</table>

SECTION 6 – DOCUMENTATION		
Inspection NOTE: Answer "Yes" or "N/A". The report shall not be issued if any "No" answers appear.	Existing Installation	New / Altered / Temporary Installation
1. Single line diagram.		
2. Local authority notification.		
3. Lightning protection risk assessment report (if applicable).		
4. Structural requirements related to EGI installation identified and addressed, i.e., SANS 0400 Roof Test Report.		

Additional Test Report for Energy Storage Systems

<table>
<tr><th colspan="11">SECTION 7 – ADDITIONAL TEST REPORT FOR ENERGY STORAGE SYSTEMS (new and existing installations)</th></tr>
<tr><td colspan="5" rowspan="2">Tests
Carry out all the tests for the energy storage system.
NOTE: Answer "Yes" or "N/A". The report shall not be issued if any "No" answers appear.</td><td rowspan="2">Units</td><td rowspan="2">Instrument</td><td colspan="4">Reading / Result</td></tr>
<tr><td colspan="2">Existing Installation</td><td colspan="2">New / Altered / Temporary Installation</td></tr>
<tr><td colspan="5">1. Maximum calculated gas build-up.</td><td>%</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">2. Torque rating of battery storage terminals.</td><td>N.m.</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">3. Ambient temperature during commissioning.</td><td>ºC</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">4. Maximum expected temperature.</td><td>ºC</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">5. Voltage of each cell.</td><td>Ω</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">6. Specific gravity of each cell.</td><td>SG</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">7. Total voltage of interconnected cells at the battery terminals.</td><td>V</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">8. Total voltage of interconnected cells at the Power Conversion Equipment (PCE) terminals.</td><td>V</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">9. Maximum load on battery-connected inverter.</td><td>W</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">10. Maximum charging voltage achieved from charge controller.</td><td>V</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">11. Earth loop impedance test during island mode (for hybrid systems only).</td><td>Ω</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">12. Neutral loop impedance test (for hybrid systems only).</td><td>Ω</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">13. Prospective short-circuit current at Point of Isolation of the storage system.</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Indicate:</td><td>kA</td><td>☐ Calculated</td><td>☐ Measured</td><td>☐ From Supplier</td><td>-</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">14. Battery bank voltage corresponds with battery inverter rating.</td><td>-</td><td></td><td>Correct</td><td></td><td>Correct</td><td></td></tr>
<tr><td colspan="5">15. Polarity of interconnection of components.</td><td>-</td><td></td><td>Correct</td><td></td><td>Correct</td><td></td></tr>
</table>

Additional Test Report for Inverter-Based Generation

SECTION 8 – ADDITIONAL TEST REPORT FOR INVERTER-BASED GENERATION (new and existing installations)						
Tests Carry out all the tests for the DC side of the Embedded Generation Installation (EGI). NOTE: Where values are not required, answer "Yes" or "N/A". The report shall not be issued if any "No" answers appear.		Units	Reading / Result Per Solar PV String			
			1	2	3	4
Array	Module size	Wp				
	Quantity	-				
Array Parameters	Voc (STC)	V				
	Isc (STC)	A				
String Test	Voc	V				
	Isc	A				
	Irradiation (Sun)	w/m²				
Polarity Check		-	Correct	Correct	Correct	Correct
Earth Continuity		-	Correct	Correct	Correct	Correct
Array Insulations Resistance (Ref IEC 60364-713-04, Test Method Annex 1)	Test voltage	V				
	Positive – Earth	MΩ				
	Negative – Earth	MΩ				
Connected to Inverter (Serial No.)		-				
EGI Inverter	Voltage at AC terminals after switching off inverter after 2s.	V				
	Time to reconnect to the AC grid.	s				
	Elevated voltage at inverter output.	V				

The DC test shall be performed in the following order:

1. Test continuity of equipment grounding / earthing conductors and system grounding / earthing conductors;
2. Test polarity of all DC cables, and check for correct cable identification and connections;
3. Test open-circuit voltage (Voc) for each PV source circuit;
4. Test short-circuit current (Isc) for each PV source circuit;
5. Test functionality of major system components (isolation, controls, protection and inverters);
6. Test the insulation resistance of the DC circuit conductors.

Additional Test Report for Synchronous Machines

This section to be expanded upon in a following edition.

Additional Test Report for Asynchronous Machines

This section to be expanded upon in a following edition.

9. Bibliography

Ahmada, M.Z.A. Ab-Kadira, M. Izadia, N. Azisa, M.A.M. Radzib, N.H. Zainia, M.S.M. Nasira. Lightning Protection on Photovoltaic Systems: A Review on Current and Recommended Practices. N.I.

EUCASOLAR PV1-F, Photovoltaic Solar PV1-F Eland Cable, SOLAFLEX PV Single Core Cable 1000V DC

Fallah N, Gomes C, Ab Kadir MZA, Nourirad G, Baojahmadi M, Ahmed RJ. 2013. *Lightning Protection Techniques for Roof-Top PV Systems. Power Engineering and Optimization Conference*. Langkawi: IEEE. 2013 (3-4). p. 417-421.

Haselhuhn, R. 2004. Auswertung von Betriebsdaten der PV-Fassadenanlage am Energieforum Berlin, DGS. Berlin.

Haselhuhn, R. 2005. *Photovoltaik - Gebaude liefern Strom, Hrsg*. BINE-Fachinformationsdienst, Karlsruhe. TUV-Verlag. Cologne.

IET Code of Practice for Grid-Connected Solar Photovoltaic Systems. Institution of Engineering and Technology (IET), 10/2015. VitalBook file.

Annexure A: Recommended Standards Related to PV Systems, Including PV Installations, Lightning Protection Systems and Electrical Installations

(Informative)

The following table presents the recommended standards related to PV systems, including PV installations, lightning protection systems and Electrical Installations.

Table A-1: Recommended Standards for Reference for PV Systems

Standards	**Description**
IEC 62305	Protection against lightning: • Part 1 – General lightning; • Part 2 – Risk management; • Part 3 – Physical damage to structures and life hazards; • Part 4 – Electrical and electronic systems within structures.
MS 1837	Installation of grid-connected PV system.
DIN EN 62305-3 (Supplement 5)	Part 3 – Protection against lightning and overvoltage for PV power supply systems.
DIN CLC / TS 50539–12	Selection and application principles – Surge protective devices connected to PV installations.
IEC 62561	• Part 1 – Requirements for connection components; • Part 2 – Requirements for conductors and earth electrodes; • Part 3 – Requirements for isolating spark gaps (ISG); • Part 4 – Requirements for fasteners; • Part 5 – Requirements for earth electrode inspection housings and electrode seals; • Part 6 – Requirements for lightning strike counters (LSC); • Part 7 – Requirements for earth enhancing compounds.
IEC 61643	Surge protective devices connected to low-voltage power distribution: • Part 11 – Performance requirements and testing methods; • Part 12 – Selection and application principles; • Part 21 – Performance requirements and testing methods; • Part 22 – Selection and application principles.
IEC 60364	Electrical Installations of buildings: • Part 7–712: Requirements for special installations or locations – PV power supply systems; • Part 4–44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances; • Part 5–53: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors.
EN 50110–1	Operation of Electrical Installations – General requirements.
IEC 60904–2	PV devices, Part 2 – Requirements for reference solar devices.
IEC 62446	Grid connected PV systems – Minimum requirements for system documentation, commissioning tests and inspection.

Annexure B: Lightning Protection on Photovoltaic Systems

(Normative where lightning protection is required or installed – See Section 5.3.6, Lightning Protection)

Lightning Protection System (LPS)

The installation of a lightning earth-termination system and suitable down conductors with equipotential bonding is a compulsory requirement.

If the equipotential bonding conductors are considered as down conductors, the minimum cross section of the down conductors shall be 50mm^2 copper or equivalent (IEC 62305-3, Table 6).

If the equipotential bonding conductors are intended to carry partial lightning currents, the minimum cross section of the down conductors shall be 16mm^2 copper or equivalent.

The minimum cross section of the bonding conductor connecting internal metallic installations to the bonding bar shall be 6mm^2 copper or equivalent (IEC 62305-3, Table 9).

If the equipotential bonding conductors are intended to carry only induced lightning currents, the minimum cross section of the down conductors shall be 6mm^2 copper or equivalent.

The minimum cross section of the bonding conductor that connects different bonding bars, and that connects the bars to the earth termination system, shall be 16mm^2 copper or equivalent in the case of PV installations not connected to the LPS (IEC 62305-3, Table 8).

Where the risk of a strike to the PV installation exceeds the requirements calculated via SANS 62305-2, an LPS that is insulated from the PV-DC is required. If the risk is not calculated, it must be applied to all PV installations exceeding 13.8kVA.

NOTE: The installation size of 13.8kVA is derived from the estimated PV array installation size of 130m^2 that will be exposed to lightning activity. It also corresponds to small scale embedded generator categories.

The following table presents risk factors for design considerations.

Table B-1: General Specifications of PV Systems and the Necessity for an LPS
[Ahmada, M.Z.A. Ab-Kadira, M. Izadia, N. Azisa, M.A.M. Radzib, N.H. Zainia, M.S.M. Nasira]

SSEG Sub-Categories	Specifications	Necessity of Lightning Protection System
Category A1	0 kVA ≤ x ≤ 13.8 kVA	To protect buildings and prevent any physical damage to the buildings, as well as life hazards from lightning strikes.
Category A2	13.8 kVA < x < 100 kVA	Can increase the return of investment of the PV system.
Category A3	100 kVA ≤ x < 1 MVA	To reduce the cost of repairing damages by installing a LPS.

The following table summarises the external and internal LPSs according to the different types of PV system installations.

Table B-2: Summary of External LPS for Different Types of PV System Installation Identified

Types of PV System Installations				
External LPS	**Category A1**			**Category A2 / Category A3**
	Parameters for Consideration Shape, elevation, arrangement of panels, and separation distance of panels to the LPS. Separation distances of panels and an Isolated LPS system should be kept between the LPS and the panel frame. Separation distances of panels and a non-isolated LPS system should be kept between the bonding conductor and mounting structure of the panel.			**Parameters for Consideration** Lightning protection system based on Class III for PV system > 10kW.
	Without an External LPS	**With an external LPS**		**Air Termination** Use the rolling sphere / protective angle method in order to determine the height and quantity.
		Isolated	**Non-Isolated**	
	Type II SPDs are to be installed at the following locations: • DC-side of the modules and inverters; • AC output of the inverter; • EGI Point of Supply; • Data and sensor lines.	Type II SPDs are to be installed at the following locations: • DC-side of the modules and inverters; • Data and sensor lines.	Type I SPDs are to be installed at the following locations: • DC-side of the modules and inverters; • Point of Utility Supply.	**Down Conductors** Terminal lugs can be used to connect with the earth termination systems.
	An additional type II SPD shall be installed on the module side if the distance between the inverter DC input and the PV generator exceeds 10m.	Type I SPDs at the Point of Utility Supply.	Type II SPDs are to be installed at the following locations: • Data and sensor lines.	**Isolated** The separation distance of the panels to the LPS should be kept between the air termination rods and the PV supporting frames
	Additional type II SPDs shall be installed upstream of the AC input of the inverter if the distance between the inverter and the EGI Point of Supply exceeds 10m.	Additional type II SPDs shall be installed upstream of the AC input of the inverter if the distance between the inverter and the EGI Point of Supply exceeds 10m.	Additional type I SPDs shall be installed upstream of the AC input of the inverter if the distance between the inverter and the EGI Point of Supply exceeds 10m.	**Earth Termination** • A ring earth electrode with a mesh size of 20m x 20m. The metal supporting frames are connected every 10m to the ground level; • At least one (1) conductor is in contact with another between the earth termination system of the PV system and the building; • At least 0.5m of the surface earth electrode is laid in the soil and its joint is wrapped in an anticorrosive band; • The meshes are interconnected with four-wire connectors.

NOTE 1: External LPS Isolated from the Structure to be Protected
LPS with an air-termination system and down-conductor system positioned in such a way that the path of the lightning current has no contact with the structure to be protected.

NOTE 2: External LPS Not Isolated from the Structure to be Protected:
LPS with an air-termination system and down-conductor system positioned in such a way that the path of the lightning current can be in contact with the structure to be protected.

NOTE 3: Separation Distance [IEC 62305-3]:
The distance between two conductive parts at which no dangerous sparking can occur.

Surge Protection

Surge Protective Devices (SPDs) are compulsory and shall be installed according to SANS 61643-12, IEC 61643-32 and SANS 10142-1, Annexure I.1.

The following table summarises the external and internal LPS according to the different types of PV system installations.

Table B-3: Summary of Internal LPS for Different Types of PV System Installation Identified

	Types of PV System Installations	
	Category A1	**Category A2 / Category A3**
Internal LPS	**Selection of SPDs Depend On** • The selected LPS for the building; • The isolation of the PV frames from the LPS; • If the system is non-isolated when the frames are bonded to the LPS; • The sizes of earthing conductors; • The location of the panels and the LPS.	**Equipotential Bonding** • Lightning current arresters through the direct connection of all metal systems and indirect connection of all live systems; • To prevent partial lightning currents from penetrating the building, it shall be connected near the entrance of the structure.
		SPD Type II is adequate, as the PV modules are within the protective area of the external LPS.

Annexure C: Fault Level Assessment

(Informative)

This section to be expanded upon in a following edition.

Annexure D: Labels and Markings

(Normative)

The installer is responsible for label application, based on the intended design and equipment specifications.

Labelling of the EGI components shall comply with labelling requirements set out in SANS 10142-1.

With the exception of Figure D-7, all notices and labels shall have a minimum font size of 8mm. See Figure D-7 for specific requirements.

All distribution boards shall have a label denoting that the distribution board is part of an EGI, as shown in Figure D-1.

All distribution boards, new and existing, which are connected directly or indirectly, upstream or downstream to an EGI up to and including the Point of Supply.

EGI label for SANS 10142-1, Clause 6.6.1.1, Switch Disconnectors, for distribution boards and sub-distribution boards.

D.2.1.1: EGI label for SANS 10142-1, Clause 6.6.1.1(b). See Figure D-2.

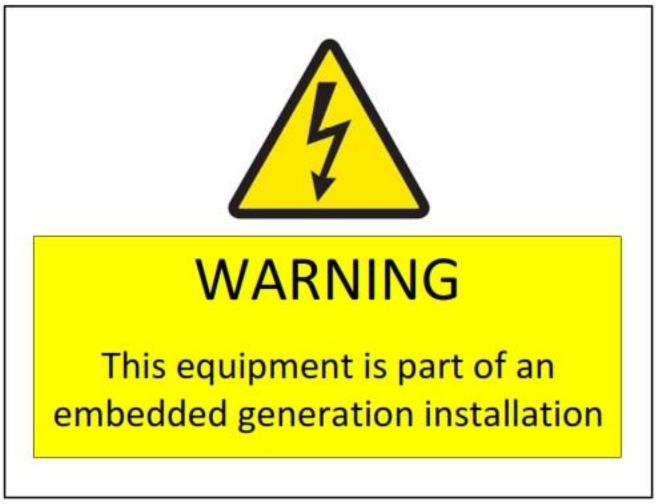
D.2.1.2: EGI label for SANS 10142-1, Clause 6.6.1.1(c). See Figure D-3.

D.2.1.3: EGI label for SANS 10142-1, Clause 6.6.1.1(d). See Figure D-4.

D2.2.3.1: All distribution boards that have more than one incoming supply from more than one main disconnecting device within the distribution board shall have a label denoting such as shown in Figure D-4.

D2.2.3.2: All distribution boards which may have more than one incoming supply (reverse energy) from a single disconnecting device within the distribution board shall have a label denoting such as shown in Figure D-5. The label shall be supplemented by a second label indicating all isolation points.

D.2.1.4: Embedded Generation Installation label for clause 6.6.1.1(e) of SANS 10142-1. See Figure D-6.



Sign : Golden yellow (B49)
Text : Black

Figure D-1

Sign : White
Text : Black

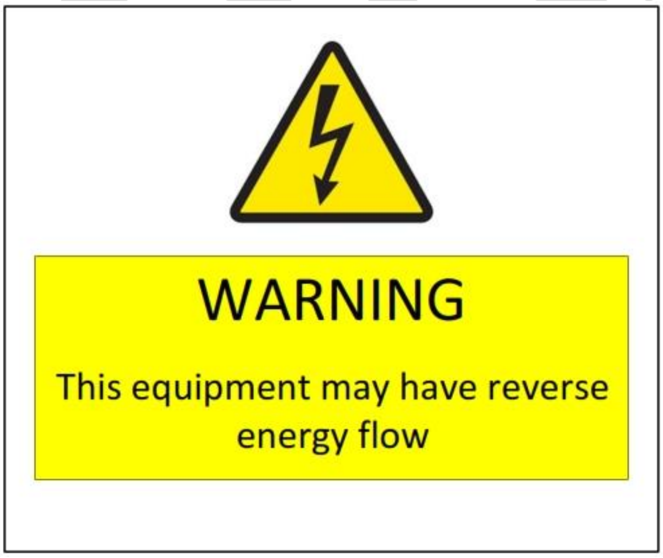
Figure D-2

Sign : White
Text : Black

Figure D-3

Sign : Golden yellow (B49)
Text : Black

Figure D-4

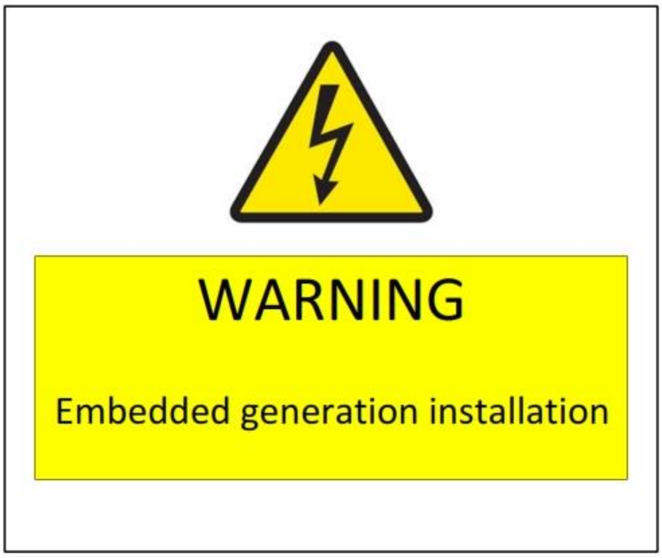


Sign : Golden yellow (B49)
Text : Black

Figure D-5

Sign : Emerald green (E14)
Text : White

Figure D-6



Sign : Golden yellow (B49)
Text : Black
Min size: 250mm x 250mm
Min font height: 35mm

Figure D-7

Annexure E: Labels and Markings – Photovoltaic Installations

(Normative)

The installer is responsible for label application, based on the intended design and equipment specifications.

Labelling of the EGI components shall comply with labelling requirements set out in SANS 1186-1 in addition to the requirements set out in this annexure.

All notices and labels shall have a minimum font size of 8mm.

Each PV string shall be numbered on the cables and on the PV panel itself (e.g., on the panel on the roof, on the cable at the inverter and on the combiner box) by a suitable identification system.

All distribution boards, combiner boxes, panels and or disconnect device within the solar PV installation shall have a label denoting the possible presence of power originating from a photovoltaic panel as shown in Figure E-1, the label shall be supplemented by a second label giving instructions for complete isolation.

NOTE 1: It is deemed acceptable to use the label as depicted in Figure E-2 as an alternative to Figure E-1.

Where the terminals of a disconnecting device may be energized in the open position by the photovoltaic system such as the panel protection fuse, a label shall be mounted adjacent to the device indicating such. See Figure E-3.

The main AC isolation device shall be marked by a label such as one shown in Figure E-4.

The main DC isolation device shall be marked by a label such as one shown in Figure E-5.

The singular photovoltaic panel isolation device shall be marked by a label such as shown in Figure E-6.

The photovoltaic panel string isolation device shall be marked by a label such as shown in Figure E-7.

When equipment is energised from more than one source, the isolation means shall be grouped, identified and labelled using a label such as shown in Figure E-8 and Figure E-9. The white middle portion of each label shall be used to print isolation means or series.

NOTE 2: Example of print: "*DC Isolation 1 of 2*".

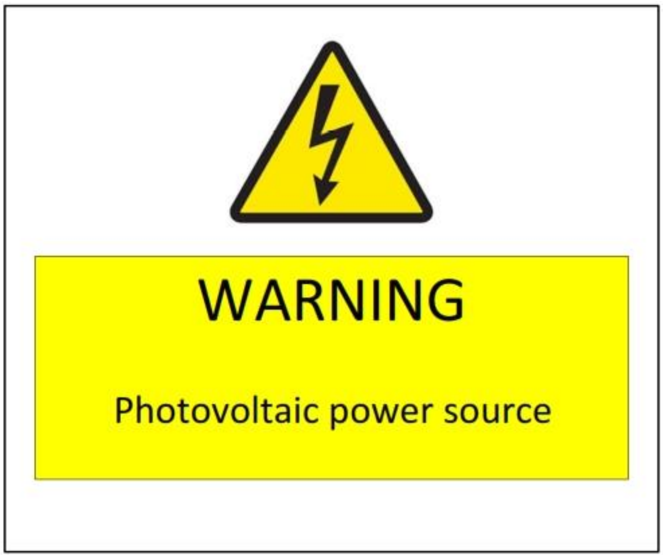
Solar PV DC circuits that are hidden under build up, laminate, or other materials shall be indicated and marked by a label such as the one shown in Figure E-10.

Solar PV combiner boxes and DC isolation devices shall be marked by a label such as the one shown in Figure E-11.

Non-load DC isolation devices shall be marked by a label such as the one shown in Figure E-12.

Electrical metallic tubing, conduit and or cableways, shall be marked by a label such as the one shown in Figure E-1 in no less than every three (3) meters, at every turn and above and below penetrations.

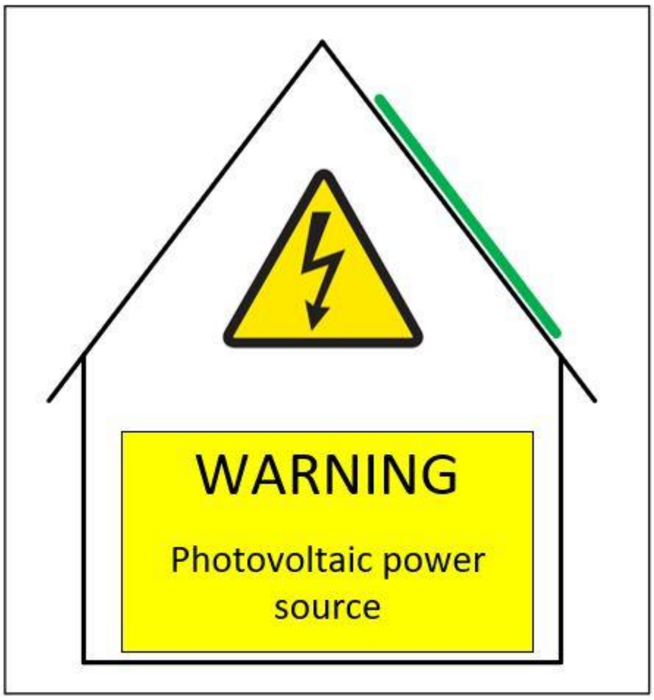
Any additional markings and labels within the photovoltaic installation shall conform to the requirements on SANS 1189-1.



Sign : Golden yellow (B49)
Text : Black

Figure E-1

OR



Sign : Golden yellow (B49)
Text : Black

Figure E-2

WARNING ELECTRICAL SHOCK HAZARD Do not touch terminals. Terminals may be energised if in the open position.
DC voltage is always present when solar photovoltaic modules are exposed to sunlight.

Sign: Golden Yellow (B49)
Text: Black

Figure E-3

Photovoltaic system Main AC isolation

Sign : White
Text : Black

Figure E-4

Photovoltaic system Main DC isolation

Sign : White
Text : Black

Figure E-5

Photovoltaic panel DC isolation

Sign : White
Text : Black

Figure E-6

Photovoltaic string DC isolation

Sign : White
Text : Black

Figure E-7

Photovoltaic system
DC isolation

Sign: White
Text: Black

Figure E-8

Photovoltaic system
AC isolation

Sign: White
Text: Black

Figure E-9

WARNING
PHOTOVOLTAIC POWER SOURCE
Do not remove unless replaced in exact location – photovoltaic power circuit directly below.

Sign: Golden Yellow (B49)
Text: Black

Figure E-10

WARNING
Turn off photovoltaic AC disconnect, prior to working on DC side.

Sign: Golden Yellow (B49)
Text: Black

Figure E-11

DO NOT OPEN UNDER LOAD

Sign: Golden Yellow (B49)
Text: Black

Figure E-12

Annexure F: Earthing

(Informative)

The most common method of system earthing on the DC side of the installation is floating, i.e., neither the positive nor the negative terminal of the DC source is earthed. This configuration is shown in Figure F-1.

Alternative methods of earthing refer to cases where either of the current-carrying conductors or the midpoint is earthed.

System Earthing Identification Code

The earthing system identification code for DC is the same as for AC systems, which is repeated below for ease of reference. [SANS 10142-1, Annexures J and K]

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

I the exposed conductive parts of the Consumer's Electrical Installation are connected direct to the source earth, which, in the case of an AC 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.

TN-S

Neither of the current-carrying conductors are earthed, i.e. the conductors are floating. There is a Protective Earth (PE) conductor that is solidly earthed at the source (utility transformer) connected to all exposed metal parts.

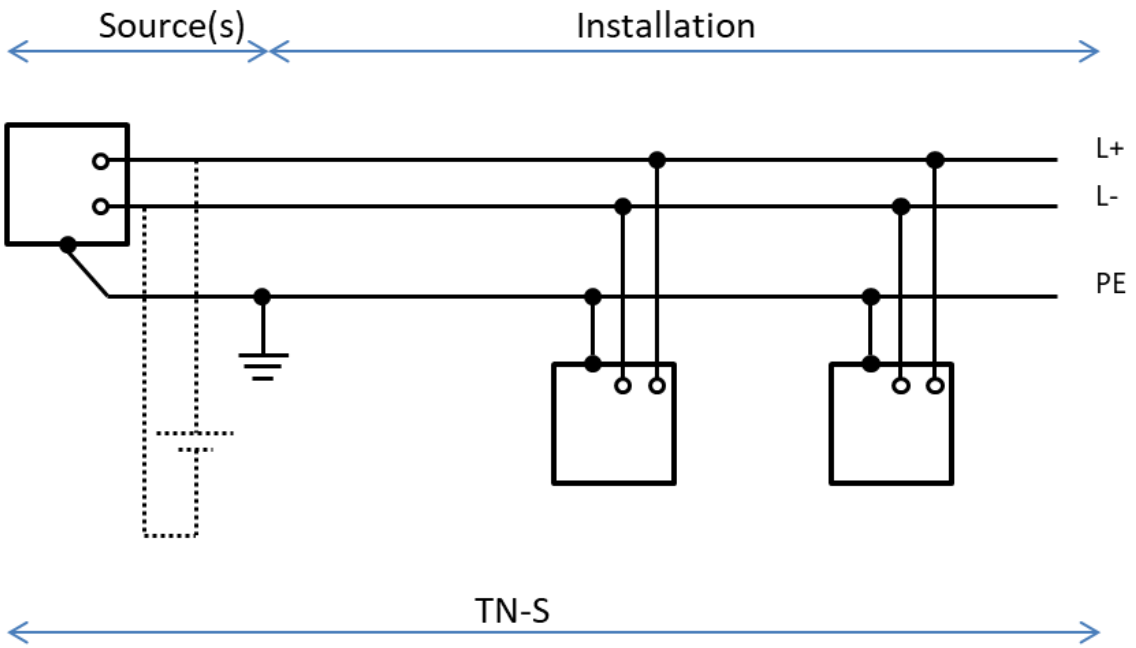


Figure F-1: Floating TN-S with Protective Earth Separate Throughout the Installation

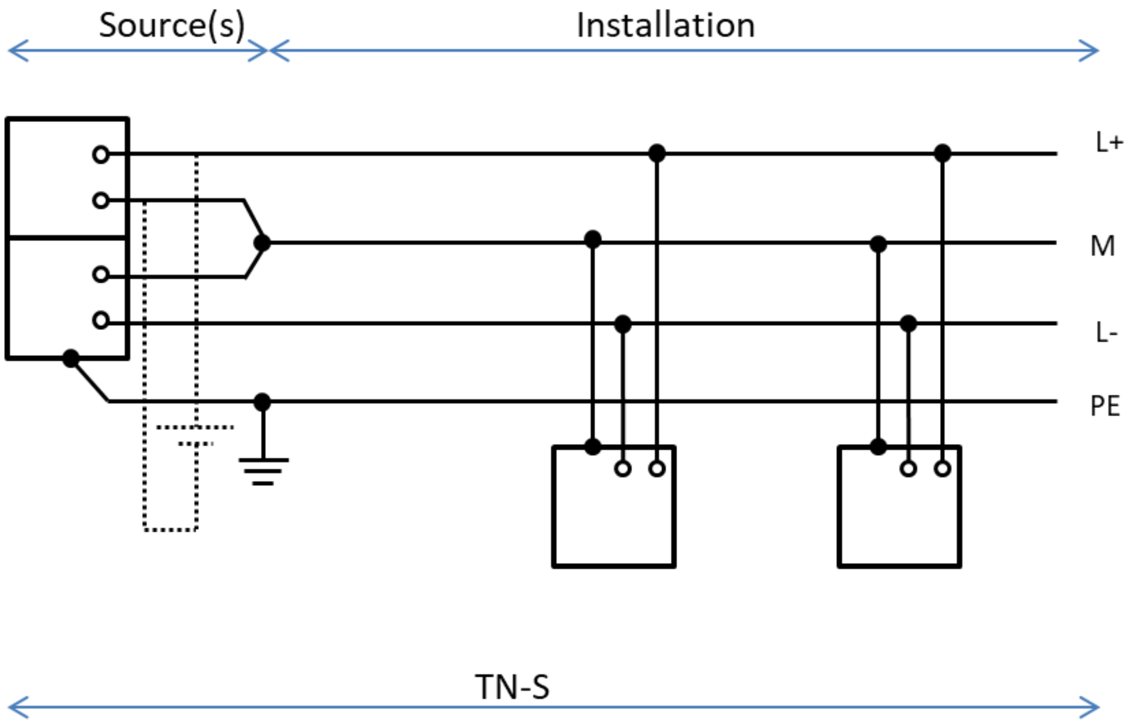


Figure F-2: Floating TN-S with Protective Earth Separate Throughout the Installation

TN-C

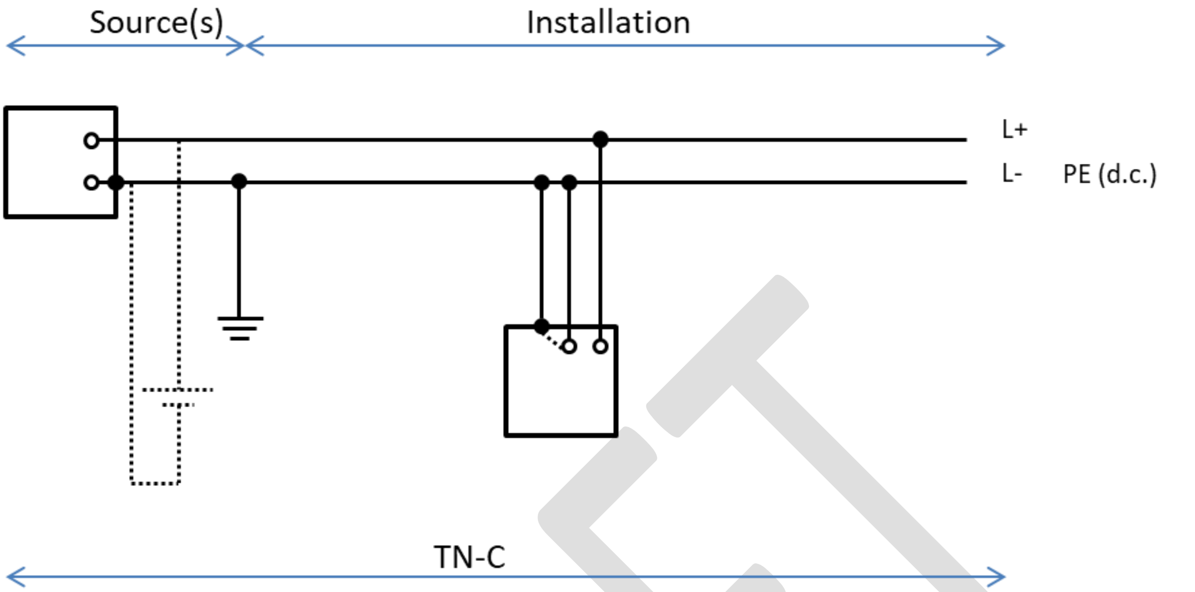


Figure F-3: TN-C DC System Earthed Line Conductor L- and Protective Conductor Combined in One Single Conductor PE Throughout the Installation

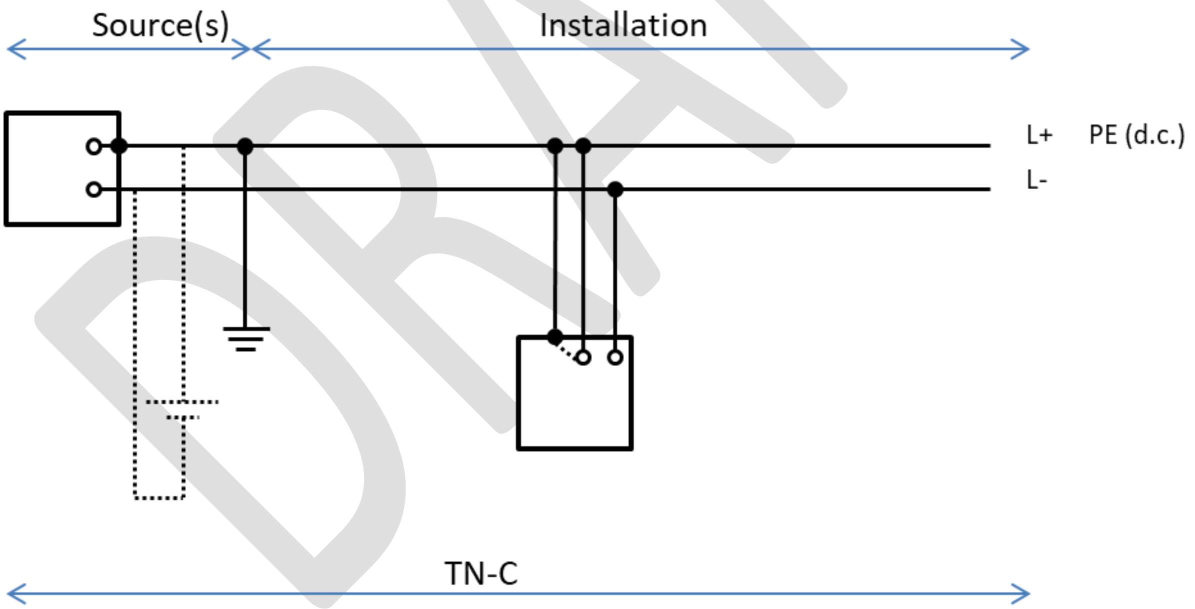


Figure F-4: TN-C DC System Earthed Line Conductor L+ and Protective Conductor Combined in One Single Conductor PE Throughout the Installation

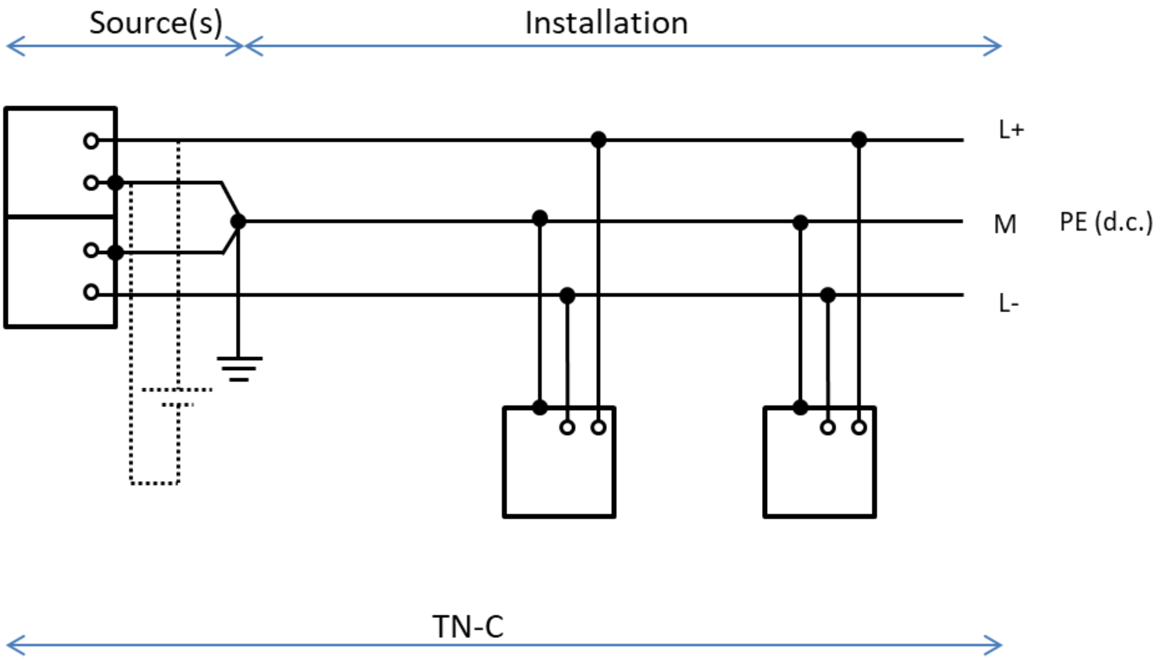


Figure F-5: TN-C DC System Earthed Midpoint Conductor M and Protective Conductor Combined in One Single Conductor PE Throughout the Installation

TN-C-S

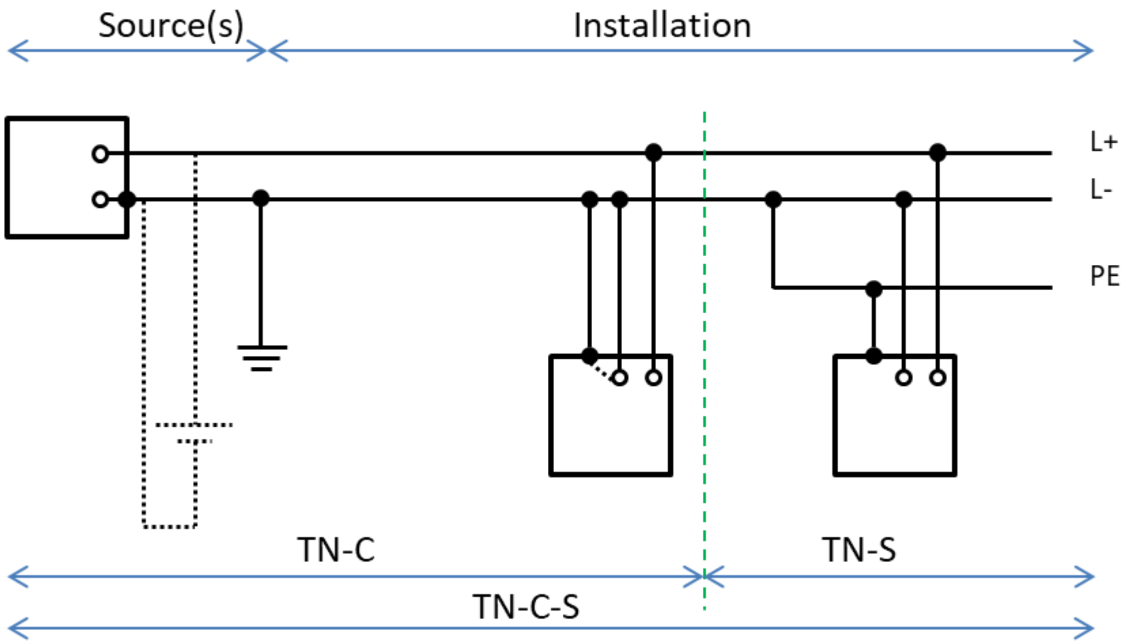


Figure F-6: TN-C-S System with Functional Earth, Line L- Conductor Combined at Source and Separate Protective Earth

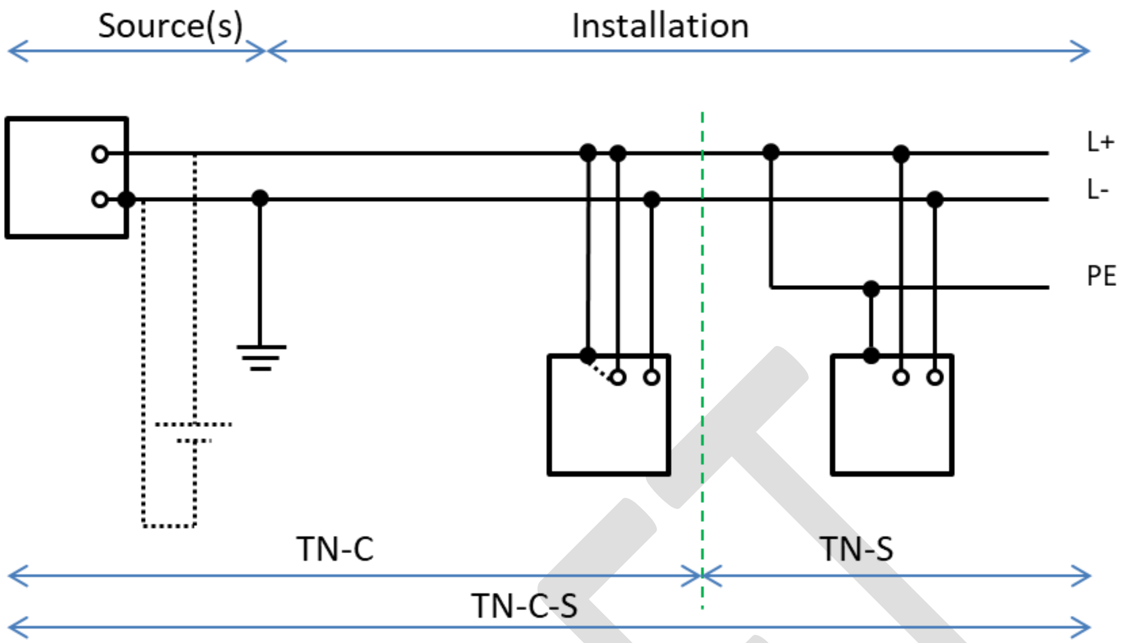


Figure F-7: TN-C-S System with Functional Earth, Line L+ Conductor Combined at Source and Separate Protective Earth

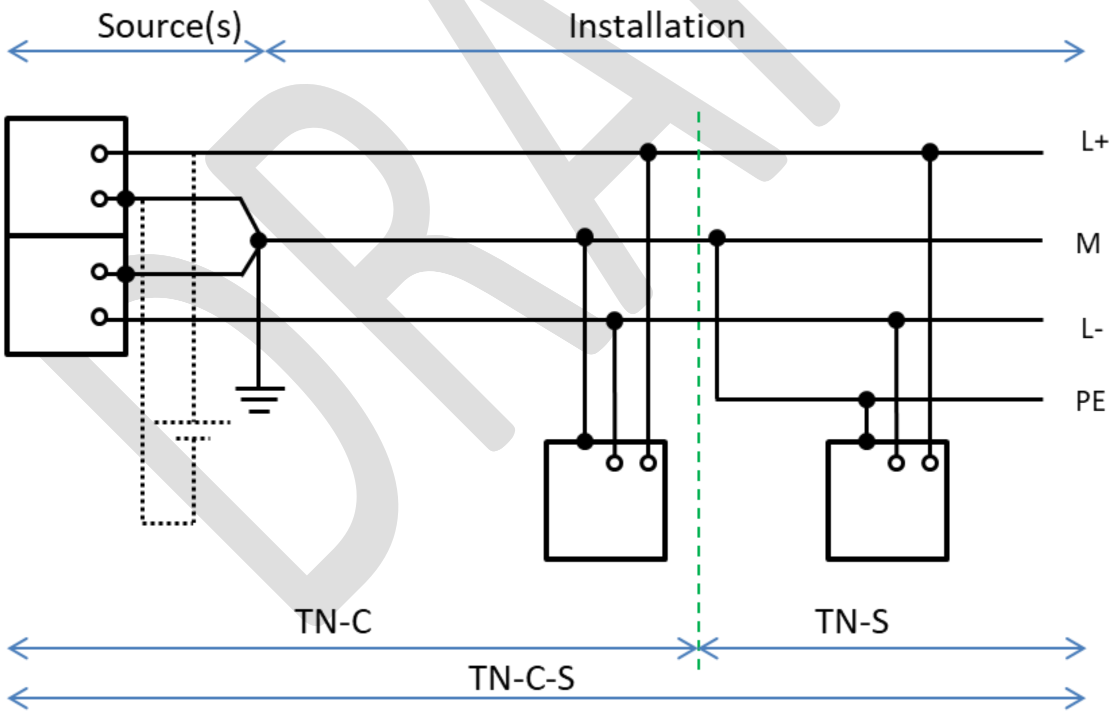


Figure F-8: TN-C-S DC System Earthed Midpoint Conductor M and Protective Conductor Combined in One Single Conductor PE in a Part of the Installation

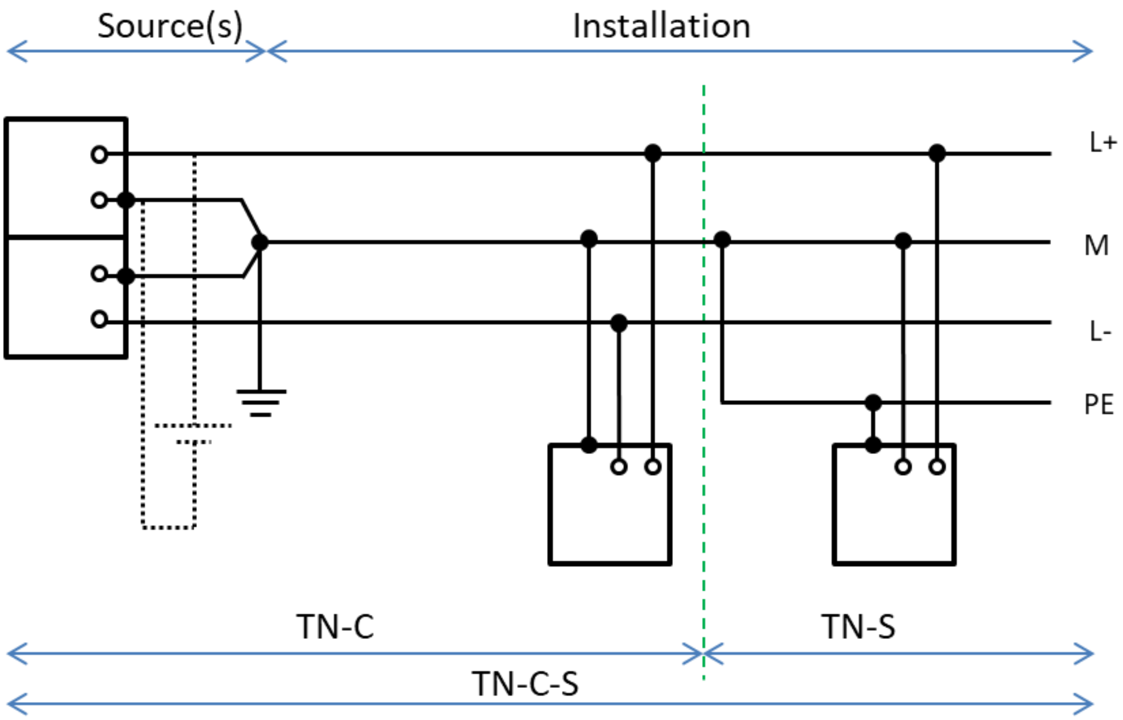


Figure F-9: TN-C-S DC System Earthed Midpoint Conductor M and Protective Conductor Combined in One Single Conductor PE in a Part of the Installation (Some loads connected between midpoint and L+ or L-)

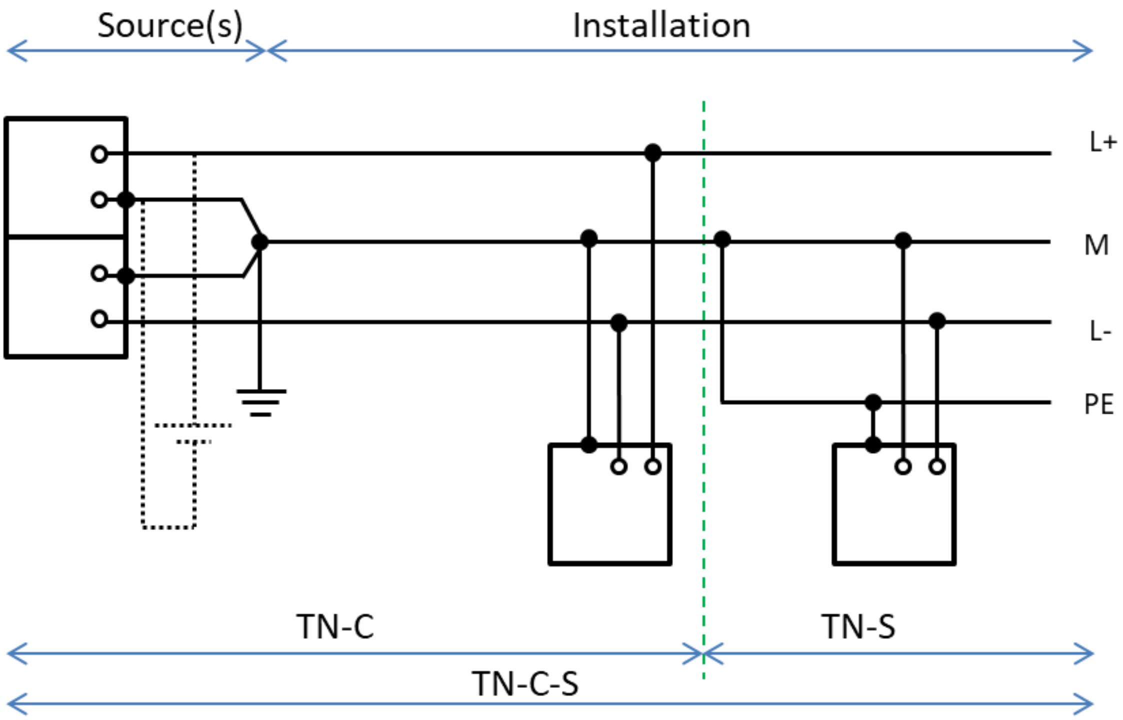


Figure F-10: TN-C-S DC System Earthed Midpoint Conductor M and Protective Conductor Combined in One Single Conductor PE in a Part of the Installation (Some loads connected between midpoint and L+ or L-)

TT

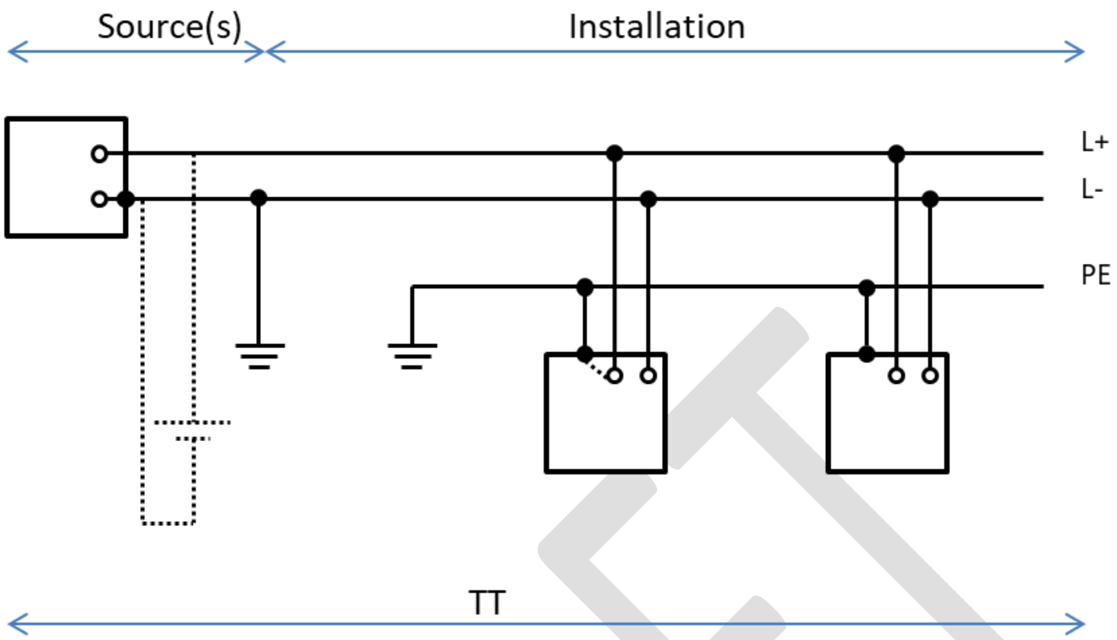


Figure F-11: TT DC System Line L- Conductor Earthed at Source, Separate Protective Conductor Earthed at Installation (PE)

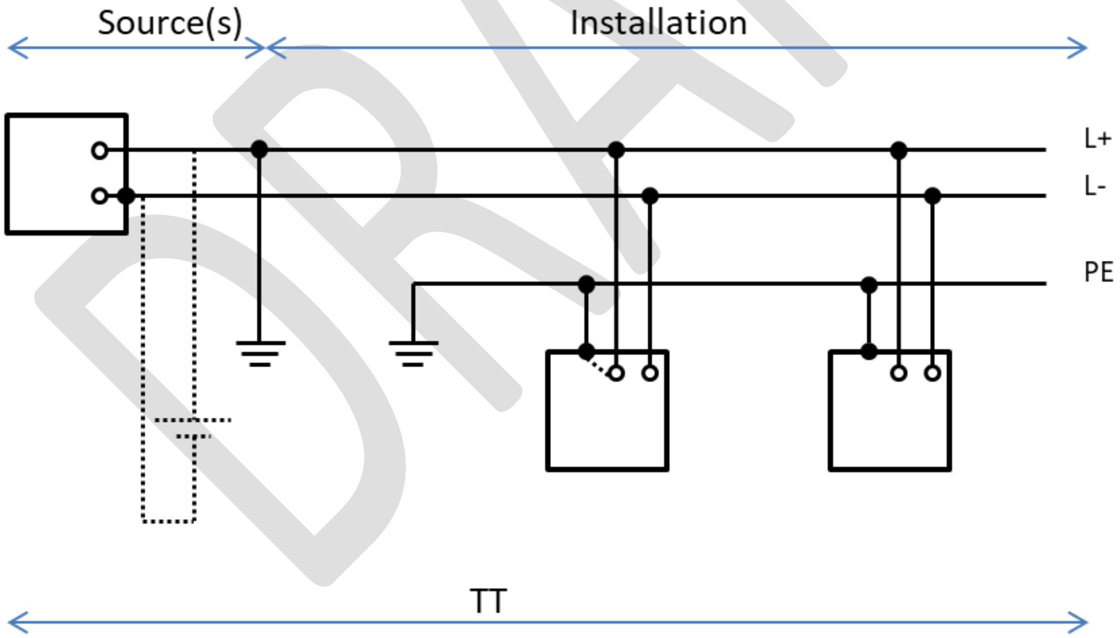


Figure F-12: TT DC System Line L+ Conductor Earthed at Source, Separate Protective Conductor Earthed at Installation (PE)

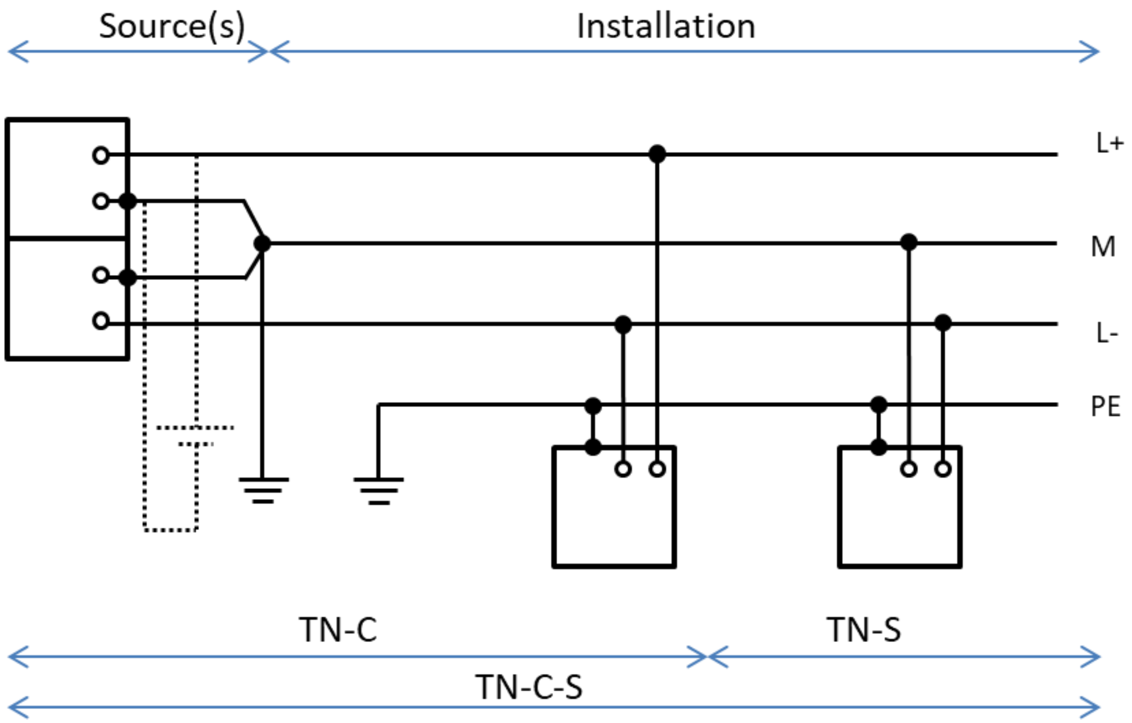


Figure F-13: TT DC System Midpoint Conductor M earthed at Source, Separate Protective Conductor Earthed at Installation (PE)

IT

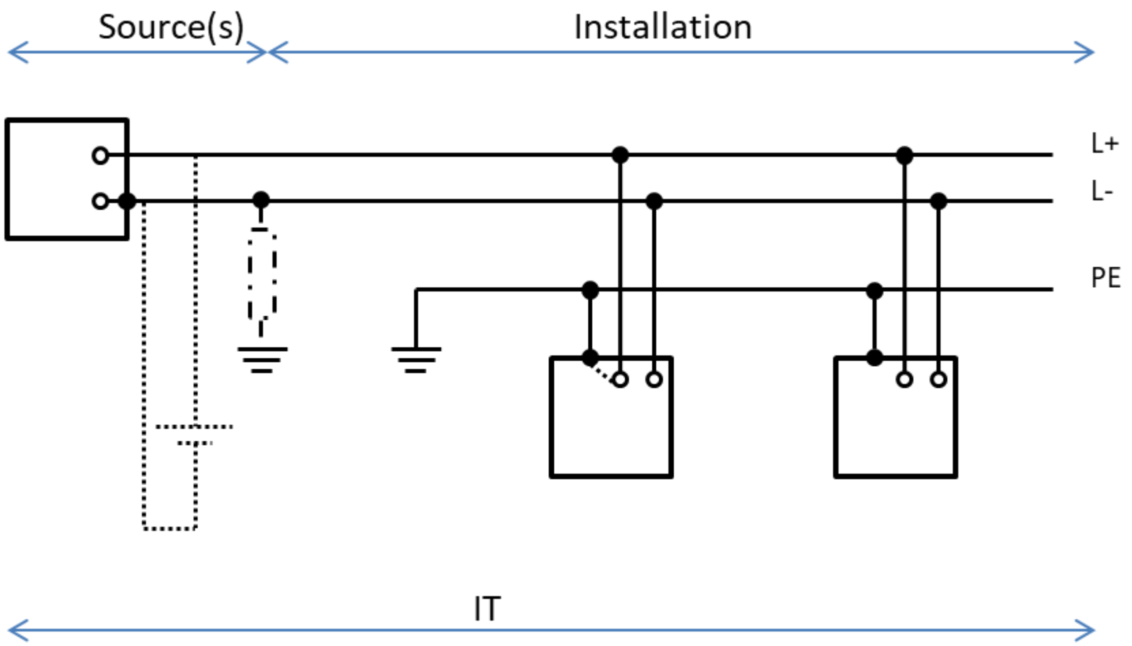


Figure F-14: IT DC System Line L- Conductor Earthed via High Impedance at Source, Separate Protective Conductor Earthed at Installation (PE)

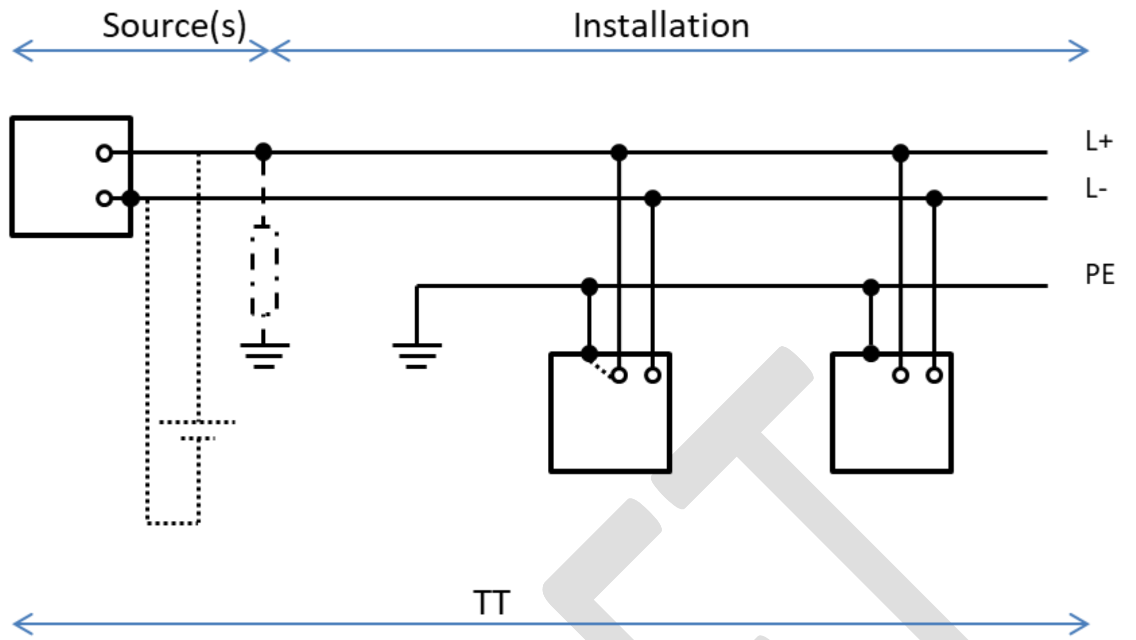


Figure F-15: IT DC System Line L+ Conductor Earthed via High Impedance at Source, Separate Protective Conductor Earthed at Installation (PE)

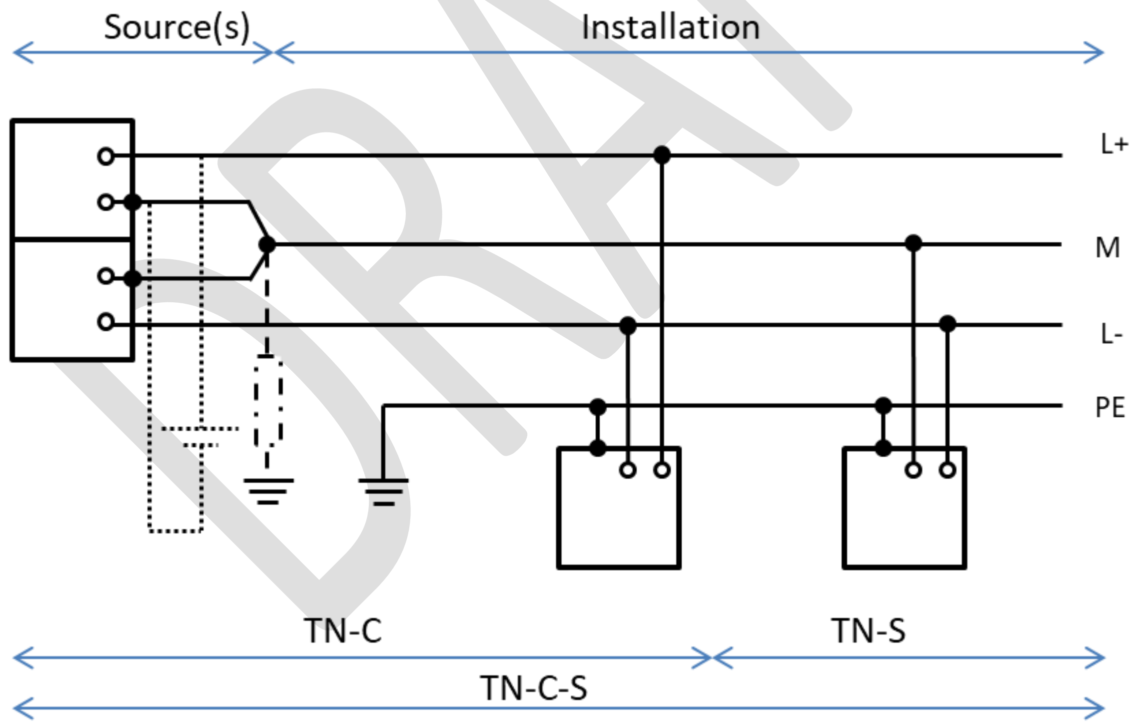


Figure F-16: IT DC System Midpoint Conductor M Earthed via High Impedance at Source, Separate Protective Conductor Earthed at Installation (PE)

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

Annexure G: Notification of Dangerous Situations

(Informative)

This section to be expanded upon in a following edition.

Annexure H: Interface Point Requirements – Additional

(Normative)

The interface points identified below can be arranged in any manner in which it complies with the associated definition.

Every Embedded Generation Installation (EGI) shall have a single line diagram depicting, as a minimum, all interface points listed below.

Point of Utility Supply

In the electrical system, the Point of Utility Supply designates the point of ownership and responsibility between the Customer and the Utility.

Disconnection Device

Typically, the Disconnection Device(s) associated with the Point of Utility Supply is the responsibility of the Utility. In the case where it is agreed between the Owner and the Utility that the Disconnection Device(s) are the responsibility of the Owner, the disconnection device(s) shall conform to the Utility's requirements.

In the case where reverse energy flow is anticipated, the Disconnection Device selected shall be capable of normal operation in either current direction.

In the absence of specific Utility requirements, the Disconnection Device(s) shall conform to the requirements set out in Section 5.3.2: Disconnection Devices – AC.

This Disconnection Device shall be lockable and accessible to the Utility, which is typically located outside of the Owner's property.

Responsibility for Electrical Installations

Refer to the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), Electrical Installation Regulations – Responsibility for Electrical Installations.

Labelling

The Point of Utility Supply is to be labelled as stipulated in Section 5.3.1, Notices, Labels and Rating Plates.

Point of Control

The Point of Control serves as the main isolation point between the Utility's Network and the Customer Distribution Network.

This point is Consumer-controlled.

Labelling

The Point of Control is to be labelled as required in Section 5.3.1, Notices, Labels and Rating Plates of this standard.

Point of Source Isolation

The Point of Source Isolation may be at the same point as the Point of Control, the Point of Source Separation or the Point of Generator Connection. If the Point of Source Isolation is combined with any of these point(s), the requirements of the combined points shall apply.

Therefore, the location of the Point of Source Isolation can physically be at any location, but must always electrically be between the Point of Utility Supply and the Point of Generator Connection.

See Section 5.3.7, Protection and Control – AC for detailed requirements.

Disconnection Device

The Disconnection Device associated with the Point of Isolation shall have an isolating function as described in SANS 60947-1: Low-Voltage Switchgear and Control Gear – General Rules.

In the case where reverse energy flow is possible, the Disconnection Device selected shall be capable of normal operation in either current direction.

This Disconnection Device shall be lockable and accessible to the Utility, which is typically located outside of the Owner's property.

The Disconnection Device(s) shall conform to the requirements of Section 5.3.2, Disconnection Devices – AC.

Labelling

The Point of Source Isolation is to be labelled as required in Section 5.3.1, Notices, Labels and Rating Plates.

Point of Source Separation

The Point of Source Separation may be at the same point as the Point of Control, the Point of Source Isolation or the Point of Generator Connection. If the Point of Source Separation is combined with any of these point(s), the requirements of the combined points shall apply.

Therefore, the location of the Point of Source Separation can physically be at any location, but must always electrically be between the Point of Utility Supply and the Point of Generator Connection.

The portion disconnected from the Utility-connected supply may include Customer loads within his / her Network.

Protection and Control

A Disconnection Device or Switch-Disconnection Device associated with the Point of Source Separation shall disconnect the EGI from the Utility.

The Network and system grid protection device(s), e.g., a relay, for the Point of Source Separation Disconnection Device shall be type-tested and certified on its own.

See Section 5.3.7: Protection and Control – AC for detailed requirements.

Labelling

The Point of Source Separation is to be labelled as required in Section 5.3.1, Notices, Labels and Rating Plates.

Point of Generator Connection (PGC)

The Point of Generator Connection (PGC) serves as the point across which a generator is synchronised to the Utility and / or other generators, or where an islanded bus is powered. The PGC serves as the point where the embedded generator(s) disconnect from the rest of the electrical Network.

The PGC cannot be installed downstream to an earth leakage device.

By definition, a PGC is regarded as a Point of Supply.

Disconnection Device

Each individual embedded generator shall have its own dedicated Disconnection Device associated with its PGC.

The PGC Disconnection Device shall not be of a standard load plug-type installation.

The PGC Disconnection Device(s) shall conform to the requirements of Section 5.3.2: Disconnection Devices – AC.

Protection and Control

See Section 5.3.7, Protection and Control – AC for detailed requirements.

Labelling

The PGC is to be labelled as required in Section 5.3.1, Notices, Labels and Rating Plates.

Annexure I: Example General Circuit Arrangements

(Informative)

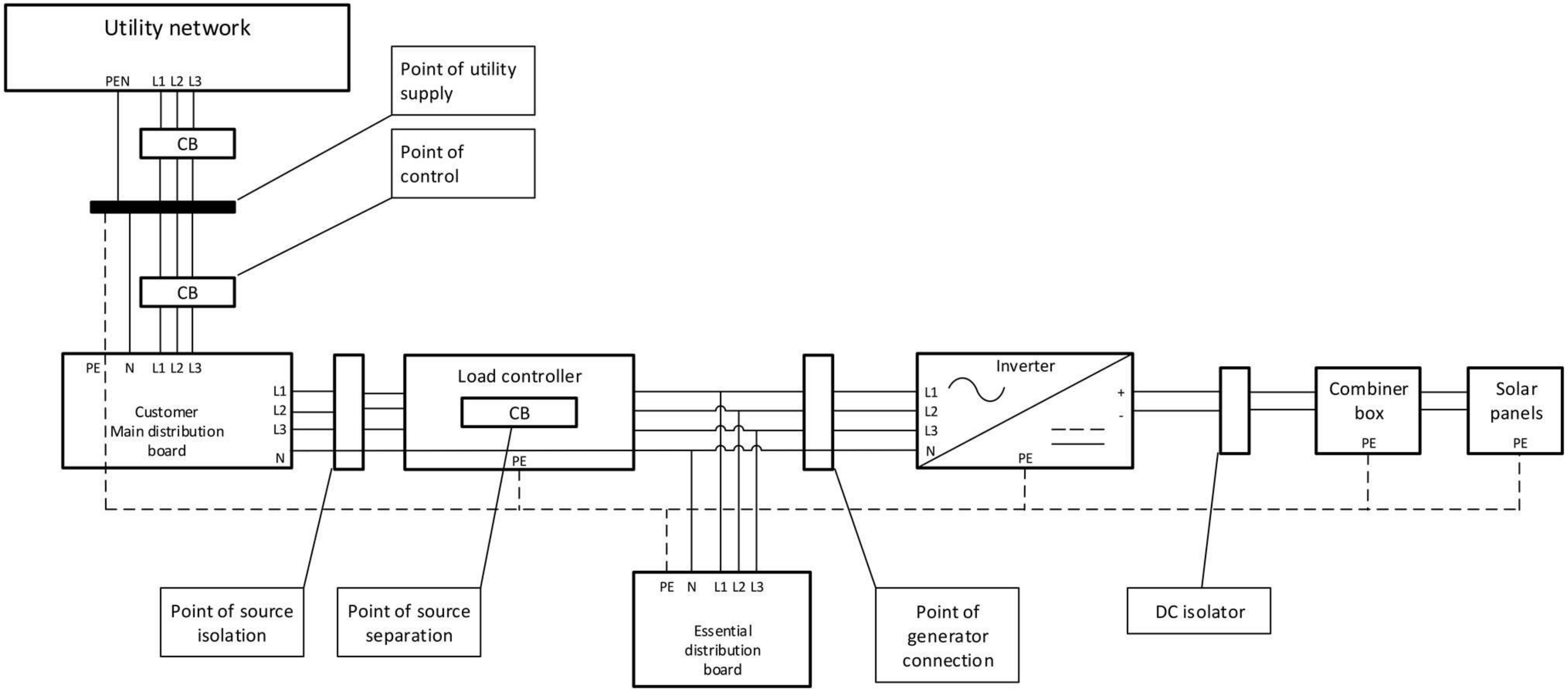
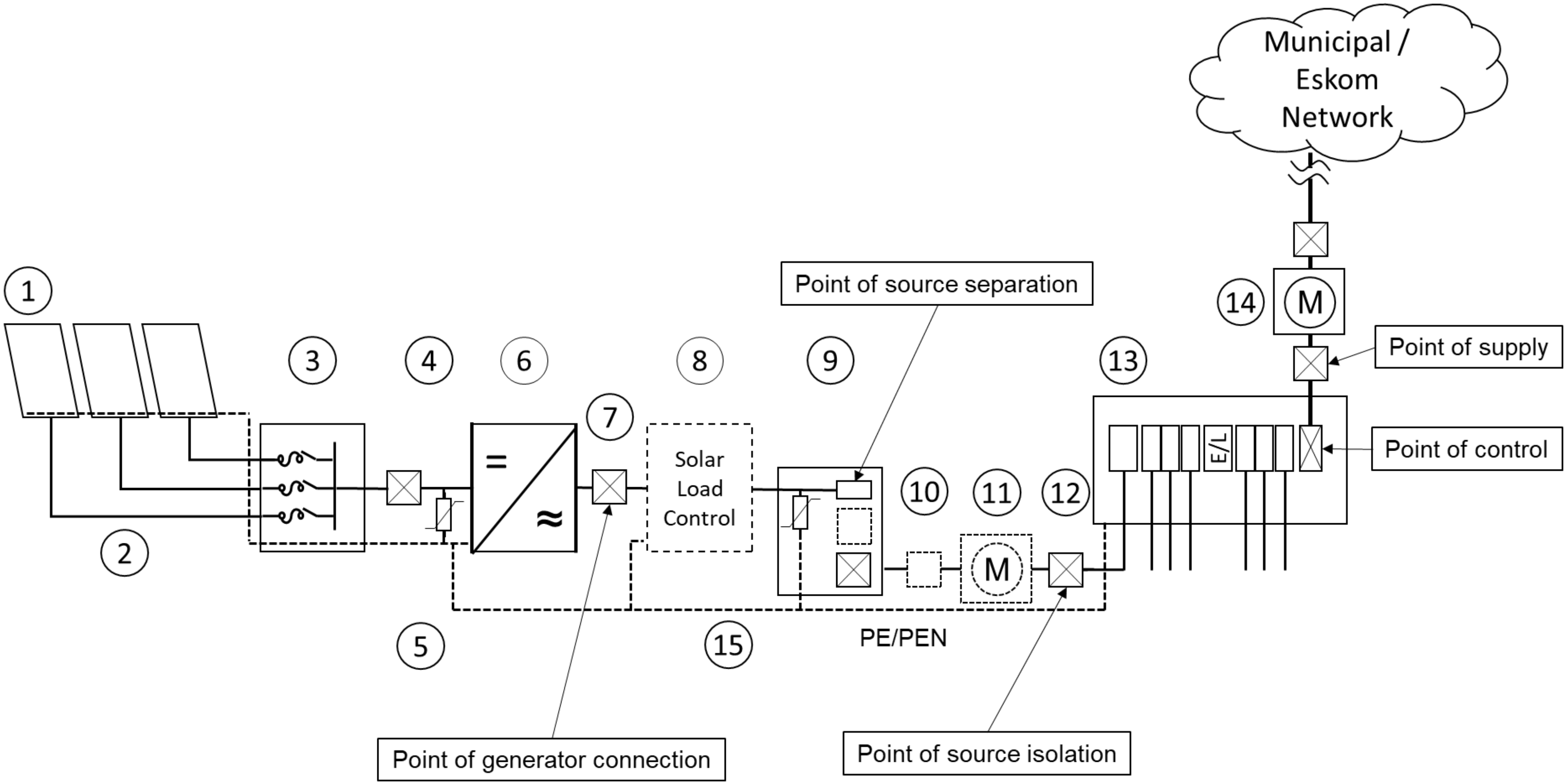


Figure I-1: General Circuit Arrangement Example – Solar PV Installation – Version A


Municipal / Eskom Network
1
2
3
4
5
6
7
8
Solar Load Control
9
10
11
12
13
14
15
M
E/L
Point of source separation
Point of supply
Point of control
PE/PEN
Point of generator connection
Point of source isolation

Key	
Item	**Description**
1	PV Modules
2	DC Strings
3	DC Combiner Box
4	DC Isolator
5	Surge Protection
6	Inverter
7	AC Isolator / Protection
8	Optional: Solar Load Controller
9	Generation Distribution Board
10	RCD Type B (If not galvanically-isolated)
11	Optional SSEG Meter
12	Utility Safety Switch (If required, e.g., Dead Grid Safety Lock)
13	Main Distribution Board
14	Utility Service Box with Main Meter
15	Earthing and Bonding

Figure I-2: General Circuit Arrangement Example – Solar PV Installation – Version B

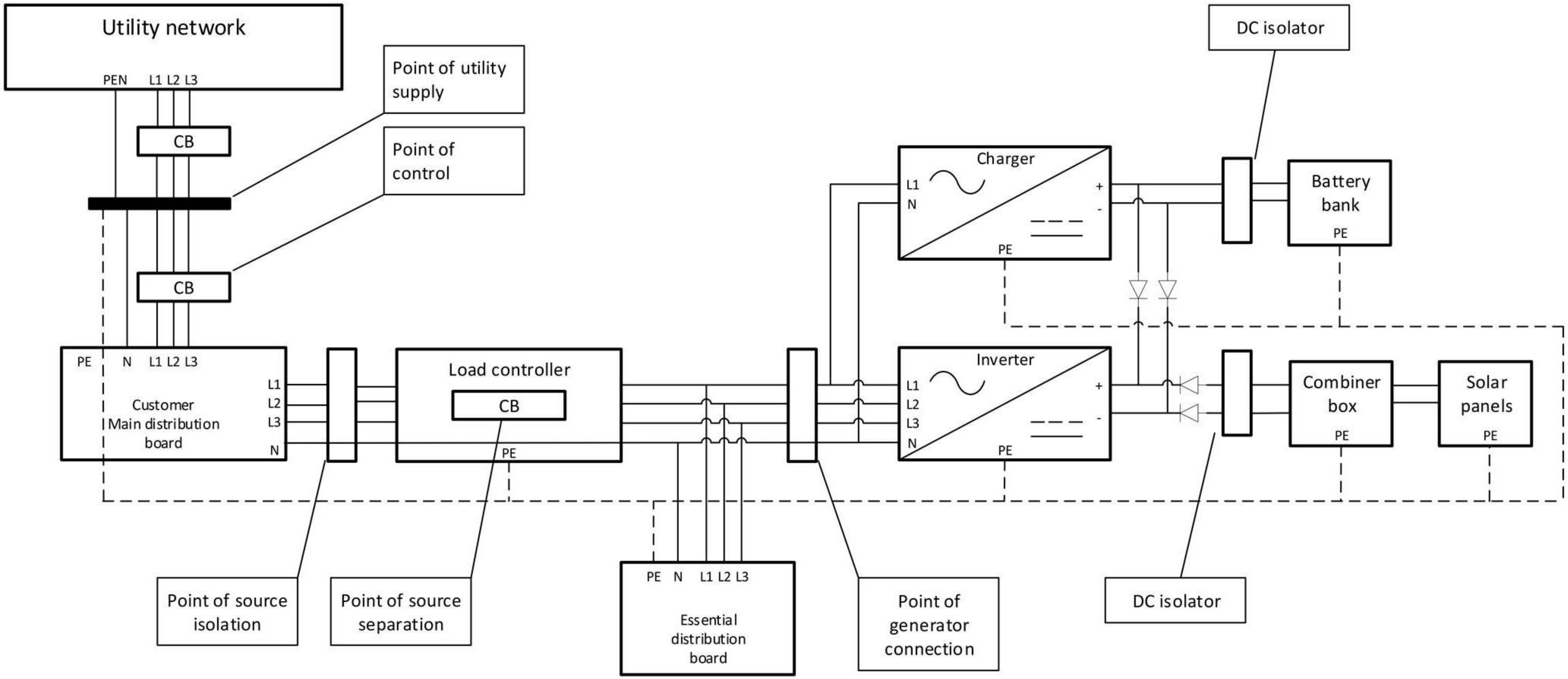


Figure I-3: General Circuit Arrangement Example – Solar PV Installation with Batteries

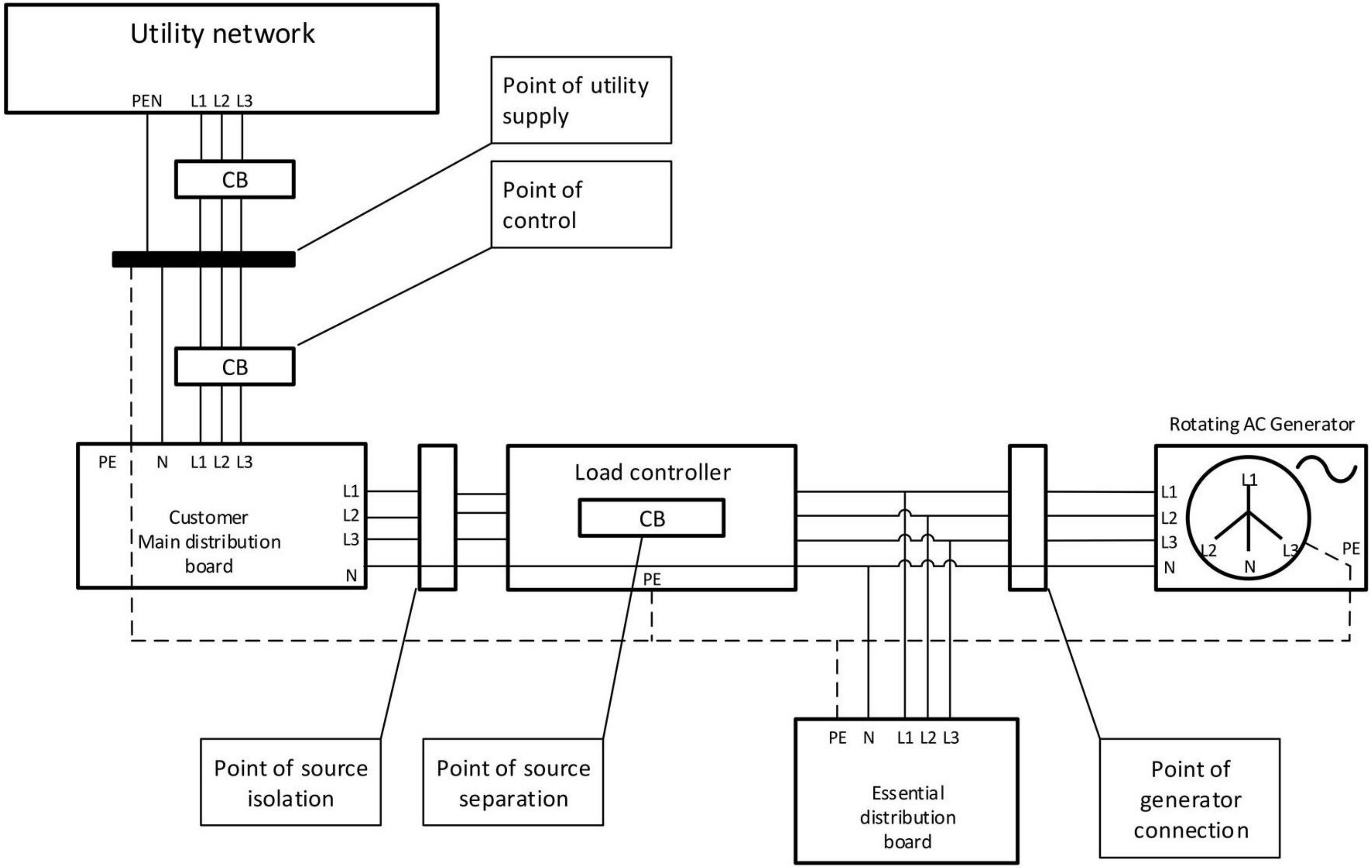


Figure I-4: General Circuit Arrangement Example – Rotating Machines