

AS/NZS 4777.1:2024



Australian/New Zealand Standard™

Grid connection of energy systems via inverters

Part 1: Installation requirements



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AS/NZS 4777.1:2024

This Joint Australian/New Zealand Standard™ was prepared by Joint Technical Committee EL-042, Renewable Energy Power Supply Systems & Equipment. It was approved on behalf of Standards Australia's Standards Development and Accreditation Committee on 03 August 2024 and by the New Zealand Standards Approval Board on 07 August 2024.

This Standard was published on 23 August 2024.

The following are represented on Committee EL-042:

Australasian Fire and Emergency Service Authorities Council
Australian Energy Council
Australian Energy Market Operator
Australian Industry Group
Australian PV Institute
Better Regulation Division (Fair Trading, SafeWork NSW, TestSafe)
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This Standard was issued in draft form for comment as DR AS/NZS 4777.1:2023.

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ISBN 978 1 76139 767 7

Australian/New Zealand Standard™

Grid connection of energy systems via inverters

Part 1: Installation requirements

Originated as AS 4777.1—2002.
Second edition 2005.
Jointly revised and designated as AS/NZS 4777.1:2016.
Fourth edition 2024.

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Preface

This document was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-042, Renewable Energy Power Supply Systems and Equipment, and is based on requirements developed by a group of utility, photovoltaic, renewable energy, battery, inverter and industry experts.

AS/NZS 4777.1:2016 will also remain current for six months after the date of publication of this document and after this time it will be superseded by AS/NZS 4777.1:2024. Regulatory authorities that reference this document in regulation may apply these requirements at a different time. Users of this document should consult with these authorities to confirm their requirements.

The objective of the document is to specify safety and installation requirements for inverter energy systems (IES) intended to supply electric power to an electrical installation that is connected to the grid. IES are distributed energy resources when connecting to the grid. The interaction of IES and the broader grid system, safety and security has been incorporated in the development of this document.

This document is part of a series, which consists of the following:

- (a) AS/NZS 4777.1, *Grid connection of energy systems via inverters, Part 1: Installation requirements* (this document).
- (b) AS/NZS 4777.2, *Grid connection of energy systems via inverters, Part 2: Inverter requirements*.

This document is required to be read in accordance with the documents listed in [Clause 1.2](#).

To improve alignment and understanding of requirements for connection of IES to an electrical installation, the terminology used in AS/NZS 3000 for supply types has been utilized throughout this document. Previously the grid-interactive port of an inverter (as specified in AS/NZS 4777.2) was not referred to as a supply, in this document this port is now referred to as a supplementary supply port.

As a result of ongoing innovation of multiple mode IES, new terms, independent supply and substitute supply have been introduced and defined, along with a section on multiple mode IES installation requirements. With the emergence of electric vehicles (EV) capable of bidirectional charging, this document now also covers EV Supply Equipment capable of reverse power transfer.

[Section 5](#) has also been modified from previous version and is dedicated to multiple mode IES installation. Previous content not relating to multiple mode IES in Section 5 of AS/NZS 4777.1:2016 has been moved into either [Section 2](#) or [Section 3](#).

The use of the term alternative supply is also used in [Section 5](#) for IES that can maintain the functioning of an electrical installation in case of the interruption of the grid supply. AS/NZS 3010 only specifies requirements for engine driven generator sets, this document covers all inverter types providing an alternative supply not covered by AS/NZS 3010. This document caters for use of inverters that are a portable IES and do not conform with AS/NZS 4777.2 that may be connected to an electrical installation via an inlet plug as an alternative supply.

This document has also been revised to remove duplication of requirements for energy sources that have a dedicated installation standard (e.g. Photovoltaic array and Battery Energy Storage Systems). This document specifies requirements for energy sources where relevant standards may not be available. Until installation, wiring and safety concepts have been developed to cover these other energy source technologies, this document provides a limited range of provisions.

Statements expressed in mandatory terms in notes to figures are deemed to be requirements of this document.

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

Contents

Preface	ii
Section 1 Scope and general	1
1.1 Scope and application	1
1.1.1 Scope	1
1.1.2 Application	1
1.2 Normative references	1
1.3 Terms and definitions	2
Section 2 General requirements	8
2.1 General	8
2.2 Typical configurations	8
2.3 Installation and selection requirements for inverter energy systems (IES)	10
2.3.1 General	10
2.3.2 Balance	10
2.4 Installation requirements	10
2.4.1 Inverter installation	10
2.4.2 Equipment weatherproofing	11
2.4.3 Seismic protection (NZ only)	11
Section 3 Connection of the IES to the electrical installation	12
3.1 General	12
3.2 Connections	12
3.2.1 General	12
3.2.2 Connection to electrical installation	12
3.2.3 Connector or coupling connections to the inverters	13
3.3 Selection and installation of wiring systems	14
3.3.1 General	14
3.3.2 Installation method	14
3.3.3 Voltage rise	14
3.4 Control and protection	15
3.4.1 General	15
3.4.2 Overcurrent protection	15
3.4.3 Isolation switches	15
3.4.4 Residual current devices (RCDs)	16
3.4.5 Interface protection for IES	17
3.4.6 Demand response mode (DRM)	20
3.4.7 IES operational settings	21
3.4.8 Generation control of an IES	21
3.5 Multiple inverter and IES installations	23
3.5.1 General	23
3.5.2 Grouped inverters with capacity no more than 5 kVA per phase (isolation requirements)	25
3.5.3 Inverters on the same switchboard	26
3.6 Inverter power sharing device	26
3.6.1 General	26
3.6.2 Selection of IPSD	27
3.6.3 Installation of IPSD	27
3.6.4 Selection and installation of wiring systems	29
3.6.5 Control and protection	29
Section 4 Connection of energy source to an inverter	31
4.1 Energy sources with applicable installation standards	31
4.2 Electric Vehicle and electric vehicle supply equipment	31
4.3 Energy sources without applicable installation standards	31
4.3.1 General	31
4.3.2 d.c. maximum voltage limits	31

4.3.3	Connectors or coupling connections	31
4.3.4	Wiring systems	32
4.3.5	Overcurrent protection	33
4.3.6	Isolation devices	33
4.3.7	Earth fault detection, protection and alarm	34
Section 5	Multiple mode IES installation	35
5.1	General	35
5.2	Substitute Supply installations	35
5.2.1	General	35
5.2.2	Connection by fixed installation wiring	35
5.3	Alternative supply IES installations	36
5.3.1	General	36
5.3.2	Connection to the installation	36
5.3.3	Multiple mode inverter local Isolator	40
5.3.4	Multiple mode inverter supply cable rating	40
5.3.5	Overcurrent protection for the alternative supply	41
5.3.6	Alternative supply switchboard	41
5.4	Independent supply IES installations	42
5.4.1	General	42
5.4.2	Connection to the installation	43
5.4.3	Independent supply inverter local isolator	44
5.4.4	Independent supply cable	44
5.4.5	Overcurrent protection for the independent supply	44
5.4.6	Independent supply switchboard	45
5.5	Electric Vehicles as energy source installations	46
5.6	Engine driven generating set connection to multiple mode inverter	46
5.7	Connection of portable IES	46
5.7.1	General	46
5.7.2	Connection to installation	47
5.7.3	Inlet plug overcurrent protection	48
5.7.4	Alternative supply cable	48
5.7.5	Alternative supply switchboard	48
Section 6	Signs and labels	50
6.1	General	50
6.2	Signs for emergency shutdown procedure	50
6.3	Signs for the switchboard to which the IES is directly connected	51
6.4	Signs for other switchboards	51
6.5	Signs for inverter locations	52
6.6	Signs located adjacent to inverter(s)	52
6.7	Signs for multiple systems	52
6.8	Signs for multiple mode inverters	52
6.9	Signs for inverters with substitute supply function	52
6.10	Signs for portable IES inlet plug	52
6.11	Energy source labelling	52
6.11.1	Energy sources with applicable installation standards	52
6.11.2	Energy source labelling for electric vehicles and electric vehicle supply equipment	53
6.11.3	Energy sources without applicable installation standards	53
6.12	Additional signs for IPSD	53
6.12.1	Signs for IPSD system layout	53
6.12.2	Signs for IPSD current sensing devices	53
Section 7	System documentation and commissioning	54
7.1	General	54
7.2	Manual	54
Section 8	Verification	56
8.1	General	56

8.2	Visual inspection.....	56
8.3	Testing.....	56
8.3.1	General.....	56
8.3.2	Additional testing substitute supply.....	56
8.3.3	Additional testing alternative supply.....	57
8.3.4	Additional testing independent supply.....	59
8.3.5	Additional testing portable IES.....	61
8.4	Commissioning.....	61
8.4.1	General.....	61
8.4.2	IPSD commissioning.....	61
Appendix A (informative) Example signs.....		63
Appendix B (informative) Voltage rise calculation.....		69
Appendix C (normative) Phase balance.....		82
Appendix D (informative) Information on electricity distributor requirements.....		84
Bibliography.....		86

NOTES

Australian/New Zealand Standard

Grid connection of energy systems via inverters

Part 1: Installation requirements

Section 1 Scope and general

1.1 Scope and application

1.1.1 Scope

This document specifies the electrical and general safety installation requirements for inverter energy systems (IES) that supply electric power at low voltage to an electrical installation connected to the grid.

This document applies to the installation of Electrical Vehicle (EV) Supply Equipment for connection of electric vehicles that supply electric power at low voltage to an electrical installation connected to the grid.

This document also applies to the installation of inverters capable of operating in an alternative supply mode or independent supply mode at low voltage whether or not they are capable of supplying power to an electrical installation while connected to the grid.

This document is for low voltage systems with nominal values of 230 V/400 V that conform with AS IEC 60038 for Australia or IEC 60038 for New Zealand. This document may be used for low voltage installation of systems that may be connected to the grid at high voltage.

This document does not apply to inverter energy systems connected to dedicated high voltage systems with no local low voltage load.

This document does not apply to installation requirements for uninterruptible power supplies (UPS) that conform with AS 62040.1, AS IEC 62040.2 and AS IEC 62040.3.

1.1.2 Application

This document shall be used in conjunction with AS/NZS 3000. The particular requirements of this document are additional to, replace, or modify the general requirements of AS/NZS 3000.

Connection and technical requirements of the relevant electricity legislation, electricity distributor, and appropriate system operator may apply in relation to the requirements of this document.

NOTE 1 See [Appendix D](#) for further information on electricity distributor requirements.

NOTE 2 In some locations, there can be further limitations due to the characteristics of the electricity distributor's grid at the point of supply from the grid.

1.2 Normative references

The following are the normative documents referenced in this document:

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

AS/NZS 3008.1.1, *Electrical installations — Selection of cables, Part 1.1: Cables for alternating voltages up to and including 0.6/1 kV — Typical Australian installation conditions*

AS/NZS 3008.1.2, *Electrical installations — Selection of cables, Part 1.2: Cables for alternating voltages up to and including 0.6/1 kV — Typical New Zealand conditions*

AS/NZS 3112, *Approval and test specification — Plugs and socket-outlets*

AS/NZS 4755.1, *Demand response capabilities and supporting technologies for electrical products, Part 1: Demand Response Framework and requirements for Demand Response Enabling Devices (DREDs)*

AS/NZS 4777.2, *Grid connection of energy systems via inverters, Part 2: Inverter requirements*

AS/NZS 5033, *Installation and safety requirements for photovoltaic (PV) arrays*

AS/NZS 5139, *Electrical installations — Safety of battery systems for use with power conversion equipment*

AS/NZS 60320.1, *Appliance couplers for household and similar general purposes, Part 1: General requirements (IEC 60320 1, Ed. 2.1 (2007) MOD)*

AS/NZS 61008.1, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs), Part 1: General rules (IEC 61008-1, Ed. 3.2 (2013) MOD)*

AS/NZS 61009.1, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs), Part 1: General rules (IEC 61009-1, Ed. 3.2 (2013) MOD)*

AS IEC 60038, *Standard voltages*

AS/NZS IEC 60947-6.1, *Low-voltage switchgear and controlgear, Part 6.1: Multiple function equipment — Transfer switching equipment*

NZS 4219, *Seismic performance of engineering systems in buildings*

IEC 60038, *IEC standard voltages*

IEC 60309-1, *Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes — Part 1: General Requirements*

IEC 60947-6-1, *Low-voltage switchgear and control gear — Part 6-1: Multiple function equipment — Transfer switching equipment*

IEC 60255-1, *Measuring relays and protection equipment — Part 1: Common requirements*

IEC 60255-26, *Measuring relays and protection equipment — Part 26: Electromagnetic compatibility requirements*

IEC 60255-27, *Measuring relays and protection equipment — Part 27: Product safety requirements*

IEC 60255-127, *Measuring relays and protection equipment — Part 127: Functional requirements for over/under voltage protection*

IEC 60255-181, *Measuring relays and protection equipment — Part 181: Functional requirements for frequency protection*

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

IEC 62477-1, *Safety requirements for power electronic converter systems and equipment — Part 1: General*

IEC 62955, *Residual direct current detecting device (RDC-DD) to be used for mode 3 charging of electric vehicles*

ISO 17409, *Electrically propelled road vehicles — Conductive power transfer — Safety requirements*

1.3 Terms and definitions

For the purposes of this document, the terms and definitions in AS/NZS 3000, AS/NZS 4777.2 and those below apply. Where an additional term is defined in a particular section or clause, the term takes the meaning defined in that section or clause.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

NOTE Some definitions of AS/NZS 4777.2 may have been repeated below for ease of access to the definition.

1.3.1

demand response

automated alteration of an electrical product's normal mode of operation in response to an initiating signal originating from or defined by a remote agent

1.3.2

demand response enabling device

DRED

device applying demand response signals to the inverter as documented in AS/NZS 4755.1

1.3.3

energy source

voltage or current source requiring conversion from one kind of electrical power to another kind suitable for connection to the electrical installation

Note 1 to entry: Examples include battery energy storage, fuel cell, hydro turbine, photovoltaic, or wind turbine.

1.3.4

export limit

limit on the export of electricity towards the grid from an inverter energy system

1.3.5

export limit control

function to limit the active power from IES or multiple IES that can flow from an electrical installation towards the grid

1.3.6

generation control functions

inverter or IES response mode that can operate to meet an active power export limit and/or an active power generation limit

1.3.7

generation limit control

function to limit the active power that can flow from an IES or combination of IES towards the rest of an electrical installation while meeting the requirements of AS/NZS 4777.2

1.3.8

grid

portion of the electrical distribution system that is operated by an electricity distributor

1.3.9

independent external generation control device

device that has not been tested in combination with an inverter for conformance to AS/NZS 4777.2 generation control functions

1.3.10

independent supply inverter

type of inverter that provides an independent supply and does not provide a supplementary supply to a grid supply, and includes an a.c. port for connection to an a.c. supply source such as the grid

1.3.11**inlet plug**

refer to AS/NZS 3120 for definition

Note 1 to entry: Inlet plugs were previously specified as appliance inlets.

1.3.12**interface protection**

combination of protection relay functions that opens the disconnection device of the inverter energy system (IES) and prevents its closure, whichever is appropriate, in the case of:

- (a) a fault on the grid;
- (b) an unintentional islanding situation; or
- (c) voltage and frequency being outside the continuous operating range

1.3.13**inverter**

device that uses semiconductor devices to transfer power between a d.c. source(s) or load and an a.c. source(s) or load

Note 1 to entry: For the purposes of this document, a.c. to a.c. converters that use semiconductor devices to transfer power between non-grid energy sources and an a.c. source or load are considered to be inverters.

1.3.14**inverter energy system****IES**

system comprising one or more inverters together with one or more energy sources (which may include batteries or EVs for energy storage) and controlled up to the single main switch for that system. It also may include additional equipment used for monitoring and control. Multiple IES installations can exist within a single electrical installation

1.3.15**inverter power sharing device****IPSD**

device used to share the supplementary supply from an inverter or multiple inverters to provide supplementary supplies to a number of electrical installations that are part of a multiple electrical installation

1.3.16**islanding**

situation where the electricity supply from a grid is disrupted or fails and one or more inverters or generators maintains any form of electricity supply, be it stable or not, to any section of that grid or within the electrical installation

Note 1 to entry: Prevention of the injection of energy and prevention of an unintentional island with the grid or part thereof when supply is disrupted is key to maintaining safety on the grid and within electrical installations.

1.3.17**mode 3**

method for the connection of an EV to an a.c. EV supply equipment permanently connected to an a.c. supply network, with a control pilot function that extends from the a.c. EV supply equipment to the EV

[SOURCE: IEC 61851-1:2017 Clause 6.2.3]

1.3.18**mode 4**

method for the connection of an EV to an a.c. or d.c. supply network utilizing a d.c. EV supply equipment, with a control pilot function that extends from the d.c. EV supply equipment to the EV

[SOURCE: IEC 61851-1:2017 Clause 6.2.4]

1.3.19 multiple-phase

systems either connected to all phases and neutral (i.e. star connected) or connected between phases (i.e. delta connected)

Note 1 to entry: Multiple-phase includes two-phase, split-phase (also known as single-phase, three-wire) and three-phase. For IES connected to a multiple-phase point of supply from the grid, the nominal voltage for two-phase and three-phase connections to four-wire systems is 400 Vac phase-to-phase (120°). For three-wire split-phase systems the nominal voltage is 460 Vac phase-to-phase (180°).

1.3.20 multiple mode inverter MMI

inverter that operates in more than one mode, for example, having grid-interactive functionality when grid voltage is present, and alternative supply mode when the grid is de-energized or disconnected

[SOURCE: IEC 62109-2:2011, Clause 3.107 (modified)]

Note 1 to entry: Inverters with battery storage ports are considered multiple mode inverters.

1.3.21 pluggable equipment type B

equipment that is intended for connection to the installation wiring via an industrial plug and socket-outlet or an appliance coupler, or both, conforming with IEC 60309-1

[SOURCE: IEC 62109-1:2010, 3.58 with Note 1, 2 to entry added]

Note 1 to entry: For the purposes of this document, appliance couplers and connectors within the scope of IEC 60320 or AS/NZS 60320.1 are not equivalent connectors to IEC 60309-1.

Note 2 to entry: PV circuits that use connectors are examples of pluggable type B or fixed equipment.

1.3.22 port

location giving access to a device where electromagnetic energy or signals may be supplied or received or where the device variables may be observed or measured

[SOURCE: IEC 62109-1:2010, Clause 3.64 (modified)]

1.3.23 portable inverter and portable power station

inverters that conform with AS/NZS 4763

1.3.24 rated

value assigned, generally by a manufacturer, to a specified operating condition of an inverter, device or component

[SOURCE: IEC 62109-1:2010, Clause 3.77 (modified)]

1.3.25 rated apparent power

output apparent power of the inverter, which is a product of the rated current and rated voltage

Note 1 to entry: The SI unit is the volt ampere (VA). Typically inverters are rated in kilovolt amperes (kVA).

1.3.26**rated current**

grid-interactive port output current of the inverter or IES that can be supplied continuously for seven hours at the rated voltage when the input power to the inverter or IES does not exceed the maximum input limits

Note 1 to entry: For an individual inverter, the maximum continuous current of IEC 62109-1, which is marked on the inverter, can be considered equivalent to the rated current.

1.3.27**reverse power transfer**

supply of electric power from an EV using the EV plug [case A], the vehicle inlet [case B or case C], or automatic coupler [case D or case E] to an external circuit

[SOURCE: ISO17409:2020, Clause 3.50, modified, with Note 3 to entry added]

Note 1 to entry: Unintended current flow from an EV to an external electric circuit is not considered a reverse power transfer.

Note 2 to entry: Supply of power by using an on-board inverter that is equipped with a socket-outlet is not reverse power transfer.

Note 3 to entry: See AS/NZS 3000 for case A, case B, and case C description for types of connections.

1.3.28**service life of the IES**

expected life of the system or the acceptable period of use in service

1.3.29**shall**

indicates that a statement is mandatory

1.3.30**should**

indicates a recommendation

1.3.31**single-phase**

systems connected to the active of a phase and the neutral

1.3.32**supply, alternative**

refer to AS/NZS 3000 for alternative supply definition

Note 1 to entry: A supply that is only available in the event of an outage of the grid supply may be a type of alternative supply.

1.3.33**supply, independent**

supply system intended to supply the functioning of an electrical installation or part thereof, as an islanded operation instead of the grid supply, whilst the grid supply remains connected to the electrical installation

1.3.34**supply, normal**

refer to AS/NZS 3000 for normal supply definition

Note 1 to entry: the grid supply is a type of normal supply.

1.3.35**supply, substitute**

electrically separated supply system intended to supply a single socket-outlet in the event of an outage of the grid supply where another energy source is available. The supply is limited to the energy source available

1.3.36**supply, supplementary**

refer to AS/NZS 3000 for supplementary supply definition

1.3.37**three-phase**

systems either connected to all phases and neutral (i.e. star connected) or connected between phases (i.e. delta connected)

1.3.38**utilization voltage**

phase-to-phase or phase-to-neutral voltage at the outlets or at the terminals of equipment

1.3.39**voltage imbalance**

condition in which the r.m.s. values of the phase voltages or the phase angles between consecutive phases are not all equal in a polyphase system

[SOURCE: IEC 161-08-09]

Section 2 General requirements

2.1 General

The inverter/s used in an IES that are used to provide a supplementary supply to an electrical installation in conjunction with a grid supply shall conform with the requirements of AS/NZS 4777.2.

Where the inverter is a multiple mode inverter, it may also provide an alternative supply, independent supply, or substitute supply. See [Section 5](#) for additional requirements.

Where an inverter provides an independent supply to the electrical installation and conforms to [Clause 3.4.4](#) and Appendix M of AS/NZS 4777.2:2020, it shall not provide a supplementary supply to an electrical installation in conjunction with a grid supply. See [Section 5](#) for additional requirements.

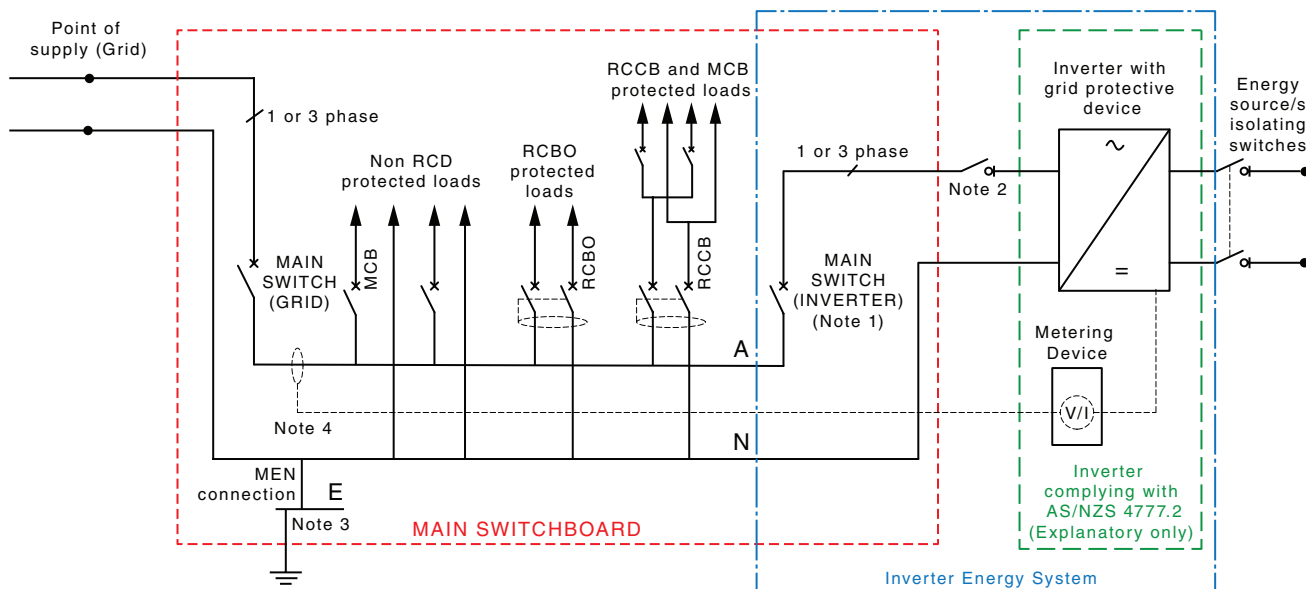
Where an inverter does not provide a supplementary supply and does not conform with [Clause 3.4.4](#) and Appendix M of AS/NZS 4777.2:2020, it may be used to provide an alternative supply to an electrical installation and shall be isolated from the grid. See [Section 5](#) for additional requirements.

NOTE Installers using this document are advised legislation in the relevant state or territory in Australia or in New Zealand will have requirements related to what is electrical work and who can undertake such work for that jurisdiction.

2.2 Typical configurations

Some typical installation configurations providing a supplementary supply are shown in [Figures 2.1](#) and [2.2](#). These typical configurations are shown for guidance only, other configurations may be acceptable.

See [Section 5](#) for typical installation configuration for alternative supply, substitute supply and independent supply.



NOTE 1 For the MAIN SWITCH (INVERTER) and cable protection requirements, see [Clause 3.4](#).

NOTE 2 For isolating switch requirements, see [Clause 3.4.3](#).

NOTE 3 Earth connections other than the main earth conductor and earth electrode are not shown.

NOTE 4 Measurement location for IES metering device.

Figure 2.1 — Typical installation of an inverter energy system to a main switchboard

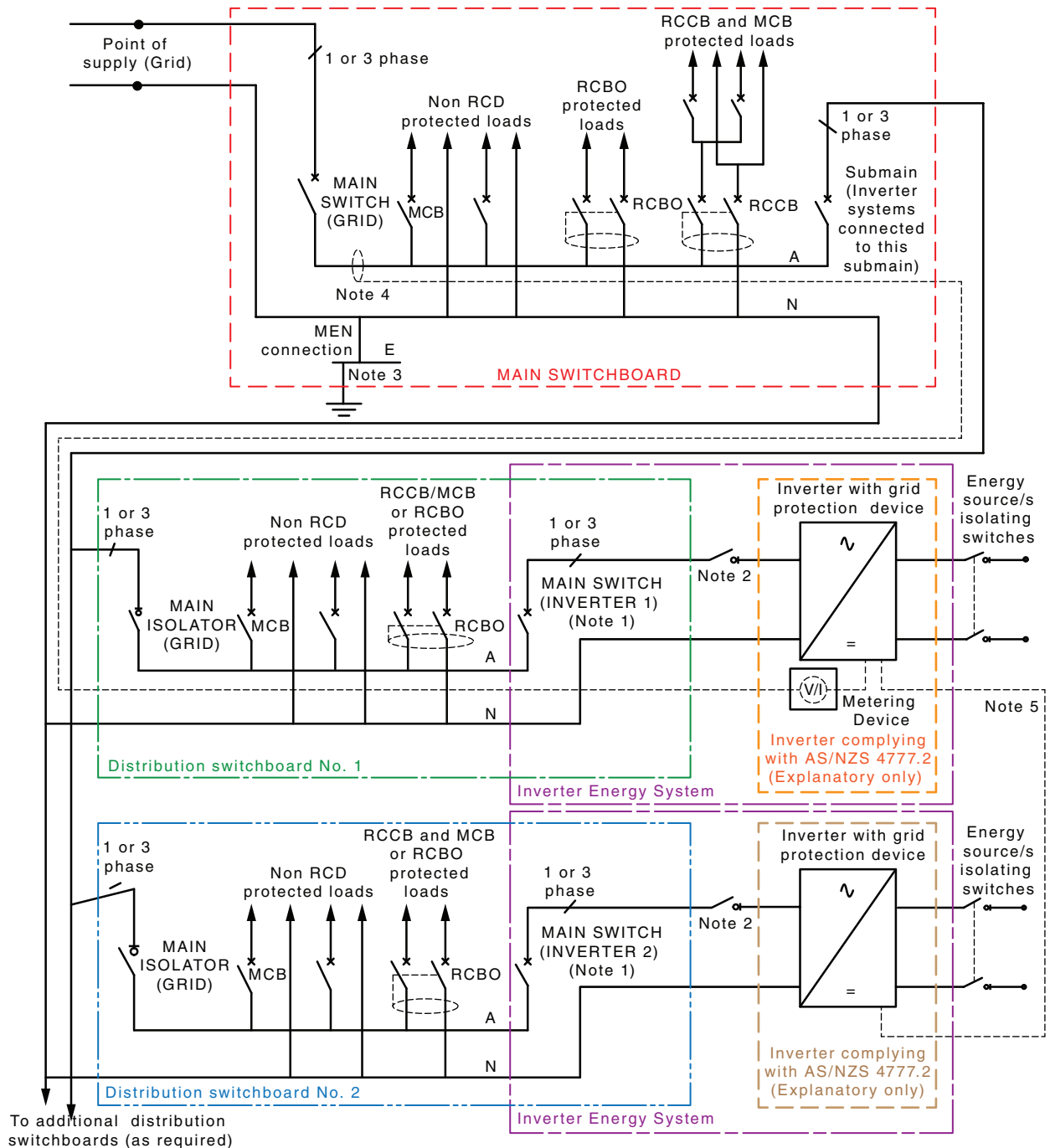


Figure 2.2 — Typical installation of inverter energy systems to distribution switchboards

2.3 Installation and selection requirements for inverter energy systems (IES)

2.3.1 General

An IES installation is made up of one or more inverters, one or more energy sources, and associated wiring, control, monitoring and protection devices connected at a single point in an electrical installation. Multiple IES installations can exist within a single electrical installation.

The electrical equipment used within an IES installation shall be installed in accordance with the requirements of this document, and the additional requirements as specified in the electrical equipment manufacturers' instructions. Where there is a conflict, this document shall prevail.

2.3.2 Balance

Multiple-phase IES should have a balanced output across the electrical installation. [Appendix C](#) shall be followed for balancing the IES installation.

2.4 Installation requirements

2.4.1 Inverter installation

The inverter(s) used in an IES that provide a supplementary supply shall conform with the requirements of AS/NZS 4777.2 to ensure safe operation when connected to any electrical installation supplied from a grid. Additional protective functions, earth fault and overcurrent protection shall be in accordance with the requirements of this document.

The inverter shall be—

- (a) installed in a suitable, well-ventilated place;
- (b) installed in accordance with the manufacturer's specific requirements;
- (c) installed in a location suitable for the inverter IP rating;
- (d) arranged so as to provide accessibility for operation, testing, inspection, maintenance and repair, with sufficient space and access for the initial installation and for later replacement of individual items of the control and protective devices,
- (e) arranged to prevent ingress of vermin, insects, water and dust; and
- (f) installed to prevent deterioration of the operational functions of the inverter.

All wiring into the inverter and any associated switchboard shall be installed in such a manner that, in the event of a fire in the inverter or associated switchboard, the spread of fire shall be kept to a minimum.

The inverters used in an IES that provide a supplementary supply may also provide an alternative supply, or a substitute supply. See [Section 5](#) for additional requirements.

The inverters used in an IES that do not provide a supplementary supply and provides an alternative supply may be used provided the IES is installed with the additional requirements of [Section 5](#).

The inverters used in an IES that do not provide a supplementary supply and provides an independent supply may be used provided the IES is installed with the additional requirements of [Section 5](#).

The inverter shall not be located in a restricted location as defined for switchboards in AS/NZS 3000. Where an inverter has an internal load break disconnection device to break photovoltaic (PV) d.c. circuits, the inverter shall be readily available.

NOTE No mounting height has been nominated within this document. Some local regulations may have relevant requirements.

2.4.2 Equipment weatherproofing

Electrical equipment, components and connections, where the presence of water or high humidity presents an increased risk, shall be selected and installed to—

- (a) operate safely near or within a damp or wet environment;
- (b) provide additional protection against electric shock; and
- (c) provide adequate protection against damage that might reasonably be expected from the presence of water, high humidity or solar radiation (direct sunlight).

Wiring systems or enclosures shall be selected and installed so that the entry of water is prevented and does not cause damage.

Where water can collect or condensation can form in a wiring system, to the extent that it creates a hazard, provision shall be made for its harmless escape through suitably located drainage points in a way that does not compromise the IP rating of the enclosure.

NOTE Damp situations and exposure to the environment are considered to be outdoors and unprotected.

2.4.3 Seismic protection (NZ only)

In New Zealand, all equipment and wiring shall be restrained to cater for seismic (earthquake) forces. NZS 4219 provides guidance on suitable restraint arrangements.

Section 3 Connection of the IES to the electrical installation

3.1 General

This section outlines the requirements for the a.c. connection of an IES that provides a supplementary supply to an electrical installation's normal supply. Typically the normal supply for an electrical installation is from the grid supply. EV supply equipment capable of reverse power transfer used as an IES may provide a supplementary supply to the electrical installation.

For a Multiple Mode IES that provides the following:

- (a) An alternative supply and a supplementary supply to an electrical installation, the alternative supply a.c. connection shall also conform with requirements of [Section 5](#).
- (b) An alternative supply to an electrical installation, without providing a supplementary supply, the alternative supply a.c. connection shall conform with requirements of [Section 5](#).
- (c) A substitute supply shall also conform with the requirements of [Section 5](#).
- (d) An independent supply without providing a supplementary supply shall conform with requirements in [Section 5](#).

For a portable IES that provides an alternative supply to an electrical installation, the alternative supply a.c. connection shall conform with requirements of [Clause 5.7](#).

The control, protection, wiring system equipment and installation of an IES shall conform with AS/NZS 3000 unless modified by this document and any additional requirements as specified in the electrical equipment manufacturer's instructions. Where there is a conflict, this document shall prevail.

The addition of a supplementary supply to a grid supply at a switchboard can create a summation of current to occur resulting in equipment or cabling being overloaded and not appropriately protected by overcurrent protection.

3.2 Connections

3.2.1 General

The IES shall be connected by either fixed installation wiring, or by a connector/coupling arrangement using flexible cord, to a dedicated circuit on a switchboard. Where a connector or coupling is used, it shall be in accordance with [Clause 3.2.3](#).

Where the IES is an EV and an EV supply equipment combination, the EV supply equipment shall be connected by fixed installation wiring only. Any EV providing an inverter operation shall be connected by a fixed EV supply equipment (i.e. mode 3).

Auxiliary equipment for use with the IES may be connected to the main switch (inverter). Where a socket-outlet is used for auxiliary equipment, overcurrent and RCD protection shall be provided in accordance with AS/NZS 3000. The socket-outlet shall be for exclusive use with the IES auxiliary equipment, and not be readily accessible.

3.2.2 Connection to electrical installation

3.2.2.1 General

The IES should be connected directly to the main switchboard. In installations where this is not practicable, the IES should be connected to the distribution switchboard located physically nearest to the inverter. The main switchboard, the distribution switchboard to which the IES is connected, and

any distribution switchboard electrically connected between the main switchboard and a distribution switchboard to which an IES is directly connected shall be labelled in accordance with [Section 6](#).

NOTE When selecting the distribution board for the IES connection, minimizing the cable run and voltage rise to the point of supply is important (see [Clause 3.3.3](#) and refer to AS/NZS 3000).

The IES shall not have any devices that modify the voltage or frequency between the point of supply from the grid at nominal voltage of 230 V/400 V and the supplementary supply from the grid-interactive port of the inverter/s within the IES. The IES shall not have any voltage stabilization devices between the point of supply from the grid and the supplementary supply from the grid-interactive port of the inverter/s within the IES. These voltage stabilization devices include any transformer based or power electronic based equipment that change the voltage level from the grid side of the device to the load or generation side of the device. These voltage stabilization devices render important voltage-based safety functions in the inverter ineffective.

3.2.2.2 Installations with engine driven generating sets

Where an engine driven generating set is installed for purposes of an alternative supply system in conformance with AS/NZS 3010, an IES shall be connected to the grid side of any generator changeover device in the electrical installation, except when the engine driven generating set operating as the alternative supply and the IES are appropriately designed to operate in parallel, or where the IES has an interlock with the changeover device to disconnect the IES when the generator is operating.

NOTE A engine driven generating set cannot absorb energy from an IES.

3.2.2.3 Connection using flexible cord

Flexible cords shall be of the heavy-duty sheathed type and installed in the same manner as insulated and sheathed cables.

The flexible cord shall be secured in such a way as to prevent inadvertent disconnection or mechanical stresses on electrical connections with no greater than 300 mm of flexible cord unsupported. The flexible cord shall be provided with strain relief by a cable gland or clamping mechanism at each end of the flexible cord.

3.2.3 Connector or coupling connections to the inverters

Where a flexible cord is used, it shall be chosen to be appropriate for the connector or coupling device to which it will be attached.

Where inverters have connectors or couplers for their port connections, only pluggable equipment type B shall be used. Any connector or coupling device used shall ensure that there are no accessible live parts to at least IP2X either disengaged or engaged. Only connectors and couplers of the make, type and model specified by the equipment manufacturer shall be used. The inverter connector type shall not be modified.

Plug and socket connections (as defined in AS/NZS 3112 and AS/NZS 60320.1) or pins for direct insertion into a socket-outlet shall not be used.

NOTE 1 The plug and socket connections defined in AS/NZS 3112 and AS/NZS 60320.1 are typical two and three pin plugs and socket connections for typical electrical installations and equipment.

NOTE 2 See [Clause 4.2](#) for the connection between the EV and the EV supply equipment requirements.

3.3 Selection and installation of wiring systems

3.3.1 General

All cables shall be installed and sized in accordance with AS/NZS 3000, the AS/NZS 3008.1 series, the requirements of this document, and any additional requirements as specified in the electrical equipment manufacturer's instructions. For the purposes of AS/NZS 3000 where the supplementary supply cable meets the definition as a consumer mains cable it is considered a protected consumer mains where the IES is a current limited source.

All the cables between the IES and any switchboard and all the cables between any distribution switchboards and the main switchboard that carry current from the IES shall have a current-carrying capacity of not less than the rated current of the IES. A current value derived from a generation limit or export limit shall not be applied to determine current carrying capacity of the cables.

NOTE Where the IES is configured as a multiple mode inverter [Section 5](#) may have additional requirements.

The inverter current output and balancing for multiple-phase installations shall be included in the design of IES and the calculation of voltage rise or drop.

3.3.2 Installation method

Particular attention shall be given to the mechanical protection requirements specified in AS/NZS 3000 to maintain the integrity of the cable insulation and conductors.

Cables shall be supported so they do not suffer fatigue due to wind/snow effects.

Cables shall not lie on roofs or floors without an enclosure or conduit. Cable enclosures and conduits on roofs or floors shall not obstruct the natural water drain paths or promote accumulation of debris.

Cables shall be protected from abrasion, tension, compression and cutting forces that can arise from thermal cycles, wind and other forces during installation and throughout the service life of the IES.

All conduit and ducting exposed to sunlight shall be of a UV resistant type.

The method of cable support and fixing shall have a lifetime greater than or equal to the service life of the IES.

NOTE Typically, plastic cable ties exposed to UV will degrade within 2 to 5 years.

3.3.3 Voltage rise

The voltage rise requirements of this clause apply in addition to the voltage drop requirements of AS/NZS 3000.

All existing and new cabling shall be designed and checked for the calculated maximum voltage rise between the point of supply from the grid and the inverter a.c. terminals (grid-interactive port) in accordance with the following requirements.

The overall voltage rise from the point of supply from the grid to the inverter a.c. terminals (grid-interactive port) shall not exceed 2 % of the nominal voltage at the point of supply from the grid.

The value of the current used for the calculation of voltage rise shall be either—

- (a) the rated current of the inverter or IES;
- (b) the maximum per phase current at a node that is generation limited;
- (c) the maximum per phase current at a node that is export limited, applied at different nodes or segments of an electrical installation; or

- (d) any combination of the above.

A node may be at a switchboard, a change in cable cross-sectional area or a segment of cabling that has a generation control function limit applied (i.e. generation limit or export limit). Multiple current values may be used for the calculation of voltage rise between different nodes or segments within an electrical installation to the point of supply from the grid and summated to get total voltage rise from the IES to the point of supply from the grid. The value of current used is the maximum value of the current that may flow from the node along each cable segment, this can be from a single inverter, multiple inverters or the IES.

All generation sources, including IES, within the electrical installation shall be considered.

In the case of a group of inverters with a rating of no more than 5 kVA per phase (see [Clause 3.5.2](#)), calculations shall be based on the location where the interconnecting cable connects into the fixed installation wiring.

NOTE 1 The system designer should consider that systems with a reduced site export limit, may be later permitted to have a greater export limit and that value should be considered.

NOTE 2 See [Appendix B](#) for examples.

NOTE 3 For an aggregate IES rating greater than 30 kVA, the minimum load of the site can be taken into account in calculation of voltage rise at point of supply from the grid. For example, the known minimum load from a 12-month period for the entire site, or a factor of 0.7 of the constant minimum load may be used.

3.4 Control and protection

3.4.1 General

A main switch (inverter) shall be provided on the switchboard to which the IES is directly connected. An isolation switch or circuit-breaker with the characteristics in [Clause 3.4.3](#) may be used.

The current rating of an IES comprised of a single inverter shall be the rated current of the inverter. Where the IES comprises multiple inverters, the IES current rating shall be the summation of the rated currents of all the inverters of that IES on the same phase. The main switch (inverter) shall be sized to suit the total IES rated current for those inverters connected to it. A current value derived from a generation limit or export limit shall not be applied to determine rated current for the inverters for sizing of control and protection devices.

3.4.2 Overcurrent protection

All IES cabling shall be protected against overcurrent in accordance with AS/NZS 3000. Where overcurrent protection for the cabling to the IES is not provided by other overcurrent protection, the main switch (inverter) shall be a circuit-breaker with rating suitable to protect all cabling up to the IES.

Any conductor within the electrical installation shall not be overloaded due to summation of current from grid supply and supplementary supply(s).

NOTE Overcurrent protection of the cable should take into account normal and fault currents that can be sourced from either the IES supplementary supply or the grid supply.

3.4.3 Isolation switches

3.4.3.1 General

An isolation switch or circuit-breaker shall —

- (a) be provided on the switchboard to which the IES is directly connected (see Note 1);
- (b) be able to be secured in the open position;

- (c) operate in all active conductors;
- (d) be capable of breaking the rated current of the IES;
- (e) isolate the IES from that switchboard; and
- (f) be labelled as specified in [Section 6](#).

NOTE 1 The purpose of this switch is to provide isolation of the IES for persons working on other parts of the electrical installation.

Where the isolation switch or circuit-breaker for the inverter is the main switch (inverter), it shall be installed in accordance with the requirements for main switches, as specified in AS/NZS 3000 (see Note 2).

NOTE 2 The electrical requirements for isolation devices specified in AS/NZS 3000 include the prohibition on the use of solid state devices for isolation purposes.

Where both an isolator and circuit overcurrent protection are required, this may be two separate devices or a single circuit-breaker capable of being secured in the open position.

3.4.3.2 Isolation at the inverter

The supplementary supply from the inverter shall be provided with a means of isolation. A separate means of isolation shall be provided externally and adjacent to the inverter.

Exception: Where the inverter is within 3 m and fully visible from the switchboard to which it is connected, the isolator in the switchboard may be used.

For groups of inverters with capacity no more than 5 kVA per phase see [Clause 3.5.2](#) for isolation requirements.

For groups of inverters connected to a dedicated switchboard without loads see [Clause 3.5.3.2](#) for isolation at the inverter.

For an inverter comprising of pluggable equipment type B and connected by a flexible cord, an installation coupler may be used as an isolation point as an alternative for the adjacent isolation switch. The use of an installation coupler for isolation does not apply to multiple mode inverters. When an installation coupler is used it shall be—

- (a) shrouded, touch-safe and suitable for the environment;
- (b) at the point of transition from inverter interconnect cable to the fixed installation wiring;
- (c) adjacent to the location of the inverter or group of inverters; and
- (d) labelled as to its purpose and include a warning if it is not suitable to interrupt the rated current of the inverter or group of inverters.

3.4.4 Residual current devices (RCDs)

If an RCD is used, the RCD shall—

- (a) disconnect all live conductors (including the actives and neutral);
- (b) be of the type specified in the inverter manufacturer's instructions or as labelled on the inverter;
- (c) conform with AS/NZS 61008.1 or AS/NZS 61009.1;
- (d) installed in accordance with AS/NZS 3000; and
- (e) be non-polarized type with respect to the line and load.

The provision of AS/NZS 3000 for the use of RCDs as a method for mechanical protection of the IES supplementary supply port shall not be used for the multiple mode inverter supplementary supply cable.

For EV supply equipment capable of reverse power transfer used as an IES the use of RCD shall be in accordance with manufacturer instructions.

For Mode 3 EV supply equipment capable of reverse power transfer used as an IES, a dedicated RCD shall be installed at the switchboard and be one of the following types:

- (i) Type B.
- (ii) Type A in conjunction with a residual direct current detecting device (RDC-DD) conforming with IEC 62955.
- (iii) Type F in conjunction with a residual direct current detecting device (RDC-DD) conforming with IEC 62955.

Exception: For Mode 3 EV supply equipment protected by other protective measure against electric shock such as safety extra-low voltage (SELV) or electric separation, an RCD may not be required.

For Mode 4 EV supply equipment capable of reverse power transfer used as an IES, a dedicated RCD should be installed at the switchboard.

[SOURCE IEC 60364-7-722:2018 CI 722.531.2.101]

NOTE If the IES has a multiple mode inverter, then the requirements of [Section 5](#) also apply.

3.4.5 Interface protection for IES

3.4.5.1 General

Interface protection should be installed for an IES or multiple IES with aggregated rated apparent power greater than 200 kVA at any single electrical installation. Where installed, the interface protection shall perform the following functions:

- (a) Coordinate multiple IES installations for one point of supply from the grid.
- (b) Provide protection for all inverters or IES installations using one device within one point of supply from the grid.
- (c) Provide backup islanding protection to the connected grid.
- (d) Be integrated in such a way that it fails safe, and the IES does not generate while the interface protection is out of service.
- (e) Preserve safety of personnel working on the grid and the general public.

Exception: Where an electrical installation has an IES or multiple IES with aggregated rated apparent power greater than 200 kVA that is part of a multiple electrical installation that is connected to a single point of supply from the grid, with separate consumers and separate IES at different electrical installations, each of the separate IES connected to the same single point of supply from the grid may not be subject to [Clause 3.4.5.1\(a\) and \(b\)](#).

NOTE 1 Electricity distributors can have additional requirements that specify when interface protection is required and specific configurations for the region.

The interface protection provides a level of coordination between the point of supply from the grid, any IES, individual inverters and equipment within an electrical installation. Any interface protection shall

reference a single point that is located on the electrical installation between the main switch (grid) and all IES within the electrical installation.

NOTE 2 For additional IPSP interface protection requirements see [Clause 3.6.5.4](#).

The interface protection, which is in addition to and separate from the inverter integrated protection, shall include the protection functions specified in [Table 3.1](#).

Interface protection settings shall be secured against inadvertent or unauthorized tampering. Changes to settings shall require the use of a tool and special instructions not provided to unauthorized personnel.

NOTE 3 Special interface devices and passwords are regarded as tools.

3.4.5.2 Interface protection voltage and frequency protection requirements

The setting parameters in [Table 3.1](#) shall be coordinated with the inverter protection requirements of AS/NZS 4777.2. Default settings are provided in [Table 3.1](#).

The interface protection shall respond to the setting parameters of [Table 3.1](#) conditions by disconnecting all IES from the installation by automatic operation of a disconnection device located, either—

- (a) adjacent to the main switch (inverter);
- (b) adjacent to the inverter;
- (c) in the inverter by asserting DRM 0 to the inverter; or
- (d) in the inverter by a communication protocol recognized by the inverter.

The additional disconnection device for automated operation of interface protection shall not replace the main switch (inverter).

Exception: Where the main switch (inverter) is used as the disconnection device for automated operation of the interface protection, then the main switch shall conform with Clause 2.3.3.6 of AS/NZS 3000:2018.

Table 3.1 — Interface protection protective functions and default set points

Protective Functions	Setting parameters	Regions			
		Australia A	Australia B	Australia C	New Zealand
Over voltage ($V >$)	Protective function value	267 V		267 V	267 V
	Trip delay time	2.5 s		2.5 s	2.5 s
	Max disconnection time	3 s		3 s	3 s
Under voltage ($V <$)	Protective function value	69 V		69 V	69 V
	Trip delay time	2.5 s		2.5 s	2.5 s
	Max disconnection time	3 s		3 s	3 s
Under voltage ($V <$)	Protective function value	179 V		179 V	179 V
	Trip delay time	11.5 s		11.5 s	11.5 s
	Max disconnection time	12 s		12 s	12 s
Over frequency ($F >$)	Protective function value	52 Hz		55 Hz	55 Hz
	Trip delay time	1 s		1 s	1 s
	Max disconnection time	1.5 s		1.5 s	1.5 s
Under frequency ($F <$)	Protective function value	47 Hz		45 Hz	45 Hz
	Trip delay time	2.5 s		6.5 s	2.5 s
	Max disconnection time	3 s		7 s	3 s
Rate of change of frequency (df/dt)	Protective function value	± 4 Hz/s		± 4 Hz/s	± 4 Hz/s
	Trip delay time	0.5 s		1 s	0.5 s
	Max disconnection time	1 s		1.5 s	1 s

NOTE 1 Regions noted in this document have the same meaning as those used in AS/NZS 4777.2.

NOTE 2 The max disconnection times are inclusive of the trip delay time. Therefore the trip occurs between the trip delay time and the max disconnection time.

3.4.5.3 Interface protection equipment

3.4.5.3.1 General

Where interface protection is installed, the protection equipment shall conform with the following standards:

- (a) IEC 60255-1, Common requirements.
- (b) IEC 60255-26, EMC requirements.
- (c) IEC 60255-27, Product safety requirements.
- (d) IEC 60255-127, Functional requirements for over/under voltage protection.
- (e) IEC 60255-181, Functional requirements for frequency protection.

The measurement and calculation accuracy of the protection device shall conform with the specification for measurement and calculation accuracy of AS/NZS 4777.2.

Exception: A minimum frequency measurement accuracy of 100 mHz is permitted under transient conditions for protection devices.

Devices external to the protection device necessary for interface protection operation (e.g. ancillary control or communication equipment) shall also conform with [Clause 3.4.5.3.1](#) (a), (b) and (c).

The interface protection shall have fail-safe operation that includes continuous self-supervision features that monitor the integrity of the interface protection and control by means of a watchdog contact for connection to the disconnection device.

3.4.5.3.2 Disconnection device

Interface protection shall incorporate the fail-safe operation of the disconnection device(s) with a separate mechanism.

The disconnection device(s) shall operate within 5 s when the interface protection operation is interrupted by one of the following failures:

- (a) Power supply operation failure or shutdown.
- (b) Loss of control signal to the disconnection device(s).
- (c) An internal fault of the protection device.
- (d) A watchdog protection relay contact operation.

NOTE 1 A watchdog protection relay is a device that monitors the correct operation of the protection function.

Where a wireless communication channel or device is used the communication link shall be a supervised communication link. The delay to the operation of the disconnection device due to wireless link should not exceed 0.5 s.

NOTE 2 A supervised communications link is where information is transmitted across the communications link specifically for the purpose to constantly monitor the status of bidirectional data transfer over the link and provide a local signal to indicate the up/down status of the link. Supervision may be performed by a separate function block within the communications equipment, or by external equipment that sends supervision information over the same link as the user data.

A semiconductor (solid state) device shall not be used as a disconnection device.

3.4.5.3.3 Instrument transformers

Instrument transformers used with interface protection shall conform with the following Standards:

- (a) AS 61869.1, General requirements.
- (b) AS 61869.3, Additional requirements for inductive voltage transformers.
- (c) AS 61869.6, Additional general requirements for low-power instrument transformers.

3.4.5.4 Connection and reconnection procedure

Only after all of the conditions for connection and reconnection in accordance with AS/NZS 4777.2 have been met shall the interface protection device operate the disconnection device to connect or reconnect the IES to the grid.

3.4.6 Demand response mode (DRM)

The demand response enabling device (DRED), where provided, shall be connected to the DRM port of the inverter or as per the manufacturer's specifications. The connection to the DRED shall be via the provided terminal block or RJ45 socket labelled as the DRM port. DRED communication is via extra-low voltage (ELV) and as such cabling shall be suitably protected and segregated from other cables.

NOTE Electricity distributors can have additional requirements for enabling DRED.

3.4.7 IES operational settings

A setting for the Region as directed by the electricity distributor shall be applied to all inverters that are a part of the IES. The inverter protection settings shall be as specified in AS/NZS 4777.2 for each region identified.

Exception: The inverter default power quality response modes for each regional setting as specified in AS/NZS 4777.2 may be modified in some situations to meet grid requirements as directed by the electricity distributor.

NOTE The applicable settings are provided by the electricity distributor. Each inverter may have a different methodology of applying settings, in each case the manufacturers instruction should be followed.

3.4.8 Generation control of an IES

3.4.8.1 General

The generation control functions of an IES may be used to control the active power output levels of an IES to less than the total rated apparent power of the IES such that it does not exceed a predetermined generation or export level. Two generation control functions may be utilized to control an IES to a specified limit either from an electricity distributor or to meet a design outcome, these functions are—

- (a) generation limit control, intended to ensure electrical installation design capacity is not breached; and
- (b) export limit control, intended to ensure constraints on the grid are not exceeded.

Either or both of these generation control functions may be integrated into the inverter(s) or provided by an independent external generation control device. Where the inverter provides the generation control functions with or without an external device for the IES then the generation control functions shall conform with AS/NZS 4777.2.

Where the generation control functions are integrated within the inverter in conformance to AS/NZS 4777.2, then the inverter shall be installed and configured in accordance with manufacturer's instructions, with additional meters or sensors for measurements. Any current sensing devices for generation control shall be installed to prevent the current sensing device from being inadvertently opened or removed.

Where an independent external generation control device is used the requirement for operation are in this Clause and [Clause 3.4.8.2](#).

NOTE 1 An inverter manufacturer can provide information on independent external generation control devices that are compatible with manufacturer's inverters and maintains conformance to AS/NZS 4777.2 for these generation control functions.

Both the generation limit and export limit may be configured in a single IES. Whereas the export limit may be configured and used with multiple IES.

Where the generation control limits have been utilized / specified for an IES or multiple IES installation then they shall be set according to those limits at installation.

NOTE 2 The electricity distributor can provide the specific generation control limits for an IES or an electrical installation.

The rated current-carrying capacity of the IES cable shall be no less than the nameplate capacity of the inverter or IES when a lower generation limit is used (see [Clause 3.3.1](#)).

The generation control functions for an IES may operate with the following limits:

- (i) Soft limit: A limit that will cause the IES to reduce its output, preventing generation that would breach the limit.