ADVICE ON AS/NZS 5033

Issue 1, December 2021

CLEAN ENERGY COUNCIL

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PREFACE

About this document.

This advice document has been prepared by the Clean Energy Council to help accredited designers and installers understand and interpret AS/NZS 5033:2021 – Installation and safety requirements for photovoltaic (PV) arrays.

This advice does not modify existing legal obligations and should be read in conjunction with existing relevant standards, codes, and network service provider rules. While all care has been taken to ensure this advice is free from omission and error, no responsibility can be taken for the use of this information.

The CEC have created a dedicated web page for accredited people to access for specific information relating to the new standard.

https://www.cleanenergycouncil.org.au/account/resources/as-nzs-5033-2021-advice

The CEC would like to encourage installers to provide feedback or requests for additional clarification requirements using the online form provided. The CEC will continue to work with the Clean Energy Regulator (CER), electrical safety regulators and industry bodies to keep accredited designers and installers updated in relation to their obligations.

The objective of this advice is to:

- improve the safety, performance, and reliability of photovoltaic (PV) arrays
- encourage industry best practice for all design and installation work.

Where possible, this advice document aligns with the section references of AS/NZS 5033:2021. The performance of a reliable installation that fulfils system owner expectations requires both careful design and correct installation practice. Further tools to assist you to interpret the standard can be accessed via the installer login section of the website.
cleanenergycouncil.org.au/account/resources/solar-technical-information

NOTE: AS/NZS 5033:2021 will supersede AS/NZS 5033:2014 SIX MONTHS from the date of publication, however, local state and territory electrical safety regulators will have their own requirements around when this standard must be complied with.

NSW HAS MANDATED AS/NZS 5033:2021 FROM DATE OF PUBLICATION WITH NO TRANSITION PERIOD.

1 INTRODUCTION AND SCOPE

Summary

AS/NZS 5033 has undergone a significant rewrite over the last couple of years. This has included a draft that was released for public comment as DR AS/NZS 5033:2021

The finial published version was released on 19 November 2021.

This advice document does not go beyond the scope of AS/NZS 5033:2021 as outlined in clause 1.1 of the standard.

Key points

There are a number of changes in requirements in this revision. They include but are not limited to —

- increase in maximum PV array voltage for residential systems
- PV Array isolation requirements – load breaking disconnectors and disconnection
- DC cable installation requirements for wiring systems and wiring enclosures
- earthing requirements
- changes to d.c. optimiser and micro inverter requirements
- updated testing and verification requirements.

AS/NZS 5033:2021 ***does not*** apply to PV arrays in the following electrical installation types:

- less than 100 W and less than 35 V d.c. open circuit voltage at STC
- transportable structures and vehicles that are in accordance with AS/NZS 3001
- boats in accordance with AS/NZS 3004.

The standard ***does not*** apply to PV arrays on large-scale ground mounted PV power plants with restricted access to personnel and connected to dedicated high voltage systems. However, in the absence of an Australian Standard, this document should be used as guidance, subject to appropriate engineering principles being applied.

Some state or territory electrical safety regulars may still enforce this standard through their legislation. Please check before undertaking this sort of work.

CEC code – 5033.2021.0.1.1

1.2 References

CEC accredited designers and installers who are installing PV systems should have access to the following standards, codes and guides when reading this document. This advice is designed to be read in conjunction with the documents listed below.

AS 1768	Lightning protection
AS/NZS 1170.2	Structural design actions, Part 2: Wind actions
AS/NZS 3000	Electrical installations [known as the Wiring rules]
AS/NZS 3008.1.1	Electrical installation – Selection of cables. Part 1.1
AS/NZS 3008.1.2	Electrical installations – Selection of cables. Part 1/2
AS/NZS 4509 (series)	Stand-alone power systems
AS/NZS 4777 (series)	Grid connection of energy systems via inverters
AS/NZS 5139	Electrical installations – Safety of battery systems for use with power conversion equipment

The system shall also comply with the relevant electrical Codes of Practice, Service and Installation Rules (SIRs) for the state or territory where the system is installed.

The network service provider (NSP) may have additional requirements, including provision of documentation to enable connection to the grid.

NOTE: CEC V13 Install and Supervise Guidelines

With the release of AS/NZS 5033:2021 on Friday the 19th of November 2021, sections of the Clean Energy Council - *Grid-Connected Solar PV Systems: Install and Supervise Guidelines for Accredited Installers – Version 13* (mandatory from 29 June 2019), have been superseded.
The CEC Guidelines Version 13 have specific references to AS/NZS 5033:2014.

In most states and territories there will be a transition period of six (6) months where installers *can choose to follow the old **or** new version* of the standard.

- Installers that are installing to the 2014 version must also follow all sections of the CEC guidelines V13.
- Installers that choose to follow the new 2021 version of the standard must still follow the CEC guidelines V13 unless the clause has been superseded by the newer standard.
- This is also the case for the references to AS/NZS 1170.2 and AS/NZS 3000:2018 (to allow for amendments).

During this six-month transition period either standard (AS/NZS 5033:2014 or AS/NZS 5033:2021) can be applied to solar PV installations, but in either case, the whole standard will need to be followed. (e.g. if you choose to use the 2021 version the whole standard is to be followed, you are not able to use some requirements in 2021 version and some of the requirements in the 2014 version).

1.3 Terms and Definitions

Throughout this document, the definitions in AS/NZS 3000 and the new definitions in AS/NZS 5033:2021 apply.

There are many new definitions in AS/NZS 5033:2021 and CEC accredited designers and installers are encouraged to obtain their own copy of the document as soon as possible.

NOTE: Additional clarity to the definitions found in AS/NZS 5033:2021 will be provided to this document based on industry feedback and as required for clarity.

1.4 Notations

AS/NZS 5033:2021 has a detailed list of notations relating to formulas and measurements that a CEC accredited designer and installer will need to be aware of. Should any of these references require additional clarification, the CEC will use this advice document to assist.

2 PV SYSTEM CONFIGURATION

2.1 Configuration

2.1.1 General

One of the first new terms used in this standard is “application circuit”. This is defined in the standard as – final circuit supplied by the PV array (Cl 1.3.2).

The new version of the standard considerers the following as types of application circuits

- PV array connected to d.c loads
- PV array connected to an a.c. system via a separated PCE
- PV array connected to an a.c. system via a non-separated PCE.

2.1.2 PV system architectures

The standard refers to the architecture of a system as the way in which the PV system relates to earth

and is determined by:

- any functional earthing of the array in use
- the earth status of the application circuit to which the array is connected.

Both issues may affect the safety of the array and installers shall follow all manufactures instructions (including the PCE manufacturers) when considering earthing arrangements.

2.1.3 Array electrical diagrams

The standard provides some possible configurations of PV systems. Figures 2.2 to 2.4 in the standard show some basic typical electrical configurations of single string, multiple parallel strings and multi-sub-array PV respectively.

The CEC will add interpretation drawings to this document based on feedback received.

2.1.4 General

2.1.4.1 Use of PCE with multiple d.c. inputs

Summary

PV array/s are often connected to PCE with Multiple d.c. inputs.

These inputs can either be separate maximum power point tracking (MPPT) inputs OR multiple inputs internally connected (paralleled) in the PCE.

The input circuits of the PCE will have a critical impact on the selection of overcurrent protection and cable sizing.

Each PV section connected to a MPPT input may be treated as a separate PV array For the purposes of this standard see Figure 2.5. Manufactures specifications will need to be referenced.

Key points

- PCEs with multiple d.c. inputs and the various sections of the PV array(s)
- overcurrent protection and cable sizing requirements are critically dependent on internal input circuits of the PCE
- each PV section connected to a MPPT input may be treated as a separate PV array
- manufactures specifications required
- see AS/NZS 5033:2021 Cl 2.1.4.2 & 2.1.4.3
- see AS/NZS 5033:2021 Figures 2.5 and 2.6

CEC CODE – 5033.2021.0.2.1.4.

3 SAFETY ISSUES

3.1 Maximum voltage limits

Summary

In domestic installations the PV array maximum voltage has been raised to 1000V d.c. allowing greater flexibility with string configurations.

In non-domestic installations the PV array maximum voltage is allowed to be up to or equal to 1500V d.c.

Note: 'domestic' is defined in AS/NZS 3000 Cl 1.4.53

Key points

- The calculated PV maximum voltage of PV d.c. circuits shall not be greater than 1000V d.c. for domestic electrical installations.
- The calculated PV maximum voltage of PV d.c. circuits shall not be greater than 1500V d.c. for other electrical installations.
- *NOTE: See Clause 4.2.1.3 for PV d.c. circuit maximum voltage calculation.*
- *NOTE: See AS/NZS 4777.1 for extra requirements around domestic voltage limits for grid connected systems.*

CEC code – 5033.2021.0.3.1

3.3 Protection against overcurrent

3.3.3.1 Calculation of maximum string current

- String containing no DCUs:
  - ISTRING MAX = 1.25 x KI x ISC MOD
- Strings containing partial DCUs, the greater of the following:
  - ISTRING MAX = IDCU string max
    OR
  - ISTRING MAX = 1.25 x KI x ISC MOD
- Strings with DCUs on all modules:
  - ISTRING MAX = IDCU string max
- See AS/NZS 5033:2021 Appendix J for the determination of K.

CEC code - 5033.2021.0.3.3.3.1

3.3.4.1 Strings

Summary

When strings are connected in parallel there is the potential for fault conditions to occur where current can backfeed and damage PV modules.
This could be any combinations of d.c. equipment connected in parallel.

Examples:

- multiple parallel strings of PV modules ($I_{F\ STRING}$)
- a single string of PV modules ($I_{F\ STRING}$) and a d.c. coupled battery ($I_{BF\ TOTAL}$).

To protect against this, overcurrent protection shall be provided when:

$I_{F\ STRING} + I_{BF\ TOTAL} > I_{MOD\ MAX\ OCPR}$

Where:

$I_{F\ STRING}$ = potential fault current in a string from other parallel strings (see clause 3.3.3.)
$I_{BF\ TOTAL}$ = total continuous backfeed current from all sources not originating at the PV modules.
$I_{MOD\ MAX\ OCPR}$ = PV module maximum overcurrent protection rating as determined by IEC 61730-2

If overcurrent protection is required see AS/NZS 5033:2021 Cl 3.3.5.
Additional voltage and current calculations for PV d.c. can be found in AS/NZS 5033:2021 Cl 4.2

Key points

- When strings are connected in parallel there is the potential for fault conditions to occur where current can backfeed and damage PV modules.
- This could be any combinations of d.c. equipment connected in parallel.
- To protect against this, overcurrent protection shall be provided when:
- $I_{F\ STRING} + I_{BF\ TOTAL} > I_{MOD\ MAX\ OCPR}$.
- If overcurrent protection is required see AS/NZS 5033:2021 Cl 3.3.5
- Voltage and current calculations for PV d.c. can be found in AS/NZS 5033:2021 Cl 4.2

CEC code - 5033.2021.0.3.3.4.1

4 SELECTION AND INSTALLATION OF ELECTRICAL EQUIPMENT

4.3 PV arrays

4.3.3.1 Disconnection points

Summary

A disconnection point shall be provided to isolate each string at the PV modules when the calculated PV d.c. circuit maximum voltage exceeds 120V, unless there is a load-break disconnection device installed adjacent to the array (refer to exception).

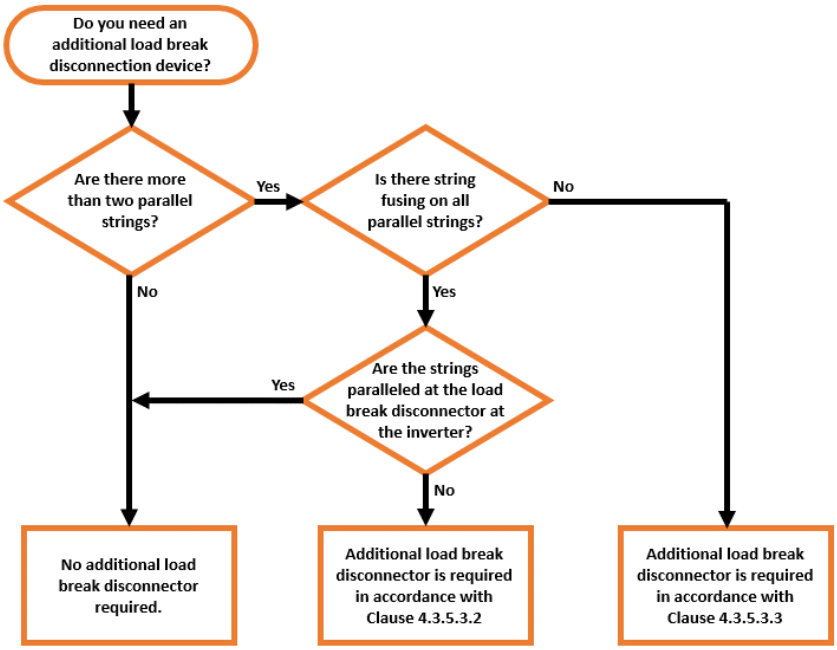
The requirements for disconnection points are described in AS/NZS 5033:2021 4.3.5.2.1
The decision tree in Figure 4.2 is used to determine if an additional load break disconnection device is required.

An additional load break disconnector is required in arrays with more than two parallel strings where the strings are fused or, if they are fused but **NOT** paralleled at the load break disconnector at the inverter.

Where a load break disconnection device is required in addition to the disconnection point, it shall be selected in accordance with AS/NZS 5033:2021 Clause 4.3.4.2 and installed in accordance with AS/NZS 5033:2021 Clause 4.3.5.3.

Key points

- a disconnection point shall be provided when PV d.c. circuit maximum voltage exceeds 120V
- use Figure 4.2 decision tree to determine requirements (summary below)
- there is an exception to this requirement where a disconnection point is not required to isolate each string, where a load break disconnection device is installed adjacent to the PV modules of the PV array that is being isolated.



CEC code – 5033.2021.0.4.3.3.1

4.3.4.2.2 Switch disconnectors

Summary

Suitably rated load break switch disconnectors or circuit breakers may be used to disconnect the PV circuits under load.

The ratings of load break switch disconnector or circuit breakers shall consider full load and prospective fault currents that may originate at the PV array and any other connected power sources (such as batteries).

Key points

- When selecting a switch disconnector, they shall:
  - be rated for d.c. use
  - interrupt all live conductors simultaneously (i.e.- have at least one pole per polarity)
  - be capable of being secured in the open position.
  - be an independent manual operation
  - not be polarity sensitive
  - conform with switch disconnector requirements of AS 60947.3 with utilization category d.c.-PV2
  - be rated according with AS/NZS 5033:2021 Cl 4.3.4.2.3.

CEC code – 5033.2021.0.4.3.4.2.2

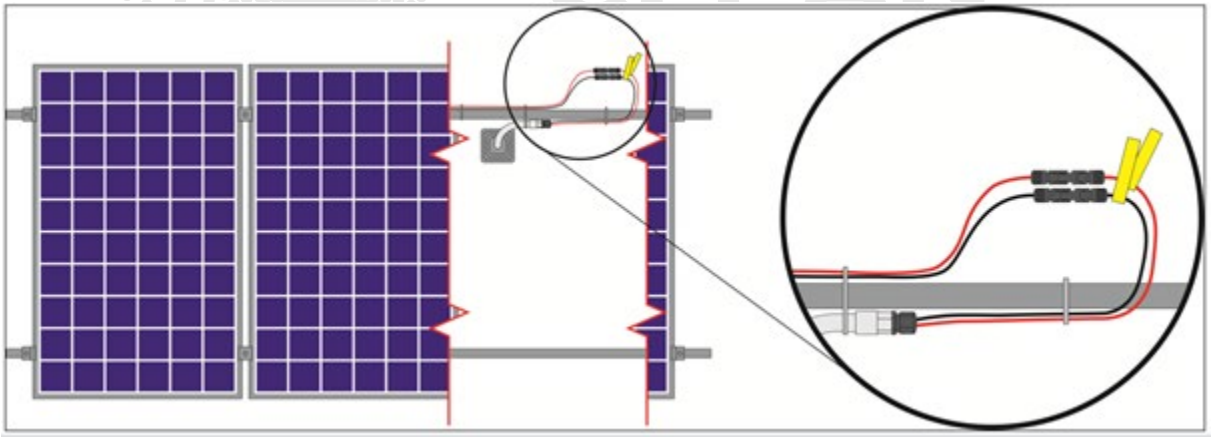
4.3.5.2.1 Disconnection point

Summary

A disconnection point is a **non-load break disconnection device** that can be used, where permitted, in the place of an alternative disconnection device.
It must be selected as per AS/NZS 5033:2021 Cl 4.3.8 and installed as per AS/NZS 5033:2021 Cl 4.3.9

Key points

- When selecting a disconnection point, they shall:
  - be adjacent to the PV modules of the array
  - be readily available
  - be protected against weather and water, no more than 150mm from the edge of the module that they are installed under
  - adequately supported so that there is no undue stress on the connection, but able to be disconnected
  - have both the positive and negative disconnection device located together
  - labelled in accordance with AS/NZS 5033:2021 Cl 5.5.2.2
  - documented in accordance with AS/NZS 5033 Cl 5.6
- Selected in accordance with AS/NZS 5033:2021 Cl 4.3.8
- Installed in accordance with AS/NZS 5033:2021 Cl 4.3.9.



CEC code – 5033.2021.0.3.2.5.2.1

4.3.5.3 Load break disconnection device

4.3.5.3.1 General

Summary

Where required to be installed by other clauses, a load break disconnection device must meet the requirements of AS/NZS 5033:2021 Cl 4.4.7.

This clause also contains location, marking and documentation requirements and a number of methods to protect against the spread of fire.

Key points

- The load break disconnection device shall;
  - Meet the requirements of AS/NZS 5033:2021 Cl 4.4.7
  - Be readily available
    (*Note 1 of the clause specifies additional requirements for devices mounted under modules to be considered readily available)*
  - Marked in accordance with AS/NZS 5033:2021 Cl 5.5.2.1
  - Documented in accordance with AS/NZS 5033:2021 Cl 5.6
- Be installed external to the building
- Meet one or more of the requirements of the clause to protect against the spread of fire by being installed in a metal enclosure, on a non-combustible surface, or mounted on a shroud, with specific requirements for each specified by the standard.
  (*with any penetration through a surface that protects against the spread of fire that has an internal free space greater than 5mm diameter, sealed with fire retardant.)*

CEC code – 5033.2021.0.4.3.5.3.1

4.3.5.3.2 Load break disconnection devices on systems with string fusing

Summary

When a load break disconnection device is required according to AS/NZS 5033:2021 Cl 4.3.3.1 and Figure 4.2 it shall be installed at the connection point, where the strings are parallel together.

Key points

- Determine if a load break disconnection device is required according to AS/NZS 5033:2021 Cl 4.3.3.1 and Figure 4.2.
- When a load break disconnection device is required, it shall be installed at the connection point.
- There are exceptions to this clause if being applied to PV arrays on large scale ground mounted PV power plants, if they are electing to apply the standard to meet safety requirements. (Not applicable for arrays installed within the scope of the standard).

Note: The requirement for this load break disconnection device to be installed on the roof can be avoided by ensuring strings are paralleled at the inverter. See Figure 4.2

CEC code – 5033.2021.0.4.3.5.3.2

4.4 Wiring systems

4.4.5 Wiring enclosures for the wiring system

4.4.5.2.1 General

Summary

The installation requirements for wiring enclosures are dependant on the location of the wiring system. There are four installation conditions that relate to different sections of the wiring system.

- Between the PV modules and the disconnection point. See AS/NZS 5033:2021 Cl 4.3.2.3.
- Between a load break disconnection device(s) and application circuit. See AS/NZS 5033:2021 Cl 4.4.5.2.2.
- Between the disconnection point and a load break disconnection device. See AS/NZS 5033:2021 Cl 4.4.5.2.2 & 4.4.5.2.3.
- Between non-adjacent groups of PV modules. See AS/NZS 5033:2021 Cl 4.4.5.2.4.

CEC code – 5033.2021.0.4.4.5.2.1

4.4.5.2.2 Additional mechanical protection requirements

Summary

The installation requirements for additional mechanical protection are dependant on the location of the wiring system. These requirements are in conjunction with the mechanical protection requirements of AS/NZS 3000.

There are requirements that relate to PV d.c. cables installed within buildings and that relate to PV d.c. cables installed external to a building.

Note: Where the wiring system is installed near building surfaces (such as those concealed within 50 mm from a surface), extra protection methods beyond the requirements of this Clause may be required to meet AS/NZS 3000.

Key points

Where PV d.c. cables are installed within buildings:

- Enclosed in metal or heavy-duty insulating conduit where installed within a ceiling space, in wall cavities or under a floor or;
- Installed in medium duty insulating wiring enclosure in other locations within buildings.

Note: There is an exception for non-domestic. Where PV d.c. cables are installed external to the building, and not in a restricted access location, they shall be installed in a wiring enclosure to ensure restricted access of the PV d.c cables. Where PV d.c. cables are installed external to the building and in a restricted access location, there are no additional mechanical protection requirements for the wiring system.

A maximum distance of no more than 300 mm of unprotected PV d.c. cable is allowed at the PCE or the load break disconnection device, provided the location is not subject to mechanical damage. CEC code – 5033.2021.0.4.4.5.2.2

4.4.5.2.3 Wiring systems between disconnection point and load break disconnection device or an application circuit

Summary

This clause applies to the wiring system between the **disconnection point/s** and the **load breaking disconnection device** or **application circuit** when the wiring system is run through a ceiling space. This means, if you do not install a load breaking disconnection device on the roof (roof top isolator) and only install disconnection point/s, then you will need to follow this clause.

Key points

- This clause in conjunction with other clauses in this standard provides a method to install a PV array/s without load breaking disconnection device/s (roof top isolator) on the roof.
- Wiring systems installed within a ceiling space shall not be located within 0.6 m above the surface of the ceiling unless—
    - the wiring system is located within 1 m from the internal surface of the external wall, see Zone 1 in AS/NZS 5033:2021 Figure 4.6.
    - the wiring system is located within 1 m to 1.5 m from the internal surface of an external wall, and it is attached to roof structure, see Zone 2 in AS/NZS 5033:2021 Figure 4.6; or
    - the wiring system is located within a vertical plane that extends 0.2 m from the external edge of the load break disconnection device at the PCE or the application circuit, see vertical conduit zone in AS/NZS 5033:2021 Figure 4.5.
- Where the ceiling height is not greater than 0.6m in height, the wiring system shall remain within 1m from the internal surface of the external wall.
- Where wiring systems are installed within buildings, additional mechanical protection is required, see AS/NZS 5033:2021 Cl 4.4.5.2.2.
- Wiring systems installed within a ceiling space shall be secured to prevent inadvertent dislodgement from conduit support.
- Wiring systems installed within a ceiling space shall not be fixed in a position within 50 mm from the underside of the roofing material.
- Where PV d.c. cables are installed in an accessible roof or floor space, a sign as per AS/NZS 5033:2021 Cl 5.3.1.2 shall be installed.

NOTE: *Some of these requirements are also for wiring in ceilings between groups of non-adjacent panels. See AS/NZS 5022:2021 Clause 4.4.5.2.4*

See Figures 4.5, 4.6 and A1 in the standard for more detail.
The CEC will provide additional interpretive drawings in the next version of this advice document.

CEC code – 5033.2021.0.4.4.5.2.3

4.4.6.2 Selection of enclosures containing disconnection devices

Summary

Enclosures containing disconnecting devices shall be selected as specified in AS/NZS 5033:2021 Table 4.5

Depending on the disconnection device you select, and the environment it is installed in the enclosure will need to meet different requirements.

Key points

- Enclosures containing disconnecting devices installed in an outdoor environment shall have pressure equalization valves fitted in the enclosure except where a pressure equalization valve is integrated into other equipment installed within 300mm of the enclosure.
- AS/NZS 5033:2021 Table 4.5 breaks down the selection process based on the type of disconnection device being used.
- Minimum IP 56 and in some cases IP 56NW.
- There are additional requirements contained within the clause relating to:
    - maintaining double insulation
    - earthing of enclosures
    - flaps and covers on IP rated enclosures

See Table 4.5 in the standard for more detail.
The CEC will provide additional information in the next version of this advice document.

CEC code – 5033.2021.0.4.4.6.2

4.4.7 Installation of enclosures containing conductor terminations

4.4.7.1 General

Summary

This clause identifies broad requirements that apply to the installation any enclosure containing d.c. conductor terminations.

Water ingress into d.c. systems can lead to arcing and fires. Effective work practices that comprehensively prevent the ingress of water into enclosures should be used.

Key points

- Manufacturers mounting instructions must be followed including screw location and screw type.
- Silicone and other sealants shall not be relied on unless specified by the manufacturer.
- Enclosures shall be free from dust and debris at completion of installation.
- Conductor terminations shall be provided with strain relief. This may be achieved using a gland connector or securing the cables as the enter the enclosure.
- Double insulation shall be maintained.

CEC code – 5033.2021.0.4.4.7.1

4.4.7.2 Entries/exits of enclosures containing conductor terminations

4.4.7.2.1 General

Summary

Entries/exits of an enclosure that contains conductor terminations can be achieved by two methods: cable glands and conduit systems.

There are specific requirements for enclosures that contain disconnection devices and relate to AS/NZS 5033:2021 Cl 4.4.7.2.2 & 4.4.7.2.3

In all instances, only manufacturers entry/exit points shall be used.

Cable glands and conduit fittings shall not enter/exit the top face of the enclosure. There are exceptions to this relating to indoor installations but the wiring system coming from the roof must not enter/exit the top face.

Conduit and fittings shall be installed to manufacturer's instructions, including being glued.

Silicone or other sealant product as means of sealing entry/exit points shall not be used unless it is a type specified by disconnector manufacturer's instructions.

Key points

- Entries/exits of an enclosure that contains conductor terminations can be achieved by two methods: cable glands and conduit systems.
- Only manufacturers entry/exit points shall be used.
- Cable glands and conduit fittings shall not enter/exit the top face of the enclosure.

CEC code – 5033.2021.0.4.4.7.2.1

4.4.7.2.2 Cable glands in outdoor locations

Summary

Where a cable gland is used in an outdoor environment, the cable gland must meet a number of requirements.

The beginning of the clause covers the requirements for the cable gland as a piece of equipment and then moves into the installation of cable glands.

Non-continuous conduit system eg. where the conduit is butted up to a multi-hole gland installed in an isolator, can be less onerous on installation requirements.

There are a number of figures in the clause that assist in explaining the installation requirements for cable glands in outdoor locations.

Ensure that you read all the notes in this clause as they assist in understanding the requirements of the clause and how it relates to other figures and clauses in this standard.

Key points

The cable gland/s shall -

- be used to enter/exit an enclosure containing conductor terminations;
- be rated at least IP56;
- be installed so that each cable enters/exits through an individual hole and have hole diameter to maintain IP rating for the outside diameter of the cable used;
- have any spare holes sealed with the manufacturer approved sealing plug.

Installation of cable gland/s –

- Cable glands may enter/exit the bottom face of an enclosure containing conductor terminations, see AS/NZS 5033:2021 Figure 4.7.
- Where cable glands, enter/exit the side face of an enclosure installed in an outdoor location, the entry/exit point into the enclosure containing conductor terminations shall be higher than the lowest point of the wiring system (i.e. to create a drip loop), see AS/NZS 5033:2021 Figure 4.7, and —
    - be within 30 degrees of the space contained by the soffit and the plane from the outer edge of the soffit; or
    - be within 30 degrees from the top of the shroud and a plane from the outer edge of the mounting surface, see AS/NZS 5033:2021 Figure 4.8 and Figure 4.9.

See Figures 4.7, 4.8 and 4.9 in the standard for more detail.
The CEC will provide additional interpretive drawings in the next version of this advice document.

CEC code – 5033.2021.0.4.4.7.2.2

4.4.7.2.3 Conduits terminating into enclosures containing disconnection devices

Summary

There are different requirements for a continuous conduit system that has a section in an outdoor environment, depending on what the conduit system is terminated into.

Key points

Where a continuous conduit system has a section in an outdoor environment that terminates into an enclosure containing a disconnection device, it shall have a device to drain liquid from the conduit system.

- the device to drain shall –
    - be installed at the lowest point of the conduit system and;
    - shall be rated to at least IP 56.
- see AS/NZS 5033:2021 Figure 4.10 and Figure 4.11.

Where a continuous conduit system has a section that is in an outdoor environment, and that terminates into an enclosure containing conductor terminations, any open ends of the conduit system shall be sealed with a gland conforming to AS/NZS 5033:2021 Cl 4.4.7.2.2.

Where conduits and fittings enter/exit the side face of an enclosure installed in an outdoor location, the entry/exit point into the enclosure containing conductor terminations shall be in accordance with item (i) or item (ii) of AS/NZS 5033:2021 Cl 4.4.7.2.2.

See Figures 4.10, and 4.11 in the standard for more detail.
The CEC will provide additional interpretive drawings in the next version of this advice document.

CEC code – 5033.2021.0.4.4.7.2.3

4.4.7.3 Protection against weather and water for dedicated individual enclosures containing switch disconnectors

Summary

Where a dedicated individual enclosure contains a switch disconnection device/s it shall be protected against the effects of weather and water.

Key points

Dedicated individual enclosures containing switch disconnection devices are considered to be protected against the effects of weather and water when installed either—

- Within the space contained by the soffit and a plane from the outer edge of the soffit, at an angle of 30 degrees continuing to the surface that the enclosure is mounted on, see AS/NZS 5033:2021 Appendix K Figure K.1; or
- Within a non-combustible, and mechanically stable shroud resistant to ultraviolet radiation (UV) exposure where the shroud protects the switch disconnectors and meets at least the requirements of AS/NZS 5033:2021 Appendix K Figures K.2 and Figure K.3.

See Figures K1, K2 and K3 in the standard for more detail.
The CEC will provide additional interpretive drawings in the next version of this advice document.

CEC code – 5033.2021.0.4.4.7.3

4.6 Earthing arrangements

4.6.2 Earthing of PV array exposed conductive parts

Summary

Where the calculated PV d.c. circuit maximum voltage is greater than 35 V, there are a number of earthing requirements for the conductive parts of the PV array.
This clause covers:

- conductive PV module frames.
- array mounting frames that are directly in contact with PV d.c. cables.
- conductive cable support systems or conductive wiring enclosures that are directly in contact with PV d.c. cables.

PV array cabling that is installed in an insulating wiring enclosure is not deemed to be in direct contact.

PV systems that are connected to a non earth referenced system, exposed conductive parts of all associative equipment shall be equipotentially bonded. An example of this is an independent water pumping system that does not have direct connection to earth.

Key points

- all conductive PV modules frames shall be earthed
- array mounting frames that are directly in contact with PV d.c. cables
- conductive cable support systems or conductive wiring enclosures that are directly in contact with PV DC cables
- PV array cabling that is installed in an insulating wiring enclosure is not deemed to be in direct contact
- PV systems that are connected to a non earth referenced system, exposed conductive parts of all associative equipment shall be equipotentially bonded.

CEC code – 5033.2021.0.4.6.2

4.6.3 Earthing or bonding connections requirements

Summary

There are multiple methods to create earthing or bonding connections withing the PV array frame. PV array frames consist of conductive PV module frames and conductive mounting frames.

- A purpose-made fitting providing earthing or bonding connections for dissimilar metals and installed according to the manufacturer's instructions. (Some of these fittings are not designed for stranded cable).
- Purpose-made washers with serrations or teeth, designed to penetrate the surface for the connection of dissimilar metals between the PV module and mounting frames. These shall be installed at every connection between the PV module and mounting frame or in accordance with manufacturer's instructions.
- Tinned cable lugs of earthing and bonding cables fixed by stainless steel bolts washers and star washers to aluminium frames.
- Self-tapping screws and rivets shall not be used.
- Earthing or bonding connections to PV array frames shall be protected against corrosion.
- The earthing or bonding connections shall be arranged so that the removal of any one PV module will not affect the continuity of the earthing or bonding connections to any other PV module.

Key points

- Self-tapping screws and rivets shall not be used.
- Earthing or bonding connections to PV array frames shall be protected against corrosion.
- The earthing or bonding connections shall be arranged so that the removal of any one PV module will not affect the continuity of the earthing or bonding connections to any other PV module. Earthing or bonding connections to PV array frames shall be protected against corrosion.
- See AS/NZS 5033:2021 Cl 4.7.3.2 for testing requirements.

CEC code – 5033.2021.0.4.6.3

4.6.4 Connection to installation earth

Summary

The type of earthing required in PV systems is dependent on whether the site is subject to lightning.

When a site is ***not*** subject to lightning the inverter main earth conductor in the a.c. cable may be used as the earth connection point.

When earthing PV systems as part of a Lightning Protection System (LPS), the bonding conductors shall be connected to the electrical installation earthing systems as specified in AS 1768.

The PV array earthing conductors shall be connected to the electrical installation earthing system in all other applications.

Key points

- Sites not subject to lightning may use the inverter main earth conductor in the a.c. cable as the earth connection point.
- Sites subject to lightning have to comply with AS 1768 and cannot use the inverter main earth conductor in the a.c. cable.

CEC code – 5033.2021.0.4.6.4

4.6.5 Earthing or bonding conductor size

Summary

The earthing conductor between the exposed conductive parts of a PV system (above 35V) and the installation earthing system shall have a resistance of no more than 0.5Ω and must be selected in accordance with Figure 4.13 – PV array exposed conductive parts earthing or bonding decision tree.

The decision tree will either provide you with the minimum earthing or bonding conductor size or refer you to Table 4.6 – Earth conductor size.

There are a number of NOTES that must be read in conjunction with the decision tree.

NOTE 3 – Examples of separated PCEs are transformer based inverters

NOTE 4 – Examples of non-separated PCEs with powered neutral are single phase and three phase transformerless inverters with voltage balancing capability and multiple mode inverters.

If using a non-separated PCE, Figure 4.13 will refer you to Table 4.6 to determine earth conductor sizing.

Key points

- The earthing conductor between the exposed conductive parts of a PV array and the installation earthing system shall have a resistance of no more than 0.5Ω.
- Use Figure 4.13 decision tree to determine minimum earthing or bonding conductor size
- Minimum earth conductor size should be 4mm.
- If using a non-separated PCE, Figure 4.13 will refer you to Table 4.6 to determine earth conductor sizing.

CEC code – 5033.2021.0.4.6.5

5 MARKING

5.1 Equipment marking

All electrical equipment shall be marked as per the requirements for marking to local standards and regulations where applicable.

The CEC will provide additional interpretive drawings and marking examples in the next version of this advice document.

5.2 Requirements for labels and signs

5.2.1 General

All labels and signs required shall be –

- durable and designed to have a lifetime greater than or equal to the service life of the PV system.
- constructed of appropriate materials suitable for the location.
- fixed in a manner appropriate for the location.
- in English.
- legible and the letter size to be appropriate for the location.
- Indelible.
- visible where applicable (e.g. some signs may be enclosed in a switchboard cabinet, but not visible when an operator opens the switchboard to perform maintenance or emergency services).
- where installed exposed to direct sunlight conform to Clause 5.2.2.

6 SYSTEM DOCUMENTATION AND COMMISSIONING

6.1 General

At the completion of the installation of a PV system, documentation shall be provided in accordance with the requirements of this section in the standard. This documentation should ensure key system information is readily available to customers, inspectors, maintenance service providers and emergency service personnel.

The CEC will provide additional interpretive drawings and documentation examples in the next version of this advice document.
The CEC MyJobs tool already provides some of the documentation required. For more information on MyJobs go to https://www.cleanenergycouncil.org.au/account/jobs