Clean Energy Council

GRID-CONNECTED PV SYSTEMS (No Battery Storage)
SYSTEM INSTALLATION GUIDELINES
for Accredited Installers and Supervisors

Clean Energy Council ACCREDITED

GENERAL

The performance of a reliable installation that fulfils a customer's expectations requires both careful design and correct installation practice. Compliance with relevant State Health and Safety regulations is necessary.

STANDARDS for INSTALLATION

The following standards SHALL be complied with where applicable …

AS/NZS 3000	Wiring Rules	AS 4777.1	Grid connect - Installation
AS/NZS5033	Installation of Photovoltaic (PV) Arrays	AS 1768	Lightning Protection
AS 4509	Stand-alone Power Systems	AS/NZS 3008	Selection of cables
AS 1170.2 part 2:	Wind Loads	AS2050	Installation of roof tiles
AS/NZS 1562.1	Design and installation of sheet roof and wall cladding.		

The grid-interactive inverter shall be tested in accordance with the AS 4777 parts 2 and 3 and listed on the Clean Energy Council's approved inverter list. The system shall comply with the relevant electrical service and installation rules for the State where the system is installed.

Note that the local electricity distributor may have additional requirements.

These guidelines set additional requirements to the Standards. An accredited installer or supervisor is expected to follow these guidelines in addition to the requirements within the relevant standards.

DOCUMENTATION

All complex systems require a user manual for the customer. Grid-connected PV systems are no different. The documentation for system installation that must be provided is …

- List of equipment supplied
- Warranty information.
- System performance estimate
- Array frame engineering certificate
- Shutdown and isolation procedure for emergency and maintenance.
- System connection diagram.
- Equipment manufacturers documentation
- Array frame installation declaration and
- Handbooks for all equipment supplied.

- Maintenance procedure and timetable. This item should include a note that "Installation of a roof mounted PV system may also require additional maintenance for the roof and measures for access to conduct maintenance tasks, refer to roofing manufacturers guidelines".
- Commissioning sheet and installation checklist. [Note checklist should include that the owner is satisfied that the roof is suitable to accommodate the array over its intended life. This would require the homeowner to sign off on this point].

RESPONSIBILITIES OF ACCREDITED PERSON WHEN COMPLETING SYSTEM

As an accredited person, when signing off on a system you have either

1. ***Undertaken the installation yourself OR***
2. ***Supervised the installation by others ...*** *Supervision includes:*
   * *Visiting the site while the installation is occurring*
   * *Testing & commissioning the system and completing the commissioning sheets.*
     [part of these guidelines]

These guidelines have been developed by Clean Energy Council. They represent latest industry BEST PRACTICE for the design and installation of PV Grid Connected Systems. © Copyright 2010

While all care has been taken to ensure this guideline is free from omission and error, no responsibility can be taken for the use of this information in the installation of any grid-connected power system

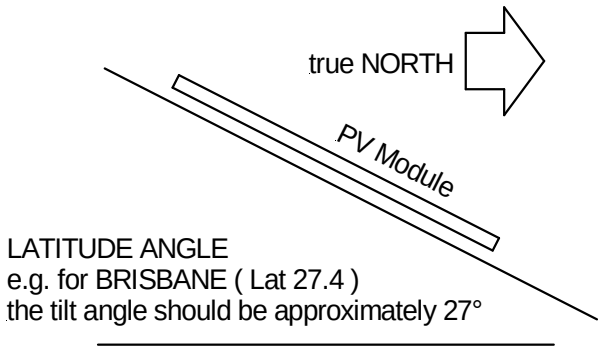
PV ARRAY

ORIENTATION AND TILT

In grid connected PV systems the solar array is generally mounted:

- "Flat" on the roof OR
- Integrated into the building OR
- On an array frame that is tilted to fix the array at a preferred angle (usually for flat roofs).

Modules that are electrically in the same string must be all in the same orientation.
For best year-round performance, a fixed PV array should be mounted facing true north (± 10°) at an inclination equal to the latitude (± 10°) angle or at an angle that will produce the best annual average performance taking into consideration: seasonal cloud patterns, local shading and environmental factors.



Note : Many roofs have a pitch between 17 and 22°
Having the array at the same tilt as the roof is generally recommended for ease of installation and may be necessary for meeting wind loading requirements.
The yearly energy loss compared to the optimum tilt angle for Adelaide, Melbourne, Perth and Sydney is about 2% while in Hobart it is 5%

If the array is "flat" on the roof or integrated into the building fabric, the array will often not be at the preferred (optimum) tilt angle and in many situations will not be facing due north.

A minimum tilt of 10° is recommended to take advantage of self-cleaning during rain events. Horizontally mounted arrays will require additional maintenance [cleaning].

Included with the design guide is a set of tables for the following locations:

- Hobart
- Canberra
- Brisbane
- Adelaide
- Darwin
- Melbourne
- Sydney
- Cairns
- Alice Springs
- Perth

These tables show the average annual daily total irradiation represented as a percentage of the maximum value

i.e. PV orientation is true North (azimuth = 0°) with an inclination equal to the latitude angle.

They provide values for a plane in 36 orientations (azimuths) and 10 inclination (tilt) angles.
[increments of 10^{o}] and have been derived from the Australian Radiation Data Handbook
(Table 5.13)

The tables provide the system designer/installer with information on the expected output of a system (with respect to the maximum possible output) when it is located on a roof that is not facing the true north (± 10°) at an inclination equal to the latitude angle.

ROOF MOUNTING [not building integrated]

- If the modules use crystalline cells then it is preferable to allow sufficient space below the array (> 50mm) for ventilation cooling. This will be subject to the constraints of the customer or architect. Insufficient ventilation will result in high operating temperatures for the modules.
- It is important to allow sufficient clearance to facilitate self-cleaning of the roof to prevent the build up of leaves and other debris, refer to roofing manufacturers guidelines
- If possums and other fauna are a problem in the vicinity of the installation then consideration should be given to how to prevent them gaining access under the array (see cable protection).
- All array supports, brackets, screws and other metal parts should be of similar material or stainless steel to minimise corrosion. If dissimilar metals are used then they should be galvanically isolated.
- Refer to manufacturers guidelines to ensure that the materials introduced are compatible with the roofing.

- Where timber is used it must be suitable for long-term external use and fixed so that trapped moisture cannot cause corrosion of the roof and/or rotting of the timber. The expected replacement time should be stated in the system documentation.
- Any roof penetrations must be suitably sealed and waterproof for the expected life of the system, refer to roofing manufacturers guidelines. If this is not possible then this must be detailed in the system's Maintenance Timetable.
- All fixings must ensure structural security when subject to the highest wind speeds for the region and local terrain - refer to AS1170.2
  This may require specific tests of the fixing/substrate combination on that roof.
- The installer shall ensure that the array frame that they install has applicable engineering certificates verifying that the frame meets AS1170.2 for that particular location.
- The installer must follow the array frame supplier's/manufacturer's recommendations when mounting the array to the roof support structure to ensure that the array structure still meets AS1170.2 certification.
- All external wiring must be protected from UV and mechanical damage in such a manner that it will last the life of the system (see cable protection).

Attachment 1 provides some guidance for securing PV arrays on roof structures.

FREE STANDING PV ARRAYS

Must be wind rated in accordance with AS 1170.2 part 2: Wind Loads.

ROOF MOUNTED PV ARRAYS

All PV array mounting systems must be wind rated (refer to Attachment 1 for guidance)

BUILDING INTEGRATED (BIPV) INSTALLATIONS

The installation of modules that are being used as building material e.g. tiles, building walls, sun-screens should only be installed by a person qualified to install that particular type of building element.

VERIFICATION OF AS1170.2

1. Installers shall obtain from their frame supplier a copy of the engineering certificate stating that the array frame is certified to AS1170.2 for their location. They must also obtain information on how the frame is to be mounted on the roof to maintain this certification.
2. The installation checklist now includes a clause stating that the system has been installed in accordance with the recommendations of the supplier/manufacturer.
3. Copies of both these documents shall be included in the manual provided to the customer.

Note: If installers are manufacturing their own frames, then they must provide the certificates and include in the manual.

ROOF MOUNT ISOLATORS and JUNCTION BOXES

Where roof mounted isolators and/or array junction boxes are mounted on roof, the installer must ensure that the integrity of the IP rating is maintained and that no moisture can enter the isolator or junction boxes.

The roof mounted isolator should be mounted such that the switch is in a sideways position (see Figures 1a and 1b).
It should not be mounted with the switch facing upwards.

It is recommended that junction boxes are mounted so that the access to the junction box is made on the side of the junction box and not on a side facing up.
The conduit entry points should be on the lower end of the box - either underneath or facing down the roof.

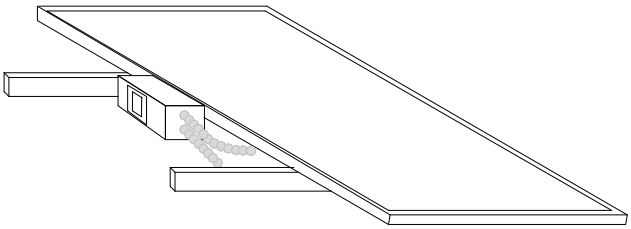


Figure 1a Roof top isolator

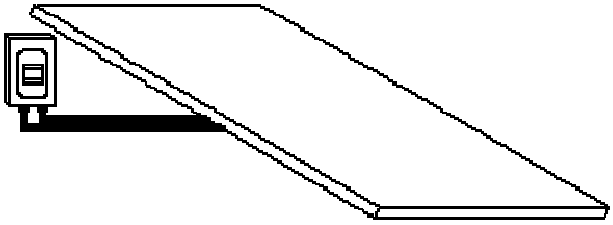


Figure 1b Roof top isolator

Note: Ensure that the switch does not shade the array.

All screw cover caps that are supplied with isolator box or junction box must be installed. All mounting holes should be silicone filled. Conduit entering the isolator box or junction box should have a drain hole to allow the exit of any moisture from conduit to isolator box or junction box.

INVERTER INSTALLATION

If the inverter is designed to be installed behind the module (a.c. module) then consideration should be given to adequate ventilation and to the ease of replacement in the event of an inverter failure. In many cases, where the inverter is not provided physically mounted on the module, then it is preferable to group such 'micro' inverters in a centralised enclosure or panel off the roof.

If a central inverter (or inverters) is used and the inverter enclosure is not weatherproof (e.g. IP 54 rated) then these should either be located inside the building or in an appropriate weatherproof enclosure.

The inverter heat sink must be clear of any obstacles to facilitate cooling of the inverter. The manufacturers recommended clearances must be followed.

PV ARRAY ISOLATOR

A double pole load break PV array isolator (switch) shall be mounted near the inverter.

In practice this isolator is typically a double pole d.c. rated circuit breaker.

NOTE:
A breaker not rated for the open circuit d.c. voltage of the array and the d.c. short circuit current of the array shall not be used as the PV Array Isolator.

If the double pole d.c. circuit breaker is polarised then the installer shall ensure that it is wired correctly. Failure to wire correctly could lead to a fire when this isolator is operated in full sun.

AC ISOLATOR at INVERTER

An a.c. isolator shall be installed at the output of the inverter unless it is located alongside the switchboard.

EQUIPMENT PROTECTION and ISOLATION

AS 4777 states all the requirements for protection and isolation when connecting inverters with the grid. All systems shall be installed in accordance with the AS 4777 standard.

AS/NZS 5033 states all the requirements for protection and isolation within the PV array. All systems shall be installed in accordance with the AS/NZS 5033 standard.

NOTE : The system shall be installed in accordance with all relevant electrical service and installation rules for the State in which the system is installed

CABLE SELECTION

For extra low voltage (ELV) arrays and low voltage (LV) arrays …

All cabling must be sized in accordance with AS/NZS 3000 and AS/NZS 3008.

Cable losses between the PV array and the inverter should be as low as practical and consistent with cable size and cost decisions. To maximise system output it is recommended that the cable less is a maximum of 1%. It is recommended that the voltage drop between the inverter and the point of connection of supply should be kept as small as possible (recommended <1%) to minimise voltage rise within the installation to limit inverter disconnection in areas where the grid voltage may be high to decrease incidents of overvoltage trips for inverters.

CABLE PROTECTION

The cables shall be electrically protected in accordance with AS/NZS 3000 and AS/NZS 3008.

All cables used in the installation should be securely fixed in place to minimise any movement of the cable in accordance with AS/NZS 3000.

Mechanical protection of the cables shall be in accordance with AS/NZS 3000.

In particular refer to the clause in AS/NZS3000 that refers to fauna which states: *Where the presence of fauna is expected to constitute a hazard, either the wiring system shall be selected accordingly, or special protective measures shall be adopted*..

If this is a problem in the locality of the system installation then mechanical protection of the array cable will be required

All conduits exposed to sunlight must be suitably UV rated. Not all corrugated conduits are UV rated so if using corrugated conduit ensure that it is UV rated.

Plastic cable ties are not suitable for cables in exposed situations. They can also chafe the cables.

The d.c. cables connecting to the inverter shall be installed in such a manner that they cannot be easily unplugged from the inverter.

This can be achieved by:

(i) having the inverter housed in an enclosure (with cables suitably supported) ;

(ii) the use of an inverter which has the cable connection area of inverter covered by a removable enclosure/cover which protects the supported cables so that there are no exposed, unsupported cable loops.

Connection of a.c. and d.c. components in the same enclosure should be segregated.

d.c. wiring shall not be placed in a.c. switchboards.

WIRING of LV ARRAYS

The electrical installation of the array shall be in accordance with AS/NZS 5033: Installation of PV Arrays. All LV wiring must be undertaken by a licensed electrician.

A dangerous situation occurs when the person installing the system is able to come in contact with the positive and negative outputs of the solar array or sub-array when the output voltage is 120V d.c. or above.
Most grid-connected systems use approved solar modules which are connected using double insulated leads with polarised shrouded plug and socket connections.

A dangerous situation is only likely to occur at:

- the PV Array isolator before the inverter;
- the roof-top isolator if one exists ; and
- the sub-array and array junction boxes (if used).

To prevent the possibility of an installer coming in contact with live wires, it is recommended practice that one of the interconnect cables in the middle of each string (as shown in Figure 2) is left disconnected until all the wiring is completed between the array and the inverter. Only after all isolators and other hard wired connections are completed, should the interconnection in the middle of the array be connected.

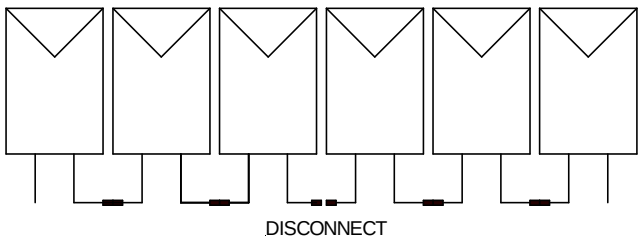


Figure 2

If the solar array is to be hard wired then the recommended procedure is provided in Attachment 2.

The installer shall ensure that all connectors used are waterproof and connected securely to avoid the possibility of a loose connection. Only connectors which are the same type/model from the same manufacturer are allowed to be married at a connection point.

Solar module interconnect cables must be supported clear of the roof surface to prevent debris build up or damage to insulation.

WIRING from LV ARRAYS to PV ARRAY ISOLATOR near INVERTER

LV PV array cable shall be clearly identified as d.c. LV cable to ensure that it cannot be mistaken for a.c. cable.

To avoid confusion it is recommended that between the array and the inverter Single core double insulated (SDI) solar cable is used similar to that used for interconnecting the solar modules in the array.

It is recommended that the cable is sized such that the maximum voltage drop between the array and the inverter is less than 1%.

SOLAR SUPPLY ISOLATOR in SWITCHBOARD

AS 4777 requires an a.c. solar supply isolator located on the switchboard (or distribution board) where the solar system is connected. Throughout the rest of this document this will be referred to as main switch inverter supply

In accordance with AS/NZS3000 the cable between the switchboard and inverter requires protection so it is recommended that the isolator is a suitably rated circuit breaker.

EARTHING of LV ARRAY FRAMES

If the system includes a transformerless inverter with no galvanic isolation, then the PV module frames (if metal) must be earthed - refer to Attachment 1 for guidance.

It is anticipated that in the future the modules may not be deemed class II and then all frames will be required to be earthed.

Further information on earthing of array frames will be provided with the next update of these Guidelines and also through Tech Info's.

It is recommended that the earthing connection is completed once the wiring of the array has been completed.

EARTHING of LV ARRAYS

If the PV array is electrically earthed (that is : either the positive or negative is earthed), such earthed arrays cannot be connected to a transformerless inverter with no galvanic isolation.

For safety, it is recommended that the earthing connection is completed once the wiring of the array has been completed. This is to ensure that the installer does not receive an electric shock by touching the unearthed output of the array during installation.

SHUTDOWN PROCEDURE

A shutdown procedure shall be installed near the inverter or switchboard to ensure safe de-energisation of the system.

The procedure should be:

- Turn off the a.c. Main Switch Inverter Supply Isolator at the switchboard and then the ac Isolator at the inverter

then

- Turn off the PV Array isolator at the Inverter.

When undertaking any work on the array cabling between the array and inverter, good practice is to disconnect a plug in the middle of each module string so that the array is then de-energised (refer to Figure 2).

METERING

The PV grid-connected system shall be interconnected to the grid at a switchboard or distribution board in accordance with AS 4777.1 and as required by the local electricity distributor's guidelines.

The metering to be installed will vary in accordance with the local electricity distributor's guidelines.

In states and territories with gross feed-in tariffs, the meter will measure the exact energy output of the solar system.

Where net metering is installed, the meters will only record the energy that is supplied to the grid not all the energy from the solar system

Some inverters have on-board metering of the instantaneous and cumulative output of the PV system. Where this is not the case and the distributor's approved metering does not provide a recording of the exact energy output of the PV inverter system, it is recommended that a separate meter is installed to ensure that the output of the PV inverter system is recorded. This will help in the event the customer thinks they are not receiving as much energy as they expected .

SIGNAGE

All signage on switches, isolators and within distribution boards and switchboards shall be in accordance with :-

- AS 4777 and AS/NZS 5033

and/or

- the relevant electrical service and installation rules for the State where the system is installed

COMMISSIONING

The commissioning sheets provided with these guidelines (or similar document) shall be completed by the accredited installer or the accredited supervisor (with suitably licensed person). A copy shall be provided to the customer in the system documentation and a copy retained by the accredited person.

LICENSING

EXTRA LOW VOLTAGE (ELV)

All extra low voltage wiring should be performed by a 'competent' person, which is defined by the Australian Standard AS/NZS 4509.1 Stand-alone Power Systems as …

" a person who has acquired through training, qualifications, experience or a combination of these, knowledge and skill enabling that person to correctly perform the task required."

LOW VOLTAGE (LV)

All low voltage work : >120V d.c.; >50V a.c., must be performed by a licensed electrician.
A licensed electrician is required to be responsible for the safety of the system wiring prior to connection of the system to the grid.
If the system contains ELV wiring installed by a non-licensed person, then a minimum level of inspection by the electrician prior to closing the PV array isolators would include :-

- An open circuit voltage test on each PV string and on the total array
- A visual inspection of an open PV junction box (randomly selected) and the master array junction box.

These inspections/checks shall confirm

- The array voltages are as designed and specified
- The appropriate cables (CSA and insulation), junction fittings and enclosures have been used.

An accredited non-electrician ELV installer would be expected to have also carried out these checks.

These guidelines alone do not constitute a fully definitive set of rules and are to be read in conjunction with all relevant Australian Standards. Where these guidelines have additional requirements above that stated in the Australian Standards then these guidelines should be followed.

INSTALLATION CHECKLIST

PV ARRAY

Mounted flat on roof ☐
Building integrated ☐
Mounted on tilted array frame ☐
PV Array tilt ……°
PV Array orientation ……°
PV Array is securely fixed and installed in accordance with the manufacturers recommendations ☐
Any timber used is suitable for external use or is properly sealed ☐
No dissimilar metals are in contact with the array frames or supports ☐
Roof penetrations are suitably sealed and weatherproofed ☐
PV wiring losses are less than 1% at the maximum current output of the array ☐
Where PV array comprises multiple strings - string protection has been provided AS/NZS 5033 ☐
Wiring is protected from UV and mechanical damage ☐
Weatherproof isolator (where required by local electricity distributor) is mounted immediately adjacent to the PV array ☐

INVERTER

Double pole DC isolator [or DC circuit breaker] is mounted close to input of the inverter (rating. ……A) ☐
If d.c. isolator is of the polarised type then it is correctly connected to ensure operation under full load ☐
Isolator is mounted on output of the inverter (can be part of inverter) ☐
Lockable AC circuit breaker mounted within the switchboard to act as the main switch for the PV / inverter system. (rating …….. A) ☐
Inverter is inside building or in weatherproof enclosure with adequate space and ventilation ☐
LV DC CABLING is clearly identified – LV DC or similar at least every 3 metres ☐

SIGNAGE (White on Red) AS 4777.1 & Appendix A

WARNING
Dual Supply
Isolate Both Normal and Solar Supplies before working on this

is permanently fixed on the switchboard. ☐

Normal Supply MAIN SWITCH

is permanently fixed at the main switch ☐

Solar Supply MAIN SWITCH

is permanently fixed at the main solar switch ☐

If the solar system is connected to a distribution board then the following sign is located on main switchboard and all intermediate distribution boards

WARNING
DUAL SUPPLY
ISOLATE SOLAR SUPPLY AT DISTRIBUTION BOARD DB???

☐

Where the inverter is not adjacent to the main switchboard, location information is provided ☐

Warning and Advisory Signs AS/NZS 5033 & Appendix G

SOLAR DC

is permanently fixed on array junction boxes (Black on White) ☐

SOLAR ARRAY
ON ROOF

Open circuit voltage: 220 V
Short circuit current: 20 A

Colour: White on red

Fire Emergency information is permanently fixed on the main switchboard ☐
(White on Red)

Shutdown procedure is permanently fixed at inverter and/or on main switchboard ☐
Any other signage as required by the local Electricity Distributor ☐

230-240 VOLT (LV) INSTALLATION

All low voltage wiring has been installed by a licensed electrical tradesperson ☐
All wiring has been tested and approved by a qualified electrical tradesperson ☐

This checklist is based on the Clean Energy Council's GC Design and Installation Guidelines. The Guidelines demonstrate the latest industry "best practice" and are to be read in conjunction with the relevant Australian Standards.

AUTHORISATION : I, ……..…….. CEC Accreditation number …… verify that the following system has been installed to the standard indicated by these guidelines and complies with all applicable Australian Standards

Name of the person for whom the system was installed ……..

Location of system ……..

signed …….. Date : / / *Attach a separate sheet detailing any departures*

TESTING and COMMISSIONING

PV ARRAY- d.c.

NOTE : where there is only 1 string and no array junction box, then the following tests will be conducted between the string and the PV array isolator at the inverter.

Isolate PV string and array wiring

CHECK that there is no voltage on input ☐
OR output sides of any array junction box (where installed)

CHECK
Continuity between strings and array junction box

- String 1 +ve ☐
- String 1 -ve ☐
- String 2 +ve ☐
- String 2 -ve ☐
- String 3 +ve ☐
- String 3 -ve ☐
- .....
- Continuity between array junction box and PV array isolator ☐

CHECK
Polarity of PV string and array wiring

- String 1 ☐
- String 2 ☐
- String 3 ☐
- ..... ☐
- Array +ve ☐
- Array -ve ☐

Polarity of wiring between array junction box and PV array isolator ☐

WARNING:
IF POLARITY OF ONE STRING IS REVERSED, THIS CAN CAUSE A FIRE IN THE ARRAY JUNCTION BOX.

RECORD PV string open circuit Voltage

String 1 V
String 2 V
String 3 V

WARNING:

The following procedures describe how to measure short circuit currents - the voltages can be very high and if the procedures are not followed then arcing and damage to components could occur.

Note: Some projects require that short circuit currents are recorded as part of the contractual commissioning; otherwise a record of the actual operating current of each string is sufficient.
This could be done by using the meter on the inverter or by using a clamp meter when the system is operational.

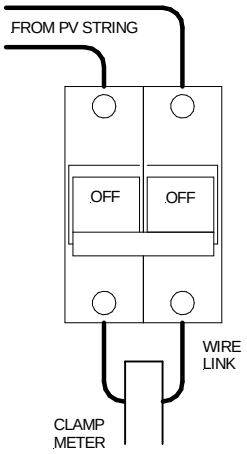


Figure 3

1. Where short circuit currents are required undertake the following steps to measure the short circuit current safely as shown in Figure 3:
   Ensure each string fuse (where required) is not connected or that LV array is disconnected in the middle of the string as shown in Figure 1 of these guidelines.
2. Leave solar array cable connected to the PV array isolator.
3. Remove the cable from the PV Array isolator to the inverter.
4. With the PV array isolator off - put a link or small cable between the positive and negative outputs of the PV array isolator.
5. Install the string fuse for string 1 or connect the ELV segments to complete the wiring of the string.
   Turn on PV array isolator - using a d.c. clamp meter measure the DC short circuit current for String 1. Turn off PV array isolator. Disconnect string fuse for string 1 or remove links to break string into ELV segments.
6. Repeat point 5 for each string
7. After each string has been individually measured – ensure PV array isolator is off- then install all string fuses or connect the ELV segments of each string. Turn on PV array isolator and measure d.c. Array current using clamp meter. Turn off switch and remove link in output of PV array isolator.

Where short circuit currents are **not** required then record the operating current/s after Start-Up of System.

RECORD

Short circuit Currents (where required) String 1 .....A

String 2 ..... A

String 3 ..... A

String 4 .....A

Array ..... A

Irradiance at time of recording the current .....W/m^2

With the PV array isolator **OFF**

CHECK continuity between PV array isolator and inverter

Array +ve ☐

Array -ve ☐

CHECK polarity between the PV array isolator and inverter ☐

RECORD Open circuit voltage at input side of the PV array isolator V

WARNING: If polarity is reversed at the inverter damage may occur which is generally not covered under warranty

INVERTER - a.c.

Ensure that the a.c. normal supply is isolated and the main switch Solar supply is OFF

CHECK continuity between Inverter & main switch Solar supply

Line ☐

Neutral ☐

CHECK continuity between main switch Solar supply & kWh meter

Line ☐

Neutral ☐

CHECK polarity at the Inverter and the main switch Solar supply ☐

CHECK polarity at the output of main switch Solar supply from the kWh meter ☐

Initial reading of kWh meter .....

Accredited Installer Name.....

Signed..... Date.....

Licensed Electrician Name.....

Signed..... Date.....

Start-Up of System

Refer to system manual for the inverter and follow start-up procedure.

This generally involves turning on the PV DC main switch followed by the Solar AC main switch but the procedures as recommended by the inverter manufacturer must be followed.

System connects to grid [after 60 seconds] ☐

When the AC main switch is turned ON
- follow the inverter start-up procedure -

Voltage at d.c. input of inverter V

Voltage is within operating limits of inverter ☐

Voltage at a.c. output of inverter V

Input power of the inverter (where available) .....W

Output power of the inverter (where available) .....W

Output power as expected ☐

Turn AC main switch OFF

System immediately disconnects from grid ☐

PV operating current

1. Where there's only one string in the array record the operating current after Start-Up of System.
2. If more than one string - turn off the inverter, the a.c. main switch and d.c. main switch. Isolate all strings.
3. With one string connected at a time turn system back on and record the operating current of that string.

Repeat 2 and 3 above until all string currents have been recorded.

NOTE: Unless you have a solar irradiance meter then any string current tests should be performed on a bright sunny day with no cloud. This is to avoid varied readings due to cloud cover.

RECORD operating currents : String 1 .....A

String 2 ..... A

String 3 ..... A

String 4 .....A

Array ..... A

ATTACHMENT 1

PV module earthing

It is especially important that PV frame earthing is provided when using non-isolated 'transformerless' inverters.

Non-isolated inverters operate at high frequency. There will be an a.c. component on the d.c. supply. This is capacitively coupled to the module frames producing an a.c. voltage. While not likely to be lethal, this electrostatic charge, if not depleted by earthing, could be enough to frighten and possibly cause a person to fall off the roof
e.g. the system owner, while cleaning modules.

IEC 61730-1 'PV module safety qualification – Requirements for construction'
will possibly no longer deem modules Class II equipment and the upcoming revision of AS/NZS 5033 'Installation of photovoltaic (PV) arrays will be recommending earthing of all LV PV module frames.

Please note …
Aluminium oxide forms on the surface of aluminium exposed to the air. It is an insulator. Anodising is just a thicker layer of coloured aluminium oxide.
Earthing the array structure does not earth the module frames. Module frames must be individually earthed using external tooth star washers to penetrate the oxide coating. The connection is then sealed – if using spray paint, take care that there is no overspray on the module surface. Excellent special purpose earthing lugs are available from the US which enable "gas tight" connections to module frames.

Earth wires must be run so that the removal of one component (e.g. module) does not interrupt the earthing of other parts of a system.

In other words daisy chaining earth connections is not permitted.

PV array roof mounting

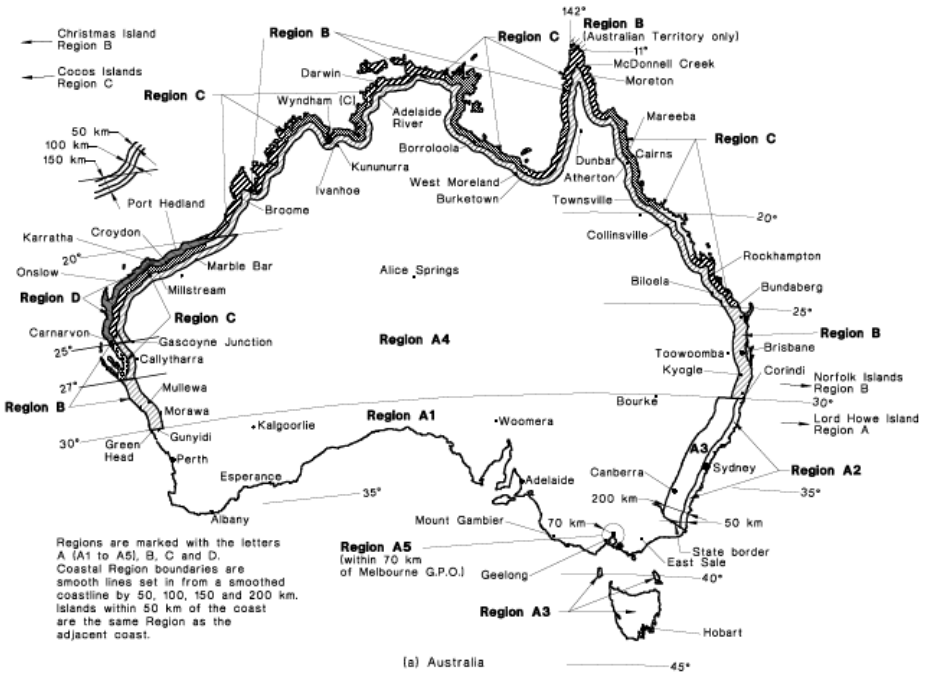
refer to *AS/NZS 1170.2*
Structural design actions - Wind actions
and *Australian Wind Regions* map below.

PV array frames must be wind rated for the site. Consult the manufacturer's specifications. (Some modules are not suitable for use in cyclone zones)

Care must be taken with roof fixing systems. Consideration must be given to factors such as …
- wind direction
- terrain category - suburban, city / industrial
- location topography - bottom / mid / top of ridge
- height of structure

As an example, where the PV array is within 1 metre of roof edges, wind loading can be doubled. Additional fixing may be required based on the wind region.

Wind regions C and D are cyclonic areas
- special roof and PV module attachment requirements. Consult the PV module structural and mounting specifications for high wind areas.



ATTACHMENT 2

Hard Wiring of PV arrays

The method outlined in this procedure is to be followed if the interconnection between the solar modules will be hard wired. It has been written to prevent a person being able to touch the two live array LV output cables either within:

- a module junction box OR
- the isolator located near the array.

Using this method, the junction boxes on the modules will only have a live ELV supply

Please read this procedure in conjunction with Figure 2.1.

a) The positive cable from the isolating switch or breaker is connected to the solar module junction box which is designated as the positive connection. This cable is double- insulated and there are no other electrical connections between the isolating switch and the array positive junction box.

b) The negative cable from the isolating switch or breaker is connected to the solar module junction box which is designated as the negative connection. This cable is double-insulated and there are no other electrical connections between the isolating switch and the array positive junction box.

c) To ensure that the installer does not work on live positive and negative cables in close proximity to the isolation switch:

either : the positive and negative cables are electrically connected to the double pole isolating switch or breaker prior to electrically terminating the cables within the array junction boxes

and/or :

there is a 'multi-contact' style insulated plug and socket connection in the middle of the array which is connected after the array is wired and the cables are connected in the isolation switch.

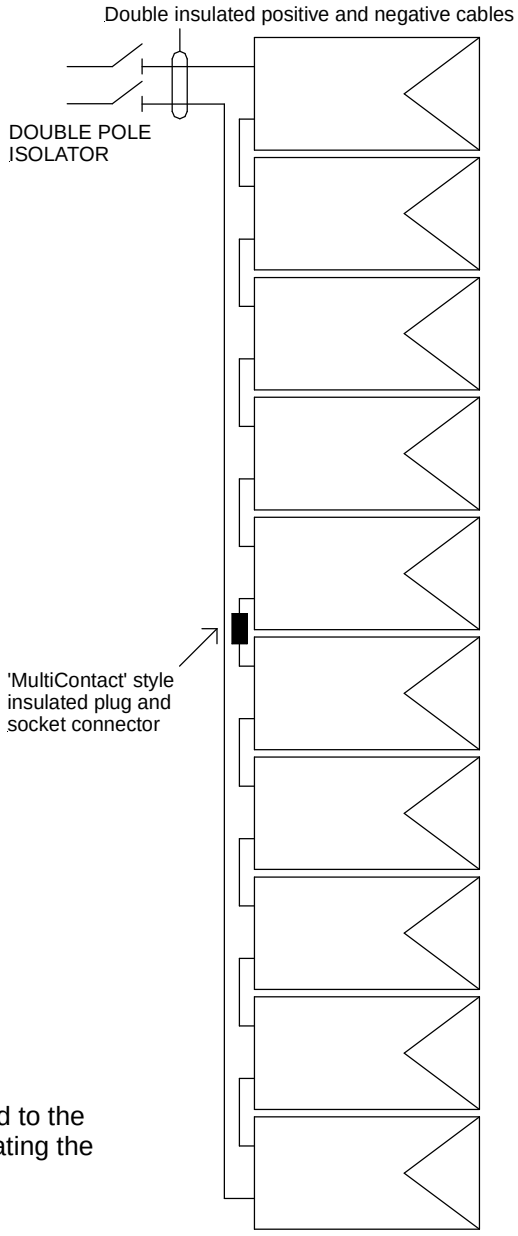


Figure 2.1