Installing grid connected photovoltaic systems in the ACT

Frequently asked questions

Note: The information published below was correct at the time of publication (December 2011).

1. What licences do I require in the ACT?

You need to hold an ACT construction occupations licence:

Occupation: Electrician Class: unrestricted

All wiring work in a grid connected PV installation is to be carried out by a holder of an ACT licence. You can apply for mutual recognition of an interstate licence using form CL2, available from our web site under forms.

2. How do we temperature adjust the Voc rating of a PV installation for the inverter?

The maximum voltage rating of the inverter needs to be higher than the maximum output voltage of the PV system when adjusted for temperature variations. Clause 4.1.2 of AS/NSZ 3000:2007 requires you to prevent any adverse effects the electrical equipment might cause on the electrical installation.

Where the temperature coefficient (Voc) of the PV panels is not stated, the inverter used must have a voltage rating equal to, or greater than, 1.12 x Voc array.

Where the temperature coefficient (Voc) of the PV panels is stated, using the minimum temperature of -10 degrees Celsius you may use the PV panels temperature coefficient to ensure your system design does not expose the inverter to a greater voltage than it is rated for.

Example 1

Using a Voc of 358.4Vdc can I use an inverter rated with 400Vdc max volts?

Option 1: Temperature coefficient (Voc) of PV panels is not stated

Voc (358.4) x 1.12 = 401.408 Vdc

You **cannot** use an inverter rated at 400Vdc max volts

Option 2: Where the temperature coefficient (Voc) of the PV panels is stated.

Temperature coefficient (VOC) –0.33 % / °C. The standard test conditions are at 25° Celsius. Using the minimum of -10° Celsius, the difference is 35° Celsius.

Therefore -35 x -0.33% = 11.55%

Voc array (358.4) x 1.1155 = 399.8 Vdc

You **can** use an inverter rated at 400Vdc max Volts.

3. Is separation of DC and AC isolators/CB's at the inverter required?

Yes. Separation is required as the generation DC supply is not part of the electrical installation that is connected to the grid. AS/NZS 3000:2007 Clause 3.9.8 covers segregation of wiring systems of different installations, particularly within common enclosures.

Separation can be achieved by individual enclosures, by internal barriers within a common enclosure or by physical separation.

A mounted inverter would, by normal wiring practice, have its DC and AC surface mounted isolators separated by practical requirements.

Compliance problems may exist if a common enclosure is used for inverter input/output isolation.

Each wiring system (DC and AC conductors terminated to their respective isolators) must have a suitable barrier (should be an accessory for the enclosure) and have a suitable voltage and fire rating.

When a barrier is not used, distance and wiring stability principles apply.

Wiring termination stability means the terminated conductor must be restrained so under failure it cannot migrate across other terminals and short circuit.

The principles of AS/NZS 5033:2005 of Clauses 3.3.4 and AS/NZS 3000:2007 5.4.1.1 - Exception C should apply.

4. What approvals are required of miniature circuit breakers?

All miniature over current circuit breakers DC and AC are prescribed articles and must exhibit evidence of approval.

Evidence is either the regulatory compliance mark (rounded edged triangle with incorporated 'C' tick) or an alpha numeric safety mark (e.g. Q - QLD, N - NSW, V - Victoria, etc) followed by the certification year (e.g. 09, 07) and the 4+ digit certificate number hence, Q071234. The *ACT Electricity Safety Act 1971* sets out product safety approval.

In addition, circuit breakers, isolators and any other load breaking disconnection devices used for protection and/or disconnecting means shall comply with the following requirements of AS/NZS 5033:2005 clause 4.3.3(a):

- Where circuit breakers are used in a PV array, they **cannot be polarity sensitive**, (as fault currents in PV array may flow in the opposite direction of normal operating currents) except for the PV array main switch in systems without batteries.
- Be rated to interrupt full load and prospective fault currents from the PV array and any other connected power sources such as batteries, generators and the grid if present.

The DC isolator adjacent the inverter is the PV array main switch. The roof top isolator and all other isolators are not the PV array main switch so **cannot be polarity sensitive**.

Notes

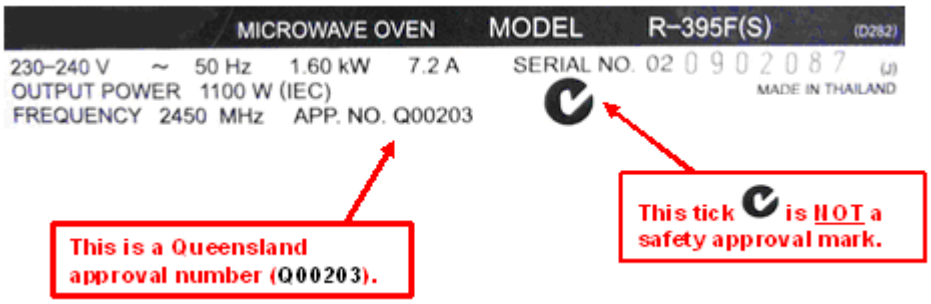
Marking requirements: Prescribed equipment must be marked with the approved mark required by the electrical regulator who approved the equipment, or be marked with the

regulatory compliance mark (RCM). Typically, these markings consist of a letter to indicate the state in which approval was granted, followed by a number of symbols.

Examples of the marks issued under the legislation of the various regulators include:

Queensland	Q91610, Q051123, ESO110345
Western Australia	W2015
Victoria	V99, V105, V98333, V05212, ESV12345
South Australia	S1, S442
Australian Capital Territory	A050
Tasmania	T05123
New South Wales	N11, N10422, NSW1234, A/10234/EA, SAI SMK EA 10578, SAA10156EA, SGSEA10345, AGA 11024EA or QAS:TE1234, SAI:TE1234 with  or 

Electrical appliance approval label:



RCM mark:

Australian Standard >AS/NZS 4417.1 Marking of electrical products to indicate compliance with regulations - general rules for use of the mark provides general requirements for using the RCM.

The C-tick:

The C-tick is not an electrical safety approval. It must be placed next to the C-Tick or RCM symbol.

The Australian Communications and Media Authority (ACMA) regulate the EMC requirements of electrical product (The C-tick). This recognition process allows the use of a number that starts with an 'N' eg N1244. This number should not be confused with the approval number issued by the New South Wales electrical safety regulator.

For information on the C-Tick and EMC requirements contact the Australian Communications and Media Authority (ACMA)

5. Where are roof top and array isolators required?

Full load breaking isolators are required on the PV array wherever the wiring system enters the building. See Q4 in relation to approvals and the use of circuit breakers as isolators.

Locations of isolators:

Where the PV array is on the roof:

- at least one isolator is required at each PV array and sub array
- isolators are to be used wherever the wiring system enters the building.

Where the PV array is on the side of buildings as glazing:

- an isolator on the inside wall adjacent to the PV panel, or between two panels
- label PV panel with location of isolator (the label must last the life of the panel)
- make the isolator accessible and label it to its function
- where the isolator is above a ceiling panel, provide access so that it can be worked on and provide a location label on the access panel
- ensure the isolator can be locked in the off position.

In all other cases:

- an isolator is required on the array where the inverter
    - is not in sight of the array
    - is more than 3m from the array.

Note:

Plugs and sockets are not to be used as isolators. Only specially constructed plugs and sockets are capable of interrupting load safely. All systems with an open circuit voltage greater than 30Vdc can experience d.c. arcs. Plugs and sockets which are not specially constructed for load interruption if disconnected under load represent a safety risk and generally incur damage to the connection, which will compromise the quality of the electrical connection and could lead to overheating.

Note:

Care should be taken to stop moisture entering isolators through conduits and glands.

6. What voltage rating do the poles of isolators need to be?

To comply with the requirements of AS/NZS 5033:2005 earth faults, the following will satisfy:

- Where the inverter has a transformer, the isolator shall be rated to Voc (temp adjusted).
- Where the inverter is transformer-less, each pole shall be rated to Voc (temp adjusted).
- Where an earth is used on the positive or negative conductor, each pole shall be rated to Voc (temp adjusted).

Note: 5 December 2011 update

Some inverter manufactures are installing RCD protection in the inverter to enable the use of lower rated isolators. At this stage we do not allow this reduction in isolator rating as there is no standard to test this claim against. The publication of the new AS/NZS5033 should address this issue. Until otherwise advised, the answer in FAQ 6 applies regardless of a RCD being fitted.

7. Is over current protection required on the DC side of the inverter?

The principles of AS/NZS 3000:2007 clause 7.3.5 apply.

- **No** – where a uni-directional inverter is used. The inverter will not pass power into the PV array either from the grid or battery bank. It is current limited.
- **Yes** – where a bi-directional inverter is used. The inverter will pass power into the PV array either from the grid or battery bank. Fault current from the grid or batteries is possible.

Note:

Bi-directional inverters are used when energy is required in the PV panels to melt snow and ice. Not typically used in the ACT.

Note:

AS/NZS 5033:2005 clause 4.3.3(a):

- Where circuit breakers are used in a PV array, they **cannot be polarity sensitive**, (as fault currents in PV array may flow in the opposite direction of normal operating currents) except for the PV array main switch in systems without batteries.
- Be rated to interrupt full load and prospective fault currents from the PV array and any other connected power sources such as batteries, generators and the grid if present.

The DC isolator adjacent the inverter is the PV array main switch. The roof top isolator and all other isolators are not the PV array main switch so **cannot be polarity sensitive**.

Please refer to Q4 for further information on approvals.

8. Where does the main switch for the PV installation go?

For gross input metered, grid connected PV systems, the main switch for the PV installation is to be on the main switchboard, and accessible to ActewAGL to isolate.

For residential installations, this would normally be in the meter box, outside the residence and accessible.

Per AS/NZS 3000:2007 clause 7.3.8.2.2 – the main switch for the grid connected inverter is to enable complete isolation. This means the active and neutral conductors.

The PV main switch shall be two poles for single phase and four poles for three-phase, and are of a type that can be locked in the off position.

For commercial installations, the main switch will still go on the main switchboard and have a KA rating compatible to the main switchboard, but may be internal to the building where business hours access is available. The point of attachment and metering locations shall also be labelled to provide information on the location of the PV system.

Where the metering and POA is internal to the building, ActewAGL and ACTPLA electrical inspectors should be consulted.

9. Is extra protection required on the DC cables between the PV array and inverter?

The wiring system between the PV array and inverter is unprotected consumer mains and shall comply with the relevant requirements of AS/NZS 3000:2007 clause 3.9.7.1.2

Care should be taken on how the cables are run through roofing materials, such as roof tiles. See AS/NZS 3000:2007 clause 3.9.4.3.1 prohibited locations.

Note: See the ACTPLA website for more information on this.

AS/NZS 5033, to be released late 2011/early 2012, will provide examples of methods that will enable you to comply with the requirements of AS/NZS 3000:2007 clause 3.9.7.1.2.

To minimise corrosion (electrolytic effect) and the risk of breakage, the cables should be fine stranded tinned copper conductors. The cable shall be rated for the maximum voltage and current carrying capacity to which it is subjected.

PV array cables shall be clearly identified so they cannot be mistaken for other power cables within the installation.

The cross-sectional area of the DC cable shall be a minimum of $4mm^2$ and rated at the appropriate voltage.

Where PV array cabling could be confused with other wiring systems, appropriate identification shall be provided at regular intervals (typically, identification should be not more than 3m apart).

Cable size - the minimum cable sizes for PV array wiring, based on current carrying capacity, shall be based upon a current rating calculated from Table 3.1 of AS/NZS 5033.

When calculating cable size, consideration needs to be given to;

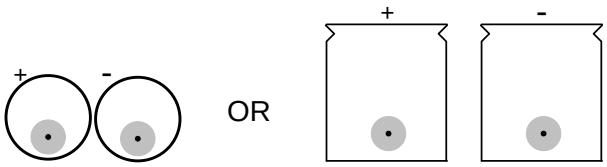
(a) voltage drop (a maximum of 5% is recommended) and

(b) de-rating of the current carrying capacity of a cable due to temperature.

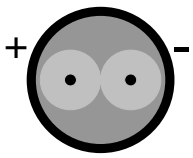
Note:

When AS/NZS 5033:2005 is superseded by an updated version, the advice below will be replaced by the ruling in the new standard. Until then, use the advice below as a guide to complying with the requirements of AS/NZS 3000:2007 clause 3.9.7.1.2. In all systems operating in the low voltage (LV) range, cables should be selected to minimise the risk of earth faults and short-circuits. This is commonly achieved using double-insulated cables, particularly for cables that are exposed or laid in metallic tray or conduit. This can also be achieved by reinforcing the protection of the wiring as shown below.

Multistranded, single conductor cable both insulated and sheathed



Multi-stranded, single conductor cable – in suitable conduit/trunking



Steel wire armoured SWA (usually suitable only for main d.c. cable)

10. Is there a minimum or maximum height for the installation of an inverter?

Yes. The maximum height to the top of the inverter is 2m above ground, floor or platform, the minimum height to the bottom of the inverter shall not be less than 500mm from ground, floor or platform.

11. Does the interconnecting wiring between each PV module require mechanical and IP protection?

Yes. The installation of wiring associated with PV array systems (operating at ELV or LV) shall be installed in accordance with AS/NZS 3000 except where varied by the additional requirements of AS/NZS 4777 Series & AS/NZS 5033.

Reference –Clause 3.1 of AS/NZS 5033:2005

Clauses related to the wiring connecting panels and arrays:

Voc Array (open circuit voltage at standard test condition) shall not exceed the maximum allowed operating voltage of the PV modules (as specified by the manufacturer)

Reference –Clause 3.2 of AS/NZS 5033:2007

Extra Low voltage - Segmentation (disconnection requirements)

Reference –Clause 2.5.4 of AS/NZS 5033:2007

PV array wiring - protection and installation

Reference –Clause 3.3 of AS/NZS 5033:2005

Wiring loops - installation

Reference - Clause 3.3.2 of AS/NZS 5033:2005

String wiring - installation

Reference – Clause 3.3.3 of AS/NZS 5033:2005

IP rating of the enclosure and cable entries

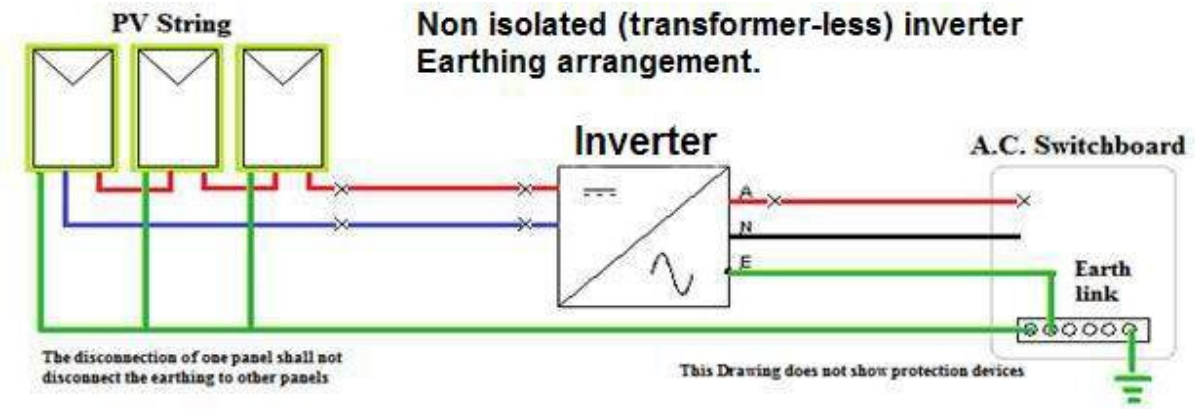
Reference –Clause 3.3.4 of AS/NZS 5033:2005

PV array and PV sub-array junction boxes locations

Reference –Clause 3.3.5 of AS/NZS 5033:2005

12. Do the exposed metallic parts of the solar array need to be earthed or equipotential bonded?

A solar generation system with a non-isolated (transformer-less) inverter requires the metallic frames and conductive structural supports of the PV arrays to be earthed in accordance AS/NZS 3000:2007 with the requirements of a protective earthing conductor. This shall be achieved by connecting the earthing conductor with a minimum cross-sectional area of 4mm^2 directly or via the inverter to the installations earthing system.



The earthing requirements of other solar generation systems shall be determined by following figure 5.9 of AS/NZS 5033:2005 - PV array framework earthing decision tree.

Equipotential bonding or protective earthing is intended to minimize the risks associated with the occurrence of voltage differences between exposed conductive parts of electrical equipment and extraneous conductive parts. *Reference - AS/NZS 5033:2005 Clause 5.3*

All PV array system bonding conductors shall comply with the material, type, insulation, identification; installation and connection requirements specified in AS/NZS 3000 but shall not have a cross-sectional area less than 4mm^2. *Reference - AS/NZS 3000:2007 Clause 5.6.3.2*

Where the solar supply is connected to a sub-board the protective earth between the main switchboard and sub-board may be of a cross-sectional area less than 4mm^2. *Reference – ruling from EL 001 committee - AS/NZS 3000:2007*

13. Do I need to install an AC switch or circuit breaker at the inverter?

Where the inverter cannot support fault current, AS/NZS 3000:2007 clause 7.3.5 exempts them from over current and short circuit protection. A switch rated to the max current and voltage will comply.

Note:

- The wiring between the inverter and switchboard needs to have a current rating higher than the max current of the inverter, see AS/NZS 3008 for current ratings.

- Per AS/NZS 3000:2007 clause 7.3.4.1 (a), each inverter is required to have an isolating switch so that a person operating the switch has a clear view of any person working on the inverter.
    - In commercial installations this would be any inverter greater than 3 meters from the switchboard.
    - In residential installations the installer shall make allowances for future obstacles such as plants, fences, additional building works and install an isolator when the view could be obstructed in the future. As a guide to installers we recommend any inverter greater than 3m from the switchboard have an AC isolator to avoid possible obstructions that may occur later.
- The isolating switch only needs to be single pole and effectively isolate the active supply conductors. Internal isolating arrangements of the inverter are not an acceptable means of isolation; it must be an externally mounted isolator.
- In installations where there is more than 1 inverter, each inverter shall have its own isolation switch.
- Per AS/NZS 3000:2007 clause 7.3.8.2.2 the main switch for the grid connected inverter is to enable complete isolation. This means the active and neutral conductors.

14. What is the process to get the grid connected PV installation energised?

When the PV installation is completed, the electrician must submit a certificate of electrical safety (CES) for a new installation to ACTPLA within 14 days of completion. As the installation of a PV system is considered as a new electrical installation, the electrician must also submit an electrical start of work notice.

Both the CES and electrical start of work notice forms are available from our web site under forms at http://www.actpla.act.gov.au/publications_forms/forms

An electrical inspector will audit the PV installation and, if it is ready for connection to the grid, attach an approval sticker to the meter box. The utility, ActewAGL will only connect the PV installation to the grid if the electrical inspector's authorisation sticker is present.

Note:

ActewAGL is the utility responsible for electricity metering in the ACT. To get the solar input meter installed you must contact ActewAGL and arrange for the solar input meter to be installed. See their web site for contact details and further information: http://www.actewagl.com.au

All grid connected systems need to be approved by ActewAGL before they are installed.

Note:

All low voltage PV electrical installations are considered as new electrical installations, and cannot be connected to the electricity network (grid) until inspected by an electrical inspector. This also applies to net metered systems.

From the *Electricity Safety Act 1971* section 4:

Part 2 Electrical wiring work

4 Connecting electrical installations to network—inspections

(1) A person commits an offence if—

(a)the person connects a new electrical installation to an electricity network and

(b) the installation has not been inspected, tested and passed by an inspector.

Maximum penalty: 50 penalty units, imprisonment for six months or both.

15. What part of the solar PV array does an electrical inspector need to inspect?

Section 8 of AS/NZS 3000:2007 sets out the minimum requirement of testing. It is expected the following items shall be additional to satisfy the minimum safety principles of Part 1 of AS/NZS 3000:2007

The inspection shall include but is not limited to the following:

- The PV array wiring for fixing and mechanical protection and isolation requirements.
- The array frame and supports for protective earthing or equipotential bonding where required.
- PV array isolating device for DC voltage and current rating, correct connection, location, UV protection and IP rating.
- The DC cable for compliance to the standard, mechanical protection, UV protection, correct polarity, size, voltage rating, roof penetration, labelling where required and voltage drop.
- The DC isolator for the proximity to the inverter, current rating, UV protection, correct connection, location and IP rating.
- The inverter for fixing, height requirements, earthing, correct connections, IP rating, UV protection and operation.
- The AC circuit breaker near the inverter if installed.
- The AC circuit wiring for polarity, current rating, mechanical protection.
- The switchboard to which the solar supply is connected for circuit arrangement, main switch rating, and marking.
- Ensure the solar neutral is identified as required.
- The installation of signage if the solar supply is connected to a sub-board.
- The installation of signage specifying the Voc and short -circuit currents is displayed on the main switchboard or at the sub-board if the solar supply is connected to a sub-board.
- The installation of signage if the solar supply is connected within a multiple installation.

16. Updating fire plans

Where a building has a fire plan adjacent to the fire or sprinkler panels, the plan is to be updated with the locations of the main switchboard and locations of the generators (inverters) as per AS/NZS 3000:2007 clause 2.9.2.4.

17. Is building approval (BA) and development approval (DA) required?

Some external photovoltaic panels and support structures don't need development or building approval if they comply with rules set out in regulations. For further information: http://www.actpla.act.gov.au/topics/design_build/da_assessment/exempt_work/process/heating_and_cooling_installations

Solar farms and non-urban blocks.

Ground based PV arrays on non urban blocks will in most cases require a DA and BA. Any person considering ground mounted PV arrays need to check with the ACTPLA DA assessment team before installation. Contact ACTPLA on 02 6207 1923 or through http://www.actpla.act.gov.au/contact_us/contact_info

18. Does ACTPLA provide design approval of a PV installation?

We do not offer a design approval service, but are willing to provide advice in any area we feel your design might not comply with the wiring rules.

We recommend any complex designs be checked by ACTPLA before construction starts. Designs can start to be complex from 10KW and we recommend the design for any system over 30KW be checked by us before you start work.

Please email your design to: COLA.Registrar@act.gov.au

If you do submit a design to us, please use PDF and show all conductors (DC positive/negative, AC active, neutral and earth.)

Commercial Systems 15KW and higher.

For commercial systems 15KW and above:

- Where an existing switchboard (SWB) or distribution board (DB) is connected to, we expect this to be a commercial SWB / DB rated for the extra current and with adequate space for the additional equipment, otherwise a new commercial SWB / DB is to be installed.
- Where a new switchboard (SWB) or distribution board (DB) is to be installed, we expect this to be a commercial switchboard with adequate space for the installed electrical equipment.

The standard NSW style meter box is not considered a commercial switchboard and is recommended only for residential installations.

19. Who is responsible for turning on the PV installation?

The installer of the PV installation is responsible for turning on and commissioning the new PV installation after:

- approval is given by ACTPLA to connect to the grid and
- ActewAGL installs the new credit meter.

ACTPLA electrical inspectors are not required to turn on the PV installation and ACTPLA is not liable for any lost revenue should the installer fail to turn on the PV installation after our approval is given.

20. How do I submit a question or a new FAQ?

Email your question to COLA.Registrar@act.gov.au

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