

# Energising Grid Connected Solar PV Systems:

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PREPARED BY: GROUP MANAGER TECHNICAL SERVICES

AUTHORISED BY: EXECUTIVE GENERAL MANAGER ENGINEERING SERVICES

ASSISTANCE: CONTRACTOR ACCREDITATION & AUDITING MANAGER,  
CONTRACTOR ACCREDITATION & AUDITING NETWORK ADVISER,  
OPERATIONS PERFORMANCE TECHNICAL OFFICER,  
GROUP MANAGER TECHNICAL SERVICES,  
GENERAL MANAGER NETWORK SUPPORT,  
MANAGER METER PROVISION

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## 1 INTRODUCTION

Installation of Grid Connected PV systems should be carried out in accordance with the Clean Energy Council's Guidelines available from the Clean Energy Council website:

<http://www.cleanenergycouncil.org.au/cec/accreditation/Solar-PV-accreditation/forms.html>

This guideline provides information to assist employees, installers, electrical contractors and Accredited Service Providers (ASP's) in the inspection of grid connected solar array installations for the NSW Solar Bonus Scheme.

In the interest of public and personnel safety Essential Energy reserves the right to revoke the offer of permanent connection at any time to contractors found in breach of this energising guideline.

All grid connected inverters must hold current Australian Standards approval.

**NOTE: Only licensed electrical contractors and ASP's are permitted to energise inverters and connect them permanently to Essential Energy's network.**

**Essential Energy is not responsible for connecting and/or inspecting all Solar PV systems**

However Essential Energy will attend every site to:

- Validate the meter installation of the ASP who provided the NOSW
- Confirm the customer, metering and solar unit details as provided
- Check the DC Isolation Circuit Breaker/s is
  - DC rated
  - Both appropriately DC voltage and current rated
  - Connected with correct polarity
- Check Solar Inverter basic operation is working correctly
  - Isolate network supply - Turn off Inverter AC isolator - the inverter should switch off within 2 seconds
  - Restore network supply to inverter (Turn On – Inverter AC isolator ) and
  - Inverter should switch back on after 1 minute after synchronising with the incoming supply

If a Essential Energy employee incidentally identifies an anomaly while confirming the above details, they should report this in the same manner as any other customer defect.

Any defect/s identified must be reported immediately and sent via internal mail to New Connections Group, Lake Road, Port Macquarie.

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To leave systems energised the following are mandatory compliance requirements:

- Use of common neutrals for the connection of inverters to the customer's installation is not permissible. Inverters must be connected via a dedicated sub main or circuit. Inverters must be earthed via an earthing conductor that originates at the switchboard that it is connected to
- All Meters must be upgraded to the latest network standard arrangement refer CEOP8027 Network Standard Metering. For Ct metered sites where metering is not able to be installed on the line side of the CT's contact 1800 065 396
- Master/subtract metered sites must be rectified to the current network metering standards prior to connection
- The customer or nominated installer must have been granted approval in writing from Essential Energy as a reply to their application for connection form
- A Certificate of Compliance Electrical Work (CCEW) must be lodged with Essential Energy within 48hrs indicating the system has been installed, tested and commissioned. Additionally noting; *"System tested per CE guideline CEOP2454 left energised"*. The customer copy must be left with the customer at the installations site on the day of energisation
- Either a net or gross meter must be installed on site with a Notification of Service Work (NOSW) being submitted to Essential Energy within 48 hours
- The maximum rating of the inverter/s is no greater than 10kW and there is not a mix of systems (solar, wind and/or hydro)
- All labelling must be in accordance with the defined signage and labelling requirements within the Clean Energy Council Guidelines and this policy
- All main Switches must be sealable with nylon sealing line (6mm gap required beside all Main Switches if mounted in DIN rail system) NOTE: Main Switches includes Normal Supply, Off Peak and Solar Main Switches which must all be located on the main switch board
- Refer to AS 3000: 2007, AS4777, AS5033 and the Service and Installation Rules of New South Wales for additional requirements

**NOTE:** Grid feed systems that incorporate fuel or battery backup generators must be left isolated. These systems will be commissioned and energised by Essential Energy ONLY.

To energise installations that incorporate fuel or battery backup generator Essential Energy will meet installers on site via prior arrangement. Contact Energy Answers on: 1800 363749 or your local inspection staff to make an appointment.

## **WARNING**

**DO NOT OPERATE THE PV ARRAY DC MAIN SWITCH / CIRCUIT BREAKER UNDER LOAD**

**– COMPLY WITH SHUTDOWN PROCEDURE.**

**Too many operations under load may cause circuit breaker failure.**

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## 2 MINIMAL TECHNICAL REQUIREMENTS

**NOTE:** Whenever permanently energising systems the following technical and system integrity tests must be performed on every occasion:

- Ensure the inverter is on the Clean Energy Council's approved inverter list
- Ensure PV array isolator is a double pole **DC rated** circuit breaker and connected according to its polarity wiring diagram (refer 2.1.3 ,1 of this document) **IF NOT THE SYSTEM MUST NOT BE ENERGISED / CONNECTED**. The circuit breaker must be rated at 1.2 times the open circuit voltage

**NOTE: Systems voltages may exceed 500V DC on larger systems**

- Check that a single "Normal Supply Main Switch" and where applicable "Off Peak Main Switch" is installed
- Ensure that the "Solar Main Switch" is installed. If there is more than one inverter with more than one AC circuit breaker installed there must be only ONE "Solar Supply Main Switch" for isolation purposes. (refer NSW Service & Installation Rules for further details)
- Check that the metering has been installed and is operating correctly
- Check labelling compliance as per Clean Energy Council Guidelines and Section 3 of this procedure (All labels must be fit for purpose and be made of durable material and remain legible for the life of the equipment that is attached or related to; main switches, warning labels, location of generator if required, open circuit. voltage and short circuit current, shutdown procedure)
- Measure line voltage to neutral with no load
- Measure line voltage to neutral with solar connected and ensure energy production. (Indicated by clip on ammeter on line side of solar main switch). Note: System may not generate electricity during times of excessive cloud due to lack of sunlight
- Ensure the AC supply main switch is off and the DC breaker on; using a **DC tong amp meter** check for **no load current flow**. This should be no greater than .5 Amps (500 mA). If current flow exceeds this do not energise system
- Whilst the inverter system is producing power (DC isolation is closed, AC isolation is closed), turn solar AC supply Main Switch off and ensure inverter shuts down immediately within 2 seconds (load drops off ammeter and check the AC supply cable from/to the inverter for voltage). The use of an AC tong meter is ideal for measuring these currents
- Restore supply by turning the solar supply Main Switch on measuring the length of time it takes for the inverter to "switch on" and produce power. This is achieved by checking the AC supply cable from/to the inverter by use of an AC ammeter. **NOTE: This time MUST exceed 1 minute**. Again, an AC tong meter is ideal for measuring these currents
- From a remote earth using a calibrated voltmeter to consumer's neutral link carry out a final test with the solar generator connected and on line. There should be no more than 5 Volts between the remote earth and neutral link
- If the system passes all safety and integrity tests perform final visual inspection and permanently connect system to network
- Complete CCEW on site and leave customer copy with customer (Additionally noting; "System tested per CE guideline CEOP2454 left energised")

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### 2.1 Double Pole DC Breakers Guideline

- Double pole DC isolators must be installed between the PV Array and the inverter. They are usually DC Circuit breakers, but only perform as a DC load breaking device as the PV array is a current limited source
- **They MUST be DC rated and rated for the DC voltage being applied to them**
- **There are two types of DC breakers available on the Australian market – polarised and non-polarised.**

#### 2.1.1 Voltage Ratings

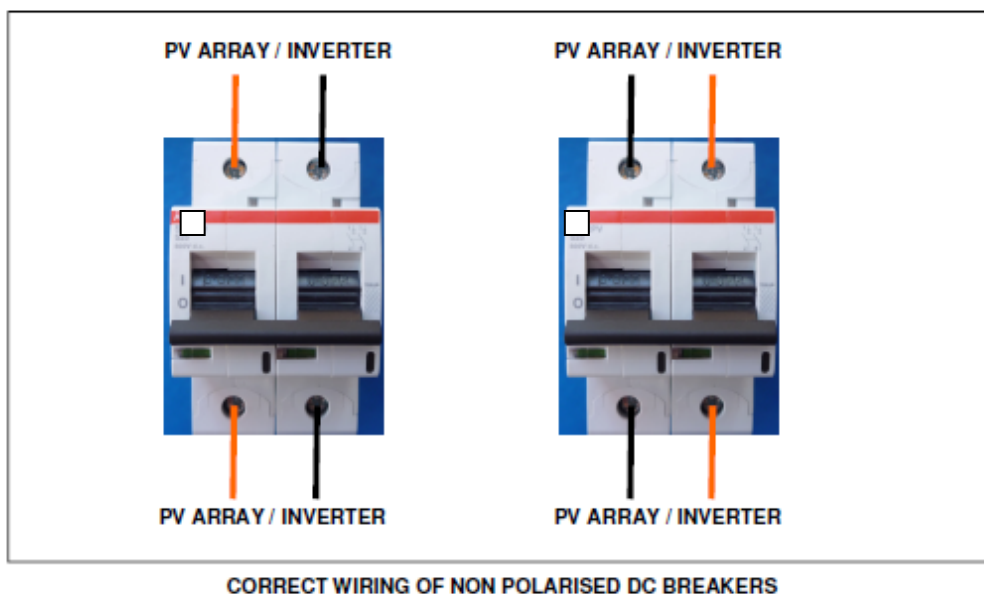
Breakers must have a maximum DC voltage rating that is at least 1.2 X the open circuit voltage (Voc) of the array installed.

A 500 V DC maximum rated breaker can only be used with arrays of no more than 416 Voc.

An 800V DC maximum rated breaker can only be used with arrays of no more than 666 Voc.

##### NON-POLARISED BREAKERS:

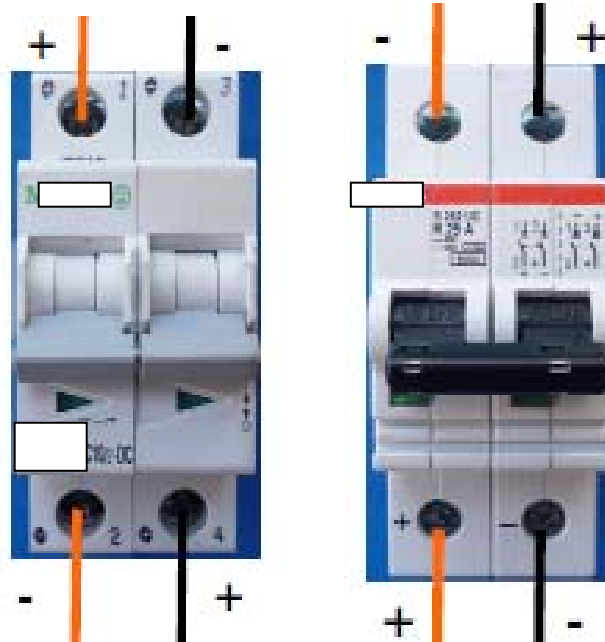
These are identified by no polarity markings on the breaker.  
These can be wired any way (ensuring polarity of source matches polarity of load).



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**2.1.2 Polarised Breakers**

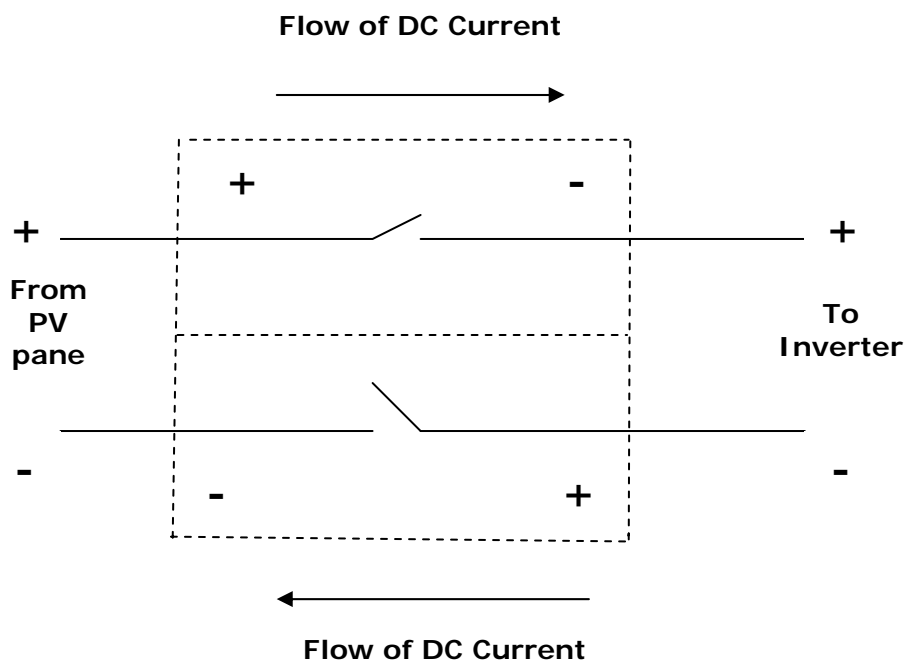
These are denoted with numbered terminals and "+" and "-" markings, such as the examples shown below.



To be correctly wired, the installer must account for the direction of current flow through the device for it to operate and perform correctly.

In its simplest form, the devices are two pole devices, with the left half of the device being electrically isolated from the right half of the device.

In block form, the devices **must** be connected as follows.



**Notice how the "+" and "-" markings on these DC polarised CBs are indicating the required flow of current THROUGH the device, from the PV panels to the Inverter.**



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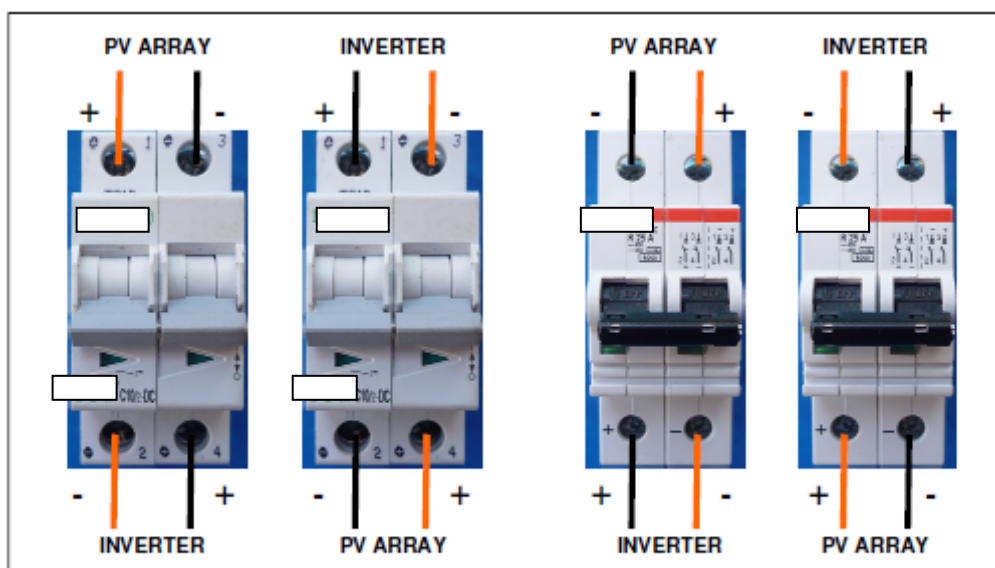
It is **IMPERATIVE** that this is correct, as a reversed polarity connection will result in a failure of the device; potentially causing fire.

Special consideration to DC breaker connections should occur when inspecting an installation that has been fitted with such a device. The 'incoming' supply to these CB's can be either at the top or the bottom of the CB, it is imperative that tests be undertaken to confirm the following.

1. Determine line and load cabling by identifying which terminals are used to connect the PV panels to the CB. With the CB in the OFF position, use a multimeter to determine which wires are coming from the PV panels; and their polarity.
2. Ensure that the positive coming from the PV panels is connected to the terminal marked with a "+" on the CB installed. Likewise, the negative from the PV panels is connected to the terminal marked with a "-" sign. Ensure that these connections for this 'incoming' supply are made using only the top or bottom terminals; according to the breakers markings (+/-) **not both**.
3. Determine the polarity of the wires from the CB to the Inverter, such that it can be confirmed which wire is connected to the "+" input to the inverter, and the "-" input to the inverter.
4. Ensure that, no matter whether the DC CB has been wired with the solar panels at the top or the bottom of the CB, that the flow of power **through** that CB is such that the positive of the PV panels is connected through to the positive of the inverter; and the negative of the panels is connected through to the negative terminal of the inverter. ***There must NOT be any transpositions (rolls or crosses) in that wiring.***

A good illustration of the differences that can be created is highlighted below.

- To avoid confusion, consider the **ORANGE** wire as always being the Positive wire, and the **BLACK** wire as always being the negative.
- The "+" and "-" marks in the illustration are the markings on the breakers only.



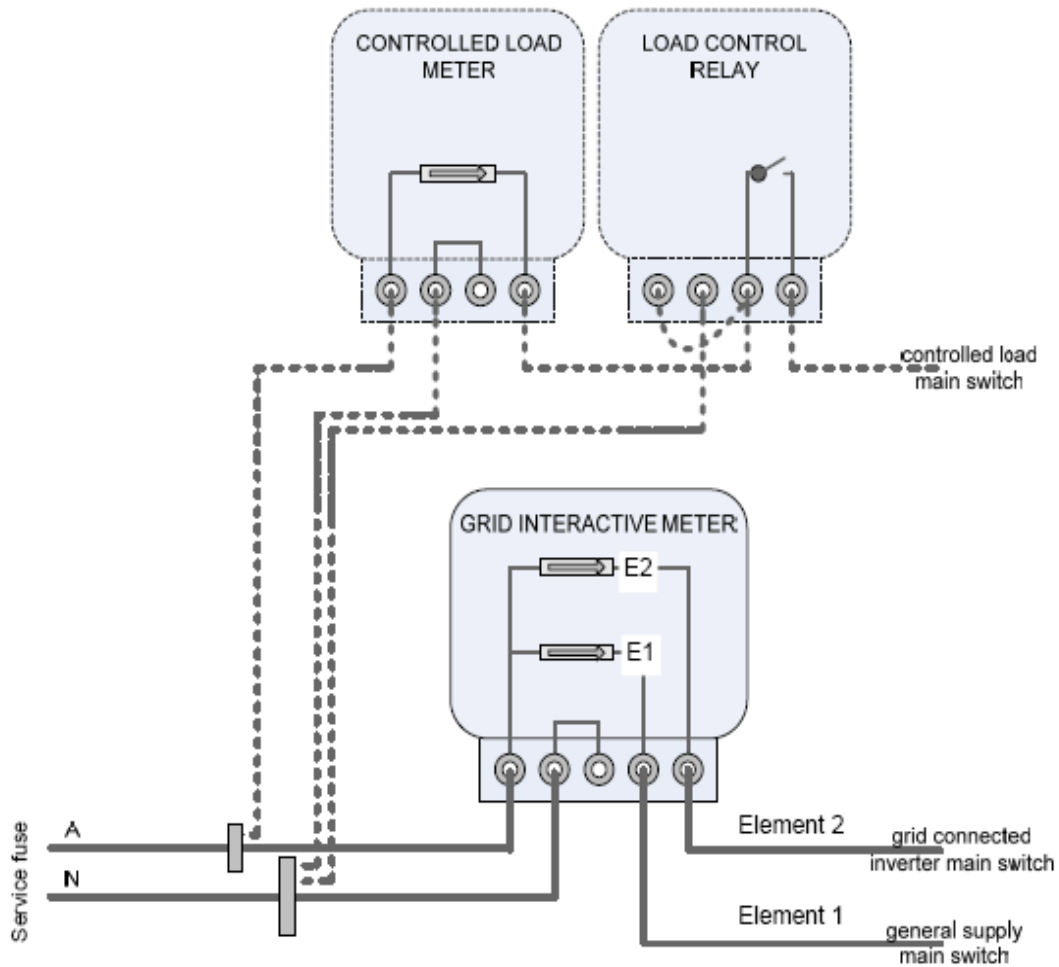
**CORRECT WIRING OF DIFFERENT POLARISED DC BREAKERS**  
+ and - SYMBOLS INDICATE MARKINGS ON BREAKER

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**2.2 Metering Installation Wiring Guide**

**2.2.1 Single Phase Installation (optional load control) – Single Phase Grid Connected Inverter**

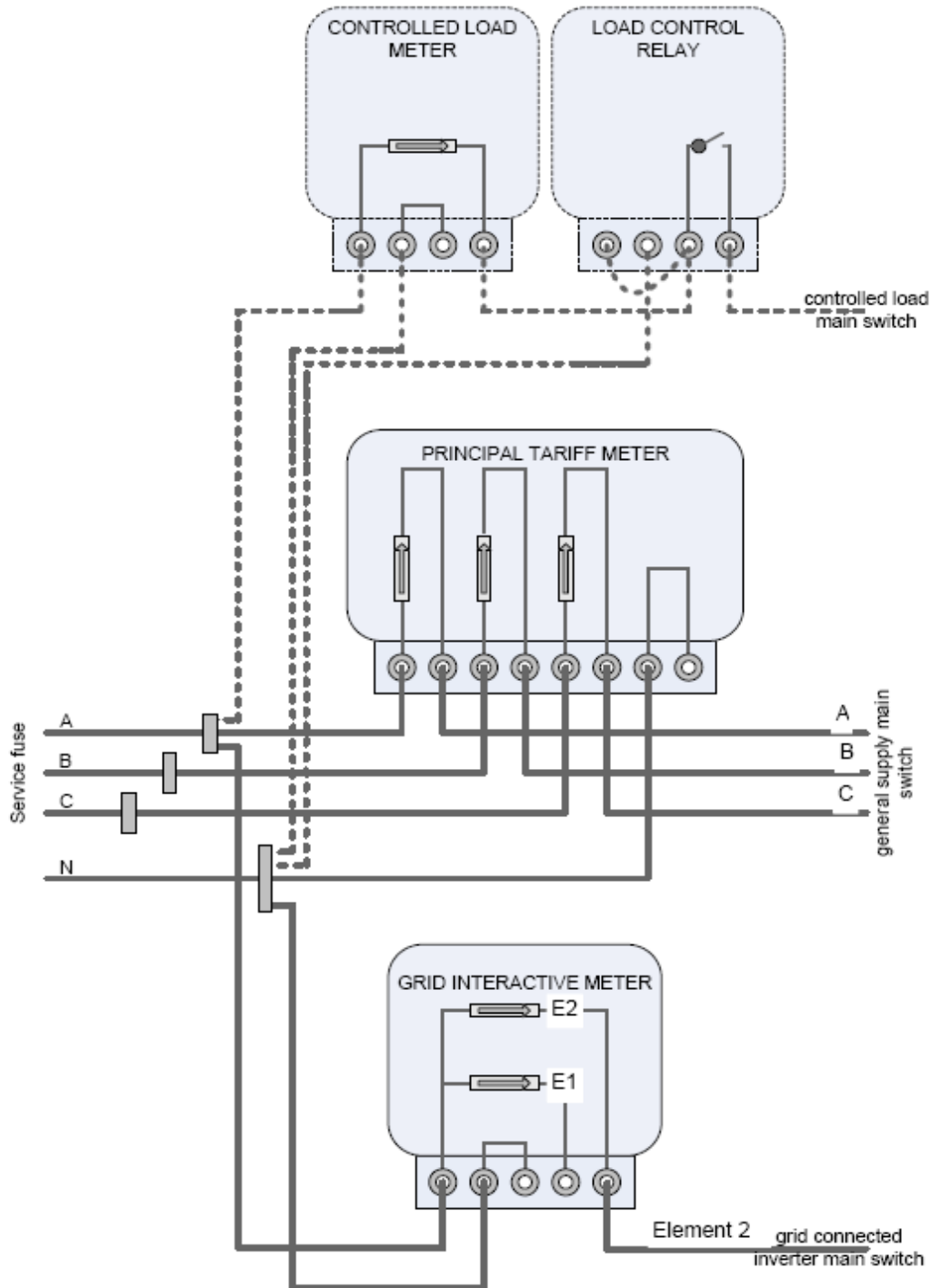
Single phase installation (optional load control) - Single phase grid connected inverter



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### 2.2.2 Three Phase Installation (optional load control) – Single Phase Grid Connected Inverter

Three phase installation (optional load control) - Single phase grid connected inverter



**NOTE:** generator shall be connected on the phase with the heaviest load

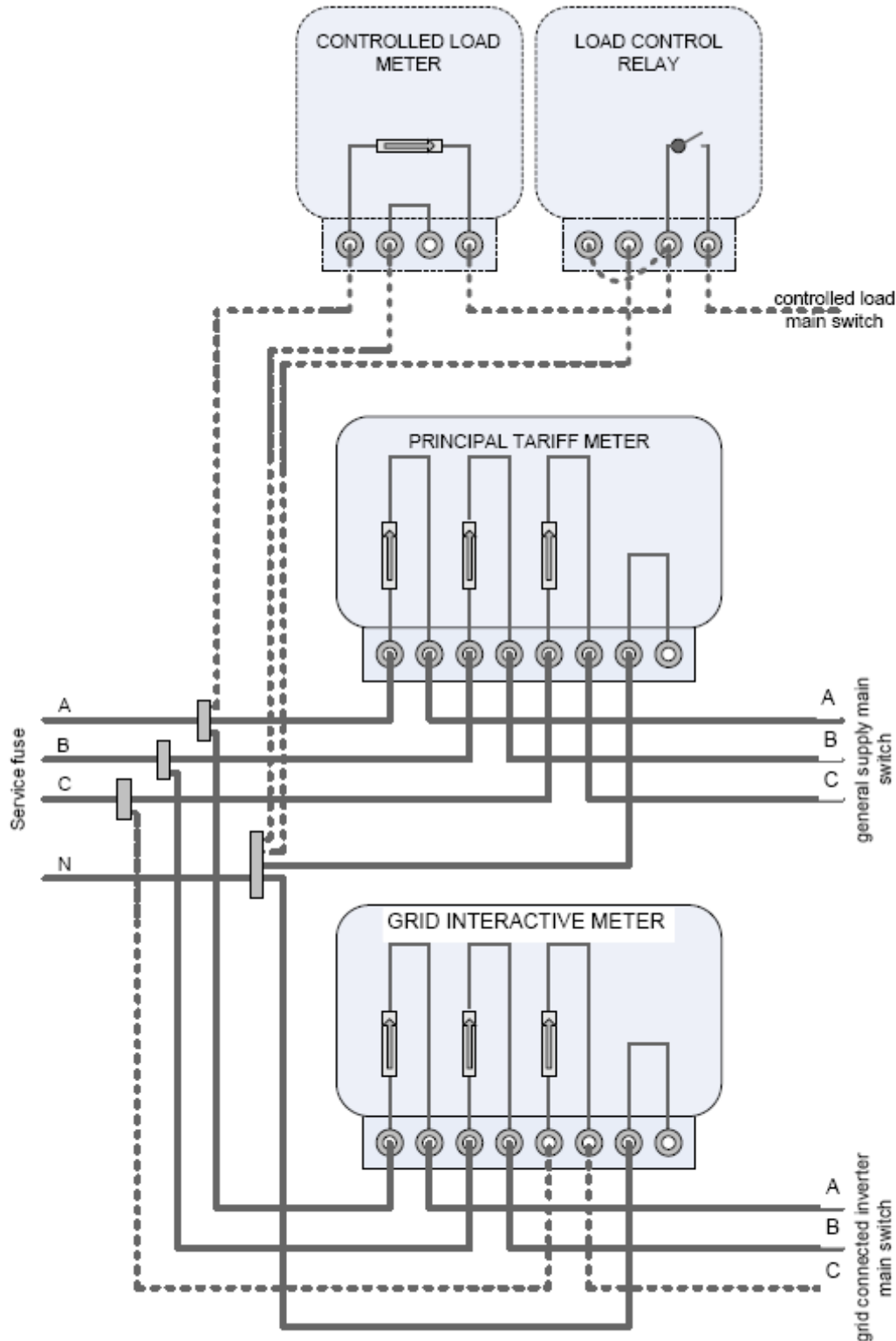
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**2.2.3 Three Phase Installation (optional load control) – Multi Phase Grid Connected Inverter**

Three phase installation (optional load control) - Multi phase grid connected inverter



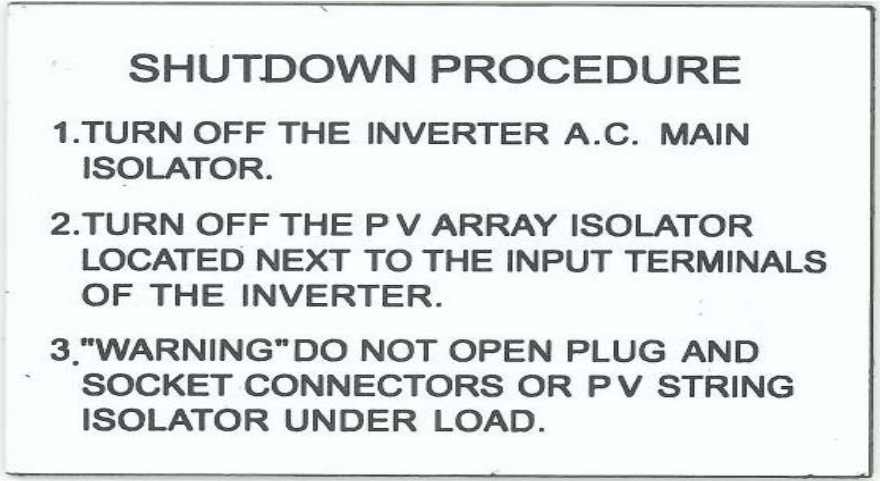



*NOTE: 2-phase generator systems shall be connected on the phases with the heaviest load*

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**3 ENGRAVED LABELS & SIGNAGE**

Refer to AS4777.1 Appendix A, AS5033 and NSW Service & installation Rules Chapter 8

Location	Signage
<p>To be <b>located on the outside of the meter box</b>, and must be secured in a manner that is fit for the purpose. This is for emergency services. – Recommended red in colour white lettering</p>	
<p>To be <b>located on the meter panel</b> with extra adhesive. ALL WARNING LABELS MUST BE IN RED, with WHITE LETERING.</p>	
<p>To be <b>located on or adjacent to the inverter</b> with extra adhesive.</p>	
<p>To be <b>located at respective isolators</b> with extra adhesive.</p>	

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## **4 REFERENCES**

CEOF6003 - Notification of Service Work (NOSW)  
CEOP8027- Metering Services: Network Standard Metering  
AS 4777 - Grid Connection of energy systems via Inverters (Parts 1, 2 and 3 inclusive)  
AS/NZS3000 Wiring Rules  
AS/NZS5033 - Installation of photovoltaic (PV) arrays  
Clean Energy Council Guidelines  
Clean Energy Council Installation, Testing and Commissioning Checklist.  
NSW Services & Installation Rules

## **5 REVISIONS**

<b>Issue Number</b>	<b>Section</b>	<b>Details of Changes in this Revision</b>
2	All	Complete revision of original document, highlighting issues with DC polarised CB's.
3	All	Updated in line with Essential Energy Branding Requirements