PowerWater

Technical Requirements for Grid Connection of Photovoltaic Systems via Inverters

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1 Introduction

This document explains the technical requirements to connect a photovoltaic (PV) inverter system to the supply system (the grid) of the Power and Water Corporation (herein referred to as Power and Water). The PV inverter system will usually consist of a photovoltaic array on the roof of the building and a suitable grid-connect inverter connected to the metering box. This arrangement allows solar energy to be supplied to the Power and Water electricity grid.

The guidelines are broken into the following sections:

- Section 2: Describes the situations this document applies to.
- Section 3: Lists the technical requirements that must be satisfied as part of the installation and ongoing operation of the PV inverter system.
- Section 4: Gives information on the metering arrangements.

This document is to be read in conjunction with the following document:

- Power and Water Corporation, 2010, "NP 010 Meter Manual", www.powerwater.com.au, in particular Chapter 10: Small Scale Parallel Customer generation.

Other related documents are:

- Power Purchase Agreement
- Photovoltaic Inverter Network Connection Agreement
- Going Solar? The process of installing a photovoltaic (PV) system in your home

2 Scope

These technical requirements are limited to the following situations:

- Inverter energy systems that have a continuous rating of no more than 10kVA for single-phase systems or 30kVA for three-phase systems.
- Connections to the Power and Water grid only.
- Systems not including battery storage, although these can be considered for special applications.

3 Installation Requirements

This section details the technical requirements to connect a photovoltaic inverter system to the Power and Water grid.

3.1 General

These requirements are valid for the following network voltages and maximum power generation capacities (continuous rating):

Voltage	Maximum Capacity
230V single-phase	10kVA
400 V three-phase	30kVA

Higher rated installations may be allowed, but will require a special agreement.

3.2 Australian Standards

These requirements pertain to Power and Water specific matters. The installation should as a minimum comply with Australian Standards AS3000, AS4777 and AS5033 and all other relevant Australian Standards and Northern Territory statutory requirements. Installations are exempted from complying with these standards only where stated (for example some clauses of AS4777.1).

The inverter to be used shall be of a model that has passed testing in accordance with the Australian Standard AS4777 guidelines. For a list of approved inverters see the website of the Clean Energy Council, and follow the link to the 'Approved PV Inverters' (www.cleanenergycouncil.org.au).

3.3 Safety

In the event of loss of network supply, the PV inverter system shall be designed to disconnect from the network via its on-board protection systems. Under certain undesirable circumstances, it is possible that PV Inverter systems could continue to provide energy to the network, resulting in a hazardous situation. This situation is known as "islanding" and the Australian Standards are designed to prevent this from occurring.

3.3.1 Applicable Equipment

The permission to operate the installation is restricted to the equipment listed on the application form and approved by Power and Water. The installation shall not have settings changed from those approved, be upgraded, replaced, modified or tampered with in any way.

Should it be necessary to change any parameter of the equipment as installed and contracted, Power and Water shall be notified for re-approval. Subsequently Power and Water will determine whether a new application is required.

3.3.2 Competent Designer

The PV Inverter system must be designed or approved by a person competent in this field prior to lodging an application with Power and Water. For a list of approved designers/suppliers, see the website of the Clean Energy Council (www.cleanenergycouncil.org.au).

3.3.3 Operating Personnel - Operation and Maintenance

The customer is responsible for the operation and maintenance of the PV inverter system. Adequately qualified and licensed persons must carry out all work.

The customer shall maintain the PV Inverter system to Australian Standard AS5033 and AS 4777. Equipment directly involved with protecting and controlling the

connection to the electricity system must be maintained to the equipment manufacturer's specification or the installer's recommendation.

3.3.4 Installation and Inspections

Installations may be routinely inspected by Power and Water once construction is completed.

An NT licensed electrician/electrical contractor shall carry out all installation and maintenance work.

3.3.5 Logbooks

For safety reasons all customers are required to maintain a logbook detailing inspections and operating activities. This log is an important document and it must be kept in a secure place (typically in the meter box) and be available for inspection by Power and Water staff. Further, any change/modifications done in the PV system will need a Certificate of Compliance. An example of logbook pages is shown below.

INVERTER	Make/Model:	Serial No.	Rating: W
Service provider	Service details		Date

PV PANELS	Make/Model:	Serial No.	Rating: W
Service provider	Service details		Date

3.4 Signage

Care must be taken to label switchboards and relevant equipment as per the Australian Standards. Power and Water allows some exceptions to AS4777.1, clause 5.5.2(a) which specifies there must be a label stating "isolate both normal and solar supplies before working on this switchboard". However, under Power and Water requirements the inverter is to be connected to a meter box. Sections 3.4.1 and 3.4.2 show the signs which should be used in place of the one specified in AS4777.1, for type 1 and type 2 connection arrangements (see section 4).

AS4777.1 clause 5.5.2(b) states that a sign "Solar Supply" should be fixed next to the main switch in the switchboard that the inverter is connected to. However, under Power and Water requirements the inverter is connected to a meter box. Thus this sign should be located next to the circuit breaker or switch located in the meter box.

Where a new meter box is to be installed (see section 4), the meter box shall be accessible to Power and Water officers and shall be labelled "Solar Meter".

3.4.1 Signage for Type 1 Connections

Main switchboard and distribution board(s).

Quantity: 1
Lettering height:
"WARNING" 8mm
other text 4mm
Colour: Red, white letters
Size: 120 x 60 mm

WARNING
DUAL SUPPLY
ISOLATE NORMAL SUPPLY TO THIS SWITCHBOARD AND "*SOLAR*" SUPPLY AT MAIN METER BOX BEFORE WORKING ON THIS SWITCHBOARD

Main meter box where private generation plant is connected.

Quantity: 1
Lettering height:
"WARNING" 8mm
other text 4mm
Colour: Red, white letters
Size: 120 x 60 mm

WARNING
DUAL SUPPLY
ISOLATE BOTH SERVICE FUSES AND "*SOLAR*" SUPPLY BEFORE WORKING ON THIS METER BOX

3.4.2 Signage for Type 2 Connections

Consumer switchboard or distribution boards connected to Solar Meter Box where private generation plant is connected.

Quantity: 1
Lettering height:
"WARNING" 8mm
other text 4mm
Colour: Red, white letters
Size: 120 x 60 mm

WARNING
DUAL SUPPLY
ISOLATE BOTH NORMAL AND *SOLAR* SUPPLIES BEFORE WORKING ON THIS SWITCHBOARD

Main switchboard and distribution board(s) upstream of distribution board connected to Solar Meter Box where private generation plant is connected.

Quantity: 1
Lettering height:
"WARNING" 8mm
other text 4mm
Colour: Red, white letters
Size: 120 x 60 mm

WARNING
DUAL SUPPLY
ISOLATE NORMAL SUPPLY TO THIS SWITCHBOARD AND *SOLAR* SUPPLY AT *SOLAR* METER BOX BEFORE WORKING ON THIS SWITCHBOARD

Solar meter box where private generation is connected.

Quantity: 1
Lettering height:
"WARNING" 8mm
other text 4mm
Colour: Red, white letters
Size: 120 x 60 mm

WARNING
DUAL SUPPLY
ISOLATE BOTH NORMAL AND "*SOLAR*" SUPPLIES BEFORE WORKING ON THIS METER BOX

Main Meter Box

Quantity: 1
Lettering height:
"WARNING" 8mm
other text 4mm
Colour: Red, white letters
Size: 120 x 60 mm

WARNING
DUAL SUPPLY
ISOLATE BOTH SERVICE FUSES TO THIS METER BOX AND *SOLAR* SUPPLY AT *SOLAR* METER BOX BEFORE WORKING ON THIS METER BOX

3.5 Protection Arrangements and Settings

Power and Water requires protection equipment to achieve the following objectives:

- to disconnect the inverter from the Power and Water system in the event of loss of Power and Water supply to the installation; and
- to prevent the inverter from energising a de-energised Power and Water circuit.

The protection arrangements should be as per AS4777 guidelines. The following specific voltage and frequency settings must be programmed into the inverter:

- For a single-phase system
  - maximum voltage trip point will be 270V phase to neutral;
  - minimum voltage trip point will be 210V phase to neutral;
  - FreqMAX will be 54Hz; and
  - FreqMIN will be 46Hz.
- For a three-phase system
  - Maximum voltage trip point will be 470V phase to phase;
  - Minimum voltage trip point will be 370V phase to phase;
  - FreqMAX will be 54Hz; and
  - FreqMIN will be 46Hz.

In addition to any protection integrated into the inverter design, short circuit and/or over-current protection must be provided by fuses or circuit breakers. This back up over-current protection function can be provided by the metering fuses or by a circuit breaker located at the connection point of the inverter within the meter box.

All protection settings shall be such that satisfactory coordination is achieved with Power and Water's protective system for the network.

3.6 Surge Protection

According to the Bureau of Meteorology, Darwin has in excess of 150 thunder days per year. Other parts of the Northern Territory are also prone to severe lightning storms. The Power and Water supply system may experience surges during such storms and at other times. The inverter contains many electronic parts and is directly connected to the Power and Water supply system and may not be able to cope successfully with the surges. The inverter is also directly connected to the PV panels. Being usually mounted on top of the roof, these are directly exposed to the elements and storms and provide an alternative path for surges.

It is the customer's responsibility to include sufficient surge protection for the PV Inverter system. In case of failure of the PV Inverter system, Power and Water is not liable.

4 Network Connection Types and Metering Arrangements

This section details the types of connection arrangement which enable Power and Water to meter and purchase the electricity supplied to the grid by a photovoltaic system. The system shall be able to measure both the energy consumed from the grid and energy supplied to the grid. Billing arrangements are detailed in the Power Purchase Agreement.

The customer will meet the cost of installing the additional metering and any modifications to the existing metering arrangement. The meters will remain the property of Power and Water.

The customer's licensed contractor will complete the wiring for the meter. When the work is complete and certified, Power and Water will install and commission the meter and connect the PV system to the PWC Grid.

Replacement of existing meter Panel containing Asbestos:

For all PV installations, if the existing meter panel contains asbestos, the panel must be replaced with a meter panel without asbestos in the first place before any work on the panel.

Replacement of the Meter Panel:

There may not be enough space on the existing meter panel for the additional meter. In this case, the customer shall provide and meet the cost of an additional meter box or relocation of fuses/circuit breakers within the existing meter box to accommodate the new meter.

4.1 Type-1 scenario - urban areas

In this scenario, the inverter generation cable is connected at the existing meter box; generally applicable to urban areas. All energy consumed from the grid at the

premises will be metered by the existing meter and billed to the customer under the applicable tariff(s).

The connection arrangement of the PV Inverter system will be such that all energy generated by the PV Inverter system will be directly supplied to the Power and Water grid and metered by the energy-supplied meter. This meter must be installed as part of the PV Inverter system installation.

Figure 1 shows a schematic of a type 1, single-phase installation.

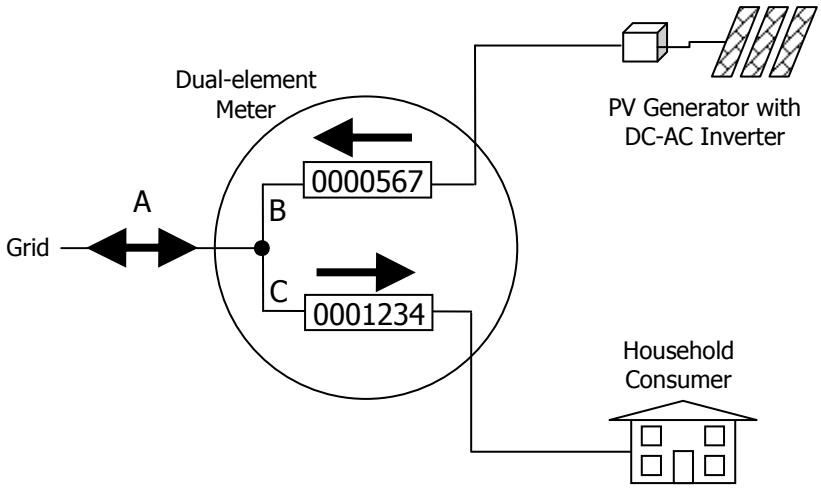

Figure 1 - Schematic Type 1 Single-Phase Metering; Dual-Element Meter

4.1.1 Single-phase customers

The customer must make a provision for installation of a single-phase, bottom-connect, dual-element meter; element 1 for energy consumed from the grid and element 2 for energy supplied from the inverter.

4.1.2 Three-phase customers with single-phase PV

The customer must make provision for installation of a three-phase, bottom connect meter for energy from the grid and one single-phase bottom connect meter for energy supplied from the inverter.

- If the existing metering arrangement consists of three single-phase meters, they will be replaced by a single three-phase meter (upgrade) for the energy consumed metering. A new single-phase meter will be required for the solar energy supplied metering.
- If the existing meter is a three-phase meter, only an extra new single-phase meter will be required for the solar energy supplied metering.
- Power and Water will consider the replacement of the existing three-phase meter on the basis of the condition of the old meter.

4.1.3 Three-phase customers with three-phase PV

The customer must make a provision for installation of two three-phase, bottom-connect meter; meter 1 for energy consumed from the grid and meter 2 for energy supplied from each inverter.

- If the existing metering arrangement consists of three single-phase meters, they will be replaced by a single, three-phase meter (upgrade) for the energy consumed metering. A new three-phase meter will be required for the solar energy supplied metering.
- If the existing meter is a three-phase meter, only an extra new three-phase meter will be required for the solar energy supplied metering.
- Power and Water will consider the replacement of the existing three-phase meter on the basis of the condition of the old meter.

4.2 Type-2 scenario - rural areas and blocks of flats

In this scenario, the existing main meter box is at the premises boundary and the house or building is far enough away that it is difficult to bring the inverter generation cable back to the main meter box at the premises boundary. The inverter generation cable is connected at a new meter box at the customer premises.

This scenario is generally applicable to rural areas. This type is also applicable to PV systems in a block of flats where it is difficult to bring the inverter generation cable back to the multimetering main meter box for the group of flats.

The energy consumed from the grid at the premises will be metered by the bi-directional meter and billed to the customer under the applicable tariff(s).

The energy supplied back to the grid will be metered by the same bidirectional meter. This arrangement is known as net-metering. The new meter must be installed for metering the Gross PV inverter energy as part of the PV Inverter system installation. This new meter Panel is to be preferably a hinged door panel installed at an accessible location at the front of the property.

Figure 2 shows a schematic of a type 2, single-phase installation.

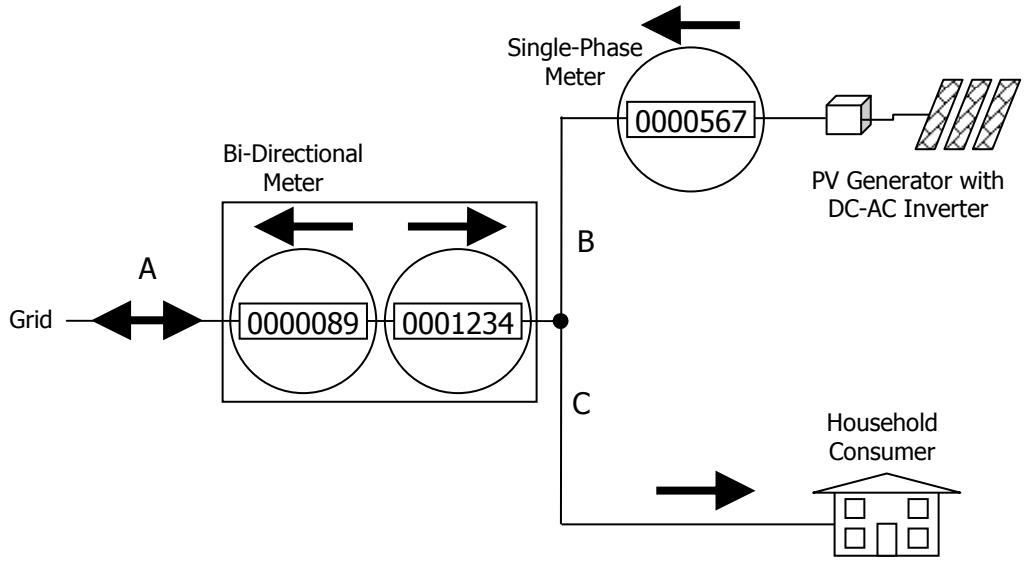

Figure 2 - Schematic Type 2 Single-Phase Metering; Bi-Directional Meter

4.2.1 Single-phase customers

The customer must make provision for replacement of the existing single-phase meter (at the main meter box) with a single-phase, bottom-connect, bi-directional meter. The customer must also install a new meter box in accordance to the Metering Manual standard drawings with provision for a single-phase, bottom-connect meter to record inverter generated energy.

4.2.2 Three-phase customers with single-phase PV

The customer must make a provision for replacement of the existing three-phase metering arrangement with a three-phase, bottom-connect, bi-directional meter. The customer must also install a new meter box in accordance to the Metering Manual standard drawings with provision for a single-phase, bottom-connect meter to record inverter generated energy.

4.2.3 Three-phase customers with three-phase PV

The customer must make a provision for replacement of the existing three-phase metering arrangement with a three-phase, bottom-connect, bi-directional meter. The customer must also install a new meter box to in accordance to the Metering Manual standard drawings with provision for a three-phase, bottom-connect meter to record inverter generated energy.

4.3 Metering arrangement schematic wiring diagrams

Figures 3, 4, 5 and 6 show schematics of the grid connection arrangements including the metering. The schematics provided in this document are to be used as guidance only and are not sufficient to be included in the documentation required for the application.
As a general guideline regarding the different connection types, the Type-1 situation is to be adopted as far as practically possible.

In the standard drawings shown in figures 3, 4, 5 and 6, a lockable switch or circuit breaker is located between the PV meter and the inverter. This fulfils the requirement in AS4777.1, clause 5.3.3 regarding lockable isolation devices between the inverter and the point where the inverter energy system is connected. AS4777.1 specifies that this point is to be a switchboard. Power and Water requirements specify that this point is at the meter box.

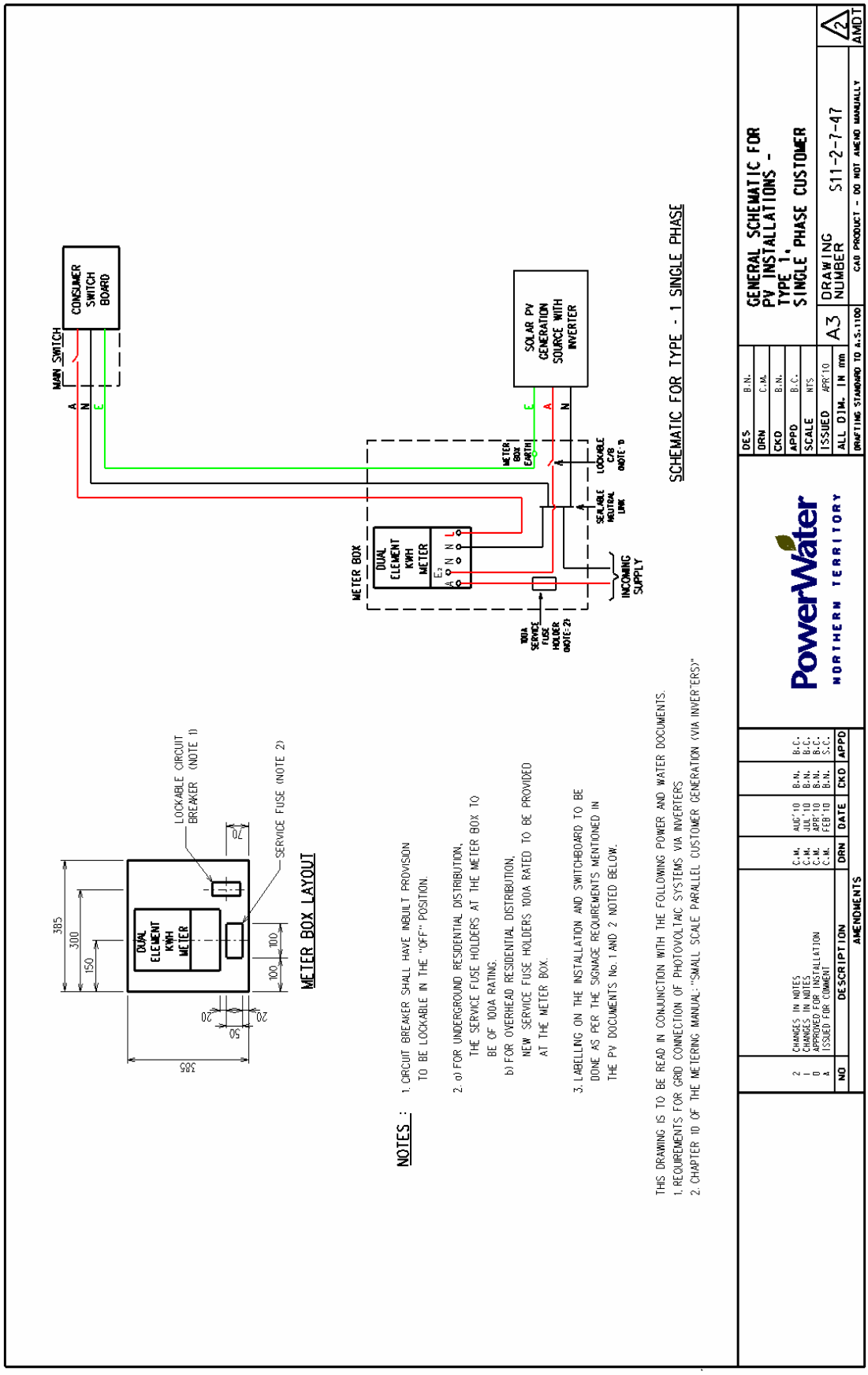

Figure 3: Example Schematic of Single-phase Type 1: parallel generation source connected at the main meter box

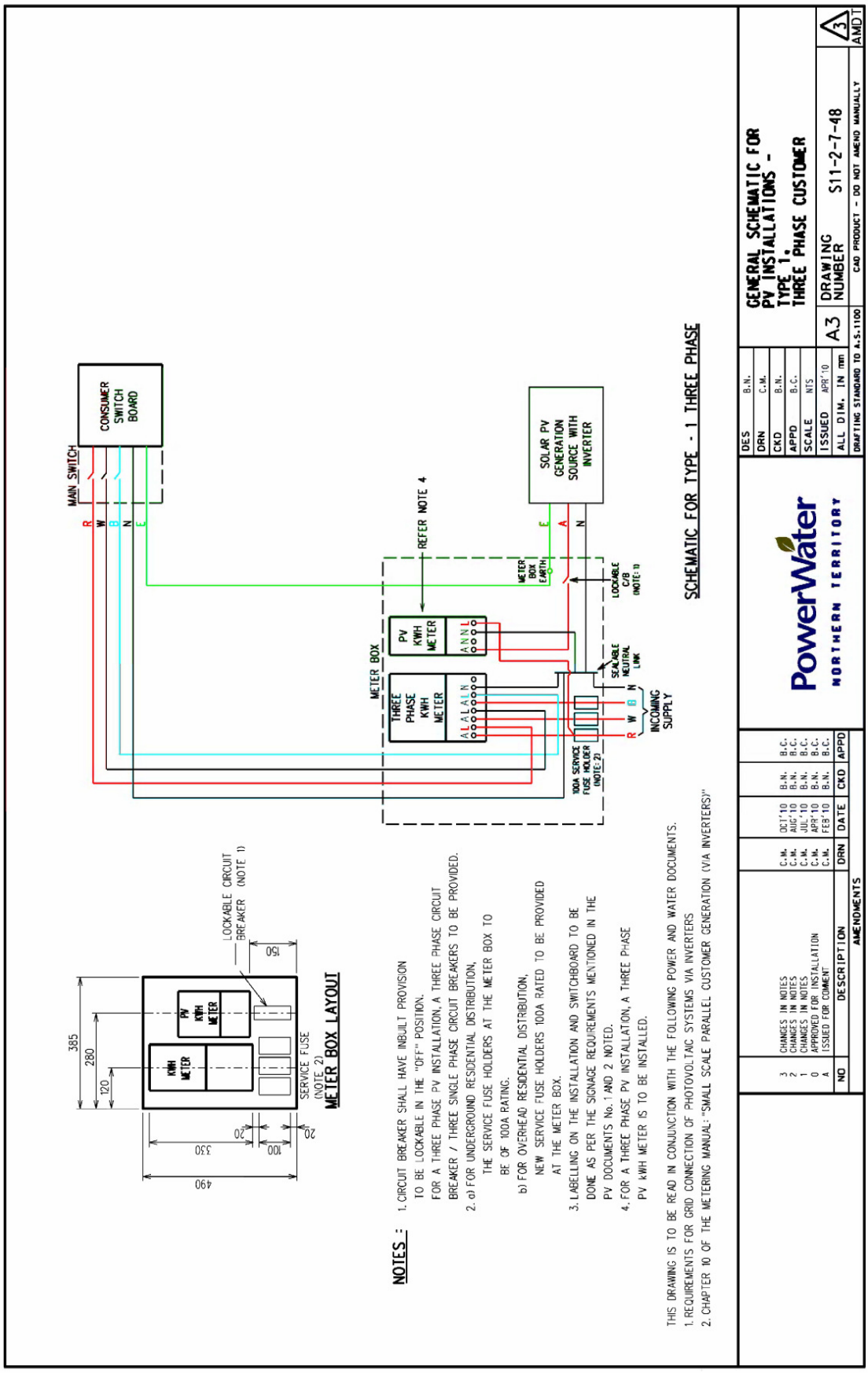

Figure 4: Example Schematic Three-phase Type 1: parallel generation source connected at the main meter box

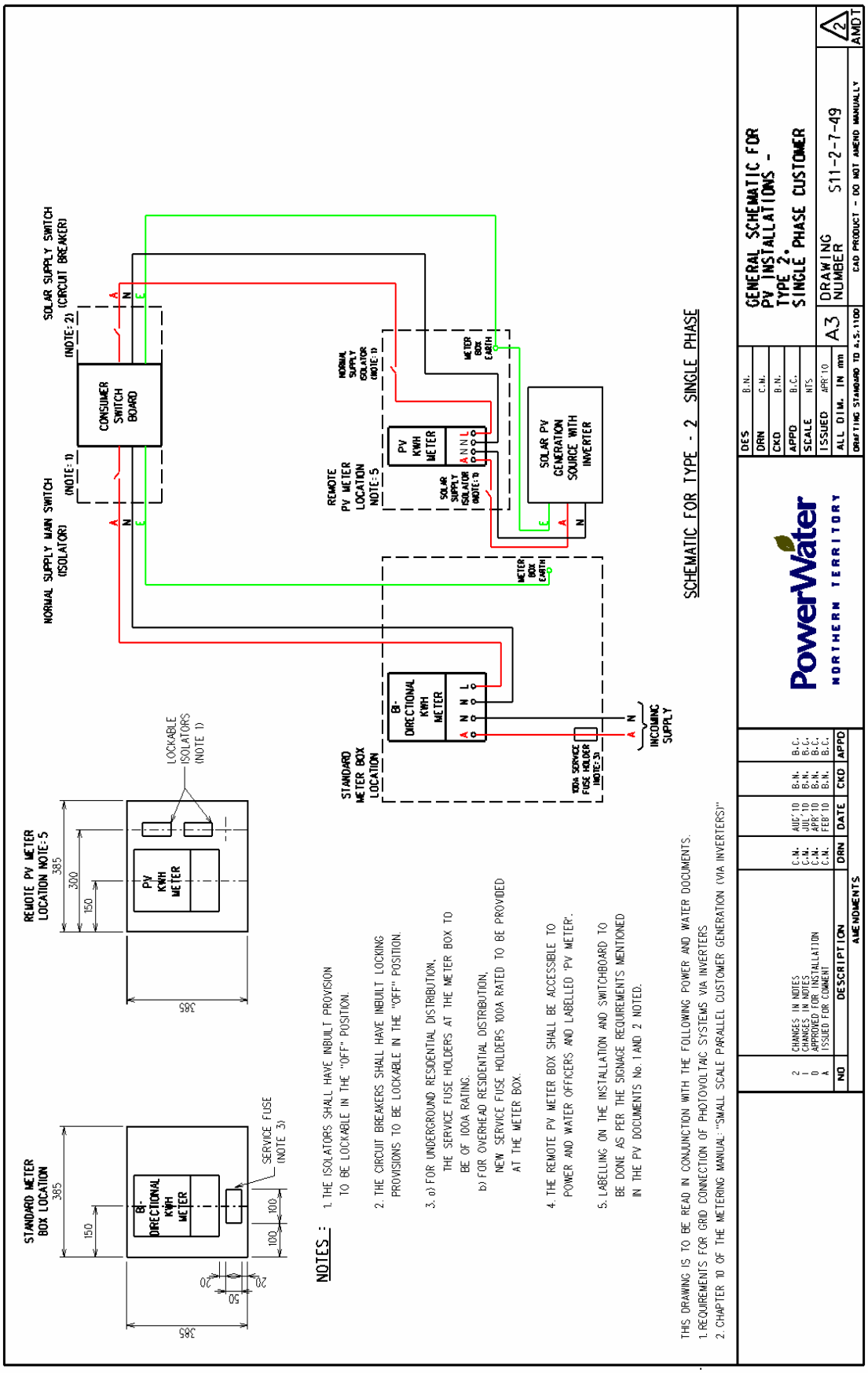

Figure 5: Example Schematic Single-phase Type 2: parallel generation source connected at the PV meter box

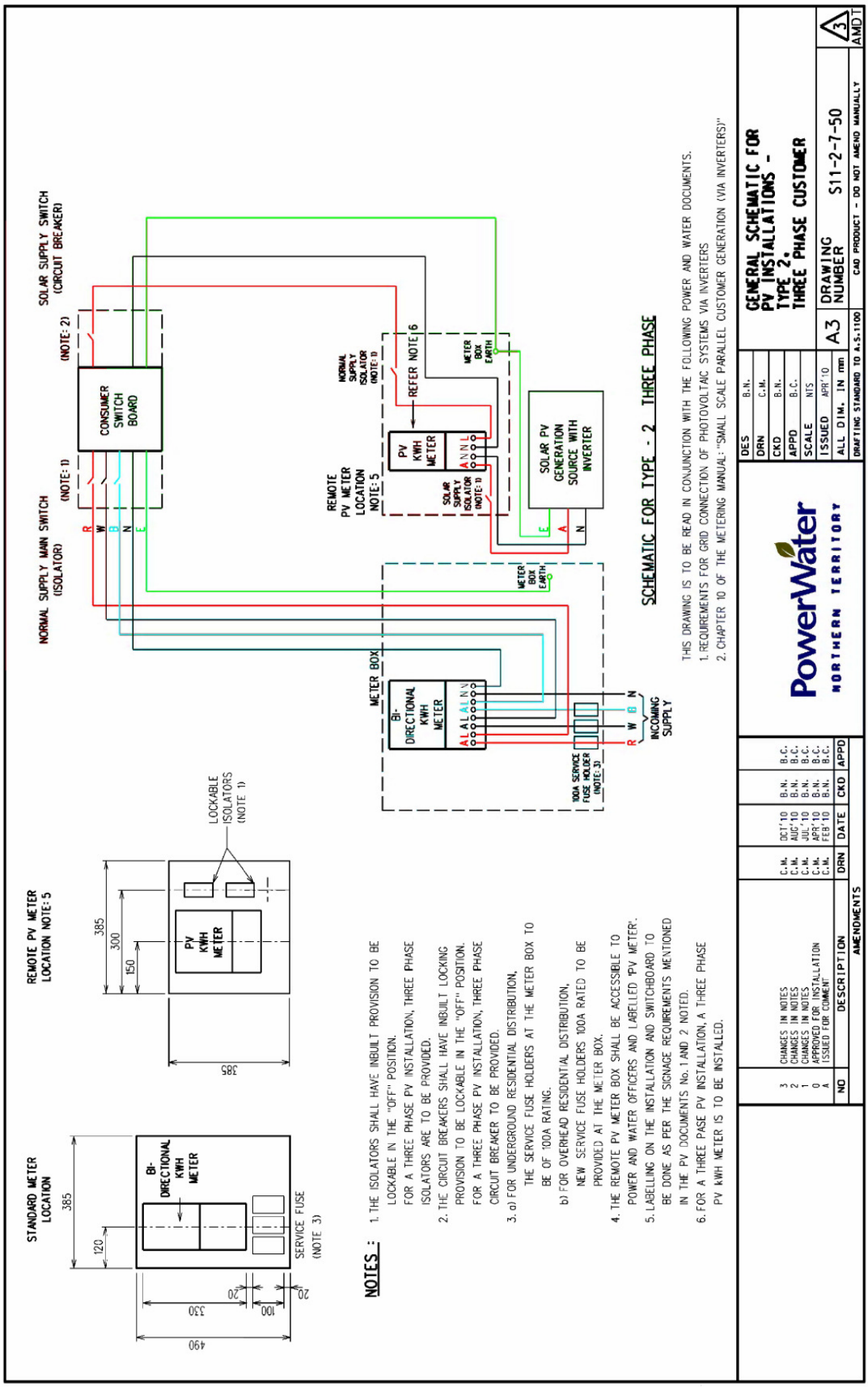

Figure 6: Example Schematic Three-phase Type 2: parallel generation source connected at the PV meter box