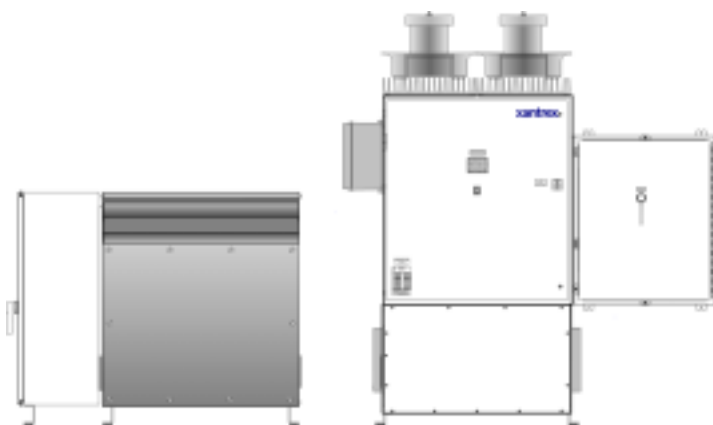


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**PV225S-480**

**Planning and Installation Manual**

# **PV225S 225 kW Grid-Tied Photovoltaic Inverter**

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# **PV225S 225 kW Grid-Tied Photovoltaic Inverter**

## **Planning and Installation Manual**

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# About This Manual

## Purpose

The purpose of this Planning and Installation Manual is to provide explanations and procedures for planning and installing the PV225S 225 kW Grid-Tied Photovoltaic Inverter.

## Scope

The Manual provides safety guidelines, detailed planning and setup information, and procedures for installing the inverter.

## Audience

The Manual is intended for use by anyone who plans to construct or install a system involving the PV225S 225 kW Grid-Tied Photovoltaic Inverter. Installers must meet all local and state code requirements for licensing and training for the installation of Electrical Power Systems with AC and DC voltage to 600 volts.

## Organization

This Manual is organized into four chapters:

Chapter 1, “Introduction” provides information about the features and functions of the PV225S 225 kW Grid-Tied Photovoltaic Inverter.

Chapter 2, “Planning” provides information to help plan the installation of the PV225S 225 kW Grid-Tied Photovoltaic Inverter.

Chapter 3, “Installation” describes the procedures needed to install the PV225S 225 kW Grid-Tied Photovoltaic Inverter. This section includes unpacking and moving instructions, mounting instructions, and cabling instructions.

Chapter 4, “Verification” provides a checklist to ensure the installation of the PV225S is correct and complete.

## Conventions Used

The following conventions are used in this guide.



### **WARNING**

Warnings identify conditions or practices that could result in personal injury or loss of life.

---



### **CAUTION**

Cautions identify conditions or practices that could result in damage to the unit or other equipment.

---

**Important:** These notes describe things which are important for you to know, but not as serious as a caution or warning.

---

## Abbreviations and Acronyms

ANSI	American National Standards Institute
CCU2	Converter Control Unit 2
CFM	Cubic Feet per Minute
CW	Clockwise
DSP	Digital Signal Processor
FPGA	Field Programmable Gate Array
GUI	Graphical User Interface
IEEE	Institute of Electrical and Electronics Engineers
IGBT	Insulated Gate Bipolar Transistor
IPM	Intelligent Power Module
kemil	1000 circular mils
LAN	Local Area Network
LCD	Liquid Crystal Display
NFPA	National Fire Protection Association
PBX	Private Branch Exchange
PSL	Phase-Shift Loop
POTS	Plain Old Telephone Service
PV	Photovoltaic
UFCU	Universal Frontpanel Control Unit

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# Important Safety Instructions

## SAVE THESE INSTRUCTIONS - DO NOT DISCARD

This manual contains important safety instructions for the PV225S that shall be followed during installation and maintenance procedures.



### **WARNING: Shock Hazard**

Read and keep this Planning and Installation Manual for future reference. Before installing the PV225S, read all instructions, cautionary markings, and all other appropriate sections of this manual. Failure to adhere to these warnings could result in severe shock or possible death. Exercise extreme caution at all times to prevent accidents.

---



### **WARNING: Shock Hazard**

The PV225S enclosures contain exposed high-voltage conductors. The enclosure doors should remain closed with the latches tightened, except during installation, maintenance or testing. These servicing instructions are for use by qualified personnel who meet all local and state code requirements for licensing and training for the installation of Electrical Power Systems with AC and DC voltage to 600 volts. To reduce the risk of electric shock, do not perform any servicing other than that specified in the installation instructions unless you are qualified to do so. Do not open the cabinet doors if extreme moisture is present (rain or heavy dew).

---



### **WARNING: Lethal Voltage**

In order to remove all sources of voltage from the PV225S, the incoming power must be de-energized at the source. This may be done at the main utility circuit breaker and by opening the AC Disconnect and the DC Disconnect Switches on the PV225S. Review the system configuration to determine all of the possible sources of energy. In addition, allow 5 minutes for the DC bus capacitors, located on the ceiling of the cabinet, to discharge after removing power.

---

## General Safety Precautions

1. When installing the PV225S use only components recommended or sold by Xantrex. Doing otherwise may result in a risk of fire, electric shock, injury to persons, and will void the warranty.
2. Do not attempt to operate the PV225S if it has been dropped, or received more than cosmetic damage during transport or shipping. If the PV225S is damaged, or suspected to be damaged, see the Warranty for this unit in the PV225S 225 kW Grid-Tied Photovoltaic Inverter Operation and Maintenance Manual.
3. To reduce the risk of electrical shock, lock-out and tag the PV225S before attempting any maintenance, service, or cleaning.

## Personal Safety

Follow these instructions to ensure your safety while working with the PV225S.

## Safety Equipment

Authorized service personnel must be equipped with standard safety equipment including the following:

- Safety glasses
- Ear protection
- Steel-toed safety boots
- Safety hard hats
- Padlocks and tags
- Appropriate meter to verify that the circuits are de-energized (600 Vac and DC rated, minimum)


Check local safety regulations for other requirements.

## Wiring Requirements

1. All wiring methods and materials shall be in accordance with the National Electrical Code ANSI/NFPA 70. When sizing conductors and conduits interfacing to the PV225S, both shall be in accordance with the National Electric Code ANSI/NFPA 70, as well as all state and local code requirements.
2. Use copper conductors only with insulation rated for 90 °C.
3. The PV225S has a three-phase output. It is marked with this symbol: Ø
4. The AC power conductor wiring interfacing with the AC terminals in the Transformer Enclosure are located at T6-X1, T6-X2, and T6-X3. These terminals should be tightened to a torque value of 420 in-lbs (47.5 Nm). Conductors terminated to these terminals must use a crimp-on type ring



terminal or compression-type lug. The terminals can accommodate up to two conductors per phase. *See Figure 3-14 on page 3–15 for the location of these terminals.*

5. The AC power conductor wiring interfacing with the AC terminals in the Main Inverter Enclosure are located at TB5, TB6, and TB7. These terminals are to be tightened to a torque value of 375 in-lbs (42.4 Nm). The terminals will accept a conductor size of 350 kcmil and can accommodate up to six conductors per phase. *See Figure 3-15 on page 3–16 for the location of these terminals.*
6. The AC power conductor wiring interfacing with the AC terminals in the AC Interface Enclosure are located at S1-2T1, S1-4T2, and S1-6T3. These terminals should be tightened to a torque value of 310 in-lbs (35.0 Nm). *See Figure 3-16 on page 3–16 for the location of these terminals.*
7. The AC neutral conductor from the utility is terminated in the AC Interface Enclosure at the TB11 terminal. This terminal requires the use of a crimp-on type ring terminal or compression-type lug and should be tightened to a torque value of 228 in-lbs (25.7 Nm). *See Figure 3-18 on page 3–18 for the location of these terminals.*
8. The DC power conductor wiring interfacing with the DC terminals at S2-6, K2-6T3, and TB4 are to be tightened to a torque value of 600 in-lbs (67.8 Nm). These terminals will accept a conductor size of 600 kcmil and can accommodate up to four conductors per pole at S2-6 and K2-6T3 and up to two conductors at TB4. Keep these cables together as much as possible and ensure that all cables pass through the same knockout and conduit fittings, thus allowing any inductive currents to cancel. *See Figure 3-19 on page 3–19 for the location of these terminals.*
9. This product is intended to be installed as part of a permanently grounded electrical system per the National Electric Code ANSI/NFPA 70. A copper ground rod must be installed within three feet of the PV225S enclosure. This is the single point earth ground for the inverter system. The single point ground for the system is to be made at the AC ground bus bar (TB12) in the AC Interface Enclosure. This terminal requires the use of a crimp-on type ring terminal or compression-type lug and should be tightened to a torque value of 420 in-lb (47.5 Nm).
10. The equipment grounds on the PV225S are marked with this symbol: 
11. AC overcurrent protection for the utility interconnect (Grid-tie) must be provided by the installers as part of the PV225S installation.



### CAUTION: Fire Hazard

In accordance with the National Electrical Code, ANSI/NFPA 70, connect only to a circuit provided with 400 amperes maximum branch circuit overcurrent protection for the PV225S-480.

## Operational Safety Procedures

Never work alone when servicing this equipment. A team of two is required until the equipment is properly de-energized, locked-out and tagged, and verified de-energized with a meter.

Thoroughly inspect the equipment prior to energizing. Verify that no tools or equipment have inadvertently been left behind.

## Lockout and Tag

Safety requirements mandate that this equipment not be serviced while energized. Power sources for the PV225S must be locked-out and tagged prior to servicing. A padlock and tag should be installed on each energy source prior to servicing.



### **WARNING: Shock Hazard**

Review the system schematic for the installation to verify that all available energy sources are de-energized. DC bus voltage may also be present. Be sure to wait the full 5 minutes to allow the capacitors to discharge completely.

---

The PV225S can be energized from both the AC source and the DC source. To ensure that the inverter is de-energized prior to servicing, lockout and tag the PV225S using the following procedure.

1. Open, lockout, and tag the incoming power at the utility main circuit breaker.
2. Open, lockout, and tag the AC Disconnect Switch (S1) on the AC Interface Enclosure. See Figure 1-4 on page 1–9 for the location of the AC Disconnect Switch.
3. Open, lockout, and tag the DC Disconnect Switch (S2) on the DC Interface Enclosure. See Figure 1-4 on page 1–9 for the location of the DC Disconnect Switch.
4. Using a confirmed, accurate meter, verify all power to the inverter is de-energized. A confirmed, accurate meter must be verified on a known voltage before use. Ensure that all incoming energy sources are de-energized by checking the following locations.
  - a) *Inverter Terminals:* **TB5, TB6, TB7 (Phase A, B, C)**  
See Figure 3-15 on page 3–16.
  - b) *Utility Terminals:* **Bottom of S1-2T1, S1-4T2, S1-6T3**  
See Figure 3-16 on page 3–16.
  - c) *PV Terminals:* **Bottom of S2-6, K2-6T3, TB4 (PV+, PV-, GND)**  
See Figure 3-19 on page 3–19.

---

## De-Energize/Isolation Procedure

The following procedure should be followed to de-energize the PV225S for maintenance.



### **WARNING**

The terminals of the DC input may be energized if the PV arrays are energized. In addition, allow 5 minutes for all capacitors within the main enclosure to discharge after disconnecting the PV225S from AC and DC sources.

---

#### **To isolate the PV225S:**

1. Turn the ON/OFF switch to the OFF position.
2. Open the DC Disconnect Switch.
3. Open the AC Disconnect Switch.
4. Open the utility connection circuit breaker.
5. Install lockout devices on the utility connection circuit breaker and DC Disconnect Switch.

## Interconnection Standards Compliance

The PV225S has been tested and listed by Underwriters Laboratories to be in compliance with *UL1741 Static Inverters And Charge Controllers For Use In Photovoltaic Power Systems*, as well as *IEEE-929-2000 Recommended Practice For Utility Interface of Photovoltaic (PV) Systems*.

IEEE-929-2000 provides guidance regarding equipment and functions necessary to ensure compatible operation of photovoltaic systems which are connected in parallel with the electric utility.

UL1741 is the standard applied by Underwriters Laboratory to the PV225S to verify it meets the recommendations of IEEE-929-2000.

Refer to both documents for details of these recommendations and test procedures.



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# 1

## Introduction

Chapter 1, “Introduction” provides information about the features and functions of the PV225S 225 kW Grid-Tied Photovoltaic Inverter.

## Description of the PV225S

The PV225S 225 kW Grid-Tied Photovoltaic Inverter is a UL 1741 Listed, utility interactive, three-phase power conversion system for grid-connected photovoltaic arrays with a power rating of 225 kW. Designed to be easy to install and operate, the PV225S automates start-up, shutdown, and fault detection scenarios. With user-definable power tracking that matches the inverter to the array and adjustable delay periods, users are able to customize start up and shut down sequences. Multiple PV225S inverters are easily paralleled for larger power installations.

The PV225S power conversion system consists of a pulse-width modulated (PWM) inverter, switch gear for isolation and protection of the connected AC and DC power sources, and a custom Wye/Wye isolation transformer. Housed in a rugged NEMA-3R rated, powder-coated steel enclosure, the PV225S incorporates sophisticated Intellimod<sup>®</sup> (IPM) Insulated Gate Bipolar Transistors (IGBTs) as the main power switching devices. An advanced, field-proven, Maximum Peak Power Tracker (MPPT) integrated within the PV225S control firmware ensures the optimum power throughput for harvesting energy from the photovoltaic array.

The advanced design of the PV225S includes an EMI output filter and the main AC contactor located electrically on the utility side of the isolation transformer. The location of the main AC contactor, and the ability to de-energize the isolation transformer during times of non-operation, greatly reduces the night-time tare losses consumed by an idle isolation transformer. An integrated soft-start circuit precludes nuisance utility-tie circuit breaker trips as the result of isolation transformer inrush current.

Additionally, the PV225S integrated controller contains self-protection features including over and under voltage and frequency safeguards. An integral anti-island protection scheme prevents the inverter from feeding power to the grid in the event of a utility outage. The PV225S includes a local user interface comprised of an ON/OFF switch, keypad, and 4-line, 80 character LCD display. A user-friendly, Graphic User Interface (GUI) provides a remote interface for operator interrogation of PV225S system status, control, metering/data logging and protective functions within the PV225S. The status, control, and logging features are also supported by the data modem (included) and can be accessed remotely.

The PV225S comes in two modules comprised of six enclosures to house the electronics described above. The first module includes the Main Inverter Enclosure, Inductor Enclosure, DC Interface Enclosure, and Communications Enclosure. The second module includes the Transformer Enclosure and AC Interface Enclosure. These components are identified in Figure 1-1 on page 1–3. Figure 1-1 also shows the dimensions and locations of the various enclosures that comprise the PV225S.

See “Layout Options” on page 2–6 for information on configuration options.

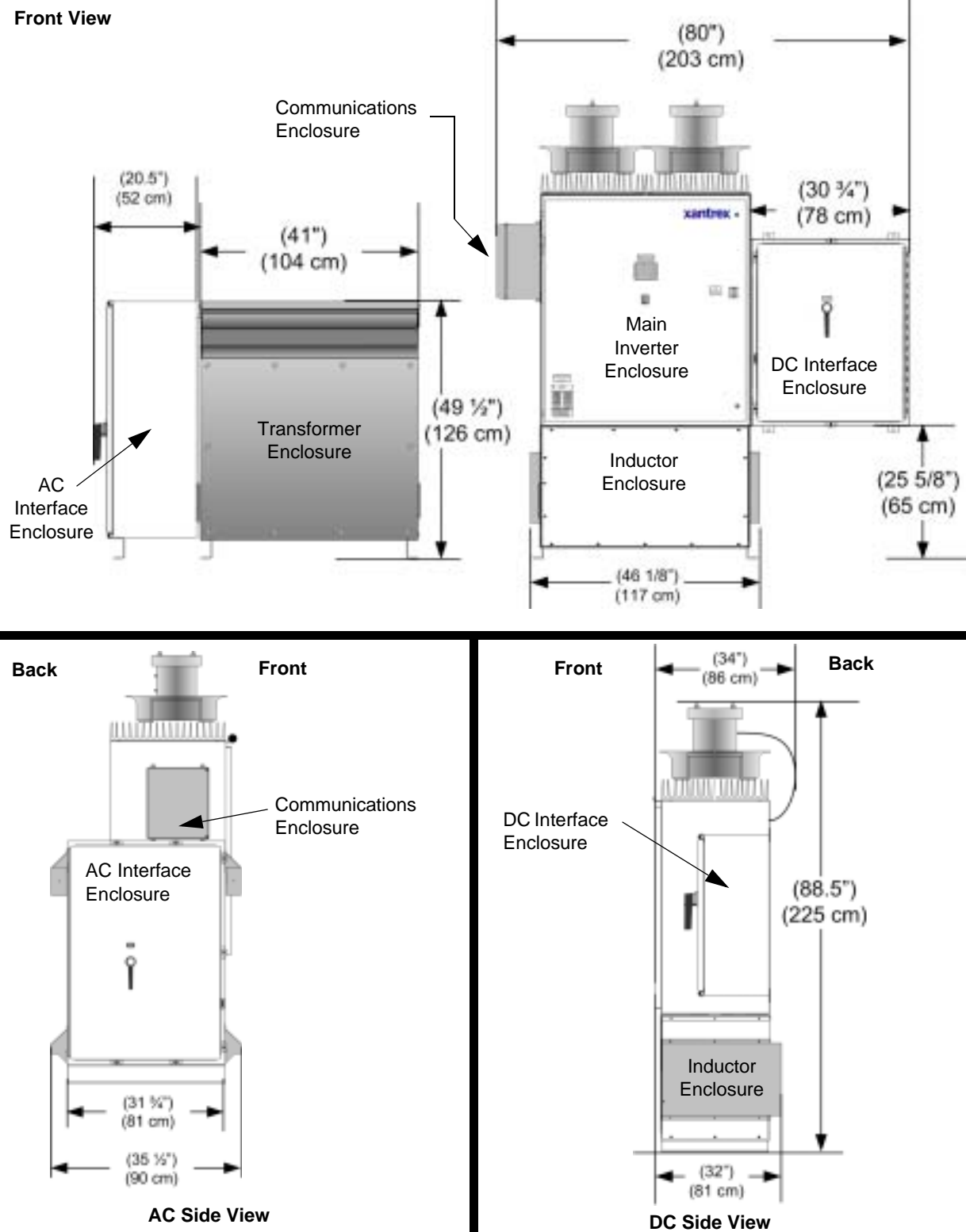


Figure 1-1 Dimensions (Not to scale)

## System Specifications

The PV225S has been designed for photovoltaic power systems, which operate within the following specifications.



### CAUTION: Equipment Damage

Operation of the PV225S in a manner other than specified in this manual may cause damage to the PV225S and other system components and will void the terms of the warranty.

## Electrical Specifications

Table 1-1 provides the AC and DC specifications for the PV225S.

**Table 1-1** Electrical Specifications

Specification	PV225S-480
Nominal AC Input Voltage (+10% to -12% acceptable range)	480 Vac (422 to 528 Vac)
Maximum AC Output Current	271 A <sub>rms</sub>
Nominal AC Input Frequency (+0.5 to -0.7 Hz acceptable range)	60 Hz (59.3 to 60.5 Hz)
Output Power	225 kW
Peak Power Tracking Window	330 to 600 Vdc
Maximum Open Circuit Voltage	600 Vdc
Maximum DC Input Current	710 amps

## Over Voltage, Under Voltage and Frequency Ranges

Table 1-2 provides the over voltage, under voltage, over-frequency, and under-frequency detection limits for the PV225S. These detection limits have been factory tested and deemed to be in compliance with IEEE-292 and UL 1741 requirements for utility interaction.

**Table 1-2** Over/Under Voltage and Over/Under Frequency Ranges

Vac Condition (% of Nominal)	PV225S-480	
	Voltage Range	Trip Time
$V_{ac} < 50\%$	$V_{ac} < 240$	6 cycles
$50\% \leq V_{ac} < 88\%$	$240 \leq V_{ac} < 422$	2 seconds
$88\% < V_{ac} \leq 110\%$	$422 < V_{ac} \leq 528$	normal operation
$110\% < V_{ac} < 137\%$	$528 < V_{ac} < 657$	2 seconds
$137\% \leq V_{ac}$	$657 \leq V_{ac}$	2 cycles
$f < \text{rated} -0.7$	$f < 59.3$	6 cycles
$f > \text{rated} +0.5$	$f > 60.5$	6 cycles

## System Ground Requirements

This product is intended to be installed as part of a permanently grounded electrical system per the National Electric Code ANSI/NFPA 70. A copper ground rod must be installed within three feet of the PV225S enclosures and connected to the unit as described in “System Grounding” on page 3–12. The single-point ground for the system is to be made at the AC ground bus bar (TB12) in the AC Interface Enclosure.

## System Neutral Requirements

The PV225S is designed to be installed as a 4-wire system. As required by the UL 1741 listing, a neutral conductor from the utility-interconnect must be terminated at TB11 within the AC Interface Enclosure to ensure that the AC voltage sensing circuit can perform an individual phase voltage (line-to-neutral) measurement. The function of the neutral connection is to provide a point of reference for measurement purposes that is essentially at ground potential. No power will flow through the neutral conductor.

## Utility Side Isolation Transformer Requirements

The PV225S is supplied with a custom, high-efficiency, isolation transformer as part of the AC Interface/Transformer assembly. The utility side windings of the isolation transformer are configured Wye and must match the voltage at the utility inter-tie. The PV225S is a balanced, three-phase, current-sourcing inverter and only operates with the presence of a stable utility voltage. The transformer is also supplied with a neutral connection on the utility interconnect. Connection of this utility-side neutral does not affect the operation of the inverter, however connection of the neutral on the inverter-side does affect the operation and must be left floating or disconnected. Single-phase, grounded loads which may be present between the transformer and utility, will maintain their existing ground reference at the utility distribution transformer.



### CAUTION: Equipment Damage

If the Isolation Transformer (T6-X0) neutral terminal is tied to ground, it will cause irreparable damage to the PV225S. Check local regulations for their requirements regarding the connection of the neutral.

---



### WARNING: Lethal Voltage

Grounding the neutral of a Wye-wound transformer may create an “open delta” condition, depending on the utility configuration. This condition may keep the PV225S from detecting a loss of phase condition on the utility system, which may allow potentially lethal voltage to be present on the open-phase wiring.

---

## Environmental Specifications

The following environmental specifications are the same for both models of the PV225S 225 kW Grid-Tied Photovoltaic Inverter.

**Table 1-3** Environmental Specifications

Specification	Value
Dimensions	
Inverter and DC Interface	88.5 in H x 80 in W x 32 in D (225 cm H x 203 cm W x 81 cm)
Transformer and AC Interface	49.5 in H x 61.5 in W x 35.5 in D (126 cm H x 156 cm W x 90 cm D)
Overall System Footprint: Layout Option A	14 ft W x 5 ft L (approximate) (4.3 m x 1.5 m)
Layout Option B	10 ft W x 9 ft L (approximate) (3 m W x 2.7 m L)
Weight	
Inverter and DC Interface	2300 lbs (approximate)
Transformer and AC Interface	2350 lbs (approximate)
Overall Weight	4650 lbs (approximate)
Allowable Ambient Temperature	
Operating	-20 °C to 50 °C Maximum
Storage	-40 °C to 50 °C Maximum
Relative Humidity	To 95%, Non-condensing
Elevation	Power Derated above 6600 ft
Clearance (ventilation and serviceability)	<i>In front of access doors:</i> 36 in (91 cm) <i>In front of access panels:</i> 36 in (91 cm) <i>Sides:</i> 12 in (30 cm) <i>Back:</i> 6 in (15 cm)
Maximum Distance between Main Inverter Enclosure and AC Interface/Transformer Enclosure	15 ft (4.5 m)



## Operator Interface Controls

Operator interface controls are located on the front door of the main inverter enclosure. These controls include an ON/OFF Switch, 4-line LCD display and keypad called the Universal Frontpanel Control Unit (UFCU). Additionally there is an AC and DC Disconnect on the AC Interface Enclosure and the DC Interface Enclosure Doors.

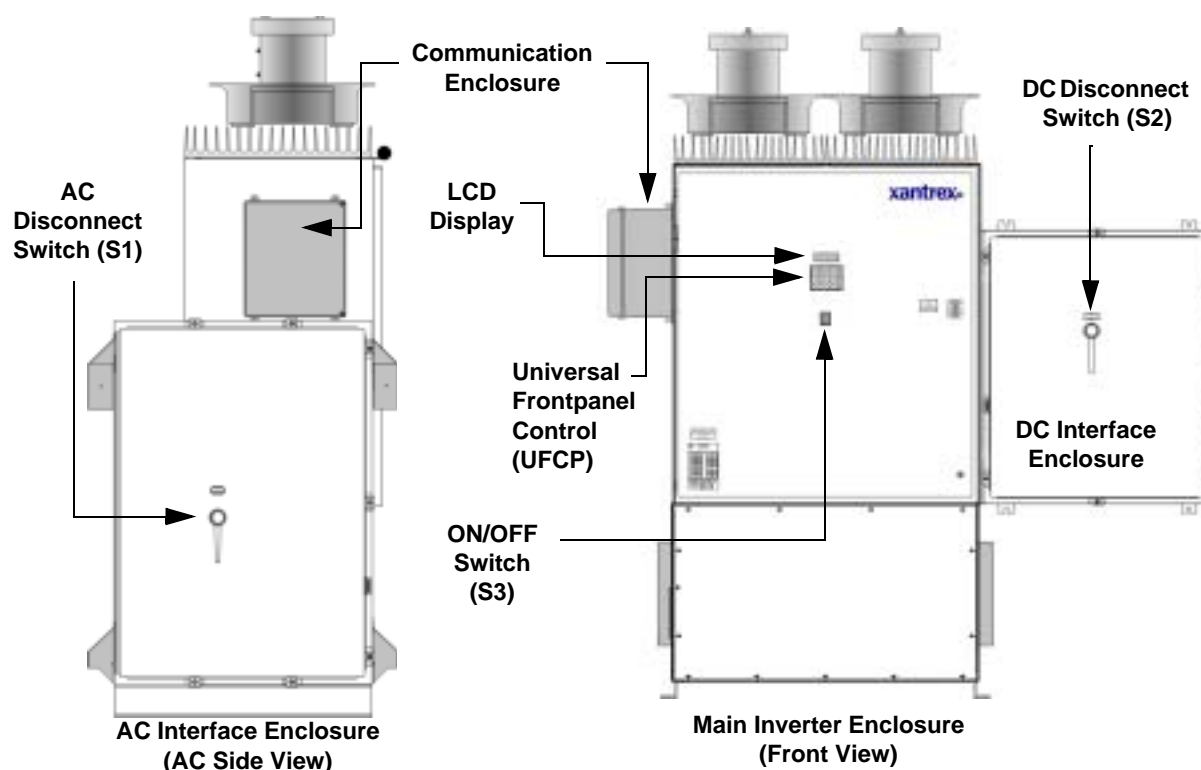


Figure 1-2 PV225S Operator Interface Components

### Main Enclosure Door Interlock Switch

The front door of the PV225S main enclosure is equipped with an interlock switch to preclude operation while the front door is open. Opening the door of the main inverter enclosure will initiate an immediate controlled shutdown of the PV225S and opens both the main AC and DC contactors. The main AC and DC contactors cannot be closed unless the door's interlock is in the engaged position. The PV225S is prevented from being restarted until the door is again closed and the switch is in the engaged position.

It is required that the PV225S main enclosure door must be locked during normal operation. The door interlock switch does NOT remove all hazardous voltages from inside the inverter. Before attempting to service the PV225S, follow the de-energize Lockout and Tag procedure on page viii.



### **WARNING: Shock Hazard**

Disengaging the main enclosure door interlock switch does NOT remove all hazardous voltages from inside the inverter. Before attempting to service the PV225S, follow the de-energize Lockout and Tag procedure on page viii.

---

## **On/Off Switch**

The PV225S incorporates a maintained position ON/OFF switch (S3) located on the front door of the main enclosure. Under normal conditions, the ON/OFF switch is in the ON position. Turning the switch to the OFF position will initiate an immediate controlled shutdown of the PV225S and opens both the main AC and DC contactors within the unit. The main AC and DC contactors cannot be closed unless the switch is in the ON position. The PV225S is prevented from being restarted until the ON/OFF switch is turned back to the ON position.

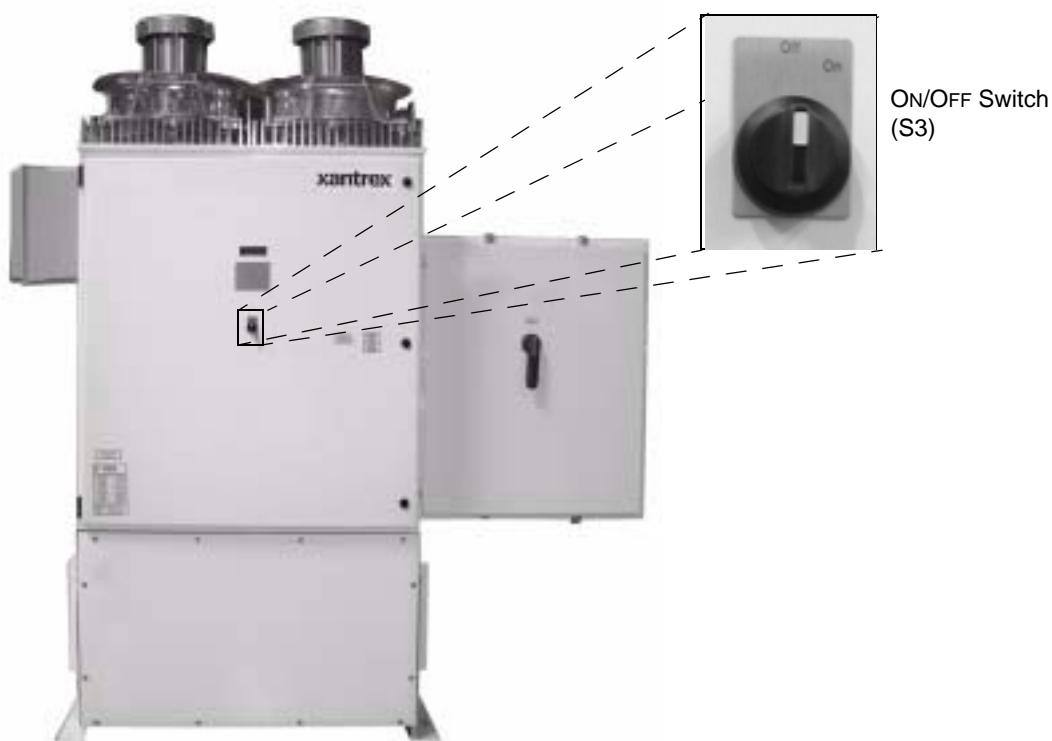
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### **WARNING: Shock Hazard**

Turning the ON/OFF switch to the OFF position does NOT remove all hazardous voltages from inside the inverter. Before attempting to service the PV225S, follow the de-energize Lockout and Tag procedure on page viii.

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**Figure 1-3** On/Off Switch (S3)

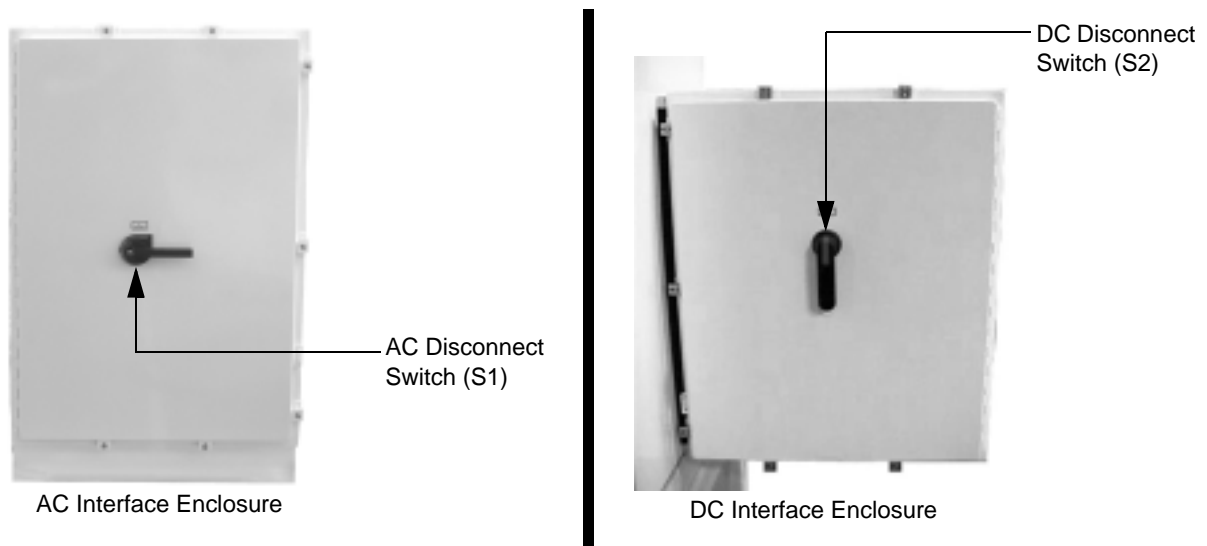
## AC and DC Disconnect Switches

Both AC and DC Interface Enclosures are equipped with lockout hasps for personnel safety. The enclosure doors should not be opened while the PV225S is operating.

The switch handles and shafts provide a door interlock for both the AC and DC Interface Enclosures. The doors cannot be opened when the switch is in the ON position.

The DC Disconnect Switch (S2) is equipped with an auxiliary contact block which enables the switch to be used as a load break DC disconnect. In the event the DC Disconnect Switch is opened while the PV225S is processing power from the PV array, the early-break contact block will signal the CCU2 (Converter Control Unit 2) to stop processing power prior to the opening DC Disconnect Switch.

Additionally, opening the DC Disconnect Switch will cause the PV225S to execute an immediate orderly shutdown, open both the main AC and DC contactors, and report a PV disconnect fault on the LCD of the UFCU.



**Figure 1-4** AC and DC Disconnect Switches (S1 and S2)

## Communication Features

The PV225S provides two types of information to the user:

- system status and/or fault information, and
- data logging information.

System status and fault information can be accessed using the Universal Front Panel Control Unit (UFCU) or a personal computer using the Xantrex Solar Graphic User Interface (GUI) software. Data logging requires the use of a PC using the GUI software.

## System Status and Fault Reporting

Basic system status and all fault conditions rising from within the PV225S are reported to the UFCU. The unit stores the time and details of all faults in non-volatile memory. The 4-line LCD will display a hexadecimal value and a brief text description of the fault.

This information can also be accessed using a personal computer using the GUI software either directly or remotely.

Types of status information include:

- Current Operating State or Goal State
- Fault Code (if applicable)
- Inverter State
- Line Voltage and Current
- Inverter Matrix Temperature
- Inverter Power
- PV State
- PV Voltage and Current
- PV Power
- Grid Frequency
- Peak Power Tracker Enabled

## Data Logging

The inverter stores data values and software metrics for debugging. These values are stored within the CCU2 controller board in non-volatile memory. Data logging requires the use of a PC connection using the Xantrex Solar Graphic User Interface (GUI) software.

- The Data Logging features include:
- Operational Values
- Internal Metrics
- Data Log Acquisition
- Graphic Data Analysis
- Fault Log Acquisition
- Software Upgrade
- Accumulated Values
- Configurable Parameters

## Communication Methods

The PV225S communicates system status information to the user using the following methods.

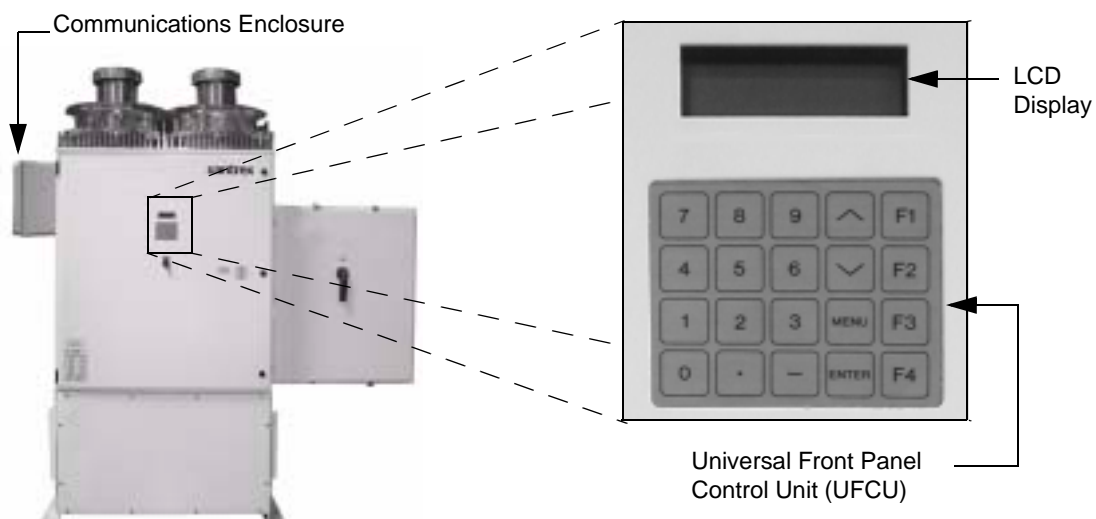
- The Front Panel Control Unit (UFCU) Display
- PC Connection (Direct or Remote) - Xantrex Solar Graphic User Interface (GUI) Software required. Communication with a PC requires the selection of one of the following options.
  - Remote Connection -- This method has three options available. One of these options will be field-installed prior to commissioning.
    - POTS Connection
    - Wireless Connection
    - Ethernet LAN Connection
  - Direct Connection -- This method is most commonly used by field technicians for local connection and troubleshooting purposes.

**Important:** The customer is responsible for providing the appropriate support service to support a PC connection. (i.e., making arrangements for an analog phone line, wireless service or local area network.)

### Universal Front Panel Control Unit (UFCU)

The UFCU keypad is located on the front of the Main Inverter Enclosure to manipulate and view system operation and status.

The keypad is comprised of 20 touch-sensitive keys that provide a means to navigate through the menus and alter user-changeable settings.



**Figure 1-5** LCD Display and UFCU Location

See the PV225S 225 kW Grid-Tied Photovoltaic Inverter Operation and Maintenance Manual for details.

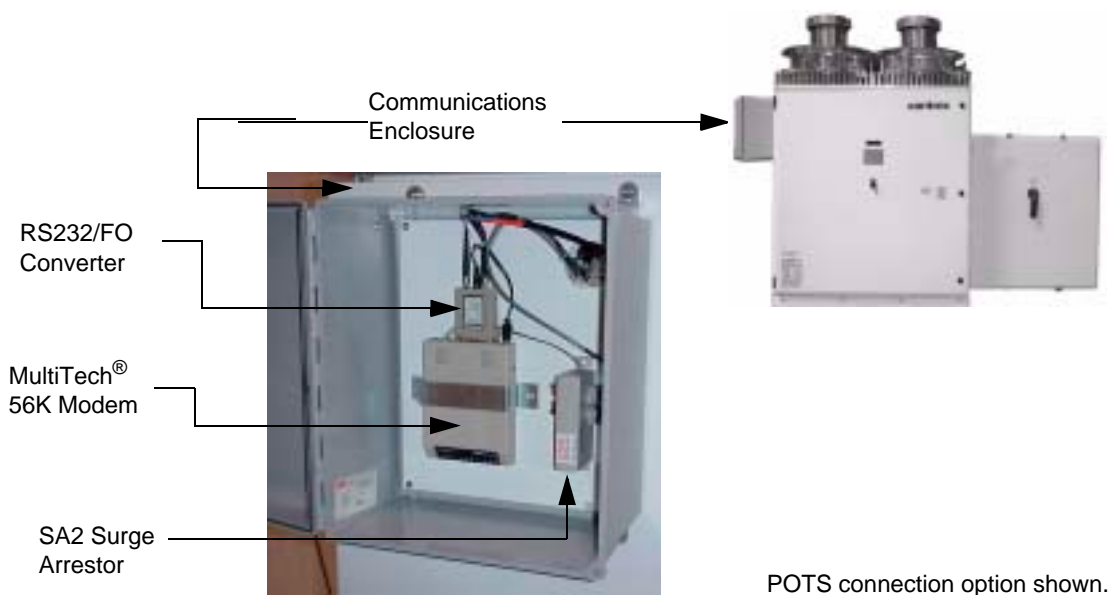
## PC Connection Methods

Personal computers can be used to access the system status and programming features of the PV225S. A computer can be connected either directly or remotely.

1. Remote Connect - uses one of the three kits below.
  - POTS Kit - uses a MultiTech® 56K Modem, RS232/Fiber Optic Converter (configured for ethernet) and SA2 Surge Arrestor.
  - Wireless Kit - uses a GSM Wireless Modem.
  - Ethernet LAN Kit - uses a data communication device to enable the unit to connect to a local area network.
2. Direct Connect - This method is used for troubleshooting. It uses a RS232/Fiber Optic Converter (configured for a PC), a DB25-to-DB25 gender changer, and a DB25-to-DB9 Serial Cable.

Software is included to provide a graphic user interface that relates important system information. This software is called Xantrex Solar Graphic Interface (GUI). See "Computer Communications with the PV225S" in the PV225S 225 kW Grid-Tied Photovoltaic Inverter Operation and Maintenance Manual for additional information.

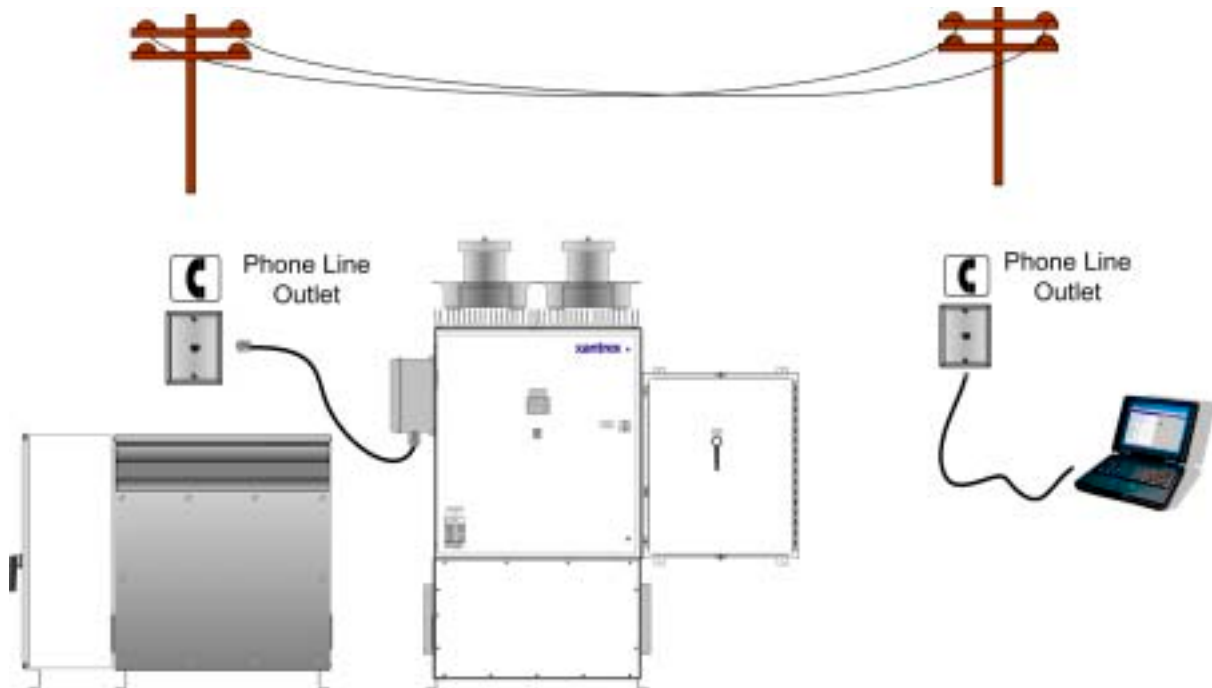
The GUI can dial up the inverter and receive fault report calls from it through a standard Hayes-compatible, landline modem. When the GUI initiates a call through the modem at the GUI computer, the inverter's modem answers the call and initiates a 9600 baud serial connection, effectively as if the GUI was connected directly. Or, if the inverter experiences a fault, it will initiate a call to the GUI and report the fault details.



**Figure 1-6** PC Connections in the Communications Enclosure

## POTS Access

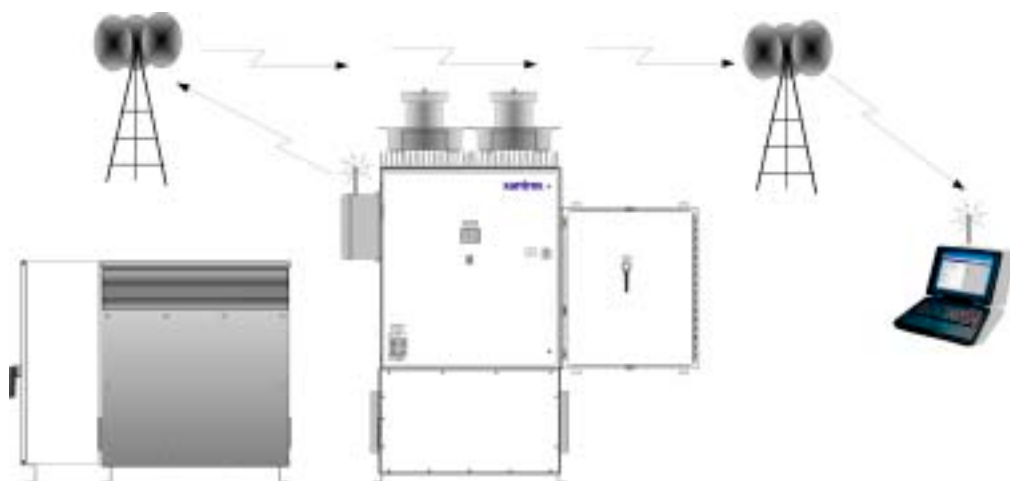
Figure 1-7 illustrates the PV225S connected remotely to a personal computer.



**Figure 1-7** POTS Access

## Wireless Access

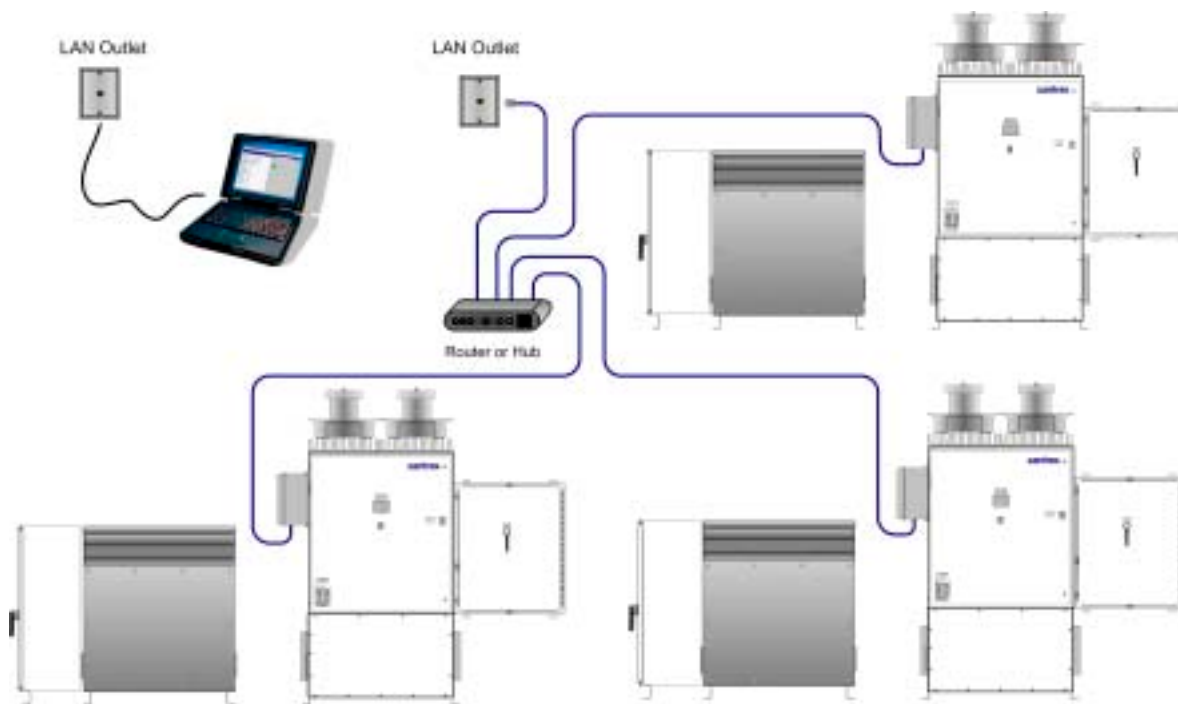
Figure 1-8 illustrates the PV225S connected directly to a personal computer using a wireless network.



**Figure 1-8** Wireless Access

## Ethernet LAN Access

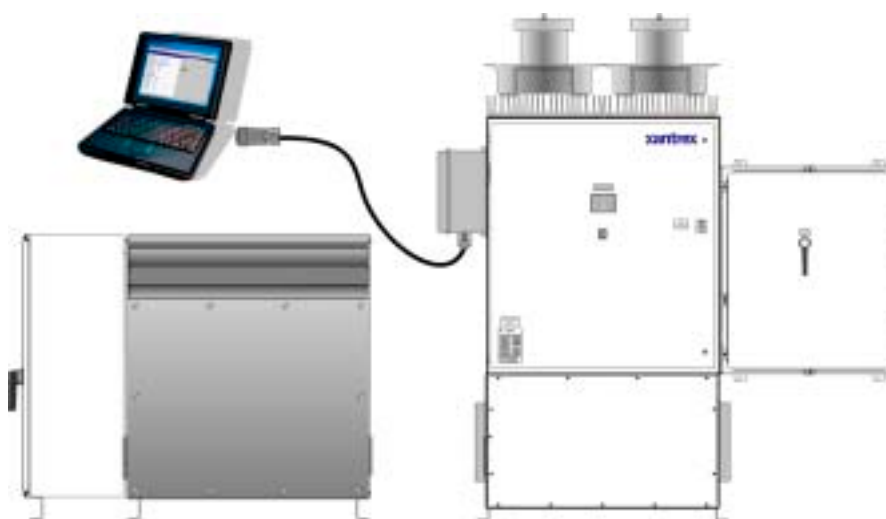
The PV225S can be remotely accessed through a local area network.



**Figure 1-9** Ethernet LAN Access

## Direct Access

Figure 1-10 illustrates the PV225S connected directly to a personal computer.



**Figure 1-10** Direct Access



# 2

## Planning

Chapter 2, “Planning” provides information to help plan the installation of the PV225S 225 kW Grid-Tied Photovoltaic Inverter.

## Overview of PV225S Installation



### **WARNING: Shock Hazard**

Installations of this equipment should only be performed by qualified technicians. Installers must meet all local and state code requirements for licensing and training for the installation of Electrical Power Systems with AC and DC voltage to 600 volts.

Planning	Planning for a system requires complete understanding of all the components that are involved to successfully install the PV225S to meet the required national, state, and local codes.
Definition	A power system (such as the PV225S) is a collection of devices designed to supply AC power to the utility grid from a solar energy (PV) source.
Components	All types of grid-tied inverter installations, residential or industrial, share common components. This chapter describes each component and suggests the minimum requirements for a safe installation.
Location	<p>The PV225S 225 kW Grid-Tied Photovoltaic Inverter is designed to be installed in either an indoor or outdoor location. The PV225S must be anchored to a level, concrete floor or pad.</p> <p>Ideally the AC Interface Enclosure/Transformer Assembly is placed on the left side of the Main Inverter Enclosure. The AC Interface Enclosure/Transformer Assembly may be co-located adjacent to the left side of the Main Inverter Enclosure up to, but not exceeding, 15 feet away.</p>
Clearance	Adequate ventilation and service access must be taken into consideration when installing the PV225S. See “Ventilation and Serviceability Requirements” on page 2–3 for specific clearance requirements and ambient temperature requirements.
Conduits and Conductors	<p>Given the flexibility to co-locate the AC Interface Enclosure/Transformer Assembly to fit a desired system layout, the conduits and conductors are to be supplied by the installer.</p> <p>See “Conduit Penetration” on page 2–8 for recommendations on enclosure penetration locations and conduit routing.</p> <p>See “Conductor and Conduit Sizing” on page 2–11 for information on sizing the conductors and conduits.</p> <p>All interconnect wiring and power conductors interfacing to the PV225S must be in accordance with the National Electric Code ANSI/NFPA 70 and any applicable local codes.</p>

Large gauge wire must conform to the minimum bend radius specified in the NEC, Article 373-6B, Ninth Edition.

Take care to keep the wire bundles away from any sharp edges which may damage wire insulation over time.

All conductors should be made of copper and rated for 90 °C (minimum).

If the installation of the PV225S is to be outdoors, all interconnect conduit and fittings must be NEMA-4 rated as required by the NEC.

## PV Planning

To determine the number of photovoltaic panels that are required for the PV power plant, please use the PV planning tool from the Xantrex website:

<http://www.xantrex.com/support/pvsizing/disclaimer.asp>

## Ventilation and Serviceability Requirements

The following environmental conditions must be established and maintained to ensure the safe and efficient operation and servicing of the PV225S. Adequate space must be provided around the unit for ventilation and access during servicing. If locating the unit indoors, ambient air temperature cannot exceed the maximum temperature for which the unit is rated.

Ventilation	Maintain a minimum clearance of 12 inches on both sides and 6 inches behind the Main Inverter Enclosure and the AC Interface Enclosure for proper cooling fan operation.
Maintenance and Serviceability	<p>Maintain a minimum clearance of 36 inches in front of the Main Inverter access door, the Transformer Enclosure access panel, and the AC Interface access door for maintenance and serviceability.</p> <p>See Figure 2-1 on page 2–6 and Figure 2-2 on page 2–7 for illustrations of these clearance requirements.</p>
Indoor Temperature Control	<p>If the PV225S is to be installed indoors and external air is used for ventilation, the required cubic feet per minute (CFM) rate must be no less than 1000 CFM. This assumes the temperature inside the building is allowed to rise only 10 °C above the outside temperature. Therefore, the maximum allowable outside ambient temperature is 50 °C (50 °C minus 10 °C equals 40 °C Maximum Ambient Temperature).</p> <p>If air conditioning is planned for an indoor installation, the heat load of the PV225S is 42,000 BTU/Hour at full load.</p>

## Ground Requirements

This product is intended to be installed as part of a permanently grounded electrical system per National Electric Code ANSI/NFPA 70. A copper ground rod must be installed within three feet of the PV225S enclosure. This is the single point earth ground for the inverter system. The single point ground for the system is to be made at the AC ground bus bar (**TB12**) in the AC Interface Enclosure.

## System Neutral Requirements

The PV225S is designed to be installed as a 4-wire system. As required by the UL 1741 listing, a neutral conductor from the utility-interconnect must be terminated at **TB11** within the AC Interface Enclosure to ensure that the AC voltage sensing circuit can perform an individual phase voltage (line-to-neutral) measurement. The function of the neutral connection is to provide a point of reference for measurement purposes that is essentially at ground potential. No power will flow through the neutral conductor.

## Communication Requirements

The PV225S can accommodate any one of the following options for PC Communication:

- **POTS Connect Kit** - uses a MultiTech<sup>®</sup> 56K Modem, RS232/Fiber Optic Converter (configured for ethernet) and SA2 Surge Arrestor. A direct analog phone line to the local phone service is required to use this feature. The phone line used for PV225S communication cannot be routed through a Private Branch Exchange (PBX) unless an analog PBX card is used.
- **Wireless Connect** - uses a GSM Wireless Modem.
- **Ethernet LAN Connect** - uses a data communication device to enable the unit to connect to a local area network.
- **Direct Connect Kit** - uses a RS232/Fiber Optic Converter (configured for a PC), a DB25-to-DB25 gender changer, and a DB25-to-DB9 Serial Cable.

Determine which communications options are required for the installation and procure the appropriate service or phone access. The personal computer to be used with this unit must have the appropriate hardware as well, such as a 56K modem for dial up connection or a Network Interface Card (NIC) for a LAN connection.

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## Utility Side Isolation Transformer Requirements

The PV225S is supplied with a custom, high-efficiency, isolation transformer as part of the AC Interface/Transformer assembly. The utility side windings of the isolation transformer are configured Wye and must match the voltage at the utility inter-tie. The PV225S is a balanced, three-phase, current-sourcing inverter and only operates with the presence of a stable utility voltage. The transformer is also supplied with a neutral connection on the utility interconnect. Connection of this utility-side neutral does not affect the operation of the inverter, however connection of the neutral on the inverter-side does affect the operation and must be left floating or disconnected. Single-phase, grounded loads which may be present between the transformer and utility, will maintain their existing ground reference at the utility distribution transformer.



### CAUTION: Equipment Damage

If the Isolation Transformer (T6-X0) neutral terminal is tied to ground, it will cause irreparable damage to the PV225S. Check local regulations for their requirements regarding the connection of these neutrals.



### WARNING: Lethal Voltage

Grounding the neutral of a Wye-wound transformer may create an “open delta” condition, depending on the utility configuration. This condition may keep the PV225S from detecting a loss of phase condition on the utility system, which may allow potentially lethal voltage to be present on the open-phase wiring.

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## Electrical Diagrams and Schematics

Since installations vary widely, a sample electrical diagram of the PV225S is provided in Figure A-1 on page A-3. This diagram is to be used for system planning purposes only.

For more detailed information, refer to the schematic illustrations.

- Figure A-2, “PV225S-480 Schematic for Main Power Distribution (152291 B1)” on page A-4
- Figure A-3, “PV225S-480 Schematic for Control Power Distribution (152291 B2)” on page A-5
- Figure A-4, “PV225S-480 Schematic for Converter Control Unit (152291 B3)” on page A-6

## Layout Options

The PV225S is shipped as two separate assemblies and can be arranged as shown in Figure 2-1 or Figure 2-2.

The PV225S can be arranged in a number of different system layout options to fit specific site requirements. The AC Interface/Transformer assembly may be co-located adjacent to the left side of (or behind) the Main Inverter Enclosure up to, and not exceeding, 15 feet away.

Given the flexibility to co-locate the AC Interface/Transformer assembly to fit a desired system layout, the interconnect AC power conductors and conduit between the Main Inverter Enclosure and the AC interface/transformer assembly are to be supplied by the installer. See Figure 2-1 and Figure 2-2, depicting two options for locating the AC interface/transformer assembly adjacent to the main inverter.

Minimum Dimension of Base:  
Approximately 14 ft. by 5 ft. (4.3 m x 1.5 m)

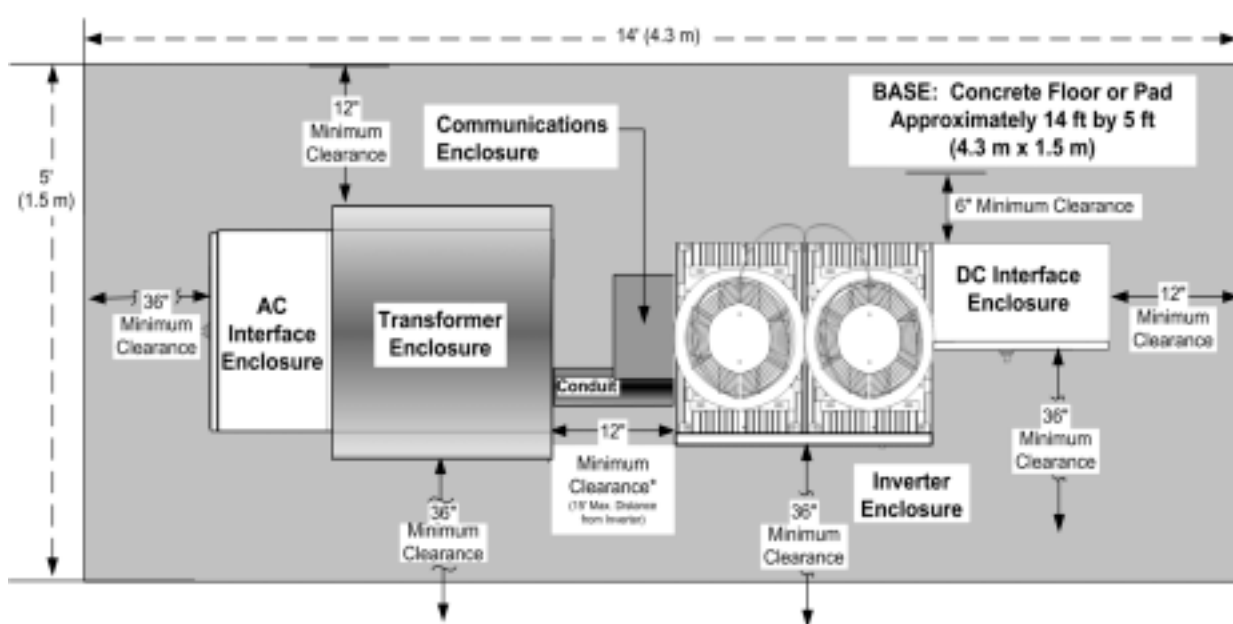


Figure 2-1 PV225S Layout Option A

Minimum Dimension of Base:  
Approximately 10 ft by 9 ft (3 m x 2.7 m)

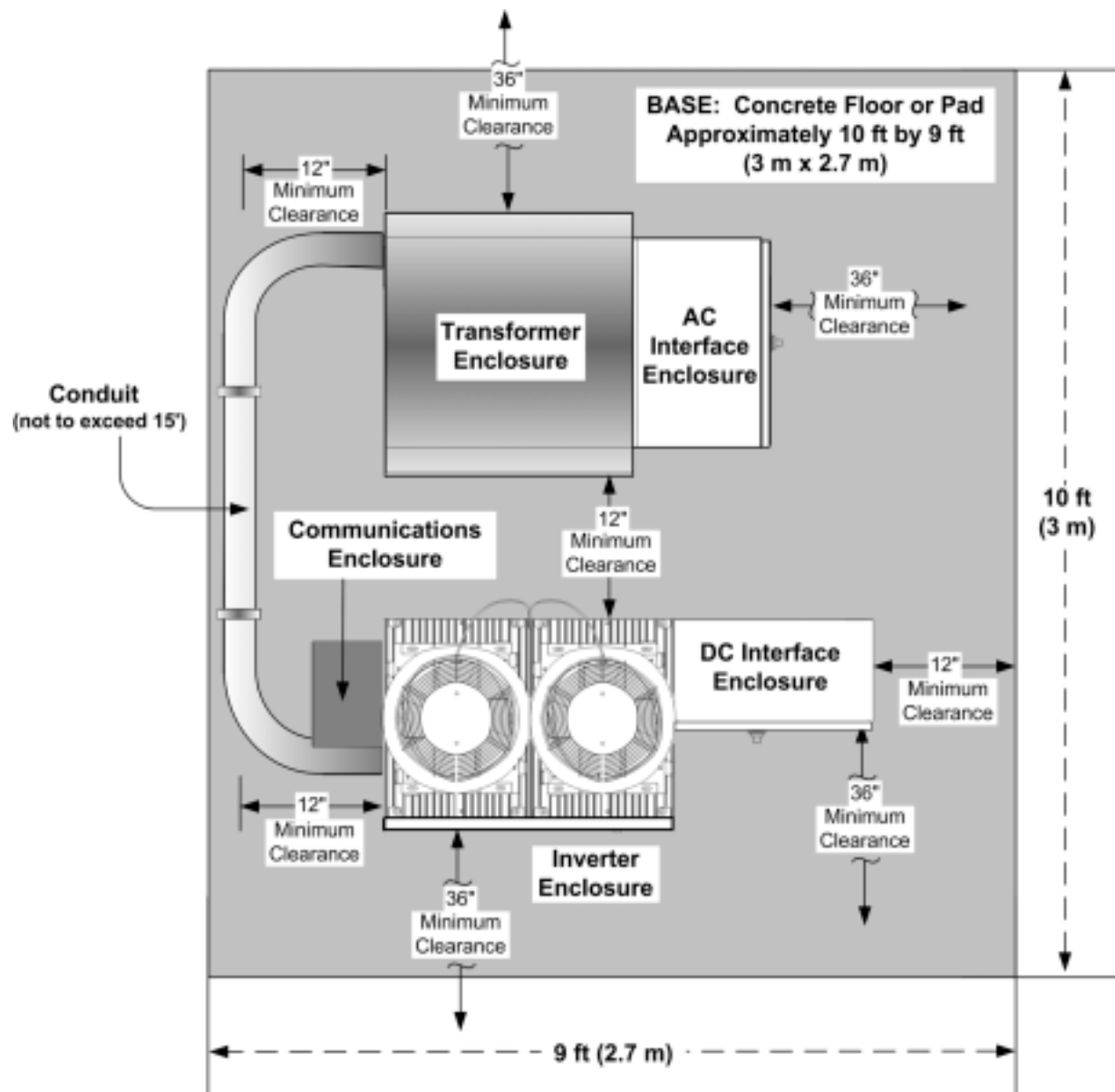
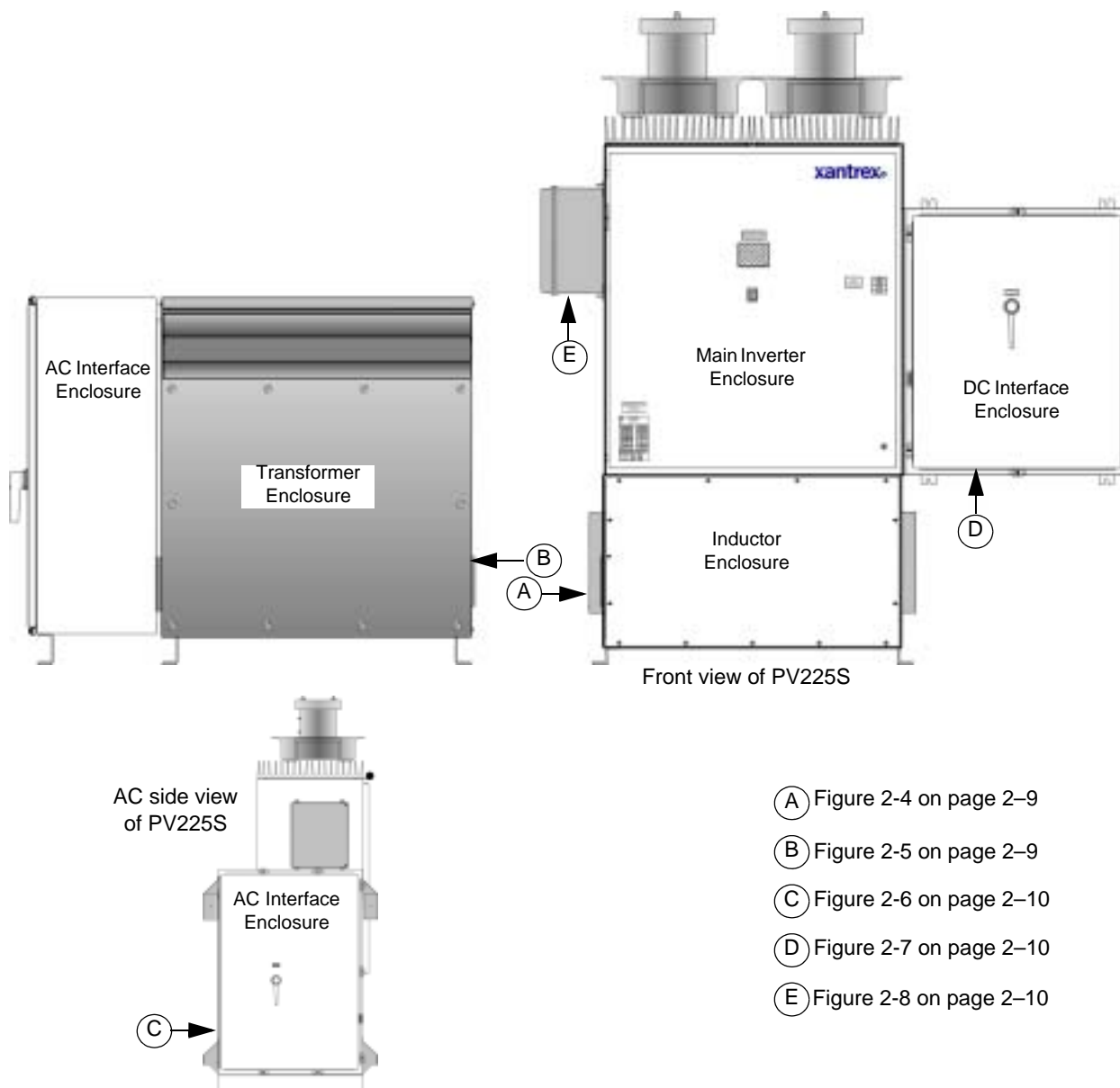


Figure 2-2 PV225S Layout Option B

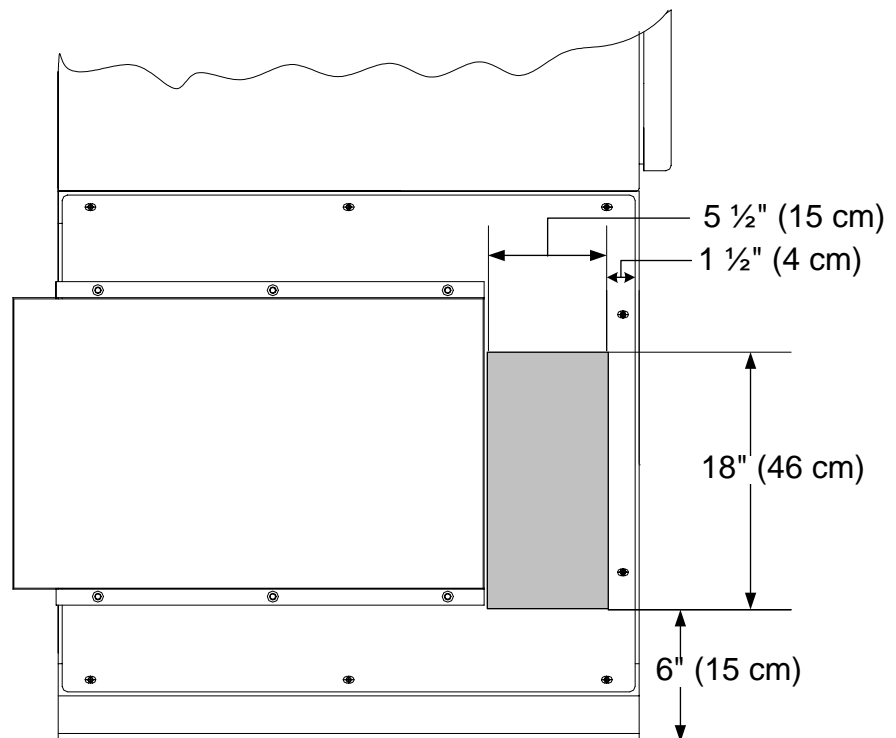
## Conduit Penetration

The following illustrations show the recommended locations for electrical conduit entry into the PV225S enclosures. These drawings are to be used for system planning purposes, such that the shaded areas are representative of the maximum allowable area and location in which electrical conduit may penetrate the enclosures of the PV225S, see Figure 2-3 through Figure 2-8. Xantrex recommends a standard trade-size conduit knock-out set for cutting/punching the PV225S enclosures and panels for conduit entry.

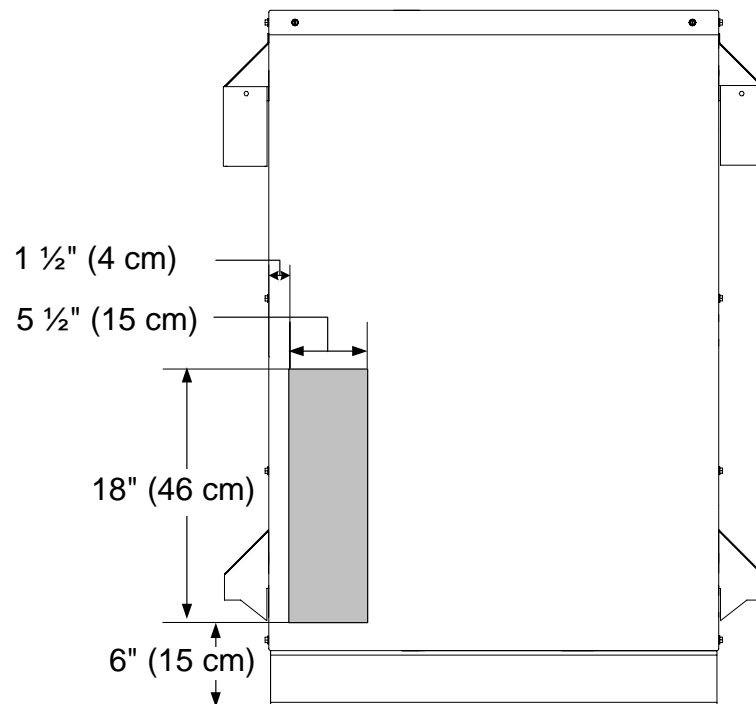


**Figure 2-3** Conduit Entry Figure Reference





**Figure 2-4** Inductor Enclosure Conduit Entry, Left Side



**Figure 2-5** Transformer Enclosure Conduit Entry, Right Side

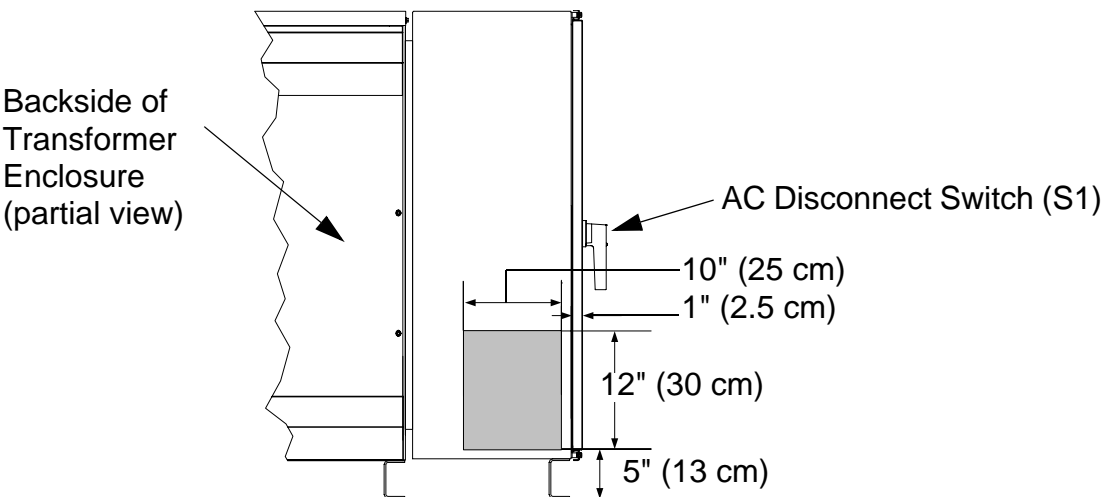


Figure 2-6 AC Interface Enclosure Conduit Entry, Left Side

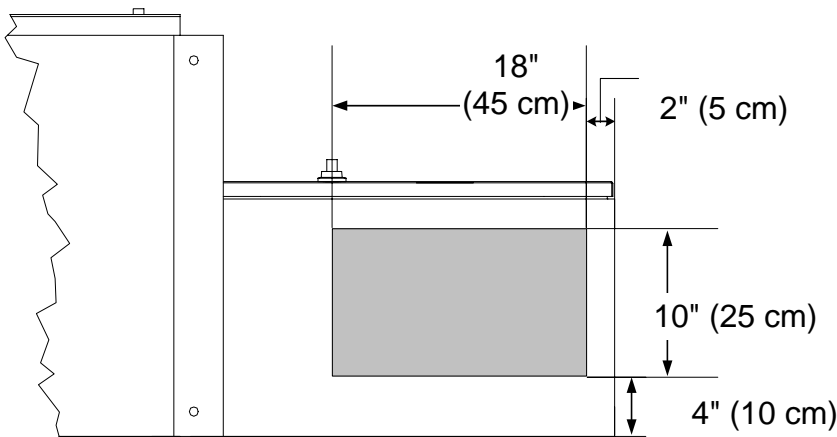


Figure 2-7 DC Interface Enclosure, Bottom Side

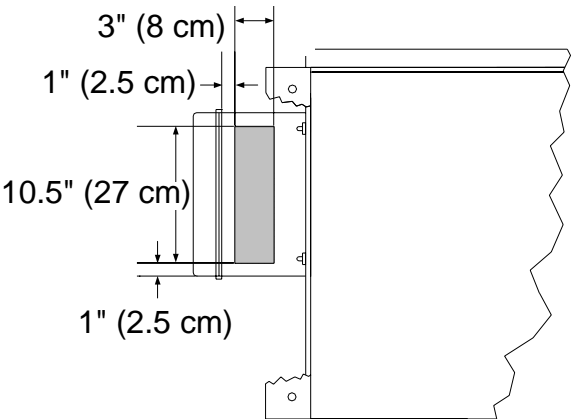


Figure 2-8 Communications Enclosure Conduit Entry, Bottom Side

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## Conductor and Conduit Sizing

All wiring methods and materials shall be in accordance with the National Electrical Code ANSI/NFPA 70. When sizing conductors and conduits interfacing to the PV225S, both shall be in accordance with the National Electric Code ANSI/NFPA 70, as well as all state and local code requirements.

Large gauge wire must conform to the minimum bend radius dependent upon the wire gauge (refer to the National Electric Code, Article 373-6B (Ninth Edition)).



### CAUTION: Equipment Damage

Be careful to keep the wire bundles away from any sharp edges which may damage wire insulation over time.

---

The following provides information on sizing the conductors and conduits for the system.

#### To calculate the proper conduit size:

1. Determine the required cable ampacity.
2. Determine the conduit length between the inverter and the transformer.
3. Determine the proper size for the cable according to the allowable ampacities indicated by NEC Table 310.16 (Ninth Edition).
4. Determine the proper size for the conduit.

The following is an example of the steps outlined above. Assumptions were made in this example which may not match your application, and the resulting design may not comply with all code requirements. Consult a licensed electrician on recommendations for specific installations.

#### Step 1. Determine the required cable ampacity.

AC Phase Cables from Inverter to Transformer:

$$225 \text{ kW} / 208 \text{ Vac} / 1.732 = 624.5 \text{ A}_{\text{rms}} \text{ (full load current)}$$

$$624.5 \times 125\% = 780.69 \text{ A (required ampacity)}$$

#### Step 2. Determine the conduit length between inverter and transformer.

- If the conduit length between the inverter and the transformer is less than 24 inches, then the cable can be sized using the NEC Table 310.16 (in raceway) (Ninth Edition).
- If the conduit length is greater than 24 inches, then the cable must be sized using NEC Table 310.16 (in Raceway) (Ninth Edition) and by using the adjustment factors in NEC Table 310-15(b)(2)(a).

**Step 3. Size the cable.**

This example assumes that the conduit length is less than 24 inches. NEC Table 310.16 (Ninth Edition) indicates the Temperature Correction Factor for 90 °C THHN cable in a 50 °C ambient is 0.82. With a required ampacity from Step 1 above of 780.6 amps, it can be calculated that the required cable ampacity at 50 °C in this application is 952 amps. (780.6 divided by 0.82)

In this example, four cables per phase termination are used, so from NEC Table 310.17 (Ninth Edition) it is apparent that the 90 °C THHN cable must be 262 kcmil or larger. Four each 262 kcmil conductors at 50°C have an allowable ampacity of 984 amps (246 multiplied by 4).

**Step 4. Size the conduit.**

In this step, the cross sectional area of all the individual cables is first calculated. Once calculated, the total cross sectional area of the cables is determined by summing their values. In this example, 262 kcmil DLO, 2000 V cable is selected for the AC Phase connections:

*DLO 262 Phase Cable:*

262 MCM DLO, 2000V, 90 °C per Phase

262 MCM has an O.D. of 0.973

$$0.973 \times 0.973 \times 12 \times 0.7854 = 8.923 \text{ in}^2$$

*Ground Cable:*

1 Each #2 AWG (per NEC Table 250.122 (Ninth Edition),  
using 400 A Breaker)

#2 AWG has an O.D. of 0.384 for THHN and 0.565 for DLO

$$0.565 \times 0.565 \times 0.7854 = 0.250 \text{ in}^2$$

*Sense/Control Wires:*

8 Each #16 AWG, UL1015, THHN, Hook-up Wire

#16 AWG has an O.D. of 0.096

$$0.096 \times 0.096 \times 8 \times 0.7854 = 0.058 \text{ in}^2$$

*Total:*

$$\text{DLO 262 Phase Cable} = 8.923 \text{ in}^2 \text{ (8.923 divided by 2 = 4.46)}$$

$$\text{Ground Cable} = 0.250 \text{ in}^2$$

$$\text{Sense/Control Wires} = 0.058 \text{ in}^2$$

2 runs of conduit between the Isolation Transformer (T6-X1, T6-X2, and T6-X3) and the Main Inverter Enclosure (TB5, TB6, and TB7)

$$\text{1st conduit run; } 4.46 + 0.25 = 4.71 \text{ in}^2$$

$$\text{2nd conduit run; } 4.46 + 0.058 = 4.52 \text{ in}^2$$

Using the "Over 2 Wires" column per NEC Chapter 9, Table 4, (Ninth Edition) indicates that the following minimum permitted conduit trade size is acceptable for the 21 wires in this exercise:

EMT = 3 ½" Trade size

IMC = 4" Trade size

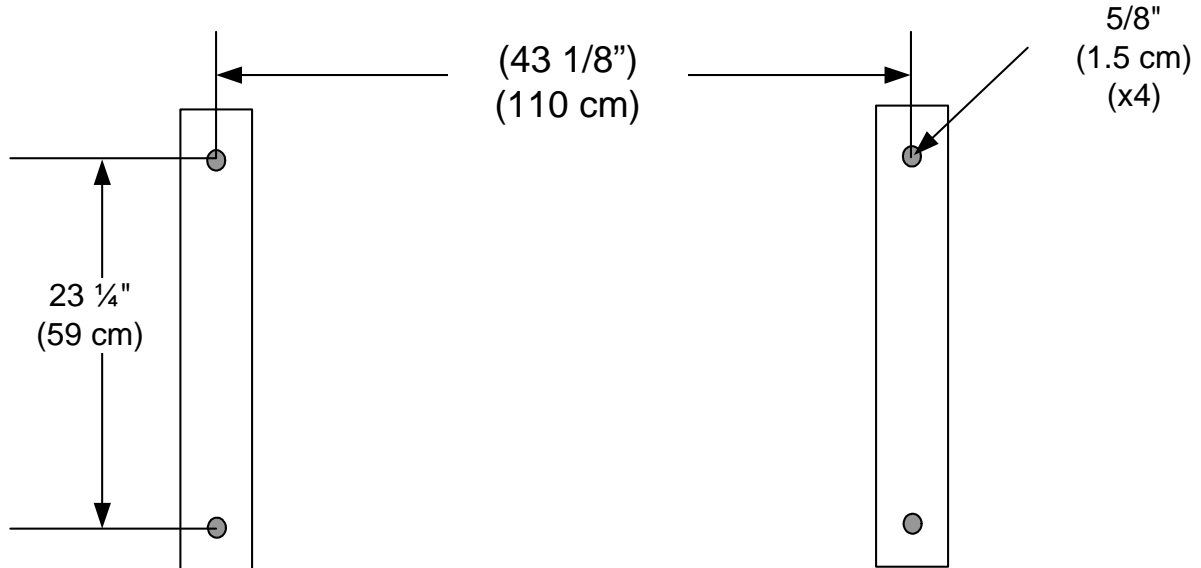
RMC = 4" Trade size

## Anchoring the PV225S

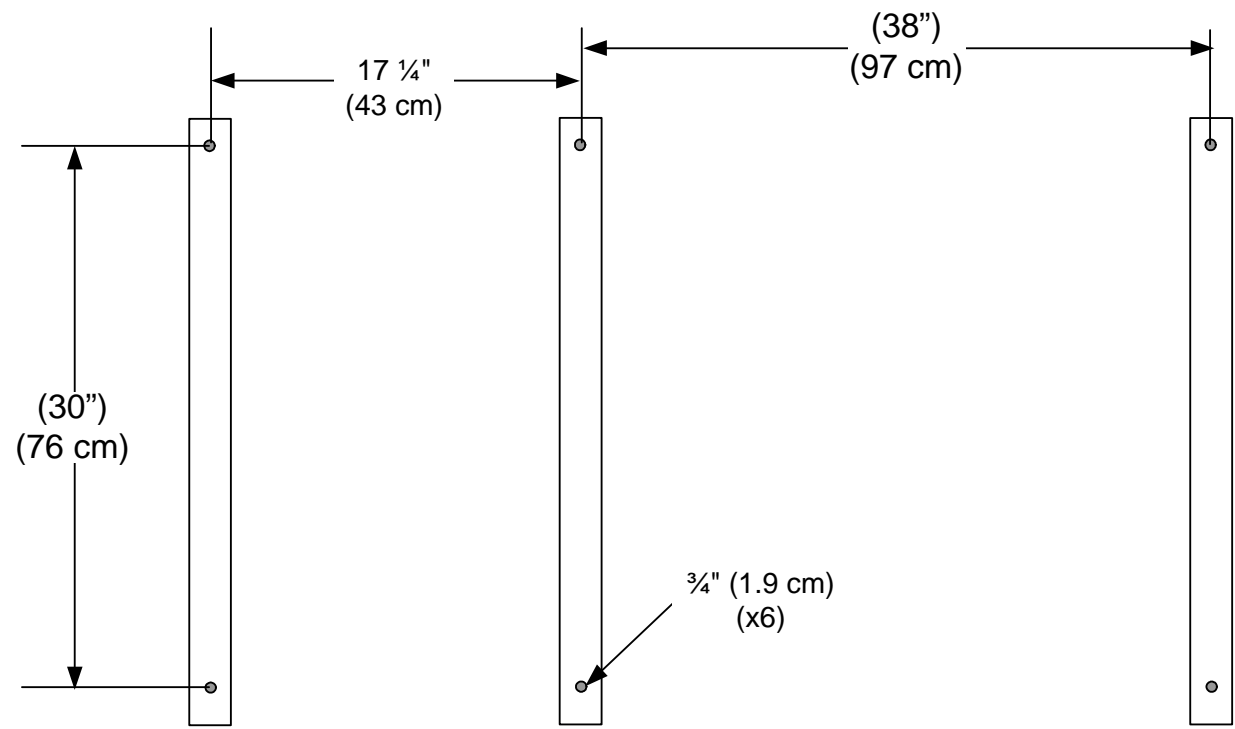
The PV225S is designed to be installed in either an indoor or outdoor location. It must be placed on and anchored to a level concrete floor or pad. The concrete floor or pad, upon which the PV225S is anchored, must be structurally designed to meet any local, state, or national requirements for weight, seismic, and wind shear if applicable.

Four 5/8" holes are provided in the feet of the main inverter, and six 5/8" holes are provided in the feet of the AC interface/transformer assembly for anchoring to the floor or pad.

Figure 2-9 and Figure 2-10 depict the layout patterns of the anchoring holes for both the PV225S main inverter and the AC interface/transformer assembly.



**Figure 2-9** Main Inverter Anchor Bolt Pattern (Not to scale)



**Figure 2-10** AC Interface/Transformer Anchor Bolt Pattern (Not to Scale)

The floor or pad should either be pre-drilled to accept masonry anchors or have pre-installed anchoring bolts.

# 3

## Installation

Chapter 3, “Installation” describes the procedures needed to install the PV225S 225 kW Grid-Tied Photovoltaic Inverter. This section includes unpacking and moving instructions, mounting instructions, and cabling instructions.

## Equipment Required

The following is a list of required tools and equipment to aid in the installation of the PV225S. This list is not a comprehensive list, but is intended to help identify the minimum recommended tools and equipment used during the installation.

- Forklift (26" minimum fork span) and/or pallet jack
- Claw hammer or pry bar
- Standard and metric socket set
- Standard and metric wrench set
- Standard Allen<sup>®</sup> Hex wrenches (5/16, 3/8, and 1/2)
- Large slip-joint pliers
- Standard and Phillips screwdrivers
- Torque wrench with 0 - 600 in-lbs minimum range
- Appropriate voltage meter (600 Vac and DC rated, minimum)
- Phase rotation meter (600 Vac rated, minimum)
- Hammer drill and masonry bits
- Trade-size conduit knock-out set

## Unloading

The PV225S is shipped partially assembled in two separate shipping crates and one cardboard box.

- ☐ One crate is the main inverter and is marked "1-152287-01".
- ☐ The other crate is the AC Interface Enclosure and transformer assembly and is marked "1-152448-01".
- ☐ The cardboard box contains one of the three remote connection kits:
  - POTS Connection 1-152674-01,
  - Wireless Connection 1-152659-01, or
  - Ethernet Connection 1-152658-01.



### **WARNING: Heavy Equipment**

The main inverter weighs approximately 2300 lbs. The AC Interface Enclosure and transformer assembly weigh approximately 2350 lbs. Attempting to lift the equipment by other than the recommended lifting points may damage the equipment or present a personnel safety hazard and void the warranty. Keep all the doors closed and latched when moving the enclosures. Leaving the door latches unsecured may result in damage to the unit and void the warranty.

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## Moving the PV225S



### **CAUTION: Equipment Damage**

To move the PV225S, use a forklift that has a sufficient lift capacity and has a 26" fork span.

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#### **To move the PV225S while it is still inside the shipping crates:**

1. Place the forks of the forklift below the shipping crate at the points specified on the shipping crate.
2. Lift the main inverter and the AC Interface Enclosure and Transformer Enclosure from beneath their shipping crates.



**Figure 3-1** Moving the crated PV225S

## Unpacking the PV225S

#### **To unpack the main inverter and the AC Interface Enclosure and transformer assembly from their shipping crates:**

1. Using a claw hammer or pry bar, remove the crate's wood top and side panels.
2. Remove the main inverter's anchor hardware that attaches it to the shipping pallet.
3. Remove the AC Interface Enclosure and transformer assembly anchor hardware that attaches them to their shipping pallet.

## Removing the Pallet and Moving the PV225S

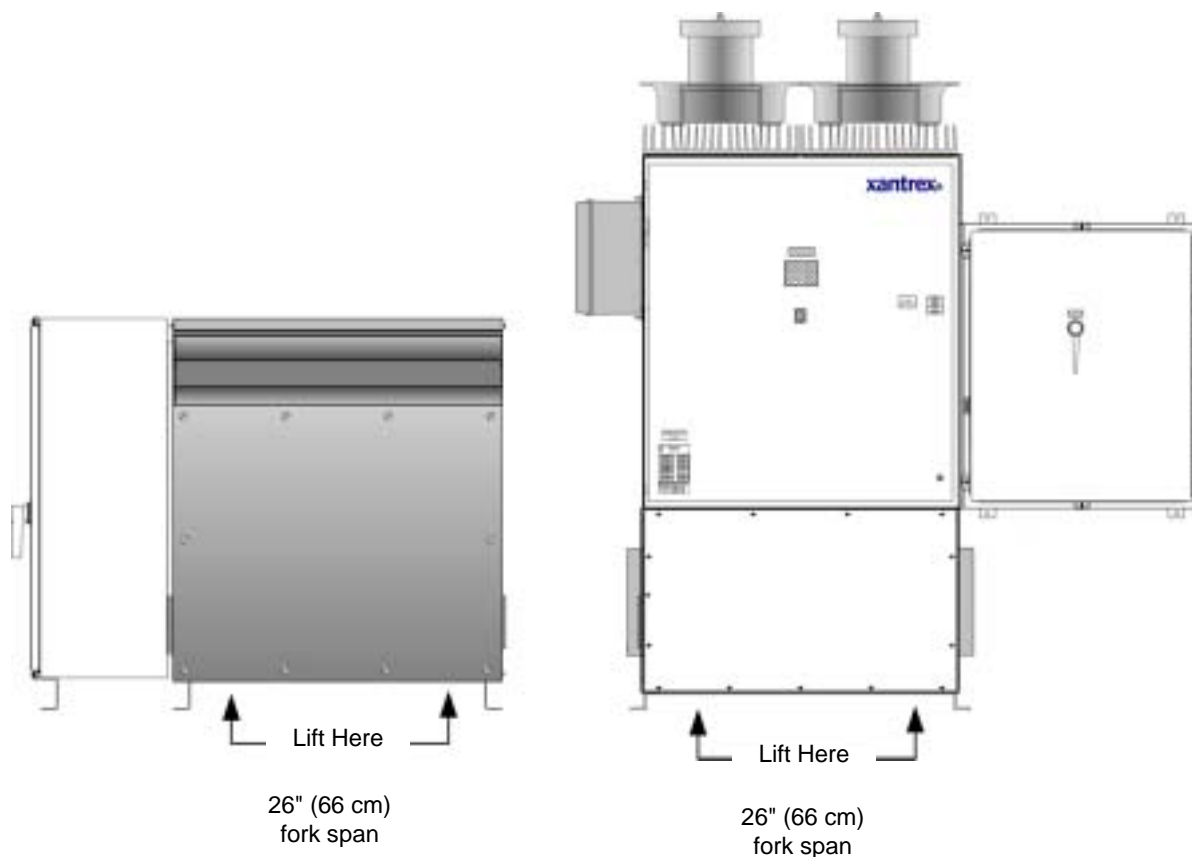


### CAUTION: Equipment Damage

To move the PV225S, use a forklift that has a sufficient lift capacity and a 26" fork span.

#### To move the PV225S using a forklift:

1. Place the forks of the forklift below the unit at the points specified in Figure 3-2.
2. Lift the PV225S from beneath the respective enclosures. Be sure to use a forklift with a 26" fork span.
3. Remove the pallet from beneath the unit.
4. Once the pallets are removed from the units, use the same lifting locations to lift the units into the place where they are to be permanently located.



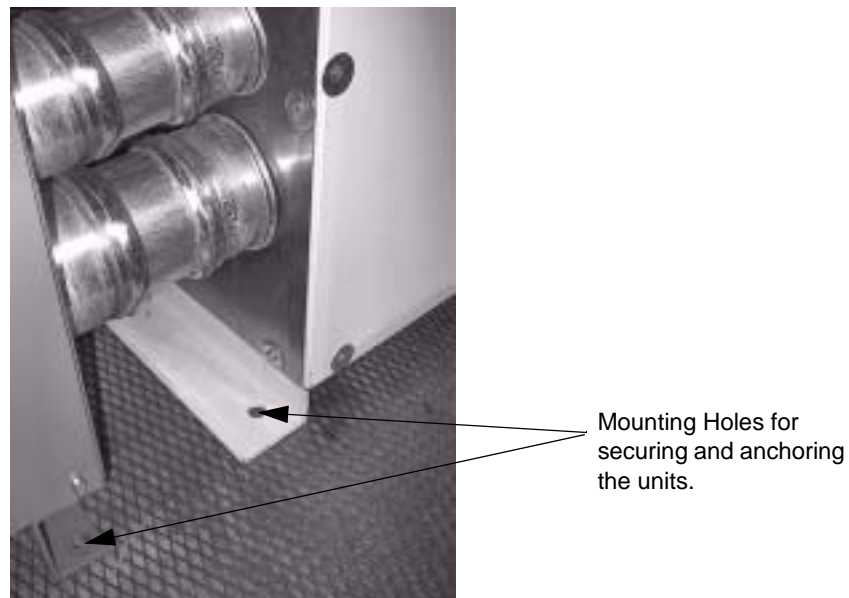
**Figure 3-2** Forklift Lifting Locations - Underneath Unit

**Important:** Before proceeding with the installation, determine the location and layout of the components, conduit penetration locations, conductor and conduit sizing, and method for anchoring the unit. Ensure adequate space is provided for clearance for ventilation and serviceability. Review Chapter 2, “Planning” if necessary before proceeding.

## Mounting and Anchoring the Units

### To mount and anchor the PV225S:

1. Predrill the floor or pad to accept 1/2" diameter masonry anchors or ensure it has pre-installed anchoring bolts that will fit the 5/8" mounting holes.
2. Lift the main inverter from beneath the lower enclosure with a forklift or pallet jack as shown in Figure 3-2 on page 3–4. Move the Main Inverter Enclosure into place.
3. Lift the AC Interface/Transformer assembly from beneath the enclosure with a forklift or pallet jack as shown in Figure 3-2 on page 3–4. Move the AC interface/transformer assembly into place.
4. Secure the Main Inverter Enclosure feet to the floor with a 1/2" diameter anchor bolts.
5. Secure the AC Interface/Transformer assembly enclosure feet to the floor with 1/2" diameter anchor bolts.



**Figure 3-3** Mounting Hole Locations

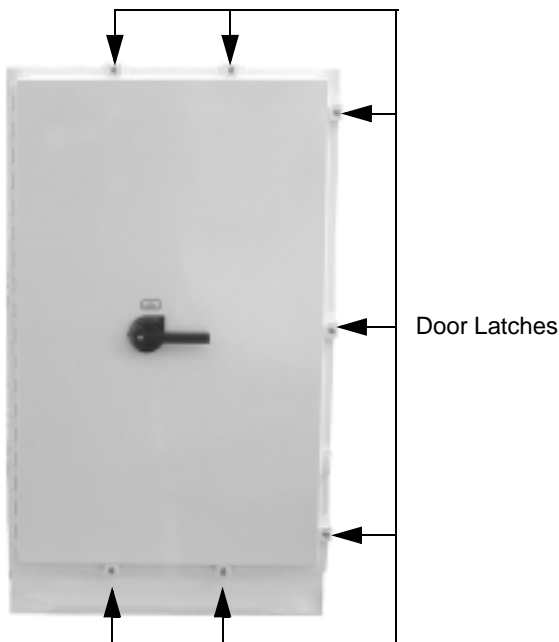
## Opening or Closing Access Doors

**To lock or unlock the front door on the main inverter:**

1. Use the 7 mm triangle key provided with the unit.
  - a) Insert the key in each lock and turn counterclockwise to open; clockwise to lock.
  - b) Pull front door open from the right side.



**Figure 3-4** Inverter Enclosure Access Doors



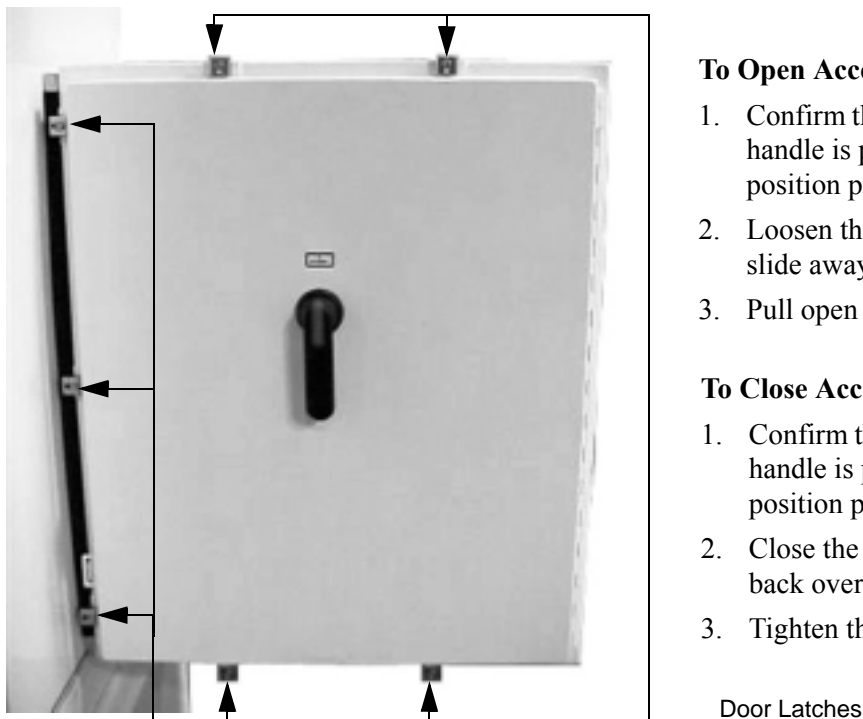
**To Open Access Door:**

1. Confirm that the AC Disconnect Switch handle is placed in the OFF (Open) position prior to opening the door.
2. Loosen the bolts on door latches and slide away from the door.
3. Pull open from right side.

**To Close Access Door:**

1. Confirm that the AC Disconnect Switch handle is placed in the OFF (Open) position prior to closing the door.
2. Close the door and slide the latches back over the edge of the door.
3. Tighten the bolts on door latches.

**Figure 3-5** AC Interface Access Door



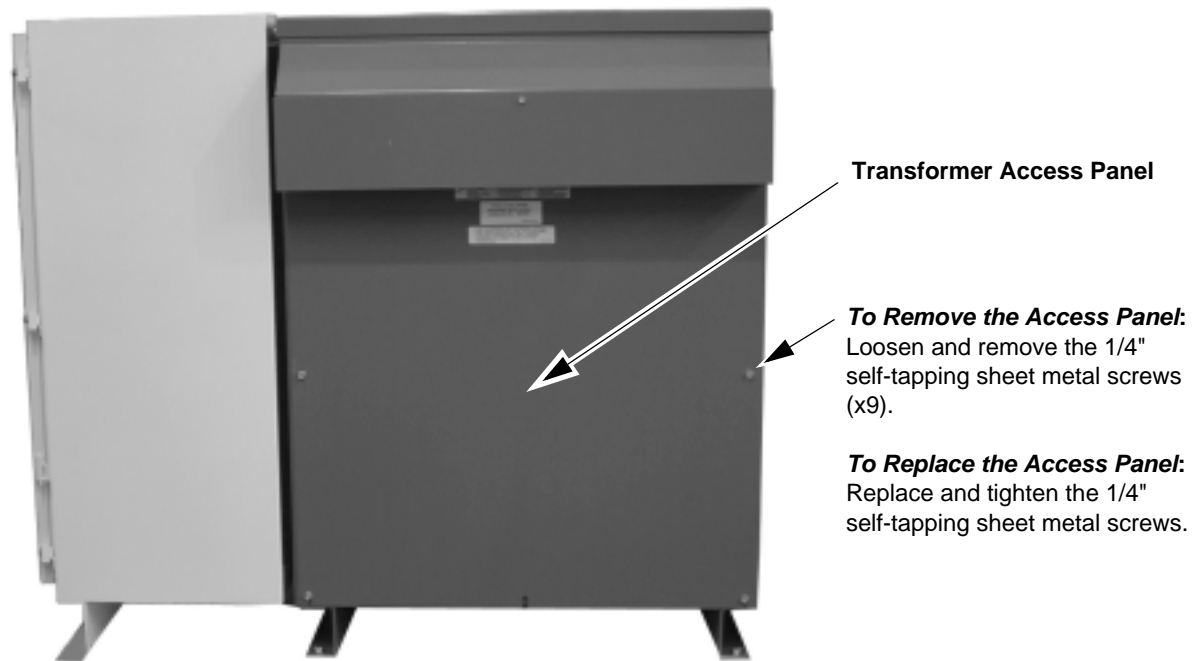
**To Open Access Door:**

1. Confirm that the DC Disconnect Switch handle is placed in the OFF (Open) position prior to opening the door.
2. Loosen the bolts on door latches and slide away from the door.
3. Pull open from the left side.

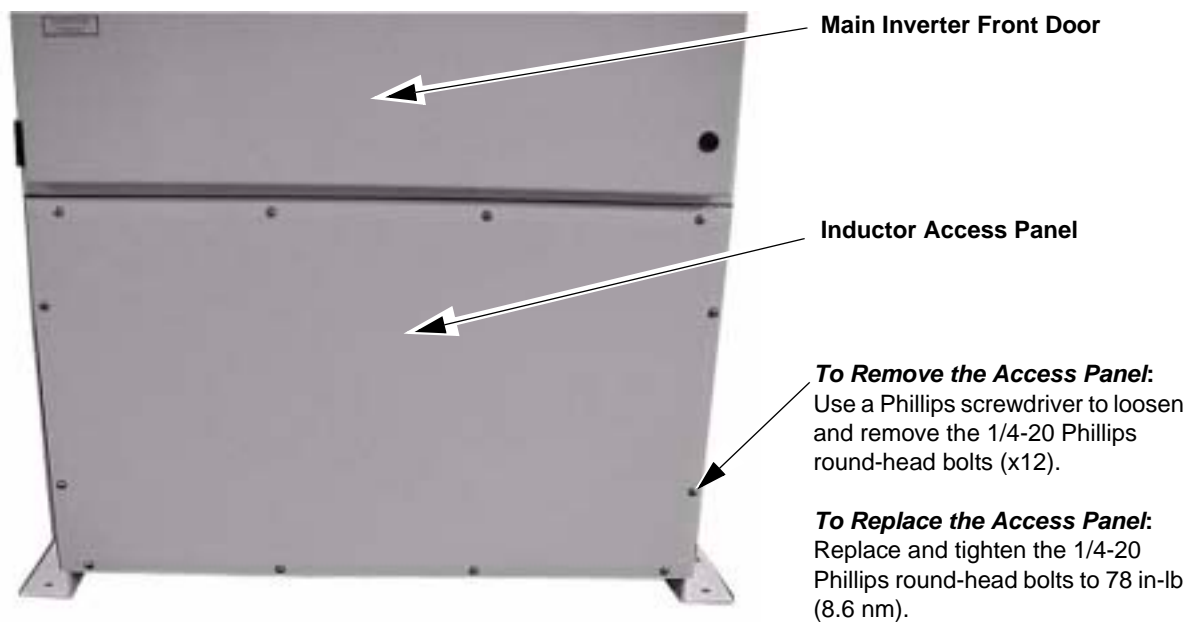
**To Close Access Door:**

1. Confirm that the DC Disconnect Switch handle is placed in the OFF (Open) position prior to closing the door.
2. Close the door and slide the latches back over the edge of the door.
3. Tighten the bolts on door latches.

**Figure 3-6** DC Interface Access Door



**Figure 3-7** Transformer Access Panels



**Figure 3-8** Inductor Access Panels

## Conduit Installation

Given the flexible nature of the system, conduit installation will be dependent upon the final configuration of the system. Procurement and installation of the conduit, therefore, is the responsibility of the installer. Since the layout will be dependent upon the location available for the installation and the size of the conductors used, specific conduit size and type must be pre-determined by the installer before the actual installation. See “Conductor and Conduit Sizing” on page 2–11 for instructions on how to determine the size of the conductors and conduits to be used. Once the size of the conductors and conduits has been determined, follow the instructions below for installing the conduits. Be sure to consult the NEC Handbook and any local codes to ensure code compliance.

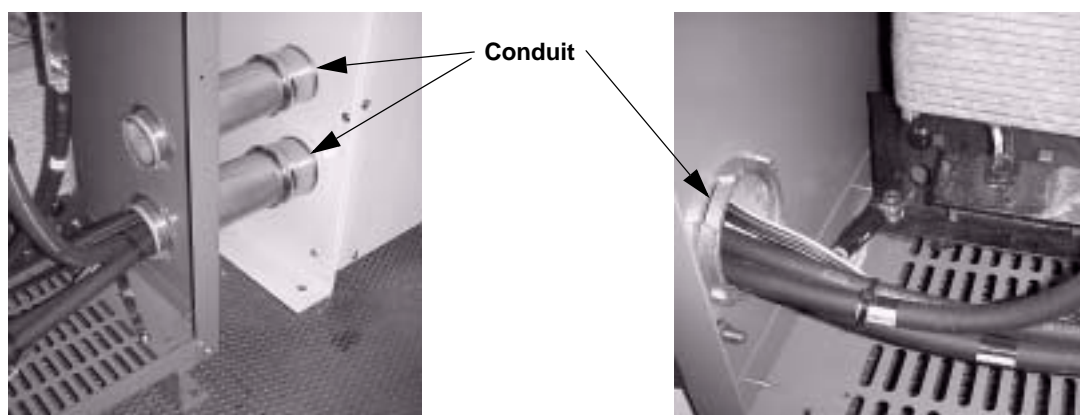
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**Important:** Outdoor installations require that all conduit fittings interfacing with the PV225S be NEMA-4 rated.

---

### To install the conduits:

1. Determine the conduit penetration locations in the Main Inverter Enclosure and the AC interface/transformer assembly. See Figure 2-3 on page 2–8 through Figure 2-5 on page 2–9.
2. Install appropriately sized conduit based upon system layout and required codes between the main inverter and the AC interface/transformer assembly. For ease of conduit installation, the access panels on both the main inverter and the AC interface/transformer assembly can be removed.
3. Determine all remaining conduit penetration locations in the AC Interface enclosure, DC Interface Enclosure, and Communication Enclosure. See Figure 2-3 on page 2–8 through Figure 2-8 on page 2–10.
4. Install all remaining appropriately sized conduit interfacing for the AC Interface Enclosure, DC Interface Enclosure, and Communication Enclosure based upon system layout and required codes.



**Figure 3-9** Conduit Installation

---

## Wiring - General

All wiring methods and materials shall be in accordance with the National Electrical Code ANSI/NFPA 70. When sizing conductors and conduits interfacing to the PV225S, both shall be in accordance with the National Electric Code ANSI/NFPA 70, as well as all state and local code requirements.

---



### **WARNING: Shock Hazard**

The PV225S enclosures contain exposed high-voltage conductors. The enclosure doors should remain closed with the latches tightened, except during installation, maintenance or testing. These servicing instructions are for use by qualified personnel who meet all local and state code requirements for licensing and training for the installation of Electrical Power Systems with AC and DC voltage to 600 volts. To reduce the risk of electric shock, do not perform any servicing other than that specified in the installation instructions unless you are qualified to do so. Do not open the cabinet doors if extreme moisture is present (rain or heavy dew).

---



### **WARNING: Lethal Voltage**

In order to remove all sources of voltage from the PV225S, the incoming power must be de-energized at the source. This may be done at the main utility circuit breaker and by opening the AC Disconnect and the DC Disconnect Switches on the PV225S. Review the system configuration to determine all of the possible sources of energy. In addition, allow 5 minutes for the DC bus capacitors, located on the ceiling of the cabinet, to discharge after removing power.

---



### **CAUTION: Equipment Damage**

When connecting external AC wires to the PV225S, positive phasing sequence must be maintained throughout the installation process. Refer to the system schematics in Appendix A of this manual for proper phasing convention.

---

**Important:** Take care to keep the wire bundles away from any sharp edges which may damage wire insulation over time. Consult the NEC ANSI/NFPA 70 Code Book to ensure code compliance.

---

The model PV225S has a three-phase output. It is marked with this symbol: Ø  
Conductor size should have been pre-determined when the conduit was installed. Prepare the appropriate length conductors for each connection.



## Overcurrent Protection

AC overcurrent protection for the Utility Interconnect (Grid-tie) must be provided by the installer as part of the PV225S installation.



### CAUTION: Equipment Damage

In accordance with the NEC, ANSI/NFPA 70 (Ninth Edition) a 400 A maximum branch-circuit overcurrent protection must be provided.

## Conductor Termination

The PV225S has terminals and bus bars for making all wiring connections required for the installation. All terminals used for making AC and DC connections require the use of copper conductors with an insulation rating of 90 °C (or higher). For wire gauge, bolt size, and torque values for the AC terminals, see Table 3-1. For wire gauge, bolt size, and torque values for the DC terminals, see Table 3-2.

### Transformer Enclosure

The AC terminals in the Transformer Enclosure (**T6-X1**, **T6-X2**, and **T6-X3**) require the use of crimp-on type ring terminals or compression-type lugs. The terminals can accommodate up to two conductors per phase.

*See Figure 3-14 on page 3–15 for the location of these terminals.*

### Main Inverter Enclosure

The AC terminals in the Main Inverter Enclosure (**TB5**, **TB6**, and **TB7**) have six openings per phase. These terminals do not require the use of ring terminals or compression lugs.

*See Figure 3-15 on page 3–16 for the location of these terminals.*

### AC Interface Enclosure

The AC line terminals in the AC Interface Enclosure (**S1-2T1**, **S1-4T2**, and **S1-6T3**) are one bolt per phase. These terminals require the use of crimp-on type ring-terminals or compression-type lugs.

*See Figure 3-16 on page 3–16 for the location of these terminals.*

The AC neutral terminal in the AC Interface Enclosure (**TB11**) has one bolt per pole and requires the use of crimp-on type ring terminals or compression-type lugs.

*See Figure 3-18 on page 3–18 for the location of this terminal.*

### DC Interface Enclosure

The DC terminals in the DC Interface Enclosure (**S2-6**, **K2-6T3**, and **TB4**) can accommodate up to four conductors per pole at S2-6 and K2-6T3, and up to two conductors at TB4. These terminals do not require the use of ring-terminals or compression lugs.

*See Figure 3-19 on page 3–19 for the location of these terminals.*

**Important:** Keep these cables together as much as possible, and ensure that all cables pass through the same knockout and conduit fittings, thus allowing any inductive currents to cancel.

## Wire Gauge and Torque Requirements

Table 3-1 provides acceptable wire gauges, bolt sizes, and torque values for AC terminal connections.

**Table 3-1** AC Terminal Wire Gauge, Bolt Size, and Torque Values

AC Terminal Connections	Acceptable Wire Size Range (both models)	Bolt (Hardware) Size	Torque Requirements
TB1 (Chassis Ground)	500MCM to #4 AWG (1 stud per pole)	3/8-16	420 in-lb (47.5 Nm)
TB12 (System Ground)	500MCM to #4 AWG (1 stud per pole)	3/8-16	420 in-lb (47.5 Nm)
TB11 (Neutral)	500MCM to #4 AWG (1 stud per pole)	3/8-16	228 in-lb (25.7 Nm)
S1-2T1, S1-4T2, S1-6T3	350MCM to #6 AWG (1 stud per phase)	M10	310 in-lb (35.0 Nm)
T6-X1, T6-X2, T6-X3	350MCM to #6 AWG (2 studs per phase)	3/8-16	420 in-lb (47.5 Nm)
TB5, TB6, TB7	350MCM to #4 AWG (6 openings per phase)	3/8 Hex	375 in-lb (42.4 Nm)

Table 3-2 provides acceptable wire gauges, bolt sizes, and torque values for DC terminal connections.

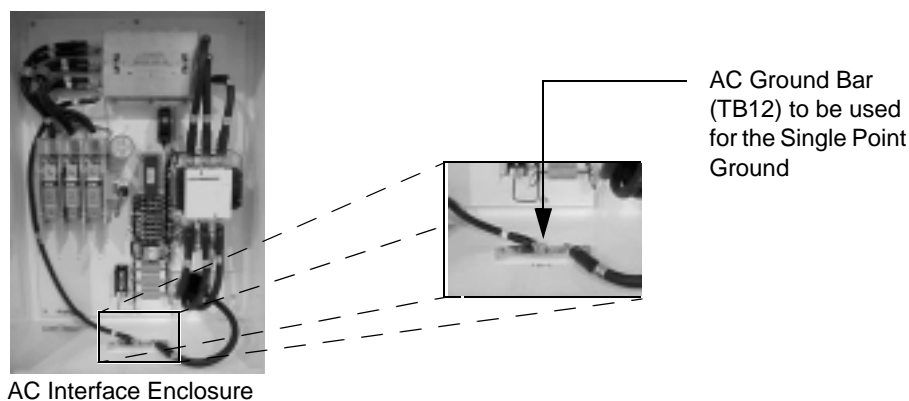
**Table 3-2** DC Terminal Wire Gauge, Bolt Size, and Torque Values

DC Terminal Connections	Acceptable Wire Size Range (both models)	Bolt (Hardware) Size	Torque Requirements
S2-6, K2-6T3, TB4	600MCM to #4 AWG (2 openings per pole)	1/2 Hex	600 in-lb (67.8 Nm)

## Grounding

### System Grounding

Install a copper ground rod within three feet of the PV225S enclosures per the National Electric Code ANSI/NFPA 70. The single-point ground for the system is to be made at the AC ground bar (TB12) in the AC Interface Enclosure.




**Figure 3-10** Single-point Ground (TB12) Ground Bar

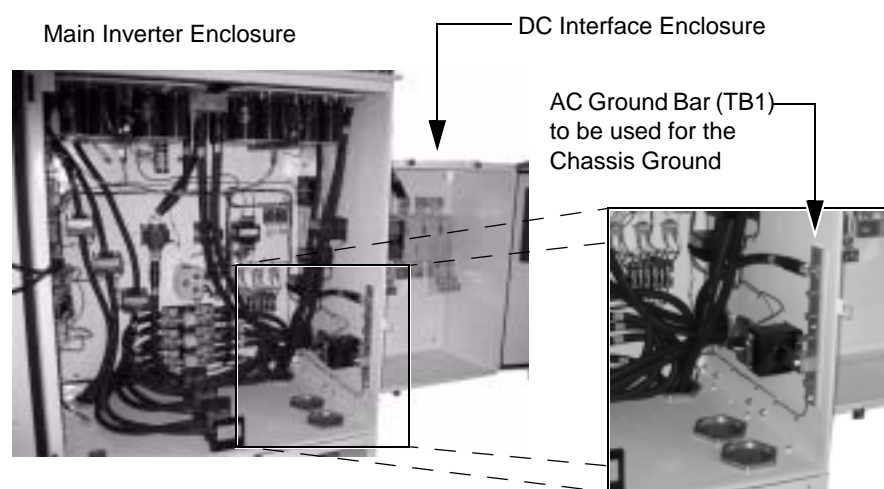
**Chassis Ground**

The chassis ground is a copper bus bar in the Main Inverter Enclosure and has 3/8-16" bolts for terminating the AC ground. The ground conductor size depends on the size of the main circuit breaker.

NEC Table 250.122 (Ninth Edition) requires that the ground conductor be at least #3 AWG for a 400 A circuit breaker.

Torque connections to ground bar in the Main Inverter Enclosure to 420 in-lb (47.5 Nm).

The equipment ground on the PV225S is marked with this symbol: 



**Figure 3-11** Chassis Ground Bar (TB1)

**Array Grounding**

NEC Article 690-41/42 (Ninth Edition) requires the PV array to be earth grounded. The PV225S chassis is also bonded to the PV safety ground terminal block.

**System Neutral Requirements**

The PV225S is designed to be installed as a 4-wire system. As required by the UL 1741 listing, a neutral conductor from the utility-interconnect must be terminated at TB11 within the AC Interface Enclosure to ensure that the AC voltage sensing circuit can perform an individual phase voltage (line-to-neutral) measurement. The function of the neutral connection is to provide a point of reference for measurement purposes that is essentially at ground potential. No power will flow through the neutral conductor.

**Utility Side Isolation Transformer Requirements**

The PV225S is supplied with a custom, high-efficiency, isolation transformer as part of the AC interface/transformer assembly. The utility side windings of the isolation transformer are configured Wye and must match the voltage at the utility inter-tie. The PV225S is a balanced, three-phase, current-sourcing inverter and

only operates with the presence of a stable utility voltage. The transformer is also supplied with a neutral connection on the utility interconnect. Connection of this utility-side neutral does not affect the operation of the inverter, however connection of the neutral on the inverter-side does affect the operation and must be left floating or disconnected. Single-phase, grounded loads, which may be present between the transformer and utility, will maintain their existing ground reference at the utility distribution transformer.



### **CAUTION: Equipment Damage**

If the Isolation Transformer (T6-X0) neutral terminal is tied to ground, it will cause irreparable damage to the PV225S. Check local regulations for their requirements regarding the connection of these neutrals.

---



### **WARNING: Lethal Voltage**

Grounding the neutral of a Wye-wound transformer may create an “open delta” condition, depending on the utility configuration. This condition may keep the PV225S from detecting a loss of phase condition on the utility system, which may allow potentially lethal voltage to be present on the open phase wiring.

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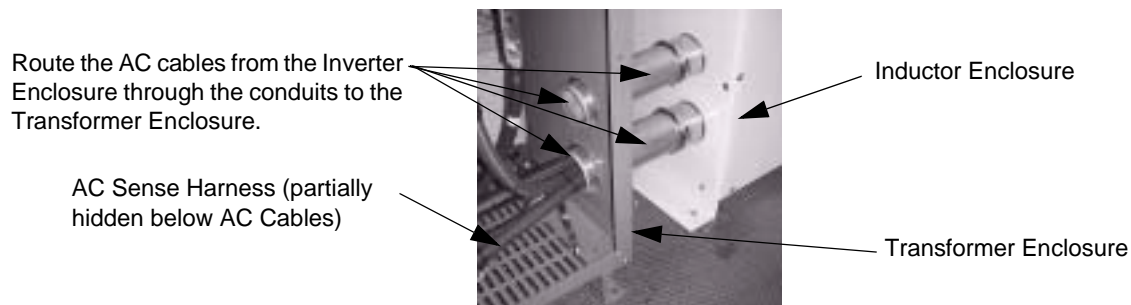
## **Wiring - Specific**

This section provides information for connecting the AC and DC conductors, ground conductors, and AC Sense Harness.

### **AC Connections**

#### **To connect the main inverter to AC interface/transformer assembly:**

1. Remove the access panels from the front of both the Main Inverter Enclosure and the Transformer Enclosure. Additionally, open the front door to the Main Inverter Enclosure.
2. Route the AC power conductors A, B, C phase cables and ground conductor through the conduit between the main inverter to the AC interface/transformer assembly (T6).



**Figure 3-12** Route AC Cables through the Conduit

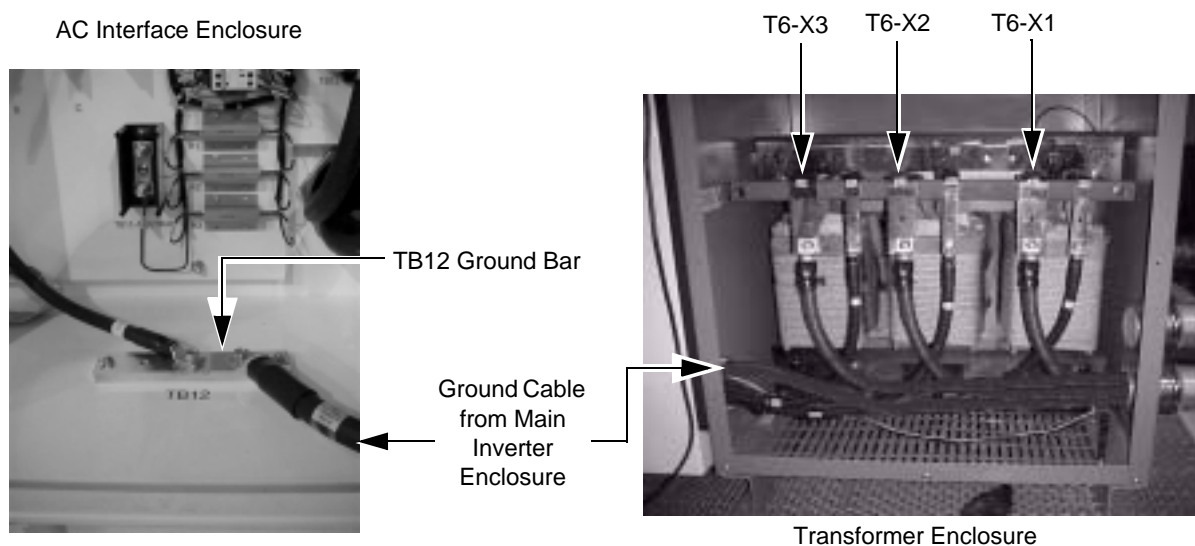
3. In addition to the power conductors, route the AC Sense Harness assembly (Xantrex P/N 1-152403-01) between the main inverter to the AC interface/transformer assembly. Prior to completing the installation of the AC Sense Harness, secure the harness to the AC power conductors with nylon tie-wraps so it does not touch the surfaces of either the L1 or L2 inductor. Failure to secure the AC Sense Harness away from these surfaces may cause deformation of the harness insulation and possibly damage due to the excessive heat generated by the L1 or L2 inductor.



Prior to completing the installation of the AC Sense Harness, secure the harness to the AC power conductors with nylon tie-wraps.

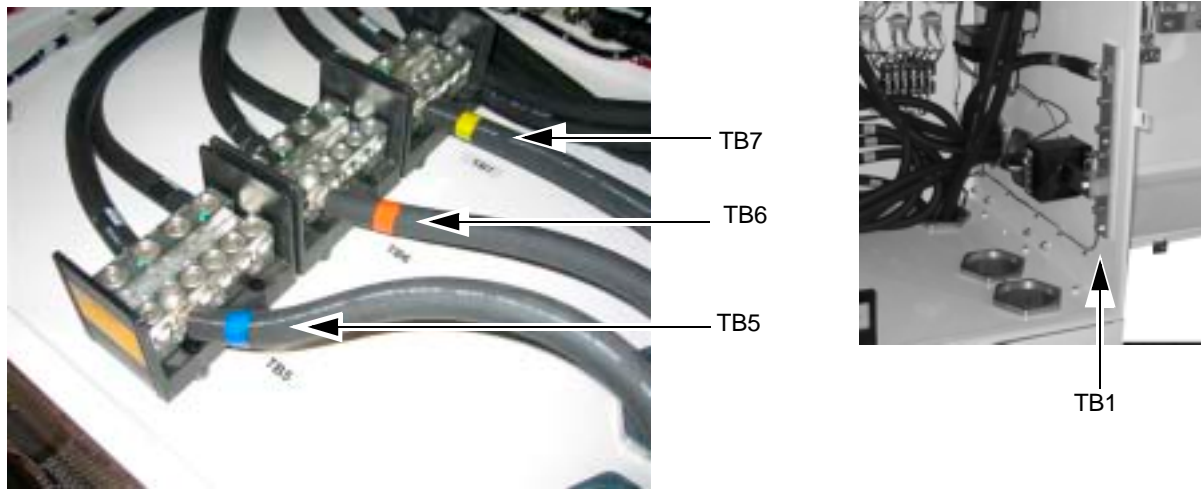
**Figure 3-13** Tie-wraps on the AC Sense Harness

4. Connect the AC power conductors in the Transformer Enclosure at the T6-X1 (A phase), T6-X2 (B phase), and T6-X3 (C phase) bus bars using 3/8-16" hardware. Connect the ground conductor in the AC Interface/Transformer Enclosure at TB12. Cables to these terminals must use a crimp-on type ring terminal or compression-type lug. Tighten these connections to a torque value of 420 in-lb (47.5 Nm).

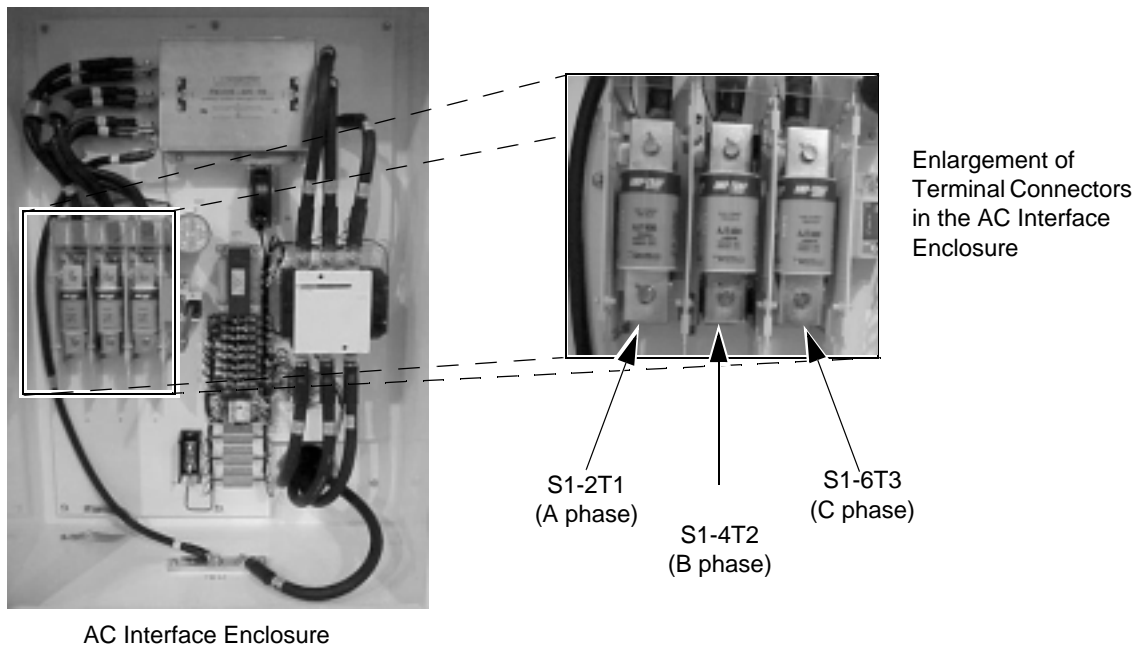


**Figure 3-14** AC Terminal Connections in the AC Interface/Transformer Enclosure

5. Connect the AC power conductors in the Main Inverter Enclosure at TB5 (A phase), TB6 (B phase), and TB7 (C phase) with a box connector using a 3/8" Hex screw. This hardware should be tightened to a torque value of 375 in-lb (42.4 Nm). Connect the ground conductor to the TB1 terminal on the ground bar on the right side of the enclosure. Torque this connection to 420 in-lb (47.5 Nm).



**Figure 3-15** AC Terminal Connections in the Main Inverter Enclosure



**Figure 3-16** AC Terminal Connections in the AC Interface Enclosure

6. The AC Sense Harness is pre-terminated within the AC interface/transformer assembly and the opposite end is mated with its 9-pin plug to the corresponding 9-pin jack within the Main Inverter Enclosure. *See Figure 3-17.*

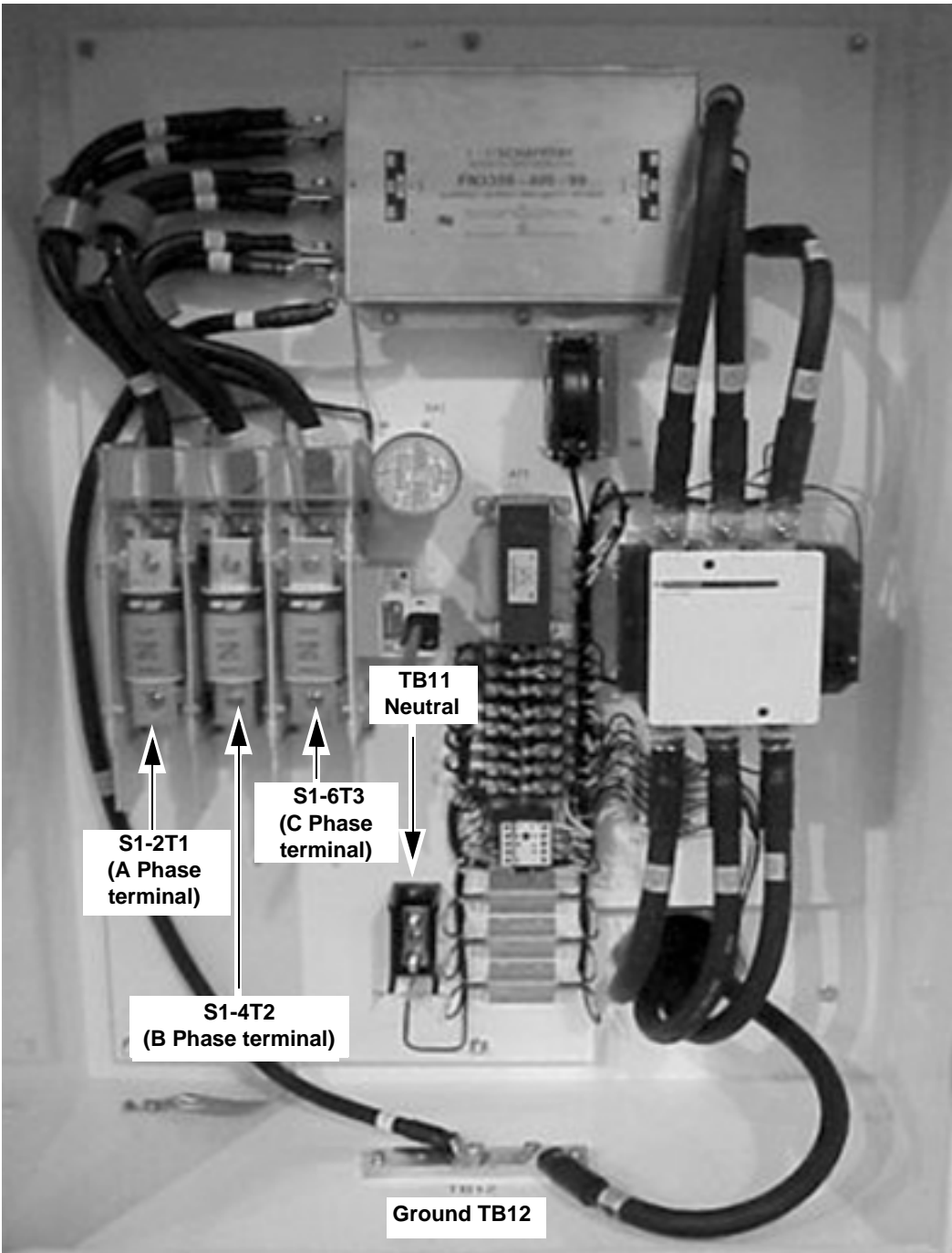


**Figure 3-17** Connecting the AC Sense Harness

7. Replace the access panels on the front of both the main inverter Inductor Enclosure and the Transformer Enclosure. Additionally, close the front door to the Main Inverter Enclosure.

**To connect the utility service to AC Interface Enclosure:**

1. Remove the door clamps and open the door to the AC Interface Enclosure.
2. Route the AC power conductors A, B, C phase, neutral, and a neutral ground cable through the conduit from the utility service to the AC Interface Enclosure. *See Figure 3-18 for the location of these terminals.*
3. Connect the AC power conductors at the S1-2T1 (A phase), S1-4T2 (B phase), and S1-6T3 (C phase) terminals using the M10 hardware. Cables to these terminals must use a crimp-on type ring terminal or compression-type lug. Torque these connections to 310 in-lb (35.0 Nm). *See Figure 3-18 for the location of these terminals.*
4. Connect the neutral conductor at TB11. Connect the ground conductor at TB12. Terminations for the neutral and ground conductors within the AC Interface Enclosure at the TB11 and TB12 locations are made with 3/8-16" hardware. Cables to these terminals must use a crimp-on type ring terminal or compression-type lug. The terminal at TB11 should be tightened to a torque value of 228 in-lb (25.7 Nm). The terminal TB12 should be tightened to a torque value of 420 in-lb (47.5 Nm). *See Figure 3-18 for the location of these terminals.*
5. Close the door to the AC Interface Enclosure and replace the door clamps.



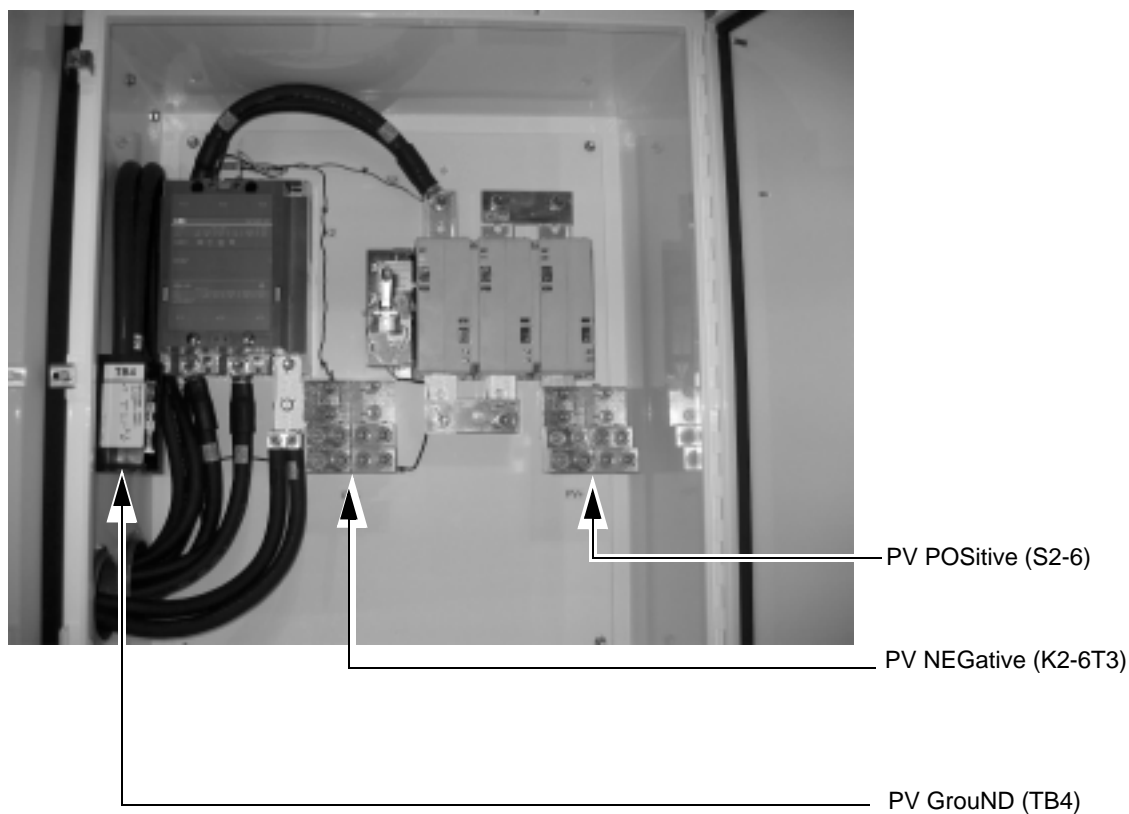
**Figure 3-18** AC Terminal Connections from the Utility



## PV Array Connections

**To make the connections from the PV Array/combiner to DC Interface enclosure:**

1. Remove the door clamps and open the door to the DC Interface Enclosure.
2. Route the PV Array cables conductors POSitive (PV+), NEGative (PV-), and PV GND through the conduit to the DC Interface Enclosure, entering on the underside.
3. The DC power conductor terminations are made at the S2-6 (POS/DC+), and K2-6T3 (NEG/DC-) and TB4 (PV Gnd) locations. *See Figure 3-19.*
4. Terminations for the S2-6, K2-6T3, and TB4 terminals are made with box connector using a 1/2" Hex Allen screw. The hardware should be tightened to a torque value of 600 in-lbs (67.8 Nm).
5. Close the door to the DC Interface Enclosure and replace the door clamps.



**Figure 3-19** PV Array Cable Routing and Terminations

## PC Communications

Personal computers can be used to access the system status and programming features of the PV225S. A computer can be connected either directly or remotely.

1. Remote Connect - uses one of the three kits below.
  - POTS Kit - uses a MultiTech® 56K Modem, RS232/Fiber Optic Converter (configured for ethernet) and SA2 Surge Arrestor and requires access to a local analog phone line (Plain Old Telephone Service-POTS).
  - Wireless Kit - uses a GSM Wireless Modem to access wireless phone service.
  - Ethernet LAN Kit - uses a data communication device to enable the unit to connect to a local area network.
2. Direct Connect - This method is used for troubleshooting. It uses a RS232/Fiber Optic Converter (configured for a PC), a DB25-to-DB25 gender changer, and a DB25-to-DB9 Serial Cable.

Software is included to provide a graphic user interface that relates important system information. This software is called Xantrex Solar Graphic Interface (GUI). See "Computer Communications with the PV225S" in the PV225S 225 kW Grid-Tied Photovoltaic Inverter Operation and Maintenance Manual for additional information.

The GUI can dial up the inverter and receive fault report calls from it through a standard Hayes-compatible, landline modem. When the GUI initiates a call through the modem at the GUI computer, the inverter's modem answers the call and initiates a 9600 baud serial connection, effectively as if the GUI was connected directly. Or, if the inverter experiences a fault, it will initiate a call to the GUI and report the fault details.

## PC Connection Methods

The personal computer can be connected to the PV225S the following ways.

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**Important:** Ensure the appropriate service has been established before proceeding. Also ensure the personal computer to be used has the appropriate hardware to support the installed feature, such as a phone line, wireless phone service, or local area network.

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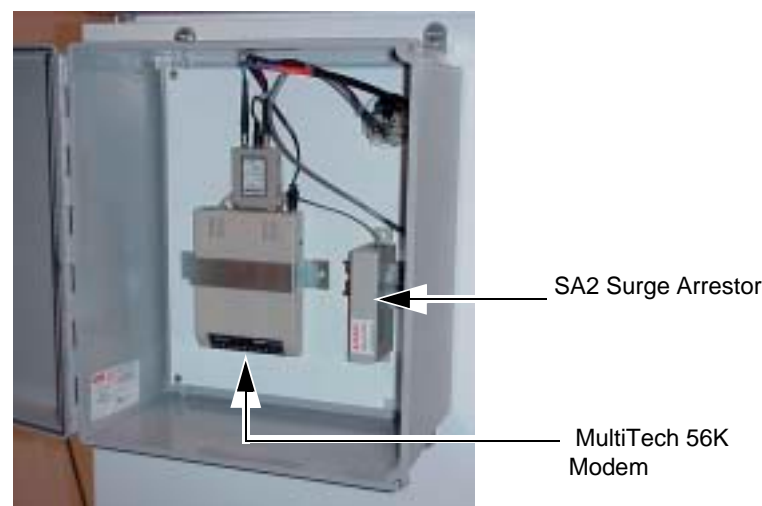
- POTS Connection
- Wireless Connection
- Ethernet LAN Connection
- Direct Connection

## Establishing a POTS Connection

**Important:** A direct analog phone line to the local phone service is required to use this feature. The phone line used for PV225S communication cannot be routed through a Private Branch Exchange (PBX) unless an analog PBX card is used.

### To connect a personal computer using the POTS Connection:

1. Ensure the personal computer to be used has a 56K modem installed.
2. Open the Communications Enclosure.
3. Plug the local phone line into the RJ11 port on the SA2 Surge Arrestor marked "UNPROTECTED".



**Figure 3-20** Telephone Cable Routing

4. Install the GUI Software following the instructions in the PV225S 225 kW Grid-Tied Photovoltaic Inverter Operation and Maintenance Manual.
5. Use a Terminal Emulation program on the PC to access the modem.  
See the GUI Help Menu "Communication by Modem" for instructions on setting up the Terminal Emulation program on the computer. See also, "Connect to Telephone Number" and "Connect to Remote Inverter by Modem" for additional information.
6. Use the GUI to setup the connection information.
  - a) From the GUI Main page, click on <TOOLS>
  - b) Click on the inverter icon for the inverter to be setup.
  - c) Click on the <INVERTER DATA>
  - d) Click on the <CONNECTION> tab.
  - e) Fill out the information required on the <GENERAL> page, the <TELEPHONE FAULT CONFIGURATION> page, and the <TELEPHONE CONFIGURATION> page.

## Establishing Wireless Connection

---

**Important:** Ensure the Wireless service has been established with the local service provider before proceeding.

---

### To connect a personal computer using the GSM Wireless modem:

1. Ensure the personal computer has the appropriate hardware installed to support this feature.
2. Install the GUI Software following the instructions in the PV225S 225 kW Grid-Tied Photovoltaic Inverter Operation and Maintenance Manual.
3. Use the GUI to setup the connection information.
  - a) From the GUI Main page, click on <TOOLS>
  - b) Click on the inverter icon for the inverter to be setup.
  - c) Click on the <INVERTER DATA>
  - d) Click on the <CONNECTION> tab.
  - e) Fill out the information required on the <GENERAL> page, the <TELEPHONE FAULT CONFIGURATION> page, and the <TELEPHONE CONFIGURATION> page.

## Establishing an Ethernet LAN Connection

---

**Important:** Ensure the local area network has been established with the local service provider before proceeding.

---

### To connect a personal computer using the Ethernet LAN Connection:

1. Ensure the personal computer has the appropriate hardware installed to support this feature (i.e., Network Interface Card [NIC]).
2. Open the Communications Enclosure and plug the LAN cable (CAT5 cable) into the RJ45 Port of the SA2 Surge Arrestor marked "UNPROTECTED".
3. Install the GUI Software following the instructions in the PV225S 225 kW Grid-Tied Photovoltaic Inverter Operation and Maintenance Manual.
4. Use the GUI to setup the connection information.
  - a) From the GUI Main page, click on the inverter icon for the inverter to be setup.
  - b) Click on <COMMUNICATION>.
  - c) Select "CONNECT TO IP ADDRESS" in the drop-down menu.
  - d) Fill in the IP address provided by the Internet Service Provider.
  - e) Click on the <CONNECT> button.
  - f) Click on the <OK> button.
  - g) Repeat this procedure for each unit to be added to local area network.

## Direct Connection

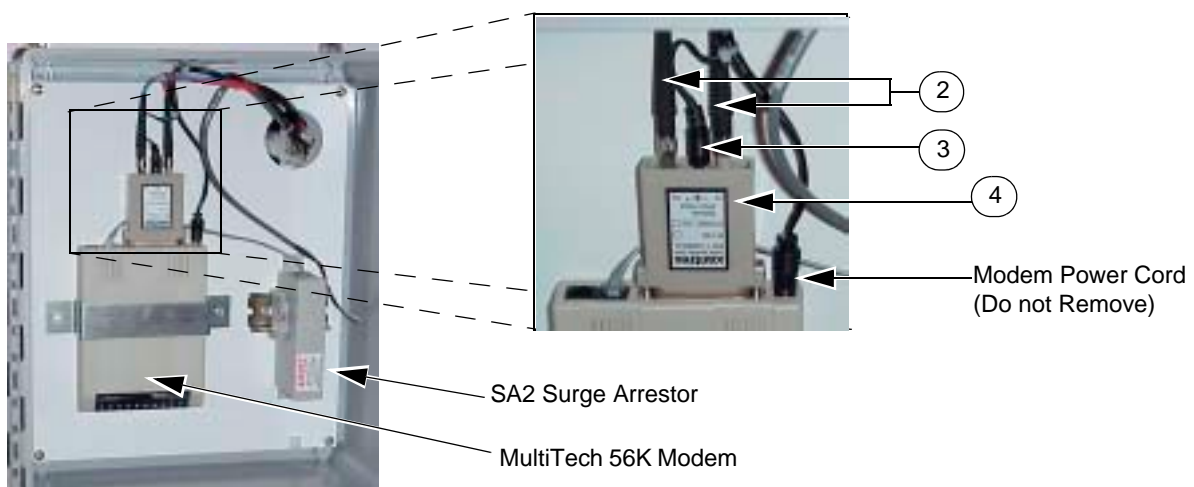
The direct connection provides the means to use the features of the GUI by connecting a PC directly to the CCU. This allows field personnel to monitor and control the inverter from a nearby laptop computer directly connected by a serial cable. The computer connects to the inverter directly through one of its serial COM ports running at 9600 baud.

The installed RS232/FO Converter will have to be removed and minor re-wiring will be required.

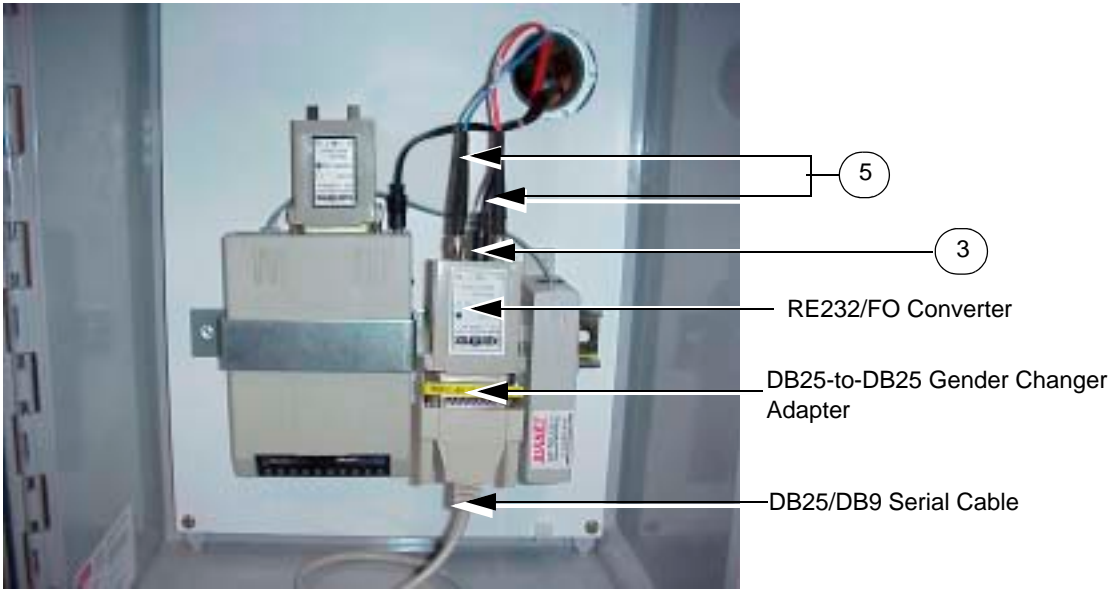
The RS232/FO Converter kit (Xantrex p/n 1-152624-01) is required for this connection to change the communication protocol from ethernet to serial in the Communications Enclosure. A DB25-to-DB25 gender-changer adapter and DB9/DB25 serial cable are provided with the RS232/FO Converter kit to complete the connection.

### If connecting the PC directly to the inverter:

1. Open the Communications Enclosure.
2. Disconnect the TX (transmit-orange) and RX (Receive-blue) wires from the installed RS232/FO Converter in the Communications Enclosure.
3. Disconnect the power plug from the installed converter and plug it into the new RS232/FO Converter.
4. Remove the installed converter. Replace with the new RS232/FO Converter.
5. Reconnect the TX (transmit-orange) and RX (Receive-blue) wires to the new Converter in the Communications Enclosure.
6. Plug the DB25-to-DB25 Gender-changer Adapter into the Serial Communications Port on the RS232/FO Converter. (Step not shown.)
7. Plug the DB25 connector on the serial cable into the gender-adapter and the DB9 connector of the serial cable into the serial port on the computer. (Step not shown.)



**Figure 3-21** RS232/FO Converter Kit Installation



**Figure 3-22** Direct Connect Installation

# 4

## Verification

Chapter 4, “Verification” provides a checklist to ensure the installation of the PV225S is correct and complete.

## Verification Procedure Summary

---



### **WARNING: Electrocution Hazard**

This chapter describes specific steps to ensure the installation of the PV225S 225 kW Grid-Tied Photovoltaic Inverter is correct and complete. Failure to adhere to these warnings could result in severe shock or possible death. Exercise extreme caution at all times to prevent accidents. *These installation instructions are for use by those familiar and skilled with high voltage procedures.*



### **WARNING: Shock Hazard**

The PV225S enclosures contain exposed high-voltage conductors. The enclosure doors should remain closed with the latches tightened, except during installation, maintenance or testing. To reduce the risk of electric shock, do not perform any servicing other than that specified in the installation instructions unless you are qualified to do so.



### **WARNING: Lethal Voltage**

In order to remove all sources of voltage from the PV225S, the incoming power must be de-energized at the source. This may be done at the utility main circuit breaker and by opening the AC disconnect and the DC disconnect switches on the PV225S. Review the system configuration to determine all of the possible sources of energy. In addition, allow 5 minutes for the DC bus capacitors, located on the ceiling of the cabinet, to discharge after removing power.

---

The following procedures are intended to verify correct installation and proper wiring of the PV225S. Prior to performing the following verification steps on the PV225S, review all safety requirements and procedures outlined in this manual and on any cautionary markings on the components within the system.

#### **Inspect the following items prior to completion of the installation:**

1. Visually inspect all the mechanical connections. This would include both electrical conduit fittings, as well as enclosure anchoring and seismic bracing if required.
2. Visually inspect the electrical connections and verify proper tightness of all terminations.
3. Visually inspect the Isolation Transformer Wye/Wye connections and ensure the T6-X0 neutral connection is left disconnected or floating.
4. Perform corrective actions if required.



## Visual Inspection of Mechanical Connections

**To perform a visual inspection of the PV225S mechanical connections:**

1. Ensure that the AC and DC Disconnect Switches, as well as any utility interconnect circuit breakers or main disconnect switches, are opened. ☐
2. Ensure all anchor bolts and any required seismic bracing is properly tightened and in place. ☐
3. Remove the wiring access panels and front covers from the AC Interface/Transformer assembly and Main Inverter Inductor Enclosure. ☐
4. Remove the latches and open the doors of the Main Inverter Enclosure, the AC and DC Interface Enclosures, and Communication Enclosure and inspect. ☐
5. Verify all wire conduit fittings and connections are properly tightened. ☐

## Visual Inspection of Electrical Connections

**To perform a visual inspection of the PV225S electrical connections:**

1. Ensure that the AC and DC disconnect switches, as well as any utility interconnect circuit breakers or main disconnect switches, are opened. ☐
2. Ensure all conductors and wiring connections interfacing with the PV225S are tightened to the correct torque value. ☐  
For specific torque values, see Table 3-1, “AC Terminal Wire Gauge, Bolt Size, and Torque Values” on page 3–12 and Table 3-2, “DC Terminal Wire Gauge, Bolt Size, and Torque Values” on page 3–12.
3. Verify AC power conductors terminated at TB5, TB6, TB7 within the Main Inverter Enclosure are terminated correctly and properly sequenced. ☐
4. Verify the AC power conductors terminated at S1-2T1, S1-4T2, and S1-6T3 within the AC Interface Enclosure are terminated correctly and properly sequenced. ☐
5. Verify DC power conductors terminated at S2-6, K2-6T3, and TB4 within the DC Interface Enclosure are terminated correctly and properly polarized. ☐

# Visual Inspection, Isolation Transformer Wye/Wye

To perform a visual inspection of the Isolation Transformer Wye/Wye:

- 1. Ensure that the AC and DC Disconnect Switches, as well as any utility Interconnect circuit breakers or main disconnect switches, are open. ☐
- 2. Verify all conductor and wiring connections interfacing with the PV225S are tightened to the correct torque value. ☐  
For specific torque values, see Table 3-1, “AC Terminal Wire Gauge, Bolt Size, and Torque Values” on page 3–12 and Table 3-2, “DC Terminal Wire Gauge, Bolt Size, and Torque Values” on page 3–12.
- 3. Verify the AC power conductors terminated at T6-X1, T6-X2, and T6-X3 within the Transformer Enclosure are terminated correctly and properly sequenced. ☐
- 4. Ensure the neutral on the inverter side (T6-X0) is left floating. If the inverter side neutral is tied to ground, the inverter will not function properly. Also, ensure that the neutral is not bonded to the isolation transformer frame. ☐

<hr/>	<hr/>
Date	Checks Completed

## Corrective Action

Perform after initial inspection (if required):

- 1. Correct any necessary repairs pertaining to the previous inspection steps.
- 2. Replace the wiring access panels to the AC interface/transformer assembly and Main Inverter Enclosure.
- 3. Replace the latches and close the doors of the Main Inverter Enclosure, the AC and DC Interface Enclosures, and communication enclosure.
- 4. Ensure that the AC and DC Disconnect Switches, as well as any utility interconnect circuit breaker or main disconnect circuit breaker, are left open.



# Schematics

Appendix A contains useful schematics to aid with installation.

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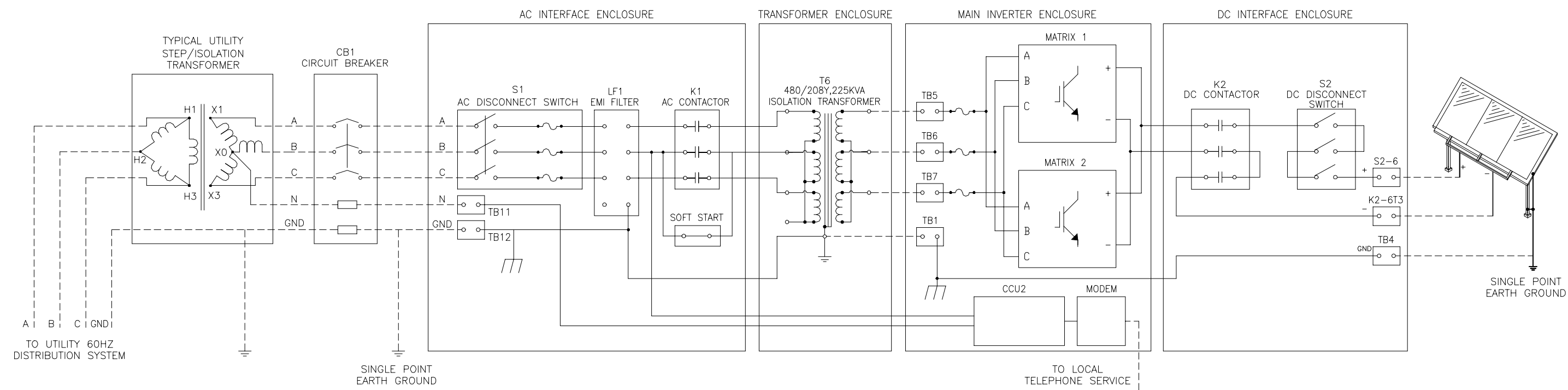


Figure A-1 Electrical Diagram (sample)

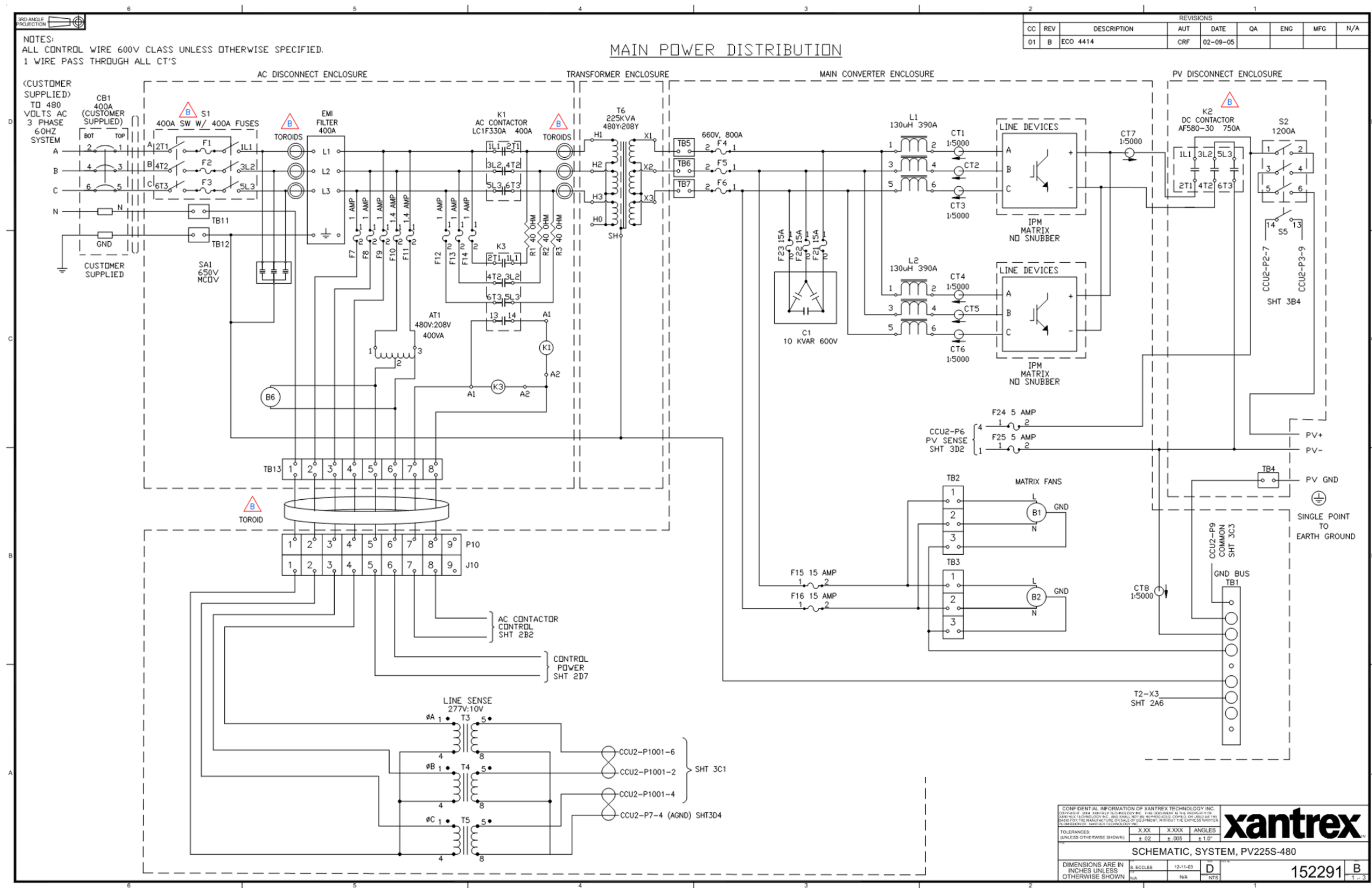


Figure A-2 PV225S-480 Schematic for Main Power Distribution (152291 B1)

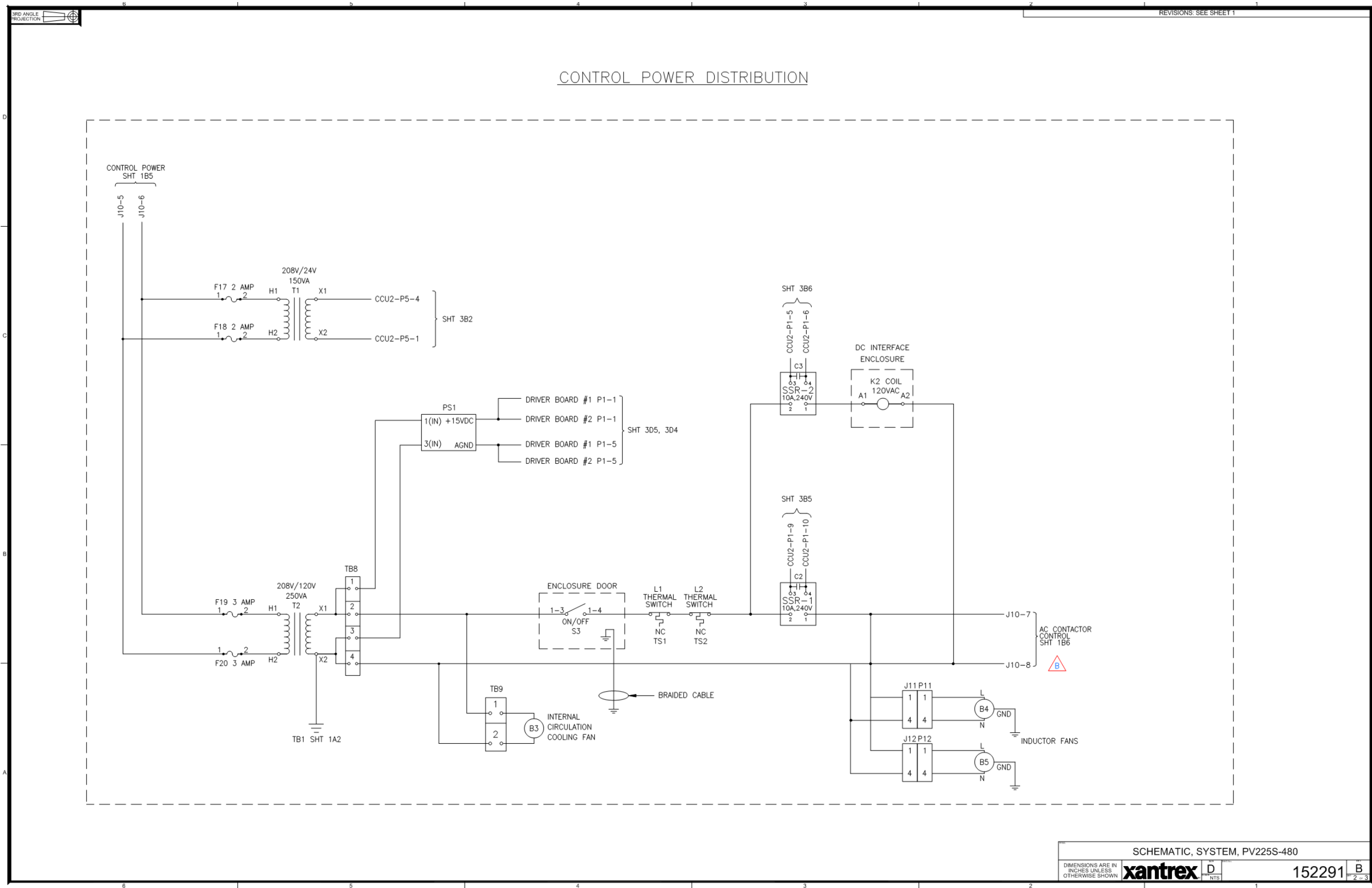
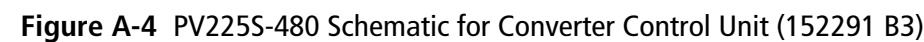


Figure A-3 PV225S-480 Schematic for Control Power Distribution (152291 B2)





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