

PowerGate® Plus Inverter

Installation, Operation and Maintenance Guide

PVS-50 (50kW) – UL Version

PM00450 -- Revision 3



Satcon

835 Harrington Court, Burlington, Ontario, Canada, L7N 3P3
Tel: 905.639.4692 | Fax: 905.639.0961 | www.SatCon.com

© 2007–2009 by Satcon.

This document is the confidential and proprietary information of Satcon. No part of this document may be photocopied, reproduced, stored in a retrieval system, or transmitted in any form or by any means whether electronic, mechanical, or otherwise without prior written permission.

Satcon reserves the right to change details in this publication without notice.

PowerGate® Plus and PV View® Plus are the registered trademarks of Satcon. Edge™ MPPT is a trademark of Satcon. Other product names and/or organization names mentioned may be trademarks and/or registered trademarks of their respective companies.

Publication Number

PM00450

Date and Revision

REV.	ECO	DATE	AUTHOR	APPR.	COMMENT
0	8224	Aug 08, 2008	G. Mounsey	H.K.	Original Release
1	8324	Sep 16, 2008	G. Mounsey	H.K.	Inside Cover: Added copyright statement Page xi: Removed ANSI acronym from acronym ANSI/NFPA 70 Page 4: Corrected to read AC circuit breaker (removed reference to AC disconnect switch). Page 8: Deleted "Warning" note at bottom of page referring to AC breaker required at service panel. Page 9: Third bullet; changed AC disconnect switch (CB1) to AC circuit breaker (CB1) Page 11: Last paragraph; changed 400VAC to 600VAC and changed AC disconnect switch (DS2) to AC circuit breaker (CB1). All: New logo substituted.
2	8544	Dec 15, 2008	G. Mounsey	H.K.	All pages, rebranding (new logos) Table 1: Added Short Circuit Interrupt Rating (kAIC) values Page 11, Corrected "AC Power Output Section" Chapter 3, All new Chapter 4, All new Chapter 5 All new
3	8925	June 4, 2009	G. Mounsey	V.X.	Inside cover page Page ix and x: Minor edits Figure 35: All new Chapter 3: All new Chapter 4: All new

Table of Contents

About This Guide..... ix

- Purpose ix
- Who Should Read this Manual..... ix
- How the Manual is Organized ix
 - Section 1: ix
 - Section 2: ix
- Reference Manuals x

Conventions Used xi

IMPORTANT SAFETY INSTRUCTIONS..... xii

- General Safety Precautionsxiii
- Electrical Safety Precautions and Practices.....xiv
 - Safe Practicesxiv
 - Shock Preventionxiv
 - Service and Maintenance..... xv
 - Fire and Explosion Prevention xv
 - Bodily Injury Prevention xv
 - Medical and First Aid Treatment xv
 - Equipment Precautionary/Warning Labels..... xv
 - Potential Equipment Damage xv
 - Integrated Electrical Safety Featuresxvi
- Handling Safety xvii
- Special Symbols..... xviii

Chapter 1 Product Information..... 1

- About this Chapter..... 1
- Overview2
 - Regulatory Standards2
- Technologies and Design Features2
 - Isolation Transformer2
- Operational Features.....3
 - Maximum Power Point Tracking3
 - Unity Power Factor.....3
 - Remote Monitoring Option3
- Safety Features5
 - Enclosure Door Interlock Switch5
 - DC Disconnect Switch.....5
 - AC Circuit Breaker.....5

ON/OFF Switch	5
Over Voltage and Over Current Detection	6
Ground-Fault Detection and Interruption Configurations	6
Standard Configuration (GDFI Option)	6
Optional Configuration (EGFDI Option).....	6
Anti-Islanding Protection	6
Ratings and Specifications.....	8
Physical Description.....	10
Access Doors	10
DC Power Input Section.....	11
AC Power Output Section	11
Enclosure Safety Ground	12
Human Machine Interface (HMI).....	12
Logic Processing Box.....	12
Enclosure Cooling Components	12
Cable Entry and Exit	12
Mounting Lugs.....	12
Dimensions and Weights	12
Human Machine Interface (HMI).....	13
ON/OFF Switch	13
Run Enable/Disable	13
Power Generation Indicator	13
Keypad and Display	13
Display	14
Keypad.....	14
Chapter 2 Installation Information.....	15
About this Chapter	15
Step 1- Before Starting Installation	16
Step 2 - Planning for Installation	17
Ventilation and Serviceability Requirements.....	17
Ventilation Requirements.....	17
Serviceability Access Requirements.....	17
Enclosure Anchoring Requirements	18
Planning Cable Entries.....	19
AC and DC Cables	19
Customer Control and Communications Wiring	19
Underground Conduit or Raceway	20
Conduit Punch Tools.....	20
Step 3 – Preparing for Installation.....	21

Handling Inverter Enclosure	21
Unloading Inverter Enclosure	21
Moving Inverter Unit	21
Unpacking and Inspecting Inverter Unit	22
Inspecting and Reporting Shipping Damage	22
Step 4 – Mounting and Anchoring Inverter Enclosure	23
Step 5 – Installing Conduits	24
Cable Gland Plate Thickness	24
Preferred Practices	24
Step 6 – Connecting Power Conductors	25
Identifying Conductor and Wiring Locations	25
Wiring and Cabling Data	26
Connecting Enclosure Safety Ground	27
Connecting DC Ground	27
Connecting DC Ground Fault Detector/Interrupter	28
Standard GFDI Configuration	28
Optional EGFDI Configuration	28
Connecting AC Ground	29
Connecting DC Input Power	30
Connecting AC Output Power	32
Step 7- Installing Communication and Control Wiring	33
Types of Communication and Control Wiring	33
Wiring Remote Communications Link (RS485SS)	34
Wiring Remote Inverter Control	35
Step 8-Verify Installation	36
Mechanical Checks	36
Electrical Checks	36
Step 9 – Verify Input and Output Power Requirements	37
Step 11-Commission Unit	37
Chapter 3 Operations Information	39
About this Chapter	39
Overview of Operations	40
Operating States	40
Inverter Control	41
Inverter Run Enabled or Disabled	41
Inverter Startup Conditions	41
Inverter Stop Conditions	42
Inverter Fault Shutdown	42
Inverter ON/OFF Control	43

Inverter Reset.....	43
Maximum Power Point Tracking	44
Local and Remote Control	45
Modbus Communication	46
Modbus Data Communication Default Settings	46
Modbus Function Codes	46
Function Code 04	46
Function Code 16	46
Inverter Modbus Parameters.....	47
Understanding Inverter Modbus Data Tables	47
Column 1: Register Number	47
Column 2: Description	47
Column 3: PCS Op Name.....	47
Column 4: Access Level	47
Column 5: Resolution	47
Units.....	47
AC Output Reactive Power Control.....	53
Fan Control.....	53
Electronic Ground Fault Detector Interrupter Operation	54
About the Keypad and Display.....	57
Keypad.....	57
HMI Display.....	57
About the Menu Structure	58
Using Keypad and Display.....	60
How to Move to Lower Level.....	60
How to Move Up One Level	60
How to Enter and Save Data (Operation Sub Menus Only)	60
How to Clear Faults.....	60
How to View Faults	60
Navigating Through the Menu Hierarchies	61
Menu Descriptions	65
Monitoring Menu Descriptions	65
Status Submenu Descriptions	65
Firmware Sub Menu Descriptions.....	65
Metering Sub Menu Descriptions.....	66
Energy Production Sub Menus	68
System Information Sub Menus.....	69
Status and Faults Menu	70
Operations Menu.....	71

Control Submenus	71
Settings Submenus	76
Field Adjustment Set Points	78
Fault and Warning Messages	80
General Faults	80
DPCB Faults	82
Hardware Faults	83
Inverter Faults	84
Temperature faults	84
Warning Messages	85
Shutdown Procedures	86
Fast Shutdown Procedure (ON/OFF Switch)	86
Controlled Shutdown Procedure (HMI)	87
Chapter 4 Maintenance Information	89
About this Chapter	89
About Warranty and Preventive Maintenance	90
Warranty Packages	90
Standard Warranty	90
Extended Warranty	90
Preventive Maintenance Plans	91
Preventive Maintenance under Standard Warranty	92
Scheduled Maintenance	93
Semi-Annual Intervals	93
Annual Intervals	93
Preventive Maintenance Guidelines for Customers	94
Customer Responsibilities	94
Guidelines for Cleaning and General Inspection	94
Guidelines for Cable Maintenance	95
Guidelines for Power Component Maintenance	95
Guidelines for Printed Circuit Board Maintenance	95
Guidelines for Blower Fan Maintenance	96
Guidelines for Air Filter Maintenance	96
General Maintenance Workmanship	96
Chapter 5 Commissioning Procedures	97
About this Chapter	97
Connecting AC and DC Power Cables	98
Initial Power Up	98
Appendix	101

Front Matter

Electrical Drawing 101
Mechanical Drawing..... 101

List of Figures

Figure 1 PV View Plus Remote Monitoring Option	4
Figure 2 PVS-50 Model.....	10
Figure 3 Enclosure Door Latch	11
Figure 4 Human Machine Interface (HMI).....	14
Figure 5 Enclosure Corner Mounting Lugs	18
Figure 6 Enclosure Mounting Dimensions (PVS-50 Model)	18
Figure 7 Planning for Cable and Wiring Entries (PVS-50 Model)	19
Figure 8 Bottom Gland Plate Dimensions (PVS-50 Model)	20
Figure 9 Ground to Gland Plate Clearance (PVS-50 Model).....	20
Figure 10 Shipping Pallet Forklift Locations.....	22
Figure 11 Corner Mounting Lugs	23
Figure 12 Enclosure Internal Locations (PVS-50 Model).....	25
Figure 13 Enclosure Safety Ground (PVS-50 Model).....	27
Figure 14 DC Ground (PVS-50 Model).....	27
Figure 15 AC Ground (PVS-50 Model).....	29
Figure 16 DC Input Connections PVS-50 Model (No Combiner Option).....	30
Figure 17 DC Input Connections PVS-50 Model (Combiner Option).....	31
Figure 18 AC Output Connections (PVS-50 Model)	32
Figure 19 Control and Communication Wiring Location (PVS-50 Model).....	33
Figure 20 RS485SS Wiring Information	34
Figure 21 TBC Control Wiring Information	35
Figure 22 Automatic Startup State Diagram	41
Figure 23 State Diagram for Inverter Shutdown	42
Figure 24 AC Output Reactive Power Control, PVS-50 Model.....	53
Figure 25 UL1741 Table for Maximum Ground Currents	54
Figure 26 UL1741 Time Delay for Opening Ground Path.....	55
Figure 27 EGFDI Connections	56
Figure 28 HMI Display.....	57
Figure 29 HMI Menu Hierarchy.....	58
Figure 30 Using Keypad.....	61
Figure 31 Monitoring Menu Hierarchy.....	62
Figure 32 Status and Faults Menu Hierarchy	63
Figure 33 Operations Menu Hierarchy.....	64

List of Tables

Table 1 Ratings and Specifications for PVS-50 Model (1 of 2)	8
Table 2 Physical Data for 50kW Model.....	12
Table 3 Wire and Cable Connection Details for PVS-50 Model	26
Table 4 Inverter Operating States.....	40
Table 5 Local and Remote Control Functions	45
Table 6 Modbus Registers for Fault Parameters	48
Table 7 Modbus Registers for Metering Parameters	48
Table 8 Modbus Registers for String Current Parameters.....	49
Table 9 Modbus Registers for String kW Hour Parameters.....	50
Table 10 Modbus Registers for Energy Parameters.....	51
Table 11 Modbus Registers for Line Feedback Parameters	51
Table 12 Modbus Registers for Fault Queue Parameters	51
Table 13 Modbus Registers for Input/Output Parameters	51
Table 14 Modbus Registers for Temperature Feedback Parameters	52
Table 15 Modbus Registers for Serial Number Parameters	52
Table 16 Modbus Registers for Components Parameters.....	52
Table 17 Modbus Registers for Writeable Parameters	52
Table 18 Menu Summary.....	59
Table 19 Status Submenu Descriptions	65
Table 20 Firmware Submenu Descriptions.....	65
Table 21 Metering Submenu Descriptions (1 of 2)	66
Table 22 Energy Production Submenu Descriptions	68
Table 23 System Information Submenu Descriptions.....	69
Table 24 Status and Faults Submenu Descriptions.....	70
Table 25 Control Submenu Descriptions (1 of 5).....	71
Table 26 Settings Submenu Descriptions (1 of 2)	76
Table 27 Default Trip Level Settings to Shutdown Inverter	78
Table 28 Trip Level Settings to Stop Inverter	79
Table 29 General Faults	80
Table 30 DPCB Faults	82
Table 31 Hardware Faults.....	83
Table 32 Inverter Faults	84
Table 33 Temperature Faults.....	84
Table 34 Warning Messages	85
Table 35 Semi-Annual Maintenance Service Tasks	93
Table 36 Annual Maintenance Service Tasks	93

About This Guide

Purpose

This manual provides information about installing, operating, maintaining, and troubleshooting the PowerGate[®] Plus inverter.

Who Should Read this Manual

This manual should be read by anyone who needs to:

- Understand the product
- Plan the installation
- Install the product
- Commission the product
- Operate the product
- Maintain the product, if necessary

How the Manual is Organized

This manual is divided into two primary sections: front matter (section 1) and five chapters (second section).

Section 1:

- **Front Matter:** This section contains important safety information, together with information about the conventions used in this manual as well as a listing of the symbols used in the equipment.

Section 2:

- **Chapter 1 Product Information:** This chapter provides general information about PowerGate[®] Plus Inverters, including their important features, ratings and specifications, physical descriptions, and user controls.
- **Chapter 2 Installation Information:** This chapter provides information to help plan the installation, how the enclosure should be mounted, and how it should be connected electrically.
- **Chapter 3 Operations Information:** This chapter provides information about the inverter operations, including its different operating states and how the user can interact with the unit.
- **Chapter 4 Preventive Maintenance:** This chapter provides information about scheduled and periodic maintenance.
- **Chapter 5 Commissioning Procedures:** Explains how to start up the inverter after installation

Reference Manuals

If you need additional information about the PowerGate® Plus options or communication interfaces, refer to the following user manuals:

- PM00440- PV View® Plus User Guide
- PM00443- PV View® Plus XML Interface Guide
- PM00445- PV View® Plus XML Utility Guide
- PM00452- PV Modbus RTU Communication Interface Reference Guide
- PM00454- PV TCP/IP Communication Interface Reference Guide
- PM00447- PV View® Plus Weather Station
- PM00459- PV View® Plus Power Meter

Conventions Used



WARNING

Warnings tell you about conditions and actions that could result in personal injury or death. A qualifier (e.g. Hazardous Voltage) may follow the warning title.



CAUTION

Cautions tell you about conditions or actions that could result in damage to the inverter or other equipment. A qualifier (e.g. Inverter Damage) may follow the warning title.



NOTE

Notes tell you about things which are important for you to know but not as serious as cautions or warnings.

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS

This manual contains important instructions for the PVS-50 that shall be followed during installation and maintenance of the inverter.



WARNING

The PowerGate[®] PLUS Inverter system presents a **SHOCK HAZARD**. Read and keep this *Operation and Maintenance Guide* for future reference. Before installing the PVS-50, read all instructions, cautionary markings and other appropriate sections of this guide. Failure to follow these warnings could result in severe shock or even death. Exercise extreme caution at all times to prevent possible accidents.



WARNING

These instructions are not meant to cover every safety eventuality nor to replace any local or site specific safety procedures. The information in this section is intended as a supplement to local or site specific procedures. Satcon does not assume responsibility for the compliance or noncompliance to any code, national, local or otherwise for the proper installation of the PowerGate[®] PLUS Inverter or associated equipment supplied.

A potential for personal injury and/or equipment damage exists if electrical codes and these instructions are not followed.



DANGER

This PowerGate[®] PLUS Inverter contains **LETHAL VOLTAGES**. Authorized service personnel only should perform all repairs and service. There are no user serviceable parts inside this inverter.

General Safety Precautions

**WARNING**

Only qualified personnel familiar with the PowerGate[®] PLUS Inverter design should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result with personal injury and or equipment damage.

**WARNING**

An incorrectly installed PowerGate[®] PLUS inverter may result in equipment damage or a reduction in product life. Incorrect wire sizing, inadequate supply, or excessive ambient temperatures may result in system malfunction.

**CAUTION**

This PowerGate[®] PLUS Inverter contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this unit. Board component damage may result if proper ESD measures are not followed.

**WARNING**

To avoid an electric shock, verify that the voltage on the bus capacitors has discharged before performing any work on the PowerGate[®] PLUS Inverter. Measure the voltage across CF (wires 14 and 15) in the inverter; this voltage must be zero to be fully discharged.

**WARNING**

The enclosure contains exposed high voltage conductors. The enclosure door should remain locked, except during maintenance or testing by trained service personnel. Do not open the cabinet doors if extreme moisture is present (rain, snow or heavy dew).

Electrical Safety Precautions and Practices



WARNING

ELECTRIC SHOCK can **KILL**. Do not touch live electrical parts. **ELECTRIC ARC FLASH** can injure eyes, burn skin, cause equipment damage and ignite combustible material. **DO NOT** disconnect load power by disconnecting power cables. Prevent tools from causing short circuits.

Be aware that you do not have to physically touch high-voltage parts to receive an electrical shock; high-voltage can jump across gaps seeking objects of lower potential (i.e. body parts, tools, or equipment).

Safe Practices

Equipment that supplies electrical power can cause serious injury or death, or damage to other equipment or property. The operator must strictly observe all safety rules and take precautionary actions. Safe practices have been developed from past experience in the use of power source equipment.

Shock Prevention

Bare conductors, terminals in the output circuit or ungrounded, electrically live equipment can fatally shock a person. Be sure to follow the following guidelines:

- Have a certified electrician verify that the equipment is adequately installed and grounded.
- Only authorized and properly trained personnel should maintain or troubleshoot the PowerGate[®] PLUS Inverter.
- Use proper safety clothing, procedures and test equipment.
- The electrical resistance of the body is decreased when wet, permitting dangerous currents to flow through it. While inspecting or servicing equipment, do not work in damp areas.
- Stand on a dry rubber mat or dry wood, and use insulating gloves when dampness or sweat cannot be avoided and never work alone.
- The equipment must be installed and maintained in accordance with the National Electrical Code NFPA 70, or other applicable codes.
- Inspect cables frequently for damage to the insulation and the connectors. Replace or repair cracked or worn cables immediately.
- Do not overload cables.
- Do not touch output terminal while equipment is energized.



WARNING

DC input terminals and output terminals remain energized when internal disconnects and breakers are open. .

Service and Maintenance

This equipment must be maintained in good electrical condition to avoid hazards stemming from disrepair. Report any equipment defect or safety hazard to the supervisor and discontinue use of the equipment until its safety has been assured. Only qualified personnel should make repairs to the inverter.

Before servicing, disconnect AC and DC sources to the inverter.



WARNING

The PowerGate[®] PLUS Inverter contains high-voltage DC capacitors. Allow five (5) minutes for all capacitors within the enclosure to discharge after disconnecting the inverter from AC and DC sources.

Fire and Explosion Prevention

Fire and explosion are caused by electrical short circuits, combustible material near the equipment, or unsafe operating conditions. Overloaded or shorted equipment can become hot enough to cause fires by self-destruction or by causing nearby combustibles to ignite. Provide primary input protection to remove short circuited or heavily overloaded equipment from the line.

Bodily Injury Prevention

Serious injury can result from contact with live circuit components inside this equipment, SHUT down this equipment for inspection and routine maintenance in accordance with *“Chapter 3 Operations Information, Shutdown Procedures”*. When equipment is in operation, use extreme care in doing necessary troubleshooting and adjustment.

Medical and First Aid Treatment

First aid procedures need to be in place in accordance with local and site health and safety procedures. Electric shock victims should be checked by a physician and taken to hospital immediately if any abnormal signs are observed.

Equipment Precautionary/Warning Labels

Inspect all precautionary, warning labels on the equipment monthly. Order and replace all labels that cannot be easily read or are worn out. Labels can be ordered by email at pv.service@SatCon.com.

Potential Equipment Damage

Improper phase connection, paralleling, or use can damage the equipment. Maintenance personnel should become familiar with the layout and be aware of the basic system parameters. Only qualified trained personnel should be allowed to work with this equipment under competent supervision. The DC input voltage present for the solar array can be as high as 660VDC (maximum). The AC output voltage can be as high as 600VAC depending on output configuration and utility voltage.

Integrated Electrical Safety Features

PowerGate[®] PLUS Inverters contain the following integrated electrical safety features:

- Software protection controls (described in *“Chapter 3 Operations Information”*).
- Enclosure Door Interlock Switches (described in *“Chapter 1 Product Information and Chapter 3 Operations Information”*).
- ON/OFF switch (described in *“Chapter 1 Product Information and Chapter 3 Operations Information”*)
- DC Disconnect Switch (described in *“Chapter 1 Product Information and Chapter 3 Operations Information”*)
- AC Disconnect switch or AC circuit breaker (described in *“Chapter 1 Product Information and Chapter 3 Operations Information”*)
- Anti-islanding protection (described in *“Chapter 1 Product Information”*)

Be sure to understand these features.

Handling Safety

When moving the enclosure, handle with care and caution.



CAUTION

Do not use the hold-down brackets for lifting. Unit must be lifted from the bottom. Unit must be supported on all four sides when lifting due to its narrow width and depth.



CAUTION

Ensure that the load rating of the lifting device is sufficient to safely lift the electrical unit.

Special Symbols

The following special symbols are used within the PowerGate® PLUS Inverter enclosure



GROUND – Symbol used throughout the enclosure to designate a connection point to ground.



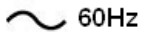
DC Positive – Symbol used throughout the enclosure designate a connection point to the DC Positive of the Solar Photovoltaic Array.



DC Negative – Symbol used throughout the enclosure to designate a connection point to the DC Negative of the Solar Phortovoltaic Array.



DC Circuit – Symbol throughout the enclosure designates the circuit intended to be connected to a DC circuit



AC Circuit – Symbol used throughout the enclosure to designate that a circuit is an AC, 60Hz circuit.



Number of Phases– Symbol used throughout the enclosure to indicate the number of the phases in the circuit



ON position– Symbol used throughout the enclosure to indicate the ON position of switches and breakers.



OFF position– Symbol used throughout the enclosure to indicate the OFF position for switches and breakers.

Chapter 1 Product Information

About this Chapter

This chapter introduces the PVS-50 PowerGate® PLUS inverter. Topics include:

- Technologies and design features
- Operational features
- Safety features
- Ratings and specifications
- Physical description
- Operator controls

Overview

The PVS-50 PowerGate® PLUS inverter is a power conversion system that is designed to be used in grid-connected photovoltaic systems. These types of systems represent one of the most important configurations of distributed energy resources (DER).

The PVS-50 has a power rating of 30kW. The unit is easy to install, easy to operate, and incorporates the latest technologies.

Regulatory Standards

The PVS-50 PowerGate® PLUS inverters are fully certified to the following standards:

- *“Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources,”* UL1741, including revisions through and including November , 2005
- *“General Use Power Supplies,”* CSA 107.1

PowerGate® PLUS inverters also comply with IEEE 1547, including testing to IEEE 1547.1 and IEEE C62.45.

Technologies and Design Features

The PowerGate® PLUS inverters convert the DC outputs of photovoltaic arrays into three phase AC power using reliable, high efficiency Insulated Gate Bipolar Transistors (IGBT) as the primary switching devices. These devices are rated for 1200V and operate at very high switching frequencies. The inverter itself makes use of a snubberless design, meaning that there are no resistive-capacitive (RC) circuits that can reduce efficiency as well as reliability.

Design features include:

- The unit is designed solely for connection to the grid, namely “Line Linkage Mode” (Grid Export Mode), where it exports power to the grid when the DC output from solar photovoltaic array is available.
- The power is exported to the grid (Grid Export Mode) by the inverter in AC Current Control mode whereby the current in each phase of the three phase inverter is precisely controlled by the inverter regulator.
- The three phases output voltages and currents are sinusoidal with low total harmonic distortion to meet the UL1741 and IEEE 519-1992 harmonic requirements.
- The control circuit uses a digital control board named “Digital Power Control Board” (DPCB) using digital signal processor (DSP) and Field Programmable Gate Array (FPGA) chips for control, system monitoring and protection.
- Many areas and components sensitive to over-temperature conditions are monitored with thermal detectors. Extensive electronic fault detection schemes, with fuses are employed to ensure safety of critical circuits.

Isolation Transformer

All PowerGate® PLUS Inverters include a high-efficiency Delta/Wye isolation transformer that has very low coil and core losses. This transformer is mounted within the inverter enclosure where it performs two functions.

- First, it provides galvanic isolation when the solar array is grounded.

- Second, it allows the inverter to match the voltage of the utility grid. The utility side windings of the inverter are configured Wye and must match the voltage at the utility inter-tie during installation.

The isolation transformer also has a tap on the low voltage side to enable the inverter to operate when the incoming PV array voltage drops below 305VDC.

The isolation transformer is a dry type transformer wound with high-temperature insulation. The unit is vacuum pressure impregnated (VPI) with polyester resin for durability and protection against the environment. The transformer is forced air cooled by ambient air and designed with a 1.10 service factor for long life. The unit includes over-temperature switches for protection and indication on the panel display of the PowerGate® PLUS Inverter.

Operational Features

Maximum Power Point Tracking

The PV array has a unique operating point (voltage-current curve) at which it can supply maximum power. This point is called the maximum power point (MPP). However this point changes continuously with the unpredictable variations in solar irradiance and cell temperatures.

Maximum Power Point Tracking (MPPT) is a method to operate the PV array in a way that allows it to deliver its maximum power more efficiently at every instant.

To do this, the PowerGate® PLUS inverters use a sophisticated algorithm to continuously seek the optimum voltage and current operating points of the PV array. The optimum settings are controlled through the Human Machine Interface (HMI) parameters entered through the keypad and display.

Unity Power Factor

The PowerGate® PLUS Inverter continuously senses the utility voltage and frequency and adjusts its output current waveform to match the utility voltage.

Remote Monitoring Option

The PowerGate® PLUS inverter may be equipped with either the Satcon PV View™ Plus option (Figure 1) or other third-party web-enabled data monitoring option.

With the remote monitoring option, the PowerGate® Plus inverter allows parameters (DC voltage and current, AC voltage and current, and power) to be transmitted over a Modbus communication link to a Gateway so that these parameters can be viewed in real-time via the internet (website). Data can then be accessed through secure servers by various State and/or Utility photovoltaic programs.

Refer to the Satcon PV View® Plus or third-party web-enabled data monitoring option manual for more information.



Figure 1 PV View Plus Remote Monitoring Option

Safety Features

PowerGate® PLUS inverters have both hardware and software safety features to suit different purposes and actions. This section describes these features.

Enclosure Door Interlock Switch

The door interlock switch is provided to prevent operation while the front door is opened (for maintenance and servicing). When a door is opened, the PowerGate® PLUS Inverter immediately starts a controlled shutdown of the unit (opens the main AC and DC contactors in a controlled sequence). These contactors cannot be closed until the door interlock switch is in the engaged position.



WARNING

The door interlock switch turns off power being delivered by the inverter. However, live power will exist in both the DC and AC sections within the enclosure. Exercise extreme care when servicing or maintaining the equipment.

DC Disconnect Switch

To make maintenance work safer, all PowerGate® PLUS inverters have a DC switch (DS1) that isolates both poles of the solar array panels from the inverter. This switch, which includes an electrical interlock, is also used as a no-load disconnecting device.



NOTE

Local electrical code may require a full load disconnect switch be accessible at all times for the user. In some cases, an additional DC disconnect switch may be required externally for compliance to some local codes. Consult local load authorities for more information.

AC Circuit Breaker

The PVS-50 Model is equipped with an AC circuit breaker to isolate the inverter from the grid.

ON/OFF Switch

The PowerGate® PLUS Inverter unit has an ON/OFF switch, located on the operator interface panel on the main door. When this switch is turned to its OFF position, the inverter immediately shuts down.



WARNING

The ON/OFF switch turns off power being delivered by the inverter. However, live power will exist in both the DC and AC sections within the enclosure

Over Voltage and Over Current Detection

Over voltage and over current are controlled by internal control electronics and associated software. If the trip set points are exceeded, the inverter will shutdown in an orderly manner.

Ground-Fault Detection and Interruption Configurations

The PowerGate® Plus Inverter can be equipped with either fuse ground-fault detection and circuit interruption (GFDI option) or electronic ground-fault detection and circuit interruption (EGFDI option). The inverter cannot be equipped with both.

Standard Configuration (GDFI Option)

The GDFI option is *standard* on all PowerGate® PLUS Inverters.

With the standard configuration, ground fault protection is provided by a fuse (FUGFDI).

A current sensor is also provided to measure operating ground current. The auxiliary contact of the ground fuse is monitored. If a ground fault occurs and the fuse opens, the PowerGate® PLUS inverter shuts down immediately by opening all AC and DC contactors. This in turn isolates the inverter from the grid. The GDFI configuration complies with NEC 690.5.

Optional Configuration (EGFDI Option)

The EGFDI (Ground Fault Detector Interrupter) is a solid-state electronic ground fault detector and interrupter designed to provide DC fault protection of the solar photovoltaic array when the array's positive or negative pole has to be grounded. The EGFDI is designed to fulfill the requirements of Section 31 of UL1741 *"Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources"*.

Refer to *"Chapter 3 Operations Information", Electronic Ground Fault Detector Interrupter Operation* for more information.

Anti-Islanding Protection

PowerGate® PLUS Inverters meet the stringent requirements of UL 1741 *"Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources"*. UL 1741 is a standard that specifies the anti-islanding protection criteria for all distributed generation solutions.

Electrical system islanding occurs when the utility grid is removed but local energy sources, such as photovoltaic inverters, continue to operate and supply power to local loads.

Unintentional islanding is an unwanted condition that can pose a shock hazard to line crew as well as damage to electric equipment.

Photovoltaic inverters monitor frequency and voltage to detect grid outages. If the grid goes down, the frequency and voltage values in the isolated section —the section containing the inverter—change from their previous values, and the inverter will disconnect itself from the load. However, if the local load starts resonating at the same frequency as the grid frequency, the inverter assumes that the grid is still operational and will continue to supply power (a condition called islanding). Therefore, monitoring frequency and voltage values alone will not prevent islanding.

PowerGate® PLUS Inverters use additional techniques to ensure islanding does not occur.

First, the inverter changes the resonant frequency of the load slightly so that the operating frequency will move out of tolerance. This change, created by a very small swing of virtual reactance from the inverter to the load, is extremely slight and does not affect the line frequency when the grid is connected. However, if the utility grid is disconnected, the resonant frequency of the load changes because of virtual reactance applied by the inverter. The resulting change in the load frequency is immediately detected by the inverter's logic system.

In addition to the applied virtual reactance, the inverter uses a sophisticated algorithm to ensure that the anti-islanding trip disconnect occurs within the times specified by UL1741. Refer to *"Chapter 3 Operations Information, Electronic Ground Fault Detector Interrupter Operation"*.

Ratings and Specifications

Table 1 provides detailed information about ratings and specifications of the PowerGate® PLUS inverters.

Table 1 Ratings and Specifications for PVS-50 Model (1 of 2)

50kW/50kVA PowerGate® PLUS Inverter RATINGS/SPECIFICATIONS				
		208VAC	240VAC	480VAC
1	ELECTRICAL			
	Input Parameters			
	Input Voltage Maximum (from solar array)	600VDC		
	Input Voltage Range	305—600VDC		
	Input Current Maximum	172A DC		
	Input Current Range	0 to 172A DC		
	Input Current Maximum Short Circuit	200A DC		
	Input Source Backfeed Current Maximum	0A		
	Output Parameters			
	Number of Phases	3	3	3
	Output Voltage Range (L-L)	183—229Vac	211—264Vac	422—528VAC
	Output Frequency Range	59.3—60.5Hz	59.3—60.5Hz	59.3—60.5Hz
	Output Nominal Voltage	208 VAC	240 VAC	480 VAC
	Output Normal Frequency	60 Hz	60Hz	60Hz
	Maximum Continuous Output Current Per Phase	139A	121A	60A
	Maximum Output Over-current Protection Per Phase (software)	167A	145A	72A
	Breaker Rating/Trip Setting	250A/0.7	250A/0.6	90A/Fixed
	Short Circuit Interrupt Rating (kAIC)	65kA rms	65kA rms	25kA rms
	Maximum Output Fault Current (AC) and Duration Per Phase	300A for 4mS Max.	240A for 4mS Max.	135A for 4mS Max.
	Maximum Continuous Output Power	50kW/50kVA		
	CEC Weighted Efficiency	95.5%	95.5%	95.5%
	Maximum Efficiency	95.9%	96.2%	96.4%
	Tare Losses	Max 95W	Max 95W	Max 95W
	Power Factor at Full Load	1		
	Adjustable Power Factor	From 0.8 lagging to 0.8 leading		
	Output Current Harmonics	THD <3%		
	Meets UL1741, IEEE 1547, including IEEE C62.41.2 and CSA 107.1-01.	X	X	X
2	ENVIRONMENT			
	Operating Ambient Temperature	-20 degree C to +50 degree C		
	Shipping Temperature Range	-30 degree C to +70 degree C		
	Relative Humidity	15%—90% Non-condensing		

Table 2 Ratings and Specifications for PVS-50 Model (2 of 2)

50kW/50kVA PowerGate® PLUS Inverter RATINGS/SPECIFICATIONS			
3	PHYSICAL		
	Location (inverter unit)	Indoor/Outdoor	
	Enclosure (inverter unit)	NEMA 3R with environmentally enclosed electronics Seismic Rating - Zone 4	
	Dimensions	74"Hx45"Wx26-7/8"D (1880mmx1143mmx683mm)	
	Weight (inverter unit) approximate	1732 lbs (785.2 kg)	1732 lbs (785.2 kg)
4	SIGNAL TRANSFER	<ul style="list-style-type: none"> • Modbus protocol on RS485 communication link • Galvanic isolated to meet UL1741 requirements • Hardwired inverter operation and PCS Fault Indication 	
5	ISOLATION	<ul style="list-style-type: none"> • Input No Load Disconnect Switch • Input DC Contactors • Inverter Fuses • AC Contactor • AC Interconnection Breaker 	
6	OPERATORS	<ul style="list-style-type: none"> • Power Generation Light (Red) • ON/OFF Switch • Located on outside of main door 	
7	METERING and SYSTEM STATUS via VFD DISPLAY at HMI	<ul style="list-style-type: none"> • Output AC Voltage (all three phases) • Output Current (all three phases) • Real Output Power (kW) • Reactive Output Power (kVAR) • Power Factor • KW-hour • Neutral Current • PV DC Voltage • PV DC Current • PV Power (kW) • DC Bus Voltage • Stop/Run Status • Fault/No Fault Status • Local/Remote Status 	

Physical Description

This section describes the physical characteristics of the PVS-50 PowerGate® PLUS inverters. These inverters are housed in NEMA R3 enclosures.

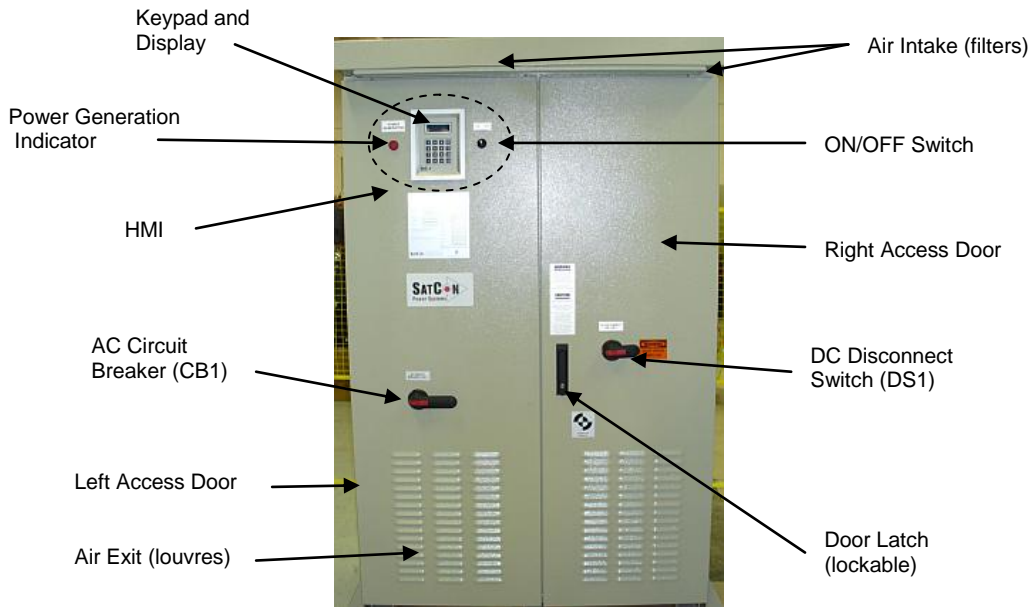


Figure 2 PVS-50 Model

Access Doors

The PVS-50 model has one access door. The following items are mounted on this door:

- Human Machine Interface (HMI)
- DC disconnect switch (DS1) handle: This handle uses a mechanical interlock mechanism, meaning that it must be turned to its OFF position before you can open the door.
- AC circuit breaker (CB1) handle: This handle also uses a mechanical interlock mechanism, meaning that it must be turned to its OFF position before you can open the door.
- Lockable door latch: The door latch is opened using a key. See Figure 3 for details.

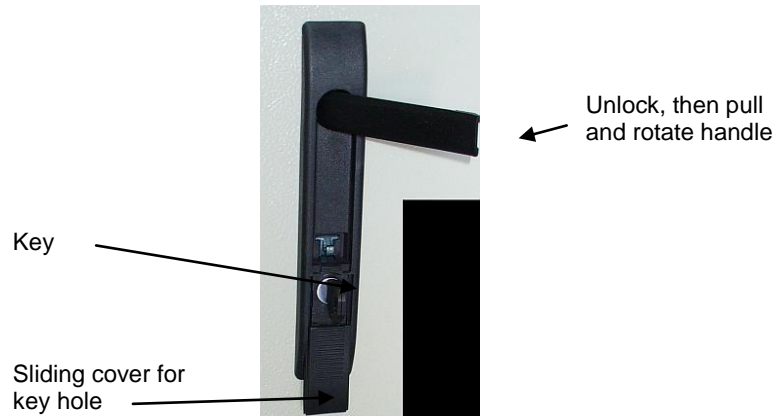


Figure 3 Enclosure Door Latch

DC Power Input Section

The DC input section is located inside the right side of the enclosure, just below the DC disconnect switch DS1. All DC power input cables and solar array cable strings are customer-supplied.

This section contains the components for conditioning the DC input from the solar array. Bus bars are provided for DC input connections. The DC input section offers the following input configurations:

- **Standard Configuration:** This configuration does not include the internal combiner. The inverter can accept up to five cables.
- **Internal Combiner Option 1:** With this configuration, you can connect up to four ungrounded solar array strings. The maximum current in each string must not exceed 32A.
- **Internal Combiner Option 2:** With this configuration, you can connect up to five ungrounded solar array strings. The maximum current in each string must not exceed 25A.
- **Grounded DC Conductors:** The inverter can accept up to five grounded DC conductors from the solar array.
- **DC Ground Connections:** The inverter can accept up to five DC ground connections from the array.

The positive input connections are attached to the DC bus bar, marked +. The negative input connections are attached to the DC bus bar, marked -. The bus bars are also connected to the + and – terminals respectively of DS1.

Refer to Table 3 for full technical specifications.

AC Power Output Section

The AC section is located on the left side of the enclosure and contains the components for conditioning the AC output from the inverters.

The 3-phase power output (A, B, and C) is connected to the 208VAC, or 240VAC, or 480VAC, 3-phase, 60Hz utility from the AC disconnect switch (DS2) terminals. Separate ground and neutral terminals are also provided.

Enclosure Safety Ground

A separate bus bar is provided for the enclosure safety ground. This bus bar is located at the bottom, inside of the enclosure (both models).

Human Machine Interface (HMI)

The Human Machine Interface (HMI) is located on the front door of the AC section. This panel includes an ON/OFF switch, keypad and display unit, and Power Generation Indicator (lit, when power is being generated by the inverter).

Logic Processing Box

Logic processing includes the Digital Power Control Board (DPCB) with embedded software and associated electronic circuits. All of these components are mounted in an environmentally sealed box. This box is located in the enclosure behind the HMI controls.

The DPCB and associated electronics generates the pulse width modulating (PWM) signals for the inverter as well as controlling the logic for the entire unit.

Enclosure Cooling Components

The enclosure uses a filtered forced air cooling system using one “backward” impeller fan. The fan, which is located inside the enclosure, draws air through filters in the enclosure hood. The air flow is directed across all semiconductor and overall system components. This air flow is also directed across the magnetics (e.g. reactors) before exiting through the louvres on the lower sides of the enclosure doors.

The louvres are designed to meet NEM R3 requirements and to prevent the ingress of water and the enclosure hood is angled to ensure water run-off occurs properly.

Cable Entry and Exit

Cable entry and exits are provided at the top right-side, bottom left-side, and bottom of the unit. These access points are covered with blank gland plates. Cutouts, for conduit penetration, are done at installation time.

Mounting Lugs

Mounting lugs are provided at four corners.

Dimensions and Weights

Table 2 summarizes the dimensions and weight of the PVS-50 model..

Table 2 Physical Data for 50kW Model

DIMENSION/WEIGHT	MEASURE
Height	74 inch (1880 mm)
Width	45 inch (1143 mm)
Depth	26-7/8 inch (683 mm)
Weight	1732 lbs (785.2 kg) approximate

Human Machine Interface (HMI)

Users interact with the PVS inverter unit through its Human Machine Interface (HMI). The HMI includes the following operator controls and indicators (see Figure 4):

- ON/OFF switch (immediate power shutdown)
- Run Enable/Disable (controlled power shutdown and startup)
- Power Generation Indicator
- Keypad and Display

ON/OFF Switch

Under normal operating conditions, the ON/OFF switch is in the ON position.

When the switch is turned to its OFF position, the PowerGate® Inverter immediately shuts down (immediately opens both the main AC and DC contactors). These contactors cannot be closed until the switch is in the ON position.



WARNING

The ON/OFF switch turns off the inverter. However, live power will exist in both the DC and AC sections within the enclosure

Run Enable/Disable

The Run Enable/Disable permits operators to either startup the inverter or shut it down in a controlled manner (rather than the immediate shutdown action of the ON/OFF switch). Run Enable/Disable is controlled using the HMI (see below).

Power Generation Indicator

The power generation indicator, when lit, visually tells you that power is being generated by the unit.

Keypad and Display

The keypad and display is mounted on the front door of the enclosure (see Figure 4). The keypad and display assembly is completely watertight and is made up of a display and touch-sensitive keypad.

The keypad and display provides an easy and convenient way to control the inverter. For example, you use it enable or disable MPPT, or change other values. It is also used for troubleshooting purposes (fault messages).

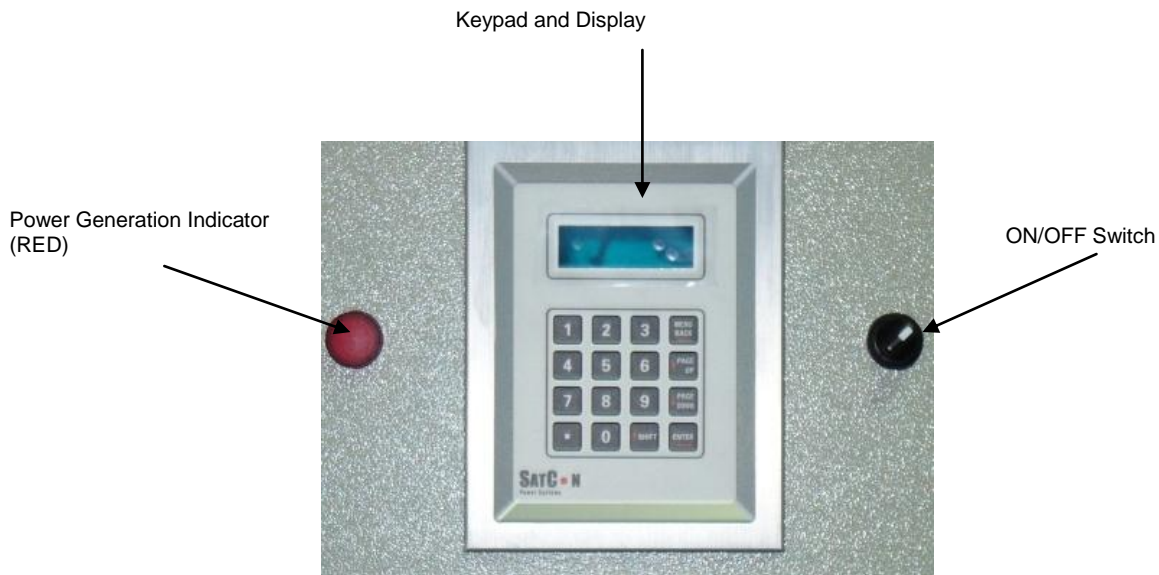


Figure 4 Human Machine Interface (HMI)

Display

The display uses vacuum fluorescent display (VFD) technology. VFD technology is superior to Light Emitting Display (LED) technology because it is more readily visible under bright conditions, such as direct sunlight.

The unit can display up to four lines of alpha-numeric characters and up to 20 characters per line.

Keypad

The keypad is made up of the following touch-sensitive keys:

- Numeric keys (0 through 9)
- Decimal key (“.”)
- Shift key (SHIFT)
- Navigation keys (“MENU BACK”, “PAGE UP”, “PAGE DOWN”)
- Data termination key (“ENTER”)

Refer to “*Chapter 3 Operations Information*” for details about using this keypad.

Chapter 2 Installation Information

About this Chapter

This chapter contains the following information:

- Planning for installation
- Moving and anchoring enclosure(s)
- Installing conduits
- Making the ground, power input and power output connections
- Making remote communications and inverter control wiring
- Verifying the installation
- Commissioning the unit

This chapter includes information about cable sizes and torque specifications for making cable connections.

Step 1- Before Starting Installation

This section contains guidelines for the installation process. Use this process to install the inverter:

1. Perform Step 2 - Plan the installation
2. Perform Step 3 – Prepare for installation
3. Perform Step 4 – Mount and anchor unit
4. Perform Step 5 - Mount and anchor transformer enclosure
5. Perform Step 6 – Install conduits
6. Perform Step 7 – Install power conductors and wiring
7. Perform Step 8 – Install communication and control
8. Perform Step 9 – Verify installation
9. Perform Step 10 – Verify input and output power requirements
10. Perform Step 11 - Commission unit

Step 2 - Planning for Installation

This section contains information to help you plan the installation process. Planning tasks include the following:

1. Allowing enough clearance for inverter ventilation and serviceability
2. Ensuring that the enclosure can be anchored properly
3. Planning the cable routing



WARNING: Shock Hazard

The method of installation, conductor size, and over-current protection must conform to the requirements of the local electrical code or other applicable codes and standards. Only qualified persons shall install the wiring and commission the unit.

Ventilation and Serviceability Requirements

Make sure that the following conditions are met to ensure the safe and efficient operation of the unit, as well as its servicing and maintenance.

Ventilation Requirements

Refer to “Environment” column in Table 1 for the operating ambient temperature and relative humidity specifications for this inverter.

This inverter uses filtered forced air-cooling for all internal cooling. A backward curved impeller fan draws air through the filtered air-intakes located at the top of the inverter unit. Air is forced downwards through the entire enclosure and out through the louvres on the front doors of the unit. The air-exhaust louvres are designed to meet NEMA 3 standards. Refer to the enclosure layout drawing in the appendix.

The resulting air flow cools:

- The 3-phase inverter assemblies, which use air-cooled heat sinks for cooling of the IGBT semiconductors.
- The magnetics at the bottom of the enclosure, which require a minimum airflow to stay within temperature specifications.

Be sure that the air flow path (from air intake at top to air exhaust at bottom) is not restricted. Any obstructions in the airflow path will degrade the performance of the inverter and can result in nuisance-tripping of the unit (power output shutting off).

Note that this PowerGate® PLUS inverter does not require any clearance at the back or sides of the unit for ventilation requirements.

Serviceability Access Requirements

The PVS-50 PowerGate® PLUS inverter is designed so that they require access only from the front. Check with local codes for any specific requirements.

Enclosure Anchoring Requirements

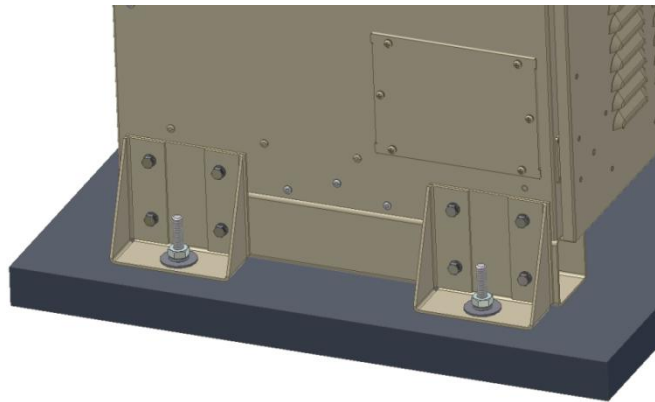
The PVS-50 PowerGate® PLUS inverter is designed to be installed in an outdoor location. The unit must be placed on and anchored to a level concrete floor or pad.

The concrete floor or pad must be designed to meet the local requirements for weight, seismic, and wind shear if necessary.

The concrete floor or pad must have pre-installed anchoring bolts. Four anchoring bolts will be required. The anchoring bolts should be M12 stainless steel hex head bolts, 1/2" heavy duty thick with large outside diameter stainless steel flat washers McMaster-Carr part number 92303A108 or equivalent, and 1/2" heavy duty stainless steel lock washer McMaster-Carr part number 92147A033 or equivalent.

Bolt the unit down using the four mounting brackets (see Figure 5), using the following lag bolts will provide a seismic zone 4 rated installation:

Refer to Figure 6 and the enclosure layout drawing in the appendix for mounting dimension requirements.



For illustration purposes only: Refer to Enclosure Drawings in Appendix for mounting configurations.

Figure 5 Enclosure Corner Mounting Lugs

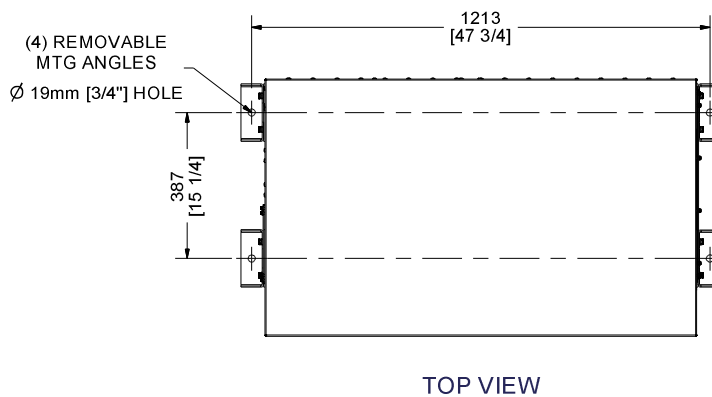


Figure 6 Enclosure Mounting Dimensions (PVS-50 Model)

Planning Cable Entries

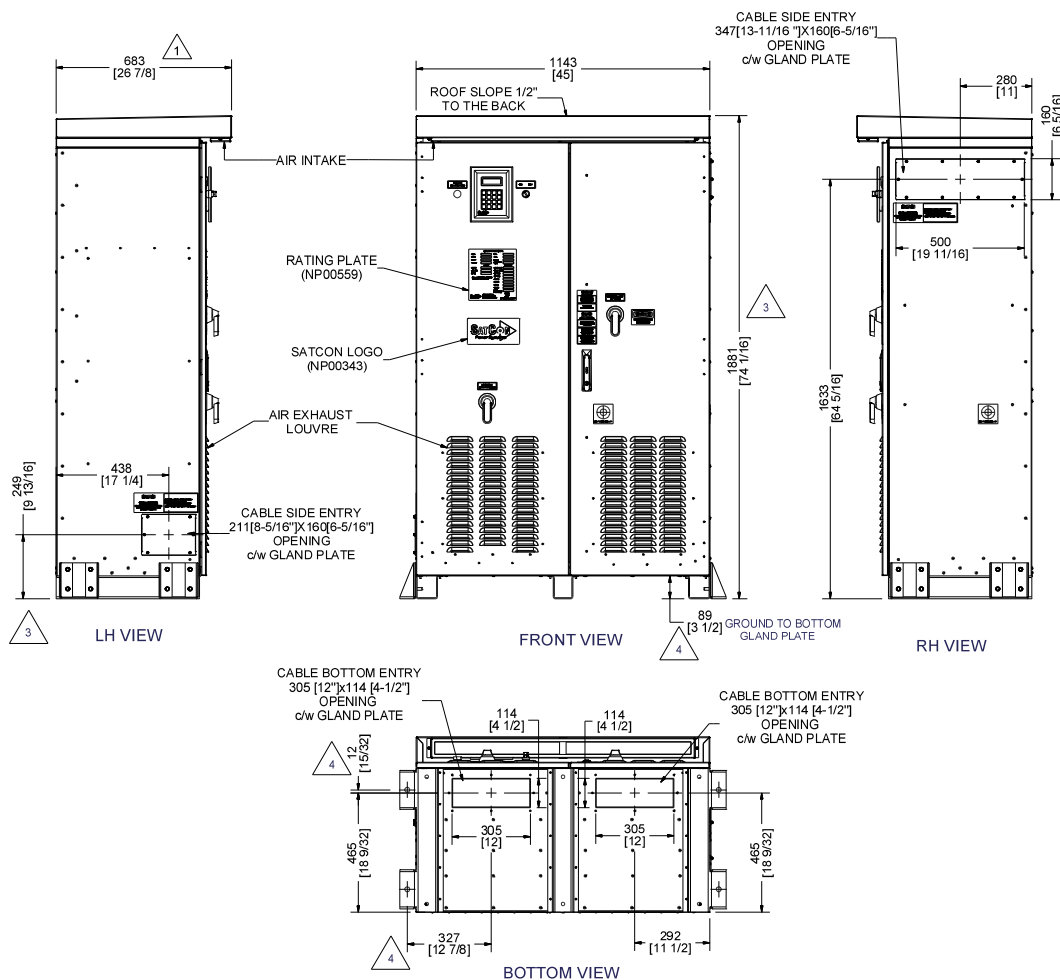
AC and DC Cables

The PVS-50 PowerGate® PLUS inverter allow you to run cables from the top (right side), bottom (left side), or bottom. Each entry point has gland plates that are removed and prepared for conduit penetration. See Figure 7.

Customer Control and Communications Wiring

Three-wire shielded wire for the RS485 communication link can be routed through the same access panels as the AC or DC cabling entry points.

If the inverter is equipped with the Satcon PV View® PLUS option, an Ethernet cable will be required to connect the inverter to a PC. This cable can also be routed through the lower-side or bottom access areas.



Underground Conduit or Raceway

For conduits or raceways below the concrete floor or pad used for anchoring the inverter, be sure to locate them accurately for bottom access before pouring the concrete. For PVS-50 model, refer to Figure 8 and Figure 9.

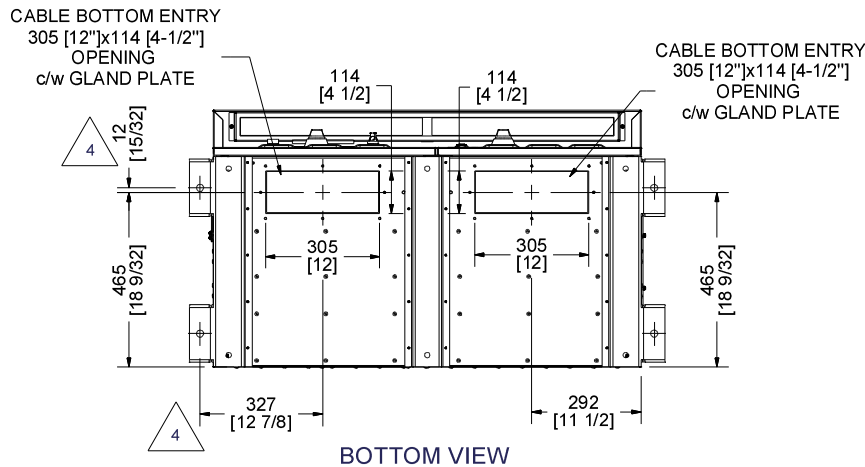


Figure 8 Bottom Gland Plate Dimensions (PVS-50 Model)

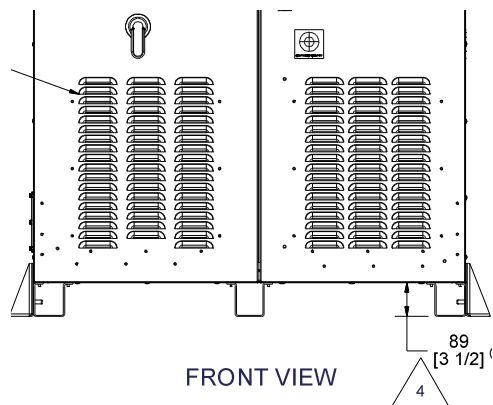


Figure 9 Ground to Gland Plate Clearance (PVS-50 Model)

Conduit Punch Tools

Conduit openings can be made using either a hydraulic punch set or knockout punch tool.

Hydraulic punch sets are preferred because they offer expanded accessories such as cable cutters for large cables (e.g. 300MCM size), and for crimping lugs onto cables for professional installations that have low impedance or low resistance connections, and so on.

Step 3 – Preparing for Installation

Handling Inverter Enclosure

The PVS-50 inverter enclosures may be moved using either a forklift or pallet jack.



WARNING: Inverter-Heavy Equipment

The PVS-50 inverters weigh approximately 1732 lbs (785 kg). Do not attempt to lift the unit by any lifting points other than the recommended lifting points otherwise you may damage the equipment or create a situation that can cause personal injury.

Keep all doors closed and latched when moving the enclosure. Leaving doors unsecured may result in damage to the equipment.

Unloading Inverter Enclosure

The PVS-50 models are shipped on pallets. Unload the unit using a forklift. Refer to “Moving Inverter Unit”.

Moving Inverter Unit



CAUTION: Equipment Damage

The enclosure must be lifted from the bottom using a forklift. The enclosure must be supported on all four sides when lifting. Precautions must be taken to avoid tipping of the enclosure front to back and side to side during lifting because the center of gravity of the enclosure is not the center of the enclosure.

To move the inverter:

1. Place the forks of the forklift below the shipping palette (see Figure 10).
2. Support the enclosure on all four sides.
3. Lift the enclosure unit from beneath its shipping palette.
4. Carefully move the unit to its destination and place the unit down.
5. Remove the forklift.



For purposes of illustration only. Enclosure sizes vary depending upon model.

Figure 10 Shipping Pallet Forklift Locations

Unpacking and Inspecting Inverter Unit

1. Unload the inverter unit
2. Cut the plastic sheeting and bubble wrap.
3. Remove shipping pallet (four mounting bolts).
4. Inspect the equipment for any damage.
5. If necessary, report damage. Refer to *“Inspecting and Reporting Shipping Damage”*.

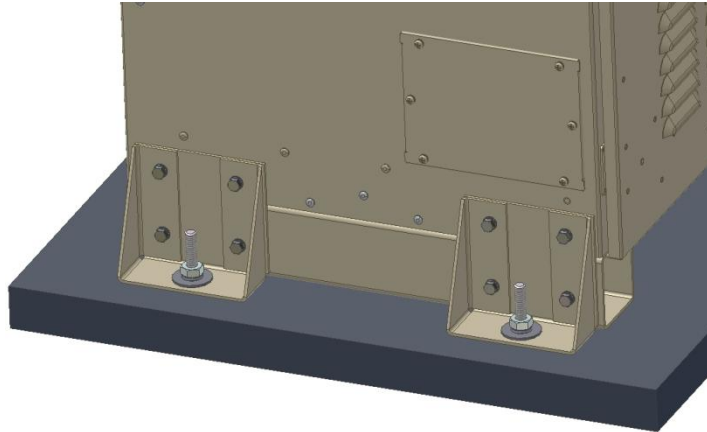
Inspecting and Reporting Shipping Damage

Use the following procedure to inspect the PowerGate® PLUS inverter and report damage, if necessary.

1. As soon as you receive the inverter, inspect the unit for any shipping damage. If damage is found, notify the carrier immediately and then notify Satcon either by email at pv.service@Satcon.com or by telephone the Help Desk at 1-866-568-0244 (U.S.A. and Canada only). Do not attempt to repair. Notify the contractor to determine the best way to correct the problem.
2. Next, remove the packing slip from the unit and check to ensure that all listed items have been received. If any items are missing notify the carrier immediately and then notify Satcon either by email at pv.service@Satcon.com or telephone the Help Desk at 1-866-568-0244 (U.S.A. and Canada only).

Step 4 – Mounting and Anchoring Inverter Enclosure

1. Be sure the mounting area has been prepared according to the guidelines provided in *“Step 2 - Planning for Installation, Enclosure Anchoring Requirements.”*
2. Lift the enclosure using a forklift or pallet jack.
3. Secure the enclosure mounting lugs to pre-installed anchoring M20 bolts (four places). *“Refer to Step 3 – Preparing for Installation, Moving Inverter Unit.”*



For illustration purposes only: Refer to Enclosure Drawings in appendix for mounting configurations.

Figure 11 Corner Mounting Lugs

Step 5 – Installing Conduits

How and where conduits are installed depends on the final system configuration (and on the planned routing of the cables and wires). Because of this dependency, the installer is responsible for procuring the proper conduits and installing them where needed.

Table 3 (PVS-50) provides the minimum wiring and cabling data you will need to determine conduit sizes. In addition, you must consult the appropriate handbooks and local codes to ensure code compliance.

Use the following information as a guide for proper conduit installation.

Cable Gland Plate Thickness

The PVS-50 models use 1.6mm G90 steel.

Preferred Practices

You can use either a hydraulic punch set or knockout punch tool to create the conduit openings in this procedure.

To install conduits:

1. Remove the glands before punching out the conduit openings.
2. Keep all sealing washers and fasteners for later reuse.
3. Drill a pilot hole in the required location in the gland.



CAUTION

Do not use hole-saws to make the opening because the metal particles will cause faults that are beyond the warranty.

4. Use either a hydraulic punch set or knockout punch tool to make the opening.
5. Install conduits.
6. Replace glands using the fasteners removed in Step 2.

Step 6 – Connecting Power Conductors

The following power conductor and wiring connections will need to be made in the inverter unit:

- Enclosure safety ground connection;
- DC ground connection;
- DC ground fault detector/interrupter connections;
- AC ground connection;
- DC power input connection;
- AC power output connection;

Identifying Conductor and Wiring Locations

All connections are made inside the enclosure. Figure 12 shows the internal locations for cable entry, DC input power and ground wiring, AC power output cabling, AC ground bus bar, and customer wiring.

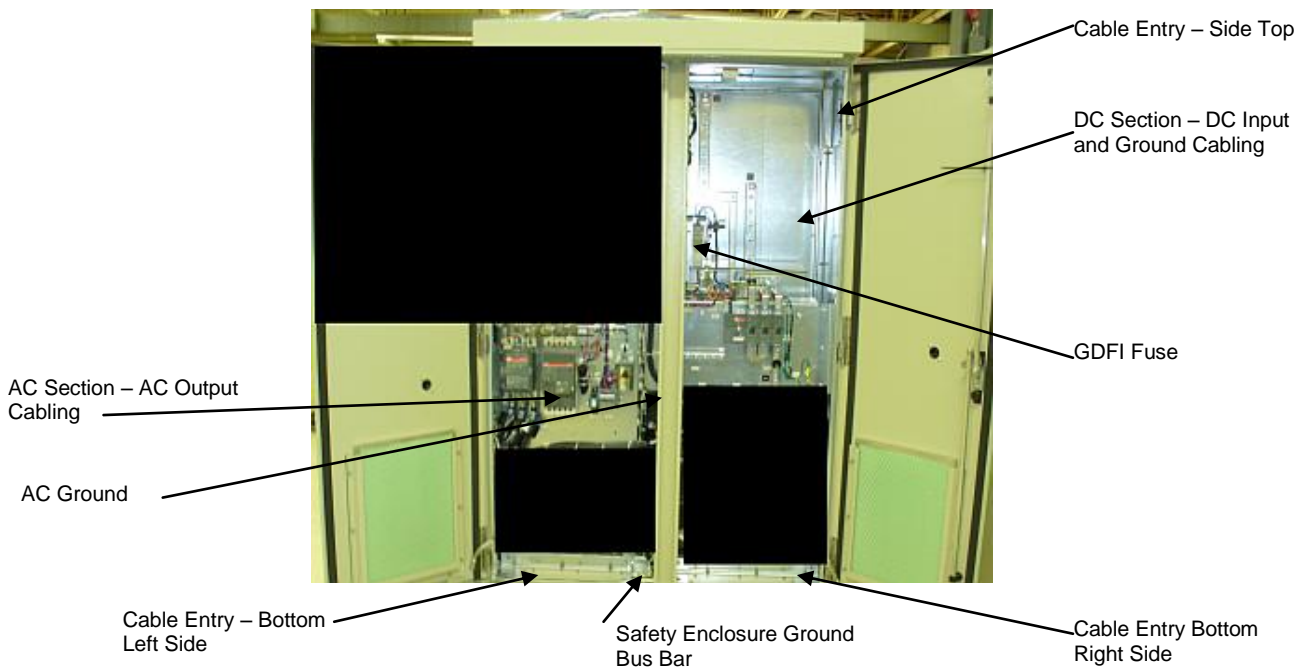


Figure 12 Enclosure Internal Locations (PVS-50 Model)

Wiring and Cabling Data

Table 3 provides detailed information about the wiring and cabling requirements.

Table 3 Wire and Cable Connection Details for PVS-50 Model

Connection	Entry	Maximum and Minimum Cable Size and Type	Tool	Torque
Ungrounded DC Conductors from Solar Array (for inverters without combiner) Bus Bar 1-1/2"x10"x1/4"	Side-Top or Bottom	Maximum: 5 x 350MCM Minimum: 1 x 300MCM or 2 x 1/0 or 3 x #3AWG or 4 x #4AWG or 5 x #6AWG	M8 Stud 13 mm or 1/2" wrench	19.1—25.5N-m Or 169.05—225.7 in-lbs.
Ungrounded DC Conductors from Solar Array (for inverters with combiner option 1 (4 strings)) FUDC 1-4 (4 x 80A) (Max. current on each string should not exceed 51A)	Side-Top or Bottom	Maximum: 250MCM each Minimum: #4AWG to each fuse holder (FUDC1-4). Total of 4 cables.	M8 Stud 13 mm or 1/2" wrench	12N-m Or 106 in-lbs
Ungrounded DC Conductors from Solar Array (for inverters with combiner option 2 (5 strings)) FUDC 1-5 (5 x 63A) (Max. current on each string should not exceed 40A)	Side-Top or Bottom	Maximum: 250MCM each Minimum: #6AWG to each fuse holder (FUDC1-5). Total of 5 cables.	M8 Stud 13 mm or 1/2" wrench	12N-m Or 106 in-lbs
Grounded DC Conductors from Solar Array (for inverters with or without combiner) Bus Bar 1-1/2"x10"x1/4"	Side-Top or Bottom	Maximum: 5 x 350MCM Minimum: 1 x 300MCM or 2 x 1/0 or 3 x #3AWG or 4 x #4AWG or 5 x #6AWG	M8 Stud 13 mm or 1/2" wrench	19.1—25.5N-m Or 169.05—225.7 in-lbs.
DC Ground Connections from Solar Array (for inverters with or without combiner) Bus Bar 1"x7"x1/4"	Side-Top or Bottom	Maximum: 5 x 3/0 Minimum: 1 x #4AWG or 2 x #6AWG or 3 x #8AWG or 4-5 x #10AWG	M6 Stud 10 mm wrench	9—10N-m Or 79—89 in-lbs.
AC Grid – A,B,C Connection (for 208VAC) Direct to disconnect switch CB1 See Note 1 below	Side-Bottom or Bottom	Maximum: 300MCM Per Phase Minimum: 1 x 4/0 per phase. Total of 3 cables.	Allen Key 10 mm	16.9—22.6Nm Or 150—200 in-lbs
AC Grid – A,B,C Connection (for 240VAC) Direct to disconnect switch CB1 See Note 1 below	Side-Bottom or Bottom	Maximum: 300MCM Per Phase Minimum: 1 x 3/0 per phase. Total of 3 cables.	Allen Key 10 mm	16.9—22.6Nm Or 150—200 in-lbs
AC Grid – Ground G (for 208/240VAC) Must be connected to the same ground potential as the Neutral of the service transformer is grounded. (Voltage sensing reference by IEEE1547)	Side-Bottom or Bottom	Maximum: 2 x 4/0 Minimum: #6AWG	M8 Stud 13 mm or 1/2" wrench	19.1—25.5N-m Or 169.05—225.7 in-lbs.
AC Grid – A,B,C Connection (for 480VAC) Direct to disconnect switch CB1 See Note 1 below	Side-Bottom or Bottom	Maximum: 2/0 per phase 1 x #3AWG per phase Total of 3 cables	Allen Key 10 mm	16.9—22.6Nm Or 150—200 in-lbs
AC Grid – Ground G (for 480VAC) Must be connected to the same ground potential as the Neutral of the service transformer is grounded. (Voltage sensing reference by IEEE1547)	Side-Bottom or Bottom	Maximum: 2 x 4/0 Minimum: #8AWG	M8 Stud 13 mm or 1/2" wrench	19.1—25.5N-m Or 169.05—225.7 in-lbs.
Customer Control Wiring (TBC and RS485 Connection)	Side- Bottom or Side-Top, or Bottom	(2) 22AWG—(2) 14AWG or (1) 10AWG	Screw Driver 1/8"	4.4—7.1 in-lbs

Note 1: The cables must be sized not to exceed 75°C at the connection points.

Connecting Enclosure Safety Ground

A bus bar (see Figure 13) is provided to ground the enclosure for safety. The enclosure safety ground must be an independent ground connected to the site ground grid/network in accordance with the National Electric Code (NEC).

Refer to Table 3 for cable sizes.

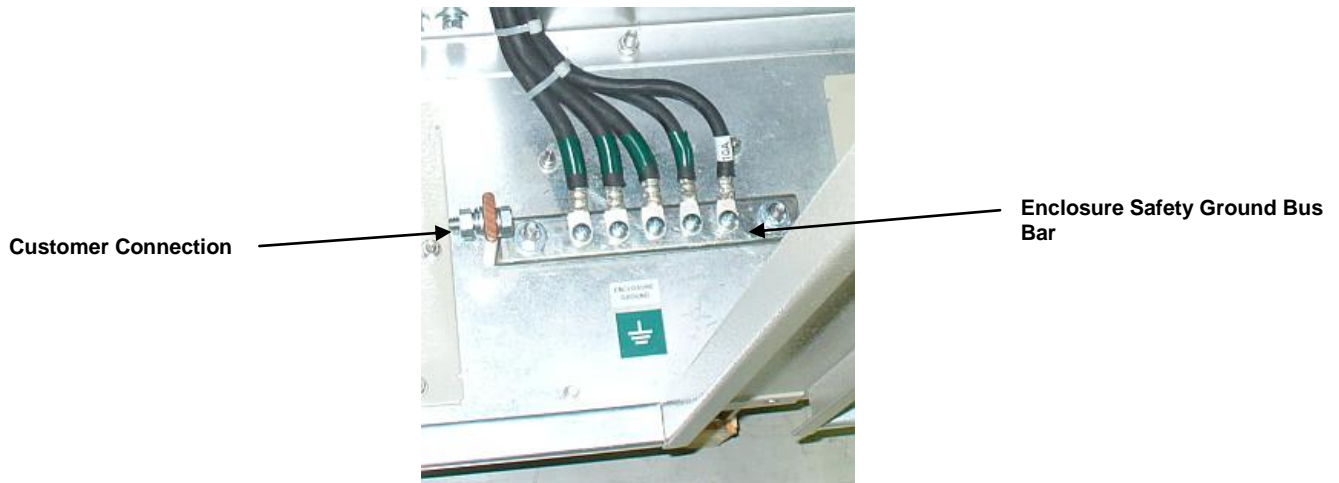


Figure 13 Enclosure Safety Ground (PVS-50 Model)

Connecting DC Ground

A DC ground bus bar is provided in the inverter (see Figure 14). This bus bar is used to connect ground cables from the frame of the solar photovoltaic array. This configuration complies with sections 690-41 and 690-42 of the NEC.



NOTE

All exposed non-current carrying metal parts of inverter are grounded in order to comply with section 690-43 of the NEC.

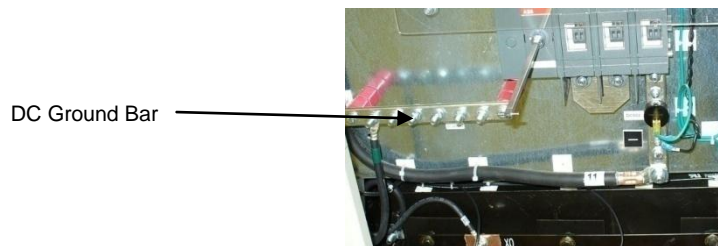


Figure 14 DC Ground (PVS-50 Model)

Connecting DC Ground Fault Detector/Interrupter

The PowerGate® PLUS Inverter may be equipped with one of the following:

- Standard fuse ground-fault detector/interrupter (GFDI configuration) or;
- Optional electronic ground-fault detector/interrupter (EGFDI configuration).

Standard GFDI Configuration

With the standard GFDI option, ground-fault protection is provided by fuse FUGFDI.

Optional EGFDI Configuration

The optional EGFDI (Electronic Ground Fault Detector Interrupter) is a solid-state electronic ground fault detector and interrupter designed to provide DC fault protection of the solar photovoltaic array when the array's positive or negative pole has to be grounded.

The GFDI is designed to fulfill the requirements of Section 31 of UL1741 *"Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources"*.

Refer to *"Electronic Ground Fault Detector Interrupter Operation"* in *"Chapter 3 Operations Information"* for a description of how this option operates.



WARNING

In the past, installers of PV systems adopted the practice of grounding the grounded-pole of the solar array as soon as it was connected to the ground terminal. You must not do this with the EGFDI unit (because of the different electrical characteristics for this type of device). Instead, treat all array conductors as live conductors unless other temporary grounding means have been provided during installation. Refer to *"Electronic Ground Fault Detector Interrupter Operation"* in *"Chapter 3 Operations Information"* for a description of how the unit works.



CAUTION

With inverters equipped with EGFDI devices, the negative or positive input is grounded only after the logic power is available to the inverter (main output breaker, named CB1), is closed and the grid is present at the output of the inverter. **WHEN THE INVERTER IS DISCONNECTED FROM THE GRID, THE GROUND PATH IS OPEN AND THE SOLAR PHOTOVOLTAIC ARRAY IS FLOATING FROM GROUND.**



CAUTION

The EGFDI is set and adjusted in the factory to the specified current and time delay set points according to the UL1741 requirements for each power rating. No extra adjustment is needed in the field. The user is not permitted to change any of the EGFDI settings.

Connecting AC Ground

A bus bar (Figure 15) is provided on the GDFI fuse panel of the inverter. This bus bar provides a ground connection to the grid ground conductor.

The PowerGate® PLUS inverter uses a high impedance grounded neutral system in which the grounding impedance resistor (RNG) limits the ground fault current to a low value. This meets NEC 250.36 standards, as long as the following conditions are met:

1. In times of maintenance and supervision, only qualified persons are allowed to service the installation.
2. Power must be continuous.
3. Ground detectors are installed on the system.
4. There are no line–neutral loads.

The installer must be sure that conditions 1, 2 and 4 are met.

Also, note the following (refer to the single line diagram in the appendix):

- The neutral from the output isolation transformer (TRO) is grounded through the high impedance resistor RNG;
- Current transformer CTN senses the neutral sensing current;
- The minimum ground connection cable is given in Table 3 (PVS-50 model).

NOTE



Be sure to run the correct ground conductor (refer to Table 3 for details) that connects the neutral of the main utility-side grid transformer to the AC ground bus bar in the inverter. This is the reference point for voltage sensing in the transformer.

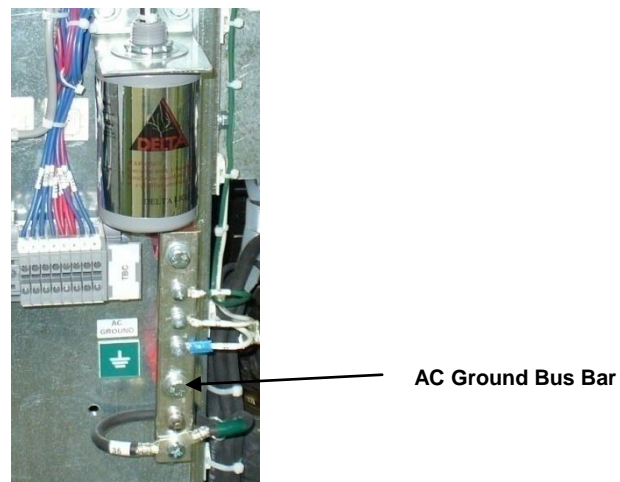


Figure 15 AC Ground (PVS-50 Model)

Connecting DC Input Power

The input power requirement is based on maximum values (maximum voltage 600VDC at maximum rated current) from the solar photovoltaic array panels. The input set of cables from the solar photovoltaic array panels must be rated for maximum rated DC current.

Two bus bars provided in the DC input section of the inverter for positive and negative connections from the PV array (see Figure 16 or Figure 17). For cable sizes and connections, refer to Table 3 (PVS-50).



CAUTION

The lugs should be installed as per lug manufacturer's specifications and recommended instructions.



WARNING

Make sure the +DC and -DC polarities are followed correctly while hooking up the DC input cables from the solar photovoltaic array panels to the inverter.

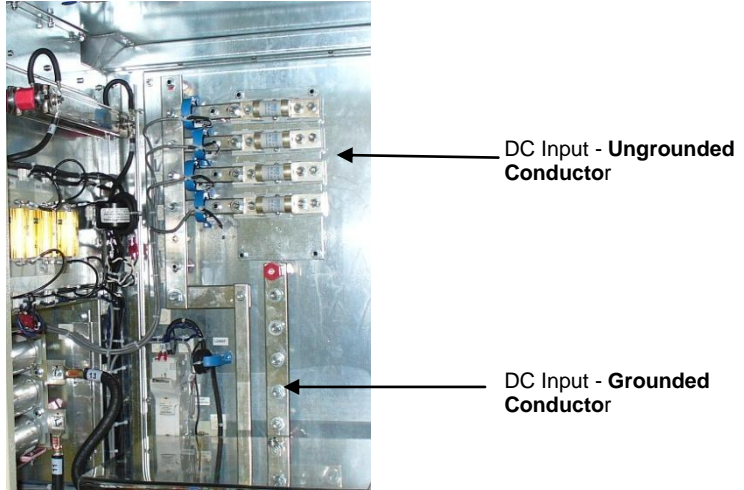


DC Input - **Ungrounded
Conductor**

DC Input - **Grounded
Conductor**

Note: Protective cover removed in illustration

Figure 16 DC Input Connections PVS-50 Model (No Combiner Option)



Note: Protective cover removed in illustration

Figure 17 DC Input Connections PVS-50 Model (Combiner Option)

Connecting AC Output Power



Figure 18 shows the AC output power connections.

The AC output power cables A, B, C are customer-supplied and must be rated to handle continuous rated AC current at rated frequency. When connecting the cables, be sure that the sequencing is correct.

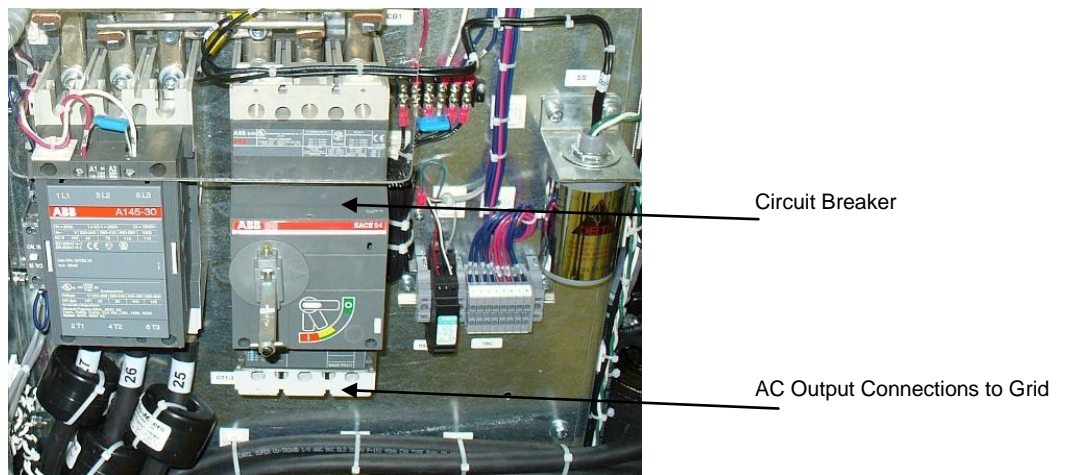


Figure 18 AC Output Connections (PVS-50 Model)

Step 7- Installing Communication and Control Wiring

Types of Communication and Control Wiring

All PowerGate® PLUS inverter may have the following optional communication and control requirements:

- PV View® PLUS remote monitoring option;
- RS485SS communication link
- Customer inverter control wiring

All control and communication wiring is done inside the enclosure (see Figure 19).

If the inverter includes the remote monitoring option, you must install the control wiring and remote RS485 serial communications link before starting the inverter.

NOTE



The wiring may be done from either the right side or front. However, it is easier do the wiring from the front (remove the front access panel of the control wiring enclosure first).

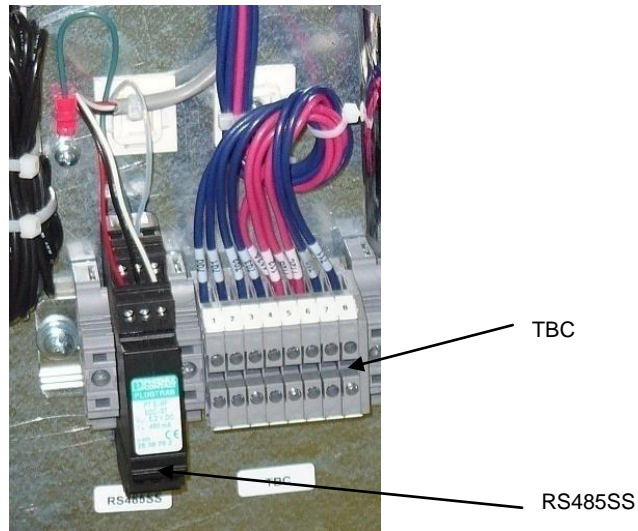
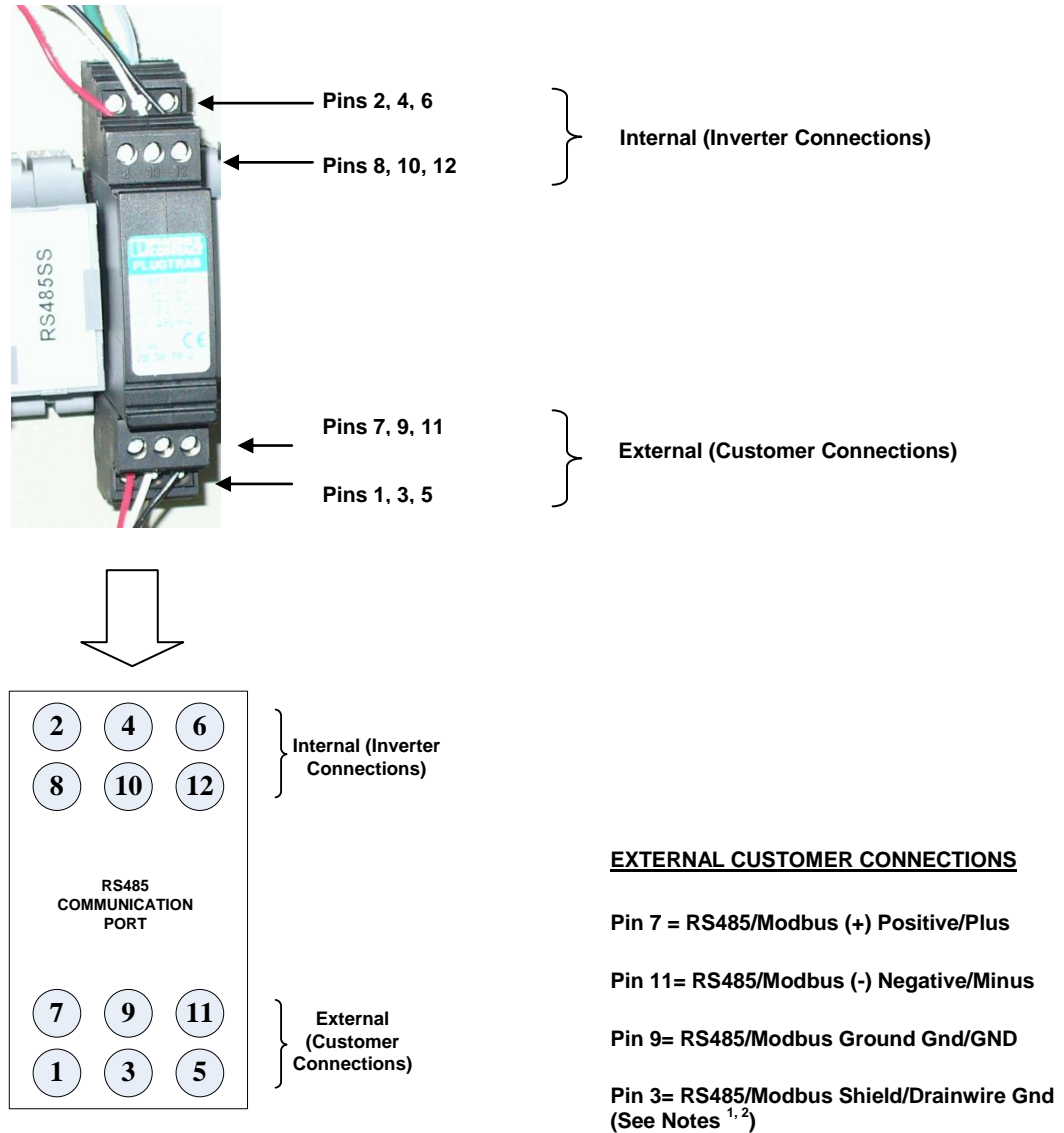


Figure 19 Control and Communication Wiring Location (PVS-50 Model)

Wiring Remote Communications Link (RS485SS)

The remote communications are made at terminal marked RS485SS (RS485 Surge Suppressor). Refer to Figure 20.



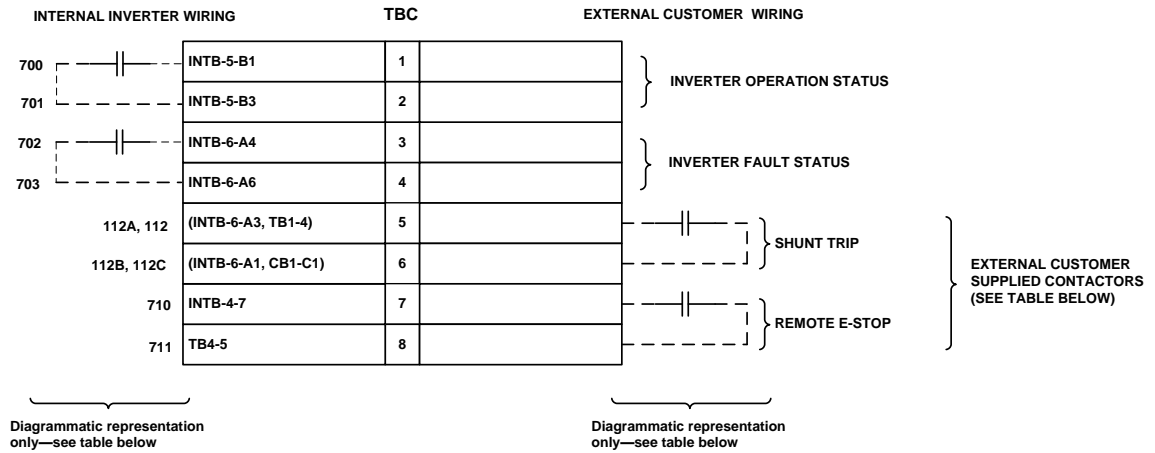
¹ Only connect the drain wire of the shielded cable at one end. Do not ground the drain wire at both ends of a cable run or connection hookup.

² Use RS485-type shielded cable only (e.g. Belden 9842, shielded 2-twisted pair jacketed cable with drain wire, 24AWG 7x32 conductor type, 120 ohm).

Figure 20 RS485SS Wiring Information

Wiring Remote Inverter Control

The remote inverter control connections are made at TBC. Refer to Figure 21.



TBC TERMINALS	CONTACTOR/COIL DESCRIPTION (INTERNAL)	EXPLANATION (CUSTOMER SIDE OF TBC)
TBC 1-2	To dry contactor (relay located inside inverter)	Remote sensing. Customer may use these terminals to determine operating status of inverter. Relay contact is closed when the inverter unit is running (short circuit at TBC 1-2). Open circuit indicates inverter not running.
TBC 3-4	To dry contactor (relay located inside inverter)	Remote sensing. Customer may use these terminals to determine fault status of inverter. Relay contact is closed when a fault occurs (short circuit at TBC 3-4). Open circuit indicates no faults.
TBC 5-6	To relay coil (rated at 24VDC, 10mA) inside inverter.	Remote control; requires customer-supplied dry contactor to energize internal relay coil. Customer may use these terminals to apply remote shunt trip by closing contact. (Note: external shunt trip signal will open circuit breaker CB1 in inverter to disconnect inverter power to grid.)
TBC 7-8	To relay coil (rated at 24VDC, 10mA) inside inverter.	Remote control; requires customer-supplied dry contactor to energize internal relay coil. Customer may use these terminals to apply remote emergency stop (E-Stop) signal by closing contact. .

Figure 21 TBC Control Wiring Information

Step 8-Verify Installation

Mechanical Checks

Verify the following and take corrective action, if necessary:

1. Ensure that the AC disconnect switch (DS2) and DC disconnect switch (DS1) are open (handles turned the correct way).
2. Ensure all anchor bolts are properly tightened.
3. Unlock and open doors on the enclosure sections.
4. Verify all wire conduit fittings and connections are properly tightened.

Electrical Checks

Verify the following and take corrective action, if necessary:

1. Ensure that the AC circuit breaker AC disconnect switch (DS2) and DC disconnect switch (DS1) are open.
2. Ensure all communication and control wiring is properly tightened.
3. Ensure all DC input power conductors to inverter are properly polarized and tightened to the correct torque values. Refer to Table 3 (PVS-50) for torque values.
4. Ensure all AC output power conductors from inverter to external transformer are properly sequenced and tightened to the correct torque values. Refer to Table 3 (PVS-50) for torque values.

Step 9 – Verify Input and Output Power Requirements

Before connecting the input cables to the power supply service, verify the following:

- Check voltage and current ratings of the service.
- Be sure that the capacity of the service is adequate for the power requirements of the unit being connected to it.
- Make certain also that the service used as the source of input power is grounded.

Verify that the cables are rated for insulation as follows:

- 600VAC or higher on the AC side;
- 1000VDC on the DC side;
- 300V for control connections.

Be sure to:

- Check all connections and ensure they are tight;
- Always connect the grounding lead to the grounded switch box or building ground;
- Ensure that the current capacity of the grounding lead will be adequate for the worst fault current situation.

After verifying the input and output power requirements, connect the input cables to the power supply service.



CAUTION

Ensure all the barriers and guards are put in place after the field connections are made.

Step 11-Commission Unit

Perform the commissioning procedures only after all installation have been done and verified. Refer to “*Chapter 5 Commissioning Procedures*” for instructions for commissioning the inverter.

THIS PAGE INTENTIONALLY LEFT BLANK

Chapter 3 Operations Information

About this Chapter

This chapter describes the PowerGate® Plus inverter operations. Topics include:

- Overview of operations
- Operating states
- Maximum Power Point Tracking control
- Local and remote control
- AC output reactive control
- Fan control
- Electronic ground fault detector interrupter operation
- Keypad and Display
- Navigating through the menus
- Menu descriptions
- Field adjustment set points
- PVS fault and warning messages
- Shutdown procedures

Overview of Operations

The inverter follows the line frequency and the voltage set by the utility while delivering power to load. It is designed for rated power and it meets or exceeds the requirements of IEEE 1547 for voltage and current power quality.

The inverter operates as an AC current-controlled voltage source inverter; meaning that it is synchronized with the phase of the line voltage automatically through a current-controlling reference signal that is synchronized with the line. This technique allows the inverter to control its power factor, real power, and reactive power.

The inverter adjusts its reactive power to the line reactive power (measured in kVAR) or reactive current demand signal. Real and reactive power accuracy is controlled to within +/-2% of the rated demand.

If the voltage or frequency (or both) of the line strays from its specified range, the PowerGate® Inverter stops and disconnects itself from the line and the PV arrays. This voltage and frequency output protection is provided by the inverter digital control board (DPCB) and has been tested by CSA to all applicable requirements in UL1741 and IEEE 1547.

Operating States

The PowerGate® Plus inverter has four operating states, shown in Table 4.

Table 4 Inverter Operating States

OPERATING STATE	DESCRIPTION
Standby	Unit is stopped, contactors are open, no fault.
Sync	Unit synchronizes to the grid..
Run	Unit is running. During this state the inverter generates real power to the grid by tracking the maximum power point of the PV or follows AC active current settings that are set from the HMI . Meanwhile, the inverter also controls AC reactive power by reactive power setting that is set from either the HMI or the remote communication.
Fault	A critical fault has occurred. The unit will shutdown and can only be reset manually.

Inverter Control

Inverter Run Enabled or Disabled

The Run Enable/Disable function permits users to start or stop the inverter either locally (from the HMI) or remotely (by sending a disable command through the communication link). This function starts up or shuts down the inverter in a controlled manner (rather than the immediate shutdown action of the ON/OFF switch).

The Run Enable/Disable command appears on the Operation menu, under the Control submenus (refer to **XXXXX**). The settings are:

- Run Enable = 1 (enable, default)
- Run Disabled = 0 (disabled)

When disabled, the inverter turns off (opens its input and output contactors). To start the inverter again, the Run Enable/Disable parameter must be in an enabled state (set to 1). This can be done either from the HMI or by a remote signal.

Inverter Startup Conditions

When all of the following conditions are satisfied, the PowerGate® Inverter will start automatically:

- The inverter is in “standby” state (i.e. no fault).
- The inverter is enabled.
- The grid is operating correctly, which indicates that the voltage and frequency of the grid is within specification for more than 5 minutes (adjustable parameter).
- The DC input voltage has been higher than 300V (adjustable parameter) for more than 30 minutes (adjustable parameter).

Refer to Figure 22 for the state diagram that shows the key sequences for automatic startup.

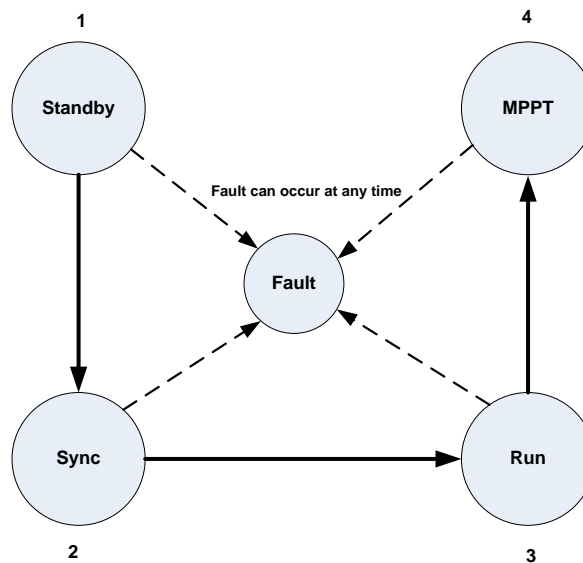


Figure 22 Automatic Startup State Diagram

Inverter Stop Conditions

When the inverter is in a “run” state, any one of the following events will cause it to go into a “stop” state:

- When the inverter receives a “disable” command (either from the HMI or from the remote communication link);
- When the inverter detects a voltage or frequency line fault;
- When the AC output power or DC input current has been zero for more than 10 minutes (this default time period can be changed from the HMI).

Refer to Figure 23 for the state diagram that shows the key sequences for inverter shutdown.

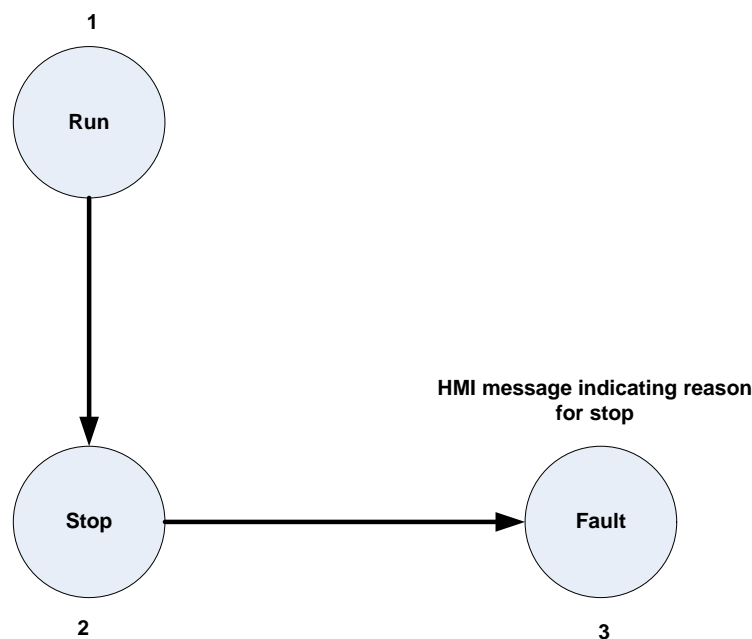


Figure 23 State Diagram for Inverter Shutdown

Inverter Fault Shutdown

Any fault will cause the inverter to shutdown, resulting in a “Fault” state. Note that some of the faults are latched and must be reset from the HMI or via the remote communication link. The following describes the sequence of events during fault shutdown:

1. Inverter gating will be stopped.
2. Contactors CRDC and CRAC open to isolate the inverter from the PV and grid.
3. Inverter is in “Fault” state.
4. The inverter faults are displayed at the HMI

Inverter ON/OFF Control

The PowerGate® Inverter can be turned ON or OFF by any of the following means:

- The ON/OFF switch on the door of the inverter
- By a remote communication command signal
- By a hardwired command signal
- By local HMI command

When the inverter is turned off, the following happens:

1. Inverter gating will be stopped.
2. Contactor CRAC opens to isolate the inverter from the grid.
3. Inverter is in “Fault” state.

Inverter Reset

When the PowerGate® Plus Inverter is in “Fault” state, it needs to be reset. You can reset the inverter from the HMI (local reset) or from the remote communication command (remote reset).

The auto-reset function will attempt to reset faults up to five times (adjustable) at one minute intervals (adjustable). After five failed attempts, the auto-reset function will lock out for one hour (adjustable) before repeating the sequence.

NOTE



The default setting for the auto-reset function is ON (AUTO-RESET = ON).

Maximum Power Point Tracking

The normal operating mode of the system is “maximum power point tracking” (MPPT), which is intended to maximize the PV output power

This operating mode operates by controlling the DC link voltage (the same as input DC voltage) in small steps (the minimum and maximum size of these steps are adjustable) every 0.5 seconds. The DC input power is measured and averaged during that interval. When the measured average DC input power increases, the DC link voltage will continually be changed by double step in the same direction. When the DC input power decreases, the DC link voltage will be changed in the other direction.

NOTE



For testing purposes, MPPT function can be turned ON or OFF from the HMI by changing the power control mode. If the MPPT function is OFF, the DC set voltage and AC output active current can be set manually from the HMI.

The unit can have three power control modes:

- 0 – constant current
- 1 – constant power
- 2 – MPPT. This is the normal operating mode. In this mode, the maximum power is limited by the “real-power-command” parameter (default value 100%).

Local and Remote Control

You can control the PowerGate® Plus inverter either locally or remotely. Table 5 is a summary of the actions that can be done.

Table 5 Local and Remote Control Functions

CONTROL ACTIONS	LOCAL	REMOTE	REMARKS
Enable or disable inverter	√	√	The inverter sets this parameter to the last saved parameter. This parameter can be 1 (Enable Run) or 0 (Disable Run). You may change this value either locally or remotely.
Shutdown inverter (emergency stop)	√	√	None
Reset inverter faults	√	√	None
Control maximum AC power output	√	√	None

Local control is done using the keypad and display unit (HMI). Refer to Figure 32 (to reset inverter faults) and Figure 33 (to enable/disable, shutdown, and control the power output of the inverter).

Remote control is done using a PC (sending Modbus commands to the inverter through the 485 communication link). Remote commands are sent using the Remote Command. Refer to Satcon publications *“PowerGate Inverter Solutions, Communication Interface Reference Guide, Modbus RTU Communications”* or *“PowerGate Inverter Solutions, Communication Interface Reference Guide, TCP/IP Communications”* for detailed information.

Modbus Communication

Modbus is a serial, asynchronous protocol. The Modbus protocol does not specify the physical interface. The PowerGate® Plus inverter uses an RS-485 interface and may use either Modbus RTU or Modbus TCP protocol

Modbus allows components of an installation (i.e. inverters, weather systems, etc.) to communicate including one or more “master” systems. Refer to Satcon publications “PowerGate Inverter Solutions, Communication Interface Reference Guide, Modbus RTU Communications” or “PowerGate Inverter Solutions, Communication Interface Reference Guide, TCP/IP Communications” for detailed information.

Modbus Data Communication Default Settings

Satcon PowerGate® Plus inverters are supplied with the following default communication settings:

- Baud Rate = 9600
- Word Length = 8
- Parity = None
- Stop bits = 1
- Slave ID is 1

The default settings can be changed using the inverter key pad and display (HMI).

Modbus Function Codes

The PowerGate® Plus inverter supports the following two function codes:

- Function code 04 (Read Input Registers)
- Function code 16 (Preset Multiple Registers)

Function Code 04

Function code 04 is used to request (“read”) the contents of the PowerGate® Plus inverter registers from 30001 to 30513. Refer to Table 6 through Table 16 for detailed information about the inverter parameters that you can read.

Function Code 16

Use function code 16 is used to “write” to the inverter. The PowerGate® Plus inverter supports the following two “write” commands:

- Remote command
- Modbus access code

The remote command can be used to do the following:

- Start or stop the inverter
- Control the power

The Modbus access code is password controlled.

Refer to Table 17 for detailed information about these parameters.

Inverter Modbus Parameters

Table 6 through Table 17 provide detailed information about the inverter Modbus parameters. Note that Table 6 through Table 16 are read-only parameters (you can read the contents of these register numbers). Table 17 shows the write parameters for this inverter.

Understanding Inverter Modbus Data Tables

The following information explains how to interpret the Modbus data tables.

Column 1: Register Number

This is the Modbus register number assigned to a parameter.

Column 2: Description

This column provides a brief one-line description of the parameter.

Column 3: PCS Op Name

This column specifies an internal programming name. It is provided only for reference.

Column 4: Access Level

This column specifies the access level of the parameter.

The PowerGate® Plus inverter has three access levels to prevent unauthorized modification of some or all of its parameters. The access levels are:

- Level 0 (open access)
- Level 1 (password protected)
- Level 2 (password protected)

Column 5: Resolution

This column explains what value will be displayed on the HMI. The following resolutions are used:

RESOLUTION	MEANING
1	Integer
0.1	One-tenth
0.01	One-hundredth

Units

This column specifies the parameter unit (V, A, %, etc).

Table 6 Modbus Registers for Fault Parameters

REGISTER NUMBER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
30010	Software number	sw_number	0	0.01	
30011	Fault word 0	faults_0	0		
30012	Fault word 1	faults_1	0		
30018	Number of active faults	number_faults	0		
30019	Program checksum read	prgm_chksum_read	0		
30020	Parameter checksum read	param_chksum_read	0		

Table 7 Modbus Registers for Metering Parameters

REGISTER NUMBER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
30021	DC input voltage in volts (signed)	dc_input_volts	0	1	V
30022	DC link voltage in volts (signed)	dc_link_volts	0	1	V
30023	DC link current in amps (signed)	dc_link_amps	0	1	V
30024	DC ground current in amps (signed)	ground_current	0	0.1	A
30036	Average line current in amps	line_amps	0	1	A
30037	Line neutral current in amps	neutral_current	0	0.1	A
30041	Average line voltage in volts	line_volts	0	1	V
30042	Line voltage unbalance	v_unbalance	0	0.1	%
30044	Input power (signed)	input_kw	0	0.1	kw
30045	Output real power (signed)	output_kw	0	0.1	kw
30046	Output reactive power (signed)	output_kvar	0	0.1	kvar
30047	Output apparent power	output_kva	0	0.1	kva
30048	Output power factor (signed)	output_pf	0	0.01	
30050	Ground impedance	gnd_impedance	0	1	kohm

Table 8 Modbus Registers for String Current Parameters

REGISTER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
30051	String current 1 in amps	string_amps_1	0	0.1	A
30052	String current 2 in amps	string_amps_2	0	0.1	A
30053	String current 3 in amps	string_amps_3	0	0.1	A
30054	String current 4 in amps	string_amps_4	0	0.1	A
30055	String current 5 in amps	string_amps_5	0	0.1	A
30056	String current 6 in amps	string_amps_6	0	0.1	A
30057	String current 7 in amps	string_amps_7	0	0.1	A
30058	String current 8 in amps	string_amps_8	0	0.1	A
30059	String current 9 in amps	string_amps_9	0	0.1	A
30060	String current 10 in amps	string_amps_10	0	0.1	A
30061	String current 11 in amps	string_amps_11	0	0.1	A
30062	String current 12 in amps	string_amps_12	0	0.1	A
30063	String current 13 in amps	string_amps_13	0	0.1	A
30064	String current 14 in amps	string_amps_14	0	0.1	A
30065	String current 15 in amps	string_amps_15	0	0.1	A
30066	String current 16 in amps	string_amps_16	0	0.1	A
30067	String current 17 in amps	string_amps_17	0	0.1	A
30068	String current 18 in amps	string_amps_18	0	0.1	A
30069	String current 19 in amps	string_amps_19	0	0.1	A
30070	String current 20 in amps	string_amps_20	0	0.1	A
30071	String current 21 in amps	string_amps_21	0	0.1	A
30072	String current 22 in amps	string_amps_22	0	0.1	A
30073	String current 23 in amps	string_amps_23	0	0.1	A
30074	String current 24 in amps	string_amps_24	0	0.1	A
30075	String current 25 in amps	string_amps_25	0	0.1	A
30076	String current 26 in amps	string_amps_26	0	0.1	A
30077	String current 27 in amps	string_amps_27	0	0.1	A
30078	String current 28 in amps	string_amps_28	0	0.1	A
30079	String current 29 in amps	string_amps_29	0	0.1	A
30080	String current 30 in amps	string_amps_30	0	0.1	A
30081	String current 31 in amps	string_amps_31	0	0.1	A
30082	String current 32 in amps	string_amps_32	0	0.1	A
30090	Average string current in amps	string_amps_avg	0	0.1	A

Table 9 Modbus Registers for String kW Hour Parameters

REGISTER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
30091	Kilowatt hours for string 1	string_kwh_1	0	1	kwh
30092	Kilowatt hours for string 2	string_kwh_2	0	1	kwh
30093	Kilowatt hours for string 3	string_kwh_3	0	1	kwh
30094	Kilowatt hours for string 4	string_kwh_4	0	1	kwh
30095	Kilowatt hours for string 5	string_kwh_5	0	1	kwh
30096	Kilowatt hours for string 6	string_kwh_6	0	1	kwh
30097	Kilowatt hours for string 7	string_kwh_7	0	1	kwh
30098	Kilowatt hours for string 8	string_kwh_8	0	1	kwh
30099	Kilowatt hours for string 9	string_kwh_9	0	1	kwh
30100	Kilowatt hours for string 10	string_kwh_10	0	1	kwh
30101	Kilowatt hours for string 11	string_kwh_11	0	1	kwh
30102	Kilowatt hours for string 12	string_kwh_12	0	1	kwh
30103	Kilowatt hours for string 13	string_kwh_13	0	1	kwh
30104	Kilowatt hours for string 14	string_kwh_14	0	1	kwh
30105	Kilowatt hours for string 15	string_kwh_15	0	1	kwh
30106	Kilowatt hours for string 16	string_kwh_16	0	1	kwh
30107	Kilowatt hours for string 17	string_kwh_17	0	1	kwh
30108	Kilowatt hours for string 18	string_kwh_18	0	1	kwh
30109	Kilowatt hours for string 19	string_kwh_19	0	1	kwh
30110	Kilowatt hours for string 20	string_kwh_20	0	1	kwh
30111	Kilowatt hours for string 21	string_kwh_21	0	1	kwh
30112	Kilowatt hours for string 22	string_kwh_22	0	1	kwh
30113	Kilowatt hours for string 23	string_kwh_23	0	1	kwh
30114	Kilowatt hours for string 24	string_kwh_24	0	1	kwh
30115	Kilowatt hours for string 25	string_kwh_25	0	1	kwh
30116	Kilowatt hours for string 26	string_kwh_26	0	1	kwh
30117	Kilowatt hours for string 27	string_kwh_27	0	1	kwh
30118	Kilowatt hours for string 28	string_kwh_28	0	1	kwh
30119	Kilowatt hours for string 29	string_kwh_29	0	1	kwh
30120	Kilowatt hours for string 30	string_kwh_30	0	1	kwh
30121	Kilowatt hours for string 31	string_kwh_31	0	1	kwh
30122	Kilowatt hours for string 32	string_kwh_32	0	1	kwh
30130	Average kilowatt hours for all strings	string_kwh_avg	0	1	kwh

Table 10 Modbus Registers for Energy Parameters

REGISTER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
30131	Not Used				
30132	Total kilowatt hours	kwh_total	0	1	kwh
30133	Total megawatt hours	mwh_total	0	1	mwh
30134	kwh Today	kwh_today	0	1	kwh
31135	kwh Yesterday	kwh_yesterday	0	1	kwh
30136	Total kwh 7 days	kwh_7days	0	1	kwh
30137	Total kwh 30 days	kwh_30days	0	1	kwh
30138	Average kwh 7 days	kwh_avg_7days	0	1	kwh
30139	Average kwh 30 days	kwh_avg_30days	0	1	kwh

Table 11 Modbus Registers for Line Feedback Parameters

REGISTER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
30176	Average line frequency	line_freq_avg	0	0.01	Hz
30177	Average line frequency error (signed)	line_freq_err_avg	0	0.01	Hz

Table 12 Modbus Registers for Fault Queue Parameters

REGISTER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
30266	FPGA version	fpga_version	0	0.01	

Table 13 Modbus Registers for Input/Output Parameters

REGISTER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
30276	Vdc in timer	vdc_in_timer	0	0.1	min
30277	Line voltage timer	v_line_timer	0	1	sec
30280	Operating state	operating_state	0		

Table 14 Modbus Registers for Temperature Feedback Parameters

REGISTER NUMBER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
30281	Internal air temperature	internal_air_temp	0	1	°C

Table 15 Modbus Registers for Serial Number Parameters

REGISTER NUMBER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
30302	Serial number word 0	serial_number_0	0	1	
30303	Serial number word 1	serial_number_1	0	1	
30304	Serial number word 2	serial_number_2	0	1	
30305	Serial number word 3	serial_number_3	0	1	

Table 16 Modbus Registers for Components Parameters

REGISTER NUMBER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
30328	Number of strings	number_strings	0	1	

Table 17 Modbus Registers for Writeable Parameters

REGISTER NUMBER	DESCRIPTION	PCS OP NAME	ACCESS LEVEL	RESOLUTION	UNITS
40437	Remote command	remote_command	0		
40476	Modbus access code	modbus_access_code	0	1	

AC Output Reactive Power Control

The AC output reactive power (kVAR) and reactive current from the inverter can be controlled only locally (from the HMI). This power and current control can only be done as long as the inverter is in its enabled state. Refer to “*Inverter Run Enabled or Disabled*”.

The inverter output reactive power is limited to 60% of its rated kVA power regardless of the HMI setting. See Figure 24.

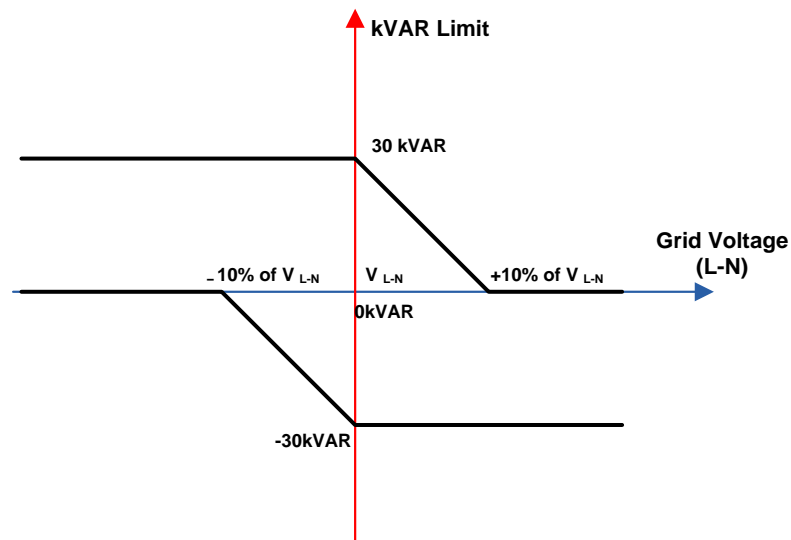


Figure 24 AC Output Reactive Power Control, PVS-50 Model

Fan Control

All semiconductor components and components not associated with the inverter magnetics (for example, contactors) are cooled using filtered forced air cooling. The fan that provides this cooling is mounted inside the inverter enclosure.

This fan is a variable speed fan that is in a normally off state. Sensing and logic circuitry automatically control the fan to keep the heat sink temperature below 60 degrees centigrade.

Electronic Ground Fault Detector Interrupter Operation

The EGFDI (electronic ground fault detector interrupter) is a solid-state electronic ground fault detector and interrupter designed to provide DC fault protection on power conversion systems for alternative energy application where the array's positive or negative pole has to be grounded. The EGFDI is designed to fulfill the requirements of Section 31 of UL1741 "Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources".

After the inverter is powered up, the EGFDI circuits will perform a self-check and close the ground path by closing (CRGF) ground contactor. It will then consistently monitor the current flowing through the ground path and, if the current exceeds the current set point, it will open the ground path and stop the inverter from exporting power to the grid.

There are two dipswitches (J1 and J2) on the GFDI.

J1 is designed to set for currents from 0.5A to 6A. According to UL1741 and power rating of our product line we will need 2A, 3A, 4A and 5A.

Figure 25 shows the UL1741 table (Table 31.1) that specifies the maximum ground-fault current detection settings.



WARNING

The ground current detection settings and time delay settings described below are not normally field adjusted. This information is provided for troubleshooting purposes only.

Table 31.1
Maximum allowable ground current detection settings

Added Table 31.1 effective May 7, 2007

Device dc rating (kW)	Maximum ground-fault current detecting setting (Amperes)
0 – 25	1
25 – 50	2
50 – 100	3
100 – 250	4
> 250	5

Figure 25 UL1741 Table for Maximum Ground Currents

J1 settings are as follows:

J1-1	J1-2	J1-3	CURRENT SET POINT [A]
Open	Close	Close	0.5
Close	Open	Close	1.0
Open	Open	Close	2.0
Close	Close	Open	3.0
Open	Close	Open	4.0
Close	Open	Open	5.0
Open	Open	Open	6.0

The EGFDI board will continuously monitor the current level and deactivates outputs PB1 and PB2 in case this current exceeds the values mentioned above.

The two outputs will deactivate coils of two relays that had been kept activated since the startup of the system.

The delay for opening the ground path will be applied by the microcontroller according to table 54.1 (see Figure 26). In order to make the board more flexible there is the second dipswitch J2 that provides different delays.

**Table 54.1
Operating time**

Table 54.1 effective November 7, 2000

Ground-fault current, amperes	Time, seconds
115 percent of pickup	shall ultimately trip
150 percent of pickup	2.0
250 percent of pickup	1.0

Figure 26 UL1741 Time Delay for Opening Ground Path

J2-1	J2-2	J2-3	BASE TIME DELAY [S]
Open	Close	Close	0.25
Close	Open	Close	0.5
Open	Open	Close	0.75
Close	Close	Open	1.0
Open	Close	Open	1.5
Open	Close	Close	2.0
Open	Open	Open	3.0

All four contacts of Relay 9 and 10 are in series. The four contacts are used to:

- Close the ground fault interrupter contactor CRGF.
- Provide an indication of GFDI status to the main controller inside the inverter.
- Open output contactor to cease exporting power to the grid.
- Provide feedback to the GFDI controller about CRGF, RL9 and RL10 status

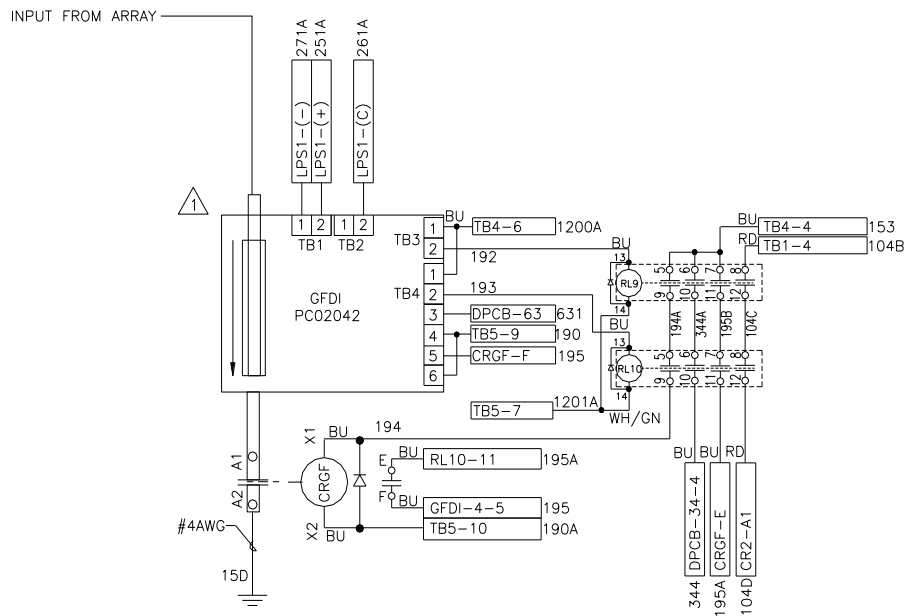


Figure 27 EGFDI Connections

There are two digital inputs to the EGFDI controller that are used as follows:

- Input 1: This input resets the EGFDI controller after a fault occurred and it was corrected.
- Input 2: This input ensures that the relays and the contactor are in normal operating state.

About the Keypad and Display

The keypad and display allows you to communicate with the PowerGate® Plus Inverter. You use it to do the following:

- Monitor specific information
- Setup or reset specific control and operating values
- View messages and fault conditions
- Reset faults after they are corrected

The operator interface includes a number of different menus. Specific menu sets are password-protected.

Keypad

The keypad is made up of the following touch-sensitive keys:

- Numeric keys (0 through 9)
- Decimal key (".")
- Shift key (SHIFT)
- Navigation keys ("MENU BACK", "PAGE UP", "PAGE DOWN")
- Data termination key ("ENTER")

HMI Display

The HMI display can display up to 20 characters on four lines. See Figure 28.



Figure 28 HMI Display

About the Menu Structure

The operator interface has three menu groups, each with a series of submenus. The Monitoring menu group and the Status and Faults menu group both are for viewing only (you cannot enter data). The Operation menu group allows you enter data, but this group is protected by a password. Refer to Figure 29 and Table 18.

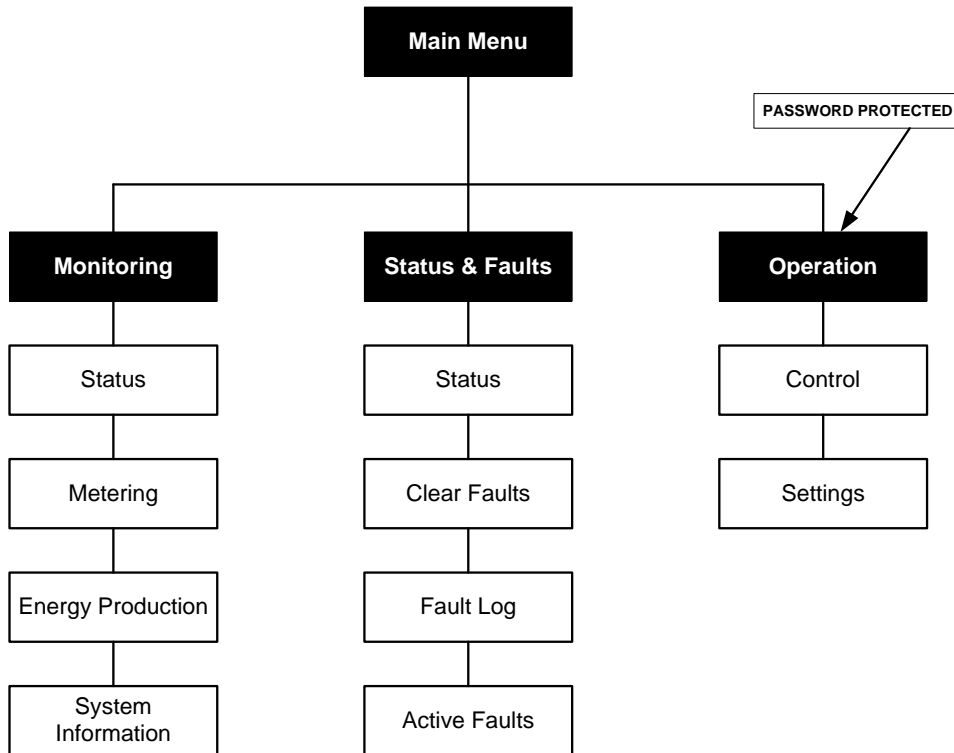


Figure 29 HMI Menu Hierarchy

Table 18 provides a brief summary of the menus.

Table 18 Menu Summary

MENU GROUP	DESCRIPTION
Main Menu	Used to navigate to the Monitoring, Status and Faults, and Operation menu groups.
Monitoring	Used to monitor the status of the inverter as well as a number of different characteristics (voltages, amperages, temperatures, and energy production). It is also used to find out the serial number of the inverter. All personnel can monitor these values.
Status and Faults	Used to view the current status of the inverter (output power and number of faults), as well as to clear faults and to view fault history and active faults. All personnel can view this information, as well as to reset faults.
Operation	Used to view and change specific parameters that affect the operation of the inverter. This menu group can be accessed by customer personnel, but is password protected.
Setup	This menu group (not described in this manual) is intended for use by Satcon service personnel or fully trained technicians. Changes cannot be made without the knowledge and approval of SatCon. This menu group requires special access privileges (additional password protection).

Using Keypad and Display

The following information explains how to use the key pad to navigate through the menus, enter data, view faults and clear faults. Refer also to Figure 30.

How to Move to Lower Level

- Use keys 1 through 4 on keypad to move to lower levels. Refer to Figure 30.

How to Move Up One Level

- Press MENU BACK on key pad. Refer to Figure 30.

How to Enter and Save Data (Operation Sub Menus Only)

If you change a parameter value, this value will not be written to non-volatile memory until you save the parameters. When the DPCB board is powered up or reset, all parameters are set to the last saved value. Use the following procedure to edit parameters and save their values.

1. On Main Menu, choose 3-Operation
2. Enter password when prompted.
3. Press ENTER (to terminate entry).
4. Press ENTER again (to activate cursor).
5. Use PAGE UP or PAGE DOWN keys to choose the item you want to edit.
6. Press ENTER again (to edit data).
7. Enter new data.
8. Press ENTER (to terminate entry).
9. If the value was successfully written the new value will be displayed and you will be returned to the previous menu.
10. Navigate to "Parameters" submenu ((2-Settings, 3-Parameters)
11. Press ENTER (to save parameter change)

How to Clear Faults

1. On Main Menu, choose 2-Status & Faults
2. On Status sub menu, choose 1 For Fault Display
3. On Fault Display Menu, choose 1-Clear Faults
4. Press ENTER

How to View Faults

1. On Main Menu, choose 2-Status & Faults
2. On Status sub menu, choose 2-Fault Log or 3-Active Faults
3. Press PAGE UP or PAGE DOWN on key pad to scroll through faults.

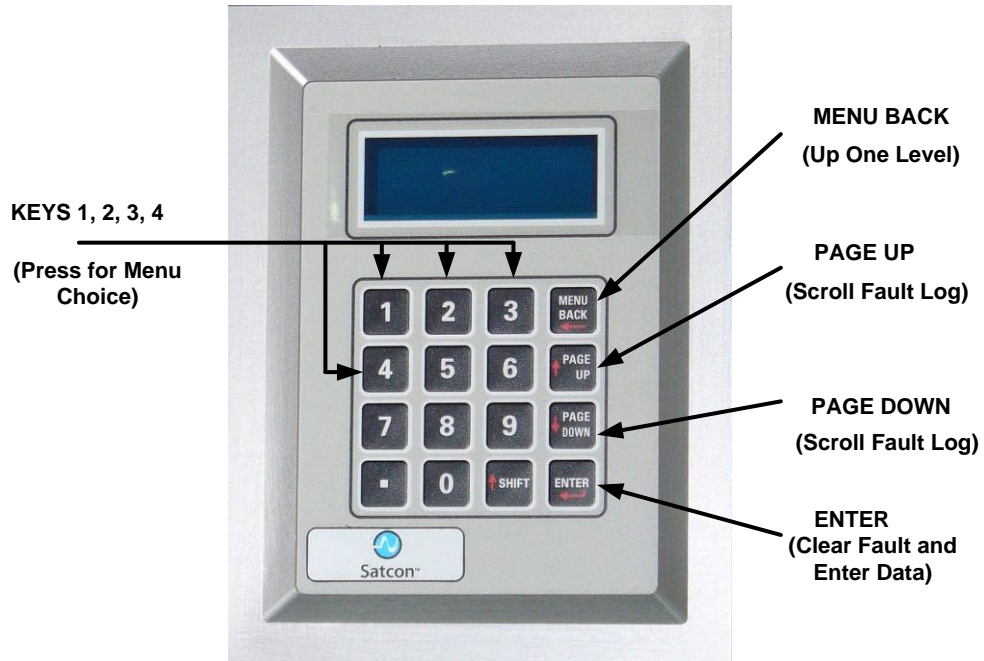


Figure 30 Using Keypad

Navigating Through the Menu Hierarchies

Refer to the following illustrations to navigate through the three primary menu hierarchies:

- Monitoring menus (Refer to Figure 31)
- Status and Faults menus (Refer to Figure 32)
- Operation menus (Refer to Figure 33)

NOTE



The Operation menus require a password.

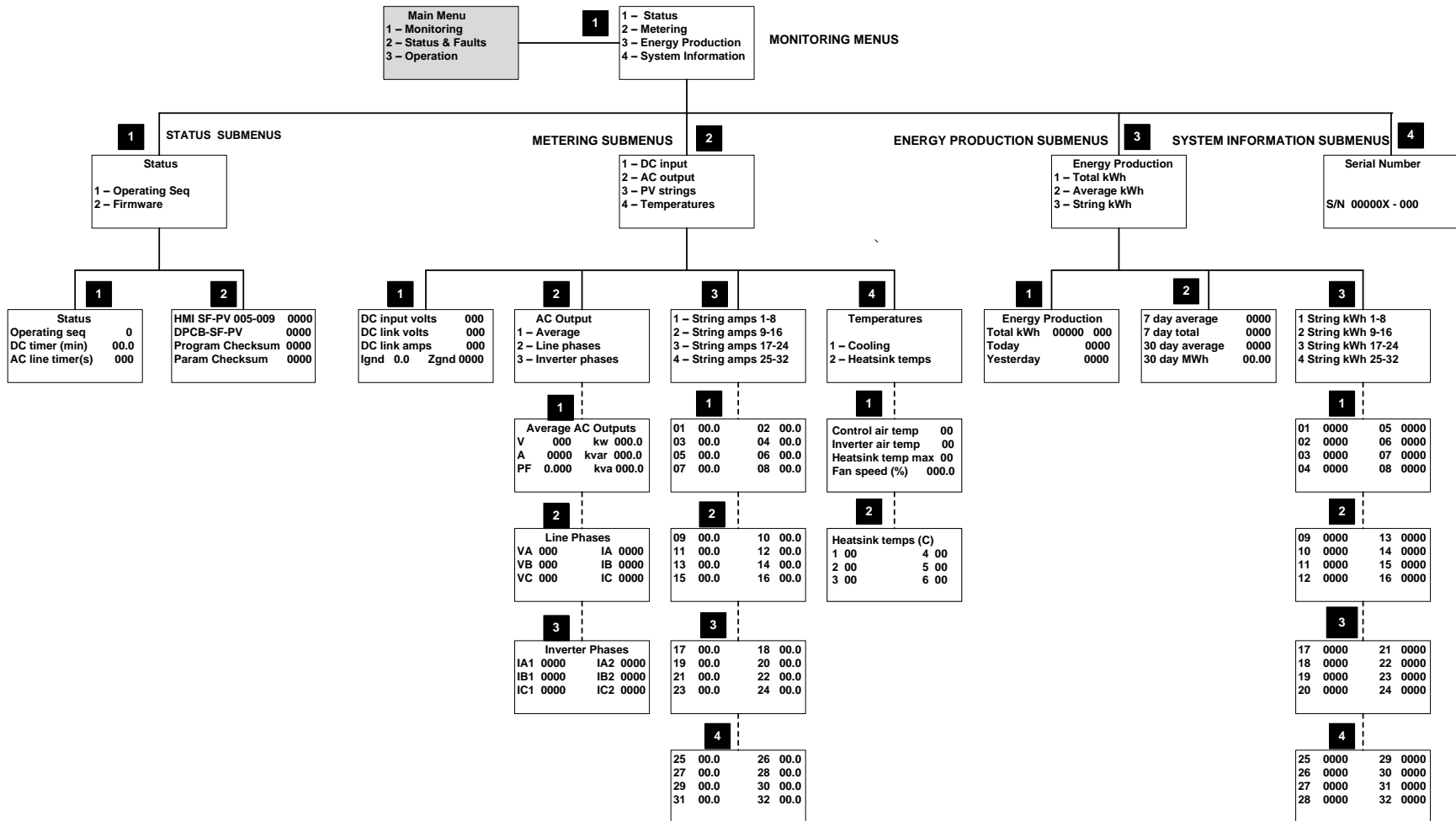


Figure 31 Monitoring Menu Hierarchy

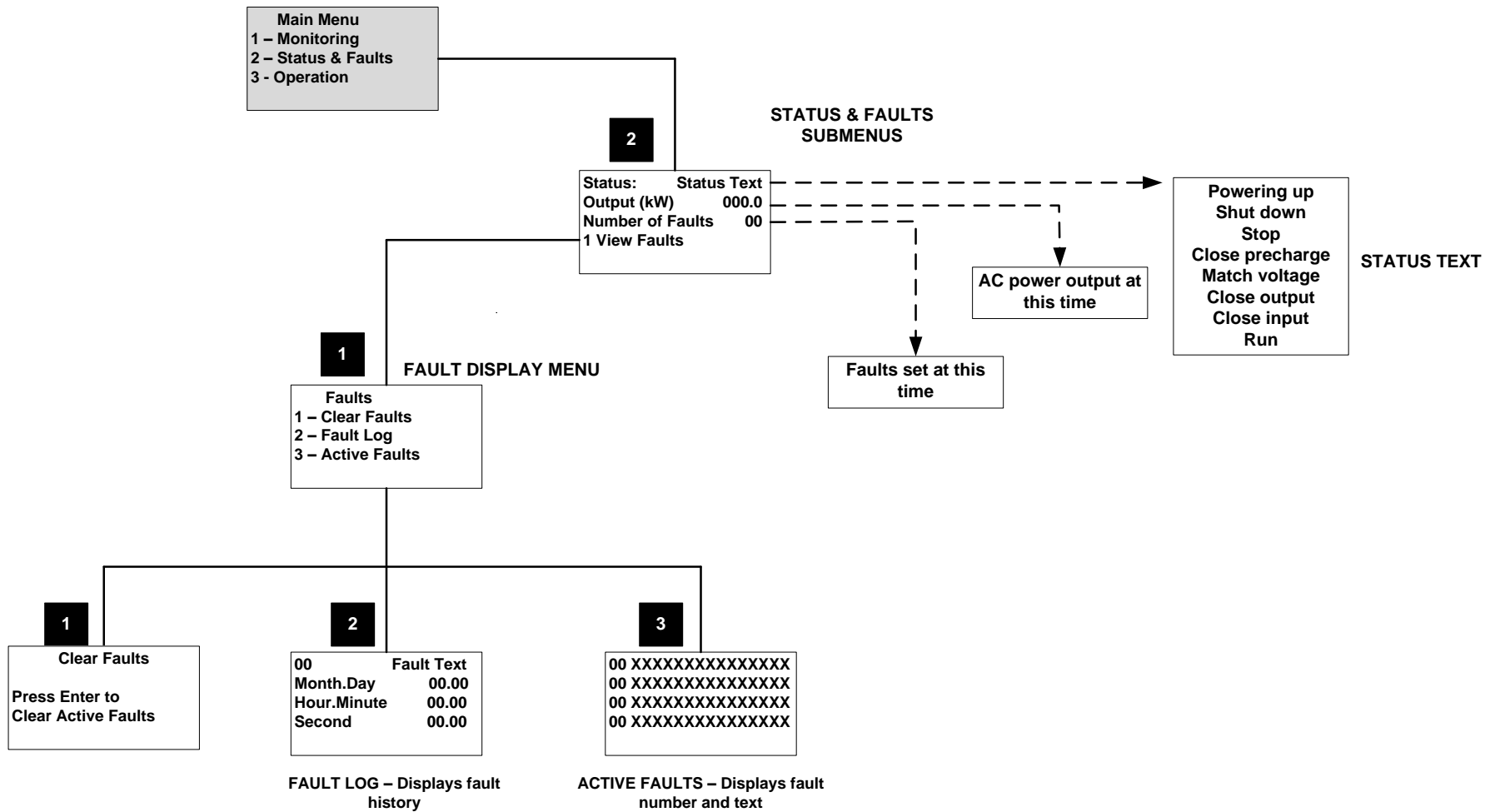


Figure 32 Status and Faults Menu Hierarchy

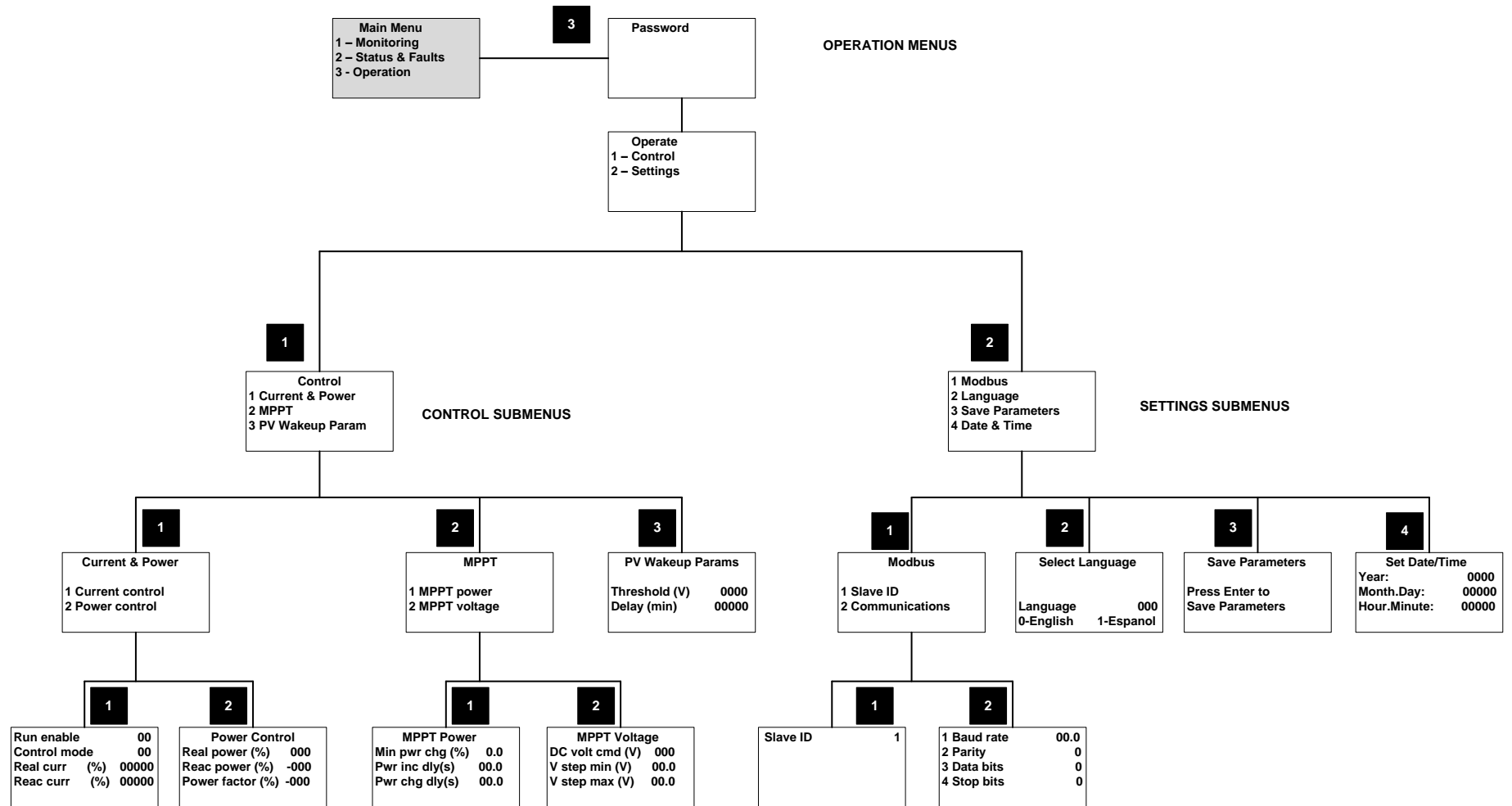


Figure 33 Operations Menu Hierarchy

Menu Descriptions

Monitoring Menu Descriptions

The Monitoring menu contains the following submenus (see also Figure 31, and Table 19 through Table 23):

- Status submenu
- Metering submenu
- Energy Production submenu
- System Information submenu

Status Submenu Descriptions

Table 19 Status Submenu Descriptions

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
Operating Seq	Displays one of eight operating sequence parameters (0-7) that is active at view time. The parameters and corresponding descriptions are as follows: <ol style="list-style-type: none"> 0. Powering up 1. Shut down 2. Stop 3. Close precharge 4. Match voltage 5. Close output 6. Close input 7. Run
DC Timer (min)	Time in minutes until dc input voltage is ready to run.
Line Timer (sec)	Time in seconds until ac line voltage is ready to run.

Firmware Sub Menu Descriptions

Table 20 Firmware Submenu Descriptions

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
SF-PV Number	Numerical part of DPCB firmware identification number (e.g. SF-PV004-001 shown as 4.01).
Program Checksum	Checksum of the program stored in flash memory. Changes only when flash is reprogrammed. Checked at power up to determine if the firmware has been corrupted.
Param Checksum	Checksum of the adjustable parameters saved in nonvolatile memory. Changes when any saved parameter is changed. Checked at power up to determine if the parameters have been corrupted.

Metering Sub Menu Descriptions

Refer to Figure 31 and Table 21.

Table 21 Metering Submenu Descriptions (1 of 2)

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
1-DC input	Displays the following DC values: <ul style="list-style-type: none"> • DC input volts • DC link volts • DC link amperes • Ground amperes.
2-AC Output	Displays submenus that contain the average, line phase, and inverter phase values: <p>1-Average:</p> <ul style="list-style-type: none"> • V-average line voltage • I-average line current • PF-line power factor • KW-total real output power • KVAR-total reactive output power • KVA-total apparent output power <p>2-Line Phases:</p> <ul style="list-style-type: none"> • VA-line voltage phase A • VB-line voltage phase B • VC-line voltage phase C • IA-line current phase A • IB-line current phase B • IC-line current phase C <p>3-Inverter Phases</p> <ul style="list-style-type: none"> • IA1-current in phase A of inverter 1 • IB1-current in phase B of inverter 1 • IC1-current in phase C of inverter 1 • IA2-current in phase A of inverter 2 • IB2-current in phase B of inverter 2 • IC2-current in phase C of inverter 2 • NOTE: IA2, IB2, and IC2 will be zero if the second inverter is not present.
3-PV-Strings	Average dc current of up to 32 PV strings. Since all 32 are measured regardless of the number of strings actually connected, the unconnected inputs may show a small current due to dc offset error in the feedback circuit. <ul style="list-style-type: none"> • 1-String Amps 1-8 • 2-String Amps 9-16 • 3-String Amps 17-24 • 4-String Amps 25-32

Table 18 Metering Submenu Descriptions (2 of 2)

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
4-Temperatures	<p>Allows you to choose the following submenus:</p> <ol style="list-style-type: none"> 1. Cooling 2. Heatsink Temps <p>1-Cooling</p> <p>Control Air Temp Temperature in °C of the air in the general enclosure.</p> <p>Inverter Air Temp Temperature in °C of the air in the inverter section.</p> <p>Heatsink Temp Max Temperature in °C of the hottest inverter heatsink. Used to control the cooling fan.</p> <p>Fan Speed(%) Speed command for the variable speed cooling fan as a percentage of full speed. Normally it is the output of the heatsink temperature regulator, but will be set to the fan test command if the test command is not zero. For units with fixed speed fans, the fan speed will be shown as 0.0% or 100.0%.</p> <p>2 -Heatsink Temps Inverter heatsink temperatures in °C. Number of temperature sensors varies from 1 for the smallest units to 6 for the largest units.</p>

Energy Production Sub Menus

Refer to Figure 31 and Table 22.

Table 22 Energy Production Submenu Descriptions

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
1-Total kwh	<p>This menu allows you to monitor the following:</p> <p>Total kwh Continuously updated running total in kwh of energy produced. Can be cleared or preset to a desired value.</p> <p>Today kwh of energy produced for current day.</p> <p>Yesterday kwh of energy produced for yesterday.</p>
2-Average kwh	<p>This menu allows you to monitor the following:</p> <p>7 day average Average kwh of energy produced per day over a 7 day period.</p> <p>7 day total Total kwh of energy produced over a 7 day period. Can be cleared or preset to a desired value.</p> <p>30 day average Average kwh of energy produced per day over a 30 day period.</p> <p>30 day MWh Total kwh of energy produced over a 30 day period.</p>
3-String kwh	<p>This menu allows you to monitor the energy produced by the different strings (zone option required)</p> <p>1 String kwh 1-8 Total kwh of energy produced by zone 1 (string 1-8).</p> <p>2 String kwh 9-16 Total kwh of energy produced by zone 2 (string 9-16).</p> <p>3 String kwh 17-24 Total kwh of energy produced by zone 3 (string 17-24).</p> <p>4 String kwh 25-32 Total kwh of energy produced by zone 4 (string 25-32).</p>

System Information Sub Menus

Refer to Figure 31 and Table 23.

Table 23 System Information Submenu Descriptions

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
System Information	Serial number of unit.

Status and Faults Menu

The following information describes the Status and Faults submenus. See also Figure 32 and Table 24.

Table 24 Status and Faults Submenu Descriptions

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
Status	<p>Displays the text corresponding to the current value (0-7) of the Operating Sequence parameter:</p> <ul style="list-style-type: none"> 0. Powering up 1. Shut down 2. Stop 3. Close precharge 4. Match voltage 5. Close output 6. Close input 7. Run
Output (kw)	Displays the current value of ac power output in kW. If the unit is not running, this number could be slightly negative.
Number of Faults	Number of fault bits set at this time.
1 View Faults	<p>Three selections that allow you to clear faults, view the fault log, and view active faults:</p> <p>1-Clear Faults Press ENTER to clear all fault bits. Faults that are currently active will come back with a new time stamp. The contents of the fault log are not affected.</p> <p>2-Fault Log Displays the fault history (fault message number and description and time).</p> <p>3-Active Faults Displays the fault number and text for all currently active faults. Faults are displayed in numerical order, four faults per screen.</p>

Operations Menu

The Operations menu contains two primary submenu groups:

1. Control Submenus
2. Settings Submenus

These menus, which may be accessed by the user, are password protected.

Control Submenus

The Control submenu allows you view and change the following submenus:

1. Current & Power Control parameters
2. MPPT parameters
3. PV Wakeup Parameter.

The following descriptions explain the submenus. Refer to Figure 33 and Table 25.

Table 25 Control Submenu Descriptions (1 of 5)

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
1-Current & Power	<p>1-Current Control</p> <p>1-Run Enable</p> <p>Minimum: 0 Maximum: 1 Default : 1</p> <p>Parameter Meanings:</p> <ul style="list-style-type: none"> • 0 – not enabled • 1 – enabled to run when dc input and ac output voltages are ready <p>2-Control Mode</p> <p>Minimum: 0 Maximum: 2 Default: 2</p> <p>Parameter Meanings:</p> <ul style="list-style-type: none"> • 0 – constant ac current • 1 – constant ac power • 2 – Maximum Power Point Tracking (MPPT)

Table 22 Control Submenu Descriptions (2 of 5)

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
1-Current & Power (cont'd)	<p>3-Real Curr(%)</p> <p>Minimum: 0% Maximum: 110% Default: 0%</p> <p>Parameter Meanings: Real current command in percent of rated for Control Mode 0.</p> <p>4-Reac Curr(%)</p> <p>Minimum: -60% Maximum: 60% Default: 0%</p> <p>Parameter Meanings: Reactive current command in percent of rated for Control Mode 0.</p> <p>2-Power Control</p> <p>1-Real Power(%)</p> <p>Minimum: 0% Maximum: 110% Default: 100%</p> <p>Parameter Meanings: Real power command in percent of rated for Control Mode 1. Real power limit in percent of rated for Control Mode 2.</p> <p>2-Reac Power(%)</p> <p>Minimum: -60% Maximum: 60% Default: 0%</p> <p>Parameter Meanings: Reactive power command in percent of rated for Control Mode 1.</p>

Table 22 Control Submenu Descriptions (3 of 5)

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
1-Current & Power (cont'd)	<p>3- Pwr Factor(%)</p> <p>Minimum: -100% Maximum: 100% Default: 100%</p> <p>Parameter Meanings: Line power factor in percent for Control Mode 2 (MPPT). Absolute value cannot be less than 80%.</p>
2-MPPT	<p>1-MPPT Power</p> <p>1-Min Pwr Chg(%)</p> <p>Minimum: 0% Maximum: 100% Default: 0%</p> <p>Parameter Meanings: Minimum Power Change in percent of rated power.</p> <p>2-Pwr Inc Dly</p> <p>Minimum: 0.0 s Maximum: 10.0 s Default: 0.5 s</p> <p>Parameter Meanings: Power Increase Delay in seconds. Time between incremental increases in power command.</p> <p>3-Pwr Chg Dly</p> <p>Minimum: 0.0 s Maximum: 10.0 s Default: 0.5 s</p> <p>Parameter Meanings: Power Change Delay in seconds. Time between incremental changes in power command.</p>

Table 22 Control Submenu Descriptions (4 of 5)

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
2-MPPT (cont'd)	<p>2-MPPT Voltage</p> <p>1-DC Volt Cmd(V)</p> <p>Minimum: 0V Maximum: 1000V Default: 330V</p> <p>Parameter Meanings: Nominal dc voltage command for MPPT operation</p> <p>2V Step Min(V)</p> <p>Minimum: 0.0V Maximum: 10.0V Default: 0.1V</p> <p>Parameter Meanings: Minimum step in dc voltage command during MPPT operation.</p> <p>3V Step Max(V)</p> <p>Minimum: 0.0V Maximum: 10.0V Default: 2.0V</p> <p>Parameter Meanings: Maximum step in dc voltage command during MPPT operation.</p>

Table 22 Control Submenu Descriptions (5 of 5)

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
3- PV-Wakeup Param	<p>1-Threshold(V)</p> <p>Minimum: 0V Maximum: 1000V Default: 300V</p> <p>Parameter Meanings: Minimum dc input voltage required for the unit to start running.</p> <p>2-Delay(min)</p> <p>Minimum: 0.0 min Maximum: 10.0 min Default: 10.0 min</p> <p>Parameter Meanings: Time in minutes that dc input voltage must be above the threshold value before the unit is allowed to start.</p>

Settings Submenus

The Settings submenus allow you to set the following:

1. Modus communications parameters
2. Choose language to be displayed on HMI
3. Save changes made to parameters
4. Set date and time

Refer to Figure 33 and Table 26.

Table 26 Settings Submenu Descriptions (1 of 2)

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
1-Modbus	<p>This Modbus submenu contains four submenus:</p> <ol style="list-style-type: none"> 1. Baud Rate 2. Parity 3. Data Bits 4. Stop Bits <p>These four parameters specify the characteristics of the Modbus communication link. Changes to these parameters take affect only after power up or reset of the DPCB.</p> <p style="text-align: center;">1-Baud Rate</p> <p>Minimum: 4.8 kbit/sec Maximum: 56.0 kbit/sec Default: 9.6 kbit/sec</p> <p>Note: For baud rate, only discrete settings are permitted (4.8, 9.6, 14.4, 28.8, 56.0)</p> <p style="text-align: center;">2-Parity</p> <p>Minimum: 0 Maximum: 2 Default : 0</p> <p>Explanation 0 – no parity 1 – odd parity 2 – even parity</p> <p style="text-align: center;">3-Data Bits</p> <p>Minimum: 7 Maximum: 8 Default : 8</p> <p style="text-align: center;">4-Stop Bits</p> <p>Minimum: 1 Maximum: 2 Default: 1</p>

Table 23 Settings Submenu Descriptions (2 of 2)

PRIMARY SUBMENU	SECONDARY SUBMENUS/EXPLANATION
2- Language	This submenu allows you choose the language that the HMI displays.
3-Save Parameters	Press ENTER to save all parameters to non-volatile memory.
4-Date & Time	<p>These three parameters are used to set the real time clock in the DPCB.</p> <p>Year</p> <p>Minimum: 2000 Maximum: 2099 Default : na</p> <p>Month.Day</p> <p>Minimum: 1.01 Maximum: 12.31 Default : na</p> <p>Hour.Minute</p> <p>Minimum: 0.00 Maximum: 23.59 Default: na</p>

Field Adjustment Set Points

This section is provided for information only.

All field adjustable set points are set using the HMI. Note the following:

- The trip levels and time delays are selectable by the **service personnel only**.
- The over/ under frequency and voltage detection have been chosen to be in compliance with UL1741 and UL1547.
- The voltage and frequency setting levels can **ONLY** be changed within the ranges that have been evaluated by UL.

The settable ranges allow the service personnel to field adjust the trip points across the actual utility voltage and frequency to verify proper operation of the over/ under frequency and voltage detection. Table 27 and Table 28 provide a summary of the field adjustable trip points for the inverter shutdown and stop conditions respectively.

Table 27 Default Trip Level Settings to Shutdown Inverter

NO	DESCRIPTION	TRIP SETTING	PERSISTENT TIME
1	DC Input Over Voltage	660Vdc	0.1 Second
2	DC Input Under Voltage	270Vdc	0.1 Second
3	DC Input Over Current	300Adc	0.1 Second
4	DC Input Instantaneous Over Current	348Adc	1.0ms
5	DC Link Capacitor Over Voltage	700Vdc	0.1 Second
6	DC Link Capacitor Under Voltage	245Vdc	3 Second
7	DC Link Instantaneous Over Voltage	800V	1.0ms
8	DC Link Instantaneous Under Voltage	100V	1.0ms
9	Inverter Over Current	300Arms	0.1 Second
10	Inverter instantaneous Over Current	480A peak	0 Second
11	Line Over Current	115% Inom Arms	0.1 Second
12	Line Neutral Over Current	5Arms	0.1 Second
13	DC Ground Overcurrent	10A	1Second

Table 28 Trip Level Settings to Stop Inverter

DESCRIPTION	MINIMUM LEVEL	MAXIMUM LEVEL	DEFAULT LEVEL	MINIMUM TIME	MAXIMUM TIME	DEFAULT TIME
Line Under-voltage Fast	30%	50%	50%	0.10 s	0.16 s	0.16 s
Line Under-voltage slow	50%	88%	88%	0.16 s	2.00 s	1.00 s
Line Over-voltage fast	120%	130%	120%	0.10 s	0.16 s	0.16 s
Line Over-voltage slow	110%	120%	110%	0.16 s	1.00 s	1.00 s
Line Under-frequency	3.0 Hz	0.2 Hz	0.7 Hz	0.16 s	300 sec	0.16 s
Line Over-frequency	0.5 Hz	1.0 Hz	0.5 Hz	0.10 s	0.16 s	0.16 s

Fault and Warning Messages

- Unless stated otherwise, all faults will cause the PVS unit to stop running.
- Unless stated otherwise, faults can be cleared by a fault reset command from the estop switch, the HMI, or an external Modbus device.
- Numerical values given are factory default settings and may have been changed.

General Faults

Table 29 lists and describes the general faults.

Table 29 General Faults

NO.	MESSAGE	MEANING	ACTION
1	dc in not ready	DC input voltage not ready. The dc input voltage has not reached and exceeded the value specified by a parameter.	None. When the dc input voltage reaches the correct value, the unit will automatically start.
2	line not ready	AC line voltage not ready. The ac line voltage has not exceeded the required level for the required time (default 5 minutes).	None. When the ac line voltage reaches the correct value, the unit will automatically start.
3	stop command	The unit has stopped because it has received a software stop command.	This command is automatically cleared by a start command.
4	shutdown cmd	The unit has stopped because it has received a software shutdown command.	
5	estop	The unit has stopped because the hardware estop switch is open. Cleared by closing the estop switch.	n/a
6	low power stop	The unit has stopped because the power output has remained at zero for more than 10 minutes.	None. This message is automatically cleared when the unit stops.
7	lo current stop	The unit has stopped because the dc link current has remained at zero for more than 10 minutes.	None. This message is automatically cleared when the unit stops.
8		Reserved	
9	door open	One of the doors is open. The unit will not run unless all doors are closed.	Close door(s).
10	disconnect open	The dc input disconnect DS1 is open.	Close DS1.
11	breaker open	The ac line circuit breaker is open.	Close CB1.
12	DPCB fault	Digital Power Control Board fault (faults 33-48)	Refer to DPCB Faults in this section.
13	hardware fault	Hardware fault (faults 49-64)	Refer to Hardware Faults in this section.
14	inverter fault	Inverter fault (faults 65-80)	Refer to Inverter Faults in this section.
15	temperature fit	Temperature fault (faults 81-96)	Refer to Temperature Faults in this section.
16		Reserved	
17	dc in overvoltage	DC input overvoltage. DC input voltage above 660V for more than 100 ms.	Contact Satcon Service
18	dc in undervoltage	DC input undervoltage. DC input voltage below 250V for more than 100ms.	Contact Satcon Service
19	dc overvoltage	DC link overvoltage. DC link voltage above 700V for more than 100 ms.	Contact Satcon Service

Table 30 General Faults (2 of 2)

20	dc undervolt	DC link undervoltage. DC link voltage below 250V for more than 1 second.	Contact Satcon Service
21	dc ground fault	DC ground overcurrent detected by ground impedance monitoring device.	Contact Satcon Service
22	In overvlt slow	Line overvoltage slow. Line voltage above 120% of rated for more than 1 second.	None. This fault is automatically cleared when the line voltage drops below the trip level.
23	In overvlt fast	Line overvoltage fast. Line voltage above 110 % of rated for more than 0.16 second. Automatically cleared when the line voltage drops below the trip level.	None. This fault is automatically cleared when the line voltage drops below the trip level.
24	In undrvlt slow	Line undervoltage slow. Line voltage below 88% of rated for more than 1 second. Automatically cleared when the line voltage rises above the trip level.	None. This fault is automatically cleared when the line voltage rises above the trip level.
25	In undrvlt fast	Line undervoltage fast. Line voltage below 50% of rated for more than 0.16 second. Automatically cleared when the line voltage rises above the trip level.	None. This fault is automatically cleared when the line voltage rises above the trip level.
26	volt unbalance	Line voltage unbalance (IEC unbalance)	Contact Satcon Service
27	line over freq	Line over frequency. Line frequency more than 0.5 Hz above rated for more than 0.16 second. Automatically cleared when the frequency drops below the trip level.	None. This fault is automatically cleared when the frequency drops below the trip level.
28	under freq slow	Line under frequency slow. Line frequency more than 0.7 Hz below rated for more than 0.16 second. Automatically cleared when the frequency rises above the trip level	None. This fault is automatically cleared when the frequency rises above the trip level.
29	under freq fast	Line under frequency fast. Line frequency more than 3.0 Hz below rated. Automatically cleared when the frequency rises above the trip level.	None. This fault is automatically cleared when the frequency rises above the trip level.
30	neutral oc	Neutral current is over the limit	Contact Satcon Service
31	line ov inst	Line over voltage instantaneous	None. This fault is automatically cleared when the line instantaneous over voltage drops below the trip level.
32	sync fault	When the unit does not receive a signal from the master unit (500kW Rear Exhaust and 1MW models only)	Contact Satcon Service

DPCB Faults

Table 30 lists and describes the Digital Processing Circuit Board (DPCB) faults.

Table 30 DPCB Faults

NO.	MESSAGE	MEANING	ACTION
33	program chksum	Program checksum error. .	If fault cannot be cleared contact Satcon Service.
34	FPGA version	FPGA version not compatible with firmware.	If fault cannot be cleared contact Satcon Service.
35	data copy 1	Checksum error for saved data copy 1. Saved data includes fault log and energy production data.	Contact Satcon Service
36	data copy 2	Checksum error for saved data copy 2	Contact Satcon Service
37	param A copy 1	Checksum error for parameter set A copy 1	Contact Satcon Service
38	param A copy 2	Checksum error for parameter set A copy 2	Contact Satcon Service
39	param B copy 1	Checksum error for parameter set B copy 1	Contact Satcon Service
40	param B copy 2	Checksum error for parameter set B copy 2	Contact Satcon Service
41	v fdbk scaling	Voltage feedback scaling error.	Contact Satcon Service.
42	i fdbk scaling	Current feedback scaling error. Check and adjust current feedback ratio and burden parameters. Save parameters and cycle control power.	Contact Satcon Service.
43	i difference	Difference between inverter input and output current feedback is too large. Check and adjust current feedback ratio and burden parameters. Save parameters and cycle control power.	Contact Satcon Service.
44	ratings change	A ratings parameter has been changed. Internal scaling parameters must be recalculated. Save parameters and cycle control power.	Contact Satcon Service.
45	stack fault	DSP stack overflow. If fault cannot be cleared replace DPCB board.	If fault cannot be cleared contact Satcon Service.
46	adc fault	Analog to digital converter fault. If fault cannot be cleared replace DPCB board.	If fault cannot be cleared contact Satcon Service.
47	NVRAM fault	Non-volatile memory fault. If fault cannot be cleared replace DPCB board.	If fault cannot be cleared contact Satcon Service.
48	FPGA fault	FPGA bus interface fault. If fault cannot be cleared replace DPCB board.	If fault cannot be cleared contact Satcon Service.

Hardware Faults

Table 31 lists and describes the hardware faults.

Table 31 Hardware Faults

NO.	MESSAGE	MEANING	ACTION
49	DPCB iso +5V	DPCB isolated +5V power supply fault. If fault cannot be cleared replace DPCB board.	If fault cannot be cleared contact Satcon Service.
50	DPCB +5V	DPCB +5V power supply fault. If fault cannot be cleared replace DPCB board.	If fault cannot be cleared contact Satcon Service.
51	DPCB +15V	DPCB +15V power supply fault. If fault cannot be cleared replace DPCB board.	If fault cannot be cleared contact Satcon Service.
52	DPCB -15V	DPCB -15V power supply fault. If fault cannot be cleared replace DPCB board.	If fault cannot be cleared contact Satcon Service.
53	FPGA watchdog	FPGA watchdog timer fault. If fault cannot be cleared replace DPCB board.	If fault cannot be cleared contact Satcon Service.
54	surge suppressor	AC or DC surge suppressor fault	Contact Satcon Service.
55	inverter fuse 1	Inverter fuse 1 open	Contact Satcon Service
56	inverter fuse 2	Inverter fuse 2 open	Contact Satcon Service
57	inv overtemp 1	Inverter hardware over temperature 1	Contact Satcon Service.
58	inv overtemp 2	Inverter hardware over temperature 2	Contact Satcon Service.
59	xrfmr overtemp	Isolation transformer over temperature	Contact Satcon Service.
60	reactor overtmp	AC filter reactor over temperature	Contact Satcon Service.
61	precharge fault	Precharge circuit fault	Contact Satcon Service.
62	test mode fault	Test mode fault	Contact Satcon Service.
63	open cct test	Open circuit test mode fault	Contact Satcon Service.
64	short cct test	Short circuit test mode fault	Contact Satcon Service.

Inverter Faults

Table 32 lists and describes the inverter faults.

Table 32 Inverter Faults

NO.	MESSAGE	MEANING	ACTION
65	gate fdbk A	Gate feedback fault phase A inverter 1	Contact Satcon Service.
66	gate fdbk B	Gate feedback fault phase B inverter 1	Contact Satcon Service.
67	gate fdbk C	Gate feedback fault phase C inverter 1	Contact Satcon Service.
68	gate fdbk A2	Gate feedback fault phase A inverter 2	Contact Satcon Service.
69	gate fdbk B2	Gate feedback fault phase B inverter 2	Contact Satcon Service.
70	gate fdbk C2	Gate feedback fault phase C inverter 2	Contact Satcon Service.
71	dc in overcurr	DC input timed over current	Contact Satcon Service.
72	dc in oc inst	DC input instantaneous over current	Contact Satcon Service.
73	dc uv inst	DC link instantaneous under voltage	Contact Satcon Service.
74	dc ov inst	DC link instantaneous over voltage	Contact Satcon Service.
75	inv sw overcur	Inverter software over current	Contact Satcon Service.
76	inv hw oc 1	Hardware over current inverter 1	Contact Satcon Service.
77	inv hw oc 2	Hardware over current inverter 2	Contact Satcon Service.
78	line overcurr	AC line over current	Contact Satcon Service.
79	i unbalance	AC line current unbalance	Contact Satcon Service.
80		Reserved	

Temperature faults

Table 33 lists and describes the temperature faults.

Table 33 Temperature Faults

NO.	MESSAGE	MEANING	ACTION
81	int air hi temp	Internal air high temperature fault	Contact Satcon Service.
82	Inv air hi temp	Inverter air high temperature fault	Contact Satcon Service.
83	htsnk hi temp 1	Heatsink 1 high temperature fault	Contact Satcon Service.
84	htsnk hi temp 2	Heatsink 2 high temperature fault	Contact Satcon Service.
85	htsnk hi temp 3	Heatsink 3 high temperature fault	Contact Satcon Service.
86	htsnk hi temp 4	Heatsink 4 high temperature fault	Contact Satcon Service.
87	htsnk hi temp 5	Heatsink 5 high temperature fault	Contact Satcon Service.
88	htsnk hi temp 6	Heatsink 6 high temperature fault	Contact Satcon Service.
89	int air lo temp	Internal air low temperature fault	Contact Satcon Service.
90	Inv air lo temp	Inverter air low temperature fault	Contact Satcon Service.
91	htsnk lo temp 1	Heatsink 1 low temperature fault	Contact Satcon Service.
92	htsnk lo temp 2	Heatsink 2 low temperature fault	Contact Satcon Service.
93	htsnk lo temp 3	Heatsink 3 low temperature fault	Contact Satcon Service.
94	htsnk lo temp 4	Heatsink 4 low temperature fault	Contact Satcon Service.
95	htsnk lo temp 5	Heatsink 5 low temperature fault	Contact Satcon Service.
96	htsnk lo temp 6	Heatsink 6 low temperature fault	Contact Satcon Service.

Warning Messages

Table 34 lists and describes the warning messages.

NOTE



Warning messages do NOT cause the PVS unit to shut down.

Table 34 Warning Messages

NO.	MESSAGE	DESCRIPTION	ACTION
97	fan fault 1	Variable speed fan fault inverter 1	Contact Satcon Service.
98	fan fault 2	Variable speed fan fault inverter 2	Contact Satcon Service.
99	dc input open	DC input contactor open when it should be closed	Contact Satcon Service.
100	dc input closed	DC input contactor closed when it should be open	Contact Satcon Service.
101	ac output open	AC output contactor open when it should be closed	Contact Satcon Service.
102	ac output closed	AC output contactor closed when it should be open	Contact Satcon Service.

Shutdown Procedures

The PowerGate® Plus Inverters have two types of shutdown: fast shutdown and controlled shutdown.

WARNING



The inverter contains LETHAL VOLTAGES. . Authorized service personnel only should perform all repairs and service. There are no user serviceable parts inside the inverter.

WARNING



Only qualified personnel familiar with the design of the inverter should plan or implement the installation, start-up, and subsequent maintenance of the system. Failure to comply may result in personal injury or equipment damage.

WARNING



Risk of electric shock from energy stored in capacitor. Do not open doors for 5 minutes after opening all breakers and disconnects.

Fast Shutdown Procedure (ON/OFF Switch)

1. Turn ON/OFF switch at front of unit to off position to immediately shutdown the inverter.
2. Open AC breaker CB1 or AC disconnect DS2 (depending on unit).
3. Open DC disconnect DS1.
4. Wait 5 minutes for internal capacitors to discharge before opening enclosure doors.
5. The system will now be in a “shutdown state.”

Controlled Shutdown Procedure (HMI)

1. Press "MENU BACK" until the "Main Menu" screen appears.
2. Press "3" to go to the "Operation" screen.
3. Enter the password (4-digit number). The "Operation" screen will appear.
4. Press "1" to go to the "Control" screen.
5. Press "1" to go to the "Current & Power" screen.
6. Press "ENTER" twice.
7. Press "0" followed by "ENTER".
8. The PCS will stop.
9. Open the ac disconnect.
10. Open the dc disconnect DS1.
11. Wait 5 minutes for internal capacitors to discharge before opening enclosure doors.

THIS PAGE INTENTIONALLY LEFT BLANK

Chapter 4 Maintenance Information

About this Chapter

This chapter contains the information to help you maintain the PowerGate® Plus Inverter. Topics include:

- Brief overview of Satcon warranty and preventive maintenance options
- The preventive tasks that customers should perform under the Satcon standard warranty (if applicable)
- Scheduled maintenance by Satcon (if applicable)
- Preventive maintenance guidelines for customers.

About Warranty and Preventive Maintenance

Satcon provides a range of servicing options that may or may not affect how customers service and maintain their PowerGate® Plus inverters. These options include the following:

- Warranty packages
- Preventive Maintenance Plans

This chapter introduces these options and lists the preventive maintenance tasks. For full details, refer to the Satcon Standard and Extended Warranty documentation, as well as the Satcon Preventive Maintenance Plan.

Warranty Packages

Satcon provides the following warranty packages:

- Standard Warranty (5-years)
- Extended Warranty (up to 20 years)

IMPORTANT



Refer to the Satcon Power System “**Photovoltaic PowerGate®Plus Warranty Registration**” for conditions that must be met in order not to void the inverter warranty.

Standard Warranty

All PowerGate® Plus inverters come with the standard 5-year, unlimited-hour usage warranty package. During this warranty period, customers must perform the annual preventive maintenance listed in this chapter, unless they have purchased a Satcon Preventive Maintenance Plan. Refer to the Satcon “Standard and Extended Warranty” documentation.

IMPORTANT



The Satcon Standard Warranty covers only service parts and labor used in accordance with the inverter semi-annual and annual scheduled maintenance (see “Scheduled Maintenance”). This warranty will not cover filters, fuses, or additional consumable parts.

Extended Warranty

Customers can purchase optional packages that can extend the standard warranty for a period up to 20 years (purchased in 5-year increments). The extended warranty package provides additional coverage of the inverter’s mechanical and safety-critical components. Refer to the Satcon “Standard and Extended Warranty” documentation.

During the warranty period, customers must perform the annual preventive tasks listed in this chapter, unless they have purchased a Satcon Preventive Maintenance Plan.

Preventive Maintenance Plans

In addition to the warranty packages, Satcon offers the following preventive maintenance plans:

- Preventive Maintenance Program (scheduled maintenance available in 5-year blocks up to 20 years)
- Up Time Guarantee (requires purchase of selected Preventive Maintenance packages. Note: Certain conditions apply.)

For full details, refer to the Satcon Standard and Extended Warranty documentation, as well as the Satcon Preventive Maintenance Plan.

Preventive Maintenance under Standard Warranty

If customers do NOT have a Satcon Preventive Maintenance Plan, they must perform the following tasks on an annual basis during the 5-year warranty period (refer to “*Preventive Maintenance Guidelines for Customers*” in this chapter):

- Check appearance/cleanliness of the cabinet, ventilation system and all exposed surfaces.
- Inspect, clean/replace air filter elements
- Check for corrosion on all terminals, cables and enclosure.
- Check all fuses.
- Perform a complete visual inspection of all internally mounted equipment including subassemblies, wiring harnesses, contactors, power supplies and all major components.
- Check condition of all the AC and DC surge suppressors
- Torque terminals and all fasteners in electrical power connections
- Check the operation of all safety devices (door switches)
- Record all operating voltages and current readings via the front display panel.
- Record all inspections completed.
- Inform Satcon of all deficiencies identified.
- Satcon will be responsible for the In-Warranty replacement of failed inverter components, parts and labor

IMPORTANT



The Satcon Standard Warranty covers only service parts and labor used in accordance with the inverter semi-annual and annual scheduled maintenance (see “Scheduled Maintenance”). This warranty will not cover filters, fuses, or additional consumable parts.

Scheduled Maintenance

Preventive maintenance must be done on a semi-annual and annual basis to ensure that your PowerGate® Plus inverters operate reliably over time.

Preventive maintenance tasks may be done either by customers (qualified service personnel only) or by Satcon service engineers (if customers purchase a Satcon Preventive Maintenance Plan).

Semi-Annual Intervals

Table 35 shows the semi-annual maintenance tasks that Satcon will perform under its Preventive Maintenance Plan option.

Table 35 Semi-Annual Maintenance Service Tasks

Perform temperature checks on all breakers, connections, and associated controls.
Perform a complete visual inspection of the equipment including subassemblies, wiring harnesses, contacts and major components and Record Ambient operating Temperature
Check Inverter modules for the following:
IGBT's and inverter board's for discoloration
Power capacitors for signs of damage
Record all voltage and current readings via the front display panel
Measure and record all low-voltage power supply levels
Check appearance/cleanliness of the cabinet, ventilation system and insulated surfaces
Check for corrosion on all terminals and cables
Torque terminals, connectors and bolts
Check all fuses for open or signs of heating (Inverter and Combiner) Record temp and Condition
Check the condition of both the AC and DC Surge Suppressors
Check the operation of all safety devices (Door Switches, GFDI)
Correct all deficiency detected
Inspect (Clean or Replace) Air filter elements
Attach / Complete Maintenance Schedule Card
Issue written inspection report

Annual Intervals

Table 36 shows the annual maintenance tasks that Satcon will perform under its Preventive Maintenance Plan option.

Table 36 Annual Maintenance Service Tasks

Perform Semi-Annual service as outlined above
Check all nuts, bolts, screws and connectors for tightness and heat discoloration
Calibrate all electronic subsystems to system specification; keep a calibration record
Install and perform any recommended Engineering Field Modifications, including software upgrades
Measure and record phase-to-phase input voltages and currents
Review system performance with the owner in order to address questions
Issue written inspection report

Preventive Maintenance Guidelines for Customers

This section provides information for customers who have chosen to perform preventive maintenance themselves (i.e. for customers who have not purchased a Satcon Preventive Maintenance plan).



WARNING

Turn off input power and de-energize all live sources in the PowerGate® Plus Inverter before any scheduled maintenance procedure is carried out. Follow proper lockout/tag out procedures to make sure that the power cannot be inadvertently turned back on.

Customer Responsibilities

Customers who do not have a Satcon Preventive Maintenance Plan should perform the following maintenance tasks at six-month intervals:

- Check appearance/cleanliness of the cabinet, ventilation system and all exposed surfaces.
- Inspect, clean/replace air filter elements.
- Check for corrosion on all terminals, cables and enclosure.
- Check all fuses.
- Perform a complete visual inspection of all internally mounted equipment including subassemblies, wiring harnesses, contactors, power supplies and all major components.
- Check condition of all the AC and DC surge suppressors
- Torque terminals and all fasteners in electrical power connections.
- Check the operation of all safety devices (E-stop, door switches).
- Record all operating voltages and current readings via the front display panel.
- Record all inspections completed.
- Inform Satcon of all deficiencies identified.

Customers should not perform any of the following (but should engage Satcon do so):

- Repair tasks
- Testing
- Calibration

Guidelines for Cleaning and General Inspection

Carefully clean dust from the interior of the PowerGate® Plus Inverter by blowing low-pressure compressed air into the interior from the bottom of the unit first and then from the top.

The equipment must be maintained in good electrical condition to avoid hazards stemming from disrepair. Report any equipment defect or safety hazard and discontinue use of the equipment until its safety has been assured.

Guidelines for Cable Maintenance

Inspect cables frequently for damage to the insulation and the connectors. Replace or repair cracked or worn cables immediately. Do not overload cables. Do not touch the output terminal while equipment is energized.

Guidelines for Power Component Maintenance

Keep power components clean and free of dirt and obstructions. This will avoid tracking and heat build-up, thereby increasing the life of the device. Clean heat sinks using low-pressure compressed air or a soft brush.

Inspect terminal blocks for evidence of overheating caused by loose electrical connections. Inspect electrical and mechanical connections for tightness; inspect closely all compression-type connectors. Inspect all wiring, leads and cables. Inspect for cuts, abrasions, and signs of deterioration and overheating. Inspect leads for broken strands at terminals. Inspect the hinges on the doors (if present). If these hinges stick and difficult to operate, spray hinges with a good silicone spray lubricant.

Thermal expansion and vibration during operation loosen fasteners. Therefore, check and re-torque the following components after three (3) months after initial commissioning:

- All clamps,
- All power bolt-on connections
- All logic screw-on connections
- Rectifier diode/ Insulated gate bipolar transistor (IGBT) mounting fasteners

Make sure the recommended torque specs for the device is followed. This should be repeated six (6) months later and then every year thereafter.

Guidelines for Printed Circuit Board Maintenance

Keep printed circuit boards clean and free of any accumulations of dirt and foreign materials. Be sure that static materials are never placed near the inverter circuit boards (either in the enclosure or being stored).

Exercise caution when near or handling circuit boards; be sure to take proper Electrostatic Discharge 'ESD' measures to avoid PCB failures.

Also, keep all logic control components clean and free of any accumulations of dirt or foreign materials. (They do not require any special maintenance except good house-keeping practices).

All printed circuit boards and logic components are subject to thermal degradation. Good housekeeping critical in making sure that these devices operate within their design parameters, as well as to increase the mean time between failure (MTBF) value of the unit.

Guidelines for Blower Fan Maintenance

Fans that rotate easily and are free of any noise or binding are less prone to operational failure.



CAUTION

Clean fan impellers **ONLY** after you de-energize the inverter.

Depending on the model, PowerGate® Plus inverters may have either one or two blower fans in the system. These fans have backward curved impellers and are mounted inside the enclosure. The entire backward curved impeller should be cleaned as necessary to remove accumulated dust, dirt and other foreign particles, which may collect on the blades or other parts. Refer to fan manufacturer data sheet for maintenance instructions in details.

Guidelines for Air Filter Maintenance

Clean the air-filters provided with the inverter at regular intervals. To maintain a uniform airflow through the power module heatsink, the air filter must be in place at all times during the operation of the inverter. Aside from proper airflow, the air filter helps provide clean air for circulation. Standard filters furnished with the fans are permanent, re-cleanable type. The recommended maximum filter load for efficient performance is 0.40# AFI dust per net sq./ft of filter area. To clean standard filters, remove and flush the filter with a stream of water. After flushing, allow filter to drain. **DO NOT USE CAUSTICS IN CLEANING WATER.** For maximum filter efficiency, coat the filters with a filter coat adhesive after cleaning.

General Maintenance Workmanship

Perform all repairs in accordance with good electrical repair practices. All interconnecting lead connections to components must be made with proper wire terminations. Route all leads neatly and secure with wire ties, cable clamps, etc. When reassembling parts on PowerGate® Plus Inverter, use only the same size hardware as what is originally fastened to the part. The preferred hardware for this unit is metric, however some of the purchased components, such as contactors, switches, transformers, may have standard imperial sizes. Use only metric tools to loosen or tighten metric hardware. Use only standard imperial size tools to loosen and tighten standard imperial size hardware. These fundamental practices will help to avoid insufficient tightening and rounding off corners.

Chapter 5 Commissioning Procedures

About this Chapter

This chapter explains how to commission the PowerGate® Plus Inverter after installation is complete. Topics include:

- Connecting the AC and DC cables
- Initial power up sequence

Connecting AC and DC Power Cables

1. Be sure to use the proper cables for the AC power cables connecting the inverter to the grid. Note the following:
 - a. Be sure the three phases are connected correctly.
 - b. For wye configurations, verify that the AC ground cable from the inverter (AC ground bus bar) is connected to the neutral of the main utility-side grid transformer (the inverter uses this point as the reference point for grid voltage sensing).
2. Be sure to use properly sized cables for the DC power cables connecting the inverter to the PV panels. Note the following:
 - a. Be sure the polarity is correct.
3. Be sure to ground the inverter only at the ground bus bar provided at the bottom of the inverter.

Initial Power Up

1. Be sure the inverter ON/OFF switch is set to OFF.
2. Measure AC voltage at the inverter. Note the following:
 - a. The inverter requires AC voltage from the grid side in order to initialize and power up the system.
 - b. You can measure the line phase AC voltages with a multi meter at the grid side of AC circuit breaker CB1.
3. Verify that the AC voltages agree with the AC output voltages on the inverter nameplate.
4. Wait 10 seconds for the processor to initialize and then check that the voltage is displayed correctly on the HMI as follows:
 - a. Press Menu Back until Main Menu appears
 - b. Select 1-Monitoring
 - c. Select 2-Metering
 - d. Select 2-AC output
 - e. Select 2-Line phases
 - f. Check Line Phase voltages (VA, VB, and VC) on the display
 - g. Check the actual line phase voltages (with a multi meter) to make sure that these voltages agree with the displayed values (within tolerances).
5. Close dc disconnect DS1.
6. Check the actual dc voltages as follows:
 - a. Press Menu Back until Main menu appears
 - b. Select 1-Monitoring
 - c. Select 2-Metering
 - d. Select 1-DC Input

- e. Check the dc voltages (with a multi meter) to make sure that these voltages agree with the displayed values (within tolerances).
7. Check status of unit as follows:
 - a. Press Menu Back until Main menu appears
 - b. Select 1-Monitoring
 - c. Select 1-Status
 - d. Select 1-Operating Seq
 - e. Operating Seq should be 02 (Stop), and DC Timer and AC Line Tmr should be counting down
8. If DC Timer is not counting down, check the dc input voltage as follows:
 - a. Press Menu Back until Main menu appears
 - b. Select 1-Monitoring
 - c. Select 2-Metering
 - d. Select 1-DC Input
 - e. DC Input Volts must be greater than 300V (default setting) before the unit will start.
9. If AC Line Tmr is not counting down, check the ac line voltage
 - a. Press Menu Back until Main Menu appears
 - b. Select 1-Monitoring
 - c. Select 2-Metering
 - d. Select 2-AC Output
 - e. Select 2_line Phases
 - f. VA, VB, & VC must all be greater than 88% of rated (default value) before the unit will start.
10. Turn the inverter ON/OFF switch to ON.
11. Check that the unit is enabled to run as follows:
 - a. Press Menu Back until Main Menu appears
 - b. Select 3-Operation
 - c. Enter the password (4-digit number)
 - d. Select 1-Control
 - e. Select 1-Current & Power
 - f. Select 1-Current Control
 - g. If Run Enable is zero go to step 12, otherwise skip to step 13.
12. If necessary, set Run Enable to 1 as follows
 - a. Press Enter twice
 - b. Press 1 followed by Enter
 - c. Press Menu Back three times to reach the Operate menu

- d. Select 2-Settings
 - e. Select 3-Parameters
 - f. Press Enter to save parameters
13. The unit is now ready to run. It will start when the dc and ac voltage timers reach zero.

Appendix

This appendix contains the following drawings:

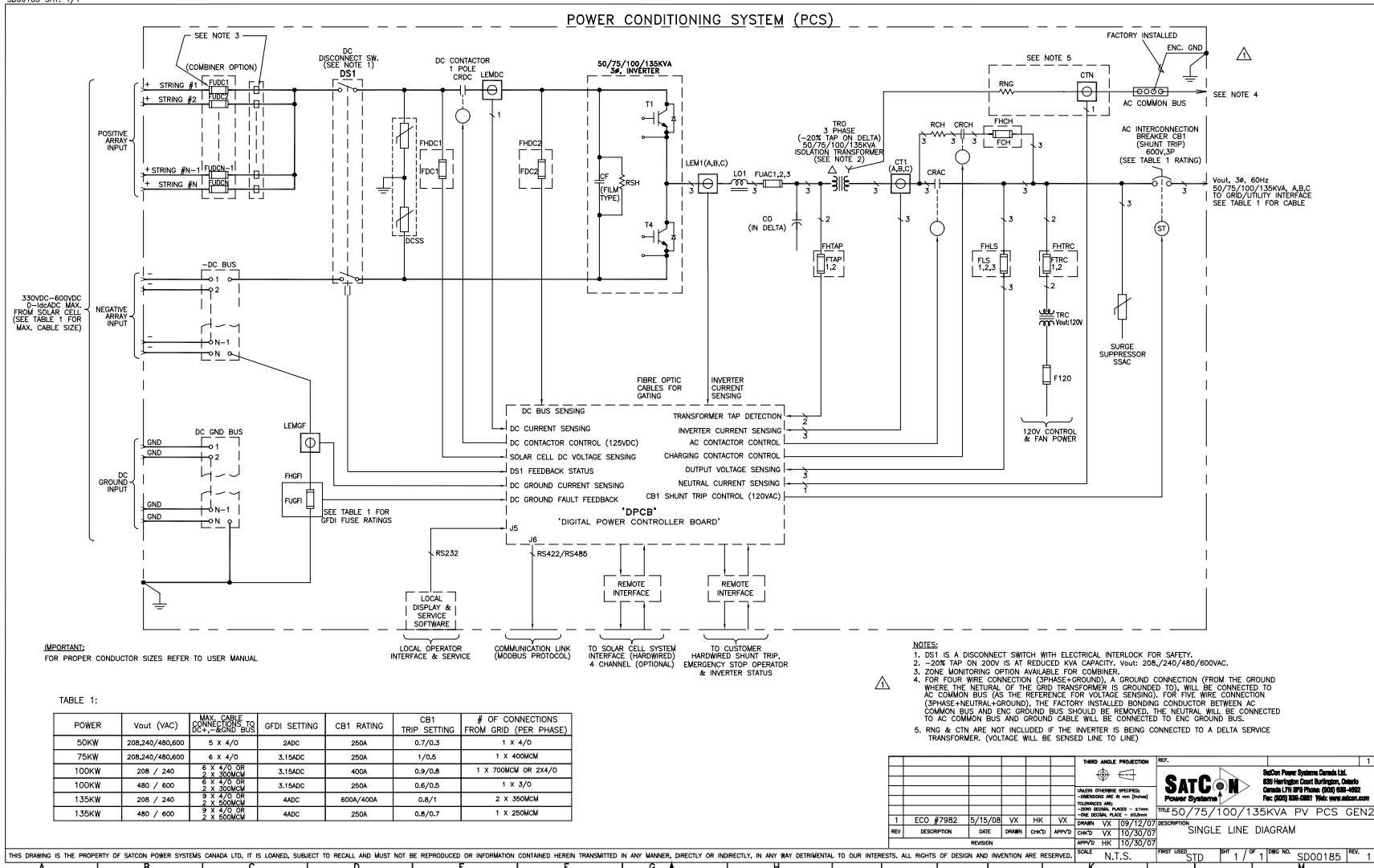
Electrical Drawing

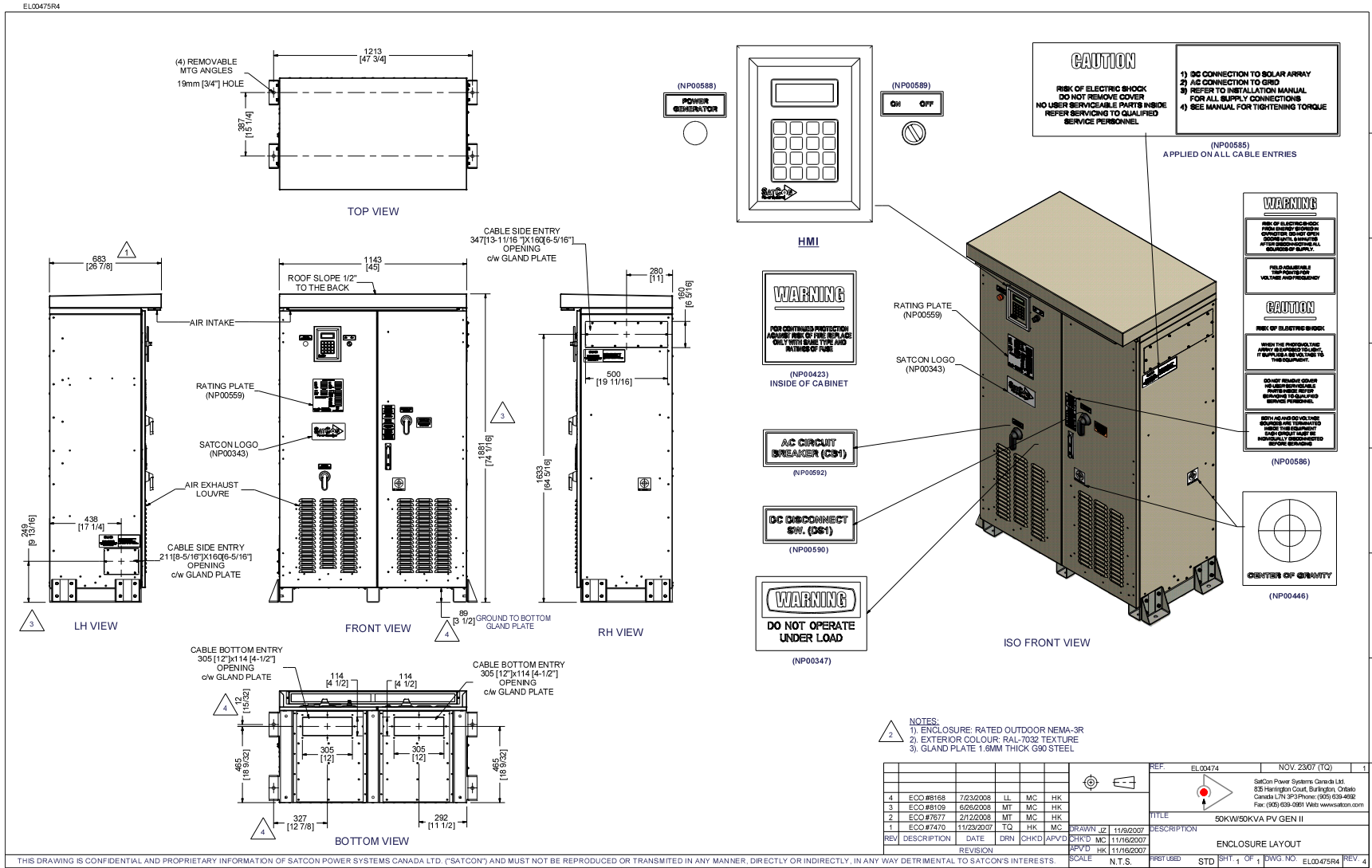
- Single Line Diagram SD00185 (50kW/50KVA)

Mechanical Drawing

- Enclosure Layout drawing EL00475 (50kW unit)

SD00185 SHT. 1/1







Satcon™

Satcon

835 Harrington Court, Burlington, Ontario, Canada, L7N 3P3
Tel: 905.639.4692 | Fax: 905.639.0961 | www.SatCon.com