

PV Powered™

PV Grid-tied Residential Inverters INSTALLATION & OPERATION MANUAL



Preface

PV Powered

PV Powered designs, manufactures, and markets the solar power industry's most reliable photovoltaic solar inverter solutions. We've assembled a highly experienced solar power electronics design team. Our vision is to spur the widespread adoption and success of solar power, by assisting our distributors, dealers and installers in this dynamic market while ensuring that our products are the best supported, easiest to install, and most reliable solar inverters in the industry. Our innovative approach to performance monitoring provides secure and easy access to system performance and inverter status over the Internet.

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Safety Information and Conventions

Designation of Danger, Warning and Caution



DANGER

The Danger statement is used to inform the installer/operator of a situation requiring the utmost attention. Failure to heed this warning will result in serious injury or death to personnel and destruction of equipment.



WARNING

The Warning statement is used to inform the installer/operator of a situation requiring serious attention. Failure to heed this warning may result in serious injury or death to personnel and destruction of equipment.



CAUTION

The Caution statement is used to inform the installer/operator of a situation requiring attention. Failure to heed this Caution may result in injury to personnel and damage to equipment.

Revisions

For applicability of technical information with your specific product, contact PV Powered Customer Service and Technical Support at support@pvpowered.com.

Certifications

UL 1741

IEEE 1547

FCC Class A & B

CEC Efficiency Testing

Acronyms and Abbreviations

AC	Alternating Current
ANSI	American National Standards Institute
AWG	American Wire Gage
CEC	California Energy Commission
CPU	Controlled Processing Unit
DC	Direct Current
EGC	Equipment Grounding Conductor
FCC	Federal Communications Commission (US)
GEC	Grounding Electrode Conductor
GFI	Ground Fault Interrupt
IEEE	Institute of Electrical and Electronics Engineers
LED	Light-Emitting Diode
LOTO	Lockout Tagout
LP	Low Power
MPPT	Maximum Power Point Tracking
NEMA	National Electrical Manufacturers Association
NEC	National Electric Code
NFPA	National Fire Protection Association
Nm	A unit of torque
PLL	Phase Lock Loop
PPE	Personal Protective Equipment
PV	Photovoltaic
STC	Standard Test Condition
UL	Underwriters Laboratory
VAC	Voltage Alternating Current
VDC	Voltage Direct Current
VFD	Vacuum Fluorescent Display
VOC	Voltage Open Circuit
VOC_TC	Voltage Open Circuit, Temperature Coefficient

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1. Introduction and Safety

1.1 Introduction

The PV Powered Grid-Tied Inverter is a utility interactive inverter for photovoltaic (PV) systems.

The inverter is tied to an electrical source provided by the local utility company as well as the PV system. The inverter contains everything needed to convert the DC energy generated by the PV array(s) into AC energy required to power a house.

This manual provides information necessary for the successful installation and use of the PV Powered Grid-Tied Inverter.

1.2 General Safety

IMPORTANT SAFETY INSTRUCTIONS: This product has been engineered and manufactured to ensure your personal safety. Improper use may result in potential electrical shock or burns. Read and follow all instructions for installation, use and servicing of this product. Read all safety warnings before installing or operating the inverter.

NOTE: A locking tab has been designed into the PV Powered Grid-tied Inverter. Locking the inverter is the sole responsibility of the end user. Secure the lid to prevent unauthorized access or damage to the inverter.

SAVE THESE INSTRUCTIONS: This manual contains important instructions for the PV Powered Grid-Tied Inverter that must be followed during installation of the PV Powered Grid-Tied Inverter.

INSTRUCTIONS IMPORTANTES CONCERNANT LA SÉCURITÉ CONSERVER CES INSTRUCTIONS. CETTE NOTICE CONTIENT DES INSTRUCTIONS IMPORTANTES CONCERNANT LA SÉCURITÉ.



CAUTION

- All electrical installations should be done in accordance with local electrical codes and the National Electrical Code (NEC), ANSI/NFPA 70.
- Before connecting the inverter to the electrical utility grid, your utility company must grant approval. Only qualified electricians should make the connection.
- When exposed to light, PV arrays form electrical energy that creates a potentially hazardous condition. To avoid this, completely cover the surface of all PV arrays with opaque (dark) material before wiring them.
- The inverter contains no user-serviceable parts. Refer maintenance to qualified service personnel.

1.3 FCC Compliance

The PV Powered Grid-Tied Inverters have been tested and found to pass FCC Class B radio interference standards with proper installation of the inverter. This is not a guarantee that there will be no interference at every installation. If you notice interference at your installation, try the following potential solutions:

- Move or re-orient the affected device.
- Increase the distance between the devices.
- Connect the device to a different AC circuit.



CAUTION

Read all safety warnings and instructions before installing or operating the inverter.

4. Operations



WARNING

Before turning on the inverter, ensure that the front cover is closed properly.



WARNING

The heat sink can reach temperatures in excess of 158°F (70°C). Do not touch the heat sink when in use, and do not place anything on top of the heat sink.

4.1 Start up Procedures

To start up the inverter, complete the following steps in the order indicated.

NOTE: *All steps are assumed completed in previous sections; including but not limited to:*

- *VOC calculation*
- *Checking the system for ground faults*

1. Turn the AC breaker ON.

Verify that the red LED light is illuminated. The LEDs are located in the upper left hand corner of the inverter's display.

- If the red LED is not illuminated or is blinking, refer to the *Troubleshooting* section.

2. Turn the PV System Disconnect ON.

The green LED should illuminate. If not, refer to the *Troubleshooting* section.

- If no green LED illuminates, verify DC voltage is present in the PV System Disconnect. The DC voltage present should be at least 15 volts greater than the minimum operating voltage stated in Appendix A.

After five minutes the inverter starts to produce power if all necessary operating conditions are met.

NOTE: *PV Powered recommends that a lock be attached to prevent unauthorized access or damage to the inverter.*

4.2 Inverter Front Panel Status Indicators

The inverter continuously monitors:

1. The AC grid connection to ensure the AC voltage and frequency levels are within safe operating limits per UL1741.
2. The DC voltage and current from the PV array to ensure safe operating conditions per UL 1741.

3. The inverter's internal operational parameters to ensure safe operating conditions exist within the operating environment.

The inverter has two LED indicator lights visible through the upper left corner of the lid. These lights indicate the inverter's status.

Green LED is illuminated when:

- All three monitored operating conditions are met.
- Inverter's operating environment is safe to export power to the AC grid.

Red LED flashes when:

- Any one of the monitored operating conditions are not met.
- When a fault condition exists.
- The operating environment moves outside the safe operating limits governed by UL 1741, IEEE 1547, and IEEE 519.

Red LED is illuminated when:

- The PV array voltage is not within required operating limits, such as:
 - At sunset, when the inverter turns off for the night.
 - When clouds reduce the amount of available sunlight or when portions of the PV array are covered with debris.
 - Any time the DC output from the PV array drops below the inverter's minimum DC operating voltage, the inverter turns off.

When the array is once again exposed to enough sunlight, the green LED illuminates, the inverter's auto-start feature begins, and after five minutes the inverter begins to export power.

If the red LED continues to illuminate when there is sufficient sunlight for operation, verify that no wiring connections are loose. If the wiring is secure, see the Troubleshooting section for additional information.

The vacuum fluorescent display (VFD) indicates the inverter's status and real-time power output into the AC grid. This display provides the following information:

- Inverter model type.
- AC power produced in real time (watts).
- Lifetime energy produced (kWh).
- AC voltage in real time (VAC).
- PV voltage input in real time (VDC).
- During start-up, a count-down timer.
- Fault code message if a fault exists or recently occurred.

Normal Display Cycle

The display changes every two seconds to show a different set of information as shown in Figures 4-1 and 4-2.

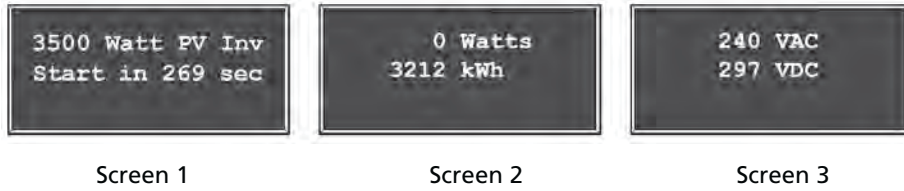


Figure 4-1 Normal Startup Screens



Figure 4-2 Running Screens

If a fault occurs, the display also provides a corresponding fault code. Refer to the Troubleshooting section for additional information.

5. Troubleshooting

The inverter provides two indicator lights in the form of Light Emitting Diodes, or LEDs. The LEDs are the primary indicators of the system status: O.K., Sleep or Faulted. The LEDs are located above the inverter display in the upper left hand corner on the front lid.

5.1 LED Status

Red LED

1. The light on the left is a red LED and is the primary indicator of system stand-by or fault condition.
2. A solid red LED and a blank screen indicates the system is in normal sleep or stand-by mode. This mode occurs if there is not enough sunlight present to generate DC voltage at night and the AC properties are within the provided specifications.
3. The red LED blinks if the inverter has had a fault condition, and the vacuum fluorescent display (VFD) displays a fault code. If the red LED is blinking, carefully record the numerical error code and text describing the error. Possible faults are listed in Table 5-1.

Green LED

1. The light on the right is a green LED and is the primary indicator the system is generating power.
2. The green LED illuminates any time the DC voltage is above the inverter's DC start voltage and all operational parameters are met. When the green light illuminates, the inverter tries to convert power from the PV array.

Red and Green LED Lights On

If both LED lights are solid at the same time, contact PV Powered Technical Support for assistance.

Ground Fault Error



WARNING

Replace the GFI fuse with the same type and rating of fuse. The inverter uses Littelfuse KLKD1 1A/600VDC.

1. The inverter's GFDI circuit reports a ground fault error if the 1 amp fuse is blown and the voltage potential between ground and the grounded terminal of the PV array is greater than +25 VDC, or less than -25 VDC. This voltage potential can only occur if the ground fault fuse in the inverter has opened.
2. A ground fault occurs when unintended current has a path to ground. The most common source of a PV system ground faults are crossed wires, a nicked PV module conductor touching a grounded surface, or cables inside a conduit have metal exposed through the insulation.
3. A less likely cause is limited to multiple inverter installations, when the positive and negative array strings are crossed. Crossed wires occur when a positive or negative

conductor from array 1 is connected with wires in array 2. An example is if inverter A has the positive conductor from array 1 and the negative conductor from array 2 connected.

4. If the fuse is blown or open, then a ground fault condition exists.
 - Check the DC voltage between the grounded terminal of the array and earth ground.
 - The voltage should be less than 25 VDC with the GFI fuse removed. If the voltage is greater than this, check the array wiring as there may be a ground fault. For the best results, perform this test with the PV System Disconnect on and off. If you are not comfortable conducting this test, DO NOT ATTEMPT IT. (See *PV System Disconnect, Installation and Operations Manual* for AC and DC disconnect information).
 - If a ground fault condition is not present because it is now repaired or intermittent, replace the fuse with a similar fuse rated at 600VDC and 1A.
5. Make sure the grounded leg of the PV array is not broken in the PV System Disconnect.

Note: *The GFI is a latching circuit which prevents the inverter from operating until the fault is repaired and the inverter is reset. The inverter will not operate, even if the fault is repaired, unless it is manually reset by turning the AC source circuit off and then on.*

5.2 Displayed Fault Codes

The vacuum fluorescent display (VFD) provides the codes shown in Figures 5-1 and 5-2 when a fault has occurred.

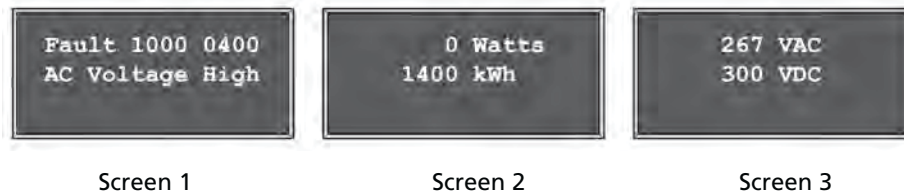


Figure 5-1 Faulted

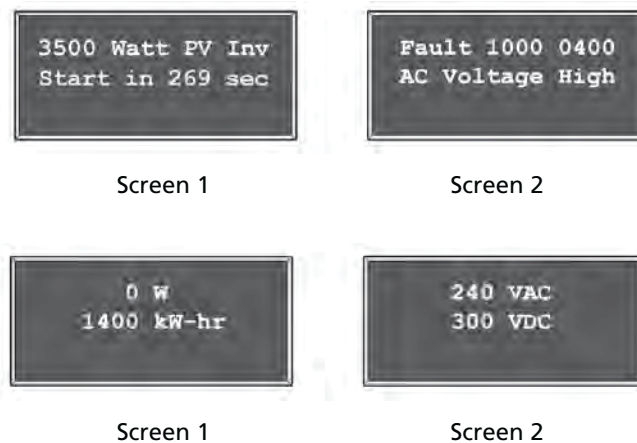


Figure 5-2 Starting Up From a Faulted State

NOTE: *In this case the fault refers to the last fault detected.*

If the inverter is in a faulted state, the red LED blinks and the VFD scrolls through the screens shown in the faulted example above. The text of the fault describes the specific fault condition that the inverter experienced.

If the inverter is no longer experiencing the condition that caused the fault (e.g. the AC voltage climbs above 264V then drops below 264V), the red LED stops blinking and the inverter starts the five minute count-down timer. During these five minutes, the display also shows the last fault.

Multiple Faults

If the inverter detects multiple faults at one time, the inverter displays the text of the first fault detected.

For multiple faults, the numerical values of the fault codes are added as shown in Figure 5-3.



Figure 5-3 AC Voltage High/DC Voltage Low Fault

Figure 5-3 displays the AC Voltage High fault (1000 0400), plus a DC Voltage Low fault (1000 0020). This might occur at night, when the panel voltage is low, due to darkness, and the utility voltage was above the limits defined in Table 3-2.

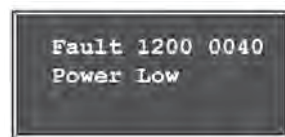


Figure 5-4 Power Low Fault

Figure 5-4 shows a Power Low fault. After the fault occurrence, the inverter had a DC Voltage High fault. In this case, the display added the fault codes 0200 0000 plus 1000 0040 to become 1200 0040.

If the faults have the same first digit (such as 1000 XXXX) the 1 remains the same and only the second block of four numbers add to the original fault code.



WARNING

These servicing instructions are for qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions unless you are qualified.

5.3 Fault Codes

Fault Code	VFD Text	Fault Description
8000 0000	Power Module	Generated by the power electronics to protect the switching module.
4000 0000	Power Module	Generated by the power electronics to protect the switching module.
1000 0800	PLL Fault	The inverter was unable to match the grid frequency. This is usually caused by an unstable power grid.
1000 0400	AC Voltage High	The grid voltage exceeded the limits in Table 3-2.
1000 0200	AC Voltage Low	The grid voltage dipped below the AC limits in Table 3-2.
1000 0100	AC Freq Low	The grid frequency went below the limits in Table 3-2.
1000 0080	AC Freq High	The grid frequency went above the limits in Table 3-2.
1000 0020	DC Voltage Low	The DC voltage is below the startup voltage.
1000 0010	DC Voltage High	DC voltage is above upper operating limit 450V.
1000 0002	Power Supply +15	Housekeeping DC power supply 15VDC is out of tolerance.
1000 0001	Power Supply +5	Housekeeping DC power supply 5VDC is out of tolerance.
0400 0000	Ground Fault	The inverter detected a blown GFI fuse.
0200 0000	Power Low	The inverter shut down because it was producing less than 60W for 5 minutes.
0100 0000	CPU Fault	The inverter encountered a problem in the CPU.
0040 0000	Over Current	Safety protection. The inverter encountered an over-current fault.
0020 0000	Pre-charge	The inverter experienced trouble energizing the transformer.
0004 0000	Heatsink Temp	The heat sink is above or below the operating limits of -25oC to 95oC.
0002 0000	Watchdog Fault	The CPU experienced a watch-dog fault.
0001 0000	Ambient Temp	The temperature detected inside the inverter is outside the normal operating limits of -25oC to 95oC.

Table 5-1 Fault Codes

The following fault codes indicate the inverter will restart once conditions are within normal operating conditions listed in Appendix A, Table A: 1000 0400, 1000 0200, 1000 0100, 1000 0080, 1000 0020, 1000 0010, 1000 0002, 1000 0001, 0200 0000, 0004 0000, and 0001 0000.

If the following fault codes occur, please contact PV Powered Technical Support for service: 8000 0000, 4000 0000, 1000 0800, 0400 0000, 0100 0000, 0040 0000, 0020 0000, and 0002 0000.

Appendix A - Specifications

The specifications detailed below are expected operational parameters, and should be used in designing your PV system in accordance with the NEC.

Specifications	PVP1100	PVP2000	PVP2500	PVP2800
Maximum DC Input Voltage (VOC)	500VDC			
DC Voltage Operating Range (V)	115VDC-450VDC	115VDC-450VDC	140VDC-450VDC	180VDC-450VDC
DC MPPT Range (V)	115VDC-380VDC	115VDC-380VDC	140VDC-380VDC	180VDC-380VDC
DC Imp Maximum Current (A)	10A	18A	20A	18A
DC Isc Maximum Current (A)	26A			
AC Operating Range (V)	105.6V-132.5V	211V-264V	211V-264V	183V-229V
AC Frequency Range (Hz)	59.3Hz-60.5Hz			
AC Nominal Voltage (V)	120V	240V	240V	208V
Normal Output Frequency	60Hz			
Synchronization in Rush Current	< 2.0A		8.4A	< 2.0A
Power Factor	0.99 - 1.0 at > 50% Power			
AC Maximum Continuous Current (A)	10A	9A	11A	13A
Continuous Output Power (Watts)	1100	2000	2500	2800
Maximum Continuous Output Power (Watts)	1100	2000	2500	2800
Enclosure	Steel- NEMA 3R to UL 50 Standards			
Dimensions (H x W x D)	22 1/2" x 15 5/8" x 8 1/4"			
With PV System Disconnect (H x W x D)	30 3/8" x 15 5/8" x 8 1/4"			
Weight (lbs)	55	65	70	80
Cooling	Natural Convection - Heat Sink			
Relative Humidity	0% to 100% Condensing			
Ambient Temperature Range	-25°C to + 40°C			
Environmental Rating	NEMA 3R			
Listings	UL 1741, IEEE 1547, IEEE 519, IEEE 929, IEEE 620			

Table A-1 PVP1100 through PVP2800 Specifications

Specifications	PVP3000	PVP3500	PVP4600	PVP4800	PVP5200
Maximum DC Input Voltage (VOC)	500VDC				
DC Voltage Operating Range (V)	170VDC-450VDC	200VDC-450VDC	205VDC-450VDC	200VDC-450VDC	240VDC-450VDC
DC MPPT Range (V)	170VDC-380VDC	200VDC-380VDC	205VDC-380VDC	200VDC-380VDC	240VDC-380VDC
DC Imp Maximum Current (A)	18A	18A	25A	26A	25A
DC Isc Maximum Current (A)	26A	26A	48A		
AC Operating Range (V)	211V-264V	211V-264V	183V-229V	211V-264V	211V-264V
AC Frequency Range (Hz)	59.3Hz-60.5Hz				
AC Nominal Voltage (V)	240V	240V	208V	240V	240V
Normal Output Frequency	60Hz				
Synchronization in Rush Current	< 2.0A	8.4A			
Power Factor	0.99 - 1.0 at > 50% Power				
AC Maximum Continuous Current (A)	13A	15A	23A	21A	23A
Continuous Output Power (Watts)	3000	3500	4600	4800	5200
Maximum Continuous Output Power (Watts)	3000	3500	4600	4800	5200
Enclosure	Steel - NEMA 3R to UL 50 Standards		Steel - NEMA 3R to UL 50 Standards		
Dimensions (H x W x D)	22 1/2" x 15 5/8" x 8 1/4"		27 1/8" x 18 1/8" x 8 5/8"		
With PV System Disconnect (H x W x D)	30 3/8" x 15 5/8" x 8 1/4"		35" x 18 1/8" x 8 5/8"		
Weight (lbs)	80	85	135		
Cooling	Natural Convection - Heat Sink				
Relative Humidity	0% to 100% Condensing				
Ambient Temperature Range	-25°C to +40°C				
Environmental Rating	NEMA 3R				
Listings	UL 1741, IEEE 1547, IEEE 519, IEEE 929, IEEE 620				

Table A-1 (continued) PVP3000 through PVP5200 Specifications

Abnormal Specifications

The specifications listed below are classified as abnormal and are not representative of normal operation.

Abnormal Specifications	PVP1100	PVP2000	PVP2500	PVP2800
Momentary current transient obtained during abnormal operation	100 A-pk / 0.54 ms	142 A-pk / 0.663 ms	88 A-pk	166 A-pk / 0.608 ms
Maximum input source backfeed current to input source	0A			

Abnormal Specifications	PVP3000	PVP3500	PVP4600	PVP4800	PVP5200
Momentary current transient obtained during abnormal operation	166 A-pk / 0.608 ms	88 A-pk	88 A-pk	88 A-pk	88 A-pk
Maximum input source backfeed current to input source	0A				

Table A-2 Abnormal Specifications

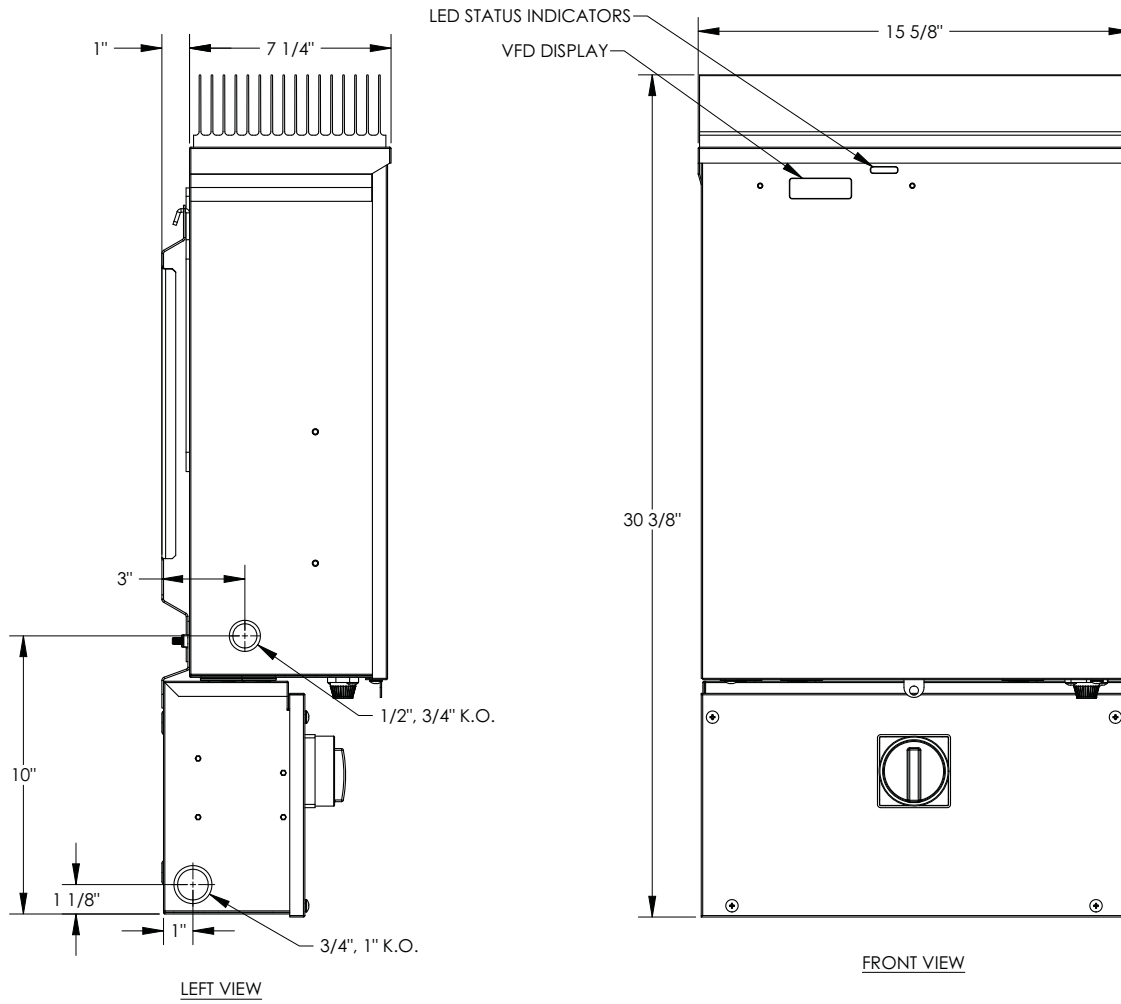


Figure B-1 Side and Front Views of PVP1100W, PVP2000W, PVP2500W, PVP2800W, PVP3000W, and PVP3500W Inverter Cabinet

Appendix B - Dimensions

B.1 Schematics for PVP1100W, PVP2000W, PVP2500W, PVP2800W, PVP3000W, and PVP3500W Inverter Cabinet

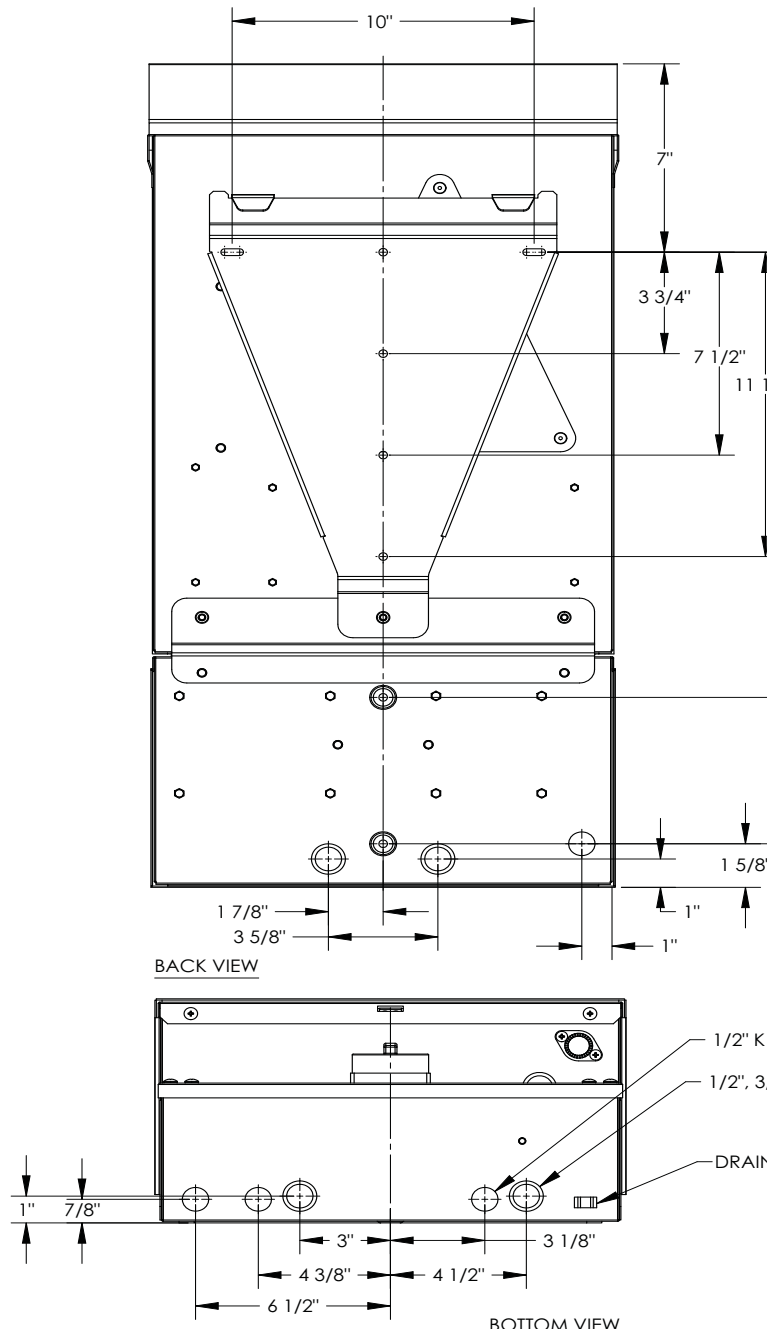


Figure B-2 Back and Bottom Views of PVP1100W, PVP2000W, PVP2500W, PVP2800W, PVP3000W, and PVP3500W Inverter Cabinet

B.2 Schematics for PVP4600W, PVP4800W, and PVP5200W Inverter Cabinet

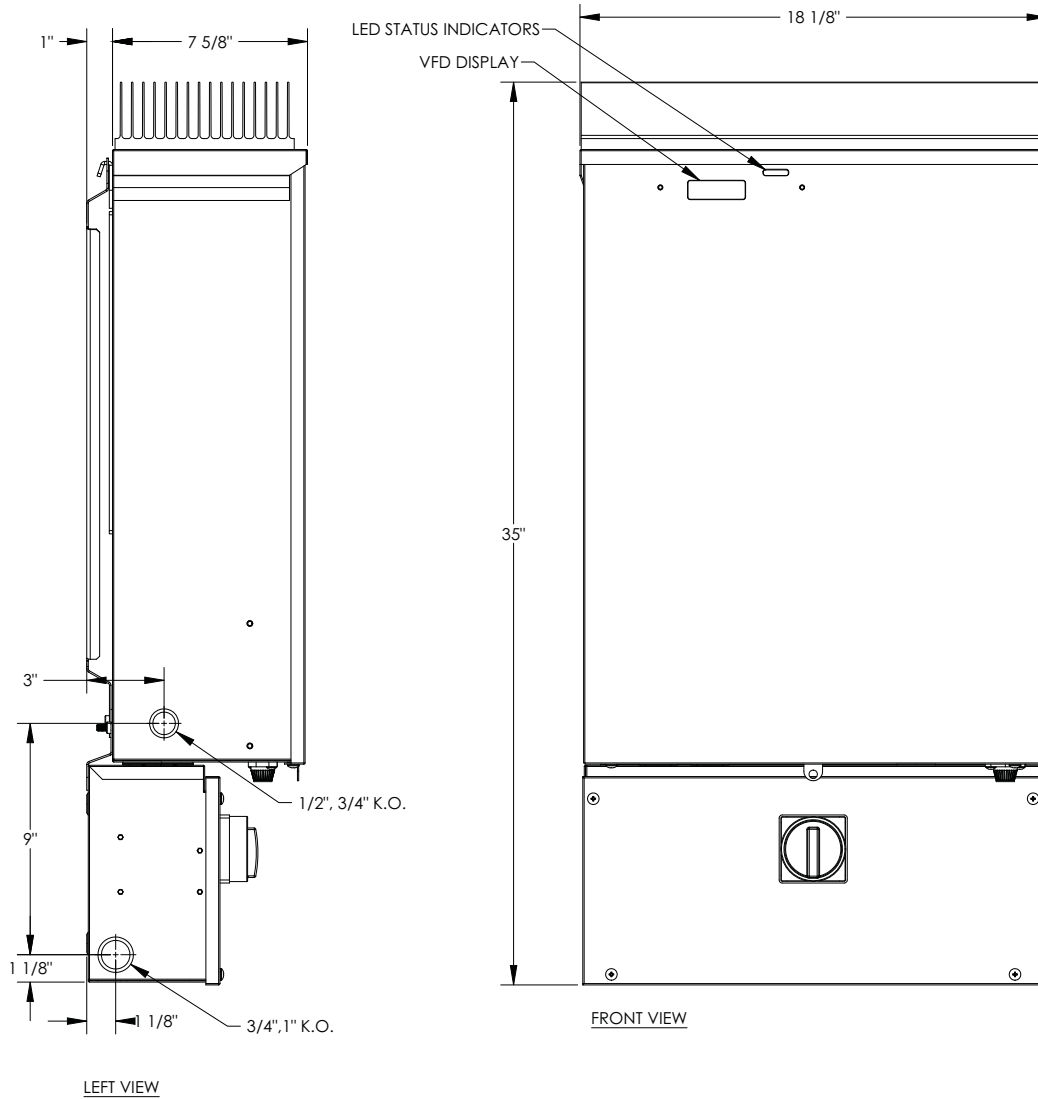


Figure B-3 Side and Front Views of the PVP4600W, PVP4800W, and PVP5200W Inverter Cabinet

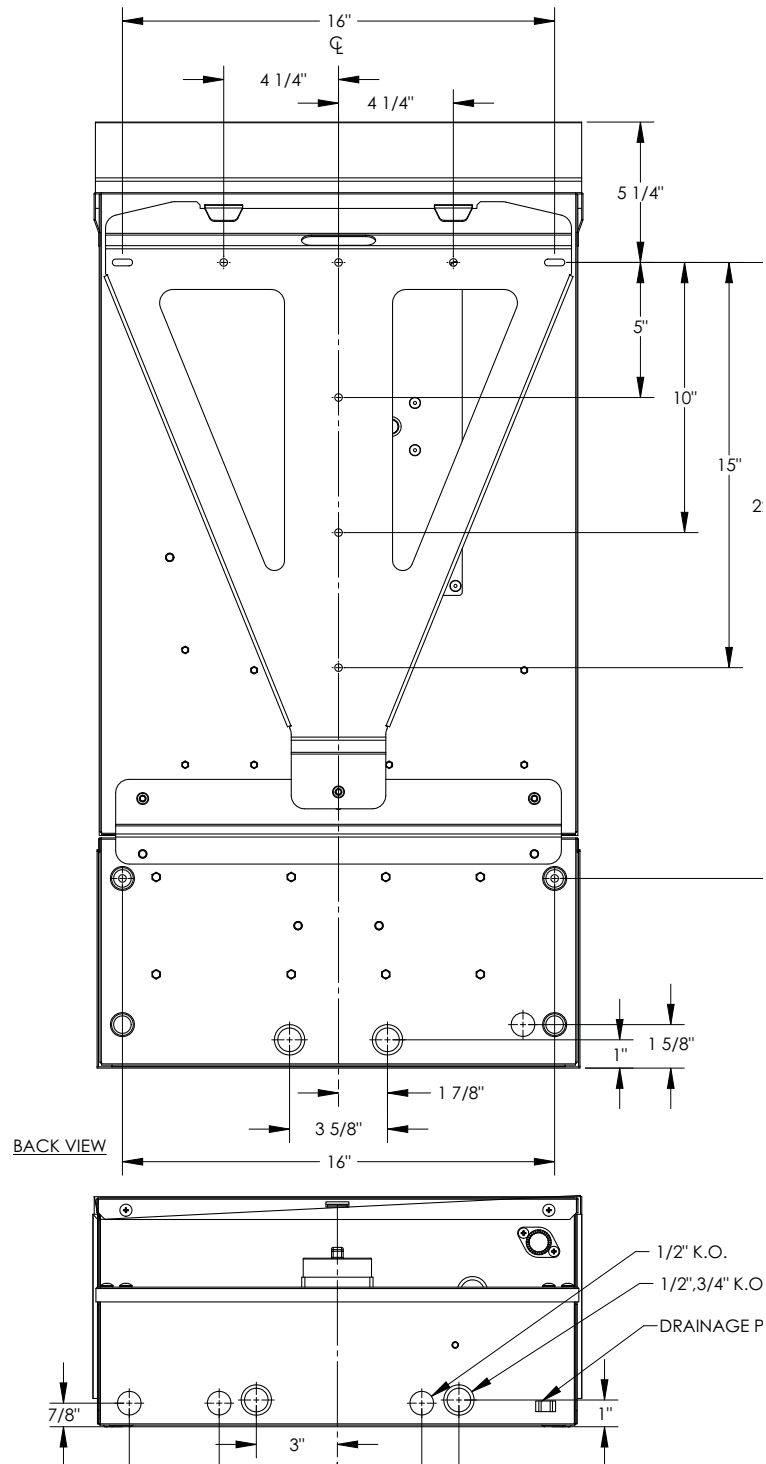


Figure B-4 Back and Bottom Views of the PVP4600W, PVP4800W, and PVP5200W Inverter Cabinet

Limited Warranty

PV Powered, Inc. provides a limited warranty for your residential or commercial inverter and optional data monitoring module for defects caused by material or manufacturing flaws. The inverter and the data monitoring module must be installed and maintained by a qualified installer in order for the warranty to be valid.

Terms of Coverage

The warranty period for the inverter is ten years, and the warranty on the data monitoring module is one year, each beginning on the date of purchase by the original end user.

Coverage

PV Powered will, at its option, repair or replace the defective component(s) free of charge, provided that you notify PV Powered of the defect during the warranty period, have a dated proof of purchase, and PV Powered determines that the defect is covered by the limited warranty set forth above. PV Powered reserves the right to inspect the defective component(s) and determine if the defect is due to material or manufacturing flaws. PV Powered also reserves the right to charge a fee for service time expended if the defect is not due to material or manufacturing flaw or is not for some other reason subject to this limited warranty.

PV Powered will, at its option, use new and/or reconditioned parts in performing warranty repair and in building replacement products. PV Powered reserves the right to use parts or products of original or improved design in the repair or replacement. If PV Powered repairs or replaces a product, its warranty continues for the remaining portion of the original warranty period or 90 days from the date of the return shipment to the customer, whichever period expires later. All replaced products and all parts removed from repaired products become the property of PV Powered.

For defects covered by this limited warranty, PV Powered will provide, at no additional cost to the customer, both parts and labor necessary to repair the product, and return shipment to the customer via a PV Powered selected, non-expedited, surface freight carrier within the United States and Canada.

What is Not Covered

PV Powered does not warrant its products from any and all defects or damage caused by:

- Normal wear and tear.
- Shipping or transportation damages.
- Improper installation.
- Improper maintenance.
- Excessive voltage or current conditions from the electrical grid or PV panels.
- Exposure to unsuitable environmental conditions (including but not limited to damage due to lightning strikes, storm, fire, flood, etc.).
- Unauthorized or abnormal use, repair, modification, or operation.
- Negligence or accidents.

- Material or workmanship not provided by PV Powered or its authorized service centers.

This warranty also does not cover costs related to the removal, installation, or troubleshooting of your electrical systems.

Disclaimer and Limitation of Liability

EXCEPT FOR THIS EXPRESS LIMITED WARRANTY, PV POWERED EXPRESSLY EXCLUDES ALL WARRANTIES WITH RESPECT TO THE INVERTER AND DATA MONITORING MODULE, EXPRESS AND IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTY OF MERCHANTABILITY, THE WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, AND ANY WARRANTIES THAT MAY HAVE ARISEN FROM COURSE OF DEALING OR USAGE OF TRADE.

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Return Procedure

Before returning the product directly to PV Powered, you must first obtain a Return Materials Authorization Number (RMA) from PV Powered. You must also pre-pay for shipping. When you contact a PV Powered representative, please have the following information ready:

1. The serial number of the product
2. The reason for the return
3. A copy of your dated proof of purchase

When you return the product to PV Powered, PV Powered advises that you use the original packaging or its equivalent, and that you fully insure the shipped product. PV Powered is not responsible for damage to the product due to improper packaging.

On the packaging, please include the following:

1. Clearly mark the Return Materials Authorization Number (supplied by PV Powered) on the outside of the box.
2. A return address where the product can be shipped.
3. A telephone number where you can be reached during business hours.
4. A brief description of the problem.

Ship the product prepaid to the address provided by your PV Powered representative.

Information about Your System

Note the following information for your records, and retain your dated proof of purchase:

Serial Number _____

Purchased From _____

Date of Purchase _____

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