125 kW Grid-Resilient Power Conversion System

Installation and Operations Manual

125B2-4F

Glossary of Terms

Acronym or Term	Full Expression
AHJ	Authority Having Jurisdiction
AR	As Required
AWG	American Wire Gauge
CEC	California Energy Commission
CPU	Central Processing Unit
CSA	Canadian Standards Association
DMM	Digital Multi-Meter
ESS	Energy Storage System
FRU	Field Replaceable Unit
LCD	Liquid Crystal Display
MOV	Metal-oxide Varistor
MPPT	Maximum Power Point Tracking
PCB	Printed Circuit Board
PCS	Power Conversion System
PV	Photovoltaic

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1.0 About This Manual

1.1 Purpose and Brief Product Line Overview

The purpose of this manual is to describe the proper installation, operation, maintenance and troubleshooting of the Ideal Power (“IPWR”) 125B2-4F Grid-Resilient Power Conversion System (“Converter” or “PCS”). The 125B2-4F Converter shares a common operating firmware platform with the 30B3-4xF [Grid Resilient Converter (AC1/DC3)] and the 30B3-4DF [Grid Resilient Multi-port Converter (AC1/DC2/DC3)], IPWR product.

1.2 Scope

This manual encompasses the features, installation, commissioning, and field servicing of the Converter. This manual covers only the Converter hardware platform: it does not address configuration, control, monitoring or diagnostics via Modbus. Information about the integration and use of the Converter’s Modbus Interface detailed in separate documents.

1.3 Who Should Read This Manual

Qualified personnel tasked with Converter installation, commissioning and field maintenance should read this manual. Such qualified personnel must be trained to deal with the dangers and hazards associated with the installation and maintenance of high-voltage electrical devices. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions unless you are qualified to do so.

1.4 How This Manual Is Organized

Section 1.0 contains important safety instructions.
Section 3.0 provides an overview of key system design considerations.
Section 4.0 describes the Converter mounting procedure.
Section 4.0 describes the Converter AC and DC wiring requirements.
Section 6.0 contains field maintenance and operator servicing procedures.
Section 7.0 details the Front Panel Display.
Section 8.0 defines system fault and status codes.
Section 9.0 outlines process for removing and returning Converter for repair
Section 10.0 provides an overview of the Modbus Interface.
Section 11.0 contains the Converter specifications.

1.5 RMA and Service Contact

Do not ship or return the Converter without prior authorization from Ideal Power Inc. Ensure you have registered you warranty online at www.idealpower.com/customers. A Return Material Authorization (RMA) number must first be obtained from our customer service department. Use the following contact information for all support:

Website

www.idealpower.com/customers

Mail

Ideal Power
4120 Freidrich Lane
Suite 100
Austin, TX 78744
Attn: Technical Support

Email & Phone

For technical support: support@idealpower.com
For warranty claims: warranty@idealpower.com
512.264.1542

2.0 IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS.

A. This manual contains important instructions for the Ideal Power 125B2-4F Converter that shall be followed during installation and maintenance of the converter.

B. Tools Required for installation with the barrel lugs provided with the unit

1. AC connections: use a 3/16 Allen wrench to the torque of 120 inch pounds.
2. DC connections: use a 5/16 Allen wrench to the the torque of 275 inch pounds

C. For torque specifications see Table 3 of the manual

D. Minimum recommended wire gauges: AC minimum 2/0, DC minimum 3/0

E. Maximum rated ambient for this unit 40 °C

F. Systems shall be installed with conductor rated cable for 175 amps AC on AC connections and 225 amps DC on DC connections

G. Class 1 wiring installation only to Modbus communications installations shall be adhered to.

H. “CAUTION” : To reduce the risk of fire, connect only to a circuit provided with 200 Amperes maximum branch-circuit overcurrent protection in accordance with the National Electrical Code.

I. “WARNING”: This unit is not provided with a GFDI device. This inverter or charge controller must be used with an external GFDI device as required by the Article 690 of the National Electrical Code for the installation location.

All wiring must be in accordance with the National Electric Code ANSI/NFPA 70.

The following safety notices are used in this manual:

DANGER	This symbol indicates **HIGH VOLTAGE**. It calls your attention to items or operations that could be dangerous to you and other persons operation this equipment. Read the message and follow the instructions carefully.
WARNING	This symbol is the “Safety Alert Symbol. **WARNING**: Indicates a potentially hazardous situation that, if not avoided, can result in serious injury or death. Do not proceed beyond a **WARNING** notice until the indicated conditions are fully understood and met.
CAUTION	**CAUTION**: Indicates a potentially hazardous situation that, if not avoided, can result in minor to moderate injury, or serious damage to the product. The situation described in **CAUTION** may, if not avoided, lead to serious results. Important safety measures are described in **CAUTION** (as well as **WARNING**), so be sure to observe them.

2.1 General Safety Precautions

WARNING	**Personnel Qualification** Inspections and operations requiring access to lethal AC or DC voltages, and should only be performed by qualified personnel.
WARNING	**Instruction and Code Compliance** Failure to install and maintain equipment in accordance with published instructions or applicable electrical codes creates the potential for personal injury, death, or equipment damage. .
CAUTION	**Electrostatic Discharge (ESD) Damage** The Converter contains ESD-sensitive equipment. Failure to use ESD control measures while servicing Battery Converter equipment may result in component damage.

DANGER	To avoid an electric shock, verify that the Converter's external AC and DC disconnects are open (off). A minimum wait time of five minutes is required after opening AC and DC disconnects to assure that the Battery Converter's internal capacitors have discharged to zero voltage before performing any work on the Converter. Utilize lockout procedures to insure that disconnects remain in the off position during all service periods.
DANGER	The enclosure contains exposed high voltage conductors. The enclosure front plates must remain on, except during installation, commissioning or maintenance by trained service personnel. Do not remove the front doors if extreme moisture is present (rain, snow or heavy dew).

2.2 Electrical Safety Precautions and Practices

DANGER	**High Voltage** The DC input voltage, AC output voltage, and various intermediate voltages inside the Converter enclosure are of lethal levels. Contact with these voltages may result in serious injury or death..
DANGER	**High Voltage** The Converter contains high-voltage DC capacitors. Allow five minutes for all capacitors within the enclosure to discharge after opening the AC and DC disconnect switches.

Equipment Configuration

Improper installation or servicing can create hazardous equipment configurations. Failure to install and maintain equipment in accordance with published instructions or applicable electrical codes creates the potential for personal injury, death, or equipment damage.

Safe Practices

Electrical power equipment can cause serious injury, death, or equipment and property damage. 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. Only qualified personnel should work with this equipment, and lockout procedures should be followed.

Shock Prevention

The DC input voltage present for the Battery Pack or PV Array can be as high as +/- 600 Volts DC for a total of

1200 Volts DC. The AC output voltage is 480 Volts AC.

Bare conductors, terminals, and improperly grounded enclosures can fatally shock a person.
Be sure to follow the following guidelines:

- Ensure that the equipment is adequately installed and grounded per this manual and all applicable codes.
- Inspect equipment and replace or repair damaged wiring.
- Only authorized and properly trained personnel should maintain or troubleshoot the Converter. Avoid working alone.
- Use proper safety clothing, procedures and test equipment.
- Avoid working in wet areas. Stand on a dry, insulating surface. Use insulated gloves when working near live conductors.

Service and Maintenance

Service and maintain the Converter in accordance with applicable Ideal Power procedures. Discontinue Converter use until all equipment defects and safety hazard have been cured. Replace damaged warning and precautionary labels.

Fire Prevention

Do not leave foreign objects in the Converter enclosure. Keep the area around enclosure clear of trash, debris and other combustible materials.

Electrical Safety Features

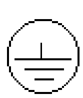
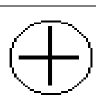
The Converter supports the electrical safety features listed in Sections 4 and 5.

2.3 Handling Safety

	**Converter Installation or Removal** The 125B2-4F Converter weighs approximately 425 pounds. If lift or power equipment is used to move, or lift the Converter, follow all safety rules. Failure to do so could result in personal injury or equipment damage.

2.4 Special Symbols

The following symbols are displayed on or in the Converter:

	GROUND – designates a connection point to earth ground.
	DC Positive – designates a connection point to the DC Positive of the Solar Photovoltaic Array

⊖	DC Negative – designates a connection point to the DC Negative of the Solar Photovoltaic Array
⎓	DC Circuit – designates that the circuit intended to be connected to a DC circuit
∼ 60Hz	AC Circuit – designates that a circuit is an AC, 60Hz circuit.
3 ∅	Number of Phases –indicates the number of the phases in the AC circuit
|	ON position – designates the ON position of switches and breakers.
○	OFF position – designates the OFF position for switches and breakers.
c ETL us Intertek	*The ETL mark indicates that the 125B2-4F Converter is certified to the UL1741 standard and meets the requirements of the National Electrical Code ®.*

3.0 System Design Considerations

3.1 DC Input Wiring

The 125B2-4F Converter has a single DC Port designed to operate with a DC input (such as an energy storage system-ESS or solar PV) that has a center-point ground reference. This is known as a bipolar configuration. The bipolar arrangement enables Converter input DC bus voltages of 1000 Vdc; while not violating NEC 600 Vdc restrictions typically found in commercial and industrial settings.

A typical 125B2-4F configuration supporting batteries on the DC3 Port is shown in Figure 1 for illustrative purposes only. During the design process, insure that both battery pack voltage meets the Converter's minimum and maximum voltage requirements, as outlined in the specifications section of this manual.

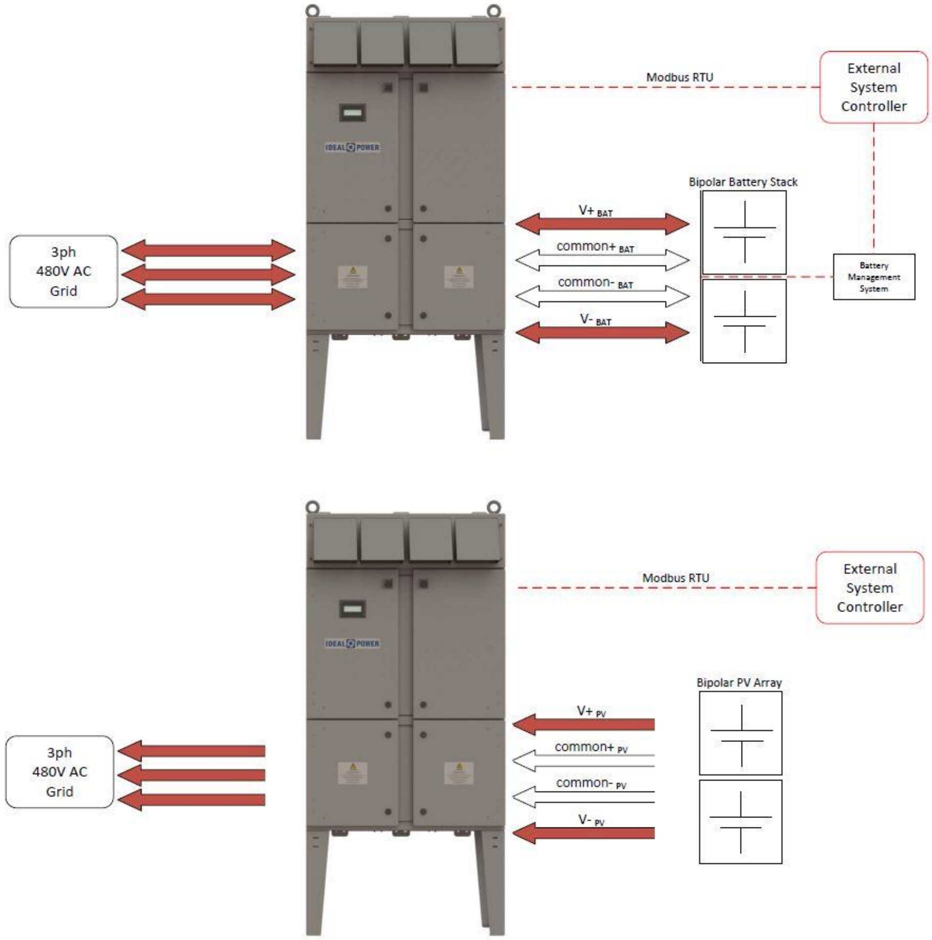


Figure 1: 125B2-4F Power Converter Design Example

4 Wire Connection

To ensure NEC compliance, IPWR recommends that the positive and negative DC input wiring be in separate conduits (two current-carrying conductors per conduit) for each active DC Port back to the Converter. If 2000 V rated wire is utilized and your local Inspector approves of such designs, the conductors may share a common conduit. Otherwise two independent conduits for each DC Port are recommended as noted above.

Single conduit approval is the responsibility of the system designer. Ideal Power will assume no responsibility for such design approaches: they must be reviewed and approved by local Inspectors, and/or Authorities Having Jurisdiction (AHJ), prior to system deployment.

3.2 External Disconnect

AC Disconnect

Note that the 125B2-4F Converter does not include internal AC disconnects. Individual Converter disconnects are covered under NEC code requirements for high-power battery systems. Additional requirements for AC disconnects will depend on the AHJ and electric utility interconnection requirements.

DC Disconnect

The 125B2-4F Converter does not have integrated DC Disconnects. Note that code requirements for energy storage and solar PV vary by jurisdiction. A single DC Disconnect located at the source may suffice; however, in many instances, a second disconnect is required, specifically if the DC source is remotely located with respect to the Converter. Check with your local AHJ and utility interconnection requirements to determine system disconnect requirements.

3.3 Converter Enclosure

The Converter is designed to be ground mounted with wall stabilization tabs installed to a load capable structure for support, and should only be installed by certified personnel. Installation locations may be on either interior or exterior walls. The enclosure's nominal dimensions are 34" W x 54" H x 16" D. The Converter weighs approximately 425 pounds.

The NEMA 3R rated enclosure includes a sealed electronics compartment. This center electronic compartment is never to be opened or serviced by field personnel. **Any attempt to do so will void the manufacturer's warranty.**

1. Air exhaust vents (4)
2. Front panel display
3. Electronics doors (do not open)
4. Wiring compartment for AC port, Modbus and auxiliary power
5. Wiring compartment for DC port

Figure 2: Converter Front View

Fans: Four fans circulate air through the Converter from the bottom to the top.

Display: The LCD Display is detailed later in this document.

Electronics Doors: Do not open; no field serviceable components inside, opening the doors will void the Converter warranty.

Wiring Compartment Doors: Open only for initial installation, commissioning and troubleshooting. Hazardous DC and AC voltages are present.

3.4 Wiring Compartment Overview

The wiring compartment doors provide access to the electrically isolated DC and AC wiring connections, as well as Modbus communication interfaces.

The wiring compartment bottom bulkhead is designed to accommodate both DC and AC conduit penetrations, up to 2 inches in diameter. All conduit penetrations must be made to the removable bottom covers, no side conduit access is allowed.

A. AC L1
B. AC L2
C. AC L3
D. AC Neutral
E. Negative monopole DC-
F. Negative monopole common
G. Positive monopole common
H. Positive monopole DC+
I. Ground

Figure 3: Wiring Compartment

(Safety plexi-glass covers not shown in above figure for clarity)

3.5 Integrated Safety Features

The 125B2-4F Converter incorporates the following integrated safety features.

Table 1: Converter Safety Features

Feature	Action
Internal wiring compartment safety covers	Prevents access to hazardous voltages and protects internal circuitry.

DC input ground fault detection	Takes the Converter off-line when a DC input ground fault is detected on the DC Port.
DC and AC overcurrent and overvoltage detection. AC Frequency out of range	The Converter shuts down if DC input voltages or currents are out of range, or if the AC voltages and currents are out of range. The Converter also shuts down if the AC frequency is out of range.
Anti-islanding protection	The Converter shuts down immediately during grid outages.

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Ground Fault Detection

During Converter operation the two monopole commons in the DC Port are connected together, placing the energy storage system or PV array in series to provide optimum DC working voltage. For the DC Port, the negative common leg of the positive monopole and the positive common leg of the negative monopole remain referenced to ground through a 2 A GFDI fuse Littlefuse part number KLKD2 in order to detect ground fault conditions. If such conditions are detected, the Converter is automatically taken off-line. The Converter will not attempt to restart until the fault condition has been cleared, and AC Power has been cycled. If the ground fault detection fuse is blown in either of the DC Ports, the fuse must be replaced in order for the Converter to attempt a restart.

AC Voltage and AC Current Fault Detection

The output voltage is synchronized to the AC utility line. The Converter operates as a current source following the grid voltage waveform. Should the Converter experience a DC or AC fault condition (voltage or current beyond specification), it is automatically taken off-line. The Converter is shipped from the factory with a default 5-minute restart countdown timer.

Frequency Fault Detection

The quality of the power delivered to the utility line meets or exceeds the requirements as specified in IEEE 1547a. If the utility frequency or voltage shifts outside of the regulatory specified limits, the Converter will automatically detect the condition and shuts down. The restart time in the event of an abnormal condition is field programmable. The Converter is shipped from the factory with a default five-minute restart counter for AC Frequency faults. All restart countdown timers are programmable via the Modbus Interface. Changes to these timers are only allowed by approved personnel.

DC Over/Under Voltage Fault Detection

The Converter also contains over-voltage (default is 1000 Vdc) and under-voltage (default is 200 Vdc) detection circuitry: if either of these limits are exceeded, the system will shut down, or if commanded to make power, it will not start. These default limits may be changed via the Modbus interface by approved personnel only.

3.6 Regulatory Information

The 125B2-4F is certified to the following standards for the North American market:

- **UL 1741**: Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
- **IEEE 1547a:** IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
- **National Electric Code** 2014 ANSI/NFPA 70: National Electrical Code (*NEC*)

International Certifications are pending, once these certifications are completed, this document will be updated to reflect those certifications.

4.0 Converter Mounting

This section describes how to mount the Converter. Read this entire section and plan your Converter layout accordingly. Upon receipt, unpack the Converter and carefully inspect the unit for shipping damage, note the Converter's Serial Number and save the enclosed Warranty Card. Execute and return the Warranty Card to Ideal Power once the Converter is installed or register warranty online at www.idealpower.com/customers.

The installation method and mounting location must be suitable for the weight and dimensions of the Converter. The installation shall be mounted on a solid non-combustible surface. The 18" legs, included with the converter, should be used in NEMA 1 installation locations. NEMA 3R Locations shall have the 18" Leg Extension Kit installed to ensure a 36" leg height.

The Converter is designed for a vertical installation. **Do not install horizontally, and avoid locations that are exposed to direct sunlight.** Horizontal installations are acceptable for initial system bench evaluation and prototyping.

4.1 Clearance and Spacing Considerations

Multiple Converters may be installed adjacent to one-another on a wall; however, take care to observe minimum clearances from unit to unit, as well from walls, and other obstructions to ensure adequate cooling airflow. Local electrical codes may require larger working clearances than those noted below.

Required Clearances:

- Above: 12 inches, (300 mm)
- Below: 18 inches, (450 mm)
- Left: 2 inches, (50 mm)
- Right: 2 inches, (50 mm)
- Front: 34 inches, (864 mm)

4.2 Enclosure Dimensions

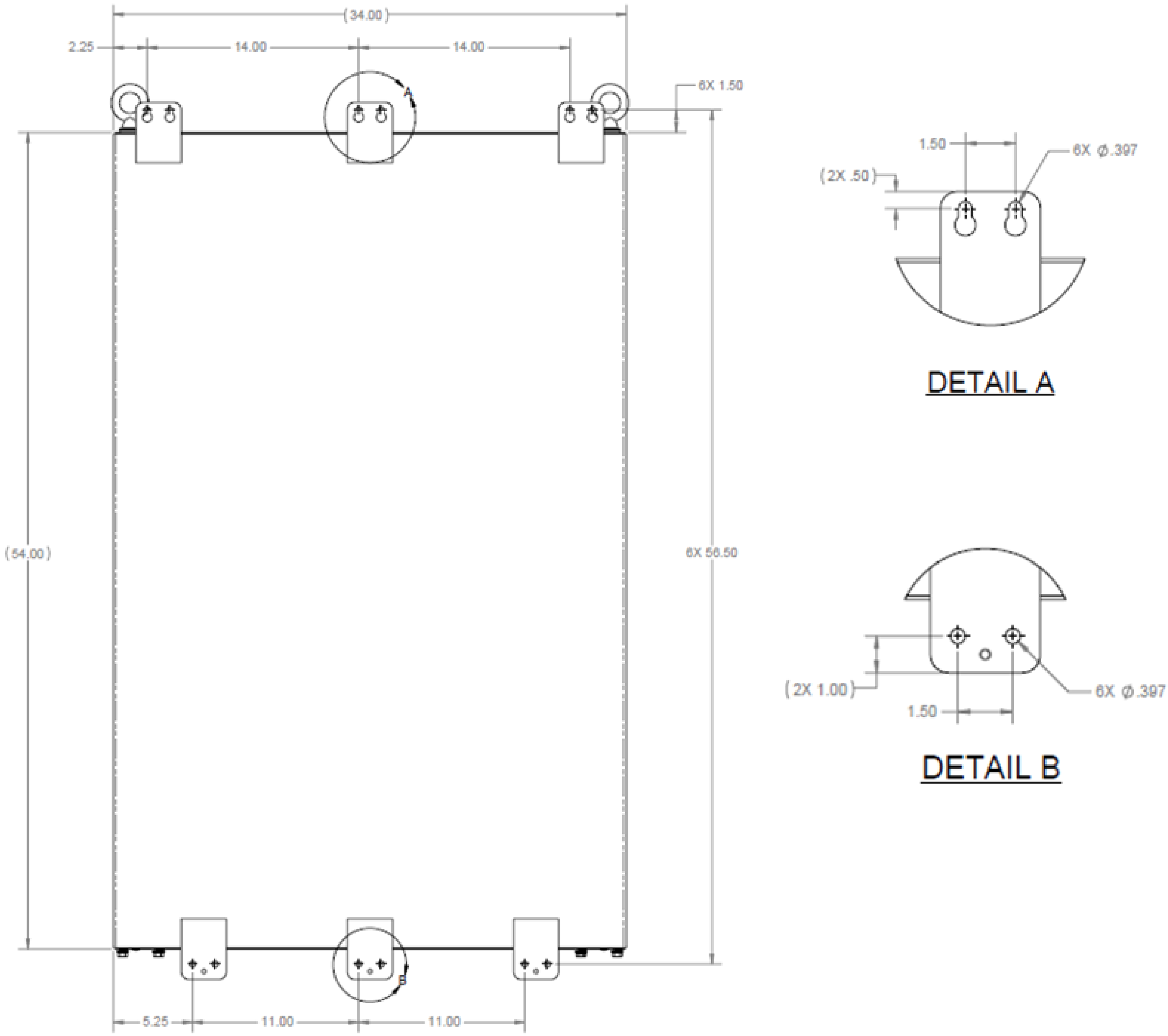

Figure 4: Enclosure Rear View

The Converter includes six stabilization tabs total: (3) tabs on top spaced 14” O.C. and (3) on bottom spaced 11” O.C. The tabs are intended to accommodate standard 3/8” bolts and are used for stabilization purposes only.

Table 2: Converter Mounting Dimensions

Description	Dimension
Horizontal center to center of stabilization holes	14” Top and 11” Bottom
Center of bottom stabilization hole to center of top key stabilization hole (final stabilization dimension)	56.5”

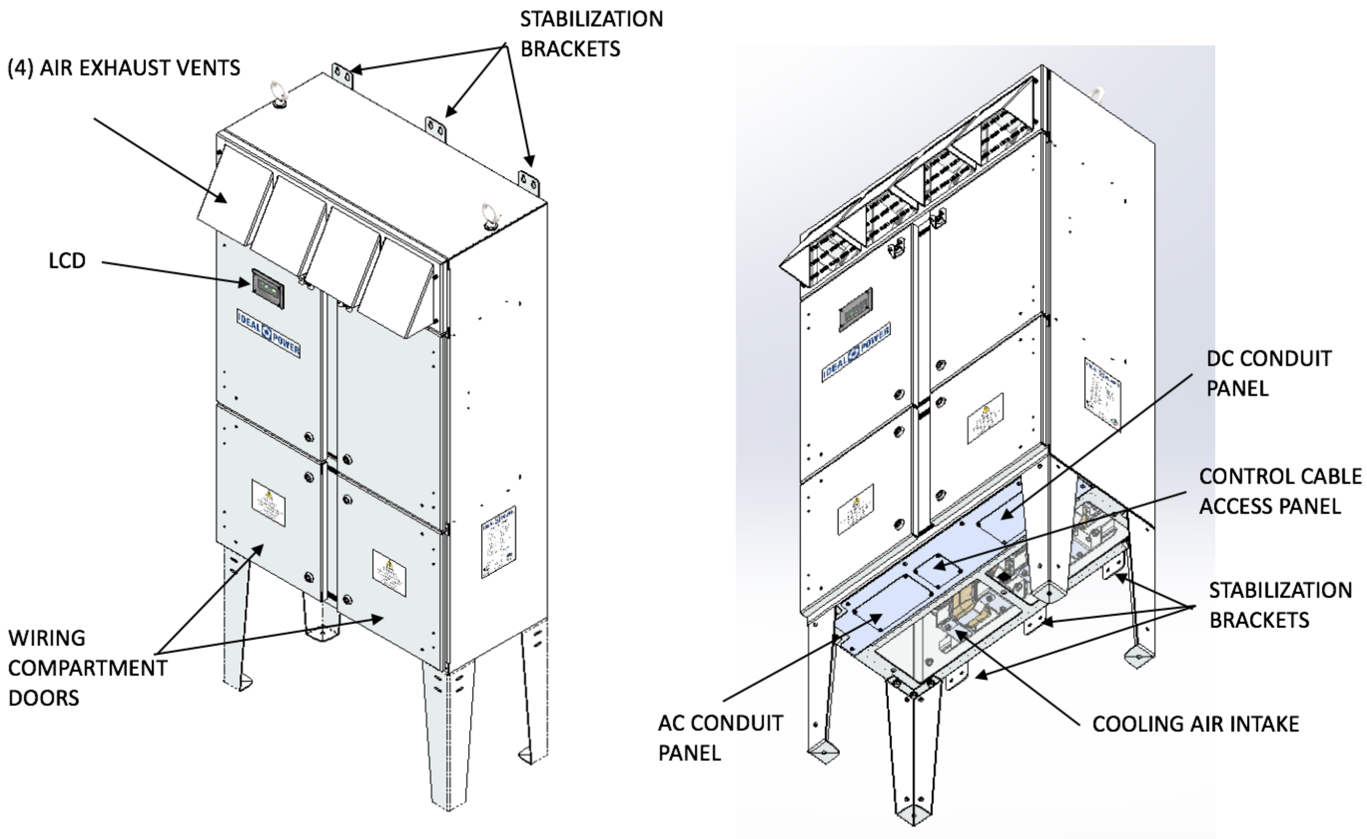

Figure 5: Enclosure 3-D Perspective

4.3 Conduit and Wiring Considerations

Beyond the mechanical considerations noted above, the routing of AC, DC, and low-voltage conduit must also be considered when designing the Converter system layout. All conduit penetrations must be made to the bottom of the Wiring Compartment: side penetrations are not permitted. All systems that are in a NEMA 3R environment must be installed with water tight conduit and NEMA 3R fittings.

5.0 Electrical Connections

The 125B2-4F Converter has terminal connector to compression fitting adapters: supporting bare wire termination and eliminating the need for field crimping.

The AC neutral and the DC common inputs also utilize separate compression terminals: the compression terminal is a bare wire type. – No terminal lug is required for these connections.

CAUTION	**Caution:** If the supplied terminal connector adapter is not used, field wiring to fuse posts must be made by an UL-listed ring lug terminal sized for the specified wire gauge on the fused AC and DC connections. The connector must be fixed by using the crimping tool specified by the connector manufacturer.
CAUTION	**Caution:** All field wiring must conform to the codes set forth in the National Electric Code ANSI/NFPA 70.

5.1 Converter Ground

1/4" ground lugs are located in the fuse tray, one of the lugs should be connected to the building's Earth Ground. Ground conductor size must be of equivalent size to the AC conductors. In accordance with 14.2.3(a), an inverter provided with a fixed ac output shall inform the installer that the input and output circuits are isolated from the enclosure and that system grounding, when required by Sections 690.41, 690.42, and 690.43 of the National Electric Code, ANSI/NFPA 70, is the responsibility of the installer;

5.2 Observe Safety Procedures

Once the conduit assemblies have been completed, and AC and DC Disconnects have been verified to be in the OFF position, route and connect the AC and DC power cables. Follow standard lockout procedures to ensure installer safety.

DANGER	**HIGH VOLTAGE** The AC and DC cables may carry hazardous voltages. Open both the DC and AC disconnect switches and wait five minutes before opening the bottom cover of the unit to access the AC, DC, and Modbus interface connections.

A. AC L1
B. AC L2
C. AC L3
D. AC Neutral
E. Negative monopole DC-
F. Negative monopole common
G. Positive monopole common
H. Positive monopole DC+
I. Ground

Figure 6: Wiring Compartment
(Safety plexi-glass covers not shown in above figure for clarity)

5.3 AC Power Connection

Connect the 3-480 Vac phase legs to terminals A, B and C; (L1, L2, and L3), utilizing the supplied compression terminal adapters as described above. The order of the phases is not critical as the Converter will sense and follow the AC grid. All power is made between the phase legs: no neutral connection ("D") is required. Connect the external AC Ground to the terminal labeled "ground". Intended wire size is 2/0 AWG, AC lugs can accommodate wire sizes 14 AWG to 2/0 AWG. Torque all connections as outlined in Table 3.

Notes:

1. *Although a neutral connection is not required, the phase legs must be must be balanced, and correctly referenced to one-another: (480 V measured between individual phase legs), and correctly referenced to neutral or earth ground, if no neutral wire is available. (277 V measured from each phase leg to neutral, or earth ground).*

2. *Corner-grounded (often called "b-grounded") Delta connections are not supported! Connecting the Converter to such grounded-leg systems may damage the Inverter and will immediately void the warranty.*

3. *An isolation transformer is required to support corner grounded Delta connections. Contact Ideal Power if you intend to use the Converter in such applications.*

5.4 DC Power Connections

At Port DC3, connect the Negative Monopole DC- to terminal E; connect the Positive Monopole DC+ to terminal H. Connect the Negative Monopole common to terminal F, and the Positive Monopole common to terminal G. DC lugs can accommodate 6 AWG to 250 MCM. Intended wire size is to be 250 MCM Torque all connections as outlined in Table 3.

Table 3: Terminal Tightening Torques

Lug Type	Tightening Torque
DC lugs, AC neutral lug	275 in-lb
AC phase lugs	120 in-lb

5.5 Modbus Connection

The center section of the Wiring Compartment is for the use of low-voltage Modbus cabling only. Do not route or place high voltage AC or DC wiring in this area.

5.6 Verification of Electrical Connections

The 125B2-4F Converter has a sophisticated system for detecting and responding to a ground fault.   The DC3 Port requires a bipolar wiring configuration, where the center-tap "common" is referenced to the internal grounding system of the Converter via a dedicated 2 A GDFI fuse. In the presence of a detected ground fault, or blown fuse, the Converter will be shut down and not attempt to respond to control commands, and a ground-fault condition will be reported on the Front-Panel LCD.

 DANGER	This symbol indicates **HIGH VOLTAGE**. It calls your attention to items or operations that could be dangerous to you and other persons operation this equipment. Read the message and follow the instructions carefully.
 WARNING	This symbol is the Safety Alert Symbol. **WARNING**: Indicates a potentially hazardous situation that, if not avoided, can result in serious injury or death. Do not proceed beyond a **WARNING** notice until the indicated conditions are fully understood and met.

5.7 Verify AC and DC Wiring

Use the following procedure to verify final Converter wiring after completing the AC, DC and Ground wiring as detailed in Section 5. High voltages are present, and only qualified personnel following safety procedures detailed in Section 2 should attempt the following:

1. Open all AC and DC Disconnects
2. Open Wiring Compartment Cover
3. Close external AC Disconnect connected to Port AC1
    a. Using a DMM on the AC voltage scale, verify that 480 Vac 3-phase power is present on the AC terminals. Measuments from each individual phase-leg to ground should read 277 Vac.
    b. If the observed AC measurements do not meet the above requirements, immediately open the AC Disconnect, and remedy any AC wiring faults.

4. Close the external DC Disconnect connected to Port DC3.
    a. Using a DMM on the DC voltage scale, measure the two bipolar inputs. Open circuit battery voltages of 500 Vdc positive and 500 Vdc negative are an absolute maximum.
    b. If observed DC voltages are higher than 500 Vdc, any/or outside of the battery pack design expectations, open the DC Disconnect, and remedy DC wiring faults
    c. Verify that the Front Panel Display indicates no faults, and that “idle” is indicated in the status field.
    d. Compare the Front-Panel Display voltage measurements to DMM observations
    e. Utilize the Modbus Interface and the Ideal Power Modbus toolkit to digitally confirm the readings noted above.
5. Close the Wiring Compartment Doors.

6.0 Maintenance and Troubleshooting

6.1 Operating and Shutdown Conditions

The Converter is shipped in an idle power state, and will not respond to power export or import commands, as sent over the Modbus Interface, until the following conditions have been met:

- All external AC and DC Disconnects are closed.
- No DC Port input ground faults have been detected.
- DC Port input voltages are within the specified operating range, as set by the Modbus Interface.
- AC grid frequency and voltage are within specified UL 1741 range, and islanding is not detected.
- There are no sensed fault conditions, as defined in Section 7.

6.2 Forced Air Vents

Ensure that the forced air intake and exhaust vents on the bottom and front of the Converter are not obstructed.

6.3 Annual Preventive Maintenance

The procedures in this section are to be performed only by qualified personnel.

	**HIGH VOLTAGE** To eliminate high voltages inside the Converter enclosure: • All DC Disconnects must be open. • All AC Disconnects must be open. • Wait at least <u>five minutes</u> for internal capacitors to discharge Do not remove the Wiring Compartment cover until the Converter has been rendered safe in this manner.

Verifying Proper Airflow

Check the bottom airflow intake screen and ensure that the forced air intake and exhaust vents on the bottom and at the top front of the Converter are not obstructed. Clean the screens if airflow has been restricted, due to dust or other debris.

Power Terminals

Annually, re-torque the power terminals listed to the specified torque levels as shown in Table 3.

1. Open the DC Disconnect and lock in the open position.
2. Open the AC Disconnect and lock in the open position.
3. Wait at least five minutes for the Converter internal capacitors to discharge to safe voltage levels.
4. Remove the Wiring Compartment cover.
5. Using a calibrated torque wrench fitted with an appropriate driver tip, tighten the terminals listed in to the specified torque levels (stated torque levels conform to UL 1741: Table 66.1). Please refer to Table 3 for specified torque levels.

Cooling Fan Inspection

1. Open the AC Disconnect and remove the upper fan cover. Clean if necessary.
2. Inspect the fans for damage, tight bearings, or debris buildup.
3. Replace the cover, and restore AC power.
4. With the Converter operating, verify that all fans are operating, with no appreciable bearing or mechanical noise.
5. If a fan has failed, or is suspect, contact Ideal Power.

6.4 Converter Troubleshooting

Do not open the center electronics compartment cover; there are no user-serviceable components inside. **Opening this compartment will void the warranty, expose hazardous voltages, and impair performance.** The only field serviceable components in the Converter are: AC fuses, DC fuses, DC Ground-Fault fuses, and cooling fans.The procedures in this section are to be performed only qualified personnel. Spare part kits are available for purchase from Ideal Power Inc.

HIGH VOLTAGE

To eliminate high voltages inside the Battery Converter enclosure:

- The AC Disconnect must be open.
- The DC Disconnects must be open.
- Wait at least five minutes for capacitors to discharge

Do not remove the Wiring Compartment cover until the Converter has been rendered safe in this manner.

Clearing GFDI Faults

In the event of a Converter ground fault the Converter will cease exporting or importing power. The fault will be noted on the front panel display. If the fault exceeds 2 A, the ground fault detection fuse will open. The DC3 Port has its own dedicated ground fault detection circuit and fuse.

If a ground fault is indicated on the DC Port, inspection and repair of wiring should be referred to qualified personnel. Once the ground fault has been cleared, check the display for indications that the ground fault has been corrected. If the display indicates the ground fault interruption fuse has opened, follow the procedure below to replace the ground fault fuse. Use an identical KLKD2 2 A fuse type for replacement.

AC Fuse Fault/Dark Front Panel

If the display is dark, one or more of the AC output fuses, may be open. Follow the fuse inspection and replacement procedure below. If the any of the AC fuses fails again, soon after replacement, contact Ideal Power for assistance.

DC Fuse Fault

DC fuse failures are highly unlikely. Use the following procedure to check the fuses.

Fuse Inspection and Replacement

Use the following procedure to measure the electrical continuity of these fuses. See Table 4 for fuse locations and types.

1. Open DC Disconnect and lock in the open position.
2. Open the AC Disconnect and lock in the open position.
3. Wait at least five (5) minutes for Converter capacitors to discharge to safe voltage levels.
4. Open the Wiring Compartment: by unlocking four latches.
5. Using a digital multi-meter (DMM) set to continuity or resistance range; connect across each fuse to determine if the fuse is open (high resistance) or intact (short).
6. Check all AC fuses (3); DC fuses; and GFDI fuse.
7. If a fuse is open, remove it from the fuse holder and replace it with a new fuse of the same rating and type.

8. Close the Wiring Compartment and lock the latches.

If any replaced fuse fails immediately after replacement, inspect both the AC and DC wiring. Inspection and repair of such wiring should be referred to qualified personnel. Contact Ideal Power if the failures cannot be attributed to faulty wiring.

Table 4: Fuse Chart

Fuse Name	**AC Fuses**	**DC Fuses**	**GFDI Fuse**
Fuse Count	3	2	1
Type and Rating	Semiconductor type 200 A, 500 V AC fast Ferraz Shawmut A50QS200-4 or equivalent	Semiconductor type 300 A, 700 V DC fast Ferraz Shawmut A70QS300-4 or equivalent	Littelfuse, KLKD2 2 A
Location	Left side of Bottom Wiring Compartment	Right side of Bottom Wiring Compartment	Right side of Bottom Wiring Compartment
Fuse Function	Protects 480 V AC outputs against excessive current and wiring shorts	Protects DC inputs against excessive array currents and wiring shorts	Isolates the ground fault current in the event of a detected ground fault condition

7.0 Front Panel Display

The 4-Line x 20 Character Front Panel Display provides a rich information set to installers, operators, as well as to system designers responsible for developing system-level control and monitoring software.Tem separate system status screens are displayed in a rotating manner. All of the front panel display information is also available via the Modbus serial interface. Note that the following section refers to DC2, which is an additional DC port planned for a future 125 kW IPWR product.

7.1 Timestamp / Power

The System Timestamp and Port Power screen displays date and time (US – Central Standard Time is the default clock setting), as well as individual port voltage, current and power as detailed in the mockup below.

```
11/26/2014  09:15:40
AC1 480V  36A   30kW
DC2   0V   0A     0W
DC3 698V  43A   30kW
```

7.2 Mode / Method

The Mode / Method screen details individual port Operating Mode and applicable Port Control Method. After AC and DC Port wiring has been completed, the displayed Method for each Port should be “Idle”, indicating that the system remains in a sleep condition awaiting Modbus configuration and control commands from an external system controller. Note that the mockup below indicates that the external system controller has reconfigured the system to move power between AC1 and DC3.

```
Port Mode   Method
AC1  AC-3W  AC Pwr
DC2  DC     Idle
DC3  DC     Net Pwr
```

7.3 AC1 Digital Multimeter (DMM)

The AC1 screen displays average line-to-line voltage, as well as all three line-to-neutral voltages. It also displays line-to-line AC current, AC power and measured grid frequency.

```
480VAC 30000W 60.0Hz
277Van 480Vab  36.1A
277Vbn 480Vbc  36.1A
277Vcn 480Vca  36.1A
```

7.4 Converter Version

The Version screen details the systems firmware revision and release date (line 1); model number (line 2); IPWR product SKU (line 3); and Serial Number (line 4).

```
Ver 1108 Dec 11 2015
Mod 125B2-4F
SKU 16_character_SKU
Ser L381500000000
```

7.5 Environmental

The Environmental screen displays case and heatsink temperatures, relative humidity and cooling fan status. Note that all fans are off when the system is idle. There are two fan systems: internal, which cools the control board and related in-cavity electronic components, and external, which cools the power switching core heatsink with outside air. Note that the fans only run when the system is moving power between active Ports: fan speed is proportional to internal heatsink temperature.

```
tCase 60.0C
  tHS 70.0C
   RH 25.0%
 Fans (i)Off (e)Off
```

7.6 Modbus

The Modbus screen displays the configuration of the Serial RS485 Modbus Interface. System defaults are displayed in mockup below: RTU (remote terminal unit - cannot be changed); Address (240); Baud (19.2 kHz); E2 (even parity/2 stop bits).

```
RTU MODBUS Settings
Address 240
Baud 19200 E2
```

7.7 kWh Summary

Each Port supports bi-directional power flows: this screen provides a lifetime summary of import (power flow into the noted Port, signed negative); export (power out of the noted Port, not signed but positive); and Net (Net = sum of export + import) energy flows in the Converter.

Note that P1 = AC1; P2 = DC2; and P3 = DC3.

```
kWh     In    Out    Net
P1     500    500      0
P2       0      0      0
P3     500    500      0
```

7.8 Fault/Status

Line 1 is the most recent fault name; line 2 is the severity; line 3 current status of the fault. The 4th line is the fault limit and the current value reported: both values are in decimal. The right side fault status bits (8 total) are reserved for remote system debug, and are typically not useful for the system installer, or operator.

```
Fault:EF2L  000300A0
lockdown    00000000
occurred    00000000
 17      0  00000000
```

Faults are detailed in the following section: "EF2L" for example indicates that cooling Fan 2 is in a locked condition. A separate Modbus User's Guide further details the scope of the Converter's fault reporting and fault processing capabilities. A short overview of reported faults is provided in Section 8.

There are five levels of fault severity (line 2)

- **lockdown** – indicates that the system aborted and will not restart without external intervention by the system controller
- **abort –** indicates that system has shut down (will not export or import power) due to fault

condition, but will automatically countdown and restart once fault clears

- **alert –** indicates that abnormal condition noted, but system did not abort, or enter lockdown
- **alarm –** indicates that system noted a limit violation (such as Port DC over/under voltage, relative to externally programmed min/max limits), but did not abort, or enter lockdown
- **info –** information only, system not in lockdown, abort, alert, or alarm

There are four levels of current status (line 3)

- **faulting** – the converter is experiencing the indicated fault at the present time
- **occurred** – the fault on line 2 is the most recent fault reported, now clear
- **no_fault** – no fault has been reported since last AC power cycle
- **disabled –** all conditional logic for the specific fault reported has been disabled, so this condition is ignored by Converter's internal fault management processor

As indicated above, line 4 reports the fault limit, and measured fault value. Fault limits are further detailed in the Modbus User's Guide.

No fault conditions, other than externally driven faults such as AC over/under voltage, AC over/under frequency or DC min/max voltage violations are generally encountered during initial system installation.

As noted earlier, the system is installed in an "all Ports idle" configuration state. No Port-to-Port power transfers can or will occur until the system is configured and commanded to move power by an external system controller.

8.0 Converter Fault/Status Codes

The Fault and Status codes detailed below are shown on the Front Panel Display: Section 7; and are also available via the Modbus Interface.

Table 5: Fault/Status Codes

ID	Name/Code	Type	Condition	Comments	Corrective Action
0	**ACSG**	AC1 surge detect	AC1 input surge detected (detection pulse high for minimum cycles)		
1	**D2SG**	DC2 surge detect	DC2 surge detected (detection pulse high for minimum cycles)		

2	**D3SG**	DC3 surge detect	DC3 surge detected (detection pulse high for minimum cycles)		
3	**D2GI**	DC2 GFDI excess gnd current	DC2 GFDI current > limit		
4	**D2GF**	DC2 GFDI blown fuse	blown_fuse flag = '1'	unit in lockdown due to open DC2 GFDI fuse	replace DC2 GFDI fuse
5	**D3GI**	DC3 GFDI excess gnd current	DC3 GFDI current > limit		
6	**D3GF**	DC3 GFDI blown fuse	blown_fuse flag = '1'	unit in lockdown due to open DC3 GFDI fuse	replace DC3 GFDI fuse
7	**RFDT**	Abnormal RF Detection	High RF detect flag = '1'	bypassed with hcr_d_diag_out.r0(8) (bit 8 of register 500)	
8	**BTMP**	Board-detect bad temp	shutdown_brdtemp = '1'		
9	**FTMP**	FPGA-detect bad temp (ADC check)	heatsink temperature reading < lower lim OR heatsink temperature reading > upper lim		
10	**B24V**	board-detect bad 24V supply	shutdown_p24v = '1'		
11	**F24V**	FPGA-detect bad 24V supply (ADC check)	24V supply reading < lower lim OR 24V supply reading > upper lim		
12	**IF1L**	int fan 1 locked	int fan 1 locked flag = '1'	software alarm only	
13	**IF2L**	int fan 2 locked	int fan 2 locked flag = '1'	software alarm only	

14	**EF1L**	ext fan 1 locked	ext fan 1 locked flag = '1'	software alarm only	
15	**EF2L**	ext fan 2 locked	ext fan 2 locked flag = '1'	software alarm only	
16	**EF3L**	ext fan 3 locked	ext fan 3 locked flag = '1'	software alarm only	
17	**EF4L**	ext fan 4 locked	ext fan 4 locked flag = '1'	software alarm only	
18	**BIFL**	int fan 1 and int fan 2 locked	both internal fans locked	unit in lockdown if both internal fans locked	check internal fan(s) and fuses
19	**BEFL**	any 2 ext fans locked	any 2 external fans locked	unit in lockdown if at least 2 external fans locked	check external fan(s) and fuses
20	**ACAG**	AC1 line A (w.r.t. ground) overvoltage	AC1 A-gnd voltage > limit		
21	**ACBG**	AC1 line B (w.r.t ground) overvoltage	AC1 B-gnd voltage > limit		
22	**ACCG**	AC1 line C (w.r.t. ground) overvoltage	AC1 C-gnd voltage > limit		
23	**ACAB**	AC1 line A-line B overvoltage	AC1 A-B line-to-line voltage > limit		
24	**ACBC**	AC1 line B-line C overvoltage	AC1 B-C line-to-line voltage > limit		

25	**ACCA**	AC1 line C-line A overvoltage	AC1 C-A line-to-line voltage > limit		
26	**D2PG**	DC2 P/+ terminal (w.r.t ground) overvoltage	DC2 P-gnd voltage > limit		
27	**D2NG**	DC2 N/- terminal (w.r.t. ground) overvoltage	DC2 N-gnd voltage > limit		
28	**D3PG**	DC3 P/+ terminal (w.r.t. ground) overvoltage	DC3 P-gnd voltage > limit		
29	**D3NG**	DC3 N/- terminal (w.r.t. ground) overvoltage	DC3 N-gnd voltage > limit		
30	**D2PN**	DC2 PN overvoltage	DC2 PN (term-to-term) voltage > limit		
31	**D3PN**	DC3 PN overvoltage	DC3 PN (term-to-term) voltage > limit		
32	**D2UV**	DC2 PN undervoltage	DC2 PN (term-to-term) voltage < limit and exporting		Adjust register 225 to voltage < lowest DC2 voltage
33	**D3UV**	DC3 PN undervoltage	DC3 PN (term-to-term) voltage < limit and exporting		Adjust register 325 to voltage < lowest DC2 voltage
34	**D2PL**	Bad DC2 polarity (negative)	DC2 PN (term-to-term) voltage < -limit (negative voltage observed)	Check DC2 config for reverse polarity	Ensure positive DC2 polarity
35	**D3PL**	Bad DC3 polarity (negative)	DC3 PN (term-to-term) voltage < -limit (negative voltage observed)	Check DC3 config for reverse polarity	Ensure positive DC3 polarity
36	**LAOV**	Link A overvoltage	Link A voltage > limit and exporting	protects IGBT/link, limit to 1200V	

37	**LBOV**	Link B overvoltage	Link B voltage > limit and exporting	protects IGBT/link, limit to 1200V	
38	**LACM**	Link A common-mode shift	Link A common-mode differential > limit and exporting	limits IGBT stress/forward bias, limit to 400V	
39	**LBCM**	Link B common-mode shift	Link B common-mode differential > limit and exporting	limits IGBT stress/forward bias, limit to 400V	
40	**LAOI**	Link A overcurrent	Link A current > limit and exporting	protects IGBT/link against overcurrent, limit to 300A single/600A dual	
41	**LBOI**	Link B overcurrent	Link B current > limit and exporting	protects IGBT/link against overcurrent, limit to 300A single/600A dual	
42	**LASV**	Link A starved (under min required energy)	Link A voltage < min required/first input at power cycle start	limits IGBT stress/forward bias, limit to 100V; indicates link A energy is too low to continue	
43	**LBSV**	Link B starved (under min required energy)	Link B voltage < min required/first input at power cycle start	limits IGBT stress/forward bias, limit to 100V; indicates link B energy is too low to continue	
44	**LAPL**	Link A P-terminal to port terminal overvoltage	abs(link A P-term - any terminal) > limit	protects IGBT CE overvoltage, limit to 1200V	
45	**LANL**	Link A N-terminal to port terminal overvoltage	abs(link A N-term - any terminal) > limit	protects IGBT CE overvoltage, limit to 1200V	
46	**LBPL**	Link B P-terminal to port terminal overvoltage	abs(link B P-term - any terminal) > limit	protects IGBT CE overvoltage, limit to 1200V	
47	**LBNL**	Link B N-terminal to port terminal overvoltage	abs(link B N-term - any terminal) > limit	protects IGBT CE overvoltage, limit to 1200V	
48	**F1AB**	AC1 AB conduction excess forward bias	ac1_v_ab > link_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	

49	**F1BC**	AC1 BC conduction excess forward bias	ac1_v_bc > link_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	
50	**F1CA**	AC1 CA conduction excess forward bias	ac1_v_ca > link_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	
51	**F1AN**	AC1 AN conduction excess forward bias	ac1_v_an > link_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	
52	**F1BN**	AC1 BN conduction excess forward bias	ac1_v_bn > link_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	
53	**F1CN**	AC1 CN conduction excess forward bias	ac1_v_cn > link_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	
54	**FID2**	DC2 PN input conduction excess forward bias	dc2_v_pn > link_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	
55	**FID3**	DC3 PN input conduction excess forward bias	dc3_v_pn > link_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	
56	**FOD2**	DC2 PN output conduction excess forward bias	link_v_pn > dc2_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	
57	**FOD3**	DC3 PN output conduction excess forward bias	link_v_pn > dc3_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	
58	**F3AB**	AC3 AB conduction excess forward bias	ac3_v_ab > link_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	

59	**F3BC**	AC3 BC conduction excess forward bias	ac3_v_bc > link_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	
60	**F3CA**	AC3 CA conduction excess forward bias	ac3_v_ca > link_v_pn at conduct start	limits IGBT stress due to forward bias switch-on (hard-switching), limit to 100V	
61	**LKTM**	Link A or Link B manager FSM state timer expiration	linkA_state_timer > limit or linkB_state_timer > limit	most likely indicates user/operator error or configuration error	check current/voltage limits on AC/DC supplies
62	**BKST**	Bad link A blackstart during normal ops or bad link B blackstart during normal ops	bad link A blackstart flag = '1' or bad link B blackstart flag = '1'	most likely indicates HW error/failure or problem in harness/cabling	check link HW/harness or blackstart circuitry
63	**METH**	Invalid method selection	Invalid method selected and commanded to export	most likely indicates user/operator error in defining methods/controls	check method and control register settings
64	**ISLD**	AC1 or AC3 islanding detected (grid-tied)	Islanding detected while exporting and grid-tied (islanding correlation value > threshold)	required per UL 1741/IEEE 1547, grid-tied operations	
65	**AUV0**	Grid-tied AC line-neutral RMS undervoltage level 0	AC RMS line-neutral voltage < limit 0 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
66	**AUV1**	Grid-tied AC line-neutral RMS undervoltage level 1	AC RMS line-neutral voltage < limit 1 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
67	**AUV2**	Grid-tied AC line-neutral RMS undervoltage level 2	AC RMS line-neutral voltage < limit 2 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
68	**AUV3**	Grid-tied AC line-neutral RMS undervoltage level 3	AC RMS line-neutral voltage < limit 3 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
69	**AUV4**	Grid-tied AC line-neutral RMS undervoltage level 4	AC RMS line-neutral voltage < limit 4 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	

70	**AUV5**	Grid-tied AC line-neutral RMS undervoltage level 5	AC RMS line-neutral voltage < limit 5 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
71	**AOV3**	Grid-tied AC line-neutral RMS overvoltage level 0	AC RMS line-neutral voltage > limit 0 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
72	**AOV4**	Grid-tied AC line-neutral RMS overvoltage level 1	AC RMS line-neutral voltage > limit 1 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
73	**AOV5**	Grid-tied AC line-neutral RMS overvoltage level 2	AC RMS line-neutral voltage > limit 2 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
74	**AOV3**	Grid-tied AC line-neutral RMS overvoltage level 3	AC RMS line-neutral voltage > limit 3 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
75	**AOV4**	Grid-tied AC line-neutral RMS overvoltage level 4	AC RMS line-neutral voltage > limit 4 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
76	**AOV5**	Grid-tied AC line-neutral RMS overvoltage level 5	AC RMS line-neutral voltage > limit 5 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
77	**AUF0**	Grid-trid AC frequency under limit 0	AC frequency < limit 0 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
78	**AUF1**	Grid-trid AC frequency under limit 1	AC frequency < limit 1 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
79	**AUF2**	Grid-trid AC frequency under limit 2	AC frequency < limit 2 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	

80	**AUF3**	Grid-trid AC frequency under limit 3	AC frequency < limit 3 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
81	**AUF4**	Grid-trid AC frequency under limit 4	AC frequency < limit 4 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
82	**AUF5**	Grid-trid AC frequency under limit 5	AC frequency < limit 5 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
83	**AOF0**	Grid-tied AC frequency over limit 0	AC frequency > limit 0 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
84	**AOF1**	Grid-tied AC frequency over limit 1	AC frequency > limit 1 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
85	**AOF2**	Grid-tied AC frequency over limit 2	AC frequency > limit 2 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
86	**AOF3**	Grid-tied AC frequency over limit 3	AC frequency > limit 3 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
87	**AOF4**	Grid-tied AC frequency over limit 4	AC frequency > limit 4 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	
88	**AOF5**	Grid-tied AC frequency over limit 5	AC frequency > limit 5 AND grid-tied	required per UL 1741/IEEE 1547, grid-tied operations	

9.0 Converter Removal and Preparation for Shipment

1. Open AC Disconnect.
2. Open DC Disconnect.

3. Wait five (5) minutes for capacitors to discharge.
4. Open the fuse access doors.
5. Disconnect the AC and DC power cables.
6. Disconnect the Conduit connections.
7. Disconnect Modbus Interface cables.
8. Disconnect chassis ground connections.
9. Close the fuse compartment doors.
10. Remove the Converter from the mountings.

Package the Converter in IPWR approved packaging.

10.0 Monitoring, Configuration and Control via Modbus

Monitoring and configuration of the 125B2-4F Converter is done via a RS485 Modbus RTU Interface, located in the center segment of the lower wiring compartment. The center segment is isolated from high voltage AC and DC fused terminals per IEEE and UL safety certification requirements. Low voltage conduit connections should be made to the bottom of the wiring compartment. The use of CAT-5, CAT-6 or similar wire type is recommended.The physical interface utilizes two (2) RJ45 jacks connected in parallel and wired identically. Each RJ45 jack supports a 2-wire Modbus RTU connection and allows for daisy-chaining multiple Ideal Power converters on the same Modbus connection.

Table 6: RJ45 Pinouts for Modbus Communication

Pin on RJ45	Usage / Description
1	Do not connect
2	Do not connect
3	Do not connect
4	D1, also known as B/B', negative half of differential pair
5	D0, also known as A/A', positive half of differential pair
6	Do not connect
7	Do not connect
8	Common, also known as C/C', signal/power supply common

The 2-wire Modbus RTU protocol relies on RS485 differential signaling. The need for external termination resistors is determined by a number of factors including Modbus run length, number of devices, cable type and selected baud rate. The optional 120-ohm Modbus terminating resistor may interfere with proper operation if installed unnecessarily. A maximum of one terminating resistor should be used if required and should be installed single-ended, not differentially. Use of the Modbus

Interface and related register definitions, as well as IPWR's evaluation and configuration tools are provided in separate documents. Refer to the 125B2-4F Quick Start Guide, Document number MAN-00106.

The DB-9 connector in the center compartment is not intended for customer use. Do not connect to these programming and test interfaces: they are used to for production test purposes, and to update the Converter's firmware.

11.0 Specifications

Table 7: Environmental Specifications

Ambient air temperature, operating	-20° C to +40° C
Ambient air temperature, non-operating and storage	-20° C to +70° C
Humidity	0 to 100%
Environmental exposure	NEMA 3R enclosure

Table 8: Electrical Specifications

Bidirectional DC (Port DC3)	
Configuration	Bipolar DC: 4-Wire Interface, with center common
Absolute Maximum Voltage	± 600 Vdc (1200 Vdc)
Minimum Start-up Current	1 A
Operating Voltage Range	± 100 Vdc to ± 500 Vdc (200 Vdc to 1000 Vdc)
Maximum Power Range	± 300 Vdc to ± 500 Vdc (600 Vdc to 1000 Vdc)
Maximum Output Power	125 kW
Maximum DC Current	225 A continuous
Ground Fault Detection	DC ground fault (GFDI) on all conductors
Ground Fault Detection	2 A fuse, programmable trip point: 200 mA to 500 mA
Transient Overvoltage Protection	Yes, MOV voltage clamps
Bidirectional AC Port (Port AC1)	
Grid Interconnection Requirements	Three phase 480 V wye grounded system
Off-grid mode	Voltage forming / load following
Voltage Range	480 Vac to 400 Vac, user programmable
Maximum Output Power	125 kW @ 480 Vac
Maximum Current	160 A per phase leg

Frequency Range	45 Hz to 65 Hz, user programmable
Power Factor	>.97 at rated output power
Typical Efficiency	> 95%
Peak Efficiency	97%
Tare Losses	< 25 W
Total Harmonic Distortion	< 4%

Other Ratings:

Trip Times are per UL 1741a

Voltage	Default Mag Trip Setpoint	Default Time Trip Setpoint	Adjustable Trip Time
Over Stage 2:	>120	0.16	0.16
Over Stage 1:	110<V<120	1	13
Under Stage 1:	60<V<88	2	21
Under Stage 2:	45<V<60	1	11
Under Stage 3:	<45	0.16	0.16
Frequency	**Default Mag Trip Setpoint**	**Default Time Trip Setpoint**	**Adjustable Trip Time**
Over 2	>62	0.16	10
Over 1	>60.5	2	150
Under 1	<59.5	2	150
Under 2	<57	0.16	10