

*A Diversified Technology, Inc. Manual*

# **AMFA-35 / AMFA-39**

## **Operator's Manual & Installation Instructions**

**Rev 1.1  
30 August 2011**



**Providing a Cohesive Approach to Embedded Computing and Power Solutions**

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Permanently-connected, utility Interactive, single-phase, inverters

Model AMFA-35 WIND TURBINE INVERTER (240 VAC nominal output – split phase)  
 The phase angle between L1 and L2 is 180°. Line to Neutral is 120 VAC nominal.

Model AMFA-39 WIND TURBINE INVERTER (208 VAC nominal output)  
 The phase angle between L1 and L2 is 120°, i.e. connection to 2 legs of a 3 phase grid.  
 Line to Neutral is 120 VAC nominal.

USL - Evaluated to the requirements of the Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources, UL 1741, 2nd Edition, dated January 28, 2010.

CNL - Additionally evaluated to CAN/CSA C22.2 No. 107.1-1, "General Use Power Supplies." 3rd Edition, Dated September 1<sup>st</sup>, 2001 with revision through 2006.

The Diversified Technology Inc. Model AMFA-35 and AMFA-39 inverters are intended for variable frequency un-rectified 3-phase AC input from Wind Powered Turbines.

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### Revision History

Date	Revision	Summary of Corrections
7/15/2011	1.0	Production Release
8/30/2011	1.1	Minor error corrections and update to connection drawing.

## 1 Ratings

### Turbine Input

Maximum Input Voltage (3 Phase Input)	470 VAC
Minimum Input Start Voltage	30 VAC
Input Operating Voltage Range for Max. Output	200 to 470 VAC
Maximum Input Frequency	400 Hz
Maximum Input Current	30 Amps
Maximum Input Short Circuit Current	30 Amps
AC Backfeed Current to Input Source	N/A

### Output

Model	AMFA-35	AMFA-39
Nominal Output Voltage (Single Phase)	240 VAC	208 VAC
Operating Voltage Range	212 – 264 VAC	184 – 228 VAC
Voltage Measurement Tolerance	+/- 10 VAC	
Maximum Continuous Output Power	6000 Watts	5200 Watts
Output Power Tolerance	+/- 10%	
Maximum Continuous Output Current	25 Amps	
Output Current Tolerance	+/- 10%	
Nominal Operating Frequency	60 Hz	
Operating Frequency Range	59.3 to 60.5 Hz	
Frequency Measurement Tolerance	+/- 0.5 Hz	
Output Power Factor	0.95 +/- 0.05	
Normal Operation Temperature Range	-68°F to 113°F -20°C to 45°C	
Maximum Output Over-Current Protection	30 Amps	
Maximum Output Fault Current	30 Amps	
Maximum Synchronization In-Rush Current	6.3 Amps	
Utility Interconnection Trip Time	100 mS	
Time Measurement Tolerance	+/- 85 mS	

## 2 Other Specifications

Dimensions	32"H x 14"W x 9" D 813 x 356 x 229 mm
Weight	124 lbs / 57 Kg
Enclosure	NEMA Type 3R

Enclosure constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, and snow; and that will be undamaged by the external formation of ice on the enclosure.

### 3 Important Safety Instructions

#### **SAVE THESE INSTRUCTIONS**

This manual contains important instructions for Models AMFA-35 and AMFA-39 that shall be followed during installation and maintenance of the inverter.

The output field wiring terminals can be used for connection of a maximum of:  
One 3 AWG wire per terminal (1 wire for each line)

The input field wiring terminals can be used for connection of a maximum of:  
One 3 AWG wire per terminal (1 wire per phase per terminal provided).

The field-wiring terminals shall be connected using the following wire types:

Copper Conductors Only (Input and Output connections)  
Use No. 10 AWG to 3 AWG, 90 °C copper wire only

The following symbols are used as markings on this product with the following meanings:

Equipment grounding conductor –



This inverter is intended for operation in an environment having a maximum ambient temperature of 45° C (113° F).

This unit or system is provided with fixed trip limits and shall not be aggregated above 30 kW on a single Point of Common Connection

#### **CAUTION**

To reduce the risk of fire, connect only to a circuit provided with 30 amperes maximum, 2-pole breaker for branch-circuit over-current protection in accordance with the National Electrical Code, ANSI/NFPA 70.

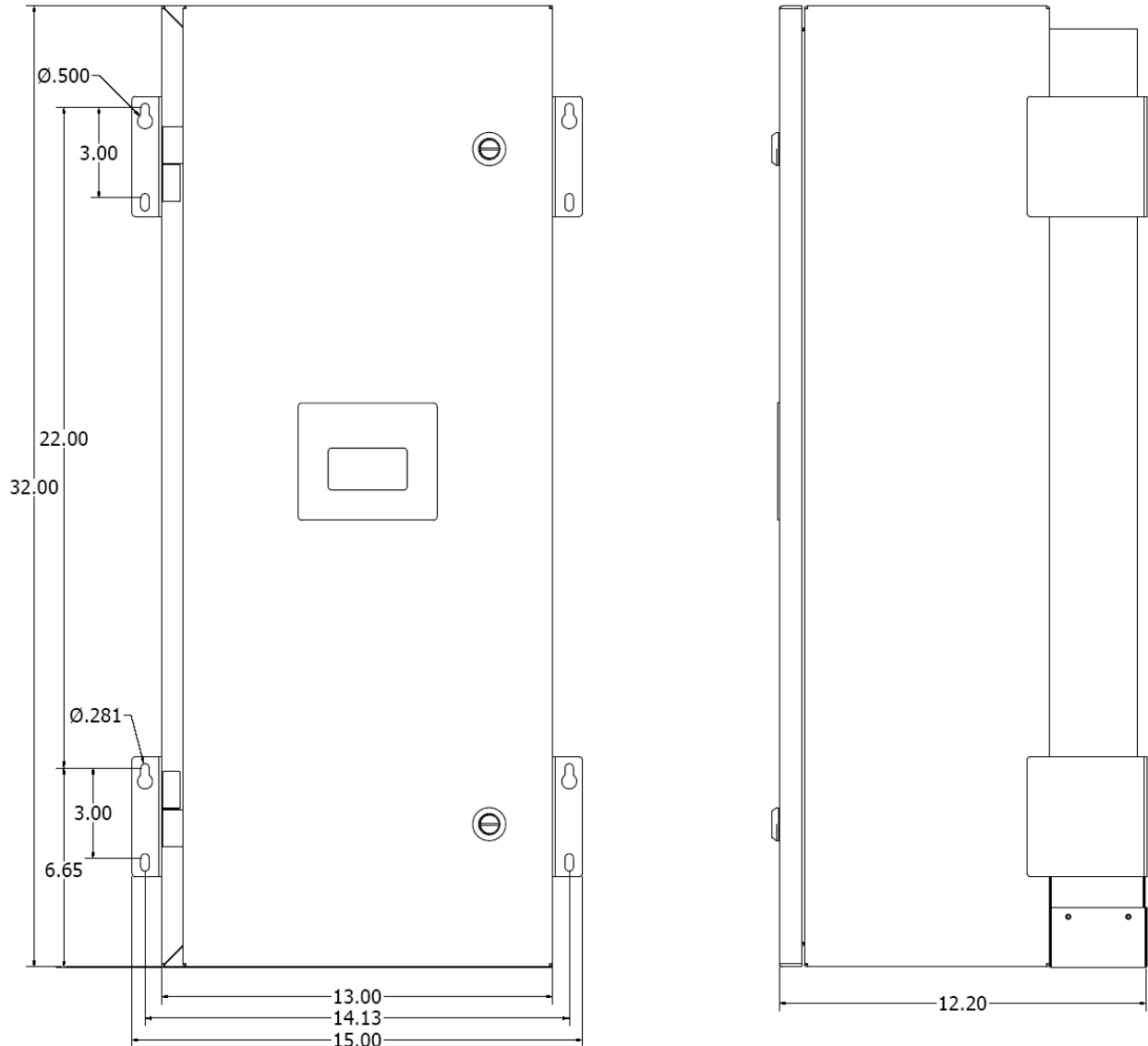


Hot surfaces – To reduce the risk of burns – Do not touch  
The enclosure and the rear heatsink can exceed 70° C (150° F)

Rain-tight or wet location hubs that comply with the requirements in the Standard for Fittings for Conduit and Outlet Boxes, UL 514B, are to be used

## 4 Installation

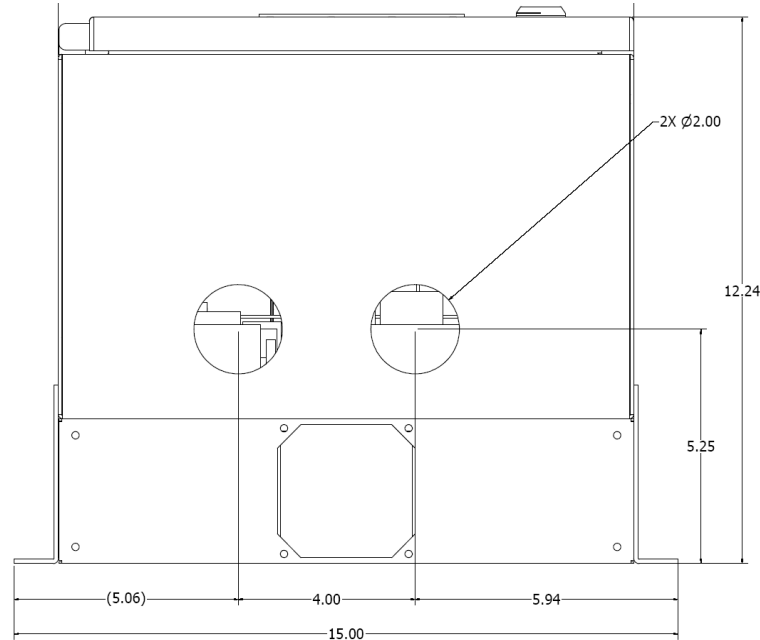
### a. Dimensions



### b. Mounting

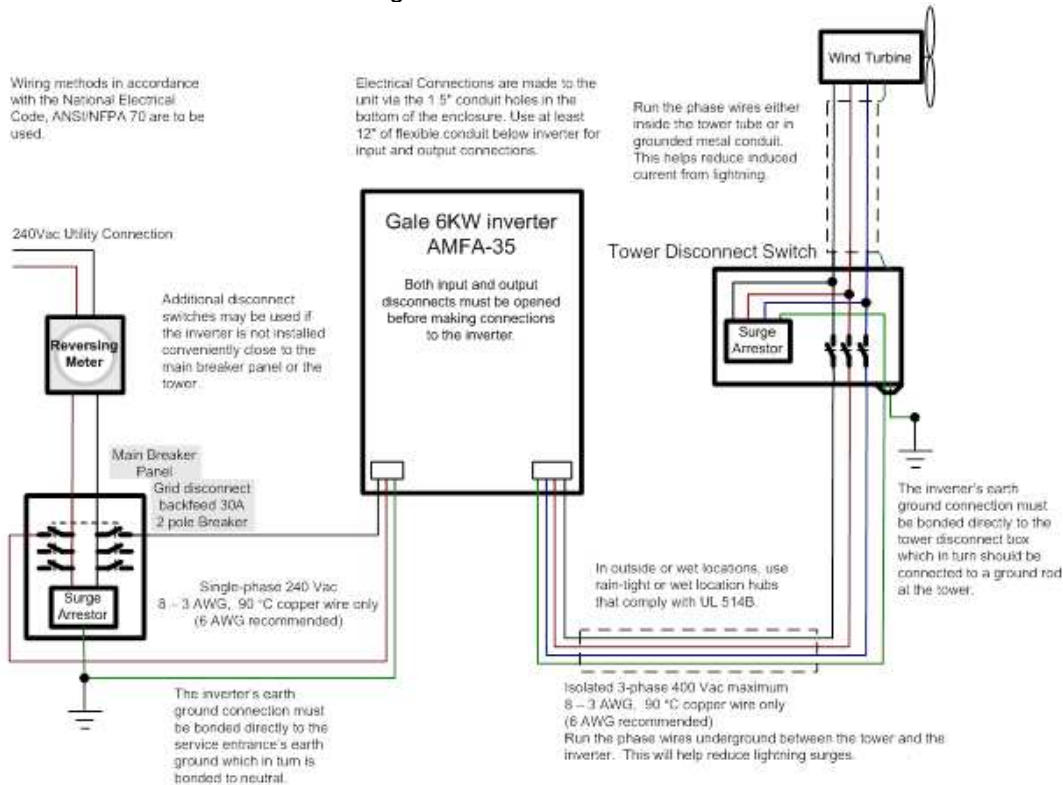
- i. The enclosure is provided with four mounting feet with 0.281" dia. mounting holes.
- ii. For all surfaces, install the top bolt/screw for the keyhole shaped holes first then lift the inverter onto these screws. Once the inverter is hanging on the wall, install the bottom bolts/screws with a flat washer under the head. The required bolt length is such that the internal threads need to be 100% engaged.
  1. For mounting to a 5/8" or thicker wood sheet, use M6 or 1/4" bolts with nuts and flat washers or Tee nuts. Alternately use 1/4" toggle bolts with a tension rating of 300lbs or greater for the keyhole shaped holes and 1/4" lag screws at least as thick as the sheet for the bottom holes.
  2. For mounting directly to wood studs on 14" centers, use 1/4" lag screws at least 2" long.

3. For mounting to a 0.10" thick metal surface, use M6, ¼-20 or ¼-28 bolts grade 3 or higher with nuts and flat washers.
  4. For mounting to concrete, use M6 or ¼" bolts using concrete anchors with an 800 pound or greater tension rating.
- iii. The enclosure is to be oriented with the conduit openings facing toward the floor.
  - iv. Enclosure ventilation is to be provided such that the following guidelines are satisfied.
    1. Use in a well ventilated area within the maximum ambient temperature rating.
    2. At least 12" of clearance is required above and below the inverter for airflow.
- c. Electrical Connections are made to the unit via the two holes in the bottom of the enclosure.



- i. Holes are sized for 1.5" rated conduit. Wiring methods in accordance with the National Electrical Code, ANSI/NFPA 70 are to be used.
  - ii. It is recommended that at least 12" of flexible conduit be used below the inverter to make alignment easier.
  - iii. **CUTTING ADDITIONAL HOLES IN THE ENCLOSURE IS NOT RECOMMENDED AND VOIDS THE WARRANTY ON THE ENCLOSURE AGAINST CORROSION AND WATER DAMAGE.**
  - iv. Rain-tight or wet location hubs that comply with the requirements in the Standard for Fittings for Conduit and Outlet Boxes, UL 514B, are to be used where the conduit is in a wet location.
- d. The input and output circuits are isolated from the enclosure. System grounding is the responsibility of the installer and must be in accordance with the National Electric Code.
- e. AC Output Connection (Utility)
- i. The AC output is single phase and not bonded to ground.
  - ii. Connect the two single phase 240VAC (208 AMFA-39) wires to the dual fuse block located on the lower left side of the enclosure.
  - iii. Tightening torque, allowable wire size, and type, for the Field-Wiring Terminals:
    1. 24 lbf-in tightening torque
    2. 10 AWG to a maximum of 3 AWG for Copper Conductors Only
    3. Wire type – rated 90°C minimum
  - iv. The inverter's earth ground connection must be bonded directly to the service entrance's earth ground which in turn is bonded to neutral.

- v. Connection to the utility through the breaker panel should be done using a 30A 2-pole breaker.
- f. AC Input Connection (Turbine)
  - i. Connect the three phase turbine wires to the terminal block located on the lower right side of the enclosure.
  - ii. The inverter's wind turbine input must be connected to a 3-phase "delta" or "wye" connection with the neutral not connected to earth ground (left floating).
  - iii. Tightening torque, allowable wire size, and type, for the Field-Wiring Terminals:
    1. 24 lbf-in tightening torque
    2. 10 AWG to a maximum of 3 AWG for Copper Conductors Only
    3. Wire type – rated 90°C minimum
- g. Earth Ground Connection
  - i. The inverter's earth ground connection must be bonded directly to the service entrance's earth ground which in turn is bonded to neutral. With a second bond, the inverter's earth ground connection must be bonded directly to the tower disconnect ground lug which in turn is bonded to the tower's ground rod.
  - ii. Allowable wire size range is 8 AWG – 3 AWG.



- h. Connection Example
  - i. Lightning surge arrestors are not required but are recommended. No lightning protection system provides complete protection. Lightning damage is not covered under your warranty.
  - ii. Contact your distributor or DTI for application specific lightning surge suppression solutions.

## 5 Markings

Enclosure: NEMA Type 3R

Earth ground is indicated by the following marking:



## 6 Operation

This equipment is a UL 1741 certified Utility Interactive Inverter and complies with the requirements of IEEE1547 which is the standard for interconnecting distributed resources with electric power systems.

The Normal Operation of the inverter is as follows: When single phase power is applied to the inverter, the display will power up and a message stating that the unit is initializing is shown. A countdown timer set for 5 minutes (300 seconds) starts before the inverter is ready to transfer power to the utility grid. The inverter will automatically transfer power to the utility when AC voltages in the range of 30VAC to 470VAC are present at the Turbine input.

## 7 Touch Screen Display

The touch screen display located on the front panel of the enclosure provides manual over-ride and status of the inverter's operation. The touch screen display also provides a Stop and a Reset button. The Stop button is used when it is desired to disconnect the inverter from the power grid and the wind turbine. After Stop is pressed the inverter will remain in a powered-up stand-by mode until Reset is pressed or Grid voltage is removed. When Reset is pressed the inverter will resume normal operation.

Status of the inverters operation is shown on the lines one and two of the display. The following table lists the status messages that may appear.

Status Message	Description
Waiting Initializing	The inverter has been reset or that the 5 minute countdown delay is in progress
Waiting For Wind	The voltage from the turbine is lower than the factory set auto-start voltage threshold
AC Running	The active rectifier is regulating the internal DC Boost voltage
Running	The inverter is transferring power to the utility grid
Fault	A fault has occurred. See fault messages. Faults are automatically reset after 20 seconds. After the fault resets a 5 minute restart timer begins to count down. To see the last fault scroll to the Last Fault parameter
Manual Stop Press Reset	The manual stop button has been pressed
Fault Limit Press Reset	Three faults have occurred in an hours time
Disconnected	Indicates that a communication problem exists between the display and the inverter. Check for bad cable connection.
Soft Grid	The inverter has detected that the output voltage is approaching the over voltage limit and is reducing its output to compensate for the less than ideal current carrying ability of the grid connection.





Sample Display

The Up and Down arrow that is visible on the left side of the touch screen display is used to scroll through a list of parameters. The list of viewable parameters is as follows:

Parameter	Description
Grid Voltage	Magnitude of the connected single phase grid voltage
Grid Frequency	Frequency of the connected single phase grid voltage
Bus Voltage	Magnitude of the actively rectified DC bus voltage
DC Current	Averaged value of the DC current
Turbine Volts	Averaged value of the rectified AC voltage from the Input
Output Power	Output power displayed in watts
Cumul. Power	Output Power accumulated over time of operation
VRef	Used for factory setup
IRef	Used for factory setup
Last Fault	Displays the last fault that occurred since the inverter was powered up along with a fault code that may be useful when troubleshooting.

A hidden feature of the display is the contrast adjustment. The right side of the display has invisible up and down arrows that can be used to increase and decrease the contrast of the display.

#### Grid Voltage

This is the voltage measured line to line on the output of the inverter. The voltage must be between 212 to 264Vac (184 to 228Vac for 208V units) for the inverter to operate. The line to neutral voltage is important as well, although it is not reported on the LCD screen. It must be between 106 and 142Vac for both 240V and 208V units.

#### Grid Frequency

This is the frequency of the grid and determined by the utility. The frequency must be between 59.4 and 60.4 Hz for the inverter to operate.

**Bus Voltage**

This is the voltage of the boosted DC bus that is used to generate the output sine wave. This voltage should stay between 200 and 640 Vdc but will not trip off until it reaches 750Vdc.

**DC Current**

This is the input current measured after the 3-phase AC input has been rectified to DC.  $I_{dc} = I_{REF} / 4.5$   
This current should not exceed 28A.

**Turbine Volts**

This is the DC voltage of the input measured after the 3-phase AC input is rectified. The inverter will begin exporting power when this voltage exceeds 85Vdc. This voltage should never exceed 750Vdc.  
 $V_{dc} = V_{ac} * 1.41$

**Output Power**

This is how much real power in Watts the inverter is currently producing or consuming if it is waiting for wind. Standby power while waiting for wind is about -10W. This measurement is not completely accurate and may not agree with an external meter.

**Accumulated Power**

This is how much real power the inverter has produced or consumed since it was last calibrated at DTI. This measurement is not completely accurate and may not agree with an external meter.

**VREF**

VREF is the input rectified voltage as a raw value.  $V_{REF} = V_{dc} * 2.52$ .

Vref is used as an index look-up into a virtual table used for a customizable 32 point power curve table.

**IREF**

IREF is the current request in counts for a given DC input voltage tracked by VREF. Using this configuration the inverter can be adjusted to provide any power curve required.  $I_{REF} = I_{dc} * 9$

**Last Fault**

Fault messages are displayed when a fault occurs and when the last fault parameter is selected. The following table is a list of possible faults that may be displayed.

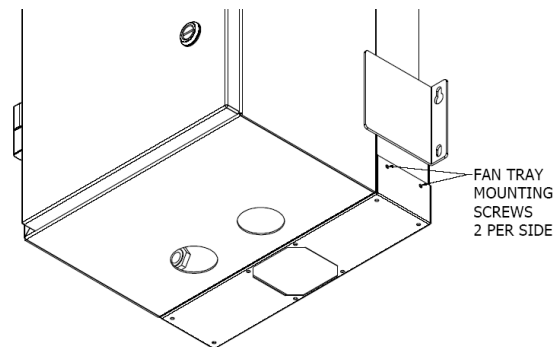
Fault Message	Fault Code	Description
INTERNAL ERROR	10	IGBT Desat or control logic fault. An occurrence of this fault requires that the unit be completely powered down to reset it.
DC OVER VOLT 1	1000	The DC Bus voltage has exceeded its maximum threshold
DC OVER VOLT 2	1500	The DC Input voltage has exceeded its maximum threshold
DC UNDER VOLT	1250	The internal DC Boost voltage has dropped below its minimum threshold
AC OVER VOLT	2030	The AC line voltage has exceeded its maximum threshold
AC UNDER VOLT	2280	The AC line voltage has dropped below its minimum threshold
TURBINE PHASE	2500	Indicates that there is a problem with one or more of the turbine input phases. Bad connection, missing phase.
OVER CURRENT	3000	Phase A line current sensed by the converter module has exceeded its maximum current threshold
OVER CURRENT	3020	Phase C line current sensed by the converter module has exceeded its maximum current threshold
OVER CURRENT	3050	The DC Boost phase of the converter module has exceeded its maximum current threshold
OVER TEMP	4000	The internal high temperature threshold has been exceeded
UNDER TEMP	4250	The internal low temperature threshold has been exceeded
GROUND FAULT	7000	An input phase appears to be shorted to chassis ground
AC UNDER FREQ	8000	The frequency of the utility grid voltage went out of range. The upper range threshold was crossed
AC OVER FREQ	8100	The frequency of the utility grid voltage went out of range. The lower range threshold was crossed

**8 Equipment Maintenance**

The touch screen display may become dirty over time. To clean the display use clean water applied to a soft non-abrasive cloth. Dirt and fingerprints do not affect the operation of the touch screen display.

Keep the heatsink clean. Remove any animal nests or dust accumulations. The inverter can be hosed down with a light spray, but do not use a pressure washer on the inverter.

The replaceable external fan is expected to last the life of the inverter. You may need to open the compartment to clean it out. Disconnect the grid and the input before opening the fan compartment. Then remove the four screws as shown.



## 9 Return Shipment Information

If service or repair is required, please contact your distributor first. They may have warranty and service options available beyond DTI's standard warranty. If they are unable to help you, contact DTI's Service Department for a Return Material Authorization (RMA) number and shipping instructions. Note that inverters must be shipped freight on a pallet and can not be handled by standard carriers. If the product is out of warranty, or was damaged during shipment, a purchase order will be required for the repair. The product should be returned in its original shipping materials. Contact DTI if replacement material is required. Seal the carton securely and ship prepaid to the following address with the RMA number on the label.

**DIVERSIFIED TECHNOLOGY, INC.**

Service Department  
476 Highland Colony Parkway  
Ridgeland, MS 39157  
RMA# \_\_\_\_\_

To contact the Service Department:  
Telephone: (601) 856-4121  
Fax: (601) 856-2888  
Email: [customerservice@dtims.com](mailto:customerservice@dtims.com)

Items determined to be covered under warranty will be returned freight prepaid. Items not in warranty will be returned freight collect, contact DTI's Service Department.