



International Series GFX Inverter/Charger

GFX1312E

GFX1424E

GFX1448E

Operator's Manual



About OutBack Power Technologies

OutBack Power Technologies is a leader in advanced energy conversion technology. Our products include true sine wave inverter/chargers, maximum power point tracking charge controllers, system communication components, as well as breaker panels, breakers, accessories, and assembled systems.

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OutBack Power Technologies Inc. warrants that the products it manufactures will be free from defects in materials and workmanship for a period of two (2) years subject to the conditions set forth in the warranty detail, found on page 51 of this manual.

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Important Safety Instructions

READ AND SAVE THESE INSTRUCTIONS!

This manual contains important safety instructions for the International Series GFX inverters. Read all instructions and cautionary markings on the inverter and on any accessories or additional equipment included in the installation. Failure to adhere to these instructions could result in severe shock or possible electrocution. Exercise extreme caution at all times to prevent accidents.

Audience

This manual is intended for anyone required to operate the GFX Inverter. Operators must be familiar with all the safety regulations pertaining to operating this kind of equipment as dictated by local code. Operators must also have a complete understanding of this equipment's features and functions. Do not use this product unless it has been installed by a qualified installer in accordance with the *International Series GFX Installation Manual*.

Symbols Used

	WARNING: Hazard to Human Life
	This type of notation indicates that the hazard could be harmful to human life.
	CAUTION: Hazard to Equipment
	This type of notation indicates that the hazard may cause damage to the equipment.
	IMPORTANT:
	This type of notation indicates that the information provided is important to the installation, operation and/or maintenance of the equipment. Failure to follow the recommendations in such a notation could result in voiding the equipment warranty.

Definitions

The following is a list of initials, terms, and definitions used in conjunction with this product.

Table 1 Terms and Definitions

Acronym	Definition
AC	Alternating Current; refers to voltage produced by the inverter, utility grid, or generator.
AGS	Automatic Generator Start
AUX	Inverter's 12-volt auxiliary output
CE	<i>Conformité Européenne</i> ; French for "European Conformity"; a marking on OutBack products indicating that they meet European Union requirements
DC	Direct Current; refers to voltage produced by the batteries or renewable source
DVM	Digital Voltmeter
Grid-interactive, grid-intertie, grid-tie	Utility grid power is available for use and the inverter is a model capable of returning (selling) electricity back to the utility grid
HBX	High Battery Transfer; a function of the remote system display
LBCO	Low Battery Cut-Out; set point at which the inverter shuts down due to low batteries
LED	Light-Emitting Diode; refers to indicators used by the inverter and the system display
Off-grid	Utility grid power is not available for use
On-grid	Utility grid power is available for use (does not imply grid-interactive capability)
PV	Photovoltaic
RE	Renewable Energy
RTS	Remote Temperature Sensor; accessory that measures battery temperature for charging
System display	Remote interface device (such as the MATE), used for monitoring, programming and communicating with the inverter; also called "remote system display"
Utility grid	The electrical service and infrastructure supported by the electrical or utility company; also called "mains", "utility service", or "grid"

General Safety

	<p>WARNING: Limitations on Use</p> <p>This equipment is NOT intended for use with life support equipment or other medical equipment or devices.</p>
	<p>CAUTION: Equipment Damage</p> <p>Only use components or accessories recommended or sold by OutBack Power Systems or its authorized agents.</p>



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Introduction

Welcome to OutBack Power Technologies

Thank you for purchasing the OutBack International Series GFX Inverter. This product offers a complete power conversion system between batteries and AC power. It can provide backup power or complete off-grid service.

- Battery-to-AC inverting which delivers 230 Vac at 50 Hz
- AC-to-battery charging
- Rapid transfer between AC source and inverter output with minimal delay time
- Inverter load support for a small AC source
- 12-, 24-, and 48-volt units
- Wattages from 1.3 kVA to 1.4 kVA
- Stackable in parallel and three-phase configurations
- Uses energy from PV, wind, and other renewable sources if appropriate controllers are used
- Grid-interactive capable
- CE compliant for off-grid use



Figure 1 International Series GFX Inverter/Charger

System Display and Controller

The GFX inverters have no external controls. They can operate normally without an external control or interface. Basic modes and settings are pre-programmed at the factory. However, if the pre-programmed settings need adjustment, a remote system display must be used for changing those settings and for more detailed monitoring activities. Modes and settings cannot be changed without the system display.

The MATE Series Display and Controller is an OutBack system display, available for remotely interfacing with the GFX series inverters.

**IMPORTANT:**

The GFX inverters have nonvolatile memory and will retain any settings that have been changed, even after the system display is removed. If a system does not have a display, an installer can bring a system display to the site temporarily, install it, change the settings, and remove the display again.

**IMPORTANT:**

Some functions are not based in the inverter, but are part of the system display's software. They will not function if the system display is removed. These functions are listed on page 28. For a detailed description and programming, please see the manual for the system display.



Operation

Functional Test

Pre-startup Procedures

1. Ensure all DC and AC breakers or fuses are disconnected.
2. Double-check all wiring connections.
3. Inspect the work area to ensure tools or debris have not been left inside.
4. Verify battery voltage using a digital voltmeter (DVM). Confirm the voltage is correct for the inverter model. Confirm the polarity.
5. Connect the system display (if present).



CAUTION: Equipment Damage

Incorrect battery polarity will damage the inverter. This damage is not covered by the warranty.

Startup

If steps are inapplicable, they can be omitted. However, it is highly recommended that all *applicable* steps be performed in the following order.

If the results of a step do not match the description, see the Troubleshooting section on page 29.

To start the system:

1. Close the main DC breaker (or connect the fuse) from the battery bank to the inverter. Repeat for every inverter present.
2. Observe the LEDs in the AC wiring compartment. One of the three BATTERY LEDs should be illuminated — green, yellow, or red. Any of them are acceptable at this stage. (See page 11 for a description of the LEDs.) The INVERTER LED (green) may come on at this time. The fan will run briefly and the relay will click as a self-test.
3. The ERROR LED may flash briefly. If it remains illuminated or continues to flash during any step, proceed immediately to page 29 for troubleshooting.
4. Confirm that the system display is operational. (See the system display manual for a description of the menu items that appear on a correctly functioning display.)



Figure 2

AC Wiring Compartment

5. If the INVERTER LED (green) is not illuminated, turn on the inverter using the system display or external switch.
6. Check the STATUS LEDs. Confirm that the INVERTER LED (green) is illuminated.
7. Using a DVM, verify 230 Vac between the AC HOT OUT and AC NEUTRAL OUT terminals. Do not turn on any AC breakers or disconnects at this time.
8. Perform all programming for stacking, battery charging, AC current, generator starting, and any other functions. Refer to the Description of Functions section beginning on page 13, the system display manual, and any other literature as needed.

After programming is completed, perform the following steps:

1. If other inverters are on the system, use a DVM to verify correct voltage from AC HOT OUT on one inverter to the next. Parallel-stacked inverters should collectively read 0 Vac (although individually they should still read 230 Vac). Three-phase inverters should collectively read 400 Vac.
2. Close the AC output breakers or disconnects. If AC Bypass breakers are present, place them in the normal (non-Bypass) position. Do not connect an AC input source or close any AC input breakers.
3. Use a DVM to verify correct voltage at the AC load panel.
4. Connect a small AC load and test for proper functionality.
5. Close the AC input breakers and connect an AC source.
6. Check the STATUS LEDs. The AC IN LED (yellow) should flash. The INVERTER LED will remain illuminated for a short time. When the AC IN LED stays illuminated, the INVERTER LED should go dark. This means the inverter is no longer drawing on batteries, but is using the AC source.
7. If the battery charger has been enabled, confirm that it is charging by using the system display. The inverter will perform a full battery charge when first powered up. This may take several hours. If restarted after a temporary shutdown, the inverter may skip most or all of the charging cycle.
8. Test any other functions which have been enabled, such as generator start, selling, or search mode. International Series GFX inverters have a minimum one-minute delay before selling will begin.
9. Compare the DVM's readings with the system display meter readings. If necessary, the system display's readings can be calibrated to match the DVM more accurately. AC input voltage, AC output voltage, and battery voltage can be calibrated.

Powering Down

If steps are inapplicable, they can be omitted. However, it is highly recommended that all *applicable* steps be performed in the following order.

To Power Down the System:

1. Turn off all load breakers and AC input breakers.
2. Turn off all renewable energy breakers.
3. Turn each inverter OFF using the system display or external switch.
4. Turn off the main DC breaker for each inverter.

Adding New Devices

When adding new devices to the system, first power down the system according to the preceding instructions. After adding new devices, perform another functional test, including programming.

LED Indicators

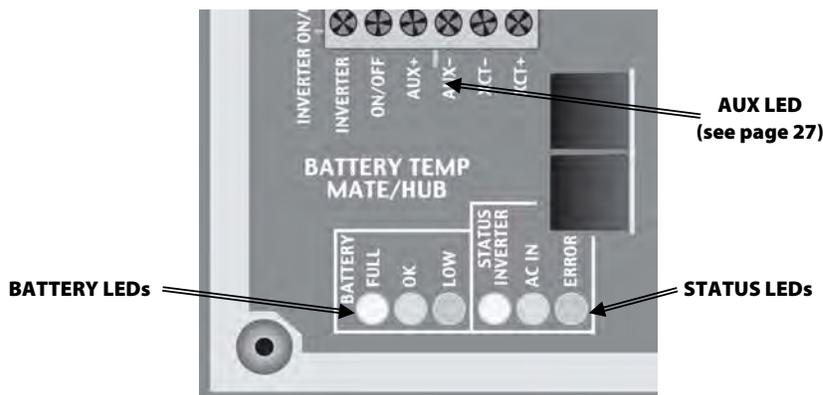


Figure 3 LED Indicators

BATTERY LEDs

The battery LEDs show the approximate battery state. (See **IMPORTANT** note below.) The BATTERY LEDs are independent of STATUS LEDs. Any STATUS LED could accompany any BATTERY LED based on certain conditions. Common combinations are noted.

- A GREEN LED means the batteries have an adequate charge at that time. It does not always mean they are full. May be accompanied by a YELLOW STATUS LED when an AC source is charging.
- A YELLOW LED means the batteries are somewhat discharged.
- A RED LED means the batteries are greatly discharged and may require attention. May be accompanied by a RED STATUS LED to indicate a Low Battery ERROR.

Table 2 Battery LED Values

Color	12 Vdc Unit	24 Vdc Unit, ± 0.2 Vdc	48 Vdc Unit, ± 0.4 Vdc	Battery Status
GREEN	12.5 Vdc or higher	25.0 Vdc or higher	50.0 Vdc or higher	ACCEPTABLE
YELLOW	11.5 to 12.4 Vdc	23.0 to 24.8 Vdc	46.0 to 49.6 Vdc	USABLE
RED	11.4 Vdc or lower	22.8 Vdc or lower	45.6 Vdc or lower	LOW

- Gaps in the table (higher-voltage units) are due to the resolution of the inverter’s DC meter.
- These voltage settings are not the same as the Low Battery Cut-Out (LBCO) set point. (See pages 13 and 34.) The Battery LED settings cannot be changed.
- Voltages higher than shown in the GREEN row usually means that the batteries are charging.



IMPORTANT:

Battery voltage does not always indicate an accurate state of charge. It is accurate if batteries have been at rest for several hours at room temperature (25 °C or 77 °F, or specified by the battery manufacturer). If they have **any** loads, a charging source, or are at another temperature, their voltage may not reflect their true state. The OutBack FLEXnet DC is a battery monitor which can provide accurate measurements.

STATUS LEDS

GREEN

- *Solid:* The inverter is ON and providing power. If accompanied by solid yellow LED, unit is selling power to the utility grid. (See page 23 for a description of the Sell function.)
- *Flashing:* The inverter has been turned ON but is idle. May be accompanied by the yellow LED. If not accompanied by the yellow LED, the unit in inverting mode and is idle due to lack of demand. This can be because the unit is a slave that is in Power Save mode. (See page 26 for a description of Power Save.) It can also be because the system is in Search mode. (See page 14 for a description of Search.)
- *Off:* Unit is OFF. It is not waiting to provide power. Any power present is from the utility grid or generator, not the inverter. (See Startup on page 9, or the system display manual, to turn the unit ON.)

YELLOW

- *Solid:* The AC source is connected and providing power. Unit may or may not be charging the batteries, depending on settings. May be accompanied by green LED.
- *Flashing:* The AC source is present but has not been accepted. If flashing continues, the unit is refusing the source. This can occur for the following reasons.
 - ~ The AC source may have quality issues. External diagnosis may be required. (See page 15 for a description of input criteria. See the system display manual for diagnosis using the meter displays.)
 - ~ In the MATE system display, the **AC Input Control** menu is set to **DROP**. (See the MATE manual for a description of the **AC IN** hot key.)
 - ~ In the MATE, the HBX feature or the Grid Use feature intentionally disconnected the inverter. (See the MATE manual for a description of these modes.)
- *Off:* No AC source is detected. If a source is supposed to be present, confirm the voltage between AC HOT IN and AC NEUTRAL IN terminals.

RED

- *Solid:* ERROR. Unit has shut down due to a critical problem which may be internal or external to the inverter. This LED is accompanied by an Error message in the system display. See page 34 for a description of ERROR messages.
- *Flashing:* WARNING. Unit has detected a non-critical problem but has not yet shut down. A Warning does not always lead to a shutdown — if it does, it becomes an Error. This LED is accompanied by a Warning message in the system display. See page 35 for a description of Warning messages.
- *Off:* No problems are detected.

Table 3 Status LED Quick Reference

Color	State	Inverter State	Notes
GREEN	Solid GREEN	Inverter is ON and providing power.	If accompanied by YELLOW LED, unit is selling.
	Flashing GREEN	Inverter is ON but standing by.	Unit may be Slave, or may be in Search mode.
	Off	Inverter is not providing power.	Unit is either OFF or has been replaced by AC source (see next item).
YELLOW	Solid YELLOW	AC source connected and providing power.	Unit may or may not be charging batteries, depending on settings.
	Flashing YELLOW	AC source present but not yet accepted.	Unit maybe programmed not to accept the source, or the source may have quality issues.
	Off	No AC source is detected.	If source is present, check AC input.
RED	Solid RED	ERROR. Unit has shut down. See Troubleshooting.	To see Error messages, see the system display manual.
	Flashing RED	WARNING. Unit detected a problem but has not yet shut down. See Troubleshooting.	To see Warning messages, see the system display manual.
	Off	No problems detected.	

Description of Functions

All items identified as settable or adjustable have set points which can be accessed using the remote system display. (See the system display manual for instructions on locating these set points.) The default settings and ranges of adjustment are listed near the end of this book, beginning on page 43.

Inverting

A GFX inverter uses a transformer and a high-frequency H-Bridge FET design to convert DC voltage from batteries into AC voltage that is usable AC by appliances. It will continue to do this as long as the batteries have sufficient energy. The batteries can be supplied or recharged from other sources, such as solar, wind, or micro-hydroelectric power.

The inverter requires batteries to operate. Other sources may not maintain DC voltages that are consistent enough for the inverter to operate reliably.



CAUTION: Equipment Damage

Do not substitute other DC sources in place of the batteries. High or irregular voltages may damage the inverter. It is normal to use other DC sources in conjunction with the batteries and the inverter, but not in place of the batteries.

Certain features will affect the inverter's operation. These features only operate when the inverter is generating AC power on its own. They do not function when the inverter is being supplied by an AC source.

- **Low Battery Cut-Out (LBCO):** This feature prevents the inverter from draining the batteries completely. It will stop functioning and give a Low Battery Voltage error when the DC voltage drops below a specified level for 5 minutes. This is one of the Error messages described on page 34. This function is intended to protect both the batteries and the inverter's output. (Continuing to invert on a low DC voltage may produce a distorted waveform.) This item is adjustable.
- **Low Battery Cut-In (LBCI):** The recovery point from Low Battery Cut-Out. When the DC voltage rises above a certain level for 10 minutes, the Low Battery error will clear and the inverter will resume functioning. This item is adjustable.
- **Adjust Output Voltage:** The inverter's AC output can be turned up or down by a certain amount, to adjust for conditions. This item is adjustable.
- The inverter is also controlled by a high battery cut-out function. If the DC voltage rises above a specified level, the inverter will immediately stop functioning and give a **High Battery Voltage** error. This is one of the Error messages displayed on page 34. (If the voltage drops below this point, the inverter automatically recovers.)
 - ~ For a 12-volt inverter, this voltage is 20 volts.
 - ~ For a 24-volt inverter, the voltage is 40 volts
 - ~ For a 48-volt inverter, the voltage is 80 volts.

The high battery cut-out voltages cannot be changed.

This function is intended to protect the inverter's output and loads. Continuing to invert on a high DC voltage may produce a distorted waveform. Note that the inverter's high battery cut-out does not alleviate or solve the high battery condition itself; the cause is an external condition.

Search

An automated search circuit is available to minimize the power draw when no loads are present. When enabled, the inverter does not always deliver full output. The output is reduced to brief pulses with a delay between them. These pulses are sent down the output lines to see if a resistance is present. In effect, the pulses “search” for a load. If one is detected, the inverter’s output increases to full voltage so that it can power the load. When the load is turned off, the inverter “goes to sleep” and begins searching again.

The sensitivity of Search mode is in increments of approximately 0.1 Aac. The default is 6 increments, or 0.6 Aac. A load which draws this amount or greater will “wake up” the inverter.

NOTE: Due to load characteristics, these increments are only approximate and may not function exactly as listed.

The pulse duration and the delay both have a time period that is measured in AC cycles. These two items and the load detection threshold are adjustable.

- Search mode can save a considerable amount of power, particularly in smaller systems with intermittent use.
- Search mode may not be useful in larger systems with loads that require continuous power (e.g., clocks, answering machines, fax machines). Search mode may cause nuisance shutdowns, or it may sleep so rarely that there is no benefit.
- Some devices may not be easily detectable by Search mode.

Input

When the GFX inverter input terminals are connected to a stable AC source, the inverter will synchronize itself with that source and use it as the primary source of AC power. (See “AC Source Acceptance” on page 15.) In this situation, the transfer relay will engage, linking the AC source directly with the inverter’s output. It can also use the source to charge batteries. (See “Transfer” on page 16 and “Battery Charging” on page 18.)

- Two sets of input criteria are available, one for the utility grid and one for a generator. Only one can be selected at a time. In the MATE system display, these options are selected using the **ac transfer control** menu. (See the next item below. Also see AC Current Settings on page 15.) Both the utility grid and generator criteria are adjustable.
- The grid-interactive function can sell power using the input connection. (See the section entitled “Selling” on page 23.) In the MATE, this function only operates if **grid** is selected in the **ac transfer control** menu. It does not function if **gen** is selected.
- The Grid/Generator Support feature can use battery power to assist a smaller AC source. (See the section entitled “Grid/Generator Support” on page 17.)
- There are a number of considerations when selecting the type and size of an AC generator. (See the section entitled “Generators” on page 16.)
- The AC input current is used to power both loads and battery charging. The combined amount should not exceed the size of the breaker or AC source. These devices should be sized appropriately during planning.
- The loads powered by the inverter **must not** exceed the size of the inverter’s transfer relay. (See the section entitled “Transfer” on page 16.)



CAUTION: Equipment Damage

Current draw in excess of the inverter’s transfer relay rating can damage the transfer relay. This damage is not covered by warranty.

AC Current Settings

The AC current settings control the amount of current that the inverter draws from the source(s). The amount of current is controlled by the grid or generator limit settings. These settings should be adjusted to match the size of the input breaker or circuit which is to be protected. In the MATE system display, if the **ac transfer control** menu is set to **grid**, the inverter uses the grid settings. If the menu is set to **gen**, the inverter uses the generator settings.

- This is intended to protect a generator or source that may not be large enough to supply enough current. If the combined charging and loads exceed this setting, the inverter will reduce its charge rate and give priority to the loads. If the loads exceed this number on their own, the charge rate will be reduced to zero. The inverter is capable of supporting the source with power from the batteries. See the section entitled "Grid/Generator Support" on page 17.
- If multiple parallel inverters are installed with an AC source of limited wattage, the total combined amperage settings for all units must be less than the input or breaker size of the AC source. The inverters do not perform this calculation. It may be necessary to divide the input size by the number of inverters and assign an equal part of the amperage to each port.

AC Source Acceptance

The input source must meet the following specifications to be accepted:

- 230 Vac, ± 22 Vac (default setting), and
- 50 Hz, ± 5 Hz

When these conditions are met, the inverter will close its transfer relay and accept the input source. This occurs after a delay which is specified below. If the conditions are not met, the inverter will not accept the source. If it was previously accepted and then rejected, the inverter will open the relay and return to inverting power from the batteries.

- If the MATE's **ac transfer control** menu is set to **grid**, there is a connection delay of approximately 15 seconds.
- If the MATE's **ac transfer control** menu is set to **gen**, there is a connection delay with a default setting of 0.5 minutes. This is intended as a generator warmup period. This item is adjustable.

Notes:

Several items, external to the inverter, may prevent the inverter from accepting AC power even if electrical conditions are met. One is the high-battery transfer (HBX) mode, which is operated by the MATE system display. (See page 28 and the MATE manual.) Another is the MATE's **AC IN** hot key, which can turn off the input to all inverters. (See the MATE manual.)

The inverter has additional criteria that govern whether it sells power. The inverter may accept AC power but refuse to sell if the acceptance criteria are met, but the grid-interactive criteria are not. (See the section entitled "Selling" on page 23.)

Generators

A generator should be sized to provide enough power for both loads and battery charging.

- The generator needs a single circuit which is sized to provide current to **all** inverters on a given phase or leg.
- It is usually recommended that the generator be sized at twice the wattage of the inverter system. Many portable generators may not be able to maintain AC voltage or frequency for long periods of time if they are loaded more than 80% of rated capacity.
- Using the MATE system display, it is recommended to set the **ac transfer control** menu to **gen** when connecting a generator. If the setting is left on **grid**, the inverter's internal settings will still be set for utility-grade power. Unless the generator delivers extremely high-quality power, it might not be accepted. (Alternately, the inverter might accept the generator and attempt to sell power back to it.) Changing to **gen** will remove the requirements for high-grade power and will prevent selling.

The generator is required to have a stable output before its power is accepted by the inverter. Some generators with less stable or uneven outputs may not be accepted.

When using capacitor-excited generators or self-excited induction generators, there can be side effects while using the Grid/Generator Support feature (see page 17). These generators do not always deliver full output when operating in parallel with another source of power, such as the Support feature. The inverter's battery charger may work erratically or at a low charge rate. It may be necessary to disable the Grid/Generator Support feature. Consult the generator manufacturer if necessary.

Transfer

The inverter uses a transfer relay to alternate between the states of inverting and of accepting an AC source. Until the relay energizes, the AC HOT IN and AC HOT OUT terminals are electrically isolated from each other; when it closes, they become electrically common. When the relay changes states, the physical transfer delay is approximately 12 milliseconds.

- The AC NEUTRAL IN and AC NEUTRAL OUT terminals are electrically common regardless of the state of the relay.
- The relay contacts are limited to 30 amps. The loads should never exceed this number.

The inverter does not filter or clean up the power from the AC source. The voltage and power quality received by the output loads is the same as that of the source. If the voltage or quality do not meet the inverter's input limits (see page 15), it will disconnect and return to the inverting mode. However, any fluctuations within the inverter's tolerance range will be transferred to the loads. If the loads are sensitive, it may be necessary to ensure the quality of the AC source.

To ensure a smoother transition, it may be advisable to raise the inverter's lower acceptance limit. The default setting is 208 Vac. A higher setting will cause the inverter to transfer sooner in the event of a quality problem.

In a stacked system, all slaves are ordered to transfer at the same time as the master. If a slave is not connected to an AC source, it will suffer a **Phase Loss** Error (see page 34). The slave will continue inverting.



CAUTION: Equipment Damage

Current draw in excess of the inverter's transfer relay rating can damage the transfer relay. This damage is not covered by warranty.

Grid/Generator Support

A system display is required to control this feature. When this feature is enabled, the inverter limits the current draw from an AC source, augmenting it with additional current from the batteries when necessary. This helps prevent overloading a small AC breaker or generator during short-term use.

- Initially, the AC source current is used for both loads and battery charging. In the MATE system display, the **ac1/grid limit** or **ac2/gen limit** settings dictate the maximum AC draw. If the AC draw exceeds this setting, the inverter reduces its charge rate to give priority to the loads.
- The charge rate will be reduced as much as necessary to support the loads. If the loads equal the amperage setting, the charge rate will be zero.
- If the AC loads **exceed** the amperage setting, the charger will begin operating in reverse. It will take power **from** the batteries and use it to support the incoming AC current.



IMPORTANT:

If the AC loads exceed the amperage limit setting, the inverter will drain the batteries. If the loads are sustained, the batteries may discharge to the point of **Low Battery Cut-Out** and the inverter may shut down with a **Low Battery** error. (See pages 13 and 34.) To prevent the loss of backup power, load use should be planned accordingly.

In the MATE system display, this feature is activated by the **ac2/gen support** menu item, located in the ADVANCED menus. (See the MATE manual.)

- Although the menu is titled “**ac2 gen support**”, it functions equally well whether the AC source is a generator or the utility grid.
- Choose between generator or grid criteria using the MATE’s **ac transfer control** menu. The default is **grid**. The <GRID> and <GEN> soft keys will toggle between these respective options.
- The default selection is **on**. It can be switched **off** using the <OFF> soft key. The MATE’s **ac transfer control** menu must be selected to **gen** in order to do this. In current models, if **ac transfer control** is set to **grid**, the support feature cannot be disabled.

Battery Charging



IMPORTANT:

Battery charger settings need to be correct for a given battery type. Always follow battery manufacturer recommendations. Making incorrect settings, or leaving them at factory default settings, may cause the batteries to be undercharged or overcharged.

Voltage

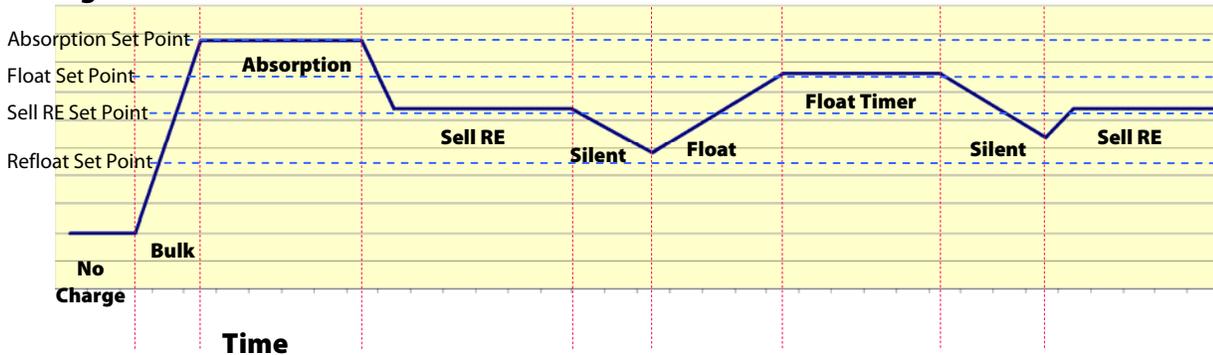


Figure 4 Charging Stages Over Time

All voltages in this section are given for a 12-volt system. For higher-voltage systems, the voltage can be multiplied by the appropriate amount. (Factory defaults for each inverter voltage are shown beginning on page 43.) Set points can be adjusted using the system display (see the appropriate manual).

The inverter uses a “three-stage” battery charging process. The three stages are Bulk, Absorption, and Float. These stages follow a series of steps, which are marked on the chart above. The points where the dark line intersects the vertical dotted line indicate a change from one step to the next. The points where they also intersect with a horizontal dotted line indicate that the charger has switched to a new target voltage. The process shown here also includes the step of selling power back to the utility, as this is integrally tied with the battery charger.

The Target Points and Time Limits cited under various steps are settable using the system display.

No Charging

If the inverter is not charging, any of the following conditions may apply:

- The unit is inverting or not connected to an AC source.
- The unit is connected to an AC source but is in a mode or stage that does not use the charger. (Silent mode is one example.)
- The unit is connected to an AC source but the charger has been turned off.

Bulk Stage

This stage activates the charger. This is the first stage in the three-stage charge cycle. It is a constant-current stage which drives the battery voltage up. This stage typically leaves the batteries at 75% – 90% of their capacity, depending on conditions.

Target point: Absorption Voltage setting. The default setting is 14.4 Vdc (in a 12-volt system).

The initial DC current is the maximum current the charger can deliver. It will begin at the charger's specified maximum, but will gradually decrease as the voltage increases. This is a tradeoff in wattage and is normal for the charger.

Absorption Stage

This is the second stage of charging. It is a constant-voltage stage. Current varies as needed to maintain the voltage, but will typically decrease to a very low number over time. This "tops off the tank", leaving the batteries at essentially 100% of capacity.

Target point: *Absorption Voltage* setting.

Time limit: *Absorption Time* setting. This timer counts down from the inception of the Absorption stage until it reaches zero. The timer can be viewed. (See the system display manual.)

The charging of multiple stacked inverters is synchronized and is governed by the master. When the master inverter reaches the end of Absorption (and other stages), the slaves will exit Absorption as well, even if their timers have not expired. The remaining time for the slaves will be retained in the timer for each inverter.

The Absorption timer does not reset to zero when AC power is disconnected or reconnected. It only resets to zero if it runs out, or if an external STOP BULK command is sent. The rest of the time, it retains any remaining time. It adds more time to the Absorption period whenever the batteries fall below a certain voltage. (See page 21 for more information on how the timer works.)

If the voltage exceeds the Absorption voltage setting (usually due to another charging source), the inverter(s) can sell current to the loads (or the source) in an effort to bring the voltage **down** to the set point. This will reduce the inverter's draw from the AC source.

Sell

This is not a charging stage and is only used once the batteries are recharged. Sell is a constant-voltage mode of operation. The inverter cannot import current to the charge batteries to this value, but it can export any excess current to hold them at a constant voltage. (Usually excess current comes into the batteries from a PV array, wind turbine, or similar renewable source.)

Target point: *Sell RE* voltage setting. The default setting is 13.0 Vdc (in a 12-volt system).

This setting is typically lower than the Float voltage setting. Although the batteries are not discharged, they are maintained at a somewhat lower voltage so that the maximum amount of power can be exported.

Excess power is sent first to any loads on the inverter's output, in what is known as "zeroing". If the exported power exceeds the loads, the remainder is sold back to the utility grid, using the inverter's AC input terminals. The unit will maintain this activity for as long as excess power is available. If excess power is not available, the battery voltage will drop below the *Sell RE* voltage and the unit will leave this stage.

See page 23 for more notes on the Sell feature.

Silent

The inverter remains on the AC source, but the charger is inactive. It enters this mode when there is not enough energy to sustain selling. The batteries are not in significant use by the inverter, but they are also not being charged by renewable sources. The battery voltage will naturally decrease when not maintained by another means.

Target point: *Refloat Voltage* setting, which activates the charger again. The default set point is 12.5 Vdc (in a 12-volt system).

Note: If the MATE's *ac transfer control* menu is set to *gen*, the charger skips both Sell and Silent, and proceeds directly to Float stage. (It will remain in Float until a new charge cycle is required, possibly through loss of AC power.) If *ac transfer control* is set to *grid*, the charger goes through Silent as noted and proceeds to Float only when the batteries drop to the Refloat voltage level. (See pages 14 and 15, and the MATE manual, for more information on *ac transfer control*.)

Float Stage

This is the third stage of charging. It is a constant-voltage stage. Current varies as needed to maintain the voltage, but typically drops to a low number. This stage offsets the batteries' tendency to self-discharge (as well as the draw of any other DC loads), and maintains them at 100% of capacity.

Target point: *Float Voltage* setting. The default set point is 13.6 Vdc (in a 12-volt system).

Time limit: *Float Time* setting.

If the voltage exceeds the Float voltage setting (usually due to another charging source), the inverter can sell current to the loads (or the source) in an effort to bring the voltage **down** to the set point. This will reduce the inverter's draw from the AC source.

Float Timer

This is not a separate stage of charging. On the chart, it is marked as a separate step to note that the timer only begins running upon reaching the Float set point. It does **not** begin running at the beginning of Float stage. (The Float timer is reset to its maximum amount whenever the batteries drop to the Refloat voltage.)

Repeated Silent

The unit re-enters the Silent mode as it did on page 19. The unit remains on the AC source, but the charger is inactive.

Target point: *Refloat Voltage* setting.

The unit will continue cycling between Float and Silent for as long as the AC source is present. However, if excess DC power is available and the batteries rise above the Sell RE set point, the unit can re-enter Sell and begin selling the excess as described above.

The unit can only re-enter Sell when none of the timers are active. If any of the timers have accumulated time while in Silent, the unit will enter the highest stage with accumulated time and proceed from that point.

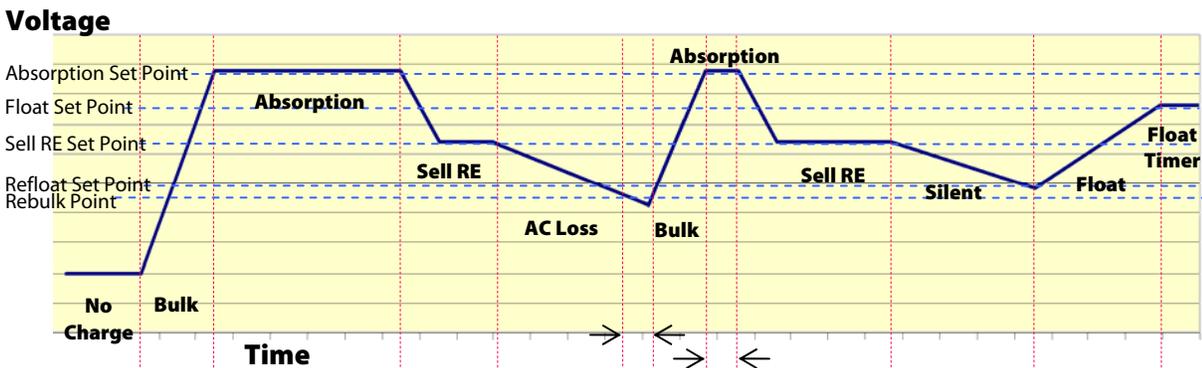


Figure 5 Repeated Charging Cycles

New Charging Cycle

If the AC source is lost or disconnected, the unit will return to inverting mode if enabled. The battery voltage will begin to decrease due to loads or natural loss. When the AC source is restored, the inverter will return to the charging cycle. If the batteries drop below the Rebulk voltage, the inverter will restart the cycle, beginning at Bulk stage. If the batteries do not drop below Rebulk, the charger will not enter the Bulk stage and will return to its previous stage.

New Absorption Stage

When entering the second stage, Absorption, the charger will not necessarily run through its full duration. The timer will count down whatever time remains from the previous cycle, or whatever time it has accumulated since then.

Absorption Timer

The Absorption timer does not reset to its maximum like the Float timer does. Instead, the timer counts upward (gaining time) whenever the battery voltage drops below the Rebulk point. This means that the Absorption period may not always be the same, depending on how much time it has acquired.

In a 12-volt system, the Rebulk voltage is 12.2 Vdc. This is a fixed setting and cannot be changed. For as long as the inverter remains below this voltage, the Absorption timer will gain an equal amount of time. This dictates the duration of the Absorption stage. Note that in Figure 5 the arrows show that the duration of time spent below the Rebulk voltage is the same as the subsequent Absorption period.

If the battery voltage drops below 12.0 Vdc (in a 12-volt system), the timer increments (counts upward) at double the normal rate. For example, if the batteries spent 8 minutes below this voltage, 16 minutes would be added to the Absorption timer. Similarly, if the battery voltage drops below 11.8 Vdc (in a 12-volt system), the timer increments at quadruple the normal rate.

The Absorption timer continues this behavior even if the charger is still on. For example, if the charger is in Float stage and there is a significant battery drain, the charger may not be able to maintain the batteries at the Float voltage. Once the batteries fall below the Rebulk point, the Absorption timer will begin accumulating time. (However, the accumulation will be minor, as this will also cause the charger to re-enter the Bulk stage.)

The timer will stop incrementing when it reaches the **absorb time limit** setting. This is the maximum duration of the Absorption stage. This means that regardless of the voltage, the timer will always run for the full Absorption period if the batteries dropped below the appropriate voltage for that amount of time. If significant battery drain caused them to drop below the set points for doubling or quadrupling the rate, it may run for the full Absorption period even after a lesser amount of time.

The rest of the charging stages will proceed as described on the previous few pages.

Equalization

Equalization is a controlled overcharge that is part of regular battery maintenance. Equalization brings the batteries to a much higher voltage than usual and “simmers” them for a period of time. This has the result of removing inert compounds from the battery plates, and reducing stratification in the electrolyte.

This process must be started manually using the system display. The inverter cannot be programmed for automatic battery equalization. This is a safety measure.

Equalization follows the same pattern as standard three-stage charging, as shown in Figure 4. However, instead of the Absorption voltage and time set points, it is controlled by the **equalize set point** and **equalize time period** settings in the system display.

Equalization is normally performed only on flooded lead-acid batteries. The schedule for equalization varies with battery use and type, but it is usually performed every few months. If performed correctly, this process can extend battery life by a considerable amount.

Equalization is not normally performed on nickel-technology batteries or any sort of sealed battery.



CAUTION: Battery Damage

- Never perform equalization on sealed gel-cell batteries. This process will destroy them.
- Contact the battery manufacturer for recommendations on equalization voltage, duration, schedule, and/or advisability. Always follow manufacturer recommendations for equalization. Do not equalize any battery unless approved by the manufacturer.

Battery Temperature Compensation

Temperature compensation is a process that corrects for changes in battery performance caused by varying temperature.

When batteries are cooler than room temperature (25 °C or 77 °F), the electrolyte reaction slows down. This causes the battery to accept charging energy less readily. Delivering the usual amount of energy that would fully recharge a battery at room temperature will undercharge a cool one.

Conversely, when batteries are warmer than room temperature, the electrolyte reaction is somewhat hyper-reactive. It takes less energy than usual to charge them. Delivering the full (room-temperature) amount of energy would overcharge them and can be hard on them over time.

The inverter, when equipped with the Remote Temperature Sensor (RTS) will compensate for changes in temperature. The RTS is attached to a single battery near the center of the bank, to achieve a representative temperature. If installed in a multiple-inverter system, only a single RTS is necessary. It must be plugged into the master inverter, and will control the charging of all slaves and all charge controllers. (See the International Series GFX Installation Manual to locate the RTS port.) This process is automatic.

When charging, an inverter system with an RTS will increase or decrease the charge voltage by 5 mV per degree Celsius per battery cell. This setting affects the Absorption, Float, and Equalization set points. The Sell RE and Refloat set points are not temperature compensated. The Equalization set points are not compensated in OutBack charge controllers.

- In a 12 Vdc system (6 cells, 2 volts each), this means 0.03 volts per degree Celsius above or below 25 °C. Maximum compensation is ± 0.6 Vdc.
- In a 24 Vdc system (12 cells, 2 volts each), this means 0.06 volts per degree Celsius above or below 25 °C. Maximum compensation is ± 1.2 Vdc.
- In a 48 Vdc system (24 cells, 2 volts each), this means 0.12 volts per degree Celsius above or below 25 °C. Maximum compensation is ± 2.4 Vdc.

Examples:

- A 12 Vdc system with batteries at 10 °C will compensate its charging to 0.3 Vdc **higher** than the set points.
- A 24 Vdc system with batteries at 35 °C will compensate its charging to 0.6 Vdc **lower** than the set points.
- A 48 Vdc system with batteries at 15 °C will compensate its charging to 1.2 Vdc **higher** than the set points.

Selling



IMPORTANT:

Selling power to the utility company requires the authorization of the local electric jurisdiction. How the local utility company handles this will depend on their policies on this issue. Some may pay for power sold; others may issue credit. Some policies may prohibit the use of this mode. Please check with the utility company and obtain their permission before using this mode.

The GFX inverters are grid-interactive. This means that in addition to using power from the utility grid for charging and loads, these models can also convert excess battery power and sell it to the utility grid. This is known as the “grid-tie” or “Sell” feature. Excess battery power usually comes from renewable energy sources, such as PV arrays, micro-hydroelectric turbines, and wind generators.

- The operation of the Sell feature is referenced heavily in the Battery Charging section, as it is integrally tied with the battery charger. In fact, selling is occasionally referred to as “charging in reverse”. Where the charger draws power from the AC input and puts it into the batteries, the Sell feature removes power from the batteries (or the DC system) and returns it to the AC input.
- The Sell feature can only operate while the utility grid power is stable and within certain limits. If the AC voltage or frequency vary outside these limits, the inverter will stop selling. It may nor may not disconnect from the utility grid. If the inverter stops selling, the system display will show the reason. Stop Sell Reasons are listed on page 37.
- The inverter’s grid-interactive limits are specified on page 42. The AC source acceptance limits are specified on page 15. These numbers are often not the same.
- Once the AC voltage and frequency become acceptable, the inverter has a minimum one-minute delay before selling will begin. Upon initial connection to the utility grid, the inverter may be required to perform a full battery charge. This may delay the operation of the sell feature.
- In the system display, the key set point is **sell re volts**. (See the system display manual to change this set point.) When the charger enters the Sell stage (see pages 18 and 19), it uses **sell re volts** as a reference point. When a renewable source of energy raises the batteries above this set point, the inverter exports power in order to bring the voltage back down or to prevent it from rising further.
 - ~ The Sell feature only functions when excess DC (renewable) power is available.
 - ~ The inverter itself cannot import AC power to raise the batteries to the **sell re volts** set point.
 - ~ The Sell feature can use other set points than **sell re volts**. If the charger is in a different stage, such as Absorption or Float, it can use the Absorption or Float voltage as reference points. As long as the renewable energy exceeds the voltage for that stage, it can sell exactly the same way as noted above.
- When power is returned to the utility grid, it is possible to completely reverse the utility meter. The net result would be to sell power to the utility company. However, this depends on whether there are other loads in the system. Loads on the main panel (not on the inverter’s output) may consume this power as fast as it is generated, preventing the meter from running backwards. In this case, the result of selling would be to reduce the consumption of AC power, not reverse it.
- The maximum amount of power an inverter can sell is *not* equal to its specified output wattage. It can exceed the specified wattage under some conditions, usually temporarily. (Its maximum output is 30 amps.)
 - ~ However, output will vary inversely with inverter temperature, battery type, and other conditions. The inverter should not be expected to sell 100% of its specified output wattage continuously. Even though it may be able to do so, this may leave it too hot to perform other functions (such as starting heavy loads if they are needed during a utility outage).
 - ~ A good guideline is that the renewable source should be sized to continuously deliver no more than 85% of the inverter’s specified wattage (per inverter, in a multi-inverter system). This recommendation is specifically for the inverter’s Sell feature. In some cases, the source may be sized larger to account for environmental conditions or the presence of DC loads. This depends on individual site requirements.

Multiple-Inverter Installations (Stacking)

Multiple inverters in a single system can support larger loads than a single inverter can handle. Installing inverters in this configuration is called “stacking”. Stacking inverters does not refer to physically placing one on top of another. It refers to how they are wired within the system and then programmed to coordinate activity. Stacking allows all units to work together as one system.

Each inverter is programmed to power an individual phase of the system and to operate at certain times. This order is assigned using a system display, such as the OutBack MATE.

Examples of stacking configurations include “parallel” and “three-phase” configurations.

Stacking requires an OutBack HUB product, as well as a system display. A system of four or fewer units may use the HUB4. Systems of up to ten units require the HUB10. All interconnections are made using CAT5 non-crossover cable. (See the *International Series GFX Installation Manual* for more stacking instructions.)

Each inverter needs to be assigned a status — “master” or “slave”. The master is the primary and most heavily used unit. Slave inverters provide assistance when the loads are more than the master can handle alone. Programming involves using the system display to assign a status and stacking value to the inverter on each port. See the system display and HUB manuals for programming instructions.

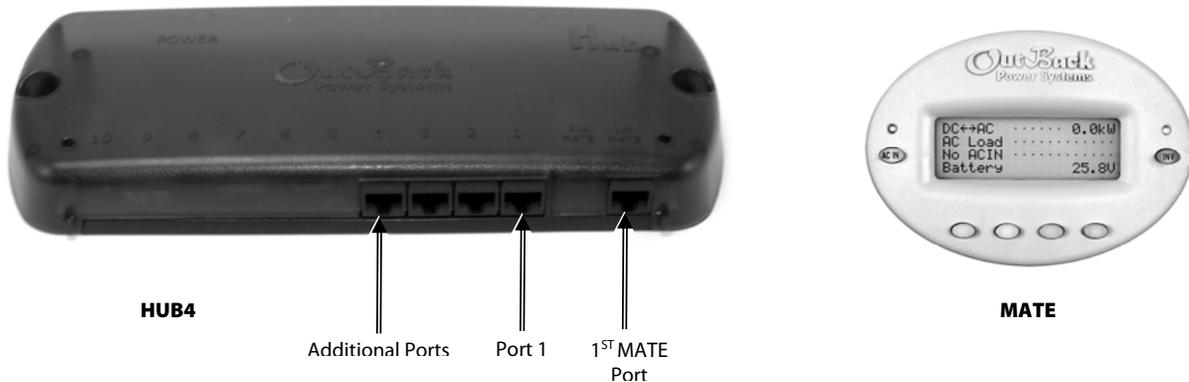


Figure 6 OutBack HUB4 and MATE



IMPORTANT:

- The master inverter must always be connected to port 1 on the HUB. Connecting it elsewhere, or connecting a slave to port 1, will result in backfeed or output voltage errors which will shut the system down immediately.
- Installing multiple inverters without stacking them (or stacking them improperly) will result in similar errors and shutdown.
- Although stacking allows greater capacity, the loads, wiring, and breakers must still be sized appropriately. Additional terminations and bus bars may be required. Overloading may cause the breakers to trip or the inverters to shut down.



CAUTION: Equipment Damage

The inverters in a stacked system should all be the same DC voltage, wattage, and model. Do not stack inverters of different wattages.

Parallel Stacking (Dual-Stack and Larger)

In parallel stacking, two or more inverters are stacked to create a single, common 230 Vac output.

- The master provides the primary output. The slaves are connected to the same output and assist the master.
- The slave inverters can be programmed to activate on demand, reducing idle-power consumption. They will remain off until the loads exceed a certain threshold.
- A two-inverter system can continuously power 2.6 – 2.8 kVA of loads, depending on the inverter model.
- Up to ten inverters may be installed in a parallel arrangement. The example on this page shows three inverters.



Figure 7 Example of Parallel Stacking Arrangement (Three Inverters)

Three-Phase Stacking

In three-phase stacking, three inverters are stacked to create three separate 230 Vac output legs. These outputs are 120° out of phase. Any two outputs produce 400 Vac between them. The three outputs can be used to power three-phase loads when all inverters work together.

- A three-phase system can continuously power 3.9 kVA – 4.2 kVA of loads, depending on the inverter model.
- Three inverters, one per phase, may be installed in a three-phase arrangement.

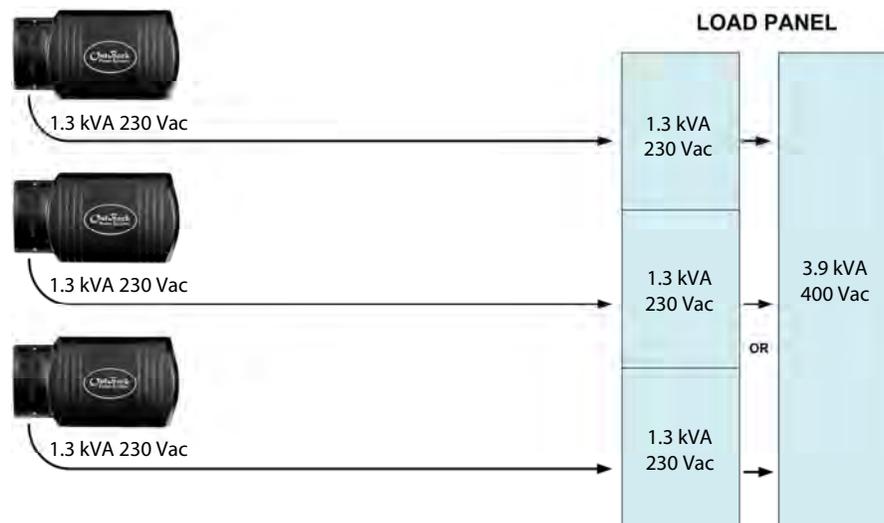


Figure 8 Example of Three-Phase Stacking Arrangement (Three Inverters)

Power Save Levels

Depending on the model, each inverter consumes approximately 20 watts of idle power while it remains on, even if it isn't actively inverting or charging. The Power Save function allows the option to put some or all slave inverters into Silent mode to minimize idle consumption. The inverters will come on again when the loads require power.

- The master inverter remains active unless specifically ordered to turn off. It does not enter Silent mode.
- When the majority of the inverter's wattage is consumed by loads, the master turns on one or more slaves for assistance. When the load drops back to a lesser wattage (as detected by the master), the slaves return to Silent mode.
- The order in which slaves turn on (or return to Silent mode) is controlled by programming in the system display. The slaves are given a "rank", or level number. The lower the number, the sooner a slave will be turned on.



IMPORTANT:

It is important to use the system display to set up the Power Save menus for any system with multiple inverters, regardless of system type. The Power Save feature itself is only usable by systems with slave inverters that have been programmed as **OB Slave L1** or **OB Slave L2**. However, many other system types have internal priorities that are controlled by the **power save level** settings. Failing to set these correctly may cause erratic or unusual behavior.

In the MATE system display, the **power save level** menus contain two screens. These are **master adjust only** and **slave adjust only**. Both screens have a settable range of values. (See the MATE manual for more information.)

- The first screen, **master adjust only**, must only be used when port P01 is selected with the <PORT> soft key. This should be the master inverter. Although the screen is still visible when other (slave) ports are available, it should not be programmed when other ports are selected. The range of rank numbers is 0 – 7. The default value is 0. The master is normally left at this value.
- The second screen, **slave adjust only**, must only be used when ports other than P01 are selected. Although the screen is still visible when the P01 (master) port is selected, it should not be programmed for P01. The range of rank numbers is 1 – 15. The default value for all ports is 1.
- The ranks are prioritized so that lower-numbered ranks turn on sooner and higher ranks turn on later. The lowest-ranked unit will not go silent and will remain on unless ordered otherwise. The lowest-ranked unit is expected to be the master. The priorities are the same across both screens; thus, if P01 (master) is set at 0 and P02 (slave) is set at 1, the slave will turn on later. Since the **master adjust only** screen is the only one that goes to 0, it is easy to ensure that all other units besides the master go silent.
- If a slave is prioritized higher than the master (by raising the master level to 2 and the slave to 1, for example), that slave will not go silent. This will keep the Power Save mode from functioning.
- It is recommended to rank the slave inverters in order (1, 2, 3, 4, etc.). It is also recommended that slaves do not share rank numbers. For example, if multiple slaves were all ranked at 1, they would all come on at the same time. Once they came on, the divided load would cause the master to detect a minimal load on its output, so it would shut off all the slaves. At this point the master would read a high load again. This could quickly escalate into a rapid on/off cycling of inverters and could cause long-term system problems.

Auxiliary Terminals

The inverter's AUX terminals provide a 12 Vdc output that can deliver up to 0.7 Adc to control external loads. The AUX LED (see page 11) illuminates when this output is present. Typical loads include signaling a generator to start, sending a fault alarm signal, or running a small fan to cool the inverter. See the *International Series GFX Installation Manual* for more information on hooking up the AUX terminals. See the system display manual for instructions on programming this feature.

The system display can turn the AUX output on and off. It can also control a series of automatic AUX functions. There are nine functions, each geared toward a different application.

- **Cool Fan** enables the AUX output when the inverter reaches a high internal temperature. It is intended to trigger a small external fan for additional cooling. This is the default setting. See the Warning Troubleshooting table on page xx for a description of the fan criteria.
 - ~ This function does not have settable parameters.
- **DivertDC** enables the AUX output to divert excess renewable energy to a DC load, such as a resistor or heater. The AUX function energizes a relay. Then the relay allows current to flow from the batteries to the load. (This is illustrated in the *International Series GFX Installation Manual*.) Diversion is triggered by high DC voltage and is usually used to regulate battery charging. The resistor must be sized to dissipate all of the energy from the renewable source if necessary.
 - ~ **DivertDC** and **DivertAC** use the same settable DC voltage and time parameters.
- **DivertAC** enables the AUX function to divert excess renewable energy to an AC load, usually an AC device powered by the inverter itself. The AUX function energizes a relay. Then the relay allows the excess current to flow to the AC load. Diversion is triggered by high DC voltage and is usually used to regulate battery charging. The AC device is usually wired to the output, or load panel, and must be left on. It must be sized to dissipate all of the energy from the renewable source if necessary. If the inverter shuts down due to overload, the AUX output will also shut down.
 - ~ **DivertAC** and **DivertDC** use the same settable DC voltage and time parameters.
- **AC Drop** enables the AUX output whenever the inverter disconnects from an AC source. It can activate a light (or alarm) to show that the utility grid has failed or that a generator has shut off. Alternately, it could be used to show that the source is operating.
 - ~ This function does not have settable parameters.
- **Vent Fan** enables the AUX output in response to high battery voltage. It can run a small fan to ventilate the battery compartment to eliminate gases that result from battery charging. **Vent Fan** runs for one minute. It then stops for a delay period before running again for another minute. This function has settable DC voltage and settable time delay parameters.
- **Fault** enables the AUX output when the inverter shuts down due to an error condition (see page 34). It can activate a light or alarm to show that the inverter has failed. With the appropriate devices, it could send an alarm signal through a radio, pager, or telephone dialer.
 - ~ This function does not have settable parameters.
- **GenAlert** is used as a simple controller for an AC generator with an automatic start feature. The generator is used to recharge batteries using the inverter's battery charger. The AUX function is used to energize a relay. Then the relay activates the remote start/stop circuit on the generator. (This is illustrated in the *International Series GFX Installation Manual*.) GenAlert is triggered by DC voltage.
 - ~ This function has settable voltage and time parameters.
 - ~ **GenAlert** has the advantage of functioning when the system display is removed. However, it may not completely charge the batteries and does not have all the advantages of the Automatic Generator Start (AGS) feature that is found in the system display. For many users, the AGS feature may prove more useful than **GenAlert**. **GenAlert**, however, could be used as a literal "Generator Alert", a signal to the user to manually start a generator.
- **LoadShed** enables the AUX function to perform load management. When battery voltage drops below a certain level, the AUX is activated. The AUX output energizes a normally closed (NC) relay, which is

connected to non-vital loads. When the relay is energized, the loads are disengaged to conserve battery power. LoadShed will also occur when the inverter enters a high-temperature condition or when the AC output voltage drops below 200 Vac for more than three seconds. There is a three-minute fixed delay before the AUX output is deactivated.

~ This function has a settable DC voltage parameter.

- **Remote** is intended for functions to be introduced in the future. Currently it is used when the MATE uses AGS to control the AUX output. Although the MATE can control the AUX even when one of the other AUX functions is enabled, selecting **Remote** keeps the inverter from interfering with the MATE.

Note that even if the auxiliary functions are disabled, the AUX output may still be triggered by an external function such as AGS (see below).

System Display-Based Functions

Automatic Generator Start (AGS)

As noted under the GenAlert feature (see page 27), the system is capable of starting a generator. GenAlert simply starts and stops the generator based on battery voltage. For more advanced control, the inverter system can use the Automatic Generator Start (AGS) feature, which runs through the entire three-stage charging cycle. It can start according to battery voltage, inverter load, time of day, and other criteria. It has a quiet time feature which restricts the generator from starting at inconvenient times. Additional features are also available.

Because this is an advanced function with capabilities beyond the inverter's GenAlert, the control logic for AGS is based in the system display, not the inverter. See the system display manual for more information on programming and using the AGS mode.

High Battery Transfer (HBX)

In HBX mode, the system is connected to an AC source such as the utility grid; however, it will use battery power as the first priority. The AC source is locked out until needed.

In this mode, the system runs on battery-supplied power for as long as the batteries can be sustained. It is expected that the system will be supplied by renewable sources such as PV power. When the batteries become depleted, the system reconnects to the AC source to operate the loads.

The batteries may be recharged during this time using the renewable source. When the batteries are recharged to a high enough voltage, the system transfers back to the batteries as the primary source (hence the name High Battery Transfer).

Note: The inverter's charger should be turned off. HBX mode is intended to use only the renewable source for charging batteries. Use of renewable charging is the motivator for returning to battery (and renewable) operation. Use of the inverter's charger interferes with this priority. It also may not charge effectively.

Because this is a system-wide function and not a function of individual inverters, the control logic for HBX is based in the system display. See the system display manual for more information.

Grid Use Programming

The inverter system is capable of connecting to, or disconnecting from, the utility grid based on time of day. It can also be programmed to connect at different times on weekdays and on weekends.

Because this is a system-wide function and not a function of individual inverters, the control logic for Grid Use is based in the system display. See the system display manual for more information.



Troubleshooting

Basic Troubleshooting

This list is organized in order of common symptoms, with a series of possible causes. Each possible cause also has inverter LEDs which may be unusual for that mode of operation. (LEDs which are normal, and LEDs on the system display, are **not** shown.) Each possible cause also shows possible troubleshooting remedies, including system display checks where appropriate.

Table 4 Basic Troubleshooting Steps

Symptom	Unusual LEDs	Possible Cause	Possible Remedy
No LEDs.	No LEDs, including battery LEDs	No DC voltage.	Use a DC voltmeter to check the voltage directly on the DC terminals. If not present, the problem is external. If present, the inverter could be damaged. Contact OutBack Technical Support (see inside front cover of this manual).
No AC output (will not invert).	No Inverter LED	Jumper JP1 missing.	See Installation Manual for location of JP1. Confirm the jumper is present. If missing, replace the jumper. Or follow Installation Manual instructions to install an external switch.
	No Inverter LED	Unit defaulted off (No MATE present; initial install; JP1 confirmed present).	The inverter may have been given an OFF command in the factory. With DC present, use narrow pliers to remove jumper JP1 from its pins. Once removed, install it again. This is the equivalent of "jiggling the switch."
	No Inverter LED	Inverter set to OFF	<i>MATE system display only:</i> Set to ON with INV hot key.
	Inverter LED flashes	Inverter set to SRCH (Search mode).	<i>MATE system display only:</i> If constant power is required, set to ON with INV hot key. (If this setting was intentional, then no action is required.)
One or more inverters will not invert while others do (in multi-inverter system).	Inverting LED not illuminated on questionable unit	Unit is slave and is in Power Save mode.	<i>MATE system display only:</i> Check Power Save levels in ADV/FX/STACK menu and test with loads. Note if inverter comes on at the appropriate levels. (If this setting was intentional, then no action is required.)

Table 4 Basic Troubleshooting Steps

Symptom	Unusual LEDs	Possible Cause	Possible Remedy
Will not charge.	No AC IN LED	No AC input.	See "Will not connect to AC" category below.
	AC IN LED normal	Charger set to OFF.	<i>MATE system display only:</i> Check Charger Control screen with AC IN hot key and set to ON or AUTO . (If this setting was intentional, then no action is required.)
Low charge rate.	AC IN LED normal	Charge complete or nearly complete.	Check the DC voltage and charging stage using the system display, if present. Confirm with DC voltmeter.
	AC IN LED normal	System display's DC meter reads significantly higher than actual battery voltage.	Check the DC voltage on the inverter's DC terminals. If different from the system display reading, the inverter could be damaged. Otherwise, check the DC voltage on batteries with a voltmeter. If different from the reading on the inverter, this could be a DC connection problem.
	AC IN LED normal	Generator type does not work well in conjunction with Grid/Generator Support feature (see page 16).	<i>MATE system display only:</i> Turn off the ac2/gen support feature in ADV/FX/GEN menu. The ac transfer control must be set to gen in order to do this. In current models, if ac transfer control is set to grid , the support feature cannot be disabled.
	AC IN LED normal	High output loads. If total loads and charge exceed input setting, charge will decrease to give priority to loads.	Turn off some of the output loads and test the charge rate again.
Will not sell power to utility grid.	None (AC IN LED is illuminated)	Inverter priority	<i>MATE system display only:</i> Check Stop Sell Reasons menu (STATUS/FX/SELL). Inverter may be behaving correctly.
	None (AC IN LED is illuminated)	AC source does not meet requirements.	Verify grid voltage and frequency. Determine if they are within the inverter's approved limits. If not the, inverter is behaving correctly. Contact the utility company if necessary. <i>MATE system display only:</i> The program selections for limits are IEEE or USER .
	None (AC IN LED and Inverter are illuminated)	High output loads will consume power before it is returned to the utility grid.	Turn off some output loads and observe the sell function.
	None (AC IN LED is illuminated)	Inverter has been set to accept a generator.	Inverter will not intentionally sell to a generator. <i>MATE system display only:</i> Set ac transfer control to grid .

Table 4 Basic Troubleshooting Steps

Symptom	Unusual LEDs	Possible Cause	Possible Remedy
Will not connect to the AC source.	No AC IN LED	No AC input.	Check the AC voltage on the inverter's input terminals. If not present, the problem is external. If present, the inverter could be damaged. Contact OutBack Technical Support (see inside front cover of this manual).
	AC IN LED flashes	Inverter set to disconnect from AC.	<i>MATE system display only:</i> Change AC Input Control setting from DROP to USE with AC IN hot key. (If this setting was intentional, then no action is required.)
	AC IN LED flashes	HBX mode has disconnected from AC.	<i>MATE system display only:</i> Check AC IN hot key screen to see if HBX mode is in use. If activated prematurely, check the HBX settings. (If this setting was intentional, then no action is required.)
	AC IN LED flashes	Grid use function has disconnected from AC.	<i>MATE system display only:</i> If activated prematurely, check both ADV/MATE/GRIDUSE menu settings and MATE clock settings. (If this setting was intentional, then no action is required.)
	AC IN LED flashes	AC source does not meet requirements.	<i>MATE system display only:</i> Check STATUS/FX/DISCON for the reason for disconnection. If unit never originally connected, check Warning menu. Confirm the source voltage and frequency.
Inverter clicks repeatedly. AC output voltage rises or drops to unusual levels with every click.	AC IN LED switches between continuous and flashing. Inverter LED remains illuminated.	Inverter's output has been connected to its input. Voltage shifts are the result of trying to match its own voltage.	Disconnect wires from either inverter's AC input terminals or AC output terminals, or both. If problem immediately disappears, it is an external wiring issue. The inverter's AC HOT IN and AC HOT OUT must remain isolated from each other.
	AC IN LED switches between continuous and flashing. Inverter LED turns on and off with each cycle.	Low AC input voltage. Can be caused by weak AC source, or by faulty input connection.	Test AC HOT IN and NEUTRAL IN connections with AC voltmeter. If low or fluctuating, this is an external problem.
	AC IN LED switches between continuous and flashing. Inverter LED turns on and off with each cycle. (Generator only)	Inverter has been set to sell to utility grid but has been connected to a generator.	Unit will drive the generator voltage up to disconnection, then reconnect to the generator and try again. <i>MATE system display only:</i> Set ac transfer control menu to gen . This will keep it from selling.

Table 4 Basic Troubleshooting Steps

Symptom	Unusual LEDs	Possible Cause	Possible Remedy
Loads drop out or crash during transfer.	None (Solid AC IN LED is replaced with solid Inverter LED)	Erratic AC source voltage.	Check AC voltage on inverter's input terminals. If not consistent, problem is external. <i>MATE system display only:</i> AC source voltage may have dipped or hovered at a low enough point to crash a sensitive load before the inverter could take over. This can happen if ac1/grid lower limit or ac2/gen lower limit were turned down to accommodate a problematic AC source. To make the inverter respond sooner, raise the lower limit setting. (If this setting was intentional, then no action required.)
	Inverter LED flashes	Inverter was set to SRCH (Search mode).	Unit will take a moment to come out of Search mode after transferring. <i>MATE system display only:</i> If constant power is required, set to ON with INV hot key. (If this setting was intentional, then no action required.)
	None (Solid AC IN LED is replaced with solid Inverter LED)	Loads sensitive to inverter's minimal transfer time.	This product is not an uninterruptible power supply. Certain loads (such as highly sensitive computers) may not respond well to the inverter's 12ms transfer time. It may be necessary to put a true UPS on the inverter's output.
	Inverter LED flickers; Error LED	Loads too large.	Unit can transfer more power than it can invert. If loads are oversized, unit will falter or crash when switching to batteries. Reduce the size of the loads.
	Inverter LED flickers; Error LED	Undersized battery cables.	Battery cables that are smaller than recommended will cause a significant voltage drop when switching to batteries, acting like either an overload or a low-battery condition. Size all cables correctly.
Generator, external fan, etc. fails to start when triggered by AUX output.	Amber AUX LED is on	AUX output is not connected, or is not delivering 12-volt output.	Test the generator or device to confirm functionality Test the AUX+ and AUX- terminals with a DC voltmeter. If voltage is present with the AUX LED on, then there is an external connection problem. If voltage is not present with the AUX LED on, the AUX circuit may be damaged. Contact OutBack Technical Support (see inside front cover of this manual).

Table 4 Basic Troubleshooting Steps

Symptom	Unusual LEDs	Possible Cause	Possible Remedy
Unit reads AC input, even though no source is present.	AC IN LED flashes	Internal transfer relay may be damaged.	Disconnect AC input wires and turn inverter on. Test the AC HOT IN and NEUTRAL IN connections with an AC voltmeter. If voltage appears there, transfer relay may be jammed. Contact OutBack Technical Support (see inside front cover of this manual).
Inverter hums loudly. System display may show messages for high battery voltage, low battery voltage, or backfeed error.	Error LED	Inverter output is being fed with an external AC source that is out of phase.	Disconnect AC output wires. Turn inverter off and then on. If the problem clears, reconnect the AC output wires. If the problem recurs when reconnected, an external AC source is connected to the output.
		Inverter has been incorrectly stacked with another unit on the same output. All units come defaulted as master.	Check HUB ports and make certain the master inverter is plugged into port 1. <i>MATE system display only:</i> Check stacking settings in the ADV/FX/STACK menu. Only one master is allowed per system.

Error Messages

An Error message is caused by a critical fault. In most cases when this occurs, the unit will shut down and the inverter’s ERROR LED (see page 11) will illuminate. See the system display manual for instructions on viewing errors. One or more messages will display **yes**. If a message says **no**, it is not the cause of the error.

Error screens can only display errors; they cannot clear them. It is possible to clear an error by resetting the inverter. The inverter must be turned off, and then on, to reset it. Other possible remedies are shown below (although it is still necessary to reset the inverter).

Table 5 Error Troubleshooting

Message	Causes	Possible Remedy
low ac output voltage	Inverter’s AC regulation cannot be maintained under high load conditions.	Check loads and measure current draw. Remove loads as necessary.
stacking error detected	Programming problem among stacked units. (Often occurs if there is no master.) Can also occur when ac output backfeed occurs.	Check stacking programming and designation of master. (See page 24.) Check for output backfeed from an external source. Disconnect output if necessary.
inverter overtemp	Inverter has exceeded its maximum allowed operating temperature.	Shut off the inverter to reduce the temperature, or add external cooling. This can occur without shutting off the Sell feature. (It turns off the inverter’s output, but not the input.) If an extra inverter is added to the system, this will distribute the sell current more widely and allow each unit to run cooler.
low battery voltage	DC voltage is below Low Battery Cut-Out (LBCO) set point. This error can be triggered by other causes. It can appear along with low AC output voltage, AC output shorted, or ac output backfeed errors.	If this error accompanies other errors, treat those conditions as appropriate. If it occurs by itself: Recharge the batteries. The error will clear automatically if an external AC source is connected and the inverter’s charger comes on.
phase loss error	A slave was ordered to transfer to AC by the master, but no AC is present. The unit continues inverting. Despite the name, this is not accompanied by a shutdown.	Check the AC voltage on the inverter input terminals. If AC voltage is not present, problem is external. If AC voltage is present, the unit may be damaged. Contact OutBack Technical Support (see inside front cover of this manual).
high battery voltage	DC voltage exceeded acceptable level (specified on page 13).	Check the charging source. This problem is usually the result of external charging. This error will clear automatically if conditions are removed.
ac output shorted	Inverter exceeded its maximum surge current due to severe overload.	Check the loads and wiring. This problem is more often the result of a wiring error (a short).
ac output backfeed	Usually indicates another AC power source (out of phase with the inverter) was connected to the unit’s AC output.	Disconnect the AC OUT wires from the inverter. Check the wires (not the inverter) with an AC voltmeter. If an AC source is present, shut it off.

Warning Messages

A Warning message is caused by a non-critical fault. When this occurs, the unit will not shut down, but the ERROR LED (see page 11) will flash to show a condition that requires attention. See the system display manual for instructions on viewing warnings. One or more messages will display **yes**. If a message says **no**, it is not the cause of the warning.

Some warnings can become Errors if left unattended. Frequency and voltage warnings are meant to warn of a problematic AC source. Often the inverter will disconnect from the source. This will occur if the condition lasts longer than the inverter’s transfer delay settings. If the inverter disconnects, the warning will display as long as the source is present, accompanied by a Disconnect message. (See next page.)

Warning screens can only display warnings; they cannot clear them. The way to correct the fault may be obvious from the message.

Table 6 Warning Troubleshooting

Message	Definition	Possible Remedy
<i>acin freq too high</i>	The AC source is above the upper acceptable frequency limit (55 Hz) and prevents connection.	Check the AC source. If it is a generator, reduce its speed.
<i>acin freq too low</i>	The AC source is below the lower acceptable frequency limit (45 Hz) and prevents connection.	Check the AC source. If it is a generator, increase its speed.
<i>acin voltage too high</i>	The AC source is above the upper acceptable voltage limit (252 Vac default setting) and prevents connection.	Check the AC source. The inverter’s range is adjustable. However, this will accommodate an AC problem, not fix it.
<i>acin voltage too low</i>	The AC source is below the lower acceptable voltage limit (208 Vac default setting) and prevents connection.	Check the AC source. Check the AC wiring. The inverter’s acceptance range is adjustable. However, this will accommodate an AC problem, not fix it.
<i>acin input current exceeds max</i>	AC loads are drawing more current from the AC source than allowed by the input setting.	Check the loads. Oversized loads can trip the input breaker. If they exceed the inverter’s transfer relay size, the relay can be damaged.
<i>temperature sensor fault</i>	An internal inverter temperature sensor may be malfunctioning. This is indicated by an unusual <i>airtemp</i> , <i>fettemp</i> , or <i>captemp</i> reading.	Check sensor readings (see below). The numeric values represent electronic counts between 0 and 255. ¹
<i>internal comm error detected</i>	Probable failure on inverter’s control board. Despite the name, this is not an inverter-defined error and is not accompanied by a shutdown.	Unit may require repair. Contact OutBack Technical Support (see inside front cover of this manual).
<i>internal fan failure detected</i>	The inverter’s internal cooling fan is not operating properly.	Turn the battery disconnect off, and then on, to determine if the fan self-tests, then contact OutBack Technical Support for the next step. Meanwhile, run the inverter at reasonable levels or apply external cooling.
<i>airtemp</i>¹	Displays a code representing the air temperature within the inverter.	Lower counts stand for higher temperatures, and higher counts mean lower temperatures. Room temperature is 210 – 220. The internal fan runs at 142, and stops at 164. A count of either 0 or 255 is a defective sensor. Contact OutBack Technical Support if necessary (see inside front cover of this manual).
<i>fettemp</i>¹	Displays a code representing the temperature of the FETs (Field Effect Transistors) and heat sink.	
<i>captemp</i>¹	Displays a code representing the temperature of the inverter’s ripple capacitors.	

¹These values are in digital counts, not degrees. The values are used for troubleshooting purposes.

Disconnect Messages

Disconnect screens explain the reason that the inverter rejected an AC source. The unit returns to inverting mode if turned on. The ERROR LED (see page 11) will not illuminate for a Disconnect message, although it may flash for a concurrent warning following the disconnect. (See previous page.) If the AC source is removed, the warning and the LED will be blank, but the cause of the last disconnect will remain. See the system display manual for instructions on viewing disconnect messages. One or more messages in this menu will display **yes**. If a message says **no**, it is not the cause of disconnection.

Disconnect screens only display the reason for the disconnection; they cannot correct it. It is usually the result of external conditions, not an inverter fault. A few settings can be changed to accommodate problems with the AC source.

Disconnect messages are not the same as the Stop Sell Reasons (see next page), although they may be caused by the same circumstance. A grid-interactive unit can stop selling and still remain connected to the utility grid.

Table 7 Disconnect Troubleshooting

Message	Definition	Possible Remedy
<i>acin freq too high</i>	The unit disconnects if the AC source exceeds 55 Hz.	Check AC source. If it is a generator, reduce speed.
<i>acin freq too low</i>	The unit disconnects if the AC source drops below 45 Hz.	Check AC source. If it is a generator, increase speed.
<i>acin voltage > max</i>	The unit disconnects if the AC source exceeds 252 Vac (default value).	Check AC source. The inverter's acceptance range is adjustable. However, this will accommodate an AC problem, not fix it.
<i>acin voltage < min</i>	The unit disconnects if the AC source drops below 208 Vac (default value).	Check AC source. The inverter's acceptance range is adjustable. However, this will accommodate an AC problem, not fix it.

Stop Sell Reasons

This screen displays a numerical value to show the reason the inverter stopped selling power. The screen is used for troubleshooting by OutBack Technicians, though often this can indicate normal operation. See the system display manual for instructions on viewing these messages.

The acceptable limits for AC source voltage and frequency are displayed on page 42. If the AC source exceeds these limits, the inverter will stop selling and display the appropriate code. After the source returns to the acceptable range, the system display will begin a 1-minute timer. When the timer expires, the inverter will begin selling power again.

Note: This screen is only functional for grid-interactive inverters.

Table 8 Grid-Interactive Troubleshooting

Code	Definition
0	The inverter is selling. Normal operation.
1	The inverter is charging batteries. It is unable to sell while charging.
2	The battery voltage is below the target point. This is usually due to lack of renewable energy.
3	1-minute reconnect timer is in effect. This timer takes effect as soon as the AC source becomes acceptable.
4	The AC source voltage is below the acceptable limit. Once it is restored, the display will change to code 3 and start the 1-minute timer. This code will also appear if the AC source fails or is completely disconnected.
5	The AC source voltage is above the acceptable limit. Once it is restored, the display will change to code 3 and start the 1-minute timer.
6	The AC source frequency is below the acceptable limit. Once it is restored, the display will change to code 3 and start the 1-minute timer.
7	The AC source frequency is above the acceptable limit. Once it is restored, the display will change to code 3 and start the 1-minute timer.
8	The inverter has been commanded to disconnect from the AC source.
9	The inverter has detected an "island" condition. The AC source frequency is unstable.
10	The inverter has lost synchronization with the AC source. This is usually the result of a rapidly-changing frequency.
11	The inverter went into an overcurrent condition while attempting to sell. This is usually caused by miswiring, incorrect programming, or an unstable AC source.

If the AC source is unstable, it may become unacceptable before the timer expires. This will cause the timer to continually reset. It is possible for brief fluctuations to occur that are too fast to be seen on a DVM. If this happens, the appropriate code will still appear on the system display for a short time to help troubleshoot the problem.

If the utility grid is not tightly regulated or has other problems, the act of selling may cause fluctuations and force the inverter to disconnect itself with one of these codes.

In addition to problems with the utility grid, other external conditions can cause fluctuations or problems with selling. Undersized wires or bad connections can result in local voltage problems. Long wires or transformers in the AC line can create inductances which will register as either voltage or frequency fluctuations.



Specifications

Specifications for Model GFX1312E

Table 9 Electrical Specifications (GFX1312E)

Specification	Value
Nominal DC Input Voltage	12 Vdc
Continuous Output Power at 25 °C	1300 VA
AC Output Voltage	230 Vac
AC Output Frequency	50 Hz
Continuous AC Output Current at 25 °C	5.65 Aac
Waveform	True Sinewave
Efficiency (Typical)	90%
Total Harmonic Distortion (Typical)	2%
Output Voltage Regulation	± 2%
Maximum Output Current (1 ms peak)	28 Aac
Maximum Output Current (100 ms RMS)	20 Aac
Overload Capability (100 ms surge)	4600 VA
Overload Capability (5 second)	2900 VA
Overload Capability (30 minute)	1800 VA
Idle Consumption - Invert mode, no load	18 Watts
Idle Consumption - Search Mode	6 Watts
AC Input Voltage Range (Adjustable)	140 to 280 Vac
AC Input Frequency Range	45 to 55 hz
AC Input Current (Maximum)	30 Aac
Grid-Interactive Voltage Range (Default)	208 to 252 Vac
Grid-Interactive Frequency Range (Default)	48 to 52 Hz
Battery Charger Maximum AC Input	6 Aac
Battery Charger Max Continuous DC Output	70 Adc
DC Input Voltage Range	10.5 to 17 Vdc
DC Input Current at Rated Power	130 Adc
Maximum DC Input Current on Surge	460 Adc
Auxiliary Output	12 Vdc, 0.7 Adc

Table 10 Mechanical Specifications (GFX1312E)

Specification	Value
Inverter Dimensions (H x W x L)	33 cm (13") x 21 cm (8.25") x 41 cm (16.25")
Shipping Dimensions (H x W x L)	55 cm (21.75") x 33 cm (13") x 56 cm (22")
Inverter Weight	22.5 kg (49.6 lbs)
Shipping Weight	25.6 kg (56.4 lbs)
Accessory Ports	RJ11 and RJ45
Non-volatile Memory	Yes
Neutral-Ground Bond Switching	No
Turbo Fan	No
Chassis Type	Sealed

Specifications for Model GFX1424E

Table 11 Electrical Specifications (GFX1424E)

Specification	Value
Nominal DC Input Voltage	24 Vdc
Continuous Output Power at 25 °C	1400 VA
AC Output Voltage	230 Vac
AC Output Frequency	50 Hz
Continuous AC Output Current at 25 °C	6.09 Aac
Waveform	True Sinewave
Efficiency (typical)	92%
Total Harmonic Distortion (typical)	2%
Output Voltage Regulation	± 2%
Maximum Output Current (1 ms peak)	28 Aac
Maximum Output Current (100 ms RMS)	20 Aac
Overload Capability (100 ms surge)	4600 VA
Overload Capability (5 second)	2900 VA
Overload Capability (30 minute)	2000 VA
Idle Consumption - Invert mode, no load	18 Watts
Idle Consumption - Search Mode	6 Watts
AC Input Voltage Range (Adjustable)	140 to 280 Vac
AC Input Frequency Range	45 to 55 hz
AC Input Current (Maximum)	30 Aac
Grid-Interactive Voltage Range (Default)	208 to 252 Vac
Grid-Interactive Frequency Range (Default)	48 to 52 Hz
Battery Charger Maximum AC Input	6 Aac
Battery Charger Max Continuous DC Output	40 Adc
DC Input Voltage Range	21.0 to 34.0 Vdc
DC Input Current at Rated Power	70 Adc
Maximum DC Input Current on Surge	230 Adc
Auxiliary Output	12 Vdc, 0.7 Adc

Table 12 Mechanical Specifications (GFX1424E)

Specification	Value
Inverter Dimensions (H x W x L)	33 cm (13") x 21 cm (8.25") x 41 cm (16.25")
Shipping Dimensions (H x W x L)	55 cm (21.75") x 33 cm (13") x 56 cm (22")
Inverter Weight	22.5 kg (49.6 lbs)
Shipping Weight	25.6 kg (56.4 lbs)
Accessory Ports	RJ11 and RJ45
Non-volatile Memory	Yes
Neutral-Ground Bond Switching	No
Turbo Fan	No
Chassis Type	Sealed

Specifications for Model GFX1448E

Table 13 Electrical Specifications (GFX1448E)

Specification	Value
Nominal DC Input Voltage	48 Vdc
Continuous Output Power at 25 °C	1400 VA
AC Output Voltage	230 Vac
AC Output Frequency	50 Hz
Continuous AC Output Current at 25 °C	6.09 Aac
Waveform	True Sinewave
Efficiency (Typical)	93%
Total Harmonic Distortion (Typical)	2%
Output Voltage Regulation	± 2%
Maximum Output Current (1 ms peak)	28 Aac
Maximum Output Current (100 ms RMS)	20 Aac
Overload Capability (100 ms surge)	4600 VA
Overload Capability (5 second)	2900 VA
Overload Capability (30 minute)	2000 VA
Idle Consumption - Invert mode, no load	18 Watts
Idle Consumption - Search Mode	6 Watts
AC Input Voltage Range (Adjustable)	140 to 280 Vac
AC Input Frequency Range	45 to 55 hz
AC Input Current (Maximum)	30 Aac
Grid-Interactive Voltage Range (Default)	208 to 252 Vac
Grid-Interactive Frequency Range (Default)	48 to 52 Hz
Battery Charger Maximum AC Input	6 Aac
Battery Charger Max Continuous DC Output	20 Adc
DC Input Voltage Range	42.0 to 68.0 Vdc
DC Input Current at Rated Power	35 Adc
Maximum DC Input Current on Surge	115 Adc
Auxiliary Output	12 Vdc, 0.7 Adc

Table 14 Mechanical Specifications (GFX1448E)

Specification	Value
Inverter Dimensions (H x W x L)	33 cm (13") x 21 cm (8.25") x 41 cm (16.25")
Shipping Dimensions (H x W x L)	55 cm (21.75") x 33 cm (13") x 56 cm (22")
Inverter Weight	22.5 kg (49.6 lbs)
Shipping Weight	25.6 kg (56.4 lbs)
Accessory Ports	RJ11 and RJ45
Non-volatile Memory	Yes
Neutral-Ground Bond Switching	No
Turbo Fan	No
Chassis Type	Sealed

Environmental Specifications

Table 15 Environmental Specifications for All Models

Specification	Value
Rated Temperature Range (meets all specifications)	0 °C to 50 °C
Operational Temperature Range (functions, but does not necessarily meet all specifications)	-40 °C to 60 °C
Storage Temperature Range	-40 °C to 60 °C

Regulatory Specifications

The International Series GFX inverters are CE compliant for off-grid use.

Grid-Interactive Use

Inverters intended for grid-interactive use must comply with established standards which provide regulation for acceptable output voltage ranges, acceptable output frequency, total harmonic distortion (THD) and anti-islanding performance when the inverter is exporting power to a utility source.

The OutBack grid-interactive models are validated through compliance testing. The following specifications refer to exporting power to a simulated utility source of less than 1% voltage total harmonic distortion (THD).

- The THD of the root mean square (RMS) current is less than 5%.
- The output of the GFX inverter exceeds the minimum power factor of 0.85 with a typical power factor of 0.96 or better.
- All International Series GFX inverters are tested to comply with Table 16.

Table 16 Interconnection Response to Voltage and Frequency

Voltage Range (AC Volts)	Frequency (Hz)	Allowed Time (Seconds)	Measured Time (Seconds)
$V < 115$	50	0.16	0.020
$115 \leq V < 202.4$	50	2.00	0.155
202.4 to 253	50	No interruption	No interruption
$253 < V < 276$	50	1.00	0.157
$V \geq 276$	50	0.16	Instantaneous, but 0.137 seconds to zero current
IEEE setting	> 51	0.16	0.098
IEEE setting	< 49	0.16	0.102
User setting	> 52	1.00	0.605
User setting	< 48	1.00	0.656

The acceptance ranges are selected using the system display. The options are **IEEE** and **USER**. The default setting is **USER**.

- The **IEEE** option allows a range of 206 – 250 Vac at 49 – 51 Hz.
- The **USER** option is not a fixed setting. It follows the **ac1/grid lower limit** and **ac1/grid upper limit** settings as shown on the tables beginning on page 43. The default is a range of 208 – 252 Vac at 48 – 52 Hz.

Reconnection delay is 12 seconds after restoration of acceptable conditions. Sell delay is one minute. These settings are not adjustable.

Default Settings and Ranges

Table 17 12-Volt Inverter Settings

12 Vdc Inverter	Default	Minimum	Maximum
Search			
<i>Search Sensitivity</i> (see page 14 for increments)	6	0	50
<i>Search Pulse Length</i>	8	4	20
<i>Search Pulse Spacing</i>	60 AC cycles	4 AC cycles	120 AC cycles
Input			
<i>AC Transfer Control</i>	<i>Grid</i>	<i>Grid or Generator</i>	
<i>AC1/Grid Limit</i>	25 Aac	2.5 Aac	30 Aac
<i>AC2/Gen Limit</i>	25 Aac	2.5 Aac	30 Aac
Inverter			
<i>Low Battery Cut-Out (LBCO)</i>	10.5 Vdc	9 Vdc	12 Vdc
<i>Low Battery Cut-In (LBCI)</i>	12.5 Vdc	10 Vdc	14 Vdc
<i>Adjust Output Voltage</i>	230 Vac	210 vac	250 Vac
Charger			
<i>Charger Limit</i>	5 Aac	0 Aac	6 Aac
<i>Absorb Voltage</i>	14.4 Vdc	13 Vdc	16 Vdc
<i>Absorb Time Limit</i>	1.0 hours	0.0 hours	24.0 hours
<i>Float Voltage</i>	13.6 Vdc	12 Vdc	15 Vdc
<i>Float Time Period</i>	1.0 hours	0.0 hours	24.0 hours
<i>ReFloat Voltage</i>	12.5 Vdc	12 Vdc	13 Vdc
<i>Equalization Voltage</i>	14.6 Vdc	14 Vdc	17 Vdc
<i>Equalization Time Period</i>	1.0 hours	0.0 hours	24.0 hours
Grid			
<i>AC1/Grid Lower Limit</i>	208 Vac	140 Vac	220 Vac
<i>AC1/Grid Upper Limit</i>	252 Vac	250 Vac	280 Vac
<i>AC1/Grid Transfer Delay</i>	6 AC cycles	0 AC cycles	240 AC cycles
Generator (Gen)			
<i>Gen Input Connect Delay</i>	0.5 min	0.2 min	15 min
<i>AC2/Gen Lower Limit</i>	208 Vac	140 Vac	220 Vac
<i>AC2/Gen Upper Limit</i>	252 Vac	250 Vac	280 Vac
<i>AC2/Gen Transfer Delay</i>	6 AC cycles	0 AC cycles	240 AC cycles
<i>AC2/Gen Support</i>	ON	ON or OFF	
Auxiliary (AUX)			
<i>AUX Output Control</i>	AUTO	ON, OFF, or AUTO	
<i>AUX Output Function</i>	Cool Fan	Cool Fan, DivertDC, DivertAC, AC Drop, Vent Fan, Fault, GenAlert, LoadShed, or Remote	
<i>GenAlert On Voltage</i>	11 Vdc	10 Vdc	14 Vdc
<i>GenAlert On Delay</i>	4 min	0 min	240 min
<i>GenAlert Off Voltage</i>	14 Vdc	12 Vdc	18 Vdc
<i>GenAlert Off Delay</i>	9 min	0 min	240 min
<i>Load Shed Off Voltage</i>	11 Vdc	10 Vdc	14 Vdc
<i>Vent Fan On Set Point</i>	13 Vdc	10 Vdc	16 Vdc
<i>Vent Fan Off Period</i>	5 min	0 min	30 min

Table 17 12-Volt Inverter Settings

12 Vdc Inverter	Default	Minimum	Maximum
<i>Diversion On Voltage</i>	14.6 Vdc	12 Vdc	16 Vdc
<i>Diversion Off Delay</i>	30 sec	0 sec	240 sec
Stacking			
<i>Stack Phase</i>	<i>Master</i>	<i>Master, OB Slave L1, 3p Classic B, or 3p Classic C</i>	
<i>Power Save Level</i>			
<i>Master Adjust Only</i>	0	0	7
<i>Slave Adjust Only</i>	1	1	15
Sell			
<i>Sell RE Volts</i>	13.0 Vdc	10 Vdc	15 Vdc
<i>Grid Tie Window</i>	<i>User</i>	<i>IEEE or User</i>	
<i>Grid Tie Authority</i>	<i>GridTie</i>	<i>GridTie or No Sell</i>	
Calibration (Cal)			
<i>Vac Input Adjustment</i> ¹	236	220	254
<i>Vac Output Adjustment</i> ¹	236	220	254
<i>Battery Vdc Adjustment</i> ²	2	0	4

¹These values are in digital counts, not volts. Lower counts stand for higher voltages, and higher counts mean lower voltages. One count equals approximately 1 Vac. The range of adjustment is 15 Vac above nominal, and 17 Vac below nominal.

²These values are in digital counts, not volts. One count equals 0.1 Vdc. The range of adjustment is 0.2 Vdc above or below nominal.

Table 18 24-Volt Inverter Settings

24 Vdc Inverter	Default	Minimum	Maximum
Search			
<i>Search Sensitivity</i> (see page 14 for increments)	6	0	50
<i>Search Pulse Length</i>	8	4	20
<i>Search Pulse Spacing</i>	60 AC cycles	4 AC cycles	120 AC cycles
Input			
<i>AC Transfer Control</i>	<i>Grid</i>	<i>Grid or Generator</i>	
<i>AC1/Grid Limit</i>	25 Aac	2.5 Aac	30 Aac
<i>AC2/Gen Limit</i>	25 Aac	2.5 Aac	30 Aac
Inverter			
<i>Low Battery Cut-Out (LBCO)</i>	21 Vdc	18 Vdc	24 Vdc
<i>Low Battery Cut-In (LBCI)</i>	25 Vdc	20 Vdc	28 Vdc
<i>Adjust Output Voltage</i>	230 Vac	210 vac	250 Vac
Charger			
<i>Charger Limit</i>	5.5 Aac	0 Aac	6Aac
<i>Absorb Voltage</i>	28.8 Vdc	26 Vdc	32 Vdc
<i>Absorb Time Limit</i>	1.0 hours	0.0 hours	24.0 hours
<i>Float Voltage</i>	27.2 Vdc	24 Vdc	30 Vdc
<i>Float Time Period</i>	1.0 hours	0.0 hours	24.0 hours
<i>ReFloat Voltage</i>	25 Vdc	24 Vdc	26 Vdc
<i>Equalization Voltage</i>	29.2 Vdc	28 Vdc	34 Vdc
<i>Equalization Time Period</i>	1.0 hours	0.0 hours	24.0 hours

Table 18 24-Volt Inverter Settings

24 Vdc Inverter	Default	Minimum	Maximum
Grid			
<i>AC1/Grid Lower Limit</i>	208 Vac	140 Vac	220 Vac
<i>AC1/Grid Upper Limit</i>	252 Vac	250 Vac	280 Vac
<i>AC1/Grid Transfer Delay</i>	6 AC cycles	0 AC cycles	240 AC cycles
Generator (Gen)			
<i>Gen Input Connect Delay</i>	0.5 min	0.2 min	15 min
<i>AC2/Gen Lower Limit</i>	208 Vac	140 Vac	220 Vac
<i>AC2/GenUpper Limit</i>	252 Vac	250 Vac	280 Vac
<i>AC2/Gen Transfer Delay</i>	6 AC cycles	0 AC cycles	240 AC cycles
<i>AC2/Gen Support</i>	ON	ON or OFF	
Auxiliary (AUX)			
<i>AUX Output Control</i>	AUTO	ON, OFF, or AUTO	
<i>AUX Output Function</i>	Cool Fan	Cool Fan, DivertDC, DivertAC, AC Drop, Vent Fan, Fault, GenAlert, LoadShed, or Remote	
<i>GenAlert On Voltage</i>	22 Vdc	20 Vdc	28 Vdc
<i>GenAlert On Delay</i>	4 min	0 min	240 min
<i>GenAlert Off Voltage</i>	28 Vdc	24 Vdc	36 Vdc
<i>GenAlert Off Delay</i>	9 min	0 min	240 min
<i>Load Shed Off Voltage</i>	22 Vdc	20 Vdc	28 Vdc
<i>Vent Fan On Set Point</i>	26 Vdc	20 Vdc	32 Vdc
<i>Vent Fan Off Period</i>	5 min	0 min	30 min
<i>Diversion On Voltage</i>	29.2 Vdc	24 Vdc	32 Vdc
<i>Diversion Off Delay</i>	30 sec	0 sec	240 sec
Stacking			
<i>Stack Phase</i>	Master	Master, OB Slave L1, 3p Classic B, or 3p Classic C	
<i>Power Save Level</i>			
<i>Master Adjust Only</i>	0	0	7
<i>Slave Adjust Only</i>	1	1	15
Sell			
<i>Sell RE Volts</i>	26 Vdc	20	30
<i>Grid Tie Window</i>	IEEE	IEEE or User	
<i>Grid Tie Authority</i>	GridTie	GridTie or No Sell	
Calibration (Cal)			
<i>Vac Input Adjustment¹</i>	236	220	254
<i>Vac Output Adjustment¹</i>	236	220	254
<i>Battery Vdc Adjustment²</i>	2	0	4

¹These values are in digital counts, not volts. Lower counts stand for higher voltages, and higher counts mean lower voltages. One count equals approximately 1 Vac. The range of adjustment is 15 Vac above nominal, and 17 Vac below nominal.

²These values are in digital counts, not volts. One count equals 0.2Vdc. The range of adjustment is 0.4 Vdc above or below nominal.

Table 19 48-Volt Inverter Settings

48 Vdc Inverter	Default	Minimum	Maximum
Search			
<i>Search Sensitivity</i> (see page 14 for increments)	6	0	50
<i>Search Pulse Length</i>	8	4	20
<i>Search Pulse Spacing</i>	60 AC cycles	4 AC cycles	120 AC cycles
Input			
<i>AC Transfer Control</i>	Grid	Grid or Generator	
<i>AC1/Grid Limit</i>	25 Aac	2.5 Aac	30 Aac
<i>AC2/Gen Limit</i>	25 Aac	2.5 Aac	30 Aac
Inverter			
<i>Low Battery Cut-Out (LBCO)</i>	42 Vdc	36 Vdc	48 Vdc
<i>Low Battery Cut-In (LBCI)</i>	50 Vdc	40 Vdc	56 Vdc
<i>Adjust Output Voltage</i>	230 Vac	210 vac	250 Vac
Charger			
<i>Charger Limit</i>	5.5 Aac	0 Aac	6Aac
<i>Absorb Voltage</i>	57.6 Vdc	52 Vdc	64 Vdc
<i>Absorb Time Limit</i>	1.0 hours	0.0 hours	24.0 hours
<i>Float Voltage</i>	54.4 Vdc	48 Vdc	60 Vdc
<i>Float Time Period</i>	1.0 hours	0.0 hours	24.0 hours
<i>ReFloat Voltage</i>	50 Vdc	48 Vdc	52 Vdc
<i>Equalization Voltage</i>	58.4 Vdc	56 Vdc	68 Vdc
<i>Equalization Time Period</i>	1.0 hours	0.0 hours	24.0 hours
Grid			
<i>AC1/Grid Lower Limit</i>	208 Vac	140 Vac	220 Vac
<i>AC1/Grid Upper Limit</i>	252 Vac	250 Vac	280 Vac
<i>AC1/Grid Transfer Delay</i>	6 AC cycles	0 AC cycles	240 AC cycles
Generator (Gen)			
<i>Gen Input Connect Delay</i>	0.5 min	0.2 min	15 min
<i>AC2/Gen Lower Limit</i>	208 Vac	140 Vac	220 Vac
<i>AC2/GenUpper Limit</i>	252 Vac	250 Vac	280 Vac
<i>AC2/Gen Transfer Delay</i>	6 AC cycles	0 AC cycles	240 AC cycles
<i>AC2/Gen Support</i>	ON	ON or OFF	
Auxiliary (AUX)			
<i>AUX Output Control</i>	AUTO	ON, OFF, or AUTO	
<i>AUX Output Function</i>	Cool Fan	Cool Fan, DivertDC, DivertAC, AC Drop, Vent Fan, Fault, GenAlert, LoadShed, or Remote	
<i>GenAlert On Voltage</i>	44 Vdc	40 Vdc	56 Vdc
<i>GenAlert On Delay</i>	4 min	0 min	240 min
<i>GenAlert Off Voltage</i>	56 Vdc	48 Vdc	72 Vdc
<i>GenAlert Off Delay</i>	9 min	0 min	240 min
<i>Load Shed Off Voltage</i>	44 Vdc	40 Vdc	56 Vdc
<i>Vent Fan On Set Point</i>	52 Vdc	40 Vdc	64 Vdc
<i>Vent Fan Off Period</i>	5 min	0 min	30 min
<i>Diversion On Voltage</i>	58.4 Vdc	48 Vdc	64 Vdc
<i>Diversion Off Delay</i>	30 sec	0 sec	240 sec

Table 19 48-Volt Inverter Settings

48 Vdc Inverter	Default	Minimum	Maximum
Stacking			
<i>Stack Phase</i>	<i>Master</i>	<i>Master, OB Slave L1, 3p Classic B, or 3p Classic C</i>	
<i>Power Save Level</i>			
<i>Master Adjust Only</i>	0	0	7
<i>Slave Adjust Only</i>	1	1	15
Sell			
<i>Sell RE Volts</i>	52 Vdc	40 Vdc	60 vdc
<i>Grid Tie Window</i>	<i>User</i>	<i>IEEE or User</i>	
<i>Grid Tie Authority</i>	<i>GridTie</i>	<i>GridTie or No Sell</i>	
Calibration (Cal)			
<i>Vac Input Adjustment</i> ¹	236	220	254
<i>Vac Output Adjustment</i> ¹	236	220	254
<i>Battery Vdc Adjustment</i> ²	2	0	4

¹These values are in digital counts, not volts. Lower counts stand for higher voltages, and higher counts mean lower voltages. One count equals approximately 1 Vac. The range of adjustment is 15 Vac above nominal, and 17 Vac below nominal.

²These values are in digital counts, not volts. One count equals 0.4 Vdc. The range of adjustment is 0.8 Vdc above or below nominal.



Product Registration

The purchase of an OutBack Power Technologies product is an important investment. Registering the products will help us maintain the standard of excellence you expect from us in terms of performance, quality and reliability.

Please take a moment to register and provide us with some important information.

SYSTEM OWNER	
Name	
Address	
City, State, Zip Code	
Country	
Telephone Number	
E-mail	
SYSTEM PURCHASE	
Product Model Number	
Product Serial Number	
Sold by	
Purchase Date	

Please check ALL factors affecting purchase decision:

- Grid-Interactive Capability
- Product Reputation
- Back-up Capability
- Reputation of OutBack Power Technologies
- Value
- Outdoor Installation Option
- Looks
- Other

INSTALLATION INFORMATION

System Install/Commission Date	
System Array Size	
System Array Nominal Voltage	
Type of PV Modules	
System Battery Bank Size (Amp-Hours)	
Brand and Model of Batteries	
Does this system include an auxiliary AC generator?	
If yes, please specify brand and model of generator	

INSTALLER INFORMATION

Contractor Number	
Installer Address	
Installer City, State, Zip	
Installer E-mail	

Extended Warranty

OutBack Power Technologies offers an optional three (3) year extension to the standard two (2) year Limited Warranty for the International Series GFX inverter. To request a 3-year limited warranty extension for a total effective warranty coverage period of five (5) years, please include a payment in the amount of **\$300** USD per inverter, payable to OutBack Power Technologies, Inc. along with the Warranty Registration. Please submit within 90 days of the first retail sale of the inverter(s). Please indicate the quantity of each product.

Remove this page from the manual and mail it to the following address. Be sure to keep a copy for your records.

OutBack Power Technologies

Attn: Warranty Registration
19009 62nd Avenue NE
Arlington, WA USA



Warranty

2-Year Limited Warranty for GFX Products

OutBack Power Technologies, Inc. (“OutBack”) provides a two-year (2) limited warranty (“Warranty”) against defects in materials and workmanship for its GFX Series inverter products (“Product”) if installed in fixed location applications.

The term of this Warranty begins on the Product(s) initial purchase date, or the date of receipt of the Product(s) by the end user, whichever is later. This must be indicated on the invoice, bill of sale, and/or warranty registration card submitted to OutBack. This Warranty applies to the original OutBack Product purchaser, and is transferable only if the Product remains installed in the original use location. The warranty does not apply to any Product or Product part that has been modified or damaged by the following:

- Installation or Removal;
- Alteration or Disassembly;
- Normal Wear and Tear;
- Accident or Abuse;
- Corrosion;
- Lightning;
- Repair or service provided by an unauthorized repair facility;
- Operation or installation contrary to manufacturer product instructions;
- Fire, Floods or Acts of God;
- Shipping or Transportation;
- Incidental or consequential damage caused by other components of the power system;
- Any product whose serial number has been altered, defaced or removed;
- Any other event not foreseeable by OutBack.

OutBack’s liability for any defective Product, or any Product part, shall be limited to the repair or replacement of the Product, at OutBack’s discretion. OutBack does not warrant or guarantee workmanship performed by any person or firm installing its Products. This Warranty does not cover the costs of installation, removal, shipping (except as described below), or reinstallation of Products or parts of Products.

THIS LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY APPLICABLE TO OUTBACK PRODUCTS. OUTBACK EXPRESSLY DISCLAIMS ANY OTHER EXPRESS OR IMPLIED WARRANTIES OF ITS PRODUCTS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. OUTBACK ALSO EXPRESSLY LIMITS ITS LIABILITY IN THE EVENT OF A PRODUCT DEFECT TO REPAIR OR REPLACEMENT IN ACCORDANCE WITH THE TERMS OF THIS LIMITED WARRANTY AND EXCLUDES ALL LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION ANY LIABILITY FOR PRODUCTS NOT BEING AVAILABLE FOR USE OR LOST REVENUES OR PROFITS, EVEN IF IT IS MADE AWARE OF SUCH POTENTIAL DAMAGES. IF YOU ARE A CONSUMER THAT PURCHASED THIS PRODUCT IN A MEMBER STATE OF THE EUROPEAN UNION, YOU MAY HAVE ADDITIONAL STATUTORY RIGHTS UNDER DIRECTIVE 1999/44/EC. THESE RIGHTS MAY VARY FROM EU MEMBER STATE TO EU MEMBER STATE. SOME STATES (OR JURISDICTIONS) MAY NOT ALLOW THE EXCLUSION OR LIMITATION OF WARRANTIES OR DAMAGES, SO THE ABOVE EXCLUSIONS OR LIMITATIONS MAY NOT APPLY TO YOU.

How to Arrange for Warranty Service

During the warranty period beginning on the invoice date, OutBack Power Technologies will repair or replace products covered under this limited warranty that are returned to OutBack Power Technologies' facility or to an OutBack Power Technologies authorized repair facility, or that are repaired on site by an OutBack Power Technologies authorized repair person.

**IMPORTANT:**

For full Warranty description, see previous page.

Contacting OutBack

To request warranty service, contact OutBack Technical Support at **360.435.6030** or direct at **360.618.4363** or **support@outbackpower.com**. To ensure warranty coverage, this contact must be within the effective warranty period. If service is required, the OutBack Technical Support representative will issue a Return Material Authorization (RMA) number.

Troubleshooting

In the event of a Product failure, the customer will need to work with an OutBack Technical Support representative to perform the necessary troubleshooting. This is a required step before a return can be performed. Troubleshooting requires a qualified technician to be present at the site of the Product, with a quality voltmeter that measures both DC and AC. The OutBack representative will request voltmeter readings, Product error messages, and other information. Many, many problems can be resolved on-site. If the customer is not willing or able to provide these readings (or is not willing or able to visit the site), and the Product is found to have no problems upon return, OutBack may choose to charge additional labor and handling fees up to \$180.00 U.S.

Return Material Authorization (RMA)

A request for an RMA number requires all of the following information:

1. Product model and serial number;
2. Proof-of-purchase in the form of a copy of the original Product purchase invoice or receipt confirming the Product model number and serial number;
3. Description of the problem; and
4. Shipping address for the repaired or replacement equipment.

Upon receiving this information, the OutBack representative can issue an RMA number.

Returning Product to OutBack

After receiving the RMA number, the customer must pack the Product(s) authorized for return, along with a copy of the original purchase invoice and warranty certificate, *in the original Product shipping container(s) or packaging providing equivalent or reasonable protection*. The RMA number must be written on the outside of the packaging where it is clearly visible.

The Product(s) must be shipped back to OutBack Power Technologies in their original or equivalent packaging, to the following address:

OutBack Power Technologies

RMA # _____
6115 192nd Street NE
Arlington, WA 98223 USA

The customer must insure the shipment, or accept the risk of loss or damage during shipment. If a shipping box is needed for return of a Product, OutBack will, upon request, send a shipping box.

**IMPORTANT:**

OutBack is not responsible for shipping damage caused by improperly packaged Products, the repairs this damage might require, or the costs of these repairs.

If, upon receipt of the Product, OutBack determines the Product or Product part is defective and that the defect is covered under the terms of this Warranty, OutBack will then and only then ship a repaired or replacement Product or Product part to the purchaser freight prepaid, non-expedited, using a carrier of OutBack's choice, where applicable.

If Product fails in ninety (90) or fewer days from original purchase date, OutBack will replace with a new Product. If Product fails after ninety (90) days and up to expiration of warranty, OutBack will, at its discretion, either repair and return a Product, or ship a replacement Product. OutBack will determine whether a Product is to be repaired or replaced in accordance with Product age and model. OutBack will authorize advance shipment of a replacement based on Product age and model.

In cases where an OutBack dealer or distributor replaces a Product more than ninety (90) days old with a new Product, OutBack will NOT compensate that dealer or distributor with new stock unless the exchange was authorized in advance by OutBack.

Out of Warranty

If Product is out of warranty, OutBack will repair and return Product for a fee. Alternately, if applicable, OutBack will advance-ship replacement parts for a fee upon request.

If a shipping box is needed for return of out-of-warranty Product, OutBack will send a shipping box upon request. The customer is responsible for paying shipping to OutBack.

The warranty period of any repaired or replacement Product or Product part is ninety (90) days from the date of shipment from OutBack, or the remainder of the initial warranty term, whichever is greater.

This Warranty is void for any Product that has been modified by the customer without authorization by OutBack. A Product with a voided warranty will be treated the same as one with an expired warranty.



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