OutBack POWER™

FXR International Series Inverter/Charger

FXR2012E FXR2024E FXR2348E
VFXR2612E VFXR3024E VFXR3048E

Operator's Manual

GRIDHybrid™

OPTICS RE Compatible

About OutBack Power

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

Applicability

These instructions apply to OutBack Power inverter/charger models FXR2012E, FXR2024E, FXR2348E, VFXR2612E, VFXR3024E, and VFXR3048E only.

Contact Information

Address:	3767 Alpha Way Bellingham, WA 98226 USA
Telephone:	+1 360-435-6030
Website:	www.outbackpower.com

Warranty

The warranty for this product can be downloaded from www.outbackpower.com/resources/warranty/procedures. A printed copy is available by sending a self-addressed envelope to the above address.

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Introduction

Audience

This book provides instructions for the functional settings and operation of this product. These instructions are for use by qualified personnel who meet all local and governmental code requirements for licensing and training for the installation of electrical power systems with AC and DC voltage up to 600 volts. This product is only serviceable by qualified personnel. Do not use this product without reading the *FXR International Series Inverter/Charger 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.

MORE INFORMATION

This symbol means that more information is available in other literature. If a number is present, it refers to the corresponding QR code near the beginning of the section. A numbered symbol is also a clickable hyperlink.

General Safety

	WARNING: Limitations on Use This equipment is NOT intended for use with life support equipment or other medical equipment or devices.
	WARNING: Reduced Protection If this product is used in a manner not specified by FXR product literature, the product's internal safety protection may be impaired.
	CAUTION: Equipment Damage Only use components or accessories recommended or sold by OutBack Power or its authorized agents.

Welcome to OutBack Power

Thank you for purchasing the FXR Series Inverter/Charger. It is designed to offer a complete power conversion system between batteries and AC power.

As part of an OutBack Power Grid/Hybrid™ system, it can provide off-grid power, grid backup power, or grid-interactive service which sells excess renewable energy back to the utility.

Figure 1 FXR Series Inverter/Charger with Turbo Fan

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Inverter Functions

- Battery-to-AC inverting which delivers power to run backup loads and other functions
  - Provides single-phase output
  - Adjustable range of output voltage
  - Settable nominal output frequency
- AC-to-battery charging (OutBack Power systems are battery-based)
  - Accepts a wide variety of single-phase AC sources
- Uses battery energy stored from renewable resources
  - Can utilize stored energy from many sources (PV arrays, wind turbines, etc.)
  - FLEXmax charge controllers will optimize PV power production as part of a Grid/Hybrid system
- Rapid transfer between AC source and inverter output with minimal delay time
- Uses the MATE3S™ System Display and Controller for user interface as part of a Grid/Hybrid system
- Supports the OPTICS RE™ online tool[1] for a cloud-based remote monitoring and control application
  - Requires MATE3S system display
- Uses the HUB10.3™ Communications Manager for stacking as part of a Grid/Hybrid system
  - Stackable in parallel and three-phase configurations
- Certified to IEC 62109-1 and IEC 62109-2
- Field-upgradeable firmware (from www.outbackpower.com); requires MATE3S system display
- Seven selectable input modes for different applications
  - ***Generator***
  - ***Support***
  - ***Grid Tied*** (available in 24-volt and 48-models only)
  - ***UPS***
  - ***Backup***
  - ***Mini Grid***
  - ***GridZero***
- Single AC input with dual input programming; individualized modes and priorities can be selected when switching from utility grid to AC generator
  - External transfer device required
  - System display required for individual programming

NOTE:

This product has a settable AC output range. In this book, many references to the output refer to the entire range. However, some references are made to 20 Vac or 60 Hz output. These are intended as examples only.

[1] **O**utback **P**ower **T**echnologies **I**ntuitive **C**ontrol **S**ystem for **R**enewable **E**nergy

Product Compatibility

The OutBack Power networking products (such as the HUB 10.3) can work with the Radian inverter and other OutBack Power products. This applicability is not universal. Table 1 describes which products can be networked.

Table 1 FXR/HUB Compatibility with Other OutBack Products

Device	Can network with Radian products
HUB products	Yes
FLEXmax products	Yes
Radian (GS series) products	Networked, not stacked
SkyBox™, Mojave™, later products	No

To determine the compatibility of a system display product, see the next page.

Inverter Controls

The FXR inverter has no external controls pre-installed. It can operate normally without an external control or interface. Basic modes and settings are pre-programmed at the factory. (See page 68 for default settings.) However, certain products can monitor, operate, or program the inverter. These include OPTICS RE and the MATE3S system display. 1

See Table 2 for system display compatibilities.

See the *FXR International Series Inverter/Charger Installation Manual* for information on wiring a manual on/off switch. 2

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MATE3-Class System Display and Controller

IMPORTANT:

Some functions are not based in the inverter, but are part of the system display's firmware. 1

They will not function if the system display is removed.

The MATE3 class of system display products (sold separately) includes the MATE3, the MATE3S, and the MATE3SL. Examples in this manual are usually for the MATE3S system display. This device is designed to accommodate programming and monitoring of a Grid/Hybrid power system. The system display provides the means to adjust the factory default settings to correctly match the installation where needed. It provides the means to monitor system performance and troubleshoot fault or shutdown conditions. It also has web-based interface functions and data logging.

Once settings are modified with the MATE3S device, it can be removed. The settings are stored in the inverter's nonvolatile memory. However, it is recommended to leave the display in place. It can monitor system performance and respond quickly to correct a fault or shutdown condition.

In the system display, the Profile Wizard is a guided program for rapidly configuring devices. It prevents the need for repetitive programming when multiple common devices are used. After collecting user input, it can automatically configure inverters to a series of preset values. Affected fields include system type, battery charging, and AC source configuration. 1

Table 2 System Display Compatibility

Device	Compatible with FXR products	Able to connect to OPTICS RE
MATE3S System Display	Yes	Yes
MATE3SL System Display	Yes	No
MATE3 System Display	MATE3 revision 002.017.000 or higher is compatible with FXR revision 001.006.046 or lower	No
MATE or MATE2 System Display	No	No
***AXS Port*™** SunSpec Modbus Interface	Yes	No

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Operation

LED Indicators

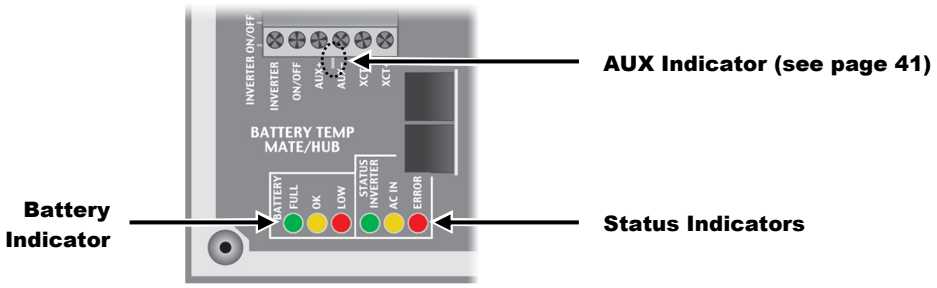


Figure 2 LED Indicators

Battery Indicators

The **BATTERY** LED indicators show the approximate battery state. (See **IMPORTANT** below.)

- A green indicator (**FULL**) means the batteries have an adequate charge at that time. It does not always mean they are full. It may be accompanied by a yellow **STATUS** indicator when an AC source is charging.
- A yellow indicator (**OK**) means the batteries are somewhat discharged.
- A red indicator (**LOW**) means the batteries are greatly discharged and may require attention. It may be accompanied by a red Status indicator to indicate a low battery error.
- The **BATTERY** indicators and the **INVERTER STATUS** indicators are independent. They may accompany each other depending on conditions. Common combinations are noted above and on page 14.

Table 3 Battery Indicator 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	MARGINAL
RED	11.4 Vdc or lower	22.8 Vdc or lower	45.6 Vdc or lower	LOW

NOTES:

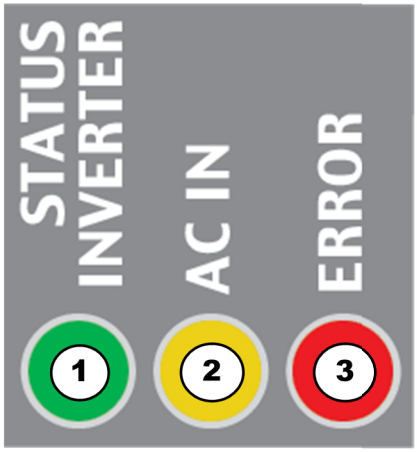
- Gaps in the table (higher-voltage units) are due to the resolution of the inverter's DC meter.
- These voltage settings are not the same as the Low Battery Cut-Out (LBCO) set point. (See page 25.) The **BATTERY** indicator settings cannot be changed.
- Voltages higher than shown in the GREEN row usually show that the batteries are charging.

IMPORTANT:

Due to different system states, 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 as 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 an OutBack Power battery monitor that can be added to the system to provide accurate measurements.

Status Indicators

(1) STATUS INVERTER (Green):



Solid: The FXR inverter is on and providing power.

- If accompanied by a solid yellow **AC IN** indicator (**2**), the inverter is also connected to the utility grid with an AC input mode that uses both inverter power and grid power (***Support***, ***Grid Tied***, or ***GridZero***).
- See page 15 for descriptions of AC input modes.

Flashing: The inverter has been turned on but is idle.

- The inverter is likely in **Search** mode. See page 28.

Off: The inverter is off. It is not waiting to provide power.

- See the system display manual to turn the inverter on.
- Any power present is from another source such as the utility grid or generator.
- The inverter may also be a slave that is in Silent mode due to the **Power Save** function. If so, the master inverter may still be providing power to the system.
- See the *Installation Manual* for a description of **Power Save**. 📖 2

(2) AC IN (Yellow):

Solid: The AC source is connected and providing power.

- The FXR inverter may or may not be charging the batteries, depending on settings.
- May be accompanied by green **STATUS INVERTER** indicator (**1**).

Flashing: The AC source is present but has not been accepted.

- If flashing continues, the FXR inverter is refusing the source. See the **Troubleshooting** section on page 49.

Off: No AC source is detected.

- If a source is supposed to be present, see the **Troubleshooting** section on page 49.

(3) ERROR (Red):

Solid: Error. The inverter has shut down due to a critical problem which may be internal or external.

- This indicator is accompanied by an error message in the system display.
- See page 54 for a description of error messages.

Flashing: Warning. The inverter 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 indicator is accompanied by a warning message in the system display.
- See page 55 for a description of warning messages.

Off: No problems are detected.

Figure 3 Inverter Status LED Indicators

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Inverter Functionality

The FXR inverter can be used for many applications. Some of the inverter's operations occur automatically. Others are conditional or must be enabled manually before they will operate.

Most of the inverter's individual operations and functions can be programmed using the system display. This allows customization or fine tuning of the inverter's performance.

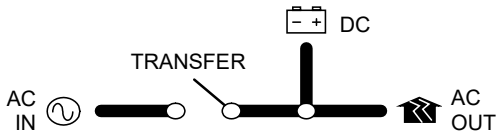
Before operating the inverter:

The operator needs to define the application and decide which functions will be needed. The FXR inverter is programmed with seven AC input modes. Each mode is optimized for a particular application. Some modes contain functions unique to that mode.

- The modes are described in detail following this section. To help decide which mode will be used, the basic points of each mode are compared in Table 4 on page 23.

Apart from the input modes, FXR inverters possess a set of common functions or operations. These operations are described in detail beginning on page 25. Most of these items operate the same regardless of which input mode is selected. The exceptions are noted where appropriate.

Each distinct mode, function, or operation is accompanied by a symbol representing the inverter and that operation:



These items represent the input from the AC source, the output to the AC loads, DC functions (inverting, charging, etc.), and the transfer relay. Arrows on each symbol represent power flow.

The symbols may have other features depending on the operation.

AC Input Connection

The FXR inverter has one set of input connections. Only one AC source can be physically wired to it at any time. However, two different AC sources can be used with an external transfer switch. It is common for backup or grid-interactive systems to use the utility grid as the primary source, but switch to a gas- or diesel-powered generator in emergencies. The inverter can be programmed with separate input criteria for each source.

The inverter's two input selections can be programmed for separate input modes (see below). The selection (***Grid*** or ***Gen***) can be chosen in the ***AC Input and Current Limit*** menu. (See the menu tables beginning on page 68.)

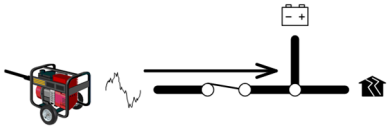
NOTE: The input types are labeled for grid and generator due to common conventions, not because of inverter requirements. Each selection can accept any AC source as long as it meets the requirements of the FXR inverter and the selected input mode. If necessary, the ***Gen*** selection can accept grid power. The opposite is also true.

Description of AC Input Modes

These modes control aspects of how the inverter interacts with AC input sources. Each mode is intended to optimize the inverter for a particular application. The names of the modes are ***Generator***, ***Support***, ***Grid Tied***, ***UPS***, ***Backup***, ***Mini Grid***, and ***GridZero***. The modes are summarized and compared in Table 4. See page 23. The following pages compare the various functions of each input mode.

When multiple inverters are stacked together in parallel, the master inverter's input mode is imposed on all slaves. (See the stacking section in the *Installation Manual*.) The slave settings are not changed; they retain any mode that was previously programmed. However, the slave will ignore its programmed mode and use that of the master. This also applies to any parameters in the mode menu (***Voltage Limit***, ***Connect Delay***, and so on).

Generator



The ***Generator*** mode allows the use of a wide range of AC sources, including generators with a rough or imperfect AC waveform. In other modes, a "noisy" or irregular waveform may not be accepted by the inverter. (Self-excited induction generators may require this mode when used with the inverter.) ***Generator*** allows these waveforms to be accepted. The charging algorithm of this mode is designed to work well with AC generators regardless of power quality or regulation mechanism. The generator must still comply with the inverter's nominal input specifications. (See page 29.)

BENEFITS:

- This mode enables the charging function to tolerate a wider range of generator performance and waveform irregularities than other modes. See page 31 for recommended generator size parameters.
- ***Generator*** mode can also be used to accommodate grid variability or irregularities. The inverter will not export power to the grid in this mode.
- A programmable delay time is available which will allow a generator to stabilize before connection. In the system display, this menu item is ***Connect Delay***. It is available in both the ***Grid AC Input Mode and Limits*** and the ***Gen AC Input Mode and Limits*** menus, depending on which input is being programmed.

NOTES:

- Any AC fluctuations that are accepted by the inverter will be transferred to the output. The loads will be exposed to these fluctuations. It may not be advisable to install sensitive loads under these conditions.
- The name of ***Generator*** mode does not mean that the inverter requires a generator input when using this mode. The use of this mode does not require the use of the ***Gen*** input type; either selection can be used. Conversely, the inverter is not required to be placed in this mode because a generator is installed.

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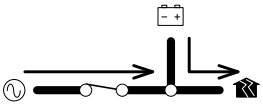
Support



The ***Support*** mode is intended for systems that use the utility grid or a generator. In some cases the amount of current available from the source is limited due to size, wiring, or other reasons. If large loads need to be run, the FXR inverter augments (supports) the AC source. The inverter uses battery power and additional sources to ensure that the loads receive the power they demand.

In the MATE3S system display, the ***Grid Input AC Limit*** dictates the maximum AC draw for the Grid input. The ***Gen Input AC Limit*** sets the maximum draw for the Gen input. The Support function takes effect if the AC demand on either input exceeds the ***AC Limit*** setting.

BENEFITS:

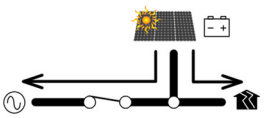
- Large inverter loads can be powered while staying connected to the AC input, even if the input is limited. The added battery power prevents overload of the input source, but the batteries are not in constant use.
- The FXR inverter will offset the loads with excess renewable energy if it is available from the batteries. See page 41 for more information on the **Offset** function.

NOTES:

	IMPORTANT: The inverter will draw energy from the batteries when the loads exceed the appropriate ***AC Limit***. With sustained loads and no other DC source, the batteries may discharge to the **Low Battery Cut-Out** point. The inverter will shut down with a **Low Battery** error. (See pages 26 and 54.) To prevent the loss of power, load use should be planned accordingly.
	IMPORTANT: A “noisy” or irregular AC source may prevent ***Support*** from working normally. The inverter will transfer the power, but will not support the source, charge the batteries, or interact with the current in any other way. This problem is more common with generators smaller than the wattage of the inverter.

- Because the inverter limits the current draw from the AC source, it will reduce the charge rate as necessary to support the loads. If the loads equal the appropriate ***AC Limit*** setting, the charge rate will be zero.
- If the AC loads **exceed** the ***AC Limit*** setting, the **Support** function is activated. Instead of charging, the inverter will take power from the batteries and use it to support the incoming AC current.
- The ***Support*** function is not available in any other input mode.
- This mode should not be used in a stacked system that uses slave inverters.

Grid Tied



IMPORTANT:

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

The ***Grid Tied*** mode allows the inverter to become grid-interactive. This means that in addition to using power from the utility grid for charging and loads, the inverter can also convert excess battery power and sell it to the utility grid. Excess battery power almost always comes from PV arrays, but may come from other sources such as wind and hydroelectric turbines.

NOTE: This mode is not available in 12-volt FXR models. It does not appear on the system display's list of available input modes.

The grid-interactive function uses Offset operation. See page 41 for more information.

BENEFITS:

- Excess power is returned to the utility grid.
  - The inverter will offset the loads with excess renewable energy if it is available from the batteries.
  - If the excess energy is greater than the AC demand (the load size), the excess will be sold to the grid.

NOTES:

- The inverter has a delay before selling will begin. This function, the ***Re-Connect Delay Timer***, has a default setting of one minute. *During this time, the inverter will not connect to the utility grid.* The timer is adjustable in the ***Grid Interface Protection*** menu (see below).
- Upon initial connection to the utility grid, the inverter may be required to perform a battery charging cycle. This may delay the operation of the grid-interactive function.
- The grid-interactive function only operates when excess DC (renewable) power is available.
- The grid-interactive function is not available in any of the other input modes.
- When power is returned to the utility grid, it may be possible to reverse the utility meter. However, this depends on other loads in the system. Loads on the main panel (not on the inverter's output) may consume power as fast as it is sold. The meter would not run backwards, even if the system display showed the inverter selling power. The result of selling would be to reduce AC power consumption, not reverse it.
- The amount of power an inverter can sell is not necessarily equal to its specified output wattage. The ***Maximum Sell Current*** can be decreased if it is necessary to limit the power sold. This item is available in the ***Grid Interface Protection*** menu (see below).
  - The amount of power that is sold is controlled by the utility grid voltage. The wattage sold equals this voltage multiplied by the current. For example, if the inverter sells 15 amps and the voltage is 231 Vac, the inverter will sell 3.47 kVA. If the voltage is 242 Vac, the inverter will sell 3.63 kVA. Additionally, output will vary with inverter temperature, battery type, and other conditions.
  - This recommendation is specifically for the inverter's grid-interactive function. 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.

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Grid Interface Protection Menu

Grid-interactive requirements vary in different locations around the world. The grid-interactive settings are adjustable in the **Grid Interface Protection** menu. This is only available with installer-level access. These settings are generally controlled by the local authorities or interconnection agreement and should not be altered by the end user. The installer password must be changed from the default in order to get access to these settings. Once this password has been changed, the settings can only be accessed with the installer password.

- See the tables beginning on page 68 for the locations of all menu items in the MATE3S menus.
- The grid-interactive function can only operate while the grid power is stable and within specific limits.
  - In ***Grid Tied*** mode, the inverter will operate in accordance with the ***Grid Interface Protection*** settings. The default settings and ranges are listed in the tables which begin on page 68.
  - If the AC voltage or frequency vary outside the ***Grid Interface Protection*** limits, the inverter will disconnect from the utility grid to prevent selling under unacceptable conditions. These limits override the AC source acceptance limits described on page 29, which are used in other input modes. The inverter will not reconnect until the source is acceptable for the duration of the ***Re-Connect Delay Timer***.
  - If the inverter stops selling or disconnects due to ***Grid Interface Protection***, the MATE3S will show the reason. Sell Status messages are listed on page 58. Disconnect messages are listed on page 57. Often these messages will be the same.
  - Before operating in ***Grid Tied*** mode, contact the utility company that provides power to the installation. They can provide information regarding the rules that must be followed in order to export power back to the utility. The items in the following list are the selectable ***Grid Interface Protection*** options. The utility company may need to review these items to make certain their standards are met.

    The utility may simply name a standard to be followed. It may be necessary to look up the requirements for a local standard and program them accordingly.

STAGE 1 Voltage (basic settings)

- Over Voltage Clearance Time (seconds)
- Over Voltage Trip (AC Voltage)
- Under Voltage Clearance Time (seconds)
- Under Voltage Trip (AC Voltage)

STAGE 2 Voltage (if required by utility)

- Over Voltage Clearance Time (seconds)
- Over Voltage Trip (AC Voltage)
- Under Voltage Clearance Time (seconds)
- Under Voltage Trip (AC Voltage)

Frequency Trip

- Over Frequency Clearance Time (seconds)
- Over Frequency Trip (Hertz)
- Under Frequency Clearance Time (seconds)
- Under Frequency Trip (Hertz)

NOTE: The ***Frequency Trip*** settings are dependent on the inverter's operating frequency, which must be set correctly.

Mains Loss

- Clearance Time (seconds)
- Reconnect Delay (seconds)

See the tables beginning on page 68 for the default settings and ranges.

Frequency and Phase Coordination

Several other inverter adjustments are located in the ***Grid Interface Protection*** menu. These sensitive items can only be changed with installer-level access.

- The FXR inverter's operating frequency can be selected to either 50 or 60 Hz using the ***Grid Interface Protection*** menu. This setting changes the inverter's input acceptance parameters, as well as its output. See page 27 for more information on the inverter's frequency.
- The FXR inverter's stacking function includes the option called ***Multi-Phase Coordination***. The selectable menu item is ***Coordinated AC Connect/Disconnect***. The default setting is ***No***.

If selected to ***Yes***, the AC source is required to deliver appropriate input to all inverters in a stacked system. If the master or subphase master inverters do not sense an acceptable AC source, the entire system disconnects from the source. None of the inverters will reconnect until the source is acceptable for the duration of the appropriate timer.

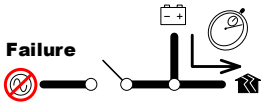
- If the inverter is in ***Grid Tied*** mode, the ***Re-Connect Delay*** timer is used.
- If the inverter is any other AC input mode, the ***Connect Delay*** timer is used.

See pages 29 and 31 for more information on input acceptance and the transfer function.

See page 43 for more information on the stacking function and subphase master inverters.

See the tables beginning on page 68 for the default settings and ranges.

UPS



In ***UPS*** mode, the parameters have been optimized to reduce the response time. If the utility grid becomes unstable or is interrupted, the inverter can transfer to inverting with the fastest possible response time. This allows it to support sensitive AC loads with minimal interruption.

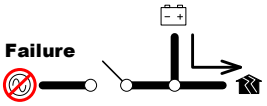
BENEFITS:

- Constant power is provided to the loads with virtually no drop in voltage or current.

NOTES:

- Due to the need for the FXR inverter to react quickly to AC source fluctuations, it must remain fully active at all times. The inverter requires a continuous consumption of 42 watts.
- For this reason, the **Search** function does not operate in this mode. (See page 28.)

Backup



The ***Backup*** mode is intended for systems that have utility grid available as the primary AC source. This source will pass through the FXR inverter's transfer circuit and will power the loads unless utility power is lost. If utility grid power is lost, then the inverter will supply energy to the loads from the battery bank. When the utility power returns, it will be used to power the loads again.

BENEFITS:

- This mode will continuously maintain the batteries in a fully-charged state, unlike the ***Support*** mode. It does not have the overhead consumption of the ***UPS*** mode.

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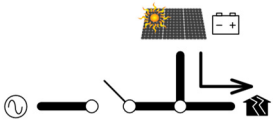
Mini Grid



In ***Mini Grid*** mode, the FXR inverter automatically rejects an AC source and runs solely from battery (and renewable) energy. The inverter only connects to the AC source (usually the utility grid) when the batteries run too low.

The FXR inverter runs on battery-supplied power for as long as the batteries can be sustained. It is expected that the batteries will also be charged from renewable sources such as PV. When the batteries become depleted, the system reconnects to the utility grid to operate the loads.

The inverter will reconnect to the utility grid if the battery voltage decreases to the ***Connect to Grid*** set point and remains there for the ***Delay*** time period. These items are shown in the tables which begin on page 68.

While connected to the utility grid, the FXR charger can be set either on or off. If the charger is turned on, the inverter will proceed through a full charging cycle. Upon reaching float stage, the inverter will disconnect from the grid.

If the inverter is connected to the utility grid and the charger is turned off, another DC source such as renewable energy should be present to charge the batteries. The inverter will observe the batteries as if it was performing the charge. When the batteries reach the required voltages and charging times to achieve float stage, the inverter will disconnect from the grid. (See **NOTES**.) This means that the regulator for the renewable source must be set to the same settings as the inverter (or higher). Check the settings of both devices as needed.

See page 32 for more information on the battery charging cycle.

BENEFITS:

- ***Mini Grid*** mode allows a system to minimize or eliminate dependence on the utility grid. This is only possible if certain conditions are met. See below.

NOTES:

- The inverter will offset the loads with excess renewable energy if it is available from the batteries. See page 42 for more information on **Offset** operation. However, **Offset** is inapplicable when the inverter disconnects from an AC source. The renewable energy supports the inverting function instead.
- The inverter will not disconnect from the grid as long as time remains on any of the charging timers. The MATE3S **Charger** hot key will display these times. 1
- This mode has similar priorities to the high-battery transfer (***HBX***) function used by the MATE3S system display. However, it is not compatible with ***HBX*** and cannot be used at the same time. When using ***Mini Grid*** mode, the system display should disable ***HBX*** to prevent conflicts.
- ***Mini Grid*** mode is also incompatible with the system display ***Grid Use Time*** and ***Load Grid Transfer*** functions. These functions do not have similar priorities to ***Mini Grid*** or ***HBX***, but they do control the inverter's connection and disconnection with the grid. ***Mini Grid*** should not be used with these functions.

- When deciding whether to use ***Mini Grid*** or ***HBX***, the user should consider the aspects of each.
  - ***Mini Grid*** logic is based in the FXR inverter. After programming, it can function in the absence of the system display. ***HBX*** logic is based in the system display. It cannot function unless the system display is installed and operating.
  - ***Mini Grid*** can use utility grid power to fully recharge the batteries every time it reconnects to the grid. ***HBX*** can only do so under specific circumstances.
  - ***HBX*** set points have a wide range. ***Mini Grid*** uses settings intended to protect the batteries from excessive discharge; however, most of its settings are automatic and do not allow customization.
  - ***HBX*** works more efficiently with a larger renewable source, but there is no specification for renewable size. ***Mini Grid*** cannot work properly unless the source is larger than the size of the loads. If this condition is not met, ***Mini Grid*** will not disconnect the inverter from the utility grid.
  - ***Mini Grid*** is one of seven inverter-level functions (modes) which share a single input. Selecting it prevents any other input mode from being used. ***HBX*** is a system-level function which can be combined with the settings of other input modes.
  - See the system display literature for more information on ***HBX*** mode, ***Grid Use Time***, and ***Load Grid Transfer***.

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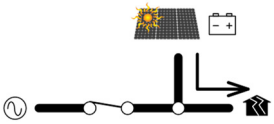
GridZero



In ***GridZero*** mode, the inverter remains grid-connected, but prioritizes the use of battery or renewable sources to run loads. It uses only renewable energy to recharge the batteries. The inverter tries to "zero" the grid use, drawing on AC power only when needed to supplement stored DC sources. Note that the inverter draws up to 1 Aac regardless of the DC sources.

In the system display, the selectable options are ***DoD Volts*** and ***DoD Amps***. The inverter sends battery power to the loads when the batteries exceed the ***DoD Volts*** setting. (12-, 24-, and 48-volt systems must exceed the setting by 0.2, 0.4, and 0.8 Vdc respectively.) As the battery voltage decreases to ***DoD Volts***, the inverter reduces the current toward zero. It will maintain the batteries at this setting.

The FXR inverter can manage large quantities of power. To prevent damage to the batteries from rapid discharge, the rate of discharge can be limited using the ***DoD Amps*** setting. This item should be set lower than the current provided by the renewable source.

- When ***DoD Volts*** is set low, this mode allows more energy to be delivered from the batteries to the loads. However, it will also leave less of a battery reserve in the event of a grid failure.
- When ***DoD Volts*** is set high, the batteries will not be discharged as deeply and will retain more of a backup reserve. However, not as much renewable energy will be sent to the loads.

The renewable energy source needs to exceed the size of all loads and possible losses. The renewable source must also charge the batteries. The inverter does not charge the batteries in ***GridZero*** mode.

BENEFITS:

- This mode seamlessly blends the use of battery power and grid power. It puts renewable energy to the most effective use without selling power to the utility grid.
- ***GridZero*** mode minimizes dependence on the grid as long as certain conditions are met.
- The inverter remains connected to the utility grid in case the grid is needed. If large loads require the use of grid power, no transfer is necessary to support the loads.

NOTES:

IMPORTANT:

Setting ***DoD Volts*** too low will severely discharge the batteries. The battery bank may not have sufficient reserve to provide backup in the event of a grid failure. To prevent the loss of power, load use and the ***DoD Volts*** setting should be planned accordingly.

- If the renewable energy source is not greater than the size of the inverter loads, this mode will not work well over time. The renewable source must be capable of charging the batteries as well as running the loads. This occurs when renewable energy production exceeds the ***DoD Amps*** setting.
- The inverter will offset the loads with excess renewable energy if it is available from the batteries. See page 42 for more information on **Offset** operation. However, the behavior of **Offset** in ***Grid Zero*** mode is different because it uses the ***DoD Volts*** exclusively.
- The inverter's battery charger cannot be used in this mode. However, the charger menu settings and timer operations are not changed when this mode is selected.
- The battery should be discharged whenever possible in the attempt to "zero" the grid usage. If the ***DoD Amps*** setting (or load demand) is too low, the renewable source will be prematurely curtailed. The system will be unable to use the renewable energy and will then be more dependent on the grid. The ***DoD Amps*** setting should be raised periodically until the renewable energy is fully utilized.
- This mode should not be used in a stacked system that uses slave inverters.

Table 4 Summary of Input Modes

Mode	Summary	Benefits	Cautions	Intended	Charger
Generator	Accepts power from an irregular or low-quality AC source	• Can use AC that may be unusable in other modes • Can charge even with a poor generator or low-quality AC source	• Will pass irregular or low-quality power to the output; could damage sensitive loads • Offset unavailable	**Source:** Generator **Loads:** Non-sensitive devices	Performs three-stage charge and goes silent as specified by settings
Support	Adds battery power to augment an AC source that has limited output	• Can use battery power in conjunction with AC source • **Offset** operation sends excess DC to loads	• Drains batteries during support; intended for intermittent use only • May not function with low-quality AC source • Do not use in stacked system with slave units	**Source:** Grid or Generator **Loads:** Can be larger than AC source	Performs three-stage charge and goes silent as specified by user settings
Grid-Tied	Inverter sells excess power (renewable) to utility; **available in 24-volt and 48-volt models only**	• Bidirectional input • Can reduce utility bills and still provide backup • **Offset** operation sends excess DC to loads • Any additional **Offset** excess is sold to the grid	• Requires utility approval • Other approvals may be required depending on electrical codes • Has exact requirements for accepting AC input • Requires renewable energy source	**Source:** Grid **Loads:** Any type	Performs three-stage charge and goes silent as specified by user settings
UPS	In grid failure, unit switches to batteries with fastest possible response time	Quick backup for sensitive devices during grid outage	• Uses higher idle power than other modes • Search function unavailable • **Offset** unavailable	**Source:** Grid **Loads:** PC, audio, video, etc.	Performs three-stage charge and goes silent as specified by user settings
Backup	In grid failure, unit switches batteries to support loads	• Simple use compared to other modes; often used with generators for this reason • Less idle power than ***UPS*** • Does not drain battery as in ***Support***	Has none of the special functions described in other modes	**Source:** Grid or Generator **Loads:** Any type	Performs three-stage charge and goes silent as specified by user settings
Mini Grid	Stays off grid most of the time; only uses grid when batteries low	• Can minimize/eliminate dependence on grid • **Offset** operation sends excess DC to loads (but only when on grid)	• Will not work properly unless renewable source is above a certain size • Conflicts with related modes in MATE3S	**Source:** Grid **Loads:** Any type	Performs three-stage charge on reconnect; if charger is disabled, inverter emulates charge cycle from external source and reacts accordingly
Grid Zero	On-grid but actual grid use is minimized (“zeroed”) with battery and renewable power; does not sell or charge	• Can minimize dependence on grid • **Offset** operation sends excess DC to loads at adjustable rate • Remains on-grid to avoid transfer problems	• Discharges batteries while remaining on grid • Will not work properly unless renewable source is above a certain size • Battery charger inoperative • Do not use in stacked system with slave units	**Source:** Grid **Loads:** Any type	Charger inoperative; batteries must be charged using an external (renewable) energy source

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NOTES:

Description of Inverter Operations

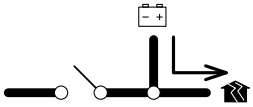
The items in this section are operations common to all FXR inverters. These are used in most or all of the input modes described in the preceding section.

Some of the items in this section are functions which can be manually selected, enabled, or customized. Other items are general topics or applications for the inverter. These items may not have their own menus, but their activity can still be influenced or optimized by changing certain settings.

Any of these items may need to be adjusted so that the inverter is best matched to a particular application. The operator should review these items to see which are applicable. All items described as settable or adjustable have set points which can be accessed using the system display. 1

The default settings and ranges of adjustment are listed in the menu tables which begin on page 68 of this manual.

Inverting

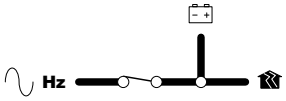


This is the FXR inverter's primary task. The inverter converts DC voltage from batteries into AC voltage that is usable by AC appliances. It will continue to do this as long as the batteries have sufficient energy. The batteries can be supplied or recharged from other sources, such as solar, wind, or hydroelectric power.

The inverter's design uses a transformer and a high-frequency H-Bridge FET module to achieve the required high-wattage output. The inverter can deliver the rated wattage continuously at 25°C. The maximum output is derated at temperatures exceeding 25°C. See pages 59 and 63 for these wattages.

Measure the total load wattage so that it does not exceed the inverter's capacity. The inverter cannot maintain its AC voltage under an excessive load. It will shut down with a ***Low Output Voltage*** error.

DC and AC Voltages



The FXR 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 with the batteries and the inverter, but not in place of the batteries.

The following items will affect the inverter's operation. These are only used when the inverter is generating AC power on its own.

- ***Low Battery Cut-Out***: This function prevents the inverter from draining the batteries completely. When the DC voltage drops below a specified level for 5 minutes, the inverter will stop functioning. The system display will give a ***Low Battery V*** error. This is one of the error messages described on page 54. It appears as an event on the system display. 1
  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.

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- ***Low Battery Cut-In***: The recovery point from ***Low Battery Cut-Out***. When the DC voltage rises above this point for 1 minute, the error will clear and the inverter will resume functioning.
  - Connecting an AC source for the inverter to charge the batteries will also clear a low battery error.
- ***Output Voltage***: The AC output voltage can be adjusted. Along with small changes, this allows the inverter to be used for different nominal voltages such as 220 Vac and 240 Vac.

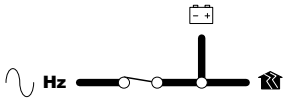
IMPORTANT:

The output voltage can adjusted to a different nominal value for a particular region. Making this change will not affect the default input voltage range accepted by the inverter from an AC source. The input range must be adjusted manually. These changes should be made at the same time. (See AC Source Acceptance on page 29.)

- The inverter is also controlled by a high battery cut-out limit. If the DC voltage rises above this limit, the inverter immediately stops functioning and gives a ***High Battery V*** error. The shutdown protects the inverter from damage due to excessive DC voltage.
  - The high battery cut-out voltages for each model are shown in Table 20 on page 65. This voltage is not a changeable set point.
  - If the voltage drops below this point, the inverter automatically recovers.
  - This is one of the errors on page 54. It appears as an event on the system display. 1

The low battery and high battery functions are summarized in Table 20 on page 65.

AC Frequency



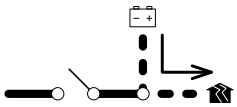
CAUTION: Equipment Damage

Setting the inverter's output frequency to deliver 50 Hz to 60-Hz loads, or setting it to deliver 60 Hz to 50-Hz loads, could damage sensitive devices. Make certain the inverter's output frequency matches the installation.

The inverter's output can operate at a frequency of either 50 or 60 Hertz. This output frequency (and the AC acceptance frequency) can be changed with the ***Operating Frequency*** menu item. This requires high-level access. Due to the possibility of damage, access to this setting was restricted by placing it in the ***Grid Interface Protection*** menu.

The installer password must be changed from the default in order to get access to this menu. Once this password has been changed, the ***Grid Interface Protection*** menu can only be accessed by using the installer password. This password can be changed in the system display. 1

See page 19 for more information on this selection in ***Grid Interface Protection***. See the menu tables, which begin on page 68, for the location of the ***Operating Frequency*** menu item.

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. Basically, the pulses "search" for a load. If a load is detected on the output, 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.

Search mode sensitivity is adjusted with the ***Sensitivity*** menu item. See the menu tables, which begin on page 68, for the location of this item. The sensitivity is adjusted in small increments which are measured in fractions of one ampere.

NOTE:

Increment sizes are difficult to define due to varying load characteristics. However, the default setting, 10 increments, is approximately sufficient to detect the load of one compact fluorescent light (CFL). A load which draws this amount or greater will "wake up" the inverter.

- **Search** mode is not particularly useful with loads requiring continuous power. (These loads include clocks, answering machines, and similar devices.) "Sleep" operation with these loads is simply a power interruption or nuisance shutdown.
- **Search** mode may not be useful with loads that are critical or are intentionally operated a large portion of the time even if they are not continuous. (These loads include computers and similar devices.) The inverter may "sleep" so rarely that the mode has no benefit.
- Some devices may not be easily detected by **Search** mode.
- **Search** is inoperative if the ***UPS*** input mode is in use. See page 19 for more information.

Search mode is ideal for use in small systems where it is critical to conserve battery capacity and avoid idle draw or "ghost" loads.

To set up Search mode for use:

1. Turn off all loads.
2. Activate **Search** mode with the system display. The inverter should "sleep" with a flashing green **STATUS INVERTER** indicator. See page 14.
3. Determine the smallest load that is to be used and turn it on.
4. If the load operates, the inverter is active and is producing power. No further adjustments are needed.
5. If the inverter does not produce power and continues to "sleep", the sensitivity is set too high. Turn the load off and lower the ***Sensitivity*** menu item. Turn on the load and test whether the inverter activates.
6. Repeat step 5 as needed until turning on the load also reliably activates the inverter.

The pulse duration and the delay both have a time period that is measured in AC cycles. These two items, ***Pulse Length*** and ***Pulse Spacing***, are adjustable in the same menu as ***Sensitivity***. If ***Sensitivity*** does not achieve the desired results, it may be useful to perform similar adjustments on these items.

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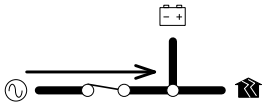
Input



When the 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. Its transfer relay will engage, linking the AC source directly with the inverter's output. It can also use the source to charge batteries. (See **Battery Charging** on page 33.)

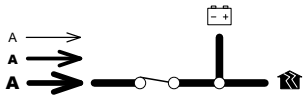
- The loads powered by the inverter **must not** exceed the size of the inverter's transfer relay.

	CAUTION: Equipment Damage Current draw in excess of the transfer relay rating can damage the transfer relay. This damage is not covered by warranty. Use protective devices of appropriate size.

- The inverter has a single AC input. However, it has two sets of AC source settings. With an external transfer switch, the inverter can be used on more than one AC source. It is common to use utility grid power and a gas or diesel generator. Other combinations of AC sources are possible.
- The inverter's two input selections can be programmed for separate input modes. The selection (***Grid*** or ***Gen***) can be chosen in the ***Input Type*** menu.

  The interactions with AC input sources are controlled by the various input modes. The ***Grid Tied*** mode allows certain models to sell power using the input connection. The ***Support*** mode can use battery power to assist a smaller AC source. When ***GridZero*** mode is selected, the battery charger cannot be used. See page 23 for descriptions of these and other input modes.

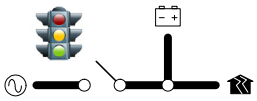
AC Current Settings



The AC current settings, ***Grid Input AC Limit*** and ***Gen Input AC Limit***, control the amount of current that the inverter draws from the source. Adjust these settings to match the input circuit breakers.

- The adjustment is meant to protect a generator or source that cannot supply enough current for both charging and loads. If the combined charging and loads exceed the 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's battery charger and grid-interactive function have individual settings. However, the ***AC Limit*** settings can also limit the charging or selling current.
- The ***GridZero*** input mode requires the inverter to use DC sources, limiting the amount of AC current used. See page 22.
- The ***Support*** input mode allows the inverter to support the AC source with battery power. See page 17.
- The AC input current is used to power both loads and battery charging. The combined amount should not exceed the size of the AC overcurrent device or AC source. These devices should be sized appropriately during planning and installation of the inverter system. 2
- If multiple parallel inverters are installed with an AC source of limited amperage, the total combined amperage settings for all units must be less than the AC input circuit. The Profile Wizard in the MATE3S system display can perform this calculation. However, the inverters do not perform this calculation. If the Profile Wizard or similar tools are not used, 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. This is true in all modes except ***Grid Tied***:

- Voltage (both input selections): 208 to 252 Vac
- Frequency (both input selections): If the output frequency is set to 50 Hz (default), the input acceptance range is 45 to 55 Hz. If output frequency is set to 60 Hz, the input range of acceptance is 55 to 65 Hz.
- See the menu tables which begin on page 68 for programming information for these items.

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. This occurs after a specified transfer delay, which is an adjustable menu item.

IMPORTANT:

The inverter's output voltage can adjusted to a different nominal value for a particular region. (See page 28.) If this occurs, the source acceptance range should be adjusted to match this nominal value or the inverter may not accept the new source normally.

- The voltage limits can be adjusted to allow (or exclude) a source with weak or irregular voltages. These items are adjustable in the MATE3S system display (***Grid AC Input Mode and Limits*** or ***Gen AC Input Mode and Limits***). The settings are titled ***Voltage Limit Lower*** and ***Upper***. There can be side effects to changing the range of allowed voltages.
- Each of the AC input selections has a settable ***Connect Delay***. This is intended as a warmup period which allows an input source to stabilize before connection.
  - The default setting for the ***Grid*** input is 0.2 minutes (12 seconds).
  - The default setting for the ***Gen*** input is 0.5 minutes (30 seconds).

  These items are adjustable in the appropriate system display menu (***Grid AC Input Mode and Limits*** or ***Gen AC Input Mode and Limits***).

NOTES:

- The ***Grid Tied*** input mode does not use these acceptance limits and uses the ***Grid Interface Protection*** settings instead. (See page 19 for more information.) The inverter may not accept AC power if it meets the settings noted here but does not meet the ***Grid Interface Protection*** settings.
- Certain input modes such as ***Mini Grid*** may prevent the inverter from accepting AC power even if electrical conditions are met. (See page 20.)

  Several items external to the inverter may prevent the inverter from accepting AC power even if electrical conditions are met. Some examples are the ***High Battery Transfer***, ***Grid Usage Time***, or ***Load Grid Transfer*** functions, all of which are operated by the system display. Another example is the **AC INPUT** hot key menu, which can order all inverters to disconnect when set to ***Drop***. 1

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Multiple Inverters

In a stacked system, whenever the master inverter senses acceptable input, it orders all other inverters to transfer to the AC source. The other inverters do not use their own input readings to transfer. It is expected that the AC source delivers input (in the appropriate phase) to all inverters. Subphase master and slave inverters cannot transfer until the master does.

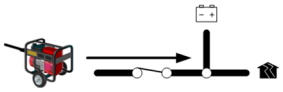
- A subphase master inverter may receive this command while not sensing acceptable input. It may have no input, or it may sense incorrect input. The inverter will not transfer and will continue inverting (in the correct phase). It will display a ***Phase Loss*** warning (see page 55).
- If a slave inverter does not sense acceptable input, it will not transfer, but also will not invert. The slave will have no output. It also will display a ***Phase Loss*** warning.
- In either case, this warning appears as an event on the MATE3S system display.

The FXR inverter's stacking function includes the option called ***Multi-Phase Coordination***. The selectable menu item is ***Coordinated AC Connect/Disconnect***. If selected, the AC source is **required** to deliver input (in the appropriate phase) to all inverters.

- If the master or subphase master inverters do not sense an acceptable AC source, the entire system will disconnect from the source.
- None of the inverters will reconnect until the source is acceptable for the duration of the appropriate timer. This may be either the ***Connect Delay*** or the ***Re-Connect Delay*** timer. See page 19.
- This function does not apply to slave inverters. A slave inverter with an unacceptable AC source will not cause a general ***System Disconnect***. The slave will still display a ***Phase Loss*** warning.
- A general ***System Disconnect*** will not cause the inverters to show a ***Phase Loss*** warning.

See page 19 for more information on ***Multi-Phase Coordination***. See the menu tables beginning on page 68 for the default settings and ranges.

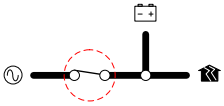
Generator Input



A generator should be sized to provide enough power for all inverters, both for loads and for battery charging. The generator's voltage and frequency must match the FXR inverter's acceptance settings. Some 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.

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. The use of the ***Generator*** input mode may assist with this problem.

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 output terminals are electrically isolated from the input. When it closes, the input and output terminals become electrically common. When the relay changes states, the physical transfer delay is *approximately* 16 milliseconds.

	CAUTION: Equipment Damage Current draw in excess of the transfer relay rating can damage the transfer relay. This damage is not covered by warranty. Use protective devices of appropriate size.

The relay contacts are limited to 30 amps per phase or leg. The continuous loads on that output should never exceed this number. When connected to an AC source, the FXR inverter cannot limit the load current. An overload condition is possible.

The inverter does not filter or actively condition 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 requirements, it will disconnect and return to the inverting mode.

NOTES:

- 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.
- If the AC source meets the inverter's requirements but is irregular, any fluctuations will be transferred to the loads. If the loads are sensitive, it may be necessary to improve the quality of the AC source.
- The ***Generator*** input mode is intended to accept irregular or unfiltered AC sources and is more likely to do so than other modes. This should be considered before using this mode with sensitive loads. (See page 16.)

If the charging function is turned off, the inverter will transfer power from the source but will not use it to charge. If the inverting function is turned off, the inverter will transfer ("pass through") the source power when connected, but will not invert when the source is removed.

In a stacked system, slaves are ordered to transfer at the same time as the master. If a slave does not sense an AC source at the same time as the master, it will experience a ***Phase Loss*** warning (see page 55). This appears as an event on the MATE3S system display. 1

NOTE: A slave in ***Phase Loss*** will continue supporting the master inverter's output.

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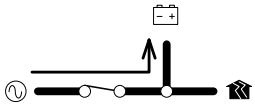
Battery Charging 

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.

Charge Current

Battery banks usually have a recommended limit on the maximum current used for charging. Often this is calculated as a percentage or fraction of the battery capacity, represented by "C". For example, C/5 would be a DC amperage figure that is $^1/_5$ of the total amp-hours of the bank.

Any chargers must be set so that the peak charge current does not exceed the recommended battery maximum. If multiple chargers are present (including other types of chargers besides the inverter), this calculation must accommodate the total combined current. The FXR charger may need to be set at less than maximum. The system display can change charger settings.

IMPORTANT:

Although the recommended current is generally represented in DC amperes (Adc), the ***Charger AC Limit*** setting is measured in AC amperes (Aac), which use a different scale. To convert the DC current into a usable AC figure, divide the DC figure by the following number (based on inverter voltage) and round up. The result can be used as a charger setting for the FXR inverter.

12-volt inverters: Divide by 20
24-volt inverters: Divide by 10
48-volt inverters: Divide by 5

Examples:

Bank consists of 8 × L16 FLA batteries in series for a 48-volt system. Recommended maximum charge current is 75 Adc. (75 ÷ 2.5 = 15 Aac)

Bank consists of 12 × OutBack Power EnergyCell 200RE VRLA batteries in series/parallel for a 24-volt system. Recommended maximum charge current is 90 Adc. (90 ÷ 10 = 9 Aac)

The maximum DC charge rate for FXR models is specified in Table 15 on page 59. The actual ***Charger AC Limit*** setting is available in the ***AC Input and Current Limit*** menu of the MATE3S. (See the menu tables which begin on page 68.) This is also summarized in Table 5 below.

NOTE: This table does not match the calculations above due to other factors in charging.

Table 5 Charge Currents for FXR Models

Model	Maximum DC Output (sent to battery)	Maximum AC Input (used from source)
FXR2012E	100 Adc	7 Aac
VFXR2612E	120 Adc	9 Aac
FXR2024E	55 Adc	7 Aac
VFXR3024E	80 Adc	10 Aac
FXR2348E	35 Adc	7 Aac
VFXR3048E	40 Adc	10 Aac

Charge Current for Multiple Inverters

If FXR inverters are stacked, the master inverter ***Charger AC Limit*** setting is used by all other inverters. Divide the total AC current by the number of chargers used and program the master with the result. The master will operate all chargers with this setting to achieve the maximum total charge current. The system display has a global ***Charger Control*** command of ***On*** which enables all available chargers.

Limiting Charge Current (Multiple Inverters)

It is not advisable to set ***Charger AC Limit*** less than 6 Aac in a stacked system. The **Power Save** function requires the master to activates the slave chargers in sequence only when the charge current exceeds 5 Aac. If the setting is less than 6, **Power Save** will not activate any other chargers.

For more information on this function, see the **Power Save** section in the *Installation Manual*.

In some systems, lower currents may be required due to battery bank size or other reasons. Chargers can be individually set to ***Off*** so that the master inverter does not activate them.

For the location of the ***Charger Control*** command, see the menu tables beginning on page 68.

For more information on controlling the charger limits in a stacked system, see page 65.

Charge Cycle

The FXR inverter uses a “three-stage” battery charging process with Bulk, Absorption, and Float stages. These stages follow a series of steps, which are shown on graphs and described beginning below. The inverter’s factory default settings are intended for three-stage charging of lead-acid batteries.

Charging Graphs

Figure 4 shows the progression of steps of the three-stage charging cycle.

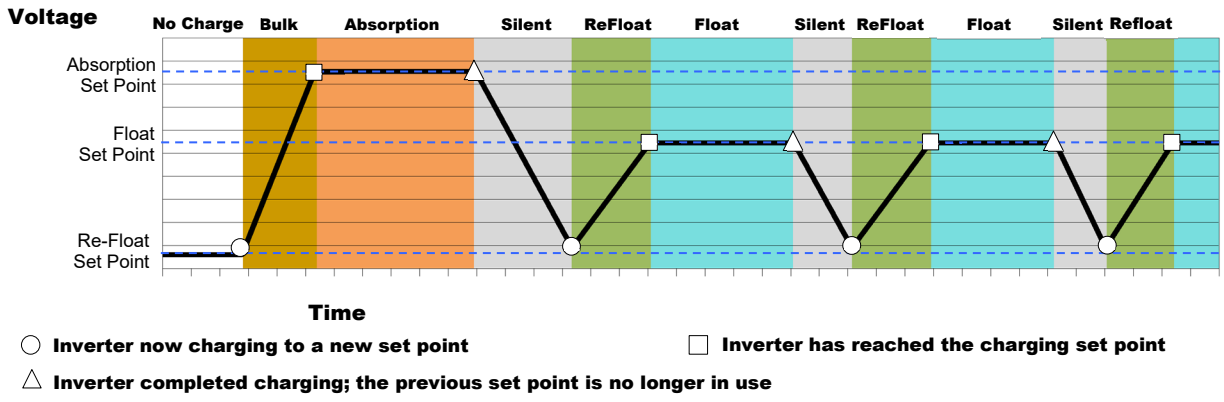


Figure 4 Charging Stages Over Time

Figure 5 shows the charge cycle used by the inverter when the ***Float Time*** menu item is set to ***24/7***. This setting eliminates the Silent and Refloat steps. The charger remains in Float continuously. The Float stage lasts until the AC source is removed.

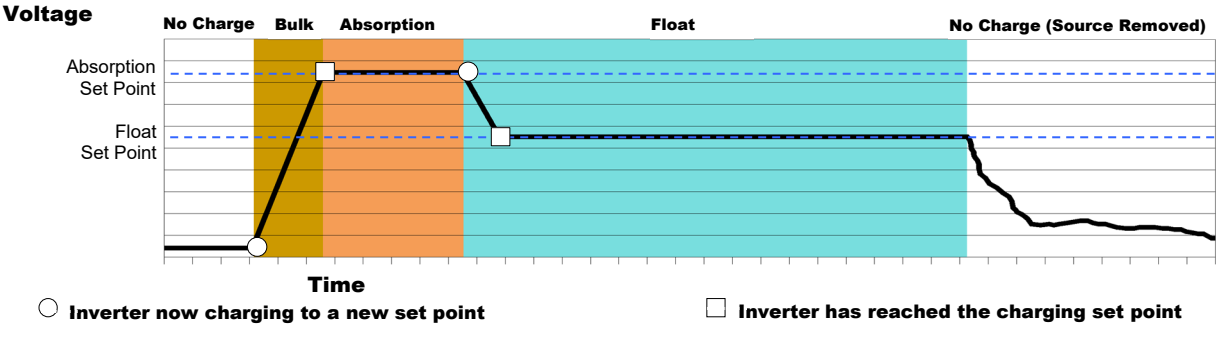


Figure 5 Charging Stages Over Time (24/7)

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Advanced Battery Technologies

Advanced battery technologies such as lithium-ion and sodium-sulfur may require very different settings from the inverter's defaults or the three-stage cycle in general. The **Charging Steps** section describes the individual selections and behavior. All charger settings are adjustable for different priorities. For example, the Float voltage could be set higher than the Absorption voltage, or a step could be completely skipped.

Charging Steps

The following items describe the operation and intended use for each individual charging step as shown in the graphs. Note that some charging cycles may not follow this exact sequence. These include cycles which were previously interrupted, and also customized charging. Each step describes how to defeat or customize the step if specialized charging is required.

See page 37 for a description of multiple cycles when the charger is restarted after completion. This page also describes multiple cycles when the charger is restarted after being interrupted.

For multiple inverters:

The charging of stacked inverters is synchronized and is governed by the master. The charger settings of all other inverters are ignored. Slave and subphase masters use the master settings.

No Charging

If the inverter is not charging, several conditions may apply:

- The unit is not connected to a qualified AC source. If a generator is present, it may not be running.
- The unit is connected to an AC source but the charger has been turned off.

Bulk Stage

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% to 90% of their capacity, depending on the battery type, the exact charger setting, and other conditions.

Voltage Used: ***Absorb Voltage*** setting.

Default Set Point (nominal voltage): 14.4 Vdc (12-volt), 28.8 Vdc (24-volt), 57.6 Vdc (48-volt)

The initial DC current may be as high as the charger's maximum current, depending on conditions. The current will begin at a high level, but will tend to drop slightly as the voltage rises. This is not a reduction in charging. It can be viewed as a wattage "tradeoff". The actual kilowatts used by the charger are shown in the ***Inverter*** menu. The reading is usually consistent at this stage. (See page 47.)

To skip this step: Setting ***Absorb Voltage*** equal to ***Float Voltage*** causes the charger to proceed through the normal three-stage cycle, but at a single voltage. Setting ***Absorb Time*** to 0 causes the charger to skip both the Bulk and Absorption stages and proceed directly to the constant-current Refloat stage. This may not be desired if the intent is to include the Bulk stage but skip Absorption.

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 leaves the batteries at essentially 100% of capacity.

Voltage Used***Absorb Voltage*** setting. This setting is also used by **Offset** when in this stage. (See page 41.) For the three-stage cycle to proceed normally, this setting should be kept higher than the ***Float Voltage*** and ***Re-Bulk Voltage*** settings.

Time limit: ***Absorb Time*** setting. The charger does not necessarily run through its full duration if it retained time from a previous charge cycle. The timer counts down from the inception of Absorption stage until it reaches zero. The time remaining can be viewed in the system display.

The Absorption timer does not reset to its maximum amount, or to zero, when AC power is disconnected or reconnected. It only goes to zero if the timer runs out during Absorption stage, or if an external **STOP BULK** command is sent. In all other cases it retains any remaining time.

Absorb Time is reset to its maximum whenever the battery voltage decreases to the ***Re-Bulk Voltage*** setting. The reset occurs immediately, regardless of the time spent below this voltage.

To skip this step: Setting ***Absorb Time*** to a very short duration causes the charger to spend minimal time in Absorption once the Bulk stage is complete. Setting ***Absorb Time*** to zero will cause the charger to skip both the Bulk and Absorption stages and proceed directly to the constant-current Refloat stage. This may not be desired if the intent is to skip Absorption but retain the Bulk stage.

Silent

This is not a charging stage, but a quiescent period between stages. The inverter remains on the AC source, but the charger is inactive. It enters this condition upon completing a timed stage such as Absorption, Float, or Equalize.

In Silent, the batteries are not in significant use by the inverter, but they are also not being charged. The battery voltage will naturally decrease when not maintained by another means such as a renewable source. (The term “Silent” is also used in an unrelated context regarding **Power Save**. See the **Power Save** section of the *Installation Manual*.)

Voltage Used: ***Re-Float Voltage*** setting. When the battery voltage decreases to this point, the charger becomes active again.

Default Set Point (nominal voltage): 12.5 Vdc (12-volt), 25.0 Vdc (24-volt), 50.0 Vdc (48-volt)

To skip this step: Setting ***Float Time*** to ***24/7*** makes the charger remain in Float continuously so that it does not proceed through the Silent, Bulk, Absorption, or Float timer steps.

Float Stage

This is the third stage of charging. It is sometimes known as maintenance charging. Float stage balances the batteries’ tendency to self-discharge (as well as balancing the draw of any other DC loads). It maintains the batteries at 100% of capacity.

Voltage Used: ***Float Voltage*** setting. This setting is also used by Offset when in this stage. (See page 41.) For the charger to work normally, this setting needs to be higher than the ***Re-Float Voltage*** setting.

Default Set Point (nominal voltage): 13.6 Vdc (12-volt), 27.2 Vdc (24-volt), 54.4 Vdc (48-volt)

The charger may perform two functions during Float. Both are called ***Float*** in the system display. They are defined here as **Re-Float** and **Float**.

Re-Float

Re-Float is a constant-current function. The initial DC current may be as high as the charger’s maximum current, depending on conditions. This stage is similar to Bulk, except that the charger uses the ***Float Voltage*** setting as noted above. The charger delivers current until the batteries reach this value.

Float

Float is a constant-voltage function. The charging current varies as needed to maintain ***Float Voltage***, but typically drops to a low number. This stage is similar to Absorption, except that the voltage is different.

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Time limit: ***Float Time*** setting. The charger will go Silent once the timer has expired (if another stage is not still in progress.) The Float timer is reset to its maximum amount whenever the batteries decrease to the ***Re-Float Voltage*** setting.

NOTE: The Float timer begins running any time the battery voltage exceeds the ***Float Voltage*** set point. This usually means that it begins running during the Bulk stage, once the battery voltage rises above that level. Often the timer will expire before the bulk and absorption stages are complete. (This will occur if the ***Float Time*** setting is less than the total of the bulk and absorption stages.) The charger will not enter Re-Float or Float but will go directly to Silent. The charger only spends time in Float stage if the timer is still running.

To skip this step: Decreasing the ***Float Time*** setting to zero causes the inverter to enter Silent as soon as the absorption stage is complete. The inverter will perform neither the constant-current Refloat nor the constant-voltage Float.

Setting ***Float Voltage*** equal to the ***Absorb Voltage*** level causes the charger to proceed through the normal three-stage cycle, but at a single voltage.

NOTE: Setting ***Float Time*** to 24/7 causes the charger remain in Float continuously so that the Float timer no longer applies. (The charger also skips Bulk, Absorption, and Silent.) However, the charger can begin a single three-stage charge if the criteria are met, after which it will return to continuous Float.

Silent

Following the expiration of the Float timer, the unit enters (or re-enters) the Silent stage. The unit remains connected to the AC source, but the charger is inactive. The unit will continue cycling between Float and Silent until the AC source is lost or a new charge begins.

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.

Re-Bulk

If the battery voltage decreases due to discharge, the inverter will restart the cycle as soon as the AC source is available, beginning at Bulk stage.

Voltage Used: ***Re-Bulk Voltage*** setting. If the battery voltage does not decrease to the Re-Bulk point, the charger will not enter the Bulk stage and will return to its previous stage.

Default Set Point (nominal voltage): 12.0 Vdc (12-volt), 24.0 Vdc (24-volt), 48.0 Vdc (48-volt)

Absorption Timer

Time limit: ***Absorb Time*** setting. This is reset to its maximum amount whenever the battery voltage decreases to the ***Re-Bulk Voltage*** setting. The reset occurs immediately, regardless of the duration spent below this voltage.

If the battery voltage does not decrease to the Re-Bulk point, the ***Absorb Time*** setting will not reset. It will retain any remaining time from the previous cycle. The Absorption stage will only last for the duration of the remaining time.

The remaining charging steps proceed as described on the previous pages.

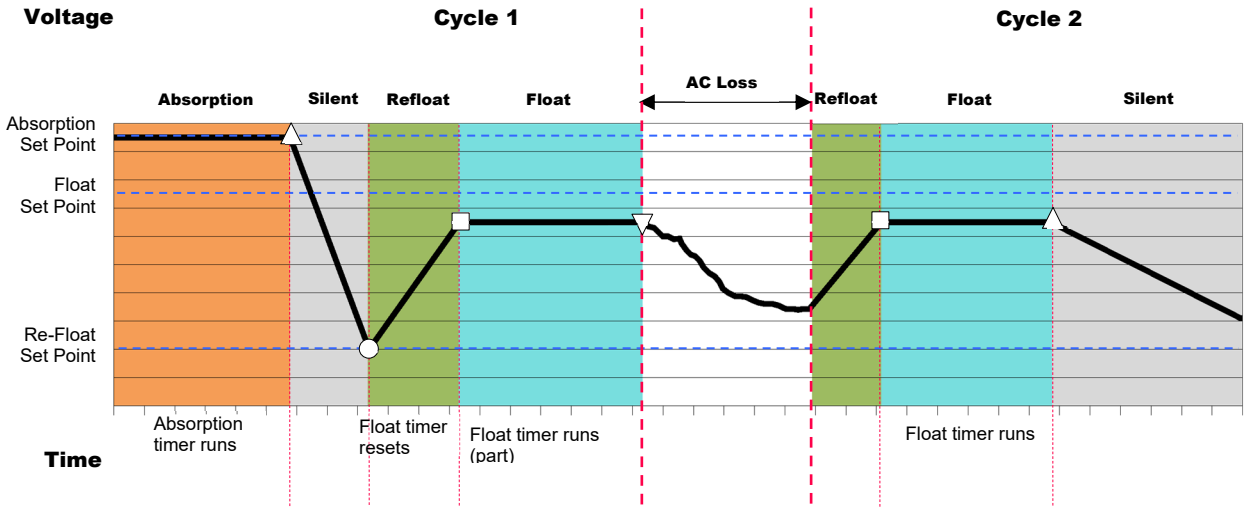

Figure 6 Repeated Charging (1st and 2nd Cycles)

Example of Multiple Cycles

- In Figure 6 (Cycle 1), the charger initially completes Absorption. When the Absorption timer expires, the charger goes Silent until battery voltage decreases to the ***Re-Float*** setting. The Float timer is reset to its maximum. The charger proceeds through Re-Float and Float until it is interrupted by a loss of AC power.
- Cycle 2 begins when the AC source is restored. During the AC loss, the battery voltage did not decrease to the ***Re-Float*** setting, so ***Float Time*** retains the remainder of the previous cycle. The charger returns to Refloat and proceeds through the Float stage. Cycle 2 completes the Float stage when its timer expires. It then goes Silent.

  Note that in Cycle 1, ***Absorb Time*** had expired. It was not reset afterward and retained a "remaining run time" of zero. The Bulk and Absorb stages do not occur on subsequent cycles until the timer reads something other than zero.
- This graph is continued in Figure 7. During the Silent period AC is lost again. The battery voltage decreases until it reaches the Re-Bulk set point. This causes the charger to prepare a new three-stage cycle from the beginning, but it cannot do so until the AC source is restored.

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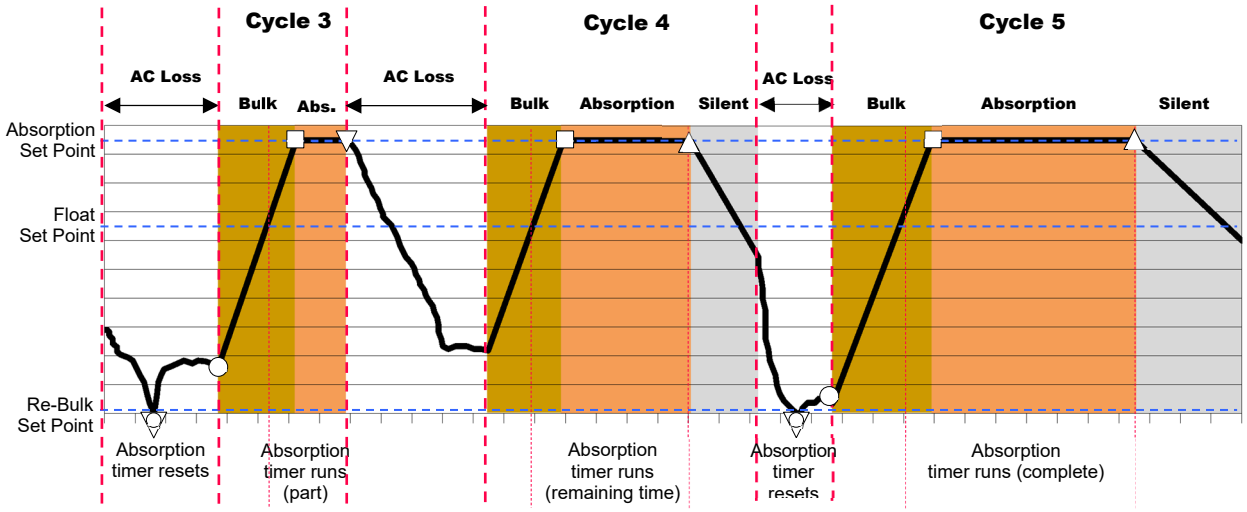

○ **Inverter now charging to a new set point**

□ **Inverter has reached the charging set point**

△ **Inverter completed charging; the previous set point is no longer in use**

▽ **Inverter waiting to charge when AC restored; the previous set point is still in use**

▽ **Inverter waiting to charge when AC restored; a new set point is in use**

Figure 7 Repeated Charging (3rd, 4th, and 5th Cycles)

- Prior to the beginning of Cycle 3, the AC source was lost. The battery voltage decreased below the level of the ***Re-Bulk*** set point. Whenever this occurs, the Absorption timer resets to its maximum amount.
- In Figure 7, Cycle 3 begins when the AC source is restored again. The charger begins a new cycle by entering Bulk stage. When it enters Absorption, the timer runs until it is interrupted by a loss of AC power.
- Following Cycle 3, the voltage does not decrease below ***Re-Bulk***. The Absorption timer retains the remaining time from Cycle 3.
- Cycle 4 begins when the AC source is restored again. The charger enters Bulk stage and proceeds to Absorption. This stage does not last for the full duration of the ***Absorb Time*** setting. The timer uses up the remaining time from Cycle 3. Absorption ends when the timer expires.

  In this example, the duration was also longer than the ***Float Time*** setting. Because the Float timer began running near the beginning of Cycle 3 and also Cycle 4 (when the batteries exceeded the ***Float Voltage*** setting), the ***Float Time*** has also expired. The charger does not enter Refloat or Float and goes Silent.

  During the Silent period, AC is lost again. The battery voltage decreases until it reaches the ***Re-Bulk*** set point, prompting a new charge cycle. The Absorption timer resets to its maximum amount.
- When Cycle 5 begins, the charger proceeds through the Bulk stage and then the Absorption stage. At the end of Cycle 5, the ***Float Time*** has expired, so the charger goes Silent.

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 maintains this high voltage for a period of time. This has the result of removing inert lead sulfate compounds from the battery plates. It also reduces stratification by circulating the electrolyte.

Equalization follows the same pattern as standard three-stage charging, as shown in the figures on page 34. However, instead of the Absorption voltage and time set points, it is controlled by the ***Equalize Voltage*** and ***Equalize Time*** settings in the system display.

The FXR inverter can perform **Offset** when equalizing. (See page 41.) ***Equalize Voltage*** is also the reference voltage for **Offset** during equalization.

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 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. It is not normally performed on any sort of sealed battery.

CAUTION: Battery Damage

- Do not equalize any sealed battery types (VRLA, AGM, Gel, or other) unless approved by the manufacturer. Some batteries may suffer severe damage from equalization.
- Contact the battery manufacturer for recommendations on equalization voltage, duration, schedule, and/or advisability. Other battery manufacturers may use a different definition of equalization than that shown above. Always follow manufacturer recommendations for equalization.

Battery Temperature Compensation

Battery performance will change when the temperature varies above or below room temperature (77°F or 25°C). Temperature compensation is a process that adjusts battery charging to correct for these changes.

The FXR inverter, when equipped with the Remote Temperature Sensor (RTS), will compensate for changes in temperature. To achieve a representative temperature, the RTS is attached to a single battery near the center of the bank. The FXR inverter has a designated port for RTS installation. 2

If temperature compensation is not used:

When a battery is cooler than room temperature, its internal resistance changes. The battery voltage will rise more quickly and the charger will reach its voltage set points more easily. However, it will not deliver all the current that the battery requires and the battery will tend to be undercharged.

Conversely, when a battery is warmer than room temperature, the voltage will rise more slowly. The charger will not reach its set points as easily. It will continue to deliver energy until the charging set points are reached, but this will tend to be more than required. The battery will be overcharged and is likely to have a shorter life.

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If installed in a system networked with a HUB Communications Manager, only a single RTS is necessary. In most cases the RTS must be plugged into the master inverter. A system display must be present for the compensation values to be shared to all devices.

NOTE: In the FLEXmax 100 charge controller, the rate of compensation is adjustable. (See **Slope**.) When changing the compensation rate in one of these products, the RTS should be plugged into that controller, not the master inverter, to share the new value with other devices. The communications manager and system display must still be present to share the values.

IMPORTANT:

- If the RTS is connected to an OutBack Power device other than those listed above, the compensation values will not be shared.
- If a system display is not connected, the compensation values will not be shared.
- If the RTS is not connected to one of the charge controllers designated above, the controller's compensation values will not be shared.
- See the applications note at www.outbackpower.com for more information on this topic.

When charging, an inverter system with an RTS will adjust the charging voltage inversely with changes in temperature. It will **increase** the charge voltage by 5 mV for every decrease of 1 degree Celsius per battery cell. Similarly, it will **decrease** the voltage 5 mV for every increase of 1°C per cell.

This setting affects the ***Absorption***, ***Float***, and ***Equalization*** set points. The ***Sell Voltage*** and ***Re-Float Voltage*** 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 to 0.45 Vdc **higher** than the set points.
- A 24 Vdc system with batteries at 35°C will compensate to 0.6 Vdc **lower** than the set points.
- A 48 Vdc system with batteries at 15°C will compensate to 1.2 Vdc **higher** than the set points.
- A 48 Vdc system with batteries at 40°C will compensate to 1.8 Vdc **lower** than the set points.

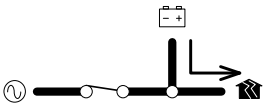
Slope

Some batteries require different amounts of compensation. The FLEXmax 100 charge controller has an adjustable rate of compensation ("slope") and is not limited to 5 mV. The HUB Communications Manager can network the controller with the inverter. If this is done, the inverter can import the slope setting from the controller.

NOTE:

Temperature compensation only applies to the battery charging function. Other set points in the inverter, such as the **AUX** functions, are not compensated for temperature.

Offset



Offset is an automatic operation which occurs in certain conditions. It is not a programmable inverter function.

This operation uses excess battery energy to power the loads when an AC source is present. The system can take advantage of renewable energy sources, "offsetting" dependence on the AC source.

The battery voltage increases as a renewable energy source charges the batteries. When the voltage exceeds a designated reference voltage, the inverter begins inverting. It draws power from the batteries (discharging them) and uses that power to offset the use of the AC source.

The FXR inverter uses excess DC energy for offset under the following rules:

- If the load demand is higher than the inverted power, the inverter's use of the AC source is reduced. The amount of inverted power has "offset" the same amount of demand on the AC source. (This is sometimes known as "selling to the loads".)
- If the excess DC energy (and inverted power) is equal or greater than the load demand, and the inverter is in the ***Grid Tied*** input mode, the inverter will sell the additional power to the utility grid. This is the key priority of the ***Grid Tied*** mode.

The inverter uses several set points as reference voltages for the offsetting operation, particularly the battery charger settings.

- The charger settings ***Absorb Voltage***, ***Float Voltage***, and ***Equalize Voltage*** (as shown in the system display) are all used as reference voltages. Normally the charger regulates to these set points by adding power to the batteries. Offsetting does the opposite; it uses the same set points but regulates the voltage by *removing* power from the DC side of the system.
- If none of the battery charger's timers are active, the reference voltage is ***Sell Voltage*** in the ***Grid-Tie Sell*** menu. This is true in any input mode where **Offset** is used, not just the ***Grid Tied*** input mode.
- The ***GridZero*** mode only uses a single reference voltage for **Offset**, the ***DoD Volts*** setting.

NOTES:

- The ***Offset Enable*** menu item must be set to ***Y*** (yes) for **Offset** to work.
- Offsetting operation is available in the ***Support, Grid Tied***, and ***GridZero*** modes.
- Offsetting operation is available in the ***Mini Grid*** mode. However, it may not be used often since the ***Mini Grid*** priority is to avoid grid use.
- Offset operation is not available in the ***Generator, UPS,*** and ***Backup*** input modes.

Table 6 Offset Interaction with AC Source

Mode	Excess DC ≥ loads	Excess DC < loads
Generator	Does not function	
Support	Offsets load use, but also uses DC to support the AC source based on ***Support*** mode settings	
Grid Tied	Sells excess to AC source (grid); remains connected	Offsets loads with whatever power is available
UPS	Does not function	
Backup	Does not function	
Mini Grid	Offsets loads with whatever power is available; inapplicable if disconnected from utility grid	
GridZero	Offsets load use, but only according to the ***DoD Volts*** setting	

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Auxiliary Terminals

The FXR inverter has an auxiliary ("**AUX**") output that responds to different criteria to control certain operations. These terminals provide a 12 Vdc output that can deliver up to 0.7 Adc.

The **AUX** output has three states: continuous ***Off***, continuous ***On***, and ***Auto***, which allows that output to be activated using the automatic auxiliary functions. (All functions are defaulted to ***Auto***.) These items are based in the FXR inverter and accessed using the system display. The system display and other devices have separate programming, such as Advanced Generator Start (AGS), that can also control the **AUX** outputs. To avoid conflicts, the output should be turned ***Off*** when the AGS function is active.

For the FXR automatic functions, typical applications include signaling a generator to start, sending a fault alarm signal, or running a small fan to ventilate the batteries. When considering these applications, plan for both connection requirements and system display programming. 1

The **AUX** terminals have a series of set points which are used by various functions. Not all points are used by all functions. Each mode description (below) will show the set points used by that function.

- Low DC voltage settings
- High DC voltage settings
- On delay settings, in increments of 0.1 minutes
- Off delay settings, in increments of 0.1 minutes

These are not temperature-compensated. Compensation is only used for inverter battery charging.

There are nine functions, each geared toward a different application. These functions are summarized in Table 7 on page 45.

NOTE: The **AUX** output is defaulted to ***Vent Fan.*** A sealed FXR inverter with the Turbo Fan is required to use the **AUX** output for fan control. In a single-inverter system, no other functions can be used.

- ***Load Shed*** can perform load management. It is intended to turn off designated loads during low battery periods to conserve remaining battery power.
  - When battery voltage rises above a settable high voltage level, the **AUX** output is activated after a settable delay. The **AUX** output is used to energize a larger external relay (normally open) which is connected to non-vital loads. The **AUX** output will be deactivated once the battery voltage falls below a low voltage setting for a settable delay period.
  - ***Load Shed*** will also turn off when the inverter enters a high-temperature condition or when the AC output voltage drops below a specific AC voltage for more than 3 seconds. This voltage limit is 30 volts below the setting of the inverter's output voltage. For the inverter's default output voltage of 230 Vac, the limit is 200 Vac. (See the menu tables beginning on page 68.) The limit is not otherwise settable.
  - ***Load Shed*** will also turn off if the input current exceeds the ***Input AC Limit*** setting while the inverter is using an AC source.
  - Settable parameters include:
    - Low and high DC voltage
    - On and off delay
- ***Gen Alert*** is used as a controller for an AC generator with a remote start feature, although it has limited functionality. (The generator recharges batteries using the inverter's battery charger.)
  - The **AUX** output will activate to start the generator when the battery voltage falls to a low set point for a settable delay. The **AUX** output is deactivated, shutting off the generator, once the battery voltage rises to a high voltage setting for a settable delay period.

- Settable ***Gen Alert*** parameters include:
  - Low and high DC voltage
  - On and off delay

  Gen Alert control logic is located in the inverter. It 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 Advanced Generator Start (***AGS***) function that is found in the system display. For many users, the ***AGS*** function may prove more useful than ***Gen Alert***. ***Gen Alert***, however, could be used as a literal "Generator Alert", a signal to the user to manually start a generator.

- ***Fault*** activates the **AUX** output when the inverter shuts down due to an error condition. (See page 54). 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.
- ***Vent Fan*** activates the **AUX** output in response to a high DC (battery) voltage set point. It can run a small fan to ventilate the battery compartment to eliminate gases that result from battery charging. (This is illustrated in the *FXR Series Inverter/Charger Installation Manual.*) When the voltage falls below this set point for a settable delay period, the **AUX** output turns off. This is the default selection.
  - Settable parameters include:
    - High DC voltage
    - Off delay
- ***Cool Fan*** activates the **AUX** output when the inverter reaches a high internal temperature. It is intended to trigger a small external fan for additional cooling. See the Warning Troubleshooting table on page 55 for a description of the fan criteria.
  - This function does not have settable parameters.
- ***DC Divert*** activates the **AUX** output to divert (or "dump") excess renewable energy to a DC load, such as a resistor, a heater, or a fuel cell. This prevents overcharging of the batteries. This function can serve as rough charge regulation for an external charging source.
  - When battery voltage rises above a settable high voltage level, the **AUX** output is activated after a settable delay. The **AUX** output controls a larger, external relay. When energized, the relay allows current to flow from the batteries to a dedicated DC load. (This is illustrated in the *FXR Series Inverter/Charger Installation Manual*.) The resistor or load must be sized to dissipate all of the energy from the renewable source if necessary. Diversion will turn off following a delay when a low DC voltage setting is reached.
  - Settable parameters include:
    - Low and high DC voltage
    - On and off delay
- ***GT Limits*** activates the **AUX** output as an alert that the utility grid does not meet Grid Interface Protection parameters for the grid-interactive function. (See page 19). It can activate a light or alarm to show that the grid-interactive function has shut down and that there may be problems with the grid. The **AUX** output will cycle on and off if grid parameters are met and the reconnection timer is counting down.
  - This function does not have settable parameters other than those of the ***Grid Interface Protection*** menu.
- ***Source Status*** activates the **AUX** output whenever the inverter accepts an AC source. It can activate a light or alarm to show that the utility grid is present or that a generator has started. Alternately, it could be used to show that the source has disconnected.
  - This function does not have settable parameters.

  AC Divert activates the **AUX** output to divert (or "dump") excess renewable energy to an AC load, usually an AC device powered by the inverter itself. This prevents overcharging of the batteries. This function can serve as rough charge regulation for an external charging source.

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- When battery voltage rises above a settable high voltage level, the **AUX** is activated after a settable delay. The output controls a larger relay, which allows current to flow from the batteries to a dedicated AC load when energized. Diversion 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 energy from the renewable source if necessary. Diversion will turn off following a delay when a low DC voltage setting is reached.
- The **AUX** output will automatically turn on to run the loads if the inverter accepts an AC source.
- Settable parameters include:
  - Low and high DC voltage
  - On and off delay
- During variable conditions, the **AUX** output is triggered no more than once per minute (if voltage conditions are still met). This prevents rapid nuisance cycling of the AC load.
- ***AC Divert*** should not be used as the sole source of battery regulation. If the inverter shuts down or fails, the batteries could suffer severe damage. This function should be supported by an external regulator.
  - If the inverter shuts down due to overload, the **AUX** output will also shut down. If the inverter load exceeds 30 Aac, the **AUX** output will turn off to prevent an overload condition.
  - If either the FETs or the capacitors (see page 56) become too hot, the **AUX** will turn off due to diminished inverter wattage capacity.

Note that even if every function in the menu is set to ***Off***, external programming from other devices may still activate the **AUX** output. An example is the system display's AGS function.

The **AUX** functions are summarized in Table 7.

Table 7 Aux Mode Functions

Name	Purpose	Triggers		Settable Points
		Start	Stop	
Load Shed	Operates designated loads normally; turns off loads in severe conditions	• High Vdc	• Low Vdc • High temp • Low output Vac • High input Aac	• Low & high Vdc • On & Off delay
Gen Alert	Starts generator to charge batteries	• Low Vdc	• High Vdc	• Low & high Vdc • On & Off delay
Fault	Signals that the inverter shut down due to error	• Error present	• Error cleared	None
Vent Fan	Runs fan to vent batteries while charging	• High Vdc	• Below high Vdc	• High Vdc • Off delay
Cool Fan	Runs fan to cool inverter	• Internal sensor > 60°C	• Internal sensor < 49°C	None
DC Divert	Turns on DC dump load to prevent overcharging	• High Vdc	• Low Vdc	• Low & high Vdc • On & Off delay
GT Limits	Signals disconnect of grid-tied inverter due to AC conditions	• GIP parameters not met	• GIP parameters met	None
Source Status	Signals that the inverter accepted an AC source	• AC source accepted	• AC source disconnected	None
AC Divert	Turns on AC dump load to prevent overcharging	• High Vdc • AC source accepted	• Low Vdc • High output load • High temperature	• Low & high Vdc • On & Off delay

NOTES:

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Metering

MATE3S System Display Screens

The MATE3S system display can monitor the inverter and other networked devices. From the ***Home*** screen, the <**Inverter**> "soft" key accesses the inverter monitoring screens. 1

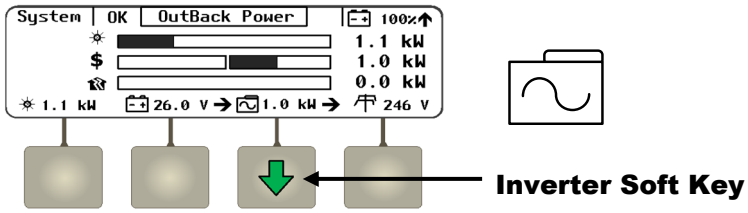
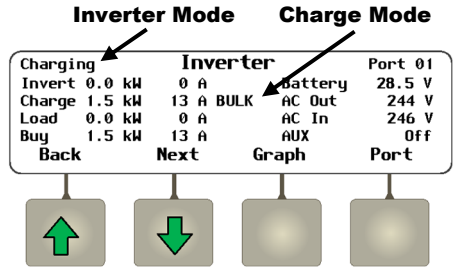


Figure 8 Home Screen

Inverter Screen

The <**Inverter**> soft key opens a screen showing the inverter operating mode, battery voltage, and status of several AC operations. The <**Port**> soft key will select other networked inverters, if present. The <**Next**> soft key accesses the Battery screen.



Inverter Modes:

- ***Inverting*** (see page 26)
- ***Searching*** (see page 28)
- ***Support*** (see page 17)
- ***Sell*** (see page 18)
- ***Charging*** (see **Bulk** on page 35)
- ***Charger Off*** (see pages 32 and 35)
- ***Float*** (see page 36)
- ***EQ*** (see page 40**Error! Bookmark not defined.**)
- ***Silent*** (see page 36)
- ***PassThru*** (see page 32)
- ***Error*** (see page 54)
- ***Off***

Inverter Modes (slave):

- ***Slave On***
- ***Slave Off***
- ***Error***

Charge Modes:

- ***BULK***
- ***FLOAT***
- ***EQ***

Figure 9 Inverter Screens

Screen items:

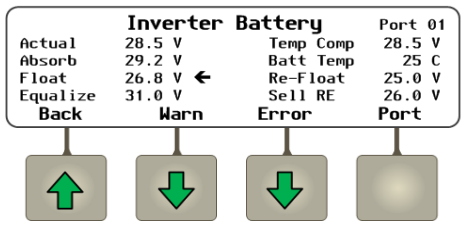
- The upper left corner is the **Inverter Mode** (see above). When ***Charging*** is indicated, the **Charge Mode** specifies the stage.
- ***Invert*** displays the kilowatts and AC amperage generated by the inverter. It may go to loads, or in a grid-interactive system it may be sold back to the utility grid.

- ***Charge*** displays the kilowatts and AC amperage consumed for the inverter to charge the battery bank. This line also shows the present charging stage.
- ***Load*** displays kilowatts and AC amperage consumed by devices on the inverter's output. It can be the same as ***Invert***.
- ***Buy*** displays the kilowatts and AC amperage brought into the inverter's input for both charging and loads. This is usually a total of ***Charge*** and ***Load***.
- ***Battery*** displays the uncompensated battery voltage.
- ***AC Out*** displays the AC voltage measured at the inverter's output. If an AC source is present, this reading is usually the same as ***AC In***.
- ***AC In*** displays the AC voltage measured at the inverter's input from an AC source. This number may be erratic or inaccurate upon first connection until the inverter synchronizes with the input source.
- ***AUX*** displays the current status of the inverter's Auxiliary (**AUX**) 12-volt output. (See page 43.)
- A diode symbol may appear to the left of the screen name to indicate "diode charging" mode. This is a mode that allows fine control of charging, selling, and load support. It does not visibly affect operation.

The <**Graph**> soft key brings up a series of screens which plot various types of data over time on the system display screen. 1

Battery Screen

The <**Next**> soft key brings up a screen showing charger status, charger settings, and battery voltage and temperature information.



NOTE:
The charger settings cannot be adjusted on this screen. 1

An arrow will appear to the right of ***Absorb***, ***Float***, or ***Equalize*** to indicate that the charger is in that stage. The arrow will not appear if the charger is in the Bulk stage, or if it is inactive.

Figure 10 Battery Screen

Screen items:

- ***Actual*** displays the uncompensated battery voltage.
- ***Absorb*** displays the charger's Absorption voltage setting. (See page 35.)
- ***Float*** displays the charger's Float voltage setting. (See page 36.)
- ***Equalize*** displays the charger's Equalization voltage setting. (See page 40.)
- ***Temp Comp*** displays the corrected battery voltage using temperature readings from the RTS. If no RTS is present, ***Temp Comp*** and ***Actual*** will read the same. (See page 40.)
- ***Batt Temp*** displays the battery temperature in degrees Celsius, as measured by the RTS. It is only valid for port 1 on the HUB. If other ports are selected, or if no RTS is present, the characters ### will be displayed.
- ***Re-Float*** displays the Re-Float setting which was programmed into the inverter's charger. This is the voltage used for the inverter to return from Silent mode to the float stage. (See page 36.)
- ***Sell RE*** voltage is the target voltage used by the inverter for the grid-interactive and other **Offset** functions when the charger is otherwise inactive. (See pages 18 and 41.)

The <**Warn**> and <**Error**> keys bring up bring up various fault screens. See the next section.

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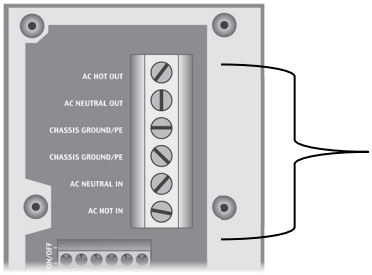
Troubleshooting

Basic Troubleshooting

Table 8 is organized in order of common symptoms, with a series of possible causes. Each also shows possible troubleshooting steps, including system display checks where appropriate.



In troubleshooting, AC voltages can be measured at the attachment screw for each AC conductor.

Figure 11 AC Test Points

WARNING: Shock Hazard

During an error shutdown, the inverter's output terminals are not live. However, if the inverter recovers from a shutdown, the terminals will become live without notice. Several error shutdowns can be recovered automatically, including ***Low Battery V***, ***High Battery V***, and ***Over Temperature***. See page 54.

NOTE:

In Table 8, many troubleshooting steps require a MATE3S device to perform the step. Complete troubleshooting may not be possible without the system display.

Table 8 Troubleshooting

Symptom	Possible Cause	Possible Remedy
No AC output (will not invert).	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.
	INVERTER ON/OFF jumper missing.	See the *Installation Manual* for the location of the jumper. Confirm the jumper is present. If missing, replace the jumper. Or follow the Installation Manual instructions to install an external switch.
	Unit defaulted off (No system display; initial install; **INVERTER ON/OFF** jumper confirmed present).	The FXR inverter is given an initial **Off** command in the factory. With DC present, use narrow pliers to remove the jumper from its pins. Once removed, install it again. This is the equivalent of "jiggling the switch."
	Inverter set to ***Off***.	Set to ***On*** with the **INVERTER** hot key. **NOTE**: The **ON/OFF** jumper must be installed.
	Inverter set to ***Search*** (Search mode).	If constant power is required, set to ***On*** with the **INVERTER** hot key. (If this setting was intentional, then no action is required.)

Table 8 Troubleshooting

Symptom	Possible Cause	Possible Remedy
One or more units have no output but others do (in multi-inverter system).	Unit is slave and is in Silent mode.	Check ***Power Save Levels*** in the ***Inverter Stacking*** menu and test with loads. Determine if the inverter comes on at the appropriate levels. (If this setting was intentional, then no action is required.)
Will not connect to the AC source.	No AC input.	Check the AC voltage on the inverter's input terminals. (See page 49.) If not present, the problem is external. If present, the inverter could be damaged.
	AC source does not meet requirements.	Check the ***Last AC Disconnect*** screen (using the **AC INPUT** hot key and the ***Discon*** selection) for the reason for disconnection. If it never originally connected, check the ***Warning*** menu (using the **<Inverter>** soft key from the Home screen). Confirm source voltage / frequency.
	AC source meets requirements but is "noisy" or irregular.	The ***Generator*** input mode can accept irregular AC power. Select that mode for that input.
	Inverter was manually set to disconnect from AC.	Change the ***AC Input Control*** setting from ***Drop*** to ***Use*** with the **AC INPUT** hot key. (If this setting was intentional, then no action is required.)
	Grid use function has disconnected from AC.	If activated prematurely, check the ***Grid Use Time*** settings and the system display clock. (If this setting was intentional, then no action is required.)
	High Battery Transfer (***HBX***) mode has disconnected from AC.	Check the **AC INPUT** hot key screen to see if ***HBX*** mode is in use. If activated prematurely, check the settings of ***HBX*** mode. (If this setting was intentional, then no action is required.)
	Load Grid Transfer mode has disconnected from AC.	Check the **AC INPUT** hot key screen to see if ***Load Grid Transfer*** mode is in use. If activated prematurely, check the settings of ***Load Grid Transfer*** mode. (If this setting was intentional, then no action is required.)
	Mini Grid input mode has disconnected from AC.	Check the ***Inverter*** part of the ***Settings*** menu to see if ***Mini Grid*** mode is in use. If activated prematurely, check the settings of ***Mini Grid*** mode. (If this setting was intentional, then no action is required.)
	Conflicting programming.	Check to see if more than one of these is enabled: ***Mini Grid***, ***HBX***, ***Grid Use Time***, ***Load Grid Transfer***. These have conflicting priorities. Only one can be used at a time.
	Grid Tied mode has disconnected from AC.	AC source does not meet requirements; see related entry under "Will not sell power to the utility grid" (next page).
Will not charge.	No AC input.	See "Will not connect to AC" category.
	Charger set to ***Off***.	Check the ***Charger Mode*** screen with the **CHARGER** hot key and set to ***On*** or ***Auto***. (If this setting was intentional, then no action is required.)
	Grid Zero mode in use.	The charger is inoperative in ***Grid Zero*** mode. (If this setting was intentional, then no action is required.)

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Table 8 Troubleshooting

Symptom	Possible Cause	Possible Remedy
Low charge rate.	Charge complete or nearly complete.	Check the DC voltage and charging stage using the system display, if present. Confirm with DC voltmeter.
	System display 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.
	High output loads.	If total loads and charge exceed the AC input setting, charge rate decreases to give priority to the loads. Turn off some of the output loads and test the charge rate again.
	High temperature.	The inverter will reduce the current rate for charging and other activities if the internal temperature exceeds a certain level. Check temperature readings and allow the inverter to cool. (See page 56.) External cooling may also be applied.
Will not sell power to the utility grid.	Grid-tied function has been manually disabled.	Check the ***Grid-Tie Enable*** setting in the ***Grid-Tie Sell*** menu. Confirm it is set to ***Y***.
	Grid Tied mode not in use.	Check the ***Inverter*** part of the ***Settings*** menu to see if ***Grid Tied*** mode is in use.
	AC source does not meet requirements; this item is usually accompanied by disconnecting from the utility grid when in ***Grid Tied*** mode.	Verify grid voltage and frequency. Determine if they are within the inverter's approved limits. If not, the inverter is operating correctly. Contact the utility company if necessary. The acceptance limits are found in the inverter's ***Grid Interface Protection*** menu. See page 19 for more information on this menu.
	The inverter has other criteria besides the AC source which must be met, such as the qualifying time.	Check ***Sell Status*** screen using the Home screen's soft keys. The inverter may be operating correctly. Depending on the conditions which need to be met, the delay may be temporary.
	The inverter will perform the **Offset** function before attempting to sell.	Output loads can consume all excess renewable power if they are large enough. (The **Offset** function "sells to the loads.") Turn off some output loads and observe the sell operation.
Reduced power sold to the utility grid.	AC source voltage is driven high when the inverter sells large amounts of power.	When the inverter senses a rise in grid voltage while selling, it reduces the sell current, to avoid forcing the voltage to unacceptable levels. Check AC input voltage while selling. The inverter may be operating correctly.
	High temperature.	The inverter will reduce the current rate for selling and other activities if the internal temperature exceeds a certain level. Check temperature readings and allow the inverter to cool. (See page 56.) External cooling may also be applied.
Inverter does not perform the Offset function when expected.	Incorrect input mode.	**Offset** does not function in ***Generator***, ***UPS***, and ***Backup*** modes. (If this setting was intentional, then no action is required.)
	Specific mode only offsets under particular conditions.	***Support*** mode will perform the Support function based on load. This may appear as **Offset** without reaching the reference voltage. ***GridZero*** mode will perform **Offset** based on the ***DoD Volts*** setting. Other reference voltages are not used.

Table 8 Troubleshooting

Symptom	Possible Cause	Possible Remedy
Unusual voltage on hot or neutral output line.	System neutral and ground may not be bonded.	Test the **AC HOT OUT** and **AC NEUTRAL OUT** terminals with AC voltmeter. (See page 49.) These measurements should give full voltage. Test neutral and ground connections. This measurement should read zero volts. Any other result means neutral and ground are not bonded correctly. (If bonding is not required or is prohibited by national or local codes, then no action may be required.)
Unusual and different voltages on AC hot input lines.	Inverter has not synchronized with input source.	The ***AC In*** reading accessed by the <**Inverter**> soft key may be erratic or inaccurate after initial connection until the inverter has synchronized with the AC source. This may require a short time.
Loads drop out or crash during transfer.	Erratic AC source voltage.	• Check AC voltage on the **AC HOT IN** and **AC NEUTRAL IN** terminals. (See page 49.) If not consistent, the problem is external. • AC source voltage may have dipped or hovered at a low enough point to disrupt a sensitive load before the inverter could take over. This can happen if the inverter's ***Grid AC Input Voltage Limits*** or ***Gen AC Input Voltage Limits*** were turned down to accommodate a problematic AC source. To make the inverter respond sooner, raise the lower limit setting in the appropriate menu. (If this setting was intentional, then no action is required.)
	Inverter set to ***Search*** (Search mode).	The unit will take a moment to come out of Search mode after transferring. If constant power is required, set to ***ON*** with the **INVERTER** hot key. (If this setting was intentional, then no action is required.)
	Loads sensitive to inverter's transfer time. ***UPS*** mode not in use.	Most of the inverter's input modes feature a small but noticeable response time during transfer. Certain loads (such as highly sensitive computers) may not respond well. The ***UPS*** input mode has a faster response time. (See page 20.)
	Loads too large.	The FXR inverter can transfer more power than it can invert. If loads are oversized, the unit will falter or crash when switching to batteries. Reduce the size of the loads.
	Undersized battery cables.	Battery cables 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.
Unit reads AC input, even though no source is present.	Internal transfer relay may be damaged. May be accompanied by ***AC Relay Fault*** error and shutdown.	Disconnect AC input wires and turn inverter on. Test the **AC HOT OUT** and **AC NEUTRAL OUT** terminals with an AC voltmeter. (See page 49.) If voltage appears there, the transfer relay may be jammed.
	False reading due to noise.	Electrical noise can cause false readings on the metering circuits when no voltage is present. The readings are usually less than 30 Vac. If this is the case, no action is required.

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Table 8 Troubleshooting

Symptom	Possible Cause	Possible Remedy
Inverter clicks repeatedly. AC output voltage rises or drops to unusual levels with every click.	Inverter's output has been connected to its input. Voltage shifts are the result of trying to match its own voltage.	Disconnect the wires from the inverter's AC input or AC output terminals, or both. If the problem immediately disappears, it is an external wiring issue. The inverter's **AC IN** and **AC OUT** must remain isolated from each other.
	Low AC input voltage. Can be caused by weak AC source, or by faulty input connection.	Test **AC HOT IN** and **AC NEUTRAL IN** terminals with an AC voltmeter. (See page 49.) If low or fluctuating, this is an external problem.
	A generator is connected to the input terminals while the unit is in the ***Grid Tied*** input mode.	The inverter is not intended to sell power to a generator. The selling activity will drive the generator voltage up to the disconnection point. It will then reconnect to the generator and try again. Change input modes.
Inverter hums loudly. System display may show messages for high battery voltage, low battery voltage, or backfeed error.	Inverter output is being supplied with an external AC source that is out of phase.	Disconnect **AC HOT OUT** and **AC NEUTRAL OUT** wires. Turn the 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. • Check stacking settings in the ***Inverter Stacking*** menu. Only one master is allowed per system.
Generator, external fan, etc. fails to start when signal is provided by AUX output.	**AUX** output is not connected.	Test the generator or device to confirm functionality. Test the **AUX** terminals with a DVM. If 12 Vdc is present when the menu indicates the function is ***On*** (and the device still does not work), then there is an external connection problem. If 12 Vdc is not present with the function ***On***, the **AUX** circuit may be damaged.
Advanced Generator Start (***AGS***) fails to activate when conditions are met (or starts when conditions are not met).	System display is not present.	***AGS*** programming is located in the system display and cannot function if the system display is removed.
	Other **AUX** functions are in operation.	***Gen Alert*** or another **AUX** function may try to start or stop the generator using the wrong criteria. Make sure all other **AUX** functions are disabled.

Error Messages

An error is caused by a critical fault. In most cases when this occurs, the **ERROR** indicator will illuminate and the inverter will shut down. (See page 13 for the FXR inverter's LED indicators.) A MATE3S system display will show an event and a specific error message. This is viewed using the ***Home*** screen's soft keys. (See system display literature for more instructions.) One or more messages will display ***Y*** (yes). If a message says ***N*** (no), it is not the cause of the error.

Some errors will reset automatically when the cause is resolved. These are noted.

It is possible to clear errors by resetting the inverter. To reset, turn the inverter off and then on. Other possible steps are shown below. Each should be followed by resetting the inverter.

Table 9 Error Troubleshooting

Message	Causes	Possible Remedy
Low Output Voltage	Inverter's AC regulation cannot be maintained under high load conditions.	Check loads and measure current draw. Remove loads as necessary.
AC Output Shorted	Inverter exceeded its maximum surge current due to severe overload.	Check the loads and wiring. This issue is usually the result of a wiring problem (a short), as opposed to a poorly-sized load.
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.
Stacking Error	Programming problem among stacked units. (Often occurs if there is no master.) Can also occur if ***AC Output Backfeed*** occurs.	• Check stacking programming and designation of the master inverter. • Check for output backfeed from an external source. Disconnect output if necessary.
Low Battery V[2]	DC voltage is below low battery cut-out set point, usually due to battery discharge. This occurs after 5 minutes at this voltage. This error can be triggered by other causes. It can appear along with ***Low Output Voltage***, ***AC Output Shorted***, or ***AC Output Backfeed***.	• 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 AC source is connected and the charger turns on.
High Battery V[2]	DC voltage exceeded acceptable level. See page 26.	Check the charging source. This problem is usually the result of external charging.
Over Temperature[2]	Inverter has exceeded its maximum allowed operating temperature. See page 56.	Allow the inverter to remain off to reduce the temperature, or add external cooling.
Comm Fault	The inverter has suffered an internal communication failure.	Unit may be damaged and requires repair.
Loose DC Neg Terminals	Loose DC connection on internal power module.	Tighten all DC connections between inverter and battery. If the error is not resolved, unit may be damaged and requires repair.
Battery Voltage Sense	Internal sensing has detected battery voltages below 8 Vdc or above 18 Vdc for a 12-volt model (or equivalent for higher-voltage models).	If these readings are not correct, unit may be damaged and requires repair.
AC Relay Fault	AC transfer relay damaged.	Unit may be damaged and requires repair.

[2] This error will clear automatically when the cause of the error is resolved. The inverter will begin functioning again when this occurs.

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Warning Messages

A warning message is caused by a non-critical fault. When this occurs, the **ERROR** indicator will flash, although the inverter will not shut down. (See page 13 for the inverter's LED indicators.) The MATE3S system display will show an event and a specific warning message. This is viewed using the ***Home*** screen's soft keys. (See system display literature for more instructions.) One or more messages will display ***Y*** (yes). If a message says ***N*** (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 page 57.)

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

Table 10 Warning Troubleshooting

Message	Definition	Possible Remedy
AC Freq Too High	The AC source is above the upper acceptable frequency limit and prevents connection.	Check the AC source. If it is a generator, reduce its speed.
AC Freq Too Low	The AC source is below the lower acceptable frequency limit and prevents connection.	Check the AC source. If it is a generator, increase its speed.
Voltage Too High	The AC source is above the upper acceptable voltage limit and prevents connection.	Check the AC source. The inverter's acceptance range is adjustable. **NOTE:** Adjusting the range may accommodate a problematic AC source, but it will not fix it.
Voltage Too Low	The AC source is below the lower acceptable voltage limit and prevents connection.	Check the AC source. Check the AC wiring. The inverter's acceptance range is adjustable. **NOTE:** Adjusting the range may accommodate a problematic AC source, but it will not fix it.
Input Amps > Max	AC loads are drawing more current from the AC source than allowed by the input setting.	Check the loads. Oversized loads can open circuit breakers. If they exceed the inverter's transfer relay size, the relay can be damaged. This issue is usually the result of a poorly-sized load, as opposed to a wiring problem.
Temp Sensor Bad	An internal inverter temperature sensor may be malfunctioning. One of the three internal sensor meters may give an unusual reading.	In the system display, the three readings are labeled ***Transformer, Output FETs,*** and ***Capacitors***. These values are given in degrees Celsius. See next page.
Phase Loss	A slave or subphase master inverter was ordered to transfer to an AC source by the master, but the AC source is the wrong phase or no AC source is present.	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 and requires repair.

Table 10 Warning Troubleshooting

Message	Definition	Possible Remedy
Fan Failure	The inverter's internal cooling fan is not operating properly. Lack of cooling may result in derated inverter output wattage.	Turn the battery disconnect off, and then on, to determine if the fan self-tests. If it does not, the unit may be damaged and requires repair. **NOTE:** The system can continue to operate if the inverter can be run at reasonable levels. External cooling may also be applied.
Transformer (in ***Temps*** screen)	Displays the ambient temperature around the inverter's transformer.	In a MATE3S system display, these values are given in degrees Celsius. If any reading does not seem to reflect the inverter's temperature or conditions, the unit may be damaged and requires repair.
Output FETs (in ***Temps*** screen)	Displays the temperature of the FETs (Field Effect Transistors) and heat sink.	
Capacitors (in ***Temps*** screen)	Displays the temperature of the inverter's ripple capacitors.	

Temperature Events

As shown in Table 10, the ***Inverter Warnings*** screen has an ***Inverter Temps*** selection for three internal temperature readings. These readings can affect inverter operations in high temperatures. Table 11 shows the temperature limits used by each sensor and the effects on inverter operations.

Table 11 Inverter Temps

Effect	Temperature Reading		
	Transformer	***Output FETs***	***Capacitors***
Over Temperature error	>125°C	>95°C	>95°C
Reduced charging or selling	=120°C	=90°C	=90°C
Fan turns on	>60°C	>60°C	>60°C
Fan turns off	<50°C	<50°C	<50°C

GT Warnings

This screen is also available under ***Inverter Warnings***. The GT (grid-tie) warnings in Table 12 indicate why a grid-interactive inverter has stopped selling. These warnings are caused when the grid exceeds one of the settings in the ***Grid Interface Protection*** menu. A ***GT Warning*** may accompany a ***Disconnect*** message (see Table 13) or a regular warning (see Table 10), depending on conditions.

Table 12 GT Warnings

Message	Definition
AC Freq Too High	The AC source has exceeded ***Grid Interface Protection*** frequency levels.
AC Freq Too Low	The AC source has dropped below ***Grid Interface Protection*** frequency levels.
Voltage Too High	The AC source has exceeded ***Grid Interface Protection*** voltage levels.
Voltage Too Low	The AC source has dropped below ***Grid Interface Protection*** voltage levels.

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Disconnect Messages

Disconnect messages explain why the inverter has disconnected from an AC source after previously being connected. The unit returns to inverting mode if turned on. The ***Last AC Disconnect*** screen is viewed using the **AC INPUT** hot key on the MATE3S system display. One or more messages will display ***Y*** (yes). If a message says ***N*** (no), it is not the cause of the disconnection. The system display may generate a concurrent event and warning message following the disconnection. (See page 55.) If the AC source is removed, the warning will be blank, but the cause of the last disconnection will remain.

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

The reasons shown in the ***Sell Status*** menu for ceasing to sell power (see next page) may be the same as disconnect messages. If the **Grid Interface Protection** settings are exceeded (see page 19), the inverter will disconnect from the utility grid. Table 13 shows the primary seven reasons for disconnection.

Table 13 Disconnect Troubleshooting

Message	Definition	Possible Remedy
Frequency Too High	The AC source has exceeded acceptable frequency levels.	Check AC source. If it is a generator, reduce speed.
Frequency Too Low	The AC source has dropped below acceptable frequency levels.	Check AC source. If it is a generator, increase speed.
Voltage > Maximum	The AC source has exceeded acceptable voltage levels.	Check AC source. The inverter's acceptance range is adjustable. **NOTE:** Adjusting the range may accommodate a problematic AC source, but it will not fix it.
Voltage < Minimum	The AC source has dropped below acceptable voltage levels.	Check AC source. The inverter's acceptance range is adjustable. **NOTE:** Adjusting the range may accommodate a problematic AC source, but it will not fix it.
Backfeed	Usually indicates that another AC power source (out of phase with the inverter) was connected to the AC output. Can also occur if an out-of-phase AC source is connected to the AC input.	Disconnect the **AC OUT** wires. Check the wires (not the inverter) with an AC voltmeter. If an AC source is present, shut it off. (This is more often accompanied by an ***AC Output Backfeed*** error.) Check input source and wiring. This can be caused by a source with phase problems.
Phase Lock	The unit cannot remain in phase with an erratic AC source.	Check AC source. This can be caused by a generator with a poorly regulated output. Some generators perform this way when low on fuel. If necessary, use the ***Generator*** input mode. (See page 16.)
Island Detect	The grid seems to be present but normal grid conditions are not detected. This can occur if the inverter's input is powered by another inverter instead of the grid. It may be the result of an open main disconnect.	Check all input disconnects or circuit breakers for an open circuit. Check for any other inverters installed in the system and disable them. This may (rarely) occur with a generator. If necessary, use the ***Generator*** input mode. (See page 16.)

Sell Status

Sell Status messages describe conditions relating to the inverter's grid-interactive mode. This is viewed using the ***Home*** screen's soft keys on the MATE3S system display. (See system display literature for more instructions.) One or more messages will display ***Y*** (yes). If a message says ***N*** (no), it is not the cause of the disconnection.

If the inverter has stopped selling or charging unexpectedly, this screen may identify the reason. More often these messages are used by a normally functioning inverter to identify external conditions that are preventing selling or charging. (If nothing has stopped, the messages will indicate that as well.)

The acceptable limits for AC source voltage and frequency are controlled by the **Grid Interface Protection** settings, which are shown in the default menus beginning on page 68. If the AC source exceeds these limits, the inverter will stop selling and display the appropriate code. (At the same time it will disconnect from the utility grid, with an appropriate message as shown in Table 13 on page 57.) After the source returns to the acceptable range, the screen will begin its reconnection timer (with a default setting of five minutes). When the timer expires, the inverter will reconnect to the utility grid and begin selling power again.

If the AC source is unstable, it may become unacceptable before the timer expires. This may 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 message will still appear on the system display for a short time to help troubleshoot the problem.

Additionally, undersized wires or bad connections can result in local voltage problems. If a ***Voltage Too Low*** or ***Voltage Too High*** message is accompanied by voltage changes that do not appear at the main utility connection, check the wiring.

Table 14 Sell Status Messages

Sell Status	Definition
Selling Disabled	The ***Grid-Tie Enable*** command has been set to ***N*** (no).
Qualifying Grid	All utility grid conditions are acceptable. The inverter is running a timed test during which it confirms the grid quality. The timer is shown on the screen. At the end of that time, the inverter may be ready to sell.
Frequency Too Low	The utility grid's AC frequency is below the acceptable range for selling.
Frequency Too High	The utility grid's AC frequency is above the acceptable range for selling.
Voltage Too Low	The utility grid's AC voltage is below the acceptable range for selling.
Voltage Too High	The utility grid's AC voltage is above the acceptable range for selling.
Battery < Target	The battery voltage is below the target voltage for that stage (Float, Selling, etc.). No excess energy is available to sell.

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Specifications

Electrical Specifications

NOTE: Items qualified with “default” can be manually changed using the system display.

Table 15 Electrical Specifications for 12-Volt FXR Models

Specification	FXR2012E	VFXR2612E
Continuous Output Power at 25°C	2000 VA	2800 VA
Continuous AC Output Current at 25°C	Up to 8.7 Aac	Up to 11.3 Aac
AC Output Voltage (default)	230 Vac	230 Vac
AC Output Frequency (default)	50 Hz	50 Hz
AC Output Type	Single-phase	Single-phase
AC Waveform	True Sinewave	True Sinewave
Typical Efficiency	90%	90%
Total Harmonic Distortion (maximum)	< 5%	< 5%
Harmonic Distortion (maximum single voltage)	< 2%	< 2%
AC Output Voltage Regulation	± 2.5%	± 2.5%
Appliance Protective Class (IEC)	Class I	Class I
Power Factor	–1 to 1	–1 to 1
Inrush Current	None	None
AC Maximum Output Current (1 ms peak)	28 Aac	28 Aac
AC Maximum Output Current (100 ms RMS)	20 Aac	20 Aac
AC Overload Capability (100 ms surge)	4600 VA	4600 VA
AC Overload Capability (5 second)	4300 VA	4300 VA
AC Overload Capability (30 minute)	2500 VA	3100 VA
AC Maximum Output Fault Current and Duration	28.3 Aac for 0.636 seconds	28.3 Aac for 0.636 seconds
Power Consumption (idle) – Invert mode, no load	≈ 34 watts	≈ 34 watts
Power Consumption (idle) – Search mode	9 watts	9 watts
Power Consumption – Off	3 watts	3 watts
AC Input Voltage Range	170 to 290 Vac	170 to 290 Vac
AC Input Frequency Range	45 to 55 Hz at 50-Hz setting 54 to 66 Hz at 60-Hz setting	45 to 55 Hz at 50-Hz setting 54 to 66 Hz at 60-Hz setting
AC Input Current (maximum continuous)	30 Aac	30 Aac
Grid-Interactive Voltage Range (default)	—	—
Grid-Interactive Frequency Range (default)	—	—
DC Input Voltage (nominal)	12 Vdc	12 Vdc
DC Input Voltage Range	10.5 to 17 Vdc	10.5 to 17 Vdc
DC Maximum Input Voltage	17 Vdc	17 Vdc
DC Input Power (continuous)	2.4 kVA	3.12 kVA
DC Input Maximum Current (continuous full power)	200 Adc	260 Adc
DC Input Maximum Current (surge)	460 Adc	460 Adc
DC Input Maximum Current (short-circuit)	1891 Adc for 0.105 seconds	1891 Adc for 0.105 seconds
Battery Charger Maximum AC Input	5 Aac	6 Aac
Battery Charger Maximum DC Output	100 Adc	120 Adc
DC Output Voltage Range (charging)	11 to 17 Vdc	11 to 17 Vdc
Auxiliary Output	0.7 Adc at 12 Vdc	0.7 Adc at 12 Vdc

Table 16 Electrical Specifications for 24-Volt FXR Models

Specification	FXR2024E	VFXR3024E
Continuous Output Power at 25°C	2000 VA	3000 VA
Continuous AC Output Current at 25°C	8.7 Aac	13 Aac
AC Output Voltage (default)	230 Vac	230 Vac
AC Output Frequency (default)	50 Hz	50 Hz
AC Output Type	Single-phase	Single-phase
AC Waveform	True Sinewave	True Sinewave
Typical Efficiency	92%	92%
Total Harmonic Distortion (maximum)	< 5%	< 5%
Harmonic Distortion (maximum single voltage)	< 2%	< 2%
AC Output Voltage Regulation	± 2.5%	± 2.5%
Appliance Protective Class (IEC)	Class I	Class I
Power Factor	–1 to 1	–1 to 1
Inrush Current	None	None
AC Maximum Output Current (1 ms peak)	35 Aac	35 Aac
AC Maximum Output Current (100 ms RMS)	25 Aac	25 Aac
AC Overload Capability (100 ms surge)	5750 VA	5750 VA
AC Overload Capability (5 second)	5175 VA	5175 VA
AC Overload Capability (30 minute)	3100 VA	3300 VA
AC Maximum Output Fault Current and Duration	36 Aac for 0.636 seconds	36 Aac for 0.636 seconds
Power Consumption (idle) – Invert mode, no load	≈ 34 watts	≈ 34 watts
Power Consumption (idle) – Search mode	9 watts	9 watts
Power Consumption – Off	3 watts	3 watts
AC Input Voltage Range	170 to 290 Vac	170 to 290 Vac
AC Input Frequency Range	45 to 55 Hz at 50-Hz setting 54 to 66 Hz at 60-Hz setting	45 to 55 Hz at 50-Hz setting 54 to 66 Hz at 60-Hz setting
AC Input Current (maximum continuous)	30 Aac	30 Aac
Grid-Interactive Voltage Range (default)	208 to 252 Vac	208 to 252 Vac
Grid-Interactive Frequency Range (default)	47 to 51 Hz	47 to 51 Hz
DC Input Voltage (nominal)	24 Vdc	24 Vdc
DC Input Voltage Range	21 to 34 Vdc	21 to 34 Vdc
DC Maximum Input Voltage	34 Vdc	34 Vdc
DC Input Power (continuous)	2.4 kVA	3.6 kVA
DC Input Maximum Current (continuous full power)	100 Adc	150 Adc
DC Input Maximum Current (surge)	287.5 Adc	287.5 Adc
DC Input Maximum Current (short-circuit)	1891 Adc for 0.105 seconds	1891 Adc for 0.105 seconds
Battery Charger Maximum AC Input	5 Aac	9 Aac
Battery Charger Maximum DC Output	55 Adc	80 Adc
DC Output Voltage Range (charging)	21 to 34 Vdc	21 to 34 Vdc
Auxiliary Output	0.7 Adc at 12 Vdc	0.7 Adc at 12 Vdc

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Table 17 Electrical Specifications for 48-Volt FXR Models

Specification	FXR2348E	VFXR3048E
Continuous Output Power at 25°C	2300 VA	3600 VA
Continuous AC Output Current at 25°C	10 Aac	13 Aac
AC Output Voltage (default)	230 Vac	230 Vac
AC Output Frequency (default)	50 Hz	50 Hz
AC Output Type	Single-phase	Single-phase
AC Waveform	True Sinewave	True Sinewave
Typical Efficiency	93%	93%
Total Harmonic Distortion (maximum)	< 5%	< 5%
Harmonic Distortion (maximum single voltage)	< 2%	< 2%
AC Output Voltage Regulation	± 2.5%	± 2.5%
Appliance Protective Class (IEC)	Class I	Class I
Power Factor	–1 to 1	–1 to 1
Inrush Current	None	None
AC Maximum Output Current (1 ms peak)	35 Aac	35 Aac
AC Maximum Output Current (100 ms RMS)	25 Aac	25 Aac
AC Overload Capability (100 ms surge)	5750 VA	5750 VA
AC Overload Capability (5 second)	5175 VA	5175 VA
AC Overload Capability (30 minute)	3100 VA	3300 VA
AC Maximum Output Fault Current and Duration	36 Aac for 0.636 seconds	36 Aac for 0.636 seconds
Power Consumption (idle) – Invert mode, no load	≈ 34 watts	≈ 34 watts
Power Consumption (idle) – Search mode	9 watts	9 watts
Power Consumption – Off	3 watts	3 watts
AC Input Voltage Range	170 to 290 Vac	170 to 290 Vac
AC Input Frequency Range	45 to 55 Hz at 50-Hz setting 54 to 66 Hz at 60-Hz setting	45 to 55 Hz at 50-Hz setting 54 to 66 Hz at 60-Hz setting
AC Input Current (maximum continuous)	30 Aac	30 Aac
Grid-Interactive Voltage Range (default)	208 to 252 Vac	208 to 252 Vac
Grid-Interactive Frequency Range (default)	47 to 51 Hz	47 to 51 Hz
DC Input Voltage (nominal)	48 Vdc	48 Vdc
DC Input Voltage Range	42 to 68 Vdc	42 to 68 Vdc
DC Maximum Input Voltage	68 Vdc	68 Vdc
DC Input Power (continuous)	2.7 kVA	3.6 kVA
DC Input Maximum Current (continuous full power)	57.5 Adc	75 Adc
DC Input Maximum Current (surge)	143.75 Adc	143.75 Adc
DC Input Maximum Current (short-circuit)	1891 Adc for 0.105 seconds	1891 Adc for 0.105 seconds
Battery Charger Maximum AC Input	5 Aac	9 Aac
Battery Charger Maximum DC Output	35 Adc	40 Adc
DC Output Voltage Range (charging)	42 to 68 Vdc	42 to 68 Vdc
Auxiliary Output	0.7 Adc at 12 Vdc	0.7 Adc at 12 Vdc

Mechanical Specifications

Table 18 Mechanical Specifications for FXR Models

Specification	FXR2012E, FXR2024E, and FXR2348E	VFXR2612E, VFXR3024E, and VFXR3048E
Inverter Dimensions (H × W × D)	13 × 8.25 × 16.25" (33 × 21 × 41 cm)	12 × 8.25 × 16.25" (30 × 21 × 41 cm)
Shipping Dimensions (H × W × L)	21.75 × 13 × 22” (55 × 33 × 56 cm)	21.75 × 13 × 22” (55 × 33 × 56 cm)
Inverter Weight	62 lb (29 kg)	61 lb (28 kg)
Shipping Weight	67 lb (30 kg)	67 lb (30 kg)
Accessory Ports	RJ11 (batt temp) and RJ45 (remote)	RJ11 (batt temp) and RJ45 (remote)
Non-volatile Memory	Yes	Yes
Neutral-Ground Bond Switching	No	No
Chassis Type	Sealed	Vented

Environmental Specifications

Table 19 Environmental Specifications for all FXR Models

Specification	Value
Rated Temperature Range (meets component specifications; however, please note that the inverter output wattage is derated above 25°C)	–4°F to 122°F (–20°C to 50°C)
Operational Temperature Range (functions, but not rated for operation; does not necessarily meet all component specifications)	–40°F to 140°F (–40°C to 60°C)
Storage Temperature Range	–40°F to 140°F (–40°C to 60°C)
IP (Ingress Protection) Rating of Enclosure	IP20
Environmental Category	Indoor unconditioned
Wet Locations Classification	Wet locations: No
Relative Humidity Rating	93%
Pollution Degree Classification	PD 2
Maximum Altitude Rating	6561’ (2000 m)
Overvoltage Category (AC Input)	3
Overvoltage Category (DC Input)	1

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Temperature Derating

All FXR inverters can deliver their full rated wattage at temperatures up to 25°C (77°F). The FXR maximum wattage is rated less in higher temperatures. Above 25°C, each inverter model is derated by a factor of 1% of that model's rated wattage for every increase of 1°C. This derating applies to all power conversion functions (inverting, charging, selling, offsetting, etc.)

Figure **12** is a graph of wattage over temperature, showing the decrease in rated wattage with increased temperature. The graph ends at 50°C (122°F) because the FXR inverter is not rated for operation above that temperature.

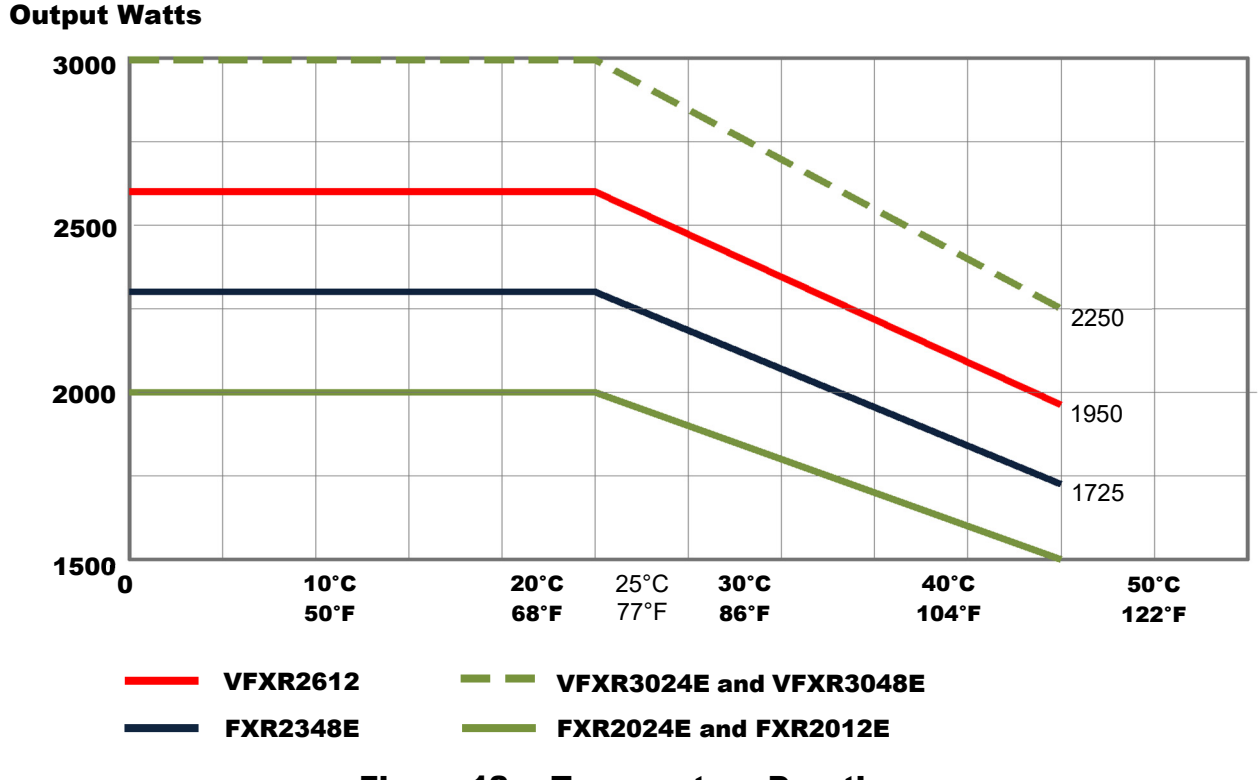

Figure 12 Temperature Derating

Regulatory Specifications

Directives

This product meets the following directives.

- RoHS: Directive 2011/65/EU — "The restriction of the use of certain substances in electrical and electronic equipment"
- LVD: 2006/95/EC — "Electrical equipment designed for use within certain voltage limits"
- EMC: 2004/10B/EC — Electromagnetic Compatibility

Certifications

This product has been certified by ETL to meet the following standards:

- IEC 62109-1:2010 and IEC 62109-2:2011 — Safety of Power Converters for use in Photovoltaic Systems

Models FXR2024E, VFXR3024E, FXR2348E, and VFXR3048E are certified to the following:

- AS4777.2:2015 — Grid Connection of Energy Systems via Inverters

CE 13

Compliance

- EN 61000-3-3 — EMC Standard: Limitation of Voltage Changes, Voltage Fluctuations, and Flicker in Public Low-Voltage Supply Systems
- EN 61000-6-1 — EMC Standard: Immunity for Residential, Commercial, and Light-Industrial Environments
- EN 61000-6-3 — EMC Standard: Emissions for Residential, Commercial, and Light-Industrial Environments
- ABNT 16149:2013 — Photovoltaic (PV) Systems

Specification Conformity

These inverter/charger models conform to AS4777.2 for single-inverter installations only.

These inverter/charger models have grid-interactive functions. All models are tested to comply with certain limits for acceptable output voltage ranges, acceptable output frequency, total harmonic distortion (THD) and anti-islanding performance when the inverter exports power to a utility source. The inverter/charger models listed in this document 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 FXR inverter exceeds the minimum power factor of 0.85 with a typical power factor of 0.96 or better.

The reconnection delay has a default setting of 5 minutes. The grid-interactive default settings are shown in the ***Grid Interface Protection Menu*** portion of Table 23 on page 70.

The ***Grid Interface Protection*** settings are adjustable. However, this is only available to operators with installer-level access. The reason for this limitation is that there are firm rules concerning the acceptable voltage range, frequency range, clearance time during power loss, and reconnect delay when exporting power back to the utility. The rules differ in different locations around the world, although generally it is expected that the settings cannot be altered by the end user. For this reason, the installer password must be changed from the default to get access to these settings.

See the ***Grid Tied*** function on page 18 for more information.

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Summary of Operating Limits

Severe conditions cause the inverter to limit its output or shut down for protection. The most common conditions are high voltage, low voltage, and temperature. The limits for these conditions are summarized in Table 20. See pages 54 and 56 for more information on these conditions and the warning or error messages which accompany them.

Table 20 Operating Limits for all FXR Models

Voltage Limits		**12-Volt Model**		**24-Volt Model**		**48-Volt Model**	
Limit	**Adjustable**	**Off**	**On**	**Off**	**On**	**Off**	**On**
High Battery	No	>17 Vdc	<17 Vdc	>34 Vdc	<34 Vdc	>68 Vdc	<68 Vdc
Low Battery (default)	Yes	>10.5 Vdc	<12.5 Vdc	>21.0 Vdc	<25.0 Vdc	>42.0 Vdc	<50.0 Vdc
Temperature Limits							
Limit		***Transformer***		***Output FETs***		***Capacitors***	
Over Temperature error		<125°C	>125°C	<95°C	>95°C	<95°C	>95°C
Reduced charging or selling		>120°C		>90°C		>90°C	
Internal Fan		<50°C	>60°C	<50°C	>60°C	<50°C	>60°C

Limiting Charge Current (Multiple Inverters)

It is not advisable to set ***Charger AC Limit*** less than 6 Aac in a stacked system. The **Power Save** function requires the master to activates the slave chargers in sequence only when the charge current exceeds 5 Aac. If the setting is less than 6, **Power Save** will not activate any other chargers. For more information on this function, see the **Power Save** section of the *FXR International Series Inverter/Charger Installation Manual*.

When the ***Charger AC Limit*** setting is 6 Aac or more, other active chargers add the same amount to the total. The total current equals the ***Charger AC Limit*** setting times the number of active chargers. In some systems, lower currents may be required due to battery bank size or other reasons. To achieve lower currents, chargers can be individually set to ***Off*** so that the master inverter does not activate them. (The global ***Charger Control On*** only enables inverters not individually set to ***Off***.) Combining the charger limit settings with a reduced number of chargers allows better control over the current.

In Table 21**, Max Charge Adc** shows examples of DC charging values which may be recommended for a battery bank. **Aac** converts these values into AC amperes.

In Table 21**, On** provides recommendations for the smallest number of chargers in operation. **Set** recommends the inverter ***Charger AC Limit*** setting. Note that this table specifies the number of chargers to leave **on**. This will achieve the closest possible charging output to the **Aac** number without exceeding it.[3] All other chargers should be turned off using ***Charger Control***. (See the menu tables beginning on page 68 to locate this command in the menu structure.)

The lowest Adc figures in this table allow for a single inverter to perform all charging. All other inverters would be turned off. The highest Adc figures are for the maximum of ten stacked chargers.

The recommended settings ensure the charging will not exceed a designated current. The amount is likely to be less.

[3] Although the calculations used to create Table 15 give the closest safe outputs, certain numbers may be much lower than the **Max Charge Adc** item. This is due to charger limitations.

To determine the chargers and settings using Table 21:

1. Obtain the battery bank's maximum charge current (in Adc) from the battery manufacturer.
2. Locate the closest number to this amount (rounded down) on Table 21.
3. Read across to the entry for the appropriate inverter model.
4. Adjust the master inverter's ***Charger AC Limit*** setting to the designated amount (in Aac).
5. Turn off the chargers for all inverters that exceed the number shown as ***On***.

   In a stacked system (using the HUB communications manager), chargers on higher-numbered HUB ports should be turned off first. Slave chargers should be turned off before turning off any subphase masters.

Table 21 Chargers On and Current Settings

Max Charge Adc	FXR2012E			VFXR2612E			FXR2024E			VFXR3024E			FXR2348E			VFXR3048E		
	Aac	On	Set	Aac	On	Set	Aac	On	Set	Aac	On	Set	Aac	On	Set	Aac	On	Set
40	2	1	2	3	1	3	5	1	5	5	1	5	8	1	7	10	1	10
60	4	1	4	4	1	4	7	1	7	7	1	7	12	2	6	15	2	7
80	5	1	5	6	1	6	10	1	7	10	1	10	16	2	7	20	2	10
100	7	1	7	7	1	7	12	2	6	12	2	6	20	3	6	25	3	8
120	8	1	7	9	1	9	15	2	7	15	2	7	24	4	6	30	3	10
140	9	1	7	10	1	9	17	2	7	17	2	8	28	4	7	35	4	8
160	11	1	7	12	2	6	20	3	6	20	2	10	32	5	6	40	4	10
180	12	2	6	13	2	6	22	3	7	22	3	7	36	5	7	45	5	9
200	14	2	7	15	2	7	25	4	6	25	3	8	40	6	6	50	5	10
220	15	2	7	16	2	8	28	4	7	27	3	9	44	6	7	55	6	9
240	16	2	7	18	2	9	30	4	7	30	3	10	48	6	7	60	6	10
260	18	3	6	19	3	6	33	5	6	32	4	8	52	7	7	65	7	9
280	19	3	6	21	3	7	35	5	7	35	4	8	56	8	7	70	7	10
300	21	3	7	22	3	7	38	5	7	37	4	9	60	8	7	75	8	9
335	23	3	7	25	3	8	42	6	7	41	4	10	67	9	7	83	8	10
370	25	4	6	27	3	9	47	6	7	46	5	9	74	10	7	92	9	10
400	28	4	7	30	4	7	50	7	7	50	5	10	---	---	---	100	10	10
435	30	5	6	32	4	8	55	7	7	54	6	9	---	---	---	---	---	---
470	32	5	6	35	4	8	59	8	7	58	6	9	---	---	---	---	---	---
500	35	5	7	37	4	9	63	9	7	62	6	10	---	---	---	---	---	---
535	37	6	6	40	5	8	68	9	7	66	7	9	---	---	---	---	---	---
570	39	6	6	42	5	8	72	10	7	71	7	10	---	---	---	---	---	---
600	42	6	7	45	5	9	---	---	---	75	8	9	---	---	---	---	---	---
640	44	6	7	48	6	8	---	---	---	80	8	10	---	---	---	---	---	---
680	47	6	7	51	6	8	---	---	---	85	9	9	---	---	---	---	---	---
720	50	7	7	54	6	9	---	---	---	90	9	10	---	---	---	---	---	---
760	53	7	7	57	7	8	---	---	---	95	9	10	---	---	---	---	---	---
800	56	8	7	60	7	8	---	---	---	100	10	10	---	---	---	---	---	---
840	58	8	7	63	7	9	---	---	---	---	---	---	---	---	---	---	---	---
880	61	8	7	66	8	8	---	---	---	---	---	---	---	---	---	---	---	---
920	64	9	7	69	8	8	---	---	---	---	---	---	---	---	---	---	---	---
960	67	9	7	72	8	9	---	---	---	---	---	---	---	---	---	---	---	---
1000	70	10	7	75	8	9	---	---	---	---	---	---	---	---	---	---	---	---
1050	---	---	---	78	8	9	---	---	---	---	---	---	---	---	---	---	---	---
1100	---	---	---	82	9	9	---	---	---	---	---	---	---	---	---	---	---	---
1150	---	---	---	86	9	9	---	---	---	---	---	---	---	---	---	---	---	---
1200	---	---	---	90	10	9	---	---	---	---	---	---	---	---	---	---	---	---

Calculating Limits

If other numbers are needed than those featured in Table 21, the results can be calculated. Do not use the calculations on page 33, due to charger efficiencies and other factors.

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To calculate the chargers and settings:

1. Look up the values for **A**, **B**, and **C**.

   A = the battery bank's maximum charge current (in Adc) from the battery manufacturer.

   B = the maximum DC output of the appropriate inverter model. This is taken from Table 22.

   C = the maximum AC input of the appropriate inverter model. This is taken from Table 22.

2. Select a value for D and perform the following calculation.

   D = the ***Charger AC Limit*** setting. This value must be 6 or higher. (See page 65.) A higher value uses fewer chargers and turns off all others. A lower value, or 6, leaves more chargers on.

3. Perform the following calculation.

$$\frac{A \times C}{B \times D} = E$$

E = the number of chargers to use. This number should be rounded down in all cases.

4. Adjust the master inverter's ***Charger AC Limit*** setting to equal **D**.
5. Turn off the chargers for all inverters that exceed **E**. In a system stacked on the HUB communications manager, chargers on higher-numbered ports should be turned off first. Chargers should be turned off by setting the ***Charger Control*** menu item to ***Off***. (See the menu tables beginning on page 68 to locate this command in the menu structure.)

Table 22 Charge Currents for Calculations

Model	Maximum DC Output (sent to battery)	Maximum AC Input (used from source)
FXR2012E	100 Adc	7 Aac
VFXR2612E	120 Adc	9 Aac
FXR2024E	55 Adc	7 Aac
VFXR3024E	80 Adc	10 Aac
FXR2348E	35 Adc	7 Aac
VFXR3048E	40 Adc	10 Aac

Firmware Revision

This manual applies to inverter models with Revision 001.006.015 or higher.
Updates to the inverter's firmware are periodically available. These can be downloaded from www.outbackpower.com. 3

Default Settings and Ranges

NOTES: Certain items are retained at the present setting even when the inverter is reset to factory defaults. These items are noted with the letter "X" in the Item column.

Certain items, particularly those in the Auxiliary menus, share common set points. If one of these items is changed in a mode menu, all menus with this set point will show the same change.

Certain menus are only visible when the installer password is used, particularly the Grid Interface Protection menu. These menus are bordered in the table with a double line of this style: ═══

Table 23 FXR Settings for 12-Volt Models

Field	Item			Default	Minimum	Maximum
INVERTER Hot Key	**Inverter Mode**			***Off***	***On***, ***Off***, or ***Search***	
CHARGER Hot Key	**Charger Control**			***On***	***On*** or ***Off***	
AC Input Hot Key	**AC Input Mode**			***Use***	***Drop*** or ***Use***	
Search	***Sensitivity*** (see page 28 for increments)			30	0	200
	Pulse Length			8 AC Cycles	4 AC Cycles	20 AC Cycles
	Pulse Spacing			60 AC Cycles	4 AC Cycles	120 AC Cycles
AC Input and Current Limit	***Input Type***			***Grid***	***Grid*** or ***Gen***	
	Charger Control			***On***	***On*** or ***Off***	
	Grid Input AC Limit			30 Aac	2.5 Aac	30 Aac
	Gen Input AC Limit			30 Aac	2.5 Aac	30 Aac
	Charger AC Limit		FXR2012E	6 Aac	0 Aac	7 Aac
			VFXR2612E	8 Aac	0 Aac	9 Aac
Grid AC Input Mode and Limits	***Input Mode***			***Support***	***Generator, Support, UPS, Backup, Mini Grid, Grid Zero***	
	Voltage Limit Lower			208 Vac	170 Vac	230 Vac
	(Voltage Limit) ***Upper***			252 Vac	232 Vac	290 Vac
	Transfer Delay			1.0 second	0.12 seconds	4.0 seconds
	Connect Delay			0.2 minutes	0.2 minutes	25.0 minutes
	If ***Mini Grid*** mode is selected:	***Connect to Grid***		12.0 Vdc	11.0 Vdc	16.0 Vdc
		(Connect) ***Delay***		10 minutes	2 minutes	200 minutes
	If ***Grid Zero*** mode is selected:	***DoD Volts***		12.5 Vdc	11.0 Vdc	16.0 Vdc
		DoD Amps	FXR2012E	6 Aac	0.5 Aac	8 Aac
			VFXR2612E	6 Aac	0.5 Aac	11 Aac
Gen AC Input Mode and Limits	***Input Mode***			***Generator***	***Generator, Support, UPS, Backup, Mini Grid, Grid Zero***	
	Voltage Limit Lower			208 Vac	170 Vac	230 Vac
	(Voltage Limit) ***Upper***			252 Vac	232 Vac	290 Vac
	Transfer Delay			1.0 second	0.12 seconds	4.0 seconds
	Connect Delay			0.5 minutes	0.2 minutes	25.0 minutes
	If ***Mini Grid*** mode is selected:	***Connect to Grid***		12.0 Vdc	11.0 Vdc	16.0 Vdc
		(Connect) ***Delay***		10 minutes	2 minutes	200 minutes
	If ***Grid Zero*** mode is selected:	***DoD Volts***		12.5 Vdc	11.0 Vdc	16.0 Vdc
		DoD Amps	FXR2012E	6 Aac	0.5 Aac	8 Aac
			VFXR2612E	6 Aac	0.5 Aac	11 Aac
AC Output	***Output Voltage***		**X**	120 Vac	100 Vac	130 Vac
Low Battery	***Cut-Out Voltage***			10.5 Vdc	9.0 Vdc	12.0 Vdc
	Cut-In Voltage			12.5 Vdc	10.0 Vdc	14.0 Vdc

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Table 23 FXR Settings for 12-Volt Models

Field	Item		Default	Minimum	Maximum
Battery Charger	***Absorb Voltage***		14.4 Vdc	11.0 Vdc	16.0 Vdc
	(Absorb) ***Time***		1.0 hours	0.0 hours	24.0 hours
	Float Voltage		13.6 Vdc	11.0 Vdc	16.0 Vdc
	(Float) ***Time***		1.0 hours	0.0 hours	24/7
	Re-Float Voltage		12.5 Vdc	11.0 Vdc	16.0 Vdc
	Re-Bulk Voltage		12.0 Vdc	11.0 Vdc	16.0 Vdc
Battery Equalize	***Equalize Voltage***		14.6 Vdc	11.0 Vdc	17.0 Vdc
	(Equalize) ***Time***		1.0 hours	0.0 hours	24.0 hours
Auxiliary Output	***Aux Control***		***Auto***	***Off, Auto*** or ***On***	
	Aux Mode		***Vent Fan***	***Load Shed, Gen Alert, Fault, Vent Fan, Cool Fan, DC Divert, GT Limits, Source Status, AC Divert***	
	(Load Shed) ***ON: Batt >***		14.0 Vdc	10.0 Vdc	18.0 Vdc
	(Load Shed ON) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(Load Shed) ***OFF: Batt <***		11.0 Vdc	10.0 Vdc	18.0 Vdc
	(Load Shed OFF) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(Gen Alert) ***ON: Batt <***		11.0 Vdc	10.0 Vdc	18.0 Vdc
	(Gen Alert ON) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(Gen Alert) ***OFF: Batt >***		14.0 Vdc	10.0 Vdc	18.0 Vdc
	(Gen Alert OFF) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(Vent Fan) ***ON: Batt >***		14.0 Vdc	10.0 Vdc	18.0 Vdc
	(Vent Fan) ***Off Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(DC Divert) ***ON: Batt >***		14.0 Vdc	10.0 Vdc	18.0 Vdc
	(DC Divert ON) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(DC Divert) ***OFF: Batt <***		11.0 Vdc	10.0 Vdc	18.0 Vdc
	(DC Divert OFF) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(AC Divert) ***ON: Batt >***		14.0 Vdc	10.0 Vdc	18.0 Vdc
	(AC Divert ON) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(AC Divert) ***OFF: Batt <***		11.0 Vdc	10.0 Vdc	18.0 Vdc
	(AC Divert OFF) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
Inverter Stacking	***Stack Mode***		***Master***	***Master, Slave, B Phase Master, C Phase Master***	
Power Save Ranking	Mode = ***Master***:	***Master Power Save Level***	0	0	10
	Mode = ***Slave***:	***Slave Power Save Level***	1	1	10
Grid-Tie Sell	***Offset Enable***		***Y***	***Y*** or ***N***	
	Sell Voltage		13.0 Vdc	11.0 Vdc	16.0 Vdc
Calibrate	***AC Input Voltage***	X	0 Vac	–7 Vac	7 Vac
	AC Output Voltage	X	0 Vac	–7 Vac	7 Vac
	Battery Voltage	X	0.0 Vdc	–0.2 Vdc	0.2 Vdc
Grid Interface Protection Menu					
Operating Frequency	***Operating Frequency***	X	50 Hz	50 Hz, 60 Hz	
Stage 1 Voltage Trip[4]	***Over Voltage Clearance Time***	X	1.5 seconds	0.12 seconds	4.0 seconds
	Over Voltage Trip	X	252 Vac	240 Vac	300 Vac
	Under Voltage Clearance Time	X	2.0 seconds	0.12 seconds	4.0 seconds
	Under Voltage Trip	X	208 Vac	160 Vac	240 Vac
Stage 2 Voltage Trip[4]	***Over Voltage Clearance Time***	X	0.2 seconds	0.12 seconds	4.0 seconds
	Over Voltage Trip	X	264 Vac	240 Vac	300 Vac
	Under Voltage Clearance Time	X	0.16 seconds	0.12 seconds	4.0 seconds
	Under Voltage Trip	X	196 Vac	160 Vac	240 vac

[4] The grid-interactive function is not available in 12-volt models. Adjusting these items will not affect operation.

Table 23 FXR Settings for 12-Volt Models

Field	Item			Default	Minimum	Maximum
Frequency Trip	*Over Frequency Clearance Time*		X	0.16 seconds	0.12 seconds	5.0 seconds
	Over Frequency Trip	60-Hz system	X	60.5 Hz	60.1 Hz	65.0 Hz
		50-Hz system		50.5 Hz	50.1 Hz	55.0 Hz
	Under Frequency Clearance Time		X	0.16 seconds	0.12 seconds	5.0 seconds
	Under Frequency Trip	60-Hz system	X	59.3 Hz	55.0 Hz	59.9 Hz
		50-Hz system		49.3 Hz	45.0 Hz	49.9 Hz
Mains Loss	*Clearance Time*		X	2.0 seconds	1.0 seconds	25.0 seconds
	Reconnect Delay		X	60 seconds	2 seconds	302 seconds
Multi-Phase Coordination	*Coordin. AC Connect/Disconn.*			*N*	*Y* or *N*	
Sell Current Limit	*Maximum Sell Current*			*This selection inoperative in 12-volt models*		
Model Select			X	Vented	Vented or Sealed	
Reset to Factory Defaults						

Table 24 FXR Settings for 24-Volt Models

Field	Item			Default	Minimum	Maximum
INVERTER Hot Key	Inverter Mode			*Off*	*On*, *Off*, or *Search*	
CHARGER Hot Key	Charger Control			*On*	*On* or *Off*	
AC Input Hot Key	AC Input Mode			*Use*	*Drop* or *Use*	
Search	*Sensitivity* (see page 28 for increments)			30	0	200
	Pulse Length			8 AC Cycles	4 AC Cycles	20 AC Cycles
	Pulse Spacing			60 AC Cycles	4 AC Cycles	120 AC Cycles
AC Input and Current Limit	*Input Type*			*Grid*	*Grid* or *Gen*	
	Charger Control			*On*	*On* or *Off*	
	Grid Input AC Limit			30 Aac	2.5 Aac	30 Aac
	Gen Input AC Limit			30 Aac	2.5 Aac	30 Aac
	Charger AC Limit	FXR2024E		6 Aac	0 Aac	7 Aac
		VFXR3024E		9 Aac	0 Aac	10 Aac
Grid AC Input Mode and Limits	*Input Mode*			*Support*	*Generator, Support, Grid Tied, UPS, Backup, Mini Grid, Grid Zero*	
	Voltage Limit Lower			208 Vac	170 Vac	230 Vac
	(Voltage Limit) *Upper*			252 Vac	232 Vac	290 Vac
	Transfer Delay			1.0 second	0.12 seconds	4.0 seconds
	Connect Delay			0.2 minutes	0.2 minutes	25.0 minutes
	If *Mini Grid* mode is selected:	*Connect to Grid*		24.0 Vdc	22.0 Vdc	32.0 Vdc
		(Connect) *Delay*		10 minutes	2 minutes	200 minutes
	If *Grid Zero* mode is selected:	*DoD Volts*		25.0 Vdc	22.0 Vdc	32.0 Vdc
		DoD Amps	FXR2024E	6 Aac	0.5 Aac	10 Aac
			VFXR3024E	6 Aac	0.5 Aac	14 Aac
Gen AC Input Mode and Limits	*Input Mode*			*Generator*	*Generator, Support, Grid Tied, UPS, Backup, Mini Grid, Grid Zero*	
	Voltage Limit Lower			208 Vac	170 Vac	230 Vac
	(Voltage Limit) *Upper*			252 Vac	232 Vac	290 Vac
	Transfer Delay			1.0 second	0.12 seconds	4.0 seconds
	Connect Delay			0.5 minutes	0.2 minutes	25.0 minutes
	If *Mini Grid* mode is selected:	*Connect to Grid*		24.0 Vdc	22.0 Vdc	32.0 Vdc
		(Connect) *Delay*		10 minutes	2 minutes	200 minutes
	If *Grid Zero* mode is selected:	*DoD Volts*		25.0 Vdc	22.0 Vdc	32.0 Vdc
		DoD Amps	FXR2024E	6 Aac	0.5 Aac	10 Aac
			VFXR3024E	6 Aac	0.5 Aac	14 Aac
AC Output	*Output Voltage*		X	230 Vac	200 Vac	260 Vac

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Table 24 FXR Settings for 24-Volt Models

Field	Item		Default	Minimum	Maximum
Low Battery	***Cut-Out Voltage***		21.0 Vdc	18.0 Vdc	27.0 Vdc
	Cut-In Voltage		25.0 Vdc	20.0 Vdc	28.0 Vdc
Battery Charger	***Absorb Voltage***		28.8 Vdc	22.0 Vdc	32.0 Vdc
	(Absorb) ***Time***		1.0 hours	0.0 hours	24.0 hours
	Float Voltage		27.2 Vdc	22.0 Vdc	32.0 Vdc
	(Float) ***Time***		1.0 hours	0.0 hours	24/7
	Re-Float Voltage		25.0 Vdc	22.0 Vdc	32.0 Vdc
	Re-Bulk Voltage		24.0 Vdc	22.0 Vdc	32.0 Vdc
Battery Equalize	***Equalize Voltage***		29.2 Vdc	22.0 Vdc	34.0 Vdc
	(Equalize) ***Time***		1.0 hours	0.0 hours	24.0 hours
Auxiliary Output	***Aux Control***		***Auto***	***Off, Auto*** or ***On***	
	Aux Mode		***Vent Fan***	***Load Shed, Gen Alert, Fault, Vent Fan, Cool Fan, DC Divert, GT Limits, Source Status, AC Divert***	
	(Load Shed) ***ON: Batt >***		28.0 Vdc	20.0 Vdc	36.0 Vdc
	(Load Shed ON) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(Load Shed) ***OFF: Batt <***		22.0 Vdc	20.0 Vdc	36.0 Vdc
	(Load Shed OFF) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(Gen Alert) ***ON: Batt <***		22.0 Vdc	20.0 Vdc	36.0 Vdc
	(Gen Alert ON) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(Gen Alert) ***OFF: Batt >***		28.0 Vdc	20.0 Vdc	36.0 Vdc
	(Gen Alert OFF) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(Vent Fan) ***ON: Batt >***		28.0 Vdc	20.0 Vdc	36.0 Vdc
	(Vent Fan) ***Off Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(DC Divert) ***ON: Batt >***		28.0 Vdc	20.0 Vdc	36.0 Vdc
	(DC Divert ON) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(DC Divert) ***OFF: Batt <***		22.0 Vdc	20.0 Vdc	36.0 Vdc
	(DC Divert OFF) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(AC Divert) ***ON: Batt >***		28.0 Vdc	20.0 Vdc	36.0 Vdc
	(AC Divert ON) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
	(AC Divert) ***OFF: Batt <***		22.0 Vdc	20.0 Vdc	36.0 Vdc
	(AC Divert OFF) ***Delay***		0.5 minutes	0.1 minutes	25.0 minutes
Inverter Stacking	***Stack Mode***		***Master***	***Master, Slave, B Phase Master, C Phase Master***	
Power Save Ranking	Mode = ***Master***:	***Master Power Save Level***	0	0	10
	Mode = ***Slave***:	***Slave Power Save Level***	1	1	10
Grid-Tie Sell	***Offset Enable***		***Y***	***Y*** or ***N***	
	Sell Voltage		26.0 Vdc	22.0 Vdc	32.0 Vdc
Calibrate	***AC Input Voltage***	**X**	0 Vac	–7 Vac	7 Vac
	AC Output Voltage	**X**	0 Vac	–7 Vac	7 Vac
	Battery Voltage	**X**	0.0 Vdc	–0.4 Vdc	0.4 Vdc
Grid Interface Protection Menu					
Operating Frequency	***Operating Frequency***	**X**	50 Hz	50 Hz, 60 Hz	
Stage 1 Voltage Trip	***Over Voltage Clearance Time***	**X**	1.5 seconds	0.12 seconds	4.0 seconds
	Over Voltage Trip	**X**	252 Vac	240 Vac	300 Vac
	Under Voltage Clearance Time	**X**	1.5 seconds	0.12 seconds	4.0 seconds
	Under Voltage Trip	**X**	208 Vac	160 Vac	240 Vac

Table 24 FXR Settings for 24-Volt Models

Field	Item			Default	Minimum	Maximum
Stage 2 Voltage Trip	***Over Voltage Clearance Time***		X	0.2 seconds	0.12 seconds	4.0 seconds
	Over Voltage Trip		X	264 vac	240 Vac	300 Vac
	Under Voltage Clearance Time		X	0.2 seconds	0.12 seconds	4.0 seconds
	Under Voltage Trip		X	196 Vac	160 Vac	240 vac
Frequency Trip	***Over Frequency Clearance Time***		X	0.2 seconds	0.12 seconds	5.0 seconds
	Over Frequency Trip	60-Hz system	X	61.0 Hz	60.2 Hz	65.0 Hz
		50-Hz system		51.0 Hz	50.2 Hz	55.0 Hz
	Under Frequency Clearance Time		X	0.2 seconds	0.12 seconds	5.0 seconds
	Under Frequency Trip	60-Hz system	X	57.0 Hz	55.0 Hz	59.8 Hz
		50-Hz system		47.0 Hz	45.0 Hz	49.8 Hz
Mains Loss	***Clearance Time***		X	2.0 seconds	1.0 seconds	25.0 seconds
	Reconnect Delay		X	60 seconds	2 seconds	302 seconds
Multi-Phase Coordination	***Coordin. AC Connect/Disconn.***			***N***	***Y*** or ***N***	
Sell Current Limit	***Maximum Sell Current***	FXR2024E	X	10 Aac	2.5 Aac	10 Aac
		VFXR3024E		10 Aac	2.5 Aac	14 Aac
Model Select			X	Vented	Vented or Sealed	
Reset to Factory Defaults						

Table 25 FXR Settings for 48-Volt Models

Field	Item			Default	Minimum	Maximum
INVERTER Hot Key	**Inverter Mode**			***Off***	***On***, ***Off***, or ***Search***	
CHARGER Hot Key	**Charger Control**			***On***	***On*** or ***Off***	
AC Input Hot Key	**AC Input Mode**			***Use***	***Drop*** or ***Use***	
Search	***Sensitivity*** (see page 28 for increments)			30	0	200
	Pulse Length			8 AC Cycles	4 AC Cycles	20 AC Cycles
	Pulse Spacing			60 AC Cycles	4 AC Cycles	120 AC Cycles
AC Input and Current Limit	***Input Type***			***Grid***	***Grid*** or ***Gen***	
	Charger Control			***On***	***On*** or ***Off***	
	Grid Input AC Limit			30 Aac	5 Aac	55 Aac
	Gen Input AC Limit			30 Aac	5 Aac	55 Aac
	Charger AC Limit	FXR2348E		6 Aac	0 Aac	7 Aac
		VFXR3048E		9 Aac	0 Aac	10 Aac
Grid AC Input Mode and Limits	***Input Mode***			***Support***	***Generator, Support, Grid Tied, UPS, Backup, Mini Grid, Grid Zero***	
	Voltage Limit Lower			208 Vac	170 Vac	230 Vac
	(Voltage Limit) ***Upper***			252 Vac	232 Vac	290 Vac
	Transfer Delay			1.0 second	0.12 seconds	4.0 seconds
	Connect Delay			0.2 minutes	0.2 minutes	25.0 minutes
	If ***Mini Grid*** mode is selected:	***Connect to Grid***		48.0 Vdc	44.0 Vdc	64.0 Vdc
		(Connect) ***Delay***		10 minutes	2 minutes	200 minutes
	If ***Grid Zero*** mode is selected:	***DoD Volts***		50.0 Vdc	44.0 Vdc	64.0 Vdc
		DoD Amps	FXR2348E	6 Aac	0.5 Aac	12 Aac
			VFXR3048E	6 Aac	0.5 Aac	15 Aac
Gen AC Input Mode and Limits	***Input Mode***			***Generator***	***Generator, Support, Grid Tied, UPS, Backup, Mini Grid, Grid Zero***	
	Voltage Limit Lower			208 Vac	170 Vac	230 Vac
	(Voltage Limit) ***Upper***			252 Vac	232 Vac	290 Vac
	Transfer Delay			1.0 second	0.12 seconds	4.0 seconds

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Table 25 FXR Settings for 48-Volt Models

Field	Item				Default	Minimum	Maximum
Gen AC Input Mode and Limits (continued)	***Connect Delay***				0.5 minutes	0.2 minutes	25.0 minutes
	If ***Mini Grid*** mode is selected:	***Connect to Grid***			48.0 Vdc	44.0 Vdc	64.0 Vdc
		(Connect) ***Delay***			10 minutes	2 minutes	200 minutes
	If ***Grid Zero*** mode is selected:	***DoD Volts***			50.0 Vdc	44.0 Vdc	64.0 Vdc
		DoD Amps	FXR2348E		6 Aac	0.5 Aac	12 Aac
			VFXR3048E		6 Aac	0.5 Aac	15 Aac
AC Output	***Output Voltage***			**X**	230 Vac	200 Vac	260 Vac
Low Battery	***Cut-Out Voltage***				42.0 Vdc	36.0 Vdc	48.0 Vdc
	Cut-In Voltage				50.0 Vdc	40.0 Vdc	56.0 Vdc
Battery Charger	***Absorb Voltage***				57.6 Vdc	44.0 Vdc	64.0 Vdc
	(Absorb) ***Time***				1.0 hours	0.0 hours	24.0 hours
	Float Voltage				54.4 Vdc	44.0 Vdc	64.0 Vdc
	(Float) ***Time***				1.0 hours	0.0 hours	24/7
	Re-Float Voltage				50.0 Vdc	44.0 Vdc	64.0 Vdc
	Re-Bulk Voltage				48.0 Vdc	44.0 Vdc	64.0 Vdc
Battery Equalize	***Equalize Voltage***				58.4 Vdc	44.0 Vdc	68.0 Vdc
	(Equalize) ***Time***				1.0 hours	0.0 hours	24.0 hours
Auxiliary Output	***Aux Control***				***Auto***	***Off, Auto*** or ***On***	
	Aux Mode				***Vent Fan***	***Load Shed, Gen Alert, Fault, Vent Fan, Cool Fan, DC Divert, GT Limits, Source Status, AC Divert***	
	(Load Shed) ***ON: Batt >***				56.0 Vdc	40.0 Vdc	72.0 Vdc
	(Load Shed ON) ***Delay***				0.5 minutes	0.1 minutes	25.0 minutes
	(Load Shed) ***OFF: Batt <***				44.0 Vdc	40.0 Vdc	72.0 Vdc
	(Load Shed OFF) ***Delay***				0.5 minutes	0.1 minutes	25.0 minutes
	(Gen Alert) ***ON: Batt <***				44.0 Vdc	40.0 Vdc	72.0 Vdc
	(Gen Alert ON) ***Delay***				0.5 minutes	0.1 minutes	25.0 minutes
	(Gen Alert) ***OFF: Batt >***				56.0 Vdc	40.0 Vdc	72.0 Vdc
	(Gen Alert OFF) ***Delay***				0.5 minutes	0.1 minutes	25.0 minutes
	(Vent Fan) ***ON: Batt >***				56.0 Vdc	40.0 Vdc	72.0 Vdc
	(Vent Fan) ***Off Delay***				0.5 minutes	0.1 minutes	25.0 minutes
	(DC Divert) ***ON: Batt >***				56.0 Vdc	40.0 Vdc	72.0 Vdc
	(DC Divert ON) ***Delay***				0.5 minutes	0.1 minutes	25.0 minutes
	(DC Divert) ***OFF: Batt <***				44.0 Vdc	40.0 Vdc	72.0 Vdc
	(DC Divert OFF) ***Delay***				0.5 minutes	0.1 minutes	25.0 minutes
	(AC Divert) ***ON: Batt >***				56.0 Vdc	40.0 Vdc	72.0 Vdc
	(AC Divert ON) ***Delay***				0.5 minutes	0.1 minutes	25.0 minutes
	(AC Divert) ***OFF: Batt <***				44.0 Vdc	40.0 Vdc	72.0 Vdc
	(AC Divert OFF) ***Delay***				0.5 minutes	0.1 minutes	25.0 minutes
Inverter Stacking	***Stack Mode***				***Master***	***Master, Slave, B Phase Master, C Phase Master***	
Power Save Ranking	Mode = ***Master***:	***Master Power Save Level***			0	0	10
	Mode = ***Slave***:	***Slave Power Save Level***			1	1	10
Grid-Tie Sell	***Offset Enable***				***Y***	***Y*** or ***N***	
	Sell Voltage				52.0 Vdc	44.0 Vdc	64.0 Vdc
Calibrate	***AC Input Voltage***			**X**	0 Vac	–7 Vac	7 Vac
	AC Output Voltage			**X**	0 Vac	–7 Vac	7 Vac
	Battery Voltage			**X**	0.0 Vdc	–0.8 Vdc	0.8 Vdc

Table 25 FXR Settings for 48-Volt Models

Field	Item			Default	Minimum	Maximum
Grid Interface Protection Menu						
Operating Frequency	***Operating Frequency***		**X**	50 Hz	50 Hz, 60 Hz	
Stage 1 Voltage Trip	***Over Voltage Clearance Time***		**X**	1.5 seconds	0.12 seconds	4.0 seconds
	Over Voltage Trip		**X**	252 Vac	240 Vac	300 Vac
	Under Voltage Clearance Time		**X**	1.5 seconds	0.12 seconds	4.0 seconds
	Under Voltage Trip		**X**	208 Vac	160 Vac	240 Vac
Stage 2 Voltage Trip	***Over Voltage Clearance Time***		**X**	0.2 seconds	0.12 seconds	4.0 seconds
	Over Voltage Trip		**X**	264 vac	240 Vac	300 Vac
	Under Voltage Clearance Time		**X**	0.2 seconds	0.12 seconds	4.0 seconds
	Under Voltage Trip		**X**	196 Vac	160 Vac	240 vac
Frequency Trip	***Over Frequency Clearance Time***		**X**	0.16 seconds	0.12 seconds	5.0 seconds
	Over Frequency Trip	60-Hz system	**X**	61.0Hz	60.2 Hz	65.0 Hz
		50-Hz system		51.0 Hz	50.2 Hz	55.0 Hz
	Under Frequency Clearance Time		**X**	0.2 seconds	0.12 seconds	5.0 seconds
	Under Frequency Trip	60-Hz system	**X**	57.0 Hz	55.0 Hz	59.8 Hz
		50-Hz system		47.0 Hz	45.0 Hz	49.8 Hz
Mains Loss	***Clearance Time***		**X**	2.0 seconds	1.0 seconds	25.0 seconds
	Reconnect Delay		**X**	60 seconds	2 seconds	302 seconds
Multi-Phase Coordination	***Coordin. AC Connect/Disconn.***			***N***	***Y*** or ***N***	
Sell Current Limit	***Maximum Sell Current***	FXR2348E	**X**	12 Aac	2.5 Aac	12 Aac
		VFXR3048E		12 Aac	2.5 Aac	15 Aac
Model Select			**X**	Vented	Vented or Sealed	
Reset to Factory Defaults						

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Definitions

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

Table 26 Terms and Definitions

Term	Definition
AUX	Auxiliary connection that supplies 12 Vdc to control external devices
AGS	Advanced Generator Start
Communications manager	Multi-port device such as the HUB10.3, used for connecting multiple OutBack Power devices on a single remote display; essential for stacking inverters
DVM	Digital Voltmeter
GND	Ground; a permanent conductive connection to earth for safety reasons; also known as Chassis Ground, Protective Earth, PE, Grounding Electrode Conductor, and GEC
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
IEC	International Electrotechnical Commission; an international standards organization
Invert, inverting	The act of converting DC voltage to AC voltage for load use or other applications
LBCO	Low Battery Cut-Out; set point at which the inverter shuts down due to low voltage
Master	An inverter which provides the primary output phase of a stacked system; other stacked inverters base their output and on/off state on the master
NEU	AC Neutral; also known as Common
Off-grid	Utility grid power ***is not*** available for use
PV	Photovoltaic
RTS	Remote Temperature Sensor; accessory that measures battery temperature for charging
Slave	An inverter which adds additional power to the master or subphase master in a stacked system; a slave does not provide an output of its own
System display	Remote interface device (such as the MATE3S), used for monitoring, programming and communicating with the inverter; also called “remote system display”
Three-phase, 3-phase	A type of utility electrical system with three “hot” lines, each 120° out of phase; each carries the nominal line voltage with respect to neutral; each carries voltage with respect to each other equaling the line voltage multiplied by 1.732
Utility grid	The electrical service and infrastructure supported by the electrical or utility company; also called “mains”, “utility service”, or “grid”

NOTES:

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World Headquarters
2366 Bernville Road
Reading, PA 19605 USA
+1 610-208-1991 / +1 800-538-3627

EnerSys EMEA
EH Europe GmbH
Baarerstrasse 18
6300 Zug Switzerland

EnerSys Asia
152 Beach Road
Gateway East Building #11-08
Singapore 189721 / +65 6508-1780

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