OutBack POWER™

member of The alpha Group™

EnergyCell PLR Series

Owner's Manual

About OutBack Power Technologies

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

Applicability

These instructions apply to OutBack EnergyCell PLR series batteries only.

Contact Information

Address:	Corporate Headquarters 17825 – 59th Avenue N.E. Suite B Arlington, WA 98223 USA	European Office Hansastrasse 8 D-91126 Schwabach, Germany
Website:	http://www.outbackpower.com	

Disclaimer

UNLESS SPECIFICALLY AGREED TO IN WRITING, OUTBACK POWER TECHNOLOGIES:

(a) MAKES NO WARRANTY AS TO THE ACCURACY, SUFFICIENCY OR SUITABILITY OF ANY TECHNICAL OR OTHER INFORMATION PROVIDED IN ITS MANUALS OR OTHER DOCUMENTATION.

(b) ASSUMES NO RESPONSIBILITY OR LIABILITY FOR LOSS OR DAMAGE, WHETHER DIRECT, INDIRECT, CONSEQUENTIAL OR INCIDENTAL, WHICH MIGHT ARISE OUT OF THE USE OF SUCH INFORMATION. THE USE OF ANY SUCH INFORMATION WILL BE ENTIRELY AT THE USER'S RISK.

OutBack Power Technologies cannot be responsible for system failure, damages, or injury resulting from improper installation of their products.

Information included in this manual is subject to change without notice.

Notice of Copyright

Trademarks

Date and Revision

September 2018, Revision A

Part Number

900-0230-01-00 Rev A

Table of Contents

READ AND SAVE THESE INSTRUCTIONS!

This manual contains important safety instructions for the EnergyCell PLR battery. These instructions are in addition to the safety instructions published for use with all OutBack products. Read all instructions and cautionary markings on the EnergyCell battery and on any accessories or additional equipment included in the installation. Failure to follow these instructions could result in severe shock or possible electrocution. Use extreme caution at all times to prevent accidents.

WARNING: Personal Injury

- Some batteries can weigh in excess of 100 lb (45 kg). Use safe lifting techniques when lifting this equipment as prescribed by the Occupational Safety and Health Association (OSHA) or other local codes. Lifting machinery may be recommended as necessary.
- Wear appropriate protective equipment when working with batteries, including eye or face protection, acid-resistant gloves, an apron, and other items.
- Wash hands after any contact with the lead terminals or battery electrolyte.

WARNING: Explosion, Electrocution, or Fire Hazard

- Ensure clearance requirements are strictly enforced around the batteries.
- Ensure the area around the batteries is well ventilated and clean of debris.
- Never smoke, or allow a spark or flame near, the batteries.
- Always use insulated tools. Avoid dropping tools onto batteries or other electrical parts.
- Keep plenty of fresh water and soap nearby in case battery acid contacts skin, clothing, or eyes.
- Wear complete eye and clothing protection when working with batteries. Avoid touching bare skin or eyes while working near batteries.
- If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters the eye, immediately flood it with running cold water for at least 20 minutes and get medical attention as soon as possible.
- Never charge a frozen battery.
- Insulate batteries as appropriate against freezing temperatures. A discharged battery will freeze more easily than a charged one.
- If a battery must be removed, always remove the grounded terminal from the battery first. Make sure all devices are de-energized or disconnected to avoid causing a spark.
- Do not perform any servicing other than that specified in the installation instructions unless qualified to do so and have been instructed to do so by OutBack Technical Support personnel.

Additional Resources

These references may be used when installing this equipment. Depending on the nature of the installation, it may be highly recommended to consult these resources.

Institute of Electrical and Electronics Engineers (IEEE) guidelines: IEEE 450, IEEE 484, IEEE 1184, IEEE 1187, IEEE 1188, IEEE 1189, IEEE 1491, IEEE 1578, IEEE 1635, and IEEE 1657 (various guidelines for design, installation, maintenance, monitoring, and safety of battery systems)

EnergyCell Batteries

Welcome to OutBack Power Technologies

Thank you for purchasing the OutBack EnergyCell battery. EnergyCell is a series of absorbed glass-mat (AGM) batteries with a valve-regulated lead-acid (VRLA) design. They are designed to provide long, reliable service with minimal maintenance. Several versions are available, including front-terminal and top-terminal designs. All have high recharge efficiency and a compact footprint for higher energy density. All have a thermally welded case-to-cover bond to eliminate leakage, all are highly recyclable, and all are UL-recognized components.

Audience

This manual is intended for use by anyone required to install and operate this battery. Be sure to review this manual carefully to identify any potential safety risks before proceeding. The owner must be familiar with all the features and functions of this battery before proceeding. Failure to install or use this battery as instructed in this manual can result in damage to the battery that may not be covered under the limited warranty.

EnergyCell PLR Front Terminal Battery

The EnergyCell PLR (Pure Lead Runtime) battery uses a unique lead plate technology called thin-plate pure lead (TPPL). It is intended to receive continuous float charging under normal conditions when utility power is present.

- Intended for use with Grid/Hybrid™ systems, particularly renewable and grid-interactive (hybrid); also grid-backup (float service) applications with occasional interruptions.
- Pure lead plates for long float service life in battery backup applications
- 18-month shelf life at 25°C

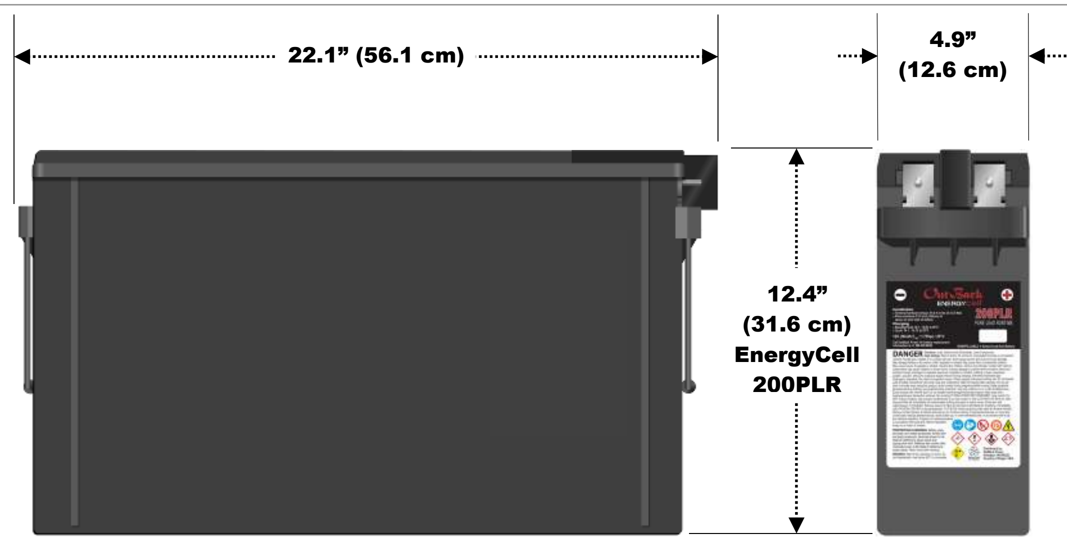


Figure 1 EnergyCell PLR Front Terminal Battery

Materials Required

Tools (use insulated tools only)

- Digital voltmeter
- Socket wrench, insulated
- Torque wrench calibrated in inch-pounds
- Box end wrench, insulated
- Battery lifting equipment (handles) and fork lift to lift pallets of batteries
- Rubber gloves
- Full face shield
- Plastic apron
- Portable eyewash
- Spill kit
- Fire extinguisher (class C)

Accessories

- Interconnect bar (provided with front terminal batteries only)
- Terminal cover (provided with front terminal batteries only)
- Hardware kit
- Interconnect cables as needed

CAUTION: Fire Hazard

Install properly sized battery cabling and interconnect cables. The cable ampacity must meet the needs of the system, including temperature, deratings, and any other code concerns.

Storage and Environment Requirements

Temperatures

- To achieve maximum life of EnergyCell PLR batteries, it is recommended not to operate them in average ambient temperatures exceeding 85°F (27°C). The peak temperature of the operating environment should not exceed 110°F (43°C) for a period of more than 24 hours. High operating temperatures will shorten a battery's life (see page 8).
- Do not allow batteries to freeze, as this will damage them and could result in leakage.
- Do not expose batteries to temperature variations of more than 5°F (3°C). This can lead to voltage imbalance between multiple batteries (or between multiple battery cells if there is a temperature differential).
- Batteries should be stored in a cool, dry location. Place them in service as soon as possible. The best storage temperature is 77°F (25°C), but a range of 60°F (16°C) to 80°F (27°C) is acceptable.

Self-Discharge

All EnergyCell batteries will discharge over time once charged, even in storage. Higher storage temperatures increase the rate of self-discharge. The EnergyCell PLR has a longer shelf life than other VRLA batteries. At room temperature (77°F or 25°C), the EnergyCell PLR has a shelf life of 18 months before self-discharging to unacceptable levels. Figure 2 shows the rate of EnergyCell PLR self-discharge at various temperatures.

Fully charged, the natural ("rest") voltage of all EnergyCell batteries is approximately 12.8 Vdc. A battery should have a freshening charge (see page 14) if its rest voltage is below 12.5 Vdc per battery (2.08 Vdc per cell). A battery should not be used if its rest voltage is 12.0 Vdc or lower upon delivery. Contact the vendor upon receiving a battery in this state.

No EnergyCell should **ever** be permitted to self-discharge below 70% state of charge (SoC). Such a condition is highly detrimental and will shorten battery life. (This situation is not the same as discharging to 70% SoC or lower under load. See page 8.)

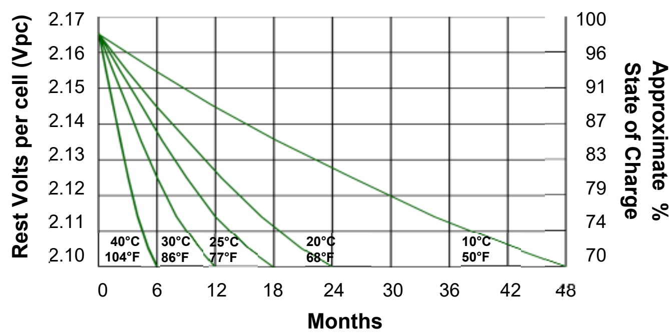


Figure 2 EnergyCell PLR Shelf Life

Storing EnergyCell PLR Batteries

The EnergyCell PLR must be kept in storage no longer than the shelf life in Figure 2 for a particular temperature. At the end of this time it must be given a freshening charge. That is, a battery stored at 104°F (40°C) should be stored no longer than six months, while it can be stored up to 48 months at 50°F (10°C) without a charge.

Stored batteries should be checked for open-circuit voltage at intervals. Any time the battery voltage is less than 2.10 Vpc (volts per cell; this equates to 12.6 volts per battery), it should be given a freshening charge regardless of the storage time.

At 104°F (40°C), the EnergyCell PLR voltage should be checked every 2 months. At 86°F (30°C), the interval is 3 months. At 77° to 68°F (25° to 20°C) the interval is 4 months. At temperatures lower than 59°F (15°C), the voltage only needs to be checked every 6 months.

Capacity

Battery capacity is given in ampere-hours (amp-hours). This is a current draw which is multiplied by the duration of current flow. A draw of *X* amperes for *Y* hours equals an accumulation of *XY* amp-hours.

Because the battery's chemical reaction constantly releases energy, its level of depletion is not always obvious. Smaller loads will deplete the batteries less than larger loads. This effectively means that the battery has more capacity under lighter loads.

For example, if the EnergyCell 200PLR is discharged at the 20-hour rate to a voltage of 1.75 Vpc (a load expected to effectively drain 100% of its capacity in 20 hours), it will be measured to have 203.8 amp-hours. However, at the 4-hour rate, a heavier load, only 177 amp-hours will be measured. For discharge rates and amp-hours, see Table 4 on page 21.

State of Charge

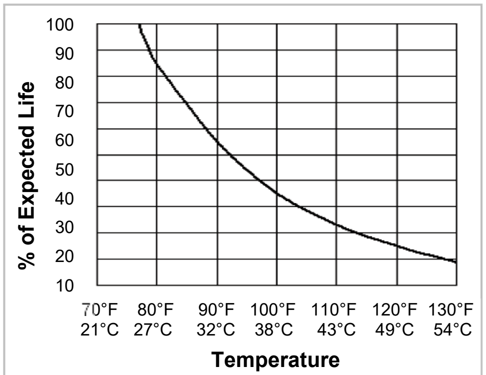


Figure 3 Battery Life

The EnergyCell SoC can be determined by two methods. One is to measure its voltage. This is accurate only if the batteries are left at rest (no charging or loads) for 24 hours at room temperature (77°F or 25°C). **If these conditions are not met, then voltage checks may not yield usable results.** If they are met, then on average, a battery at 12.8 Vdc will be at 100% SoC. A rest voltage of 12.2 Vdc represents roughly 50% SoC.

The more accurate method is to use a battery monitor such as the OutBack FLEXnet DC. Using a sensor known as a shunt, the monitor observes the current through the battery. It keeps a total of amp-hours lost or gained by the battery and can give accurate SoC readings.

The EnergyCell can be discharged and recharged (cycled) regularly to a level as low as 50% depth of discharge (DoD). This is common in a cycling application such as an off-grid system. However, for optimal battery life, the best practice is to avoid regular discharge below 50%. The battery can be occasionally discharged as low as 80% DoD (20% SoC), as is common in emergency backup systems. However, the best practice is to avoid discharging below 50%.

If operated in a range with consistent charge and discharge to 50% DoD or above, the EnergyCell will typically have a life of hundreds of cycles. With consistently lighter discharge (10 to 30% DoD with proper recharge), the battery may have thousands of cycles.

For the anticipated cycle life of a particular model, see the OutBack data sheet for that battery. (The cycle life can be affected by temperature. Figure 3 shows the effect of ambient temperature on typical battery life.)

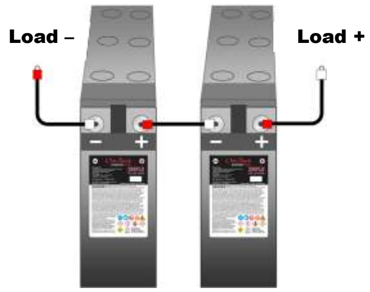
System Layout

CAUTION: Fire Hazard

Failure to ventilate the battery compartment can result in the buildup of hydrogen gas, which is explosive.

- The battery enclosure or room must be well-ventilated. This ventilation protects against accidental gas buildup. All EnergyCell batteries are valve-regulated and do not normally emit noticeable amounts of gas. However, in the event of accidental leakage, the enclosure must not allow the leaked gas to become concentrated.
- The battery enclosure or room must have adequate lighting. This is necessary to read terminal polarity, identify cable color, and view the physical state of the battery as required.
- The battery should be installed with a minimum 36” (91.4 cm) clearance in front. This allows access for testing, maintenance, and any other reasons.
- If multiple batteries are installed, they should have a minimum of ½” (12.7 mm) clearance on either side.

Battery Configurations



Batteries are placed in series (negative to positive) for additive voltages. Batteries in series are known as a "string". A string of two EnergyCell batteries has a nominal voltage of 24 Vdc and can be used for 24-volt loads. A string of four has a nominal voltage of 48 Vdc. Other voltages are possible. However, batteries in series do not have additive amp-hours. A single string of any voltage (as shown above) has the same amp-hours as a single battery.

When replacing batteries, a new battery should not be placed in series with old batteries. This will cause severe stress and shorten the life of all batteries. All batteries in a string should be replaced at the same time.

Figure 4 Series String Configurations

Batteries are placed in parallel (positive to positive, negative to negative) for additive amp-hour capacity. Three batteries in parallel have three times the amp-hours of a single battery. However, batteries in parallel do not have additive voltages. A single set of batteries in parallel (as shown in this figure) have the same voltage as a single battery.

NOTE: Use caution when designing or building systems with more than three EnergyCell batteries or strings in parallel. The extra conductors and connections used in larger paralleled systems can lead to unexpected resistances and imbalances between batteries. Without proper precautions, these factors will reduce the system efficiency and shorten the life of all batteries. For systems beyond three strings, contact an OutBack representative.

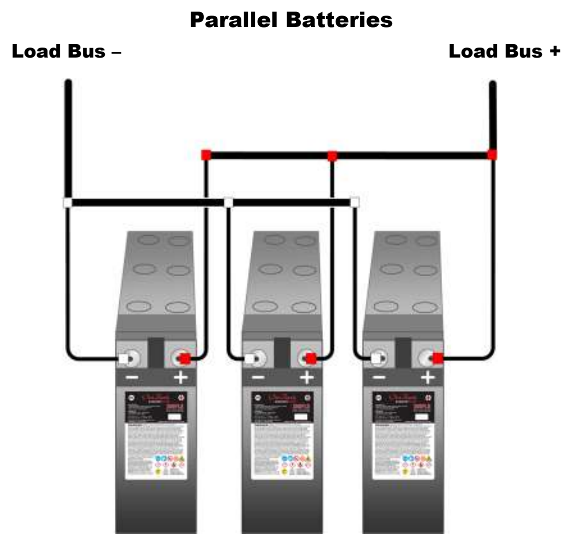


Figure 5 Parallel String Configuration

Batteries are placed in both series and parallel for both additive voltage and amp-hour capacity. Series strings placed in parallel have the same nominal voltage as each string. They have the same amp-hour capacity of each string added together. Two parallel strings of two EnergyCell batteries in series have a nominal voltage of 24 Vdc, twice the nominal voltage. They also have double the amp-hour capacity of a single battery. Two parallel strings of four batteries in series have a nominal voltage of 48 Vdc at double the amp-hour capacity of a single battery.

In a series-parallel bank, it is not recommended to connect the load to the positive and negative terminals of a single string. Due to cable resistance, this will tend to put more wear on that string. Instead, it is recommended to use “reverse-return” or “cross-corner” wiring, where the positive cable is connected to the first string and the negative is connected to the last. This will allow current to flow evenly among all strings.

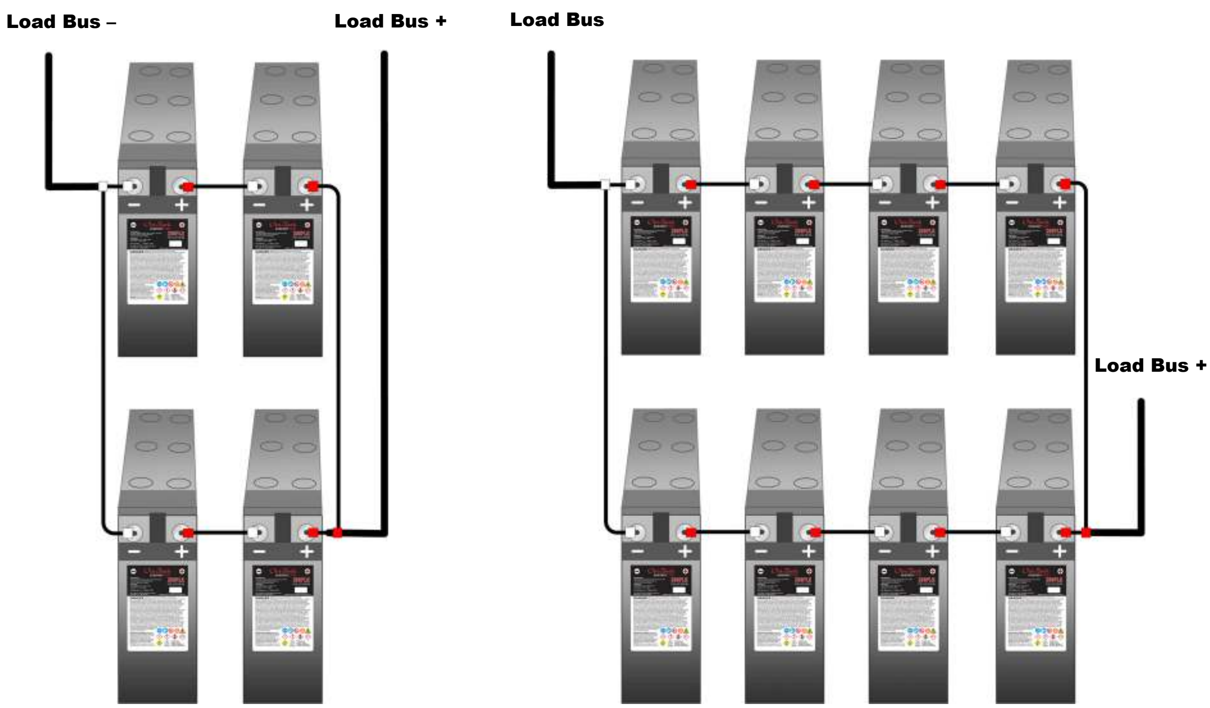


Figure 6 Series/Parallel String Configurations

DC Wiring

⚠	**CAUTION: Equipment Damage** Never reverse the polarity of the battery cables. Always ensure correct battery polarity.
⚠	**CAUTION: Fire Hazard** Always install a circuit breaker or overcurrent device on the DC positive conductor for each device connected to the batteries.
⚠	**CAUTION: Fire Hazard** Never install extra washers or hardware between the mounting surface and the battery cable lug or interconnect. The decreased surface area can build up heat.

Terminal Hardware

EnergyCell PLR batteries use a threaded stud which receives a nut. See Table 2 on page 21 for the terminal type, hardware sizes, and torque requirements. All terminal hardware is assembled as shown in Figure 7.

NOTES:

- Install the cable lugs (or interconnects) and all other hardware in the order illustrated. The lug or interconnect should be the first item installed. It should make solid contact with the mounting surface. Do not install hardware in a different order than shown.
- To avoid corrosion, use plated lugs on cable terminations. When multiple cables are terminated, use plated terminal bus bars.

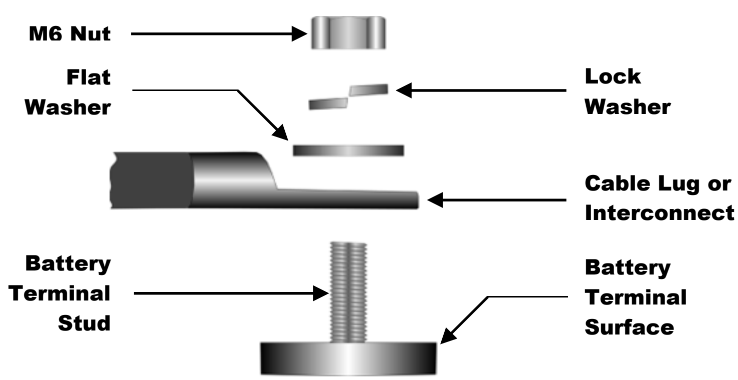


Figure 7 Terminal Assemblies

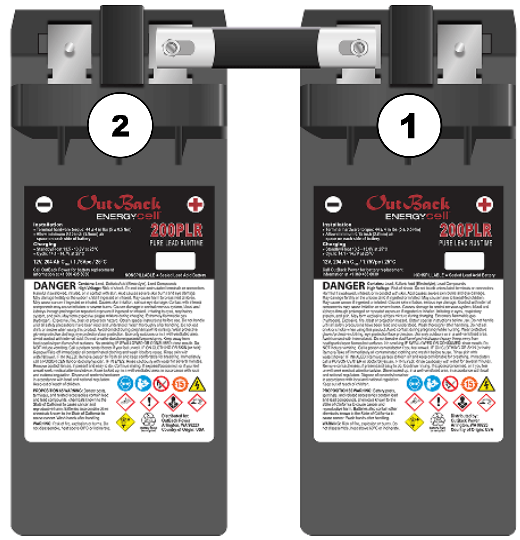
Cleaning Battery Terminals

To minimize contact resistance, it is important that the lead terminals of the batteries be cleaned of any oxidation that may have occurred during transportation and storage. It is most convenient to clean them prior to placing them on the rack.

Lightly brush the terminal contact surface areas with a brass bristle brush or the equivalent. Next apply a light coating of special antioxidant grease such as NO-OX-ID or NCP-2 to the surfaces. This will protect the lead terminal from further oxidation.

To make the DC connections:

Make certain to clean all terminals and contact surfaces according to the steps on page 11.



1. If installing batteries in a rack or cabinet, always begin with the lowest shelf for stability. Place all batteries with terminals facing to the most accessible side of the rack. If terminal protectors are present, remove and save them.
2. In common configurations, the battery on one end will be the positive (+) output for that string. This battery should be designated [**1**]. Proceeding to the other end, adjacent batteries in that string should be designated [**2**], [**3**], and so on.
3. If more than one string is present, designate the first string as A, the second as B, and so on. This should be done regardless of whether the strings are on the same shelf or higher shelves. Number the batteries in subsequent strings just as was done in step 2.
4. Install series connections. If an interconnecting bar was supplied with a front-terminal battery, it should connect from the negative (left) side of battery 1 to the positive (right) side of battery **2** as shown above. Tighten interconnect hardware "hand tight" only.
5. Repeat the process as appropriate for batteries [**2**], [**3**], and any others in the string. Connect the proper number of batteries in series for the nominal voltage of the load.
6. If multiple series strings will be used, repeat this process for strings B, C, and so on.
7. Install parallel connections. Parallel connections are made from the positive terminal of one battery or string to the positive of the next; negative connections are made similarly. (See Figure 5 on page 9.) External cables or bus bars must be provided. The interconnecting bar included with front-terminal batteries cannot make parallel battery connections.
8. Use a digital voltmeter (DVM) to confirm the nominal system voltage and polarity. Confirm that no batteries or strings are installed in reverse polarity.
9. Install cables or bus bars for DC loads. Size all conductors as appropriate for the total loads. See the manual for the battery rack or cabinet if necessary.
10. Before making the final battery connection, ensure the main DC disconnect is turned off. If this is not possible, then do not make the final connection within the battery enclosure. Instead, make it at the load or elsewhere in the cable system so that any resulting spark does not occur in the battery enclosure.
11. Once hardware is installed and batteries are properly aligned, tighten all connections to the appropriate torque value for the battery model. (See the requirements on page 21.) Lightly coat the surfaces with battery terminal grease. Reinstall the terminal covers if present.

Figure 8 Connecting Batteries

IMPORTANT:

Before using the battery bank, commission the batteries as described on the next page.

Commissioning

The commissioning charge applies when the batteries have been in storage or transit for an extended period. It should be applied before conducting a capacity discharge or fully loaded duty cycle test.

In float applications the commissioning charge consists of 7 continuous days of float charge with no battery load. See Table 3 on page 21 for the recommended float voltage.

In hybrid applications the commissioning charge consists of 24 hours charge with no battery load. The charge voltage must be equivalent to 2.40 volts/cell.

Charging

EnergyCell PLR batteries are usually charged using a "three-stage" charging cycle: bulk stage, absorption stage, and float stage. Most OutBack chargers follow this algorithm. However, not all chargers are designed or programmed the same way. The settings should be checked and changed to match the recommendations below if necessary. Contact an OutBack representative before using other charger types.

Bulk Stage

The bulk stage is a constant-current stage. The charger's current is maintained at a constant high level. The voltage will rise as long as the current flows. Each battery has a recommended maximum current limit (see Table 3 on page 21) which should not be exceeded. At excessive current rates, the battery's efficiency of conversion becomes less and it may not become completely charged. The battery may permanently lose capacity over the long term.

The purpose of bulk stage is to raise the battery to a high voltage (usually called bulk voltage or absorption voltage). This voltage is equal to the Absorb Voltage shown in Table 3 on page 21. If batteries are in series, this number is multiplied by the number of batteries in the string. This stage typically restores the battery to 85% to 90% SoC, if the charge rate does not exceed the maximum shown on page 21.

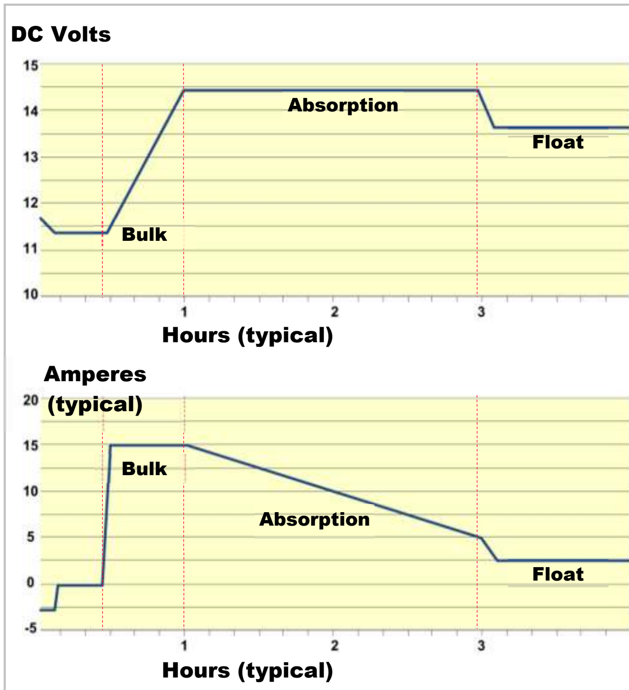


Figure 9 Three-Stage Charging

Absorption Stage

The absorption stage is a constant-voltage stage. It is established upon reaching the desired voltage target at the end of the bulk stage. The charger maintains this voltage as the charging current decreases until the batteries are full. A large amount of current is required to raise the voltage to absorption level. Less is required to maintain it there. This requirement tends to decrease as long as the absorption level is maintained. This decreasing current flow typically goes to a very low number (though not zero), known as "return amps". This "tops off the tank", leaving the battery at 100% SoC.

The battery is considered to be completely full when the following conditions are met:

The charge current decreases to a level of current equal to between 1% and 3% of the total battery amp-hours **while maintaining the absorption voltage**. At this point the charger is allowed to exit the absorption stage and enter the next stage.

NOTE: Not all chargers use return amps. Many chargers absorb for a timed period (one or two hours), assuming that the current will decrease to that level. However, if it exits absorption and ends the charge before reaching return amps, the battery may not reach 100% SoC. Repeated failure to complete the charge will cause decreased battery life.

To determine absorption time setting: Use a DC ammeter or the FLEXnet DC Battery Monitor to observe and time the current as it decreases to the proper level. Once the time is known, set the charger's Absorption timer accordingly. The correct setting could vary significantly if the charge and discharge rates change often. This could occur due to varying load demand or availability of charging sources such as solar energy.

To calculate absorption time setting:

10% battery bank Ah capacity (20-hour rate) ÷ ½ of charge amps = absorption in hours

> **Example:** A 400 Ah battery and a charging source of 20 amperes
>
> (400 Ah × 10%) ÷ (20 A × ½) = 40 Ah ÷ 10 A = absorption setting of 4 hours

NOTE: The figure of 10% is the remaining charge still needed after Absorb voltage is reached. This percentage is typical for an AGM battery but is an estimate. Some AGM batteries can range from 5% to 15%, while some flooded batteries are 15% to 25%. The remaining charge can vary with conditions. If this formula is used exclusively, the absorption time it produces may not always be accurate. The best way to accurately charge batteries is to use the FLEXnet DC (or an equivalent battery monitor) and the ***Charge Termination Control*** command.

Float Stage

The float stage is a maintenance stage which ensures the battery remains fully charged. Left with no maintenance, the battery will tend to slowly lose its charge. The float stage provides current to counter this self-discharge. As with the absorption stage, float is a constant-voltage stage which supplies only enough current to maintain the designated voltage.

The voltage requirements for float stage are much lower than for bulk and absorption. The voltage range is listed in Table 3 on page 21. The float stage should provide enough current to maintain the appropriate voltage. If batteries are in series, this number should be multiplied by the number of batteries in the string.

Freshening Charge

A maintenance or "freshening" charge is given to batteries that have been in storage. This charge should proceed for up 96 hours using a constant-voltage charger. The voltage should be 13.62 Vdc at 77°F (25°C). Alternately, it can be set at 14.4 Vdc for 16 to 24 hours. In either case the charge may be ended when the current decreases to a point where it no longer varies after a three-hour period. All charging should be temperature-compensated (see page 15).

Equalization

Equalization is a controlled overcharge. As part of regular battery maintenance, it is often performed once a month. This depends on application, number of strings, amount of discharge, and so on. (For example, an application with frequent discharge may need more maintenance than a float application.) Equalization follows the same pattern as standard three-stage charging (see Figure 9). The required voltage is listed in Table 3 on page 21. The absorption (equalization) period should be set for 6 hours.

Notes on Three-Stage Charging

The current requirements for absorption and float stages are usually minimal. This varies with conditions, with battery age, and with bank size. (Larger banks tend to have higher absorption exit current values, but they also have higher float current.) Any loads operated by the battery while charging will also impact the charger requirements, as the charger sustains everything.

Not all chargers exit directly to the float stage. Many will enter a quiet or "silent" period during which the charger is inactive. These chargers will turn on and off to provide periodic maintenance at the float level, rather than continuous maintenance.

Constant-Float Charging

"Constant-float" charging may be used with the EnergyCell PLR in backup power applications where the battery bank is rarely discharged. When a discharge occurs, it is critical to recharge the bank as soon as possible afterward. The voltage range is listed in Table 3 on page 21. The batteries are considered to be fully charged when the cell voltage is maintained at this level and the charge current has dropped to a low level over a long period of time. In constant-float charging, it is critical to compensate the settings for temperature.

Temperature Compensation

Battery performance changes when the temperature varies above or below room temperature (77°F or 25°C). Temperature compensation adjusts battery charging to correct for the changes.

When a battery is cooler than room temperature, its internal resistance goes up, the voltage changes more quickly, and the charger reaches its voltage set points more easily. However, it will not deliver all the required current and the battery will tend to be undercharged. Conversely, when the battery is warmer than room temperature, its internal resistance goes down, the voltage changes more slowly, and the charger does not reach its voltages as easily. It will continue to deliver energy until the set points are reached, but this tends to be far more than required. The battery will be overcharged. (See **Improper Use**.)

To compensate for these changes, a charger used with the EnergyCell battery must have its voltages raised by a specified amount for every degree below room temperature. They must be similarly lowered for every degree above room temperature. This factor is multiplied if additional batteries are in series. Failure to compensate for significant temperature changes will result in undercharging or overcharging which will shorten battery life.

EnergyCell PLR Required Compensation

The factor is 4 mV per cell (0.024 Vdc or 24 mV per battery) per degree C above or below room temperature (77°F or 25°C).

Remote Temperature Sensor

OutBack inverter/chargers and charge controllers are equipped with the Remote Temperature Sensor (RTS) which attaches to the battery and automatically adjusts the charger settings. When the RTS is used, it should be placed on the battery sidewall, as close to the center of the battery (or to the center of the bank) as possible.

The charger determines the RTS compensation factor. Most OutBack chargers are preset to a compensation of 5 mV per cell. If an RTS is not present, if a different charger is in use, or if a different compensation factor is required, it may be necessary to adjust the charger settings manually. (Refer to the charger manual for adjustments.) The RTS should be checked periodically. Failure to compensate correctly may result in wrong voltages.

Improper Use

⚠	**CAUTION: Equipment Damage** Read all items below. Maintenance should be performed as noted on page 18. Failure to follow these instructions can result in battery damage which is not covered under the EnergyCell warranty.
⚠	**CAUTION: Equipment Damage** Do not exceed the specified absorption voltage when charging any EnergyCell battery. Excessive voltage could result in battery damage which is not covered under the EnergyCell warranty.

For any EnergyCell battery, if the charger settings are too high, this will cause premature aging of the battery, including loss of electrolyte due to gassing. The result will be permanent loss of some battery capacity and decreased battery life. This is also true for battery charging that is not compensated for high temperatures.

"Thermal runaway" can result from high ambient temperatures, charging at higher voltages over extended time, incorrect temperature compensation, or shorted cells. When the buildup of internal heat exceeds the rate of cooling, the battery's chemical reaction accelerates. The reaction releases even more heat, which in turn continues to speed up the reaction.

Thermal runaway causes severe heat, gassing, lost electrolyte, and cell damage. It usually requires the batteries to be replaced. The process can be halted by turning off the charger. However, if cell damage has occurred, shorted cells may continue to generate heat and gas for some time.

If an EnergyCell battery is not charged completely (or if the settings are too low), it will not reach 100% SoC. Its total capacity will not be available during the next discharge cycle. This capacity will become progressively less and less over subsequent cycles. Long-term undercharging will result in decreased battery life. This is also true for battery charging that is not compensated for low temperatures.

Troubleshooting and Maintenance

Table 1 Troubleshooting

Category	Symptom	Possible Cause	Remedy
Performance	Reduced operating time	Normal life cycle	Replace battery bank when (or before) capacity drops to unacceptable levels.
		Defective cells	Test and replace battery as necessary.
	Excessive voltage drop upon applying load	Excessively cold battery	Carefully warm up the battery.
		Undersized cabling	Increase cable ampacity to match loads.
		Loose or dirty cable connections	Check and clean all connections. Physical damage on terminals may require the battery to be replaced. Replace hardware as necessary.
		Undersized battery bank	Add additional batteries to match loads.
		Defective cells	Test and replace battery as necessary.
External Inspection	Swollen or deformed battery casing; "rotten-egg" or sulfurous odor; battery is hot	Thermal runaway **NOTE**: A modest amount of swelling (or concavity) on the battery case is normal.	**NOTE**: Thermal runaway is a hazardous condition. Treat the battery with caution. Allow the battery to cool before approaching. Disconnect and replace battery as necessary. Address the conditions that may have led to thermal runaway (see page 16).
	Damaged battery casing	Physical abuse	Replace battery as necessary.
	Heat damage or melted grease at terminals	Loose or dirty cable connections	Check and clean all connections. Physical damage on terminals may require the battery to be replaced. Replace hardware as necessary.
Voltage testing	Fully-charged battery displays low voltage	High temperature	Carefully cool the battery. An overheated battery may contribute to thermal runaway.
	Fully-charged battery displays high voltage	Low temperature	Carefully warm up the battery.
	Individual battery charging voltage will not exceed 13.3 Vdc; high float current; failure to support load	Shorted cell	Test and replace battery as necessary. A shorted cell may contribute to thermal runaway.
	Individual battery float voltage exceeds 14.5 Vdc; failure to support load	Open cell	Test and replace battery as necessary.
Current testing	Charging current to series string is zero; failure to support load	Open connection or open battery cell in string	Check and clean all connections. If battery appears to have an open cell, test and replace as needed. Replace hardware as necessary.
	Charging current to series string remains high over time	Batteries require additional time to charge	Normal behavior; no action necessary.
	Charging current to series string remains high with no corresponding rise in voltage	Shorted cell	Test and replace battery as necessary. A shorted cell may contribute to thermal runaway.

This page intentionally left blank.

Periodic Evaluation

Upon replacement of a battery (or string), all interconnect hardware should be replaced at the same time.

To keep track of performance and identify batteries that may be approaching the end of their life, perform the following tests during on a quarterly basis following commissioning (see page 13). Tests must be made with a high-quality digital meter. Voltages must be measured directly on battery terminals, not on other conductors. All connections must be cleaned, re-tightened, and re-torqued before testing. If a battery fails any test, it may be defective. If this occurs under the conditions of the warranty, the battery will be replaced according to the terms of the warranty.

Bring the batteries to a full state of charge before performing either of the following tests.

24-Hour Open-Circuit Test

Remove all battery connections, then allow the battery to rest in this state for 24 hours. Test the battery voltage, compensating for temperature. The EnergyCell PLR should measure 12.8 Vdc. A battery below 12.6 Vdc has lost capacity and may need to be replaced.

Monthly Battery Inspection

- General appearance and cleanliness of battery, battery rack and battery area.
  - Inspect for contamination by dust.
  - Inspect for loose or corroded connections.
  - If necessary, isolate the string/battery and clean with a damp soft cloth. Do not use solvents or scouring powders to clean the batteries.
- Cracks in cell containers or leakage of electrolyte.
- Any evidence of corrosion at cell terminals, connectors or racks.
- Ambient temperature and condition of ventilation equipment.
- Current and voltage during charge cycle. Measure individual battery voltages at the battery terminal. The measurements should be within 5% of the average.
- Voltage at end of charge cycle. Measure individual battery voltages at the battery terminal. The measurements should be within 5% of the average.
- End of discharge voltage measured at the battery. Measure individual battery voltages at the battery terminal. The measurements should be within 5% of the average.
- Record findings clearly. List the dates for all entries.

NOTE: The batteries should be equalized on a monthly basis as noted on page 14.

Quarterly Battery Inspection

This should include the monthly observations, plus:

- End of charge voltage of every cell and battery terminal voltage measured at battery.
- End of discharge voltage of every cell and battery terminal voltage measured at battery.
- Temperature of electrolyte in representative cell(s), typically one cell/tier distributed throughout the battery.
- Record findings clearly. List the dates for all entries.

Annual battery inspection

This should include the monthly and quarterly observations, plus:

- Inter-cell / inter-unit connection integrity.
- Retighten terminals to specified torque values. See Table 2 on page 21 for specifications.
- Record findings clearly. List the dates for all entries.

Specifications

Table 2 EnergyCell PLR Specifications

Item	Specification
Battery Category	Valve-regulated, lead-acid (VRLA)
Battery Technology	Absorbed glass-mat (AGM)
Cells Per Unit	6
Voltage Per Unit (nominal)	12 Vdc
Cycle Life (50% DoD, 1.75 Vpc)	1500 cycles
Operating Temperature Range (with temperature compensation)	–40°F (–40°C) to 113°F (45°C)
Optimal Operating Temperature Range	68°F (20°C) to 77°F (25°C)
Self-Discharge	Store up to 18 months at 77°F (25°C) before a freshening charge is required.
Terminal Type	M6 (no maintenance) terminals
Terminal Hardware Initial Torque	44 ± 4 in-lb (5 ± 0.5 Nm)
Weight	132.3 lb (59.9 kg)
Dimensions H x D x W	12.46 × 22.87 × 4.92” (31.65 x 58.09 x 12.5 cm)
Warranty	3 year full replacement
Accessories	Ships with interconnect bars, terminal covers and hardware kit

Table 3 EnergyCell PLR Charger Requirements

Item	Charger Requirement
Absorption Voltage (25°C)	14.7 Vdc
Absorb Time	2 hours (see page 14)
Float Voltage (25°C)	13.5 to 13.8 Vdc
Float Time	Continuous
Equalize Voltage	14.4 Vdc
Maximum Charge Current (per battery string)	200 Adc (1/C)
Temperature Compensation	0.024 Vdc per battery in series (4 mV per cell) per degree C

Table 4 Ampere-Hour Capacity to 1.75 Volts Per Cell at 20°C

Discharge in Hours:	0.25 (15 min)	0.5 (30 min)	1	2	3	4	5	8	12	20
EnergyCell 200PLR	86.5	119	144	163.4	172	177	181	191.5	194.7	203.8

NOTES:

This page intentionally left blank.

OutBack POWER™

member of The alpha Group™

Masters of the Off-Grid.™ First Choice for the New Grid.

Corporate Headquarters
17825 – 59th Avenue N.E.
Suite B
Arlington, WA 98223 USA

European Office
Hansastrasse 8
D-91126
Schwabach, Germany