Firefly User's Manual for the "OASIS" G31 & the L16

March 2020

Congratulations on your purchase of a Firefly Oasis Battery!

The Firefly batteries use a patented carbon Microcell Foam grid structure that is highly resistant to sulfation and grid corrosion. They have the longest life of any lead acid battery used for deep cycling, even at extreme temperatures and operation at less than full charge.

The Firefly batteries have many advantages over a traditional lead acid battery:

- Plate corrosion is inhibited.
- Plates are resistant to sulfation.
- The high plate porosity allows the electrolyte to react more efficiently.

Receiving & Refreshing Charge

- Check the Individual battery voltages , It will be around 12.90 V for a fully charged 12V Battery G31 Battery and 4.20V for L16 battery.
- Freshening charge shall be carried out using a CCCV (Constant current _Constant voltage charger as per OCV voltage observed on the batteries.
- In case the OCV (Open circuit voltage) of the battery is less than 12.70 V , the G31 battery needs to be charged @ 14.40 V (2.40 V / cell) for 12 hrs. before commissioning.
- In case the OCV (Open circuit voltage) of the battery is less than 4.10 V, the L16 battery 4V 450 Ah block needs to be charged @ 4.80V (2.40 V / cell) for 12 hrs. before commissioning

Installation

MOUNTING ORIENTATION

- Both the G31 and the L16 batteries can be installed in normal orientation or on their sides with the narrow side down.

SPACE AND VENTILATION

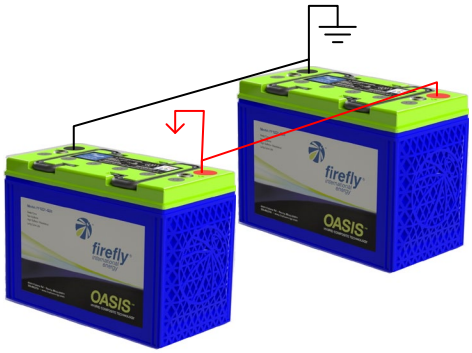
- The batteries should be installed with a minimum of 1” between batteries to allow for proper ventilation and air circulation.
- There also needs to be adequate space in the compartment for ventilation.
- If possible, mount the batteries on low stand-offs to encourage air circulation around their bases.

FOLLOW ALL ABYC INSTALLATION GUIDELINES

- The batteries should be fastened securely and restrained from movement in any direction.
- The positive terminals should be protected by a cover or boots.
- Refer to ABYC standards for more installation guidelines.

PARALLEL INSTALLATION

- Ensure proper uniform current distribution with equal resistance cables on both sides of the Battery Terminals are connected to common load/ charger busbars. No center-tappings are allowed as it would cause differential drain on batteries in the battery bank.



SERIES INSTALLATION

4V L16 CONNECTION

The battery will be shipped with the connection bar shown on the left. This connects the 2 cells inside the module in series making the battery 4V and 450Ah. For a 12V x 450Ah bank, connect 3 x 4V L16 in series (3S). For 24V x 450Ah, connect 6 in series (6S). For 900Ah x 12V, it can be either 2P (P = in parallel) x 3S, or 3S x 2P. For 900Ah x 24V, it can be either 2P x 6S, or 6S x 2P

CONNECTING THE BATTERY

- Take care not to short circuit the terminals on the battery.
- Make sure the terminals and connectors are clean and free of corrosion.
- Connect the positive cable to the positive (+) battery terminal.
- Connect the negative cable to the negative (-) battery terminal.
- The terminals on the G31 are 3/8-16 UNC and should be torqued to 16 ft lbs.

Operation & Charging

- Firefly batteries can be operated in a partial state of charge for long periods of time without sustaining any permanent damage.

- The batteries may emit gas during the first 10-20 charge cycles. This is normal.

- Max discharge Current: The maximum recommended discharge current is 0.7C for extended periods of time to ensure the longevity if the battery. The FF battery can discharge up to 3C for short periods.

- Max Charge Current: The maximum recommended sustained charge current is 0.5C. 3C can be tolerated for 10-20 seconds in the case of regenerative breaking

- Peukerts Constant: If you have hardware that requires a Peukerts constant to be entered, we recommend that you do not change the factory settings due to the large inaccuracies based on varying discharge rates. The Peukerts constant for the FF battery for the 10hr and 20hr rate is 1.07. It is 1.12 for 6.5hr and 1.8hr rate. Keep in mind that whatever Peukerts correction you use, you will lose accuracy with extremely slow discharges.

- Temperature Compensation: If you have hardware that allows the user to enter a temperature coefficient, use 24mV/C° for temperature compensation for a 12V battery & 48mV for a 24V battery. Contact us for higher voltages. The temperature compensation should be zero at an ambient temperature of 25°C/77°F. This means that for every degree the battery is ABOVE 25°C, the charge V should be reduced by 24mV/48mV. For every degree that the battery is BELOW 25°C, the charge voltage should be increased by 24mV/48mV. Note that with Firefly batteries, the battery temperature sensor only needs to be near the batteries to measure ambient temperature. It isn't necessary to put the sensor directly on the battery. This is different than other Pb batteries.

- Complete Charge Cycle Recommendations: For a complete charge cycle, charge the G31 to 14.4V/L16 to 4.8V with temperature compensation (bulk phase) and continue charging until the charging current drops to 0.5A for the G31 or 2A for the L16 (absorption phase time will vary). You DO NOT need to fully charge the batteries each cycle in order to maintain the capacity, however, we recommend doing a complete charge cycle at least once a month when cycling once per day or every 30 cycles if

running a couple cycles a day. Ideally, if the battery is under heavy use, we recommend doing a full charge cycle at least every 2 weeks.

- Float-Charging: For charging sources that may be charging the battery for an extended period of time (solar, or an alternator if motoring for a while); set the float voltage to 13.4V or 13.5V for the G31 and 4.5V for the L15. Firefly batteries do not require a float charge. But, if you are float charging, due to their longer projected lifespan, it is important to keep the float voltage at 13.4V or 13.5V (4.5V for each L16) to ensure the battery lasts for as many cycles as possible.

- Reset to bulk phase: for programmable charging sources, adjust the "reset to bulk phase" to occur if the battery voltage drops below 12.0V for >1 minute for the G31 or 4.0V for >1 minute for the L16.

- Periodic Fast Charge Recommendations: Note that periodic fast (high current) charging can help restore usable capacity after periods of repeated slow charging and deep discharge cycles. If continuously deep cycling, then ideally once a week the batteries should be charged at a current of 0.4C (40 Amps for a 100 Ah battery) or 0.2C (25A per G31 battery) at minimum. For applications lacking fast charging capability, contact OPE or Firefly USA for alternative restoration procedures. Due to the low impedance design, Oasis batteries can tolerate in-rush current levels as high as 3C (300A for a 100Ah battery). Don't be afraid of deep cycling and fast recharging with Firefly batteries!

- Operating Temperature: The optimum operating temperature for a lead-acid battery is 25°C (77°F). As a rule of thumb, every 8-10°C (14-18°F) rise in temperature will cut the battery life in half. Note that continuous duty at elevated temperature will shorten the life of any battery.

Restoration Charge

As stated, Firefly Batteries can operate in a partial state of charge for long periods of time without sustaining any permanent damage. The usable capacity will decrease, however, with each cycle within a partial state of charge, up to a point. In order to regain the full original capacity and in some cases more, it is necessary to perform a restoration charge. To perform the restoration charge: charge the G31 to 14.4V or the L16 to 4.8V and continue to charge until the current drops to 0.5 A on the G31 or 3A on a L16. Fully discharge the battery to 10.5V (G31) or 3.5V (L16), and then repeat the same charge cycle.

Safety

For any operation on the batteries, from storage to recycling, the following safety rules should be observed:

- Do not smoke.
- Use tools with insulated handles to tighten connections.
- Check that the connections between the cells / monoblocs are fitted
- correctly.
- Never place tools on the batteries (metal tools are particularly dangerous).
- Never lift the cells / monoblocs at the terminals.

- Never use a synthetic cloth or sponge to clean the cells /monoblocs.
- Use water (wet cloth) without additives.
- Avoid shocks.
- Even when disconnected, a battery remains charged.
- Always wear insulating gloves and glasses while handling batteries.
- Read the “Installation Instruction” and “Operating Instruction” carefully

EMERGENCY AND FIRST AID PROCEDURES

Battery Electrolyte Eye Contact: Immediately remove any contact lenses if present. Flush eyes with water for at least 15 minutes. Seek medical attention immediately.

Skin Contact: Remove contaminated clothing. Flush with water for at least 15 minutes. Seek medical attention immediately.

Inhalation: Remove to fresh air. If not breathing give artificial respiration. If breathing is difficult give oxygen. Seek medical attention immediately.

PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be taken in case of a broken battery case or electrolyte leakage: neutralize spilled electrolyte and exposed battery parts with soda ash, sodium bicarbonate, lime, etc. Do not use organic or combustible material. Wear acid resistant clothing, boots, gloves, face shield, and proper respiratory protection.

Waste Disposal Information: Please observe all federal, local, and state regulations regarding the disposal of lead/acid batteries.

Precautions to be taken in Handling, Storing, and Transportation: Store in cool, dry area away from combustible materials; store in well ventilated areas. Other Precautions: Do not charge in unventilated areas.

Shipping, storage and disposal

VIBRATION RESISTANCE
The carbon foam batteries have been used under conditions of extreme vibration and impact in applications such as transit buses - carbon foam plates have higher yield strength than lead plates and have high compressive strength.

D.O.T. REGULATIONS-NONSPILLABLE
Firefly’s Group 31 battery meets the non-spillable criteria. It is exempted from CFR 49, Subchapter C requirements, which translates to no proper shipping name, no hazardous class, no UN number, no packaging group and no hazardous labels when transporting, provided that the following criteria are met: 1. the batteries must be protected against short circuits and securely packaged. 2. The batteries and their outer packaging must be plainly and durable marked “NON- SPILLABLE” or “NON-SPILLABLE BATTERY”.

SHELF LIFE

Unlike other lead acid batteries that require a recharge as frequently as every six weeks in order to avoid permanent damage, the Oasis battery can be stored for up to two years at 25°C (77°F) from a fully charged state. They will discharge at a rate similar to other lead batteries but the sulfation that naturally occurs when discharging will not cause permanent damage. However, for better life cycle, it is recommended to recharge the Firefly battery at least every 6 months.

FULLY-CHARGED WHEN SHIPPED

The Oasis will be shipped from the factory fully charged. Some venting from the valves is possible when it arrives.

RECYCLING

There is an existing infrastructure to recycle lead acid batteries. Because Firefly's technology uses carbon, it actually decreases the amount of lead in the battery. Firefly's microcell technology can be recycled through the existing lead acid infrastructure.