Overview

E3 Lithium batteries are designed as a maintenance free replacement for 12 volt lead-acid, AGM or lithium batteries. To ensure a smooth replacement process, our batteries are similar in dimensions to many motorsport and power sport batteries.

Our 12V replacement lithium battery consists of 4 Lithium Iron Phosphate (LiFePO4) cells in series and one or more in parallel with built in electronics to protect the lithium cells. Our lithium cells together with our Battery Management System (BMS) create the safest lithium battery on the market, with more starting power and longer life.

The common features of our Lithium Batteries include:

- Flexible battery connection – with center mounted terminals and terminal adapters, the same batteries can be used in either left or right side polarity applications.
- Longer Storage Life –there is no need to float charge in the off season if outside of vehicle
- Environmentally Friendly – no hazardous chemicals and it can be recycled
- Fast Charge – can be fully charged in less than an hour (if charged at the maximum recommended charge rate)
- Maintenance Free!
- No Special mounting direction (could even be mounted up-side-down)
- Will Not Freeze or Boil Over – Lithium batteries are dry cell technology and will not freeze or boil ever

Charging

A lithium compatible battery charger is **required** in order to properly and safely charge your E3 Lithium Battery. We recommend OptiMate Lithium Chargers, specifically the Optimate LFP 4s5a Lithium Battery Charger, which can be purchased at shop.e3sparkplugs.com

ALWAYS FOLLOW ALL APPLICATION USE, INSTALLATION, CHARGING & STORAGE INSTRUCTIONS FOR MAXIMIUM PERFORMANCE AND SAFETY.

Battery Cells

Our batteries use cells made of Lithium Iron Phosphate (LiFePO4). This chemistry is one of the highest performing and safest on the market today. Lithium batteries are fundamentally different than lead-acid batteries. LiFePO4 cells by the nature of their chemistry are 3.3 volt. So, a 12V lithium battery is created by using 4 cells in series. This technically is a 13.2 volt battery, but nominally the full charge voltage is greater than 13.3 volts. Lead-acid batteries are made with 6 cells in series.

Lithium battery voltage delivery remains relatively constant while discharging, while voltage for a lead-acid battery decreases. A lithium battery's storage capability is nearly 100% usable (measured as AmpHour, Ah), while a lead-acid battery designed for motorsports typically only has 30% useful storage. For example, a 2Ah lithium battery has the equivalent "useable" capacity of a 6Ah lead acid. Also, a lithium battery's cranking power is stronger since the voltage while cranking is generally higher. But when the lithium battery runs out of power it does so more abruptly.

Another difference is that lithium cells are a dry cell technology, where the cells are packaged individually. As such, the individual cell's charge level will diverge with repeated charge/discharge cycles and age. This condition reduces the performance of the battery, specifically its capacity, since the battery charge level is only as good as the charge level of the weakest cell. Moreover, charging a battery with unbalanced cells results in one or more cells reaching the maximum charge (voltage) level before the rest of the cells in the series, which leads to over-charging of the cell(s) and eventual failure.

Battery Management System – E3.405

All E3 Lithium Battery Management Systems (BMS) continuously monitor each cell's voltage as part of the cell balancing and over-charge protection. If the voltage of a cell exceeds the others, the BMS circuits will work to reduce that cell's charge level. This ensures that the charge level of all the cells remains equal, even with the high discharge (> 100Amps) and charge current (>10Amps) of your vehicle.

A cell can be permanently damaged if over-charged (over-voltage) just one time. Therefore, the BMS has circuitry to block incoming current to the battery from the charging system if the voltage exceeds 15.5 volts (an over-charge condition). Once the voltage level is below 15.5V, the BMS will automatically reset itself. E3.405's BMS has short circuit protection, but it is not resettable or repairable.

Battery Management System – E3.400 – E3.404

The Battery Management Systems for part numbers E3.400 through E3.404 have all the same features as E3.405 but also offer over-discharge protection (completely draining the battery), excessive cranking protection, and short-circuit protection. The BMS disconnects the battery from the load if it is drained to less than 5% remaining charge (an over-discharge condition). An over-discharged battery typically has a voltage less than 11.5V. If the BMS disconnects the battery, the voltage reading of the battery will be zero volts. Excessive cranking protection logic includes temperature monitoring to limit "high current use" (engine cranking) to 10 - 30 seconds in any 60 second period. If the battery terminals are "shorted" (or a low impedance load is connected across terminals), which causes the battery volts to instantaneously drop to a very low level, the battery will disconnect from the load to protect the cells

and BMS from damage (short circuit protection). If the BMS disconnects due to excessive cranking protection or short circuit protection, the BMS will automatically reconnect after a cool down period of typically 1-3 minutes. These batteries are designed for short circuit protection > 1000 Amps.

Battery Management System – E3.420, E3.502, E3.503

In addition to the features found in part numbers E3.400 through E3.405, critical electronic circuits are redundant, the over-charge protection is enhanced, and fault indication is included in E3.420, E3.502 and E3.503. All components associated with main electronic battery disconnect are redundant. The built-in redundancy and fail-safe design (default is to allow charge / discharge current flow to/from battery) ensures that no single point failure results in the battery unintentionally disconnecting. In fact, this design aligns with the requirements for an FAA approved lithium battery as per RTCA performance specification DO-311a and DO-160.

The battery's micro-controller monitors all failure modes, and reports failures with a built-in LED indicator and discrete output. The discrete output for external fault monitoring is a single wire connection with a ¼" quick connect terminal. The output is a "current sinking" type circuit (see diagram below) that can handle 100mA (connects the discrete output to battery ground if a fault is present). This output can be connected to an external 12V LED or general purpose discrete input of an EFIS. The fault output has three states; fast flashing (2 second on/ 2 second off), slow flashing (5 second on/ 5 second off) or solid.

Operating Instruction

Normal Operation

Under normal operating conditions the battery performs as any lead acid battery, storing energy from the charging system and suppling it when the charging system is off.

Abnormal Operation

Under abnormal conditions that exceed the operating limits of the battery the battery may stop supplying power. Two such important examples are over-discharge and over-temperature. The over discharge protection shuts off outgoing power when the battery is 95% discharged (supplied 95% of its available energy). The over-temperature protection shuts off outgoing power when cells and electronics get too hot as the result of excessive cranking (i.e. cranking the engine for more than 15 seconds within a 1-minute period).

Monitoring

E3.420 and E3.503 all are equipped with a fault light indicator. The slow flashing fault light can indicate an improper state of charge or a problem with the cells internal to the battery. If the battery voltage is outside the normal range of operation, 12.8V to 14.6V, the battery is over-discharged or over-charged, most likely the result of an issue with the electrical/charging system. If the battery voltage is within the normal operating range, with a slow flashing fault, it is indicating an abnormal condition with a cell, such as one cell's state of charge is very different as compared to the other cells (high cell charge level imbalance). The slow flashing fault may come on briefly during or following periods of high current charging, and is not a concern. But if the fault persists, comes on consistently during changing, or remains on (charging or not), the battery will need to be replaced.

The solid fault indicates a BMS hardware failure. For example, if the micro-controller fails the fault indication output is activated (on solid). If the fault persist, comes on and stays on, the battery will need to be replaced.

The fast flashing fault is an indication of high temperature; temperature exceeding the normal operating or storage limits of the battery.

The table below shows the most common fault conditions and possible causes.

LED Light	Voltage	Possible Cause	Recommended Action
Slow Flashing (5sec on/5 sec off)	Less than 12.8v	Battery over-discharged due to a faulty charging system	Charge the battery, once charged the light will stop flashing.
Slow Flashing (5s on/5s off) (> 1 hour time period)	13.2V-14.6V	Weak or failing cell	Discontinue use.

Slow Flashing (5s on/5s off) (< 30 min. time period)	13.2V - 14.6V	Cell to cell charge levels are not balanced	May come on briefly during periods of high current charging until the cells are automatically balanced. Try charging with a plugin charger, like an Optimate Lithium charger.
Slow Flashing (5s on/5s off)	Greater than 15.2V	Over-charging due to faulty charging system	Discontinue use & contact E3 Customer Service
Solid Light	Any voltage	BMS electronic issue	Discontinue use & contact E3 Customer Service
Solid Light that turns off after 3 minutes	Any voltage	Short Circuit protection was activated	Nothing needs to be done.
Short Flashing (2s on/2s off)	Any voltage	High battery temperature (> 75°C / 170°F)	Let battery cool down prior to cranking or charging. This is not an immediate issue, but if it continues on subsequent flights, investigate and mitigate high temperature at battery location.

WARNING - A sustained fault can indicate a serious issue with the battery or vehicle charging system that requires immediate attention. Discontinue use until the issue is resolved and the battery no longer indicates a fault. Continued use of a faulty battery can result in a cell rupture, the release of flammable vapors, smoke and or a fire.

Limitations

Below are the installation specific limitation / requirements:

- The maximum charge rating shown in the model specific specification section must be adhered to at all times.
- Only modern vehicle charging systems like 3-phase alternators or permanent magnet alternators are recommended as the charging source for this battery.

The battery must be installed in such a manner and or location to limit radiant and convection heating. The maximum short term environmental temperature of battery location should be less than 85°C. The battery should not be placed in close proximity to high temperature surfaces without the use of heat shields.