PowerProducts
A MISSION CRITICAL ELECTRONICS BRAND

Unlock the Power of Lithium-Ion (Li-Ion) Battery Packs for Portable Industrial Applications

Li-Ion is the fastest-growing battery system in the modern world of electronics boosted by the fact they are perfect for the development of new portable industrial devices.

The biggest draw to Li-Ion batteries is that they offer a high energy density compared to other battery types, meaning they can store more energy in a smaller size. Offering a powerful and reliable power solution for portable electronic devices, they are a popular choice for companies looking to create new devices that can deliver high performance in a small and lightweight package.

Commercial drones and specialized industrial power tools are already taking advantage of Li-Ion batteries due to their long life, low drain current, high energy density, and desirable voltage characteristics.

Advantages of Li-Ion Batteries

Li-Ion batteries have an incredible advantage over other systems due to their higher energy density and their lighter weight. When compared to Nickel-Metal Hydride (NiMh) batteries, Li-Ion batteries are ready for use faster since they take substantially less time for the charging and discharging cycles.

Their self-discharge rate is also much lower compared to other rechargeable batteries, typically losing only about 1.5 percent of their monthly charge. They also boast a high resistance to the memory effect that would lessen their capacity long-term, making them an attractive option for high-performance devices.

When it comes to maximum discharge, a traditional lead acid battery can only go as low as 50 percent, and most Lead (Pb) battery manufacturers do not recommend discharging past 80 percent.

Surpassing an 80 percent discharge with Lead (Pb) batteries can not only void the warranty but also affect the life of the battery. Meanwhile, Li-Ion battery packs can reach nearly 100 percent depth of discharge as the safety circuitry will cut off the discharge at a safe voltage level.

A Li-Ion battery benefits from a stable voltage provided through the entire cycle of the battery, allowing them to hold a greater capacity and triple the voltage of NiMh batteries (3.7 V vs 1.2 V).

When a Li-Ion battery reaches its end and needs to be recycled, the Li-Ion battery's most expensive component, the cathode, can be reutilized in a new Li-Ion battery. There is no difference in battery performance when compared to Li-Ion batteries with a cathode made from scratch. Findings are now showing that Li-Ion batteries with recycled cathodes last longer and charge faster.

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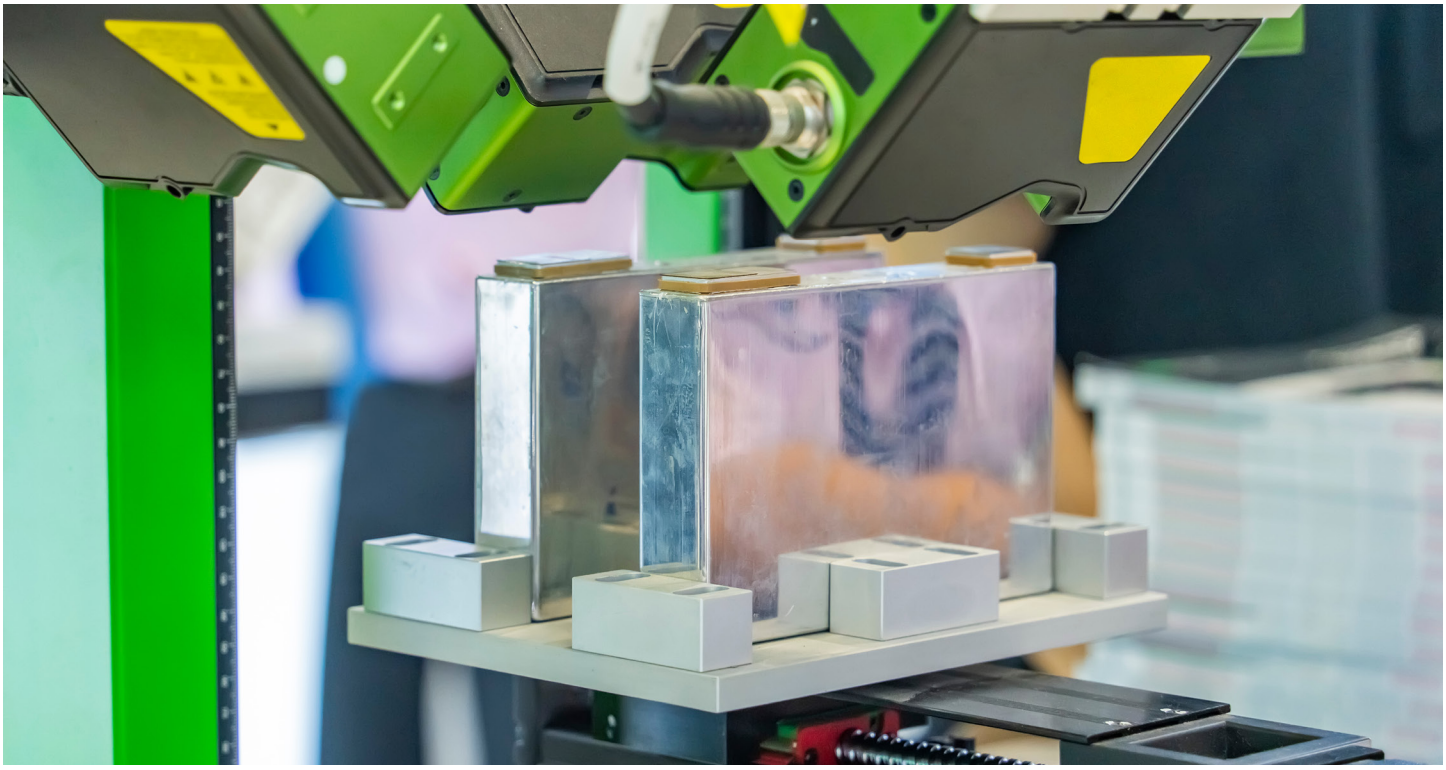

Types of Cells in Li-Ion Batteries

There are three types of cells used in Li-Ion batteries: cylindrical, prismatic, and pouch.

Cylindrical Cells: The original Li-Ion form of cell developed in the mid-'90s by SONY in an 18650 size. Today, there are several cylindrical cells to choose from. Most portable industrial applications will use this form factor for electric vehicles (EV) and energy storage systems (ESS) applications.

Prismatic Cells: These are rectangular or square in design, and are usually found in many mobile phones, tablets, and low-profile laptops.

Pouch Cells: An aluminum foil pouch with an iron phosphate polymer chemistry and two terminal tabs at one end. These deliver the most lithium by volume and are designed to be placed with or without a cell case, meaning it is internal to the device it powers.

Types of Chemistries in Li-Ion Batteries

A typical battery stores chemical energy and converts it to electricity in a process known as electrochemistry. This process works in combination with the system that underpins a battery to make an electrochemical cell. Your typical battery is comprised of one or several electrochemical cells with each electrochemical cell consisting of two electrodes separated by an electrolyte, including Li-Ion batteries.

In a Li-Ion cell, the electrolyte is a lithium salt in an organic solvent. When a lithium-based cell is discharging, the positive lithium ion is extracted from the cathode and inserted into the anode, releasing stored energy in the process. When the cell is charging, the reverse occurs.

Power Products applies a variety of Li-Ion chemistries that are dependent on customer application requirements. Without getting too technical, these include Lithium Cobalt (LiCo), Lithium Nickel Manganese Cobalt (LiNMC), Lithium iron phosphate batteries (LiFeP04), and Lithium Polymer (Li-Polymer).

While Li-Polymer is more of a form factor, it is important to point out that we build battery packs using this technology as well.

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Other Advantages of Li-Ion Batteries

Temperature Control

The performance, life, and safety of Li-ion batteries are all affected by operation and/or storage temperatures.

Li-Ion batteries work best when they are in an environment between 0 to 60 degrees Celsius. When it comes to sub-freezing temperatures, you will be able to notice a reduced capacity, and the battery should not be charged at temperatures lower than zero Celsius. It's important to remove your Li-Ion battery from this freezing zone before charging it.

Energy Density

Energy density should always be taken into consideration when discussing batteries. This is defined as the amount of energy a device can hold per unit volume you get in terms of power and size or, even more simply, how much bang you get for your buck (dollar per watt hour). The higher energy density of a Li-Ion battery makes it perfect for smaller and more compact applications.

Weight

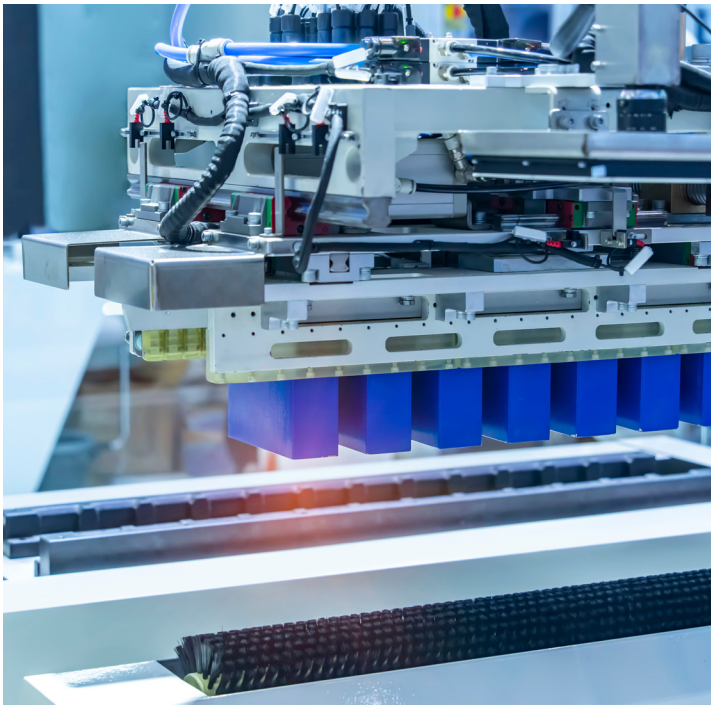
You might think that more capacity means more bulk, but the opposite is true. As the world's lightest metal, lithium gives you a huge weight advantage. Li-Ion batteries are 60-80 percent lighter than their lead counterparts and are also almost four times lighter than NiMh batteries. For example, a typical Group 31 battery weighs about 75 pounds compared to the 28 pounds a similar Li-Ion battery weighs.

Capacity

Li-Ion batteries may cost more initially but are a better investment in the long run since they can offer six to eight times more cycles than Lead (Pb), provide a greater shelf life compared to NiMh, and give constant voltage through the entire cycle of the battery.

A typical Li-Ion 18650 will have a capacity of 2.0 Amp-hours (Ah) to 3.5 Ah dependent on the chemistry type of the 18650 cell and whether it's a power or energy cell. The newer 21700 Li-Ion cells are in the range of 4.0 Ah to 5.0 Ah capacities.

Future breakthroughs in silicone-based electrodes may further increase the capacity of Li-Ion cells by as much as six times the current capacities.



Are Li-Ion Batteries Safe?

As with any new technology, accidents related to the use of Li-Ion batteries occurred worldwide and even attracted mass media attention. When Li-Ion batteries were first adopted, manufacturers sometimes overlooked the fact they required different charging algorithms than traditional batteries. Because of that, the Li-Ion batteries would occasionally fail.

At Power Products, all of our Li-Ion battery pack solutions incorporate three layers of protection that include a safety circuit as part of our battery management systems. Our battery designs are carefully engineered to ensure the highest level of performance and safety for today's demanding applications.

Safety & Reliability Certification for Li-Ion Batteries

For Power Products Li-Ion batteries, the key certification standards for safety are UL 1642, which is the standard used for testing Li-Ion cells. Battery pack level tests for safety are covered by Un 38.3, UL 2054, IEC62133, or UL 62133. These certifications cover portable primary (non-rechargeable) and secondary (rechargeable) batteries as power sources in products, protect against damage from vibration, water, and dust – and may extend the life of the batteries.

To ensure the safe shipping of Li-Ion batteries, obtaining the UN38.3 IATA certification from the Department of Transportation (DOT) Hazmat for packaging and shipping dangerous substances is required.

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For intrinsically safe applications, some of our two-way batteries have been certified with up to Class 1 Zone 1 hazardous areas protection. These batteries are certified by SGS to TIA-4950/CSA C22.2 No. 157/UL 913 5th edition for intrinsically safe and non-incendive use.

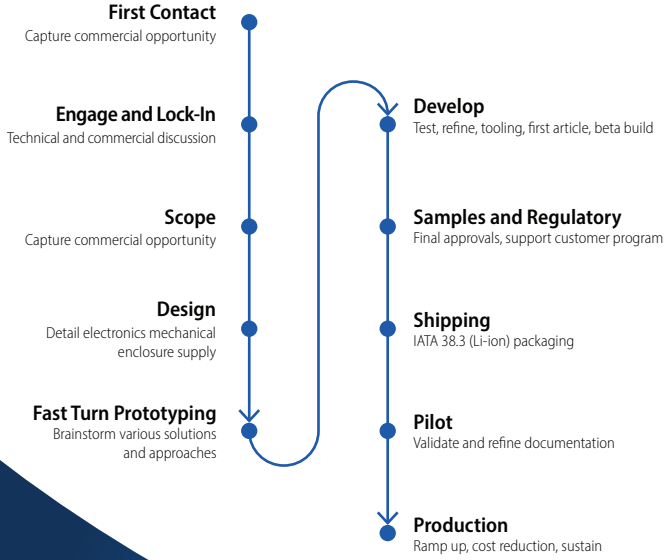
What Should Matter Most to OEMs?

Experience in battery pack design and manufacturing is extremely important to ensure that battery packs are constructed correctly and to the highest degree of safety. At Power Products, we have the knowledge and ability to design and manufacture safe, custom Li-Ion battery packs to meet our OEM customers' exact specifications and application requirements.

How Power Products Designs & Produces Li-Ion Battery Packs for OEM Engineers

Depicted below is our process to help familiarize OEM engineers with the steps necessary to move from concept to design stages and final production for Li-Ion battery packs. By following these steps, we can help prevent a battery pack from becoming a gating item and create a clear set of expectations for your planning schedules.

Typical Battery Pack Development Cycle



Beginning Stages

The first two steps can make or break a project. First Contact, obtaining the necessary details, is critically important to the success of the project. As battery pack designers, we will ask many questions to arrive at the necessary commercial details and technical specifications.

Scope of Work (SOW)

Once all our questions have been answered and decisions made, we can proceed with the development of a budgetary proposal and timeline. This includes any necessary Non-Recurring Engineering (NREs) changes, prototyping, parts tooling, and production. This is also where we address any regulatory requirements based on the OEM's market needs and budgetary pack price, all estimated with the Bill of Materials (BOM) along with the most current commercial and technical information.

Refining the SOW

At pre-determined points, the OEM and battery pack engineering teams review the proposal to be sure it meets all of the objectives. Review points include:

- Final battery pack production cost
- Battery pack performance requirements
- Realistic needs of all features originally proposed

Realistically, the SOW may reflect the availability of components and sourcing alternatives, if needed.

Design Stage - The Engineering Work

Now the electrical and mechanical work begins along with supply chain evaluation between the OEM and Power Products' engineers. This includes:

- Designing the production circuits, battery management, fuel gauging (smbus/canbus), cell balancing, and internal charging, among other aspects.
- Creation of gerbers, e-cads, and BOM to manufacture the circuits.
- Procure all the necessary materials to produce prototypes, which may include custom plastic enclosures, labels, gaskets, connectors, printed circuit board assembly (pcba), Battery Management Systems (BMS), cells, custom intercell connections, cable, fuse, and thermistor along with any others.

Power Products uses state-of-the-art tools, including Solidworks, to design and create the battery enclosure, contacts, and internal cell fitment, and uses Altium for the design of the printed circuit board assembly. In addition, all mechanical drawings, Gerbers, and step files are reviewed and refined as needed.

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We then develop the test equipment, the protocol, and create assembly with manufacturing instructions. Finally, we deliver the prototypes to the OEM so they can verify the designs. This process may take anywhere from four to 20 weeks depending on the complexity of the process and if rapid prototyping is requested with 3D-printed samples.

Quick Response Prototyping

Once the OEM is satisfied with the mechanical and electrical design files, we move to the prototyping stages. Prototypes can be built using 3D-printed plastic enclosures, along with the BMS and the cell assembly. In some cases, we can also use silicone-molded plastic enclosures. These samples are generally much quicker to assemble rather than waiting for the first article to be shot from the plastics tooling.

Development of Tooling

Once the prototypes' design validation are in hand and the customer is satisfied, we will advance to the tooling stages. The prototypes are typically delivered to the customer before final documentation is completed by the manufacturer. At this step, both mechanical and electrical changes are still feasible.

Initial Production Runs from Tooling to Regulatory Stage

During this stage, we provide a small production run for final approval by the OEM. These runs for production quality units can be used for customer production verification to specification and for regulatory, which will require actual production battery packs.

The UN38.3 certification is the minimum for a Li-Ion battery pack. This test is performed to ensure the safe transport of battery packs in boxed quantities. Other certifications, such as IEC62133 or UL 2054, may be required by the customer application or markets served.

Production & Ongoing Business

After regulatory is complete several additional items need to be finished before full production ramp-up. This includes:

- Firmware must be finalized, and programming procedures developed.
- Tools and mechanisms needed to program battery packs need to be finalized.
- Final test programs, fixtures, and equipment must be completed and go through preliminary testing.

Manufacturing Facility

A qualified manufacturing facility must be designed and equipped to:

- Quickly design, develop, and prototype new battery packs in-house.
- Manufacture the complete battery packs in-house.
- Provide immediate technical support to customers.
- The factory should also be ISO9001 certified.

In Conclusion

Li-Ion batteries have emerged as a revolutionary technology that is already transforming various industries and enabling the rapid advancement of portable electronics. With their high energy density, longer lifespan, and environmentally friendly characteristics, Li-Ion batteries offer tremendous potential for the future of industries.

Power Products is dedicated to producing high-quality Li-Ion batteries for OEM customers and is rooted in our commitment to delivering exceptional performance, reliability, and value. With direct access to manufacturing facilities, stringent quality control processes, and a team of experienced engineers, we are well-equipped to meet the unique requirements of your project.

By partnering with us, you can expect customized solutions, timely delivery, and a strong focus on customer satisfaction. We understand the importance of seamless integration and cost-efficiency for OEM applications, and our Li-Ion batteries are designed to exceed your expectations. Join the growing list of satisfied customers who have experienced the advantages of Power Products custom Li-Ion battery packs.

To contact Power Products' OEM Sales Director with any questions or upcoming projects, email Greg Weber at greg.weber@powerproducts.com or call 770-450-2129.

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