

# Aviation Lithium-Ion Batteries



[www.avionicinstruments.com](http://www.avionicinstruments.com)

[www.acme-aero.com](http://www.acme-aero.com)

Safe and Reliable

Integral Charging / Management System

Physical Segregation of Electronics & Cells

Maintenance Free

Lower Cost of Ownership

Lower Weight

TSO C-179(b) Certified

## BACKGROUND AND PROBLEM STATEMENT

The aerospace community has continually searched for improved energy storage systems to support mission critical equipment. From the days of Lead-Acid batteries to the development of Nickel-Cadmium batteries, the aerospace industry has sought higher power/ energy density battery systems to meet its needs.

With the advent of the “More Electric Aircraft” (MEA), such as the F-35, Boeing 787, and Airbus 350, electrical system power requirements have grown almost exponentially. At the same time, the requirements for reduced component weight and size have become increasingly important considerations.

The potential solution to these requirements was embodied in the Lithium-Ion battery chemistry commercially introduced by Sony in 1991. This chemistry promised a 4-5X improvement in energy/power density, at roughly half the size and weight of previous battery chemistries.

Unfortunately, highly publicized commercial product failures of early Li-Ion battery systems, combined with a few high-profile aviation incidents pointed to a serious lack of understanding of the new technology. This gave rise to intense efforts to better understand the performance and limitations of Li-Ion cells and batteries.

These efforts have contributed to the introduction of new variations of the li-Ion chemistry “family”, as well as new concepts for mitigating the thermal reactivity of these products. In addition, military and regulatory agencies have introduced new Minimum Operating Performance Standards (MOPS), such as RTCA DO-311A and MIL-PRF-29595A to provide definitive guidance on development, testing, and certification requirements for Lithium-Ion battery systems.

## OUR SOLUTION

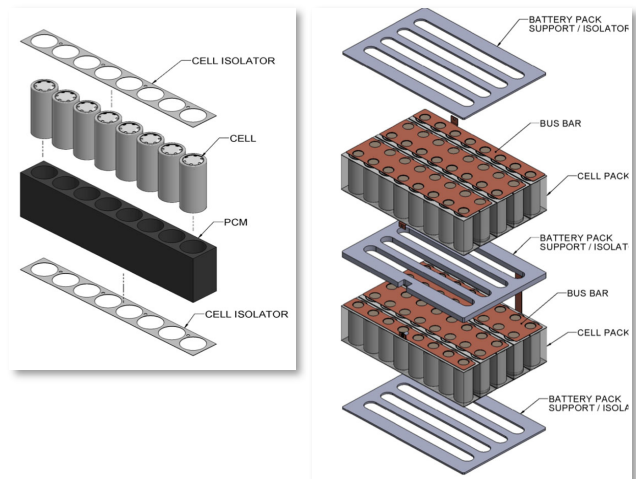
Ultimately, the industry has settled on Lithium-Iron Phosphate (LiFePO<sub>4</sub>) for aviation applications, because of its much-improved abuse tolerance.

With the addition of advanced Battery Management Systems, providing comprehensive electronic monitoring and control of the Battery, it has become possible to envision viable solutions for occupied vehicle applications.

The remaining challenges of dealing with industry concerns over undetectable cell failures can be met by proper mechanical design features such as the use of the Phase Change Material utilized by Acme Aerospace.

This material provides a very significant improvement in protection from propagating thermal events and provides the added benefit of improving performance and life-expectancy by eliminating hot spots with the battery pack during normal operation.

**The use of the Phase Change Material (PCM) provides a comprehensive mitigation against propagation of thermal events and eliminates localized heating during normal operation, improving performance and reducing the likelihood of premature heat induced ageing failure of cells.**



To these ends Avionic Instruments / Acme Aerospace has developed a family of “modular Li-Ion battery products” which are technologically advanced, meeting all the current performance and safety critical requirements for typical commercial and military aviation applications. These products incorporate the following design criteria to address every comment and recommendation from the NTSB findings:

- Lithium-Iron Nano-Phosphate chemistry for safest performance
- Advanced, DSP based Battery Management System, with redundant analog safety and control circuitry
- Ability to transmit battery system State of Charge (SOC) and State of Health (SOH) data, for improved confidence in the battery’s condition and suitability for mission completion
- Electronics developed to comply with DO-254 guidelines
- Tested to many of the most demanding categories of DO-160 environmental requirements (including rotorcraft vibration)
- Software developed to DO-178 (Latest Rev) requirements, DAL B
- ARINC 429 and additional serial communications protocols available
- 26650 Cell size chosen for improved thermal issue mitigation
- Use of Phase Change Material (PCM) between cells to control temperature dispersion and to prevent propagation of any thermal event that might occur in a single cell
- Physical segregation of cells and BMS/control electronics to prevent loss of control due to a potential thermal event in the cell pack

- Vent exhaust port to channel any gases which could arise from a potential cell vent occurrence
- Certification testing for TSO C-179(b), per the requirements of RTCA DO-311A

## COST OF OWNERSHIP

While the higher price for Lithium-Ion batteries is a concern to many, the true gauge is in the yearly cost of ownership. When taking into account the purchase price, amortized over the life of the battery product, including the yearly cost of maintenance associated with a specific battery chemistry, and accounting for weight penalties or savings, for transporting lighter battery products, it can be shown that yearly cost of ownership for Lithium-Ion batteries is on par with much lower priced Lead-Acid batteries, and roughly half the yearly cost of ownership for vented Ni-Cd batteries.

**Acme Aerospace Lithium-Ion batteries can be shown to have a significantly lower Total Cost of Ownership than the very widely used vented Ni-Cd batteries in the industry today.**



## CONCLUSION

In summary, Lithium-Ion battery systems for aerospace applications have realized significant improvements both in performance and operational safety. At present, one can safely say that Lithium-Ion battery systems designed and produced to the current standards by Avionic Instruments / Acme Aerospace are well suited for applications found on commercial and military aircraft.

The many benefits accrued include, weight savings, higher power / energy density than other electro-chemistries, definitive data transmission of SOC and SOH which is not available from other chemistries, noteworthy operational performance improvements across the environmental envelope, and on-condition maintenance instead of scheduled maintenance for significant reduction in the cost of ownership.

## ACME'S PORTFOLIO OF LITHIUM BATTERIES

### Acme 28V Lithium-ion Product Portfolio

#### 48 Amp Hour



48 Amp Hr. (End-of-Life)

##### Features

- 1.5 lbs/AH
- Weight: 67.1 lbs / 30.43 kg
- Size: 10.2 x 11.0 x 13.1 (inches)
- 1100A Cont., 1500A Max
- Lithium Iron Phosphate
- Temp: -35°C to +80°C
- Internal Heaters
- 100% SoC @ 27.5V to 29.2V
- 429 / RS 232 / Discrete
- DO-160G, DO-311A
- TSO C-179(b), DO-178 DAL A
- Floating on the BUS design
- Charger not required

#### 24 Amp Hour



24 Amp Hr. (End-of-Life)

##### Features

- 1.5 lbs/AH
- Weight: 36 lbs / 16.33 kg
- Size: 11.8 x 10.6 x 10.1 (inches)
- 725A Cont., 1220A Max
- Lithium Iron Phosphate
- Temp: -35°C to +80°C
- Internal Heaters
- 100% SoC @ 27.5V to 29.2V
- 429 / RS 232 / Discrete
- DO-160G, DO-311A
- TSO C-179(b), DO-178 DAL A
- Floating on the BUS design
- Charger not required

#### 32 Amp Hour



32 Amp Hr. (End-of-Life)

##### Features

- 1.5 lbs/AH
- Weight: 44.8 lbs / 20.32 kg
- Size: 11.8 x 10.6 x 10.1 (inches)
- 850A Cont., 1440A Max
- Lithium Iron Phosphate
- Temp: -35°C to +80°C
- Internal Heaters
- 100% SoC @ 27.5V to 29.2V
- 429 / RS 232 / Discrete
- DO-160G, DO-311A
- TSO C-179(b), DO-178 DAL A
- Floating on the BUS design
- Charger not required

#### 16 Amp Hour



16 Amp Hr. (End-of-Life)

##### Features

- 1.5 lbs/AH
- Weight: 25.2 lbs / 11.43 kg
- Size: 9.1 x 8.6 x 8.8 (inches)
- 600A Cont., 1000A Max
- Lithium Iron Phosphate
- Temp: -35°C to +80°C
- Internal Heaters
- 100% SoC @ 27.5V to 29.2V
- 429 / RS 232 / Discrete
- DO-160G, DO-311A
- TSO C-179(b), DO-178 DAL A
- Floating on the BUS design
- Charger not required

#### 4.5 Amp Hour



4.5 Amp Hr. (End-of-Life)

##### Features

- 1.5 lbs/AH
- Weight: 6.7 lbs / 3.04 kg
- Size: 12.75 x 2.35 x 8 (inches)
- A Cont., A Max
- Lithium Iron Phosphate
- Temp: -35°C to +80°C
- Internal Heaters
- 100% SoC @ 27.5V to 29.2V
- 429 / RS 232 / Discrete
- DO-160G, DO-311A
- TSO C-179(b), DO-178 DAL A
- Floating on the BUS design
- Charger not required

## **BRIEF COMPANY OVERVIEW**

AVIONIC INSTRUMENTS LLC is a world-class designer, developer and producer of advanced power conversion, control, and electrical power distribution components and systems and ACME AEROSPACE is a world-class designer, developer and producer of aircraft batteries battery systems and energy storage electronics. AVIONIC INSTRUMENTS LLC was founded in the early 1970's, with an extensive commercial, defense, prime contractor, and direct government customer base and then incorporated ACME in 2009 into its power business. AVIONIC INSTRUMENTS LLC and ACME AEROSPACE are respected providers of robust, cost efficient power electronics and energy storage systems and continue our 50+ year heritage with the introduction of its Modular Lithium-Ion battery systems.

### **PROPRIETARY DATA**

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