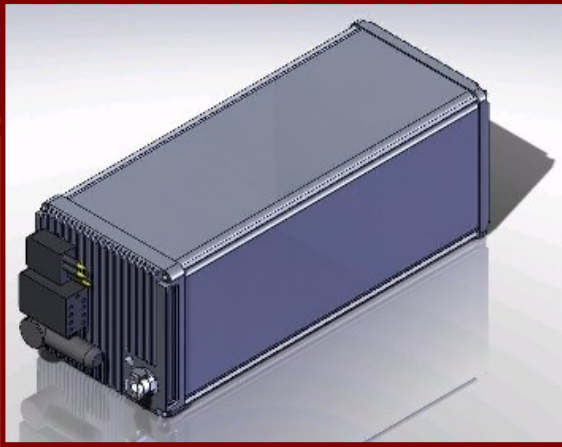


Lithium Ion Battery Modules



**1kWh Module (Nominal 33.3V) in Pressure
Balanced, Oil Filled Housing**

Rechargeable and Pressure Tolerant

Phoenix introduces the latest series of lithium ion modules for use in the next generation of underwater batteries. The advanced designs result in rechargeable batteries that are high energy, pressure tolerant, fault tolerant, and exceed Navy S9310 safety requirements. Our modules are comprised of Phoenix cells that incorporate a proprietary, networked Battery Management System (BMS) that assures charge and discharge protection. All modules contain a BMS header board and can be connected in series and/or parallel to meet differing voltage, load, and energy requirements. Phoenix lithium batteries have been field tested and proven to depths of 12,000 fsw on multiple excursions into the RMS Titanic!

Battery Features

Pressure Tolerant – Designed to operate at ambient pressure or 1 atmosphere. Currently, 1500+ hrs. of demonstrated performance at sea, under pressure. All components are production tested to 10,000 psi.

Battery Management System (BMS) – Three tier design provides control at the cell, module and battery levels. Embedded electronics protect each cell during charge, discharge, and handling. Networked cells and modules provide complete, real time reporting and control of the battery down to the individual cell.

High Energy – State of the art chemistry is packaged to maximize energy density.

Easy Operation – Stackable modules supply up to 275 VDC (higher voltage in development). Battery charging uses a DC supply (48VDC or 375VDC nominal), all cells are automatically balanced every charge. Plug and Play cell and module replacement capability.

Robust – Modules can be stacked in series and/or parallel. The BMS provides warning and resets after faults, recovers the remainder of a voltage stack's energy should a single cell fail, and isolates cells for storage/shipping.

Safety Approval – A Navy S9310 safety review approved a system with Phoenix batteries for submarine Test & Evaluation. Transportation testing is planned.

Standard Modules

Phoenix produces a range of modules for assembly into batteries of any voltage, power, or energy level. Upon request, module configurations can be optimized for specific requirements. Several high energy modules have been developed for 21 inch and larger diameter UUVs.



**Modules can be efficiently adapted
to fit your housing.**

Contact

Andrew Resnick 301.341.7800
aresnick@phnx-international.com



Phoenix Cell* Characteristics

Phoenix Cell BMS Functions	Short/Overload Protection, High Charge and Low Discharge Protection, 1 second Auto-Reset, Cell isolation, Plug-in replacement, and voltage, current, and temperature reporting.
Cell Voltage	3.7 V Nominal, Max. 4.2 V, Min 2.75 V under load
Cell Energy	Sizes available from 15 to 45 A-hr
Cell Energy Density	190 Wh/Kg (chemical cells)
Discharge Current	14 A max. (BMS limit), \leq 10 A (recommended continuous)
Charging	5 A/cell max., cells charge at 5V (large modules charge at up to 375V)
Pressure Rating	0 - 10,000 psi (production test pressure)
Temperature Range	-25°C / +45°C (operating), -20°C / +60°C (storage)
Cycle Life	>300 @ 20°C, 100% DOD to 80% Capacity <i>Cycle life may be increased by limiting voltage range.</i>
Cell Safety Features	<i>BMS in each cell for voltage and current protection during charge and discharge. Cell disconnected for storage & transport.</i>

* A Phoenix Cell integrates the Phoenix BMS to a base cell that Phoenix has made pressure tolerant.

General Module Characteristics

Max. Discharge Current (BMS limit)	Up to 14 A per module, Parallel modules to meet load
Pressure Rating	10,000 psi
Battery Management System (BMS)	Voltage, current, and temperature protection Efficiency: 98% @ 5 A, 95% @ 10 A
Case Material	G-10 FRP or aluminum
Charge Method	BMS does constant current to constant voltage charge. Input 48 or 375 VDC on large or 5 VDC on small modules



The 1.7 kWh module has been tested in 250V batteries with load profiles, overload, and shorts.

Example Module Characteristics

Module Size	1638 Wh, 13 Cell	650 Wh, 12 Cell	1000 Wh, 9 Cell
Battery Voltage	Up to 275 VDC	Up to 55 VDC	Up to 275 VDC
Module Voltage	46.8 V Nominal, 54.6 V to 39.0 V	43.2 V Nominal, 50.4 to 36.0 V	33.3 V Nominal, 37.8 V to 27.0 V
Capacity	14 A	5 A	14 A
Module Dimensions	12.4" x 9.0" x 4.2" (Al housing)	9.25" x 5.7" x 4.25" (+ .5" flange)	13.0" x 4.9" x 4.7" (Al housing)
Module Weight (flooded)	27.0 lbs	12.0 lbs	18.1 lbs
Module Configuration	13S1P	12S1P	9S1P