

# BATTERY POWER PRODUCTS & TECHNOLOGY

Solutions for OEM Design Engineers, Integrators & Specifiers of Power Management Products

## Schwinn and Toshiba Collaborate to Dramatically Alter the Electric Bike Market

Schwinn Bicycles has announced a strategic collaboration with Toshiba Corp. that is expected to dramatically alter the electric bicycle landscape in the US and around the world. Schwinn has incorporated Toshiba's new Super Charge ion Battery (SCiB) technology into the Schwinn Tailwind, a brand new electric bike.

Toshiba's SCiB power technology will enable Tailwind owners to recharge their eBike in 30 minutes through a standard electrical outlet (or as little as five to seven minutes through a commercial charger). By comparison, it takes four hours or longer to fully recharge the battery of virtually any other eBike in use today through a standard electrical outlet, allowing riders to recharge their Tailwind eBike in one-eighth the time of other electric bikes.

In addition, Tailwind owners can expect to see 2,000 recharge lifecycles with the eBike versus the industry standard of 1,000 charges before needing to replace the battery.

Tailwind riders will find that they can ride 25 to 30 miles per charge (depending upon such factors as temperature, rider weight and terrain).

"We are very pleased to supply our first SCiB product to such a well-known and respected company as Schwinn Bicycles and its parent company, Dorel Industries," said Shoshi Kawatsu, general manager, Super Charge Battery Division of Toshiba's Transmission Distribution & Industrial System Company. "Schwinn is one of the most recognized bicycle brands in the world and we are happy to provide Tailwind owners with our innovative SCiB technology."

According to the *Electric Bikes Worldwide Report, 2008 Update*, 20.8 million eBikes were sold worldwide in 2007, a total expected to show only modest worldwide growth in 2009 to 21.6 million units. However, eBikes represent the fastest-growing bicycle category within the US, Europe and a number of other regions.



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### Product News

#### Atmel Extends Li-Ion Battery Lifetime and Safety with Single-Chip Battery Management Family

Atmel Corp. has announced a family of single-chip Li-Ion battery management devices. The new family gives a high analog accuracy at a low power consumption, while ensuring that portable handheld applications have all the necessary safety functions.

Atmel has been working with key battery manufacturers to develop optimized solutions and is now offering a full range of microcontrollers dedicated to Li-Ion battery management supporting one to four cells. This product family offers a unique set of features to optimize performance and safety. By giving extremely accurate voltage measurements it is possible to control the charge and discharge cut-off voltages more accurately, thus making it possible to use up to 15 percent extra energy of the battery compared to less accurate solutions while maintaining all safety requirements.

The family consists of six devices targeting different end markets. The ATmega4HVD and ATmega8HVD target the low-end consumer market requiring protection and authentication. For applications requiring gas gauge, the ATmega8HVA and ATmega16HVA are well suited products, while the ATmega16HVB and ATmega32HVB targets the notebook battery market.

All parts are single chip battery side solutions incorporating a protection with high-side N-channel FET drivers.



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# QUALLION

# Powering Life



Vehicles



Military



Aerospace



Medicine

Since 1998, Quallion has delivered custom battery solutions for demanding applications. From medical implants to high voltage power supplies, Quallion leads the Lithium ion battery industry in safety, reliability and performance. Drawing upon its unique ties to the Japanese Lithium ion battery market, Quallion now offers new battery solutions to the Heavy Duty Truck Market. Enabling technologies such as the Matrix™ Battery Design, Zero-Volt™ capability and SaFE-LYTE™ offer proven battery solutions that can pass the most aggressive test conditions, including full crush and constant overcharge.

Quallion's Matrix™ Battery System was designed specifically for the vehicle market. The concept is based on matrix arrays of 18650 Li ion cells arranged in series to establish voltage, and strings of cells configured in parallel to establish capacity. The advantage of this approach is nominal use of control electronics and cell redundancy for efficient increases in reliability and survivability. Utilization of commercial grade 18650 cells offers the greatest cost effective solution and the highest variability of chemistry configuration as the cells are interchangeable in the Matrix™.

Quallion was founded by biotechnology entrepreneur and philanthropist Alfred E. Mann and Dr. Hisashi Tsukamoto.



(Top) Quallion's new 48.8V Matrix™ Module (4.2kg) comes in 7.5Ah, 9.5Ah and 12.5Ah configurations.

(Above) This 72Ah matrix-design pack offers as a lead-acid replacement for military applications for high power or high energy.

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BATTERY POWER PRODUCTS & TECHNOLOGY (ISSN #1092-3616) is published bi-monthly by Webcom Communications Corp., 7355 E. Orchard, #100 Greenwood Village, CO 80111. Free for the qualified US \$58.00 non-qualified US and \$72.00 elsewhere.

Periodicals Postage paid at Englewood, CO and additional mailing offices.

**POSTMASTER:**

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## From the Editor

As 2008 is starting to wrap up, the editors of Battery Power Products & Technology are developing new features to bring you in 2009. A new addition to 2009 is "Ask an Expert". Email us a battery/power related question. What are the power limitations of thin film batteries? What type of battery monitoring system is best for my remote site facility? Your question and answer, provided by an industry expert, may be featured in an upcoming issue of Battery Power magazine. Simply send me your question and your contact information.

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As always, we look forward to hearing from you!

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## New Batteries on the Market

### East Penn Introduces New Deka Unigy 12AVR170ET Battery Design

East Penn Manufacturing Co., Inc. has introduced the new 12AVR170ET. This front access, 12-volt battery offers 170 amp hours of power. The 170ET maximizes its power offering while fitting into many of the same cabinets as the 150ET with less than an inch of additional height required. For example, a 48-volt/170 Ah battery system will fit into a 23-inch relay rack tray.

All Deka Unigy Batteries use pure lead alloyed with tin, which gives the product higher corrosion resistance. These batteries feature an exclusive individual plate formation process to optimize cell voltage and performance providing dependability and long life. Each plate is hand inspected to ensure full formation.

The 170ET utilizes space saving absorbed glass mat (AGM) construction to maximize performance. Along with a high power and space saving design, its front access terminals makes it easier to install and perform routine maintenance checks. The 170ET is designed specifically for long discharge telecommunication applications such as cellular, PCS and outside plant cabinets.

Proven epoxy-sealed posts and recessed terminals prevent post leakage concerns. In addition, reinforced flame-retardant, polypropylene cases resist bulging and meet safety requirements. This battery is designed to deliver 10 years in full float applications at 77°F (25°C) with the proper charging care and maintenance. The design and construction of the 170ET meets UL recognition requirements and the performance meets or exceeds IEEE 485 and Telcordia capacity requirements. The design is pending IATA approval.



### EnerSys Launches EcoSafe Batteries for Renewable Energy Generation Applications

EnerSys has significantly broadened its product support for the fast growing renewable energy market with the recent launch of its EcoSafe product line. EcoSafe batteries, which use lead, nickel and lithium technologies, were developed specifically for renewable energy storage applications including solar, wind turbine and other electricity-generation alternatives.

EcoSafe products include an enhanced line of lead chemistry batteries, as well as batteries that employ nickel and lithium technologies. EcoSafe batteries offer a selection of energy storage solutions designed to meet the requirements of the latest renewable power-generating operations.

This year, EnerSys is investing in its worldwide manufacturing facilities to expand capacity of lead-based products, including its proprietary thin plate pure lead (TPPL) technology. Recent investments also led to new developments in

nickel-based products for solar and wind turbine applications and developments in new lithium-based solutions. These investments resulted in the acquisition and utilization of a comprehensive range of technologies, with particular attention paid to battery chemistry, manufacturing processes and quality control.

### Saft Develops the Tel.X Battery

Saft has unveiled its new Tel.X battery, the first high-volumic energy density, long-life, maintenance-free nickel-cadmium (Ni-Cd) battery designed specifically to ensure maximum reliability and optimum TCO (total cost of ownership) for telecom equipment installed in OSP (outside plant) cabinets.

Over the last 10 years, telephony platforms have evolved to include added services like data and video. Maintaining the traditional POTS (plain old telephone service) while adding these other services has significantly increased the power demanded by equipment installed in OSP cabinets. However, in turn, there is a greater need for stored energy for back-up power to maintain the same runtime as before, typically eight hours.

However, the battery compartments in OSP cabinets have not grown in size in proportion with the growth in telephony loads. In other words, only the same volume is available to accommodate capacity requirements that are now significantly greater. To compensate for this change in requirements, the runtime must decrease, non-essential loads must shed during a power outage, the amount of stored capacity must increase or some combination of all of these things. Currently, increasing the stored capacity seems like the prudent approach. This puts the burden directly on the battery designers and manufacturers.

The new Tel.X battery offers high-volumic energy density of up to 100 Wh/L while weighing around 30 percent less than a conventional battery. It is designed for use in standard 19 inch and 23 inch racks and cabinets, where its compact size makes it easy to fit and install as a direct replacement for VRLA batteries, a typical installation time for a 48 V battery is 15 minutes and is compatible with all telecoms rectifiers.

Another key feature of the Tel.X is its long service life, more than 20 years in normal temperatures and more than 14 years at 40°C. In many cases the battery can be expected to outlive the installation, during which time it will be maintenance-free, under normal operating conditions, with no need for topping-off with water.

The Tel.X battery design has been certified for compliance to NEBS (Network Equipment Business Systems) Level 3, which is the world's highest safety level for telecom equipment. Furthermore, the Tel.X delivers predictable performance over a wide temperature range, from -20°C to 40°C and can withstand extremes of -50°C to 70°C. This is particularly important as the majority of cabinet installations will not offer a temperature-controlled environment.



### ChargeGuard Introduces New Select Model that Expands Features of Original Vehicle Power Management System



Ledco-ChargeGuard has introduced its new ChargeGuard Select model, which expands upon the company's original automatic shutdown timer for mobile electronics by adding more user-friendly settings and diagnostic features.

The new ChargeGuard Select model continues to offer the standard features of the original ChargeGuard while adding new features including more selectable sensing modes, improved high and low voltage surge protection with a new voltage diagnostic LED to indicate voltage problems, protected terminals, easier setting of timeout delay switches and MIL-STD 810F compliance.

In addition to being the standard vehicle power management system for emergency vehicles, the new ChargeGuard Select is also applicable for use in any vehicle that is reliant on radios, mobile electronics, computers and GPS navigation systems, such as boats, trucks, farm equipment, construction equipment and military vehicles.

### DPI Develops Charging System Aimed at Golf Cart Industry

Diversified Power International (DPI) has developed a battery charging system with a built-in select mode for choosing battery types. While the general rule in golf cart maintenance is always to use the charger made for the golf cart, DPI's new product offers the flexibility of needing one charger to rev up multiple battery brands. DPI's 48-volt golf cart charger has a select switch located on the front so users can choose between four charging modes: Mode 1 for the 48-volt US battery, Mode 2 for the 48-volt Trojan battery, Mode 3 for the 48-volt Exide battery, and Mode 4 for 36-volt general-purpose charging.

The technology resulted when DPI engineers brought in various battery brands and closely worked with them to devise specific charge algorithms for each brand. They then applied the technology to a single charger with select-mode capability.

The company's new 48-volt golf cart charger, priced at \$399.00 (MSRP), comes with a robust output cable Anderson SB 50 connector. DPI has also produced a variety of interface cables for connecting its charger to leading cart brands, including Yamaha, E-Z-GO and even Club Car, which is known for having a built-in power supply system. Cart-customized interface connection cables, called One-2-All, are low cost and readily available in stock.



### DC Battery Power System Provides Accurate Monitoring and Charging Capabilities for Critical Industries

Shurite Systems, a division of Prime Technology, LLC, has introduced the DC power management system, a full scale DC management system that combines charging and monitoring functions for battery powered applications.



The accuracy of the power system is crucial for key industries, such as emergency medical carts, where precise charging information is of the utmost importance.

The DC power monitor provides crucial power source information required in a mobile working and computing environment, thus enhancing the marketability of DC equipment. The monitor is capable of completing diagnostics for troubleshooting and evaluating warranty claims as well as automatically scheduling power supply and battery maintenance. Additionally, the monitor is capable of creating event log spreadsheets and charge/discharge curves. Event logs are useful for both keeping track of the battery system history and making changes in the product's use in order to extend and maintain proper operation. The system is designed to incorporate specific curves for battery manufacturers and

chemistry, which helps to prolong the duration of the battery system by accurately predicting the life of the battery and charge time. Conveniently, the system can be adapted to be used with any power platform.

The DC charger is a 10 or 20 amp, three stage, multi-profile, precision, multi-chemistry battery charger that utilizes a microprocessor. The charger provides full communication with the aforementioned DC power monitor and the system allows the end user to receive data for evaluation via a USB port. A computer program is supplied to the end user specifically for this function. The DC charger has built in A/D inputs that monitor and control battery charging voltage and current, while also compensating for load current during charge. Furthermore, the charger has a driver that will support the standard indicator/switch functions of a customer provided fuel board. The algorithms used to charge the batteries can be uniquely designed for the specific chemistry as well as each manufacturer's features. This option to fully customize the unit allows for complete optimization of the charging system.

The combination of the DC power monitor and charger provides a robust and unique system, capable of full battery power charging, management and data capture/logging. The system is designed to operate as a single source solution for DC power management and is UL60601 approved for all medical applications.

### Rogue Engineering Launches National Product Line of Charge Controllers

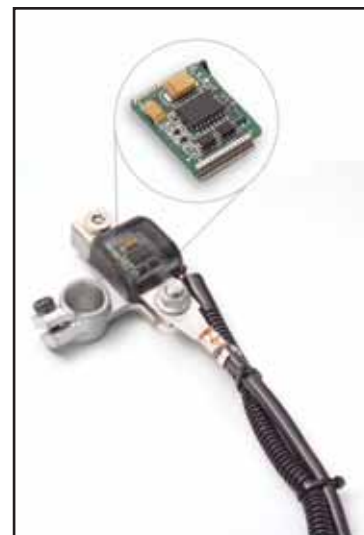
Rogue Engineering has launched their new line of Rhino charge controllers. The Rhino, a product line of 6, 12 and 24 volt, 5 amp solar charge controllers, is designed to operate with no maintenance in the most challenging industrial and recreational settings. Consuming 400 micro amps, the smallest self-consumption rate in the industry, the Rhino provides optimal battery performance. Simple and rugged, this charger can be powered by a solar panel or an AC adaptor for either on or off-grid systems. The Rhino product line is one of the only 5 amp controller lines to offer three-stage charging. The Rhino also features linear charging, pluggable connectors and urethane encapsulation all in a small convenient size.

### Delphi Battery Monitoring Device Can Have Impact on CO<sub>2</sub> Emissions

If the entire vehicle population of Russia, currently about 31 million vehicles, was equipped with intelligent energy management systems featuring the Delphi Battery Monitoring Device from Delphi, CO<sub>2</sub> emissions could be cut by about 4.65 million tons of per year.

The Delphi Battery Monitoring Device combines an innovative IVT sensor with software that calculates the battery state of health (SOH) and state of charge (SOC) and alerts drivers to batteries that are in need of replacement or charging. It helps ensure optimal battery performance, making more electronic features possible while ensuring sufficient power for starting the engine. When integrated into a vehicle as part of active energy management system, the Delphi Battery Monitoring Device can also help improve fuel efficiency and extend battery life.

With the Battery Monitoring Device and innovative components, such as the IVT battery sensor, Delphi stands prepared to support the international automotive industry actively in their efforts to improve the environmental compatibility of their



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## Charging, Testing &amp; Monitoring

vehicles and to reduce CO<sub>2</sub> emissions.

Delphi's Battery Monitoring Device features local interconnect network (LIN) or controller area network (CAN) interface for data and diagnostic communication. It is mounted on the negative battery post or in a pre-fuse box on the battery and is designed for use in passenger and commercial vehicles beginning with model year 2010. The CAN interface version will be available soon. The Battery Monitoring Device can also be adapted for use in off-road vehicles and the marine industry.

### Dual-Channel Power Optimized for High-Speed Testing of Portable Battery Powered Devices

Keithley Instruments, Inc. has introduced the Model 2308 Portable Device Battery/Charger Simulator, a dual-channel battery- and charger-simulating power supply designed to provide the lowest cost testing of both the growing range of mobile phones with new, complex transmission schemes and other types of new portable devices that consume extremely low amounts of power. The Model 2308's fast transient output response maximizes production yields by maintaining a stable voltage level under dynamic loading conditions. In addition, its measurement engine enables more accurate characterization of both full power operation and low current sleep modes for quantifying power consumption so that design and manufacturing can ensure that battery life of the latest portable electronic devices is maximized.



Unlike conventional power supplies, the Model 2308 features extremely fast recovery even when load currents change by a factor of 10 or greater. This can happen when a portable device or component transitions near-instantaneously from a sleep or standby state to a full power operating state and then returns to the original state. If the load pulse is too short, the conventional power supply may never return to its stable output level during the pulse. Even with long test leads, which add substantial inductance to the load circuit between the power supply and the device under test (DUT), the Model 2308 maintains a stable output voltage in response to pulse loads with a transient voltage drop of under 90 mV and a transient recovery time of under 35  $\mu$ s.

For R&D applications, the Model 2308 not only has wide current measurement range for analyzing power consumption, the power supply also has an analog output to enable developers to analyze all the details of their load current including the start-up sequence and all operating modes. R&D engineers can easily determine total device power consumption. In addition, the Model 2308 can simulate the performance of a battery by simulating the battery's internal resistance with a programmable output resistance.

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### Introducing the SBS-2500 Digital Specific Gravity Tester at SBS

Storage Battery Systems, Inc. offers a new solution for Digital Specific Gravity testing. The SBS-2500 offers accurate, temperature-compensated, specific gravity results within seconds and has a testing range of 0.000 to 2.000.

Field studies have shown time savings of more than 5 times (500 percent) using the SBS-2,500 digital hydrometer versus a standard glass hydrometer and thermometer. The storage capability is 1,100 results internally, which includes a custom excel software that enables the user to download the results for instant battery records.



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## High Voltage Battery Stack Monitor Supports Hybrid/Electric Vehicles and Battery Backup Systems

Linear Technology has released the LTC6802, a highly integrated multicell battery monitoring IC capable of measuring up to 12 individual battery cells. The device's proprietary design allows multiple LTC6802s to be stacked in series without optocouplers or isolators, for precision voltage monitoring of every cell in long strings of series-connected batteries. Long battery strings enable high power, rechargeable applications, such as electric and hybrid electric vehicles, scooters, motorcycles, golf carts, wheelchairs, boats, forklifts, robotics, portable medical equipment and uninterruptible power supply (UPS) systems.

With improved energy density, lithium-ion batteries are poised to be the power source of choice for these applications. However, designing a large, highly reliable and long-lasting Li-Ion battery stack is a very complex problem. Li-Ion cells are sensitive to overcharging or over-discharging, requiring that each cell in a stack is carefully managed. The LTC6802 makes this possible with quick and accurate measurements of all cell voltages, even in the presence of stack voltages over 1,000 V.

The maximum total measurement error is guaranteed at less than 0.25 percent from -40°C to 85°C and all cell voltages in a battery stack can be measured within 13 ms. Each cell is monitored for undervoltage and overvoltage conditions, and an associated MOSFET switch is available to discharge overcharged cells. Each LTC6802 communicates via a 1 MHz serial interface, and includes temperature sensor inputs, GPIO lines and a precision voltage reference.

The LTC6802 was designed for the environmental and reliability challenges of automotive and industrial applications. The LTC6802 is an 8 mm by 12 mm surface mount device. The combined robustness, exceptional precision and tiny package directly address the critical requirements of emerging and advanced battery technologies.

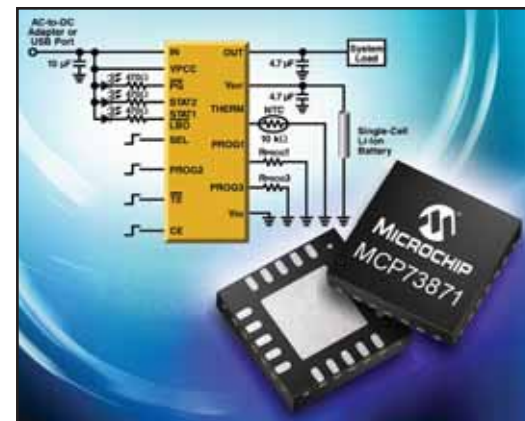
## Microchip Technology Debuts USB/AC Load-Sharing Li-Ion/Li-Polymer Battery Charger

Microchip Technology, Inc. has introduced the MCP73871 charge-management controller, a Li-Ion/Li-polymer charger with an intelligent charge management feature that enables simultaneous AC-DC-adapter or USB-port charging and powering of devices. The single-chip charger features an integrated pass transistor and numerous battery and termination-voltage options making it well suited for complex, space-constrained portable applications.

By enabling electronic devices to be simultaneously powered and charged via either an AC-to-DC adapter or through a USB port, the MCP73871 charge-management controller simplifies the charging and powering of today's portable electronic

devices. With highly accurate voltage regulation of 0.5 percent, the new charger extends battery life by allowing the battery to be charged closer to its optimal limit. Additionally, with its integrated pass transistor, the charger eliminates the need for an external FET, and only a few small passive components are necessary. This results in smaller, less complex and less expensive designs.

The MCP73871 charge-management controller is well suited for portable consumer electronic products, such as GPS units, phone chargers, toys, cameras, PDAs and Bluetooth headsets. The MCP73871 charger is available in a 20-pin, 4 mm by 4 mm QFN package, for \$1.28 each in 10,000-unit quantities.



## Battery Charger Enables True Universal USB Charging While Minimizing Solution Footprint

Summit Microelectronics has introduced its third-generation programmable battery charger integrated circuit (IC) for single-cell Li-Ion and Li-polymer powered systems.



The SMB339 integrates the largest feature set in the industry, including compatibility with all relevant industry standards: USB 2.0 Specification, USB on-the-go supplement, USB battery charging specification 1.0, IEEE1725 Standard, Chinese USB charging specification and others. This charging solution automatically adapts to and delivers the fastest battery charging from any power source (USB host/hub, AC/DC, etc.) with-

out the software required in typical implementations. Additionally, high integration reduces bill-of-material count/cost and solution size to levels comparable to inferior linear charging solutions, while cutting power dissipation by 80 percent. Like all Summit's solutions, digital programmability is built-in, providing design and system flexibility at no additional cost.

The SMB339, based on a high performance 3 MHz switch-mode architecture, is the industry's most integrated single-cell Li-Ion charger. The device's high-efficiency operation, coupled with Summit's proprietary TurboCharge patent-pending technology, allows for highest charging current (up to 750 mA from 500 mA USB source) and lowest power dissipation. This allows for slim industrial designs and significantly faster charging times; two valuable differentiating factors for handset and other consumer products.

A wide variety of programmable safety features are also integrated to meet the strictest safety standards, including IEEE1725. These include dual redundant protection for input/output current and voltage, chip and battery thermal protection, hardware and software safety timers, battery missing detection and a variety of status and fault registers.

The SMB339 operates with an input range from 3.5 V to 6.2 V input and safely withstands continuous input over-voltage up to 16 V (non-operating), while protecting downstream circuitry. The SMB339 is offered in a 2.3 mm by 2.0 mm, 20-ball, lead-free chip-scale (CSP) package with an operating temperature range of -30°C to 85°C. Available now in production quantities, the SMB339 is priced at \$1.24 each in quantities of 10,000 units.

## Infineon Helps Protect Consumers From Counterfeit Batteries with Authentication Chip

Infineon Technologies AG has introduced the world's first chip that uses asymmetric authentication featuring elliptic curve cryptography (ECC) and integrated temperature sensor that

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can be used by battery and electronics manufacturers to detect unauthorized accessories and after-market replacements. This counterfeit detection capability helps manufacturers ensure the intended user experience and protect against safety risks posed by unauthorized and untested accessories or batteries.

The new ORIGA SLE95050 family includes a version with an integrated temperature sensor that can further improve the safety level of batteries for electronic devices such as digital cameras, mobile phones and portable computers. The ORIGA SLE95050 can also be used for printer cartridges, replacement parts, medical disposables, networking equipment or other accessories, such as earphones, speakers, docking stations and chargers. With SLE95050 production start projected for the end of 2008, first consumer products, such as digital cameras, integrating Infineon's authentication chips are expected to hit the shelves during the second half of 2009.

The ORIGA SLE95050 complies with emerging battery safety regulations, for example in Japan, that require temperature monitoring of lithium-based batteries. It has a built-in analog-to-digital converter that allows convenient temperature monitoring from either its on-chip or an external sensor. This is done by just sending a bus command via Infineon's proprietary single wire interface. This single wire interface of the ORIGA SLE95050 allows smooth system integration and remote powering over this single line. With non-volatile memory (NVM) of up to 1 kbit including NVM for write-protection and unique chip ID, ORIGA also provides the added benefit of personalization by storing data about the specific accessory, the logistics chain and the usage of the accessory itself.

The SLE95050 operates at the temperature range from -25°C to 85°C and at an operating voltage range of 2.0 V to 5.5 V. The ORIGA SLE95050 family today comprises two members. The SLE95050F1 including the temperature monitoring feature and SLE95050F2 without temperature monitoring. Samples of both devices are available with production expected to start at the end of 2008.

The TPS65920, TPS65930 and TPS65950 devices reduce board space and efficiently manage system power and control for an OMAP35x processor. The TPS65950 supports up to 14 channels of power management conversion. In addition to integrated 3 MHz DC/DC converters and low-noise LDOs, it includes a dual audio codec and drivers, monitor and control features, a battery charger, an LED driver, a 10-bit, three-input analog-to-digital converter, vibra and keypad functionality, a high-speed USB transceiver with integrated 5 V power supply and an I2C communications interface, all in a 7 mm by 7 mm BGA package. The TPS65920 and TPS65930 devices, which offer a subset of features of the TPS65950, come in a 10 mm by 10 mm package and support up to 8 voltage rails.

The TPS659xx, TPS65023 and TPS6235x devices use a dedicated I2C communications interface to enable TI's SmartReflex power and performance management technologies, resulting in additional power savings.

Visit the Battery Power Online Knowledge Center for in-depth, technical articles on integrated circuits including power management, fuel gauging and power conversion.

[www.batterypoweronline.com/bppt\\_edhighlights.htm](http://www.batterypoweronline.com/bppt_edhighlights.htm)



### Integrated Analog Companion Chips Combine Power Management And Signal Chain Functionality to Optimize Power Performance

Building on its power management portfolio targeting embedded processor designs, Texas Instruments, Inc. (TI) has introduced three fully integrated power management and signal chain companion chips to support all system power requirements of an OMAP35x processor-based design. Combining leading power management circuits with TI's low-power embedded processors results in optimized power and performance, leading to longer battery life and system run-time.

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## New 120 Watt External Power Supply from SL Power Electronics Meets Energy Star and EISA Requirements

SL Power Electronics has announced the newest addition to its line of Ault brand AC-DC external power supplies. The CENT1120 series is a single output, desktop-style external power supply with an output range of 110 watts to 120 watts. The new family complies with Environmental Protection Agency (EPA) Energy Star Level IV and Energy Independence and Security Act of 2007 (EISA) requirements. The new Ault CENT1120 is available in five voltages from 12 volts to 48 volts.



The Ault CENT1120 family is suited for applications in the industrial, computer peripheral, networking, displays and test/measurement markets. The series also meets EMI/RFI regulations and is IPX1-compliant, featuring casings that can withstand falling water at a rate of 10 mm per minute for 10 minutes with no water reaching the internal components.

All models feature a universal input of 100 VAC to 240 VAC and an impact-resistant, non-vented polycarbonate enclosure. Competitively priced at \$39.38 in OEM quantities, the CENT1120 is a reliable, high-performance solution for a variety of applications in the global electronics market.

All models of the Ault CENT1120 can be modified to meet unique power or connectivity requirements, and private label marking needs. SL Power Electronics also can design a completely custom solution to meet specific OEM requirements.

## Eaton Introduces Energy Saving UPS for Protecting Servers, Storage Devices and Telecommunication Systems

Diversified industrial manufacturer Eaton Corp. has introduced its new Pulsar M uninterruptible power supplies (UPSs). Responding to user's needs to maximize energy efficiency, the Pulsar M, sold under the MGE Office Protection Systems brand, features a high-efficiency design that saves energy and prevents excess heat when installed

into a network rack.

The Pulsar M is the first on-line double-conversion UPS in its class with an adaptable, multi-position, hot-swappable Power Distribution Unit (FlexPDU). The FlexPDU provides a space saving method of adding receptacles to the back, side or top of the UPS, freeing up much needed space in dense rack environments. In addition, optional universal HotSwap Maintenance By-Pass modules allow the UPS to be replaced, serviced or upgraded without interrupting the supply of power.

At 3.5 inches (2U) high for deep racks along with a 5.25 inch (3U) short depth unit to accommodate shallow telecom racks/enclosures, the Pulsar M's slim design offers users system flexibility and increases the power density to allow for continual power for information technology (IT), telecommunications, healthcare and industrial systems.

For applications requiring several hours of backup during a power outage, the units feature scalable runtimes and, with the 3,000 VA XL model, can accommodate up to 12 external battery banks. Furthermore, in order to maximize backup time for critical devices connected to the UPS, Eaton's Powershare technology enables users to remotely reboot systems and gracefully turn off less critical equipment.

## APC Expands its MGE Galaxy 5000 UPS Product Line in North America

APC by Schneider Electric has released of the MGE Galaxy 5000 uninterruptible power supply (UPS) for the North American market. Designed for flexibility to meet the needs of many environments, the MGE Galaxy 5000 UPS line also offers paralleling capability, without the need for an external static switch, to enable scalability for increased capacity or redundancy. This new solution, which can boost capacity from 40 kVA up to 520 kVA, allows IT and facilities managers to respond to increasing demands placed on power infrastructure in growing facilities.

The on-line, three-phase MGE Galaxy 5000 offers scalable power protection using innovative high availability topology to protect all critical loads. Single module systems are available with 40 kVA to 130 kVA power ratings.

Relying on advanced inverter technology to restrict total harmonic distortion to less than 5 percent, the MGE Galaxy 5000 delivers clean reliable power even in the harshest of electrical environments. A 100 percent step-load capability ensures a fast response to load changes with accurate voltage regulation. In addition, the MGE Galaxy 5000 incorporates fault tolerant circuitry that protects the UPS from accidental short circuits usually caused by load side failures or overloads.

Energy shortages and increasing power demands require full generator compatibility for many critical installations. To meet this requirement, the MGE Galaxy 5000's distortion-free power factor corrected input boasts the industry's best generator compatibility that improves efficiency and eliminates the need to significantly oversize connected generators for reliable operation with the UPS.



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## Sealed Air Corp. Deploys Blue Spark Thin Printed Batteries to Power its New RFID Time and Temperature Data Logging Sensors

Sealed Air Corp. has selected Blue Spark Technologies' thin, flexible batteries as a core component of its TurboTag RFID-enabled time and temperature monitoring and data logging solution.

According to Bill Roberts, a research fellow in Sealed Air's Technology and Innovation group, the TurboTag "active packaging" sensor solution represents a breakthrough in time and temperature monitoring technology due to its ability to track and record temperatures in real time, from the processing plant, in transit and up to the point of delivery. This enables suppliers of consumables and temperature-sensitive products, such as meat and dairy products, fresh produce, frozen and refrigerated foods, pharmaceuticals, biologicals and other chemical substances, to minimize waste by ensuring proper cold chain quality control and compliance.

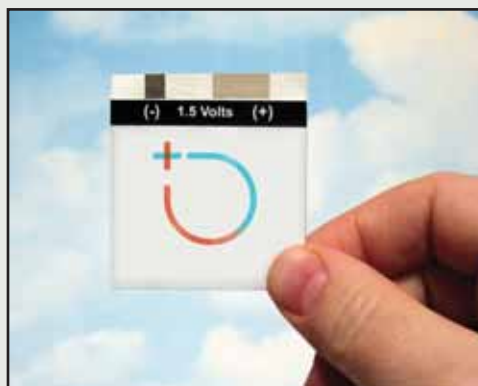
"Our TurboTag battery-assisted RFID smart card's real-time temperature sensing and data capture capabilities offer a huge

improvement over existing time and temperature monitoring technology," explains Roberts. "To power our system's autonomous data logging capabilities, we selected Blue Spark

Technologies' 1.5-volt printed batteries. Theirs was the only eco-friendly battery that fully met Sealed Air's specified operating temperature range, and was thin, flexible and affordable enough to be embedded with the RFID chip into our compact credit card size form factor."

Matt Ream, Blue Spark Technologies' vice president of marketing, said, "We are excited to be working with Sealed Air, a global leader of innovative performance-based materials. Their TurboTag battery powered RFID smart card application is a perfect example of how Blue Spark works

with customers to provide a safe, reliable 'green' power boost advantage to their new product concepts. Typically, selecting thin, printed batteries enables them to reduce material costs, simplify production and bring products to market faster."



Power Supplies



**HP R5500 UPS Delivers 4,500 Watts in 3U Rack-to-Tower Profile**

Introducing the rack-to-tower HP R5500 uninterruptible power system (UPS). Designed for dense data-center environments, the HP R5500 UPS offers improved power density of watts per U-space. More true power in a smaller form factor provides more performance while saving valuable rack space for server and storage equipment. The HP R5500 UPS has 1,500 watts per U, 4,500 watts total in 3 U. This line-interactive UPS uses a digital signal processor rather than a transformer and provides voltage regulation without using the battery. With two independently controllable load segments, an optional rack-to-tower conversion kit, and no-cost HP Power Management software bundled in the box, it's easy to

customize this UPS to unique situations and manage systems quickly and remotely. Option cards and Extended Runtime Modules (ERMs) add networking capabilities and load segmentation, while increasing system back up time.

The two load segments provide the flexibility to configure scheduled startups and shutdowns, in addition to independently control separate loads. Working in conjunction with HP Power Management Software, the HP UPS R5500 can be configured to prioritize and extend the runtime of critical devices. By shutting down a load segment that is connected to less critical equipment, the runtime for more critical equipment is extended, providing additional protection.



**Redundant DC/DC Converter System with 500 Watt Plug-In Modules Built to Last in Heavy-Duty Environments**

Absopulse Electronics' BAP 419 is a redundant DC/DC converter system comprised of up to five, 500 W DC/DC plug-in modules in a pre-wired 4U by 19-inch by 15-inch shelf. It is based on the same design topology as similar systems that have been operating in power utilities, industrial plants, air-traffic control systems, telecom and other critical applications for more than 20 years. Cooled by natural air convection, the BAP 419 system has no fans or other moving parts. This, as well as very large design headroom, ensures high reliability and makes the system well suited for maintenance-free operation in remote locations.

The BAP 419 plug-in modules each deliver 24 VDC, 48 VDC or 125 VDC and accept an input of 24 VDC, 48 VDC or 125 VDC. Every module is hot-insertable and has a built-in redundancy diode, which allows for parallel and N+1 redundant operation. Built-in redundancy also allows for a battery to be connected to the output for back-up purposes. Modules with different outputs can be combined in one shelf to create a multiple-output system.

**High Efficiency AC-DC Power Supply**

Emerson Network Power has launched a high efficiency 100 to 150 watt AC-DC supply that features both ITE and non-patient contact

and non-patient critical medical safety approvals. The new LPS103-M power supply is a compact open-frame design. Measuring 2 by 4 inches, with a height of 1.29 inches, it has a typical full load efficiency of 88 percent and a power density in excess of 14 watts per cubic inch. The supply is primarily intended for use in information technology equipment and light industrial systems, as well as for equipment intended for non-patient contact and non-patient critical use in low power medical, dental and laboratory applications.

LPS103-M power supplies are comprehensively protected against overvoltage, overtemperature and short-circuit conditions, and feature a power fail signal for remote monitoring purposes that will change state at least 6 ms before the main output loses regulation. The power supplies have a full load ambient operating temperature range of 0°C to 50°C without de-rating and can cold-start from temperatures as low as -20°C. Between 50°C and 70°C, the output should be derated by 2.5 percent per degree.



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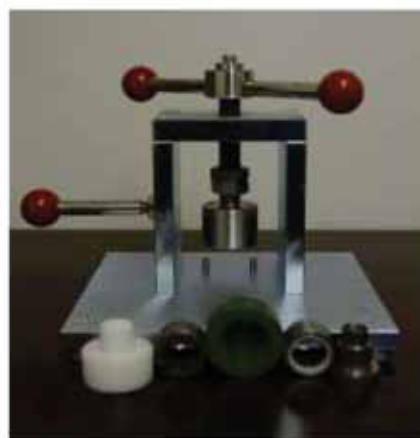


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# Accurate Battery Backup for Medical Devices

**Keith Keller, Analog Field Applications / Power Management Engineer**

*Texas Instruments*

**Michael Banak, Principle Design Engineer**

*Eclectic Engineering*

## The Challenge

Reliable power is essential in medical systems. To guarantee uninterrupted power, a battery backup is used. Historically, larger medical devices used lead-acid batteries to provide uninterrupted power. To be practical, they required sophisticated motion systems that are also expensive, resulting in a large, heavy, expensive system. Now with the latest generation of battery "gas" gauging electronics, Lithium-Ion (Li-Ion) batteries can be used safely to determine extremely precise available energy. This allows for much smaller and lighter weight medical equipment, versus lead-acid battery technology from the past.

The natural alternative to lead-acid battery cells is nickel metal hydrate (NiMH) or Li-Ion chemistry batteries, both of which provide much better energy density. Li-Ion cells provide the highest energy density with more volatile chemical components that can be unsafe, if not properly handled. For patient-critical systems no matter what battery chemistry is used, accurately estimating the remaining energy is essential. With Li-Ion batteries the best of both worlds can be achieved: accurate knowledge of gauging and highest energy density.

With previous battery metering electronics, inaccuracies in reported capacity would creep in over time. We could only make an educated guess on how the individual cells would "age" over time. The primary reason that Li-Ion batteries have less usable capacity over time is due to increased internal impedance of the electrolyte anode/cathode material. Li-Ion cells have certain known characteristics such as impedance, which is extremely dependent on temperature, impedance changes during discharge and high temperatures and minute over-voltage charging cause a large degradation to cell capacity. One hundred charge/discharge cycles can double internal impedance [1] as shown in Figure 1. (A cycle is defined by a

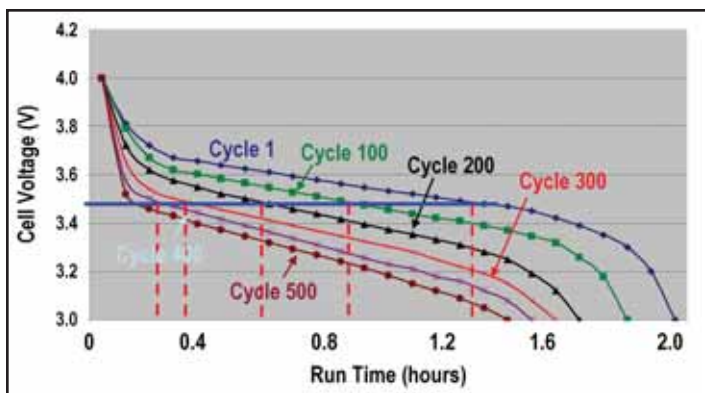


Figure 1. Impedance Change with Charge/Discharge Aging. The system terminate voltage will be reached sooner with an aged Li-Ion cell with higher impedance.

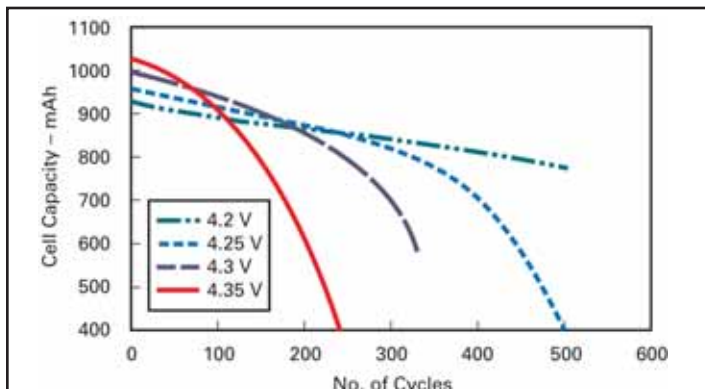


Figure 2. Charge Voltage Affects Battery Service Life. Properly charging Li-Ion batteries requires highly accurate charging voltage. Over charging shortens battery cycle life.

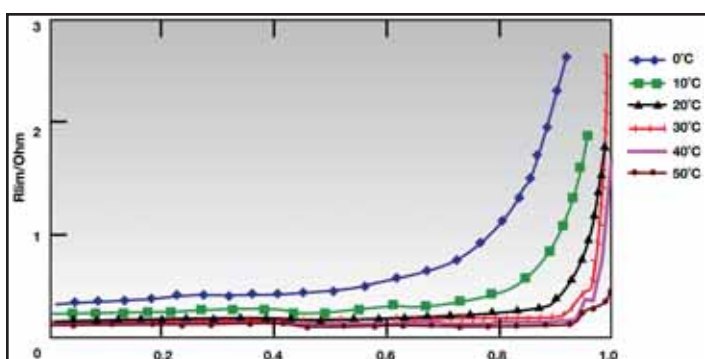


Figure 3. Li-Ion Impedance Dependence on Temperature and Depth of Discharge (DOD). Li-Ion battery cell impedance is highly dependent on temperature. Impedance decreases about 1.5 times with a 10°C increase.

greater than 70 percent energy that flows out of and into the cell.) Charging even 50 mV above a 4.2 V (max) cell will decrease cell life by half [1] (Figure 2). Cells more than 80 percent discharged will see a five times increase in impedance from room temperature to 0°C [1] (~300 mOhm to greater than 1.5 ohm DC impedance). See Figure 3.

Impedance is key to the whole equation. In the past, going to production with a battery pack design was very involved. Charge and discharge characteristics over minimum, room and maximum temperatures were needed to generate coefficients used in a polynomial equation for better discharge estimation. Knowing how the individual cell's impedance actually changes over time could only be estimated before. Additionally, traditional gas gauges needed to be occasionally "reset" to relearn the battery pack's maximum capacity. Therefore some medical system battery packs would need to be sent back to the manufacturer to do this learning cycle.

With all of these uncertainties addressed, the designer understood that the accuracy of reported capacity could be off by as much as 20 percent. Designers would double the capacity actually needed up front, assume unpredictable degradation of cells over time, as well as buffer the information received by the gas gauge's estimated capacity calculation to the user. To be sure, a reliable medical system cannot report remaining runtime as with laptops: "20 minutes remaining," then "you must plug in immediately."

## The Solution

This inaccuracy in reporting true remaining battery capacity is removed with next generation Impedance Track algorithm technology from Texas Instruments. This algorithm determines the state-of-charge for a Li-Ion cell, as well as fully predicts discharge behavior using the following parameters as part of a comprehensive battery model:

1. The cell's total chemical capacity ( $Q_{max}$ ) is initially specified as the datasheet capacity (e.g., 2,400 mAh for an 18650 cylindrical cell), but is automatically updated after the first charge/discharge cycle of the battery by the gas gauge.
2. The amount of electric charge that has passed into or out of the cell is measured/acquired by the "coulomb counting" process.
3. The present load current in the system (average and peak loading).
4. The cell's internal impedance while delivering current changes over temperature, cell-aging affects, and during discharge as individual cell impedance varies by state-of-charge.
5. The cell's open-circuit "relaxed" voltage is measured at light load ( $<C/20$ ) with a change in battery voltage less than a few milli-volts over a sampling period. When fully charged the required rest period is shorter than when the cells are deeply depleted.

A precise capacity estimate can be calculated by:

1. Measuring cell open-circuit voltage (in a relaxed state)
2. Monitoring the cell voltage profile while loaded (finding cell impedance)
3. Integrating current in and out of the battery

All Li-Ion batteries of the exact same chemistry / anode / cathode material have extremely similar relaxed voltage / state-of-charge profiles. Amazingly, this is independent of cell manufacture. This knowledge allows us to determine the maximum capacity of the cell and the cell's remaining capacity.

For example, if you know that: 1) a 3.6 V relaxed voltage correlates to 10 percent state-of-charge; 2) during charge the gas gauge integrates 1,000 mA; and 3) the resulting open-circuit voltage of 3.95 V correlates to 93 percent state-of-charge, the batteries true capacity is 1,206 mAh (1,000 mA/83 percent). If the cell voltage increases from 3.6 to 3.8 V with a 1 A charge current, the DC impedance is 0.2 Ohm at 10 percent state-of-charge and room temperature. If the minimum voltage our system can tolerate is 3 V, Impedance Track will calculate and report the remaining battery runtime of perhaps seven minutes remaining at a 1 A load from 10 percent state-of-charge.

Over the past several years, electronics hardware implementation has evolved. The original chipset consisted of three separate ICs: a gas gauging microprocessor, an analog front-end (AFE) and secondary over-voltage protector. The microprocessor integrates current and runs the gas gauging algorithms, as well as communicates directly to the AFE. The high-voltage tolerant AFE measures cell voltages (with integrated analog-to-digital converters - ADCs), provides over-current protection

as well as performs cell-balancing. Both ICs can work independently from a safety standpoint. A third level of protection comes from an independent secondary voltage protector that triggers a chemical fuse for a permanent fault condition. (Over-voltage is the most dangerous condition for Li-Ion batteries as it has the potential to cause combustion.)

The latest generation of Li-Ion battery meters integrates both the microprocessor and AFE silicon into one plastic package, thus significantly reducing system level complexity and board space requirements. Communication with the gas gauge is handled over SMBus standard protocol (SMBus is based on the I2C communication protocol). The gas gauge can communicate directly with a compatible battery charger or microcontroller.

Impedance Track technology is actually a lower-cost battery solution implementation. This technology removes the need for a production learning cycle. For batteries of any significant capacity, this can take several hours. Now, each battery coming off the line is programmed with what is called a "golden image." This file is created during the engineering evaluation stage. The Impedance Track algorithm is constantly adapting to the state of the cells. So during the battery's first discharge in the field, Impedance Track learns precisely the true pack capacity within the first 40 percent discharge or charge. After that the reported capacity will be 99 percent accurate.

## Conclusion

Impedance Track battery metering technology allows the medical engineering community to design life-sustaining and portable devices with battery backup that are more reliable than previously possible. Most importantly, it offers dramatically improved fuel gauge accuracy and removes the necessary "reset", which certainly isn't practical in a life-sustaining medical applications. It eliminates the need to drastically over-engineer battery capacity to meet specific backup timeframes and offers a lower cost solution by eliminating the need to cycle every battery pack during the production phase.

Understanding and tracking individual battery cell impedance is key to precisely predicting remaining runtime and energy. As has been discussed, the most significant cell aging effect is due to high temperature, as well as charging above its maximum rated voltage - even a 50 mV higher than rated voltage can reduce a battery's lifetime by half. Li-Ion cell internal impedance increases (ages) from normal usage charge / discharge cycling, and impedance drastically increases at low temperatures without decreasing lifetime.

The adaptive nature of the Impedance Track algorithm monitors these aging factors by monitoring cell voltage in a relaxed and loaded state, and integrating current during charge and discharge. There is no need to "guess" the impedance as it is continuously monitored and, therefore, the true battery capacity can be precisely calculated over the entire life of the battery.

*Keith James Keller is a power analog field applications engineer for Texas Instruments. His current responsibilities include customer support for power devices in the Midwest region, primarily focused on portable systems. He received his MSEE and BSEE from the University of Wisconsin.*



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*Michael A. Banak, PE, received his MSEE and BSEE from IIT, Chicago. He is an Electronics Design Consultant operating in the Chicago area since 2006. His focus includes Industrial Electronics, Battery Management, Intrinsic Safety, IC Design, Telecomm, SPICE Modeling and Geomatics.*



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## References

[1] "Factors that affect cycle-life and possible degradation mechanisms of a Li-Ion cell based on LiCoO<sub>2</sub>," *Journal of Power Sources* 111 (2002) 130-136.

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# Load Switches in Today's Mobile Applications

**Stephen Stella, Segment Marketing Manager, Low Voltage, Mobile Power Solutions**  
Fairchild Semiconductor

Consumers have an insatiable appetite for smaller, lighter and function-rich portable electronic devices. This desire forces consumer companies to pursue their own insatiable desires. "Make it smaller, cheaper and easier." The answer is not new, it's all about integration, and it is evident everywhere in portable electronics product design. These integration trends are commonplace in the latest power management ICs, evolving from the simple MOSFET switch into today's advanced load switches.

## Integration

The ultimate benefit, while not a new concept, is clear: "design simplification". This integration trend in power management has resulted in numerous benefits, including

reduced package count, optimized power consumption, improved system robustness, reduced design effort and reduced costs. All of these combine to form even more benefits. For instance, the packaged solution adds functionality, which reduces component count and improves system robustness. This solution ultimately reduces PC board space, reduces the application processor load and alleviates the need for design resources to spend time debugging designs. The resulting benefit allows engineers to integrate more functionality into their products, while simultaneously providing the processor loading, PC board space and BOM cost savings to accomplish it.

The latest generation of load switches adds new levels of functionality, including information. New products are providing fault and diagnostic information, which in turn allows the application controller to better address safety and performance concerns and improves the end-application experience.

## Evolution of Load Switch Integration

The simple MOSFET switch offered the most basic of protections, allowing a load and source to be disconnected. The downside was that the application processor could not directly drive the gate of the power switch. The discrete solution added a separate driver circuit, but that increased BOM count, required more PCB area and increased the design effort and the overall cost.

Over the past few years the device manufacturers have integrated the gate-drive circuitry inside the switch package, addressing the weaknesses of the discrete approach. As expected, the PC board space was then used to incorporate additional functionality. This added functionality, however, came at a tradeoff, a higher load. The application design engineer was confronted with two new, but related problems, transient over-current spikes and voltage sags. The source still needed to be disconnected from the load, but to avoid the transient spikes and damage to components and service interruptions, the power path required a simple signal conditioning.

Building upon discrete solutions, device manufacturers responded by integrating slew-rate functionality into the load switch. As this functionality was added, there was clear opportunity to perform additional functions. The design mentality shifted from 'Simple' switch, to 'First Line of Protection'. Not just should the switch interface the battery to the load, it should offer protection to the application load circuitry, everything down circuit from the battery.

## What Functionality?

The convergence of mobile solution applications continues to increase, and affects more than just the power circuits. How can a design engineer protect against a seemingly countless number of potential hazards? The primary function of the load switch is offer the application protection. It must protect the application load circuitry, it must protect the source, be it anything from a battery to a USB-connected accessory, and it must protect itself. It is with this in mind that the value of integrating additional functionality is legitimized.

## Self-Protection

Starting with the third of these three, it must protect itself. With continuing integration and constant pressure to reduce solution size, thermal performance comes to the forefront of device design. To satisfy design requirements and avert thermal issues, a thermal protection function feature can be incorporated into the switch. This provides a balance between performance and size. This thermal shutdown feature controls the gate and can turn off the switch to protect the

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device from temperatures exceeding the over-temperature threshold. The addition of this protection feature simplifies the application design engineer's evaluation of the load switch in their specific application, reducing the requirements down to a quantifiable feature set.

## Source-Protection

Load switches are employed in a wide variety of applications, including interface protection for USB or Memory cards, as well as connecting the application loads to the battery or auxiliary power interfaces. With this diverse array of applications, protecting against unexpected voltages and current becomes a key design concern. We have discussed the slew-rate functionality, which controls the in-rush current, minimizing current spikes and sags in the buss voltage, but how can applications be protected against low voltage operation?

Advanced load switches offer an undervoltage lockout function, which can be used to disconnect the interface in the event that the voltage drops too low.

Another important protection issue involves handling unexpected current flow. Simple switches rarely differentiate the direction of current flowing. With an increasing array of accessories being plugged in to mobile platforms, it is essential to provide protection in situations where unintended/uncontrolled current may flow the wrong way, damaging components. The reverse current blocking feature addresses this design concern.

Functionally this is similar to having a diode in the power path, but advanced implementations avoid the diode voltage drop and thus the losses. This can be important in a standard USB power design, and can protect the USB host from reverse current flow situations.

## System-Protection

In addition to the protection features identified, the latest load switches now incorporate an over-current protection function, which limits the current to a set value. This improves the application robustness and reduces the hardware and software design effort. Two additional features are commonly offered in conjunction with the over current protection, to provide flexibility in the behavior of the fault and recovery methods. Depending on the cause of the over-current fault and the desired response, there may be a need to immediately hard-fault and sever the connection when the fault is detected. This provides the utmost protection, but is also guaranteed to interrupt service. The first feature, blanking time, defines the amount of time to delay before shutting down. This feature improves the fault tolerance of the system by allowing it to ignore the current-limiting fault condition for a set time, before activating the protection. This may allow the fault to self-recover, or perhaps it is best to remain in the current-limiting mode and not shutdown. Once a fault has occurred the design engineer has two options for setting the recovery method. The auto restart function will attempt to reinitialize and close the switch after a set time period. This ensures maximum protection and minimizes system interruption, requiring no user action to attempt a restart. If there is no Auto Restart function, the user may need to power cycle the device to clear the fault.

## The Next Functional Evolution: Providing Information

Thus far we have discussed the load switch's evolution from a simple switch to the increasingly complex levels of functional integration. The next trend appears

to be providing information. While the load switch may not be able to tell why something is happening, it can provide information to determine what is happening including faults, as well as voltages or currents.

While at the preliminary stages, today's load switches provide information that can be used to improve decision-making. For instance, with the load switch informing the application the processor that it has shut down due to an over-current fault, and the application controller knowing that this load switch is connected to the USB port, the application processor may be able to assume that an incompatible device was connected. Knowing this, the controller may be better able to implement a recovery strategy, or perhaps it can request user intervention. While this not a lot of information, it can be used to minimize customer dissatisfaction and improve the user experience, all while fulfilling the primary role of protection.

## Conclusion

This article has reviewed the basic history of load switch development and into the latest in advancements and offerings into its functionality. Critical to this, and not discussed here, is recognizing the supporting technologies, including the silicon and advanced packaging development that are the key enablers that allow these trends and levels of functionality. In any case, it is clear that with the abundance of new consumer electronics, and their accessories, the load switch serves a critical function in circuit protection.

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\*U.S. Patent 7,279,867 Method for Balancing Cells or Groups of Cells in a Battery Pack







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# Material Handling Market:

## Energy Storage Trends

**Sara M. Bradford, Principal Consultant,  
North American Energy & Power Systems Group  
Frost & Sullivan**

Material handling equipment makes up an important part of the manufacturing, construction and service industries. This equipment, along with overall logistics, is essential for improving order-to-delivery cycles and decreasing inventory. It is also heavily relied on 24/7 throughout the globe. With such importance, electric-powered material handling equipment requires a strong and reliable energy source. For many years, lead acid batteries have provided the necessary power to maintain single and multi-shift operations. By keeping the equipment in operation, lead acid batteries are known for being a robust, cost attractive and reliable solution. For certain industries, these trends will likely sustain the usage of lead acid batteries. However, there is a growing trend to develop and test next-generation energy storage solutions in the material handling market.

### Motive Lead Acid Batteries - Industry Workhorse

Motive lead acid batteries are most widely utilized in material handling equipment such as forklifts, order pickers, hand-operated trucks and airport ground support equipment. Generating more than \$1.6 billion in revenue worldwide, this battery market typically grows between 5 and 10 percent a year.

Heavy-duty material handling equipment includes applications in forklifts, utility vehicles, tow tractors, burden carriers, passenger carriers, floor scrubbers, airport ground vehicles and others. This equipment is essential for manufacturing, construction, retail, transportation and many other sectors. Electric-powered forklifts now constitute more than 50 percent of the market compared with conventional internal combustion (IC) powered lifts.

The material equipment application is a significant growth driver for motive lead acid batteries. The stable growth of this application in developed regions, and the

robust growth in the Asian region, are likely to increase the demand for these batteries. Owing to the cyclic nature of the battery market, along with the unstable growth in the manufacturing sector, overall market growth can vary.

### Emerging Energy Storage Solutions - Solving Key Industry Issues

Although lead acid batteries still remain the energy storage solution of choice for electric-powered material handling equipment, other alternatives are currently being considered. These alternatives each employ unique specification to overcome certain lead acid battery weaknesses.

#### Fuel Cells

A trend that is building momentum revolves around greening the supply chain. By reducing the carbon footprint of key material handling equipment, the manufacturing, construction and service industries are continuing to transition from conventional ICE equipment to the more green option of electric-powered equipment. A further step in this direction has resulted in the development of fuel cells for material handling equipment.

Fuel cells directly convert the chemical energy in the fuel to usable electricity. Byproducts of this conversion are generally water and heat. Several fuel cell designs are currently being developed. At this time, hydrogen and direct methanol fuel cells have demonstrated success above other competing designs.

As with all new forms of energy and energy storage technology, the development cycle is a lengthy and exhaustive process. There are numerous steps involved, from research, design protocols, testing (internal and external), manufacturing and ultimately market adoption. Fuel cells for material handling equipment are no exception to this rule of thumb. The technology has evolved over the last few years at a faster rate and has received an increasing amount of awareness from several aspects including the investment community, user trials and market consolidation.

Fuel cells can provide users with improved operations and maintenance when compared to conventional lead acid batteries. For example, fuel cells do not require lengthy charging and cooling periods that often challenge multi-shift operations. Additionally, fuel cells provide users with a constant voltage as long as the fuel is supplied. This eliminates the common voltage drop experienced by lead acid batteries.

Fuel cell companies such as Plug Power (recently acquired Cellex Power), Ballard, Oorja Protonics, Hydrogenics, Nuvera, among others are key developers in the material handling market. Users and equipment manufacturers such as Crown Equipment, NACCO Material Handling Group, Toyota Material Handling, The Raymond Corp., Federal Express, WalMart, General Motors, and others have active or completed fuel cell trials in place.

### Development in Progress - A Sample

Ballard is currently focused on three channels to market within the forklift industry. First, the company is developing a fuel cell battery emulator targeted to be a direct replacement of lead acid batteries. The emulator offers the same voltage ratings for factor and center of gravity as comparable to lead acid batteries with the key benefits of fuel cell operation and maintenance improvements. This product line can be easily implemented in the users existing fleet. Ballard

is also developing a fuel cell battery hybrid product, which utilizes a smaller fuel cell to consistently trickle charge the lead acid battery. This product can also be easily implemented into a users existing fleet.

Ballard is also involved with advancing what is known as an integrated forklift truck. This new truck design contains a built-in fuel cell engine. Essentially a next generation lift truck, this design eliminates the constraints of developing fuel cells around conventional electric-powered trucks and batteries.

### Ultracapacitors

Ultracapacitors, also known as electrochemical double layer capacitors (EDLCs) and supercapacitors, are static and passive electrical energy storage devices. This technology encompasses an enormous surface area that is achieved for the electrodes by making them from a porous carbon-based material. Ultracapacitors bridge the gap between batteries and conventional capacitors because they offer more power density than a battery, and they offer more energy density than a conventional capacitor. These storage devices can also have energy densities that are 300 times greater than that of the largest conventional capacitors. In addition, an ultracapacitor can provide 10 times more power density than that of a conventional battery.

When combined with traditional batteries, the ultracapacitor/battery combination can become an ideal energy storage solution to provide instant release of power and charge. Additionally, by implementing a distributed power architecture, battery strain will decrease and ultimately provide extended runtimes. Hybrid vehicles, regenerative braking and stop-and-go (ignition acceleration and starting) applications (such as with forklifts) also impact the demand for ultracapacitors. For forklift applications, the ultracapacitor bank stores power with each loading fork descend, and releases it when high power bursts are required, such as in heavy lifting scenarios.


Ultracapacitor developers such as Maxwell Technologies, Renewable Energy Development, Inc. (REDI), Matsushita Electric Industrial Company Ltd. (Panasonic), NessCap., Inc., and other players are active in the market.

### Conclusion

In the current economic conditions, supply chain optimization is of key importance. Coupled with reducing the carbon footprint and identifying solutions that can lower operation and maintenance fees, the material handling market is expected to witness great fluctuation over the next three to five years. Alternative energy solutions such as fuel cells or ultracapacitors strive to improve performance. These solutions, however, face stiff challenges in terms of commercialization such as user acceptance, increase and/or maintain financial resources, and other key issues. Though these challenges are short to mid-term in duration, the solid and proven reliability and current user dependence of lead acid batteries continues to be known in this application market, the workhorse of the industry.

*Sara Bradford is principle consultant for the Frost & Sullivan North American Energy and Power Systems Practice. She focuses on monitoring and analyzing emerging trends, technologies and market dynamics in the battery, alternative energy, fuel cell, power supplies/power quality and energy industries worldwide.*

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### Hong Kong Highpower Technology Completes Lithium-Ion Production Facility Build-Out

Hong Kong Highpower Technology, Inc., a developer, manufacturer and marketer of nickel-metal hydride (Ni-MH) and lithium-ion (Li-Ion) batteries and related products, has completed the construction and build-out of two production lines for the development and manufacturing of a range of Li-Ion rechargeable batteries and products. The new Li-Ion production facilities are part of the company's main Ni-MH factory located in Shenzhen, Guangdong Province, PRC.

"We are currently producing approximately 100,000 Li-ion units per month. With continued production ramping expected through the end of this year, we are targeting an average monthly production rate of 250,000 Li-ion units by end of year 2008," said Chairman and CEO George Pan.

Hong Kong Highpower continues with construction planning for a new manufacturing facility in Huizhou, Guangdong Province, PRC, which will eventually house all Ni-MH and Li-ion production for the company. The new industrial park's production capacity will be approximately three times that of the current Shenzhen facility.

Hong Kong Highpower develops, manufactures and markets rechargeable Ni-MH and Li-ion batteries and related products for use in a variety of electronic devices. The majority of Hong Kong Highpower's products are distributed worldwide to markets in the US, Europe, China, Hong Kong, Southeast Asia and Taiwan.

### Plug Power Selects Maxwell Technologies' BoostCap Ultracapacitors for Fuel Cell-Based Lift Trucks

Plug Power, Inc., a developer of hydrogen fuel cell-based power systems for electric lift trucks, has selected Maxwell Technologies' BoostCap ultracapacitors to enhance performance and energy management in its line of GenDrive power units.

Andy Marsh, Plug Power's president and CEO, said that GenDrive power units provide a high-efficiency, low-maintenance "drop-in" replacement for lead-acid battery packs in electric lift trucks. The GenDrive system delivers enhanced productivity by eliminating the downtime associated with the changing and charging of lead-acid batteries.

"Productivity drives purchasing decisions in the material handling industry," Marsh said. "Integrating Maxwell's ultracapacitors into our fuel cell systems enhances the value of our GenDrive product for our customers. Ultracapacitors' burst power capabilities for lifting, as well as regenerative braking for energy recuperation and longer operating life make them an ideal complement to hydrogen fuel cells in this application."

### Bosch and Samsung Joint Venture For Lithium-Ion Batteries Starts Operations

The joint venture, SB LiMotive Co. Ltd., of Bosch and Samsung SDI started its operations on September 1, 2008. The objective of the new company is to develop, manufacture and sell lithium-ion batteries for automotive applications. It is planned to start series manufacturing of efficient lithium-ion battery systems customized to automotive requirements and to market them worldwide in 2011. To achieve this, the partners will jointly invest between \$300 and \$400 million in the next five years.

Lithium-ion batteries are the basis for forward-looking technologies in the automobile, such as hybrid or electric drives. Bosch and Samsung expect a market volume of some three million hybrid vehicles by 2015. The prime objective of the joint venture is to optimize lithium-ion battery technology to meet the exacting requirements associated with the automobile, with respect to power density and safety, for example, and in this way to allow purely electrically powered driving over longer distances.

### ViaSpace's New Lithium Batteries for Light Electric Vehicles Begin Evaluation With Customers

ViaSpace, Inc., a company that transforms proven space and defense technologies from NASA and the Department of Defense into hardware and software solutions, has announced that its light electric vehicle

(LEV) battery pack is now available for sale. The first battery pack has been delivered for evaluation to an electric bike (eBike) manufacturer. The pack is based on special cells produced by ViaSpace partner, Yoku of Hong Kong. Until now, most eBike batteries have been made from lead-acid cells similar to those used to start automobiles. Lead acid cells are heavy, bulky and need to be replaced often. The VIASPACE lithium polymer batteries are four times lighter, and nearly three times smaller than lead-acid batteries, and they also demonstrate much greater life. This weight and space savings is critical to eBike handling and style, providing users with a powerful boost while keeping the eBike light, good looking, and easy to handle.

A single small battery pack yields a 40 mile range, and a pack the size of the current lead acid battery will yield over 100 miles.

Industry News continued on page 18

## Planar Energy Devices Acquires Cell And Separator Technology Enabling Highly Safe Lithium Ion Batteries

In a licensing agreement with Policell Technologies, Inc., Planar Energy Devices, Inc. has acquired technology and manufacturing rights for a new generation of safe, large format lithium ion batteries based on a breakthrough bondable nano-composite separator technology. This new cell and separator technology has a chemically engineered shutdown feature that prevent cells from triggering thermal runaway, which can result in batteries catching on fire. Safely preventing thermal runaway without reducing the capacity and cycle life of lithium ion batteries has been a major technical impediment to broader use of lithium ion energy storage.

"In recent years we have seen increasing numbers of high-profile incidents where batteries catch on fire or in some cases explode," said Planar CEO Scott Faris. "The industry has reached a crossroads where traditional approaches to increasing battery capacity have also led to decreasing safety. Planar's proprietary approach enables a new generation of

lithium ion batteries that address both the demands of safety and capacity in a product that can be manufactured in volume."

"As laminated flat cell structure rapidly becomes the lithium battery format of choice for many consumer applications, ranging from wireless devices to hybrid electric vehicles (HEV) and electric vehicles (EV), safety will be the major impediment to wide scale market acceptance," Faris said.

Planar's new PowerBlade line of batteries deliver very high energy under heavy load, and have higher cycle life and stable cell impedance during long term cycling. Unlike the lithium ion battery separators currently used in the market, PowerBlade separator does not show any shrinkage in the battery with time or usage at high temperatures and shuts down the battery when overheated to prevent thermal runaway and battery explosion. These safety features have been verified in customer testing of large size batteries.

The addition of this technology platform is part of an ongoing strategy by Planar to acquire and consolidate key technologies that enable scalable solid state energy storage products.

"There are tremendous opportunities to leverage

this new cell and membrane technology with Planar's portfolio of solid state electrolyte and high capacity cathode materials creating exciting future products that will allow Planar to provide higher capacity batteries without sacrificing safety," said Faris.

Planar is currently sampling PowerBlade cells to initial customers and expects to manufacture cells at its Orlando facility, making Planar one of only a handful of companies that manufacture large format lithium ion cells domestically.

## Altair Nanotechnologies Develops Battery for the US Navy

Altair Nanotechnologies, Inc. has completed the 500<sup>th</sup> full depth cycle of a unique lithium titanate battery developed for the US Navy. Altair's \$2.5 million contract is funded as part of a \$3.5 million US Navy program that includes independent product testing by the Navy. Additional funding of \$5 million has been approved by Congress for FY 2008.

The Mark 0, Characterization Module allows the Navy to test and better understand the unique properties of Altair batteries. For example, capacity tests show that the battery has lost about one percent of total capacity, a remarkable result, and highlights one of the benefits (long life) of the technology. It is anticipated that early next year Altair will deliver a 1 MW battery-based energy storage demonstrator.

With an Altair battery installed as an uninterruptible power supply (UPS), a vessel could avoid the cost of keeping the backup generator online. If there is a problem with the primary generator, the battery would provide enough power to get a second unit up and online.

## Superlattice Power, Inc. Attracts US Company for Development of Li-Ion Battery Technology Using Partially Lithiated Cathode and Anode

Superlattice Power, Inc. will soon partner with a major US company to achieve advanced development of lithium ion battery technology. Superlattice Power, Inc. researchers established an innovative idea to increase the cycle life of lithium ion battery packs when their proprietary battery design is used with partially lithiated metallic anodes and cathodes. Today's fully lithiated cathode materials with unlithiated anode material exhibits huge capacity loss after few preliminary cycles. It has been observed that metallic oxide anodes have the potential of higher capacity



Hoppecke Batteries Inc. the North American subsidiary of Hoppecke Germany an industrial battery manufacture of lead acid and nickel cadmium battery systems. We provide complete DC power systems including battery chargers, UPS systems, racks and enclosures for industrial applications for the utility, power generation, telecom, UPS, AGV, rail and transit markets.

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Quallion LLC is a Lithium Ion battery company that produces primary and secondary cells and batteries for the medical, aerospace, military and automotive industries. Founded in 1998, Quallion began as a medical device battery company and soon developed a range of novel enabling technologies, including the world's smallest implantable secondary battery, as well as its proprietary Zero-Volt<sup>TM</sup> and SaFE-LYTET<sup>TM</sup> technologies. Leveraging its core engineering capabilities, Quallion has since expanded into the aerospace and military markets by focusing on niche markets where advanced battery technology, safety, reliability and custom engineering are most valued. Quallion has recently entered the automotive market and is actively developing products for clean energy vehicles like hybrid electric vehicles (HEV) and plug-in hybrid electric vehicles (PHEV).

Quallion was founded by biotechnology entrepreneur and philanthropist Alfred E. Mann and Dr. Hisashi Tsukamoto.

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compared to carbonaceous materials. However, currently investigated metal oxide anodes suffer from large irreversible capacity loss initially due to formation of solid electrolyte interface (SEI) and irreversible lithium oxide in metallic oxide anode. It requires a strong effort and many process steps to reduce formation of lithium oxide. The formation of lithium oxide reduces the reversible capacity due to deficiency of lithium ion present in anode structure.

An introduction of partially lithiated anode and cathode in a lithium ion rechargeable battery system will have some advantages including non-existent or negligible irreversible capacity loss, higher discharge capacity and its retention from first cycle and an extended cycle life due to negligible reversible loss of lithium per cycle.

## Celgard Expands Capacity to Meet Rising Global Demand

Celgard, LLC, a global supplier of materials for lithium-ion batteries, has opened a 112,000-square-foot, \$18 million expansion of production and warehouse facilities adjacent to its headquarters in the South Point Business Park in Charlotte, N.C.

Celgard unveiled new machinery and equipment that boosts capacity for production of the company's lithium-ion battery membrane separators, and showcased its expanded R&D capabilities and improvements in warehousing and logistics capabilities.

"The global market for lithium-ion batteries is expanding rapidly, and this new facility enables us to support our customers' growth as they continue to ramp up production," said Celgard vice president and general manager Mitch Pulwer. "It also strengthens our already robust R&D efforts to create technologies essential for more powerful, longer lasting, highly reliable batteries."

Celgard develops and produces specialty microporous membranes including separators for rechargeable lithium-ion batteries that are the primary power supply for electronic devices such as notebook computers, mobile telephones and other personal electronic devices. Celgard membrane separators also are used in lithium-ion batteries in other growing high performance applications such as power tools and plug-in electric (PEVs) and hybrid-electric vehicles (HEVs).

The company supplies lithium-ion battery makers throughout the world from facilities in Charlotte and China, with production expected to begin in South Korea in the near future. Celgard has the lithium-ion battery

separator industry's broadest product portfolio including a dry-process tri-layer (PP/PE/PP) and polypropylene (PP) monolayer lithium-ion battery separators.

The Charlotte expansion comes on the heels of a \$25 million investment in a manufacturing facility in Ochang, South Korea, in May, and continuing investment in a slitting operation in Shanghai, China.

## Hoppecke Introduces High Reliability Flooded Industrial Batteries with 20 Year Water Topping Interval

Hoppecke Batteries has introduced its full range of flooded lead acid batteries with Auagen catalyst technology that allows the battery systems to operate for 15 to 20 years without water addition. This ultra low maintenance concept for flooded batteries produces a product range unique in the industry.

Recent changes to the technology have enhanced the already 20-year field proven technology. These changes involve increasing the resident time of the hydrogen and oxygen gasses given off by the battery with the catalyst interface, as well as improving the efficiency of the design so that more than 98 percent

of all gasses are recombined even at low milliamp current charge levels.

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Slaughter Test Systems provides innovative, dependable solutions for electrical test and measurement. STS Battery Element Testers provide a unique method for the detection of assembly level insulation defects in lead-acid batteries, including missing and damaged separators. STS serves a wide variety of industries including manufacturers of motors, windings, electromechanical devices, coils and lead-acid batteries. Worldwide customers include leading manufacturers of appliances, automobiles, home & garden equipment, power tools, batteries and industrial controls.

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Pred Materials is a 100% American company, founded in 1996. We market specialty chemicals and equipment, made mostly in Japan, to support the advanced energy storage industry, fine ceramics, and other high-tech markets. We have a growing line of lithium titanates, nano-sized powders and carbon nanotubes. Most of our products are listed on our web site, with together with technical data: [www.predmaterials.com](http://www.predmaterials.com).

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Ulbrich Stainless Steels and Special Metals, Inc., an international company supplies custom rolled strip, foil, flat, fine and shaped wire products. Ulbrich is involved in the battery industry in our strip and wire divisions. Our strip division supplies materials with stringent tolerances and cleanliness requirements. Our Specialty Wire Group supplies wire rolled from rod. This produces a clean, smooth edge. This technology eliminates burrs and metal slivers. Ultrasonic cleaning produces wire free of dirt and oxides. This highly increases the material's weld ability. Ulbrich developed this process exclusively for Li-Ion components. Ulbrich's rolling technology produces wire with low surface roughness averages (RA).

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Continued from page 15

The eBike can be simply recharged by plugging in to a standard electrical plug.

The first target for VIASPACE eBike batteries in this \$6 billion industry, expected to grow four fold over the next two years according to industry sources, will be an advanced folding "commuter" bike that is small enough to be folded and taken on trains and in car trunks. In this application, light weight and small size are critical. VIA-SPACE eBike batteries are also under test for use in both mountain and street eBikes.

Carl Kukkonen, CEO, stated, "We believe that eBikes and other light electric vehicles will see rapid adoption. VIASPACE is pleased that we have been selected for evaluation in this rapidly growing market segment. We are providing our customers with safe batteries with excellent performance at a good price, as well as fuel cell technology and instrumentation. All of this is part of our expanded focus on a broadened range of clean, renewable energy solutions."

## Notebook Computer Owners Want Greener, Better Batteries

Thirty six percent of notebook computer owners are willing to pay more for batteries that are better for the environment. That finding is reflected in a survey conducted by Harris Interactive and released on behalf of Boston-Power, Inc.

Among other highlights revealed in the survey:

- 40 percent of notebook computer owners are only somewhat satisfied or not at all satisfied with the performance of their notebook computer batteries.
- 51 percent of notebook computer owners would pay more for a battery that came with a two-year warranty.
- 40 percent of consumers who have owned their notebook for three years or more have replaced the battery as many as five times.
- 54 percent of notebook computer owners would pay more for a battery that recharged more quickly.
- The quality of the battery (92 percent), the screen (92 percent) and processing power (93 percent) are important or very important features to consumers.
- Notebook owners have employed a range of methods to dispose of notebook computer batteries, including manufacturer-related disposal (7 percent), recycling centers (6 percent), exchanging where the replacement was purchased (6 percent) and placing in a bin at a retail outlet (5 percent). Conversely, 4 percent discarded the battery in the trash.

"Notebook computers are among our most important devices, whether we're using them for work or leisure activities," said Boston-Power founder and CEO Dr. Christina Lampe-Onnerud. "The good news is that the survey indicates that users are generally

happy with their laptops. The great news is that there are opportunities to improve user experience, to the mutual benefit of consumers, vendors and the environment."

## HP Breaks the 24-Hour Battery Life Barrier Customizable HP EliteBook Delivers All-Day Power

HP has announced a milestone in mobile computing: up to 24 hours of continuous notebook operation on a single battery charge. As measured by an industry-standard benchmark, the new HP EliteBook 6930p configured with an optional ultra-capacity battery delivered up to 24 hours of battery runtime.

"All-day computing has been the holy grail of notebook computing," said Ted Clark, senior vice president and general manager, Notebook Global Business Unit, HP. "With the HP EliteBook 6930p, customers no longer have to worry about their notebook battery running out before their work day is over."

Designed and tested to last, HP batteries benefit from a combination of HP engineering and energy-efficient notebook components such as Intel solid-state hard drives (SSD) and mercury-free LED displays. For example, the highly efficient HP Illumi-Lite LED display boosts battery run time by up to four hours compared to traditional LCD displays, while the Intel SSD provides up to a 7 percent increase in battery life compared to traditional hard drives.

## PowerGenix Closes \$30 Million Round Fueled by Energy Storage, Clean Transportation Demands

PowerGenix, manufacturer of nontoxic, high performance rechargeable Nickel-Zinc (NiZn) batteries, closed its \$30 million Series D financing round. The round was led by Bessemer Venture Partners and included existing investors: Advent International, Angeleno Group, Braemar Energy Ventures, Granite Ventures, OnPoint Technologies and Technology Partners.

Amid a global restructuring of energy storage markets, propelled by increased concern over battery safety and toxicity and revived interest in automotive technologies, PowerGenix has seen huge demand for its nontoxic rechargeable NiZn batteries. The company has signed \$75 million in customer supply agreements since beginning high-volume manufacturing in March of this year and is supplying NiZn cells into multiple markets including power tool, lawn and garden, consumer AA, military and light electric vehicles (LEV).

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bustible and recyclable battery solution, PowerGenix's NiZn cells pack one-third more power and energy than existing rechargeable alkaline cells. The company's cells have also received compliance, under third-party testing, with the European Union's Reduction of Hazardous Materials (RoHS) and Battery Directive requirements, widely recognized as the world standard for banning toxic material in new electronic devices. In the US, the Rechargeable Battery Recycling Corporation (RBRC), which represents 90 percent of the global battery industry, recently expanded its recycling program for the first time in seven years to include PowerGenix's NiZn.

"PowerGenix's advanced Nickel-Zinc batteries provide more performance at a lower cost than any other energy storage option, allowing products used by millions of people every day to weigh less and have longer run-time," said Justin Label, partner at Bessemer Venture Partners. "PowerGenix has combined ground-breaking battery technology with targeted application engineering to produce products primed to capture significant market share as the energy storage industry moves toward clean solutions."

### Safaricom Kenya Approves VRB Energy Storage Systems

VRB Power Systems, Inc. has completed the trial period and acceptance of two 5 kW by 4 hour VRB Energy Storage Systems (VRB-ESS) sold to Winafrique Technologies Ltd., of Kenya in November 2007. The systems were tested in two remote cellular telecommunications sites in Kenya with Safaricom Limited, a mobile telephone operator in Kenya. The approval of these systems signifies the potential roll out of several hundreds of systems at cellular telecommunications sites throughout East Africa. Winafrique has identified an initial 300 sites in Kenya alone.

In addition to an immediate reduction in diesel fuel usage and greenhouse gas emissions, the installation of the VRB technology will enable telecommunication providers to integrate a significant amount of variable wind generation at these remote sites, further reducing the dependence on fossil fuels. Additional benefits include lower diesel engine maintenance costs and an extended life of the overall systems.

Safaricom, like other telecommunication groups in Africa, are moving toward integrating energy storage systems and eventually alternative forms of energy like wind and solar to power cellular sites to reduce the expense and environmental impact of rising diesel costs, high maintenance requirements of diesel generators and lead acid batteries and concerns over diesel emissions. As a distributor of the 5 kW VRB-ESS in Kenya, Winafrique has arranged to sell, install and integrate the systems at cellular sites, monitor and service the systems and further provide some of the electrical components.

The VRB-ESS is a vanadium redox flow battery that can economically store and supply large amounts of electricity on demand and is focused on stationary applications. It is a long life, cost effective, low maintenance, efficient technology that allows for the scalability of power and storage capacity independently. The VRB-ESS is particularly beneficial to renewable energy providers, utilities and end users through its ability to inventory electricity, allowing for the optimal match of supply and demand.

The VRB-ESS is capable of providing backup power solutions including applications for utility sub-stations and telecommunication sites. The VRB-ESS is characterized by having the lowest ecological impact of all energy storage technologies and is unlike most other conventional energy storage systems that rely on substances such as lead or cadmium.

### Saft Wins Contract to Power Hybrid Electric Mobile Utility Systems

Titan Energy Development, Inc., the exclusive manufacturer of the Sentry 5000 mobile utility system, has selected Saft to power its Renewable Energy Mobile Utility System (REMUS). Designed for military application, REMUS incorporates renewable wind power, solar power and battery power to supplement a dependable diesel generator and provide utility scale electrical services in situations where continued fuel sources are not available or too costly.

"Saft is proud to play such an integral role in the development and successful operation of REMUS," said Thomas Alcide, general manager of Saft's Specialty Battery Group. "The trailer requires a small, lightweight battery capable of controlling numerous operations while maximizing fuel efficiency and Saft's technology most effectively meets these specifications."

Under the new contract, Saft is supplying a rechargeable

Li-ion battery system, which is part of its standard line of products for hybrid electric military vehicles (HEMV). The Li-ion system recharges using renewable energy generated by the trailer's wind turbines and solar panels, enabling REMUS' diesel generator to run more efficiently and reduce fuel costs. The battery is also responsible for powering the trailer's HVAC and lighting package.

According to Thomas Black, president of Titan Energy Development, "The REMUS is an exciting development in the emergency energy industry as it offers a solution that is less dependent on traditional fuels, particularly in emergency and remote situations where fuel sources may be limited. By leveraging new alternative energy technologies to supplement traditional power sources, REMUS seamlessly extends the run-time of a single tank of fuel reducing operating costs."

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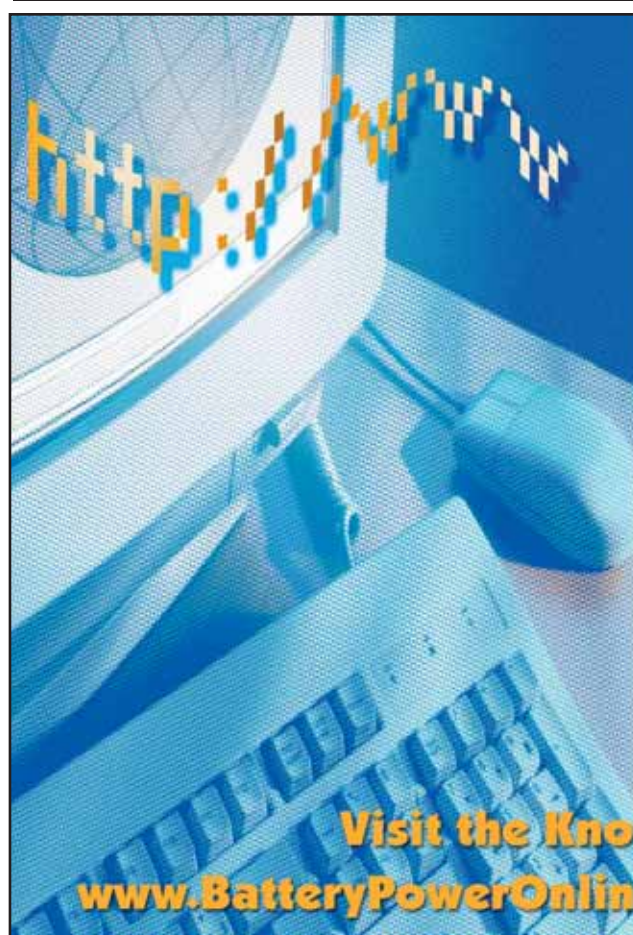
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### QuantumSphere Files Key Patent on Technology to Increase Li-Ion Battery Life

QuantumSphere, Inc., a developer of advanced catalyst materials, electrode devices and related technologies and systems for portable power and clean-energy applications, has filed a key patent for technology it has developed that extends the capacity of rechargeable lithium ion batteries up to five times. Next-generation batteries featuring this technology could dramatically

improve the operating life of portable consumer electronics, hybrid-electric vehicle range and a wide variety of energy storage applications.

"The electrodes our company is developing will expand battery capacity in a profound way, without a sacrifice in safety. Instead of four hours of operating time on a laptop computer, a single charge could last up to 12 hours and provide users with enough computing time for a complete round-trip flight between Los Angeles and New York," said Kevin Maloney, president and CEO of QuantumSphere. "This important research is another example of QuantumSphere's focused plan to bring next-generation, high-capacity lithium ion battery systems to market. We believe this is a commercially viable technology that will have a major impact in a variety of consumer, industrial and transportation applications."

Today's patent filing covers a novel electrode structure enriched with nano lithium particles that increases

the fuel source in a rechargeable lithium ion battery, thus increasing battery life. QuantumSphere intends to commercialize the technology to improve next-generation batteries for energy storage, consumer and transportation applications.

"QuantumSphere has created electrodes with much higher lithium capacities than current state-of-the-art lithium ion batteries, as described in this patent application," said Subra Iyer, principal technologist and co-inventor at QuantumSphere. "In the next phase of the QuantumSphere research efforts, we will further improve these anode and cathode electrodes and formulate electrolytes with wide electrochemical windows. All of this is part of a structured research approach to create new high-voltage battery chemistries, enabling both higher energy density and higher power density in next-generation rechargeable lithium ion batteries, taking advantage of the newly improved anode, cathode, and electrolyte molecular architectures."

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### Axion Power International Gets \$1.2 Million in Federal Funding to Develop Batteries for US Marine Vehicles

Axion Power International, Inc., a developer of advanced batteries and energy storage devices, has received a \$1.2 million federal grant. The grant will fund work aimed at the development of new lightweight, high-power batteries for use in US Marine Corps vehicles.

The device is modeled on Axion's patented lead-carbon (PbC) technology. The goal of the program is to reduce weight and increase power in military assault and silent watch vehicles.

Axion's new lead-carbon technology will offer several advantages in this application including less lead, higher power delivery rates, improved cold temperature performance, faster recharge rates and longer life cycle than those achieved from current conventional lead-acid batteries.

### New Department of Transportation Rules Impact Lithium-Ion Cell-Phone Battery Recycling

New Federal Department of Transportation Hazardous Materials Regulations covering lithium-ion batteries will impact both the cell-phone recycling industry and consumers who want to ship their wireless handsets for recycling.

ReCellular, Inc. is making changes to its own practices to comply with the regulations, and is introducing new information that will help consumers and ReCellular's partners comply as well.

"The Department of Transportation wanted to address potential safety hazards of shipping large quantities of lithium-ion batteries," said Brandi Farwig, ReCellular environmental manager. "Accordingly, the majority of the changes only apply to commercial shipments, but some of the changes will also impact consumers sending small numbers of phones for recycling."

Rechargeable lithium-ion batteries are used in many devices, such as cell phones, computers and cameras. Even though they are more costly than alkaline batteries, lithium cells provide a much longer operating life. However, lithium batteries can provide extremely high currents and can discharge very rapidly when short-circuited. A short-circuit can release the electric charge quickly enough to potentially set fire to surrounding materials.

Accordingly, the US Department of Transportation (DOT) recently issued a new regulation that requires that lithium-ion batteries either be shipped in their original equipment, or have tape over the terminal connections to help prevent short-circuits. In addition, the DOT requires packages

containing lithium batteries to be properly marked and labeled.

ReCellular recycles an average of 14,000 pounds of lithium-ion batteries every month, which are stored and shipped in 55-gallon steel drums in accordance with existing DOT rules. Updated shipping labels and documentation will be required by the new regulations. To assist their recycling partners, ReCellular will update their Website ([www.recellular.com/](http://www.recellular.com/)) with information detailing the required changes to commercial shipments.

### Odyne Corp. Awarded Patent for Battery Energy Management And Monitoring System

Odyne Corp., a clean technology company that develops advanced hybrid electric vehicle propulsion systems, has announced that the US Patent Office has approved its application for its Battery Energy Management and Monitoring System. Odyne has now been awarded three patents in the area of Battery Energy and Thermal Management.

According to Joe Ambrosio, founder and CTO of Odyne, "The use of the technology embodied in this patent will improve the functionality and extend the operating life of battery modules used in mobile applications. Electric and Hybrid Electric Vehicles require the series connection of many battery modules

to get the voltage up to ranges as high as 400 VDC to 800 VDC. When this is done, it is necessary to monitor each of the modules to make sure that they do not become electrically imbalanced which leads to poor performance and life expectancy. The Battery Management System monitors and provides an equalization function to ensure all the batteries are acting together which maximizes the capacity of the entire string. Odyne's Battery Management System can be used on any battery chemistry."

Approved for patent is a battery monitoring and equalization system which monitors the temperature and voltage of each battery module. In addition, the system allows for the equalization of each battery module through an intelligent network. The key feature of the system is that it stores information on battery operation when the vehicle is being operated and during charging. This information is used to determine when to equalize deficient modules, calculate accurate state of charge, maintain safe operating parameters and predict battery failure. The system is also an important diagnostic tool for service personal when inspecting battery packs. The system is comprised of a main controller and individual sensor nodes which are affixed to each module. The nodes are connected via a data and power network which is easily integrated into a battery pack design.

### Nexergy Applies for Patents for Battery Designs Addressing Complex Charging, Gauging Challenges

Nexergy, Inc. has solved complex battery fuel gauge and charging issues with two innovative circuits now awaiting patent approval. One patent application is for a robust discharge circuit that can be applied to the calibration of fuel gauges. The other is for a buttonless battery charger interface that can be used in designs in which a switch is not practical and in designs for harsh environments. The inventor behind both applications is Randolph A. Ibrahim, Nexergy's vice president of technology.

In battery charging and conditioning systems, discharge circuits may be used to completely discharge a battery before beginning a charging cycle. In battery calibration systems, discharge circuits may be used to determine the characteristics of batteries. For battery types such as lithium ion (Li-Ion), determining the characteristics of the battery under load conditions may assist in determining battery condition as it ages. Additionally, calibration systems produce information that allows predicting performance of the battery over its service life.

The discharge circuit for which Nexergy seeks its patent is designed to address the challenges of battery calibration in environments where consistent power is often unavailable, such as in military vehicles and ambulances.

"Normally, when you lose power, you have to go through a whole new cycle in order to calibrate," Ibrahim said. "And if you get continuous interruptions of power, you'll never get a clean calibration, especially on the older coulomb-counter fuel gauges. This unique circuit addresses this challenge by feeding power back on itself during moments of power interruptions. In fact, during a calibration cycle, the user could unplug the charger from the power source, and sequential discharging lights and charge status indicators will remain operating when power is automatically diverted from the battery being discharged to the charger/discharger circuitry to keep it alive and operating. The patent covers a multitude of methods of accomplishing this functionality."

The patent application for the buttonless battery charger interface applies a fresh approach to the issue of controls attached to the interfaces of battery chargers. Harsh environmental factors particularly cause the most simple control mechanism to fail under normal and heavy use. This battery-charging invention applies "a plurality of modes" for charging a battery. The method of control is mainly time-based with debouncing circuitry included to minimize false commands from being issued.

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1. Publication Title: Battery Power Products & Technology

2. Publication Number: 1092-3616

3. Filing Date: 9/9/2008

4. Issue Frequency: Bi-Monthly

5. Number of Issues Published Annually: 6

6. Annual Subscription Price (if any):

7. Complete Mailing Address of Known Office of Publication (Not printer) (Street, city, county, state, and ZIP+4®):  
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8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer):  
Same As Above

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do not leave blank):  
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13. Publication Title: Battery Power Products & Technology

14. Issue Date for Circulation Data Below: Sep/Oct 2008

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### Calendar of Events

#### November

5-6 - Remote 2008 Conference & Expo, Atlanta, Ga.

11-12 - Battery Power 2008, Dallas, Texas  
 For more information, please visit [www.BatteryPowerOnline.com](http://www.BatteryPowerOnline.com)

#### December

1-5 - MRS Fall, Boston, Mass.

2-4 - Power-Gen International 2008, Orlando, Fla.

8-9 - Lithium Mobile Power, Las Vegas, Nev.

2009

#### March

10-12 - Aviation Industry Expo, Las Vegas, Nev.

16-19 - 26th International Battery Seminar & Exhibit, Fort Lauderdale, Fla.

#### April

27-29 - Battcon 2009, Orlando, Fla.

#### June

8-9 - Advanced Automotive Battery Conference 2009, Long Beach, Calif.

Send Calendar of Event Items to  
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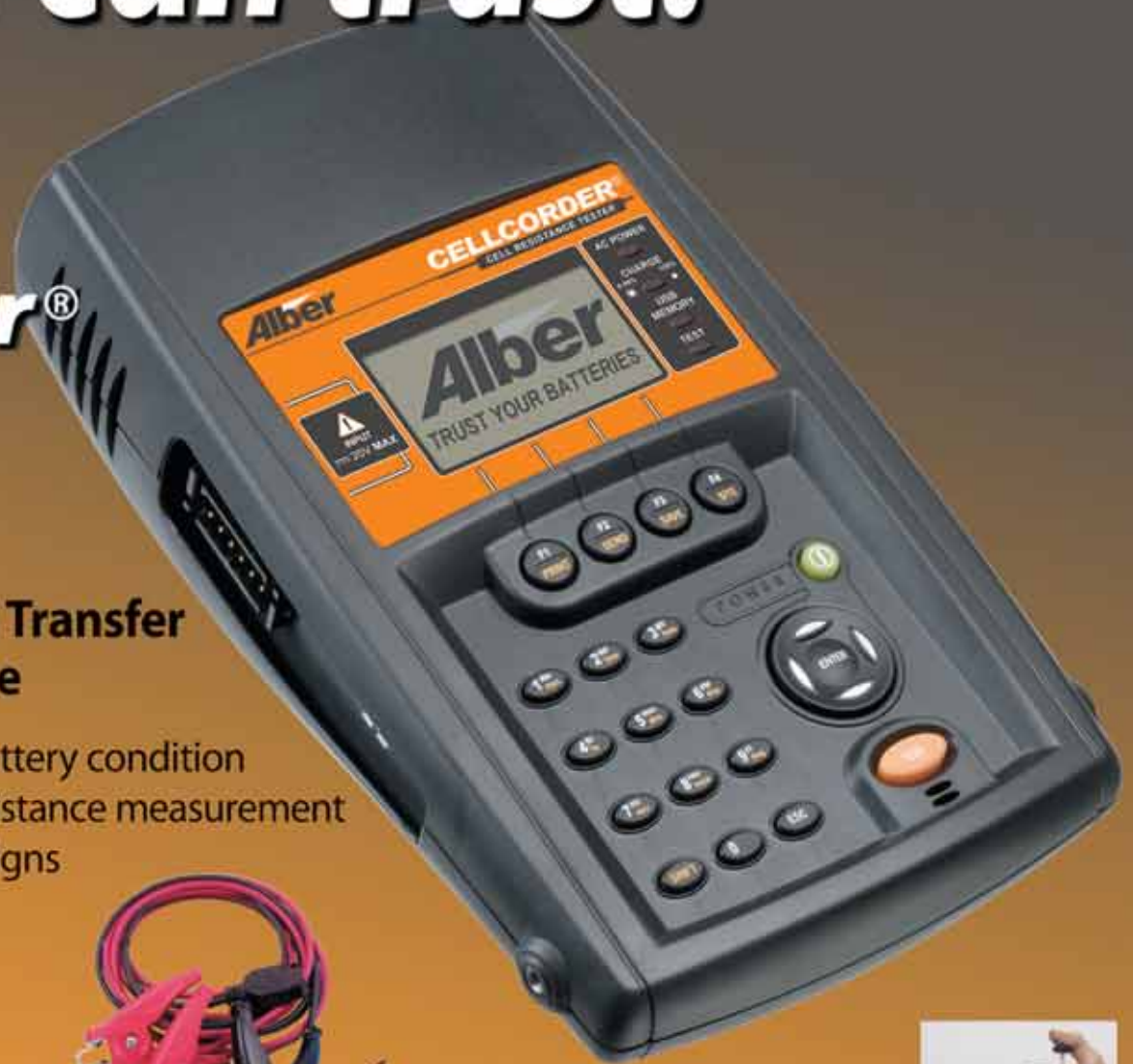
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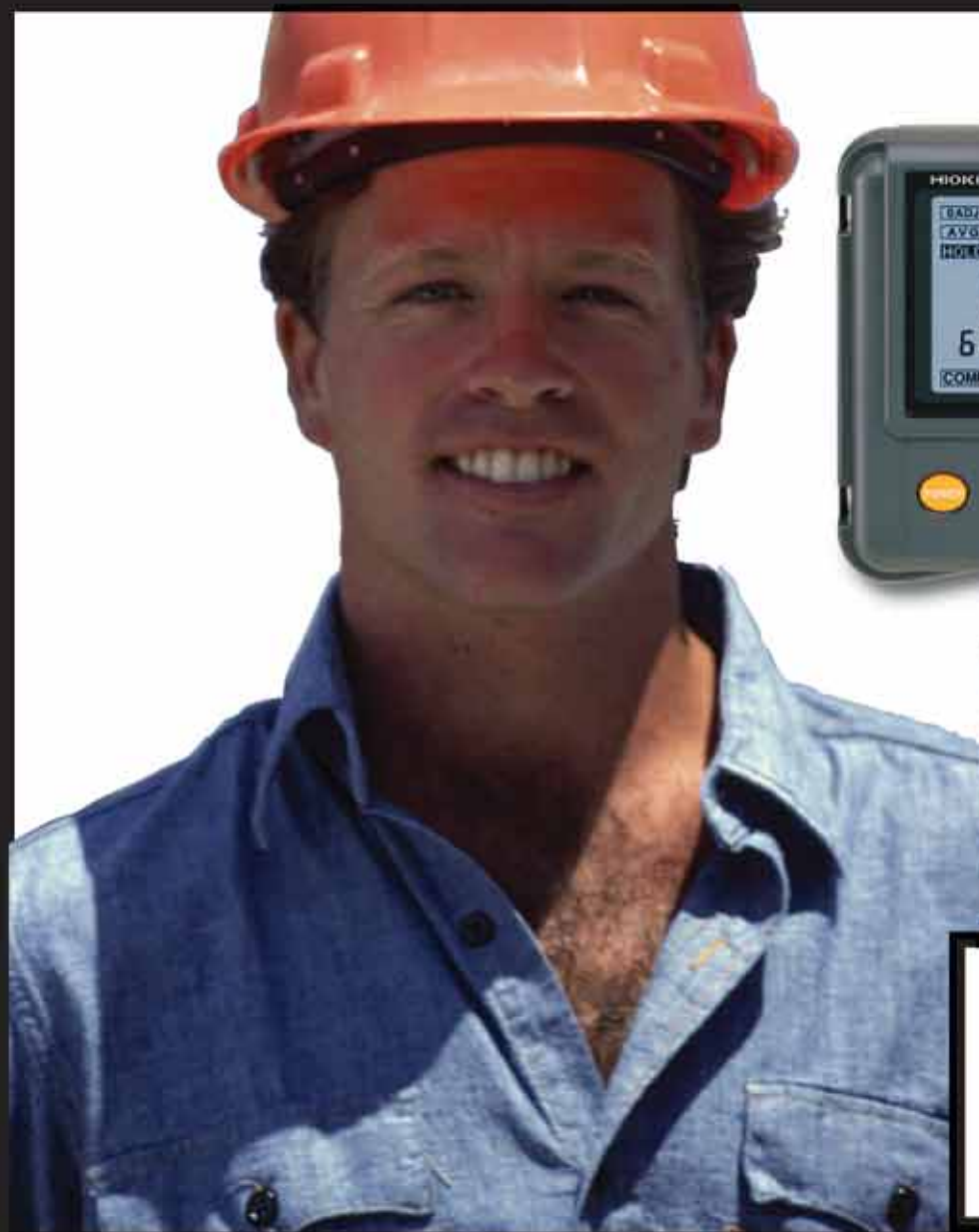
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