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BATTERY POWER PRODUCTS & TECHNOLOGY

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

AES Installs A123Systems H-APU Energy Storage System at Facility in California

A123Systems, a developer and manufacturer of advanced Nanophosphate lithium-ion batteries and battery systems, has delivered and installed its first Hybrid Ancillary Power Units (H-APU) with AES Energy Storage, LLC, a subsidiary of The AES Corp., one of the world's largest global power companies. The H-APU is designed to create another way for AES' existing facilities to meet the power industry's need for capacity, by supplying power plant reserve requirements and other ancillary services, which enable the increasing use of renewable energy sources.

A123 is under contract to provide multiple Hybrid Ancillary Power Units in 2008 and 2009 for use in grid stabilization applications in several AES facilities across the world. The initial unit, installed at one of AES's Southern California power plants, is capable of delivering 2 MW of power at close to 90 percent efficiency.

"We believe A123's H-APU product line addresses the demanding performance requirements of grid stabilization and offers an innovative solution for the utility industry. When fully deployed in 2009, we believe this will be the largest fleet of battery storage systems in operation on the electric grid," said Dave Vieau, CEO of A123 Systems.

The Hybrid Ancillary Power Unit energy storage system can serve two functions. First, A123's H-APU will absorb (charge) energy from the grid during times when the frequency or voltage is too high and inject (discharge) that energy back to the grid when it is too low. A123's H-APU is expected to allow greater use of variable sources of energy such as wind and solar by rapidly absorbing or injecting energy as these sources vary. The H-APU is expected to provide variable service much faster than existing power plants responding in seconds rather than minutes. Because it is recycling energy already in the system, it will provide these services without unnecessary emissions.

Second, the Hybrid Ancillary Power Units are designed to provide backup services by storing energy until it is needed by the grid in the event of a power plant or other asset failure. In some markets, the portion of thermal power plant capacity normally reserved for ancillary services to provide reserve capacity and frequency regulation services can be freed up to operate at a higher capacity and produce more electricity and associated revenue.

AES is working with industry leaders to selectively deploy energy storage solutions to improve the capacity, responsiveness, and efficiency of its existing thermal, renewable and distribution facilities. As one of the world's largest global power companies, with operations in 29 countries, AES is comprised of a platform of more than 120 power facilities and 12 million distribution customers.

News in Brief

Celgard Receives Battery Development Contract from USABC

Celgard, LLC, a wholly-owned subsidiary of Polypore International, Inc., and a global supplier of material for lithium-ion batteries, has received a $2.3 million contract from the US Advanced Battery Consortium (USABC) to develop separator technology for lithium-ion batteries for hybrid-electric (HEV) and plug-in hybrid-electric (PHEV) vehicles. The 18-month cost-share contract involves demonstrating performance characteristics of high-temperature melt integrity (HTMI) lithium-ion battery separators, focusing on abuse tolerances, production process definition and scale-up parameters. A standard definition and protocol for measuring HTMI will also be developed as a part of this contract.

Panasonic and Sanyo Agree to Start Discussions for Capital And Business Alliance

Panasonic Corp. and Sanyo Electric Co., Ltd. have agreed to start discussions for capital and business alliance between the two companies. Panasonic and Sanyo will start discussions, with the aim of maximizing both companies' corporate values by pursuing synergies between both companies and further strengthening initiatives to achieve potential revenue and profit growth through this alliance.

In the Energy Business Domain, both Panasonic and Sanyo will be able to utilize their complementary technology by cooperating with each other in order for both companies to contribute to the development of the rechargeable battery market as well as its provision of global sales networks in order to expand Sanyo's solar and energy businesses.

Panasonic and Sanyo will immediately set up a project team, to start intensive discussion on the capital and business alliance between both companies based on the premise of making Sanyo a subsidiary of Panasonic.

INSIDE

PRODUCTS & SERVICES

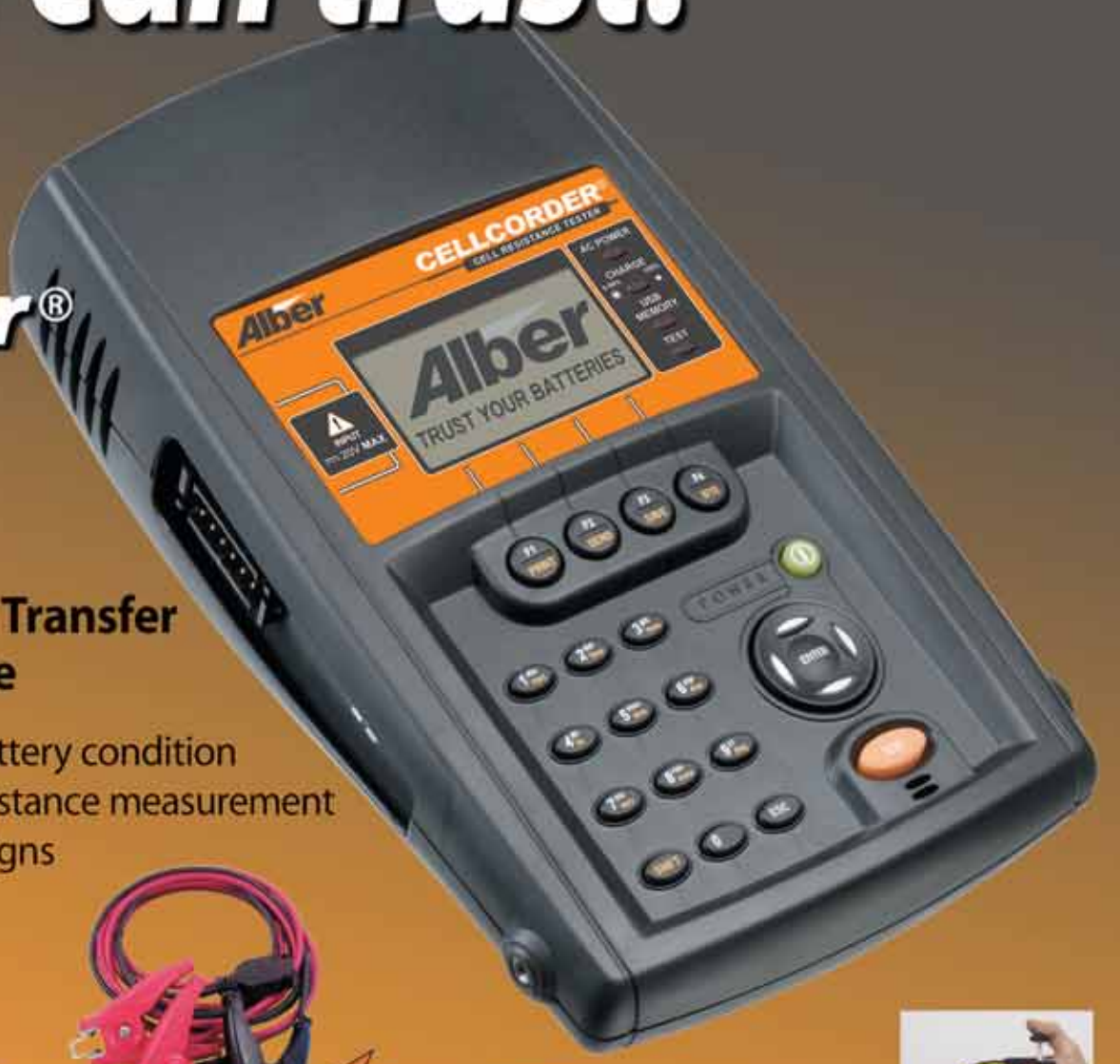
DEPARTMENTS

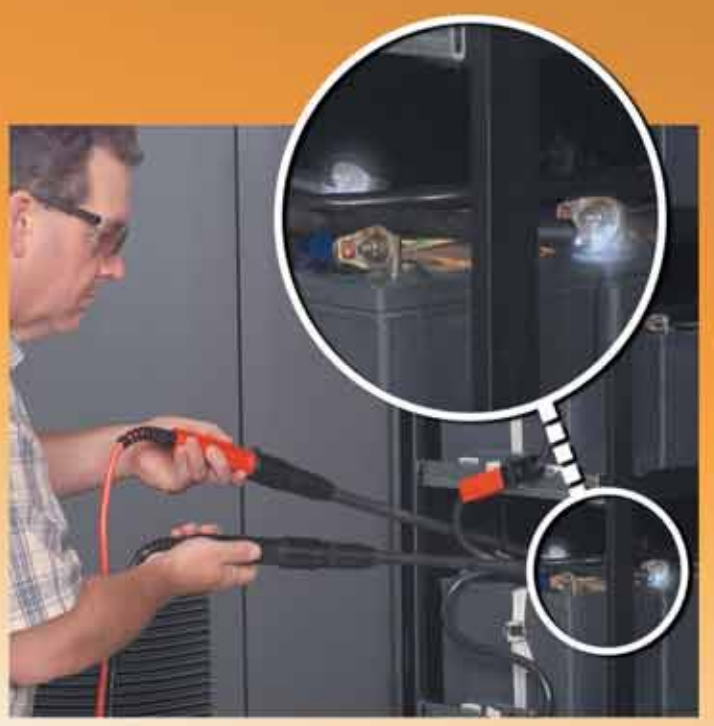
Battery Test Equipment you can trust!

CRT-400 The Cellcorder®

- **Albér Reliability**
- **Flexible Clamps**
- **Lighted Probe Options**
- **New USB Flash Drive for Data Transfer**
- **Bluetooth® Capable Interface**

The Cellcorder is a test instrument for battery condition assessment. Albér's patented internal resistance measurement method is the best way to detect early signs of battery performance problems.





Easy to use interface, test connection options for every application, and powerful trending, analysis and reporting software allow you to do your job without wasting time.

Log on to ***www.alber.com*** for more information about Cellcorder and Albér's technology

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New Batteries on the Market

Saft Launches Standard High-Power Module To Provide Defense Customers Immediate Delivery

In order to address increasing customer demand, Saft has launched a standard customizable lithium-ion (Li-ion) module for high-power defense applications, the Power Module. This module offers an in-stock solution for customers seeking high-performance Li-ion technology.

Saft's Power Module combines the energy and power necessary to meet the demands of high-performance defense applications including underwater vehicles, hybrid electric military vehicles and other demanding power applications. This product has not only proven successful in a variety of hybrid electric military vehicles, but is currently being used in Titan Energy's Renewable Energy Mobile Utility System (REMUS).

Made up of 12 VL34P Li-ion cells, the Power Module enables system performance by supplying and receiving electric power and supporting the overall function of the energy storage system. To maximize performance and ensure total safety, Saft integrates individual Li-ion cells both mechanically and electrically into the energy storage system. Saft's Power Module can provide thousands of cycles with minimal maintenance and reduced operating costs during its projected 15-year life.

Panasonic Introduces the Evolta

Proving that there is still room to enhance the performance of everyday batteries, Panasonic has introduced the Evolta battery. The Evolta AA alkaline battery lasts longer in more devices than the company's own previous generation AA alkalines, as well as those from other brands.

The new structure of the Evolta battery provides more internal space than Panasonic's previous generation batteries, allowing storage of extra active materials and incorporating an improved sealing technology, creating a more durable battery. Newly-developed active materials for the battery's cathode (manganese dioxide and oxy-hydroxide titanium) and anode (zinc) facilitate a chemical reaction that delivers improved performance. To maximize the chemical reaction within the battery, Panasonic has improved the manufacturing process to pack active materials more evenly and densely.

Energizer Introduces Zero Mercury Hearing Aid Batteries

Energizer Battery is replacing its current hearing aid batteries with equally-performing zero-mercury batteries. This development comes more than two years ahead of the National Electrical Manufacturers Association's (NEMA) commitment to eliminate mercury from button cell batteries by June 30, 2011.

Currently, all other zinc air hearing aid batteries sold in the US contain mercury. Through a combination of new product designs, purer raw materials and new manufacturing processes, Energizer's R&D scientists have developed batteries that can now be produced without added mercury. After more than a decade of development and extensive testing, the new zero-mercury product will be widely available throughout the US.

International Battery Introduces New Battery Pack Designed to Extend Utility Terrain Vehicle Drive Time

International Battery, Inc. (IB), a producer of high-capacity, large-format rechargeable batteries, has released a 48-volt 160-amp-hour battery pack designed to improve the drive time and reduce recharging requirements for electric utility terrain vehicles (UTVs). The battery is currently undergoing testing by a major UTV manufacturer in the US.

The new IB battery pack also has the proprietary IB designed, developed, and manufactured battery management system (BMS) to regulate and improve the safety, quality control, and performance of the battery pack. In addition to the tests already taking place, several European Union manufacturers are preparing to evaluate sample units in vehicles slated for EU use.

Saft and ABB Develop High Voltage Li-Ion Battery System to Enhance the Stability of Power Distribution Grids

Saft and ABB have developed a high voltage lithium-ion (Li-ion) battery system designed to improve the stability of power distribution grids. The new system combines dynamic energy storage provided by Saft's 5.2 kV battery, which will help respond to disruptions in the grid, with ABB's SVC (Static Var Compensation) Light technology for dynamic voltage control. Potential applications include industries with high short term power demands as well as utility grids fed by a high percentage of variable renewable energy sources, especially wind power.

Li-ion battery technology offers a number of important features in this application, such as excellent cycling capability, long calendar life, high energy density, very short response time, high power capability both in charge and discharge and maintenance-free design. Furthermore, Saft's Li-ion technology provides the system with information on the state of charge (SOC), which is a vital function in a dynamically operating energy storage system. The battery system comprises eight individual units based on Saft's Intensium Flex modular, rack-mounted Li-ion modules. The units, rated at 646 V and 41 Ah, are connected in series to achieve a nominal voltage of 5.2 kV and the system can deliver 200 kW for an hour and 600 kW for over 15 minutes.

Saft is also supplying the control and management devices for the battery, as well as a CAN-based optical communication interface with ABB's MACH-2 controller that will monitor the battery continuously and optimize its operation.

EnerSys Launches EcoSafe Batteries for Renewable Energy Generation Applications

EnerSys has 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.

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Integrated Circuits & Semiconductors

Intersil Delivers a Highly-Integrated Battery Charger for Cell Phones, Bluetooth Devices and Portable Media Players

Intersil Corp. has introduced the ISL9222A, a battery charger innovation designed to detect auxiliary and external power connections in mobile devices. The ISL9222A is a high input, single cell, Li-Ion battery charger IC that incorporates a charger and digital logic (OR gate) into a single chip. This compact package enables customers to create small footprint solutions. The ISL9222A's high level of integration and small size make it well suited for applications that require overvoltage protection, test fixture power detection or reverse blocking.

The ISL9222A accepts an input voltage up to 28 V, but is disabled when the input voltage exceeds the overvoltage protection threshold (typically 7.2 V) in order to prevent excessive power dissipation. The 28 V rating eliminates the overvoltage protection circuit required with a low input voltage charger.

The charge current is user-programmable with an external resistor. When the battery voltage is lower than 2.55 V, the charger preconditions the battery with 20 percent of the programmed charge current. The ISL9222A also features a thermal foldback function that protects the charger from over-temperature conditions. The ISL9222A also features voltage accuracy is 1 percent. The ISL9222A is available now in 8-lead TDFN packages, priced at $1.40 each in 1,000-unit quantities.

Single-Chip Lithium-Ion Protector Provides Comprehensive Protection and Cell Balancing for 5- to 10-Cell Battery Packs

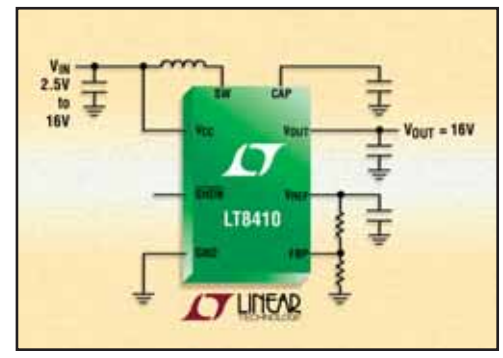
Maxim Integrated Products has introduced the DS2726, a comprehensive standalone protection IC with integrated cell balancing for 5- to 10-cell lithium-ion (Li+) battery packs. Combining voltage and current monitoring with cell balancing in a single chip, the DS2726 provides an space-saving solution for battery-operated devices. It is a well suited protector for power tools, e-bikes, portable household appliances, battery-backup systems, or any application with a 5- to 10-cell Li+ battery pack.

The DS2726 employs high-side p-channel protection FETs to provide comprehensive overvoltage, undervoltage, discharge-current and short-circuit protection. The protection circuit monitors individual cell voltages to detect overvoltage and undervoltage conditions. Additionally, high-side protection allows the host system to maintain communication with a fuel gauge, such as the DS2788, even when a fault condition causes the protection FETs to switch off.

This device provides robust protection while extending battery life by ensuring that all cells are equally charged. During cell balancing, internal switches shunt an industry-leading 15 0mA (typ) of current. For added flexibility, cell balancing can be enabled automatically on detection of a charger or by signaling a control pin. The DS2726 is available in a space-saving, 7 mm by 7 mm, 32-pin TQFN package. Prices start at $4.58 (1,000-up, FOB USA).

Ultralow Power Boost Converters Only Require 8.5 uA of Quiescent Current

Linear Technology has released the LT8410/-1 low noise micropower boost converters with integrated power switches, Schottky and catch diodes and output disconnect circuitry packaged in a 2 mm by 2 mm DFN package. The LT8410/-1 use a unique design scheme, requiring 8.5 uA of quiescent, which is further reduced to 0 uA in shutdown. Integrated high value (12.4 M/0.4 M) output feedback divider resistors enable the LT8410/-1 to regulate a 16 V output with no load with less than 30 uA of quiescent current. Very small switch current limits (25 mA for the LT8410 and 8 mA for the LT8410-1) enable these converters to operate very efficiently from high impedance sources, such as coin cell batteries without any inrush current limitations.



The LT8410/-1's wide 2.6 V to 16 V input voltage range enables them to operate from single cell Li-Ion batteries up to fixed 12 V input rails, delivering outputs up to 40 V. The output voltage can be adjusted dynamically by driving the FBP pin with an external voltage source. The LT8410 can deliver over 8 mA of output current at 16 V from a single Li-Ion cell making it well suited for applications such as precision sensor or biasing power. Both parts use a unique control technique that delivers efficiencies as high as 88 percent and low output ripple (<10 mVPK-PK) over a wide load current range. Other features include integrated soft-start and overvoltage protection. The LT8410EDC and LT8410EDC-1 are both available from stock in an 8-lead 2 mm by 2 mm DFN package. Pricing starts at $1.75 each for 1,000-piece quantities.

Semtech Introduces Industry's First High Voltage ESD Protection Solution for Mobile Phone USB Battery Charging

Semtech Corp. has released the RClamp3654P, an ESD protection product for battery charging USB ports on mobile phones. It is the only device on the market with a separate 28 V transient voltage suppressor (TVS) diode to protect the VBus against fault conditions when the standard USB port is being used for battery charging.

Semtech's RClamp3654P complies with China's new standard for USB charging, making it well suited for products targeting that market, or for products that are sold into multiple markets including China. The "Technical Requirements and Test Method of Charger and Interface for Mobile Telecommunication Terminal Equipment" (YD/T 1591-2006), announced by China's Minister of Information and Industry in December 2006, requires all new mobile phones that request network access in China to adopt the new universal battery charger interface.

Protecting the VBus against fault conditions during charging is important for many reasons. Standardizing on USB creates protection issues if users think that their cell phone can be connected to any power source that has a USB plug. As USB has been a common interface for various chargers, the adapter output voltage for a device such as a portable player may be well above the 5 V defined by the mobile phone adapter standard. Another potential threat could result from faulty adapter designs.

Battery Components

Philadelphia Scientific Introduces Changer-Mounted Water Supply

Philadelphia Scientific, an international manufacturer of industrial battery components, accessories and tools, has introduced a changer-mounted water supply, which enables battery room personnel to immediately water batteries even as they are being retrieved from a charging rack. This enables personnel to combine two tasks into one, saving time and improving efficiency.

The changer-mounted water supply features a powder-coated industrial steel frame that cradles a sturdy 20-gallon polypropylene tank. The frame is secured to the back frame of a battery changer and fits most battery changer brands. A submersible pump, which is mounted inside the tank, provides the water volume and pressure required by the Philadelphia Scientific single-point Water Injector System. A highly visible control unit is mounted on top of the tank and provides an on-off switch, power indication and run-dry protection. The controller also shuts the pump off after 10 seconds of non-use to save energy and conserve pump life. Twenty feet of 5/8-inch industrial hose is supplied with each unit.

New Optical State of Charge Sensor

JSA Photonics has introduced an optical state of charge sensor for lead acid and other suitable electrolyte batteries. The patented solution is based on fiber optic sensing technology originally developed at Sandia National Laboratory (SNL) that effectively measures SOC and enables inexpensive, accurate and continuous monitoring of battery capacity. Flexible sensor configurations provide the SOC measurement capability to sealed batteries at manufacture as well as retrofitting of existing wet batteries providing functional assurance and reduced maintenance costs to the user. The SOC sensor offers additional benefits including cell temperature sensing enabling tailored charging programs for fast and efficient charging and electrolyte level sensing to detect fault conditions well before they occur. The software, interface control and GUI provides power, easy calibration and continuous monitoring of SOC, temperature and electrolyte levels for one to several thousand batteries for on-site as well as Internet monitoring.

Keystone's New SMT AA and A Battery Clips

In keeping with accelerated demands for AA and A surface mount battery clips for dense packaging use, Keystone Electronics has developed a new group of low profile clips which firmly secure inserted batteries and withstand shock and vibration.

Featured are an exclusive "flow hole" SMT solder tail design which significantly enhances joint strength and assures battery retention. At the same time, low profiles make the clips well suited for dense PCB placements.

The new SMT clips are made of 0.012-inch (0.30 mm) thick, nickel plated steel and is available in bulk (part #53) or on tape and reel (part#53TR) with 125 pieces per 15.0-inch reel. A 44 mm wide Polystyrene carrier tape, meeting ANSI/EIA-481 standards, is used as the reel with parts mounted on a 24 mm pitch. The new clips are priced from $0.12 each, loose parts in bulk.

Pulsed Nd:YAG Lasers Well Suited for Battery Tab Welding

Miyachi Unitek has introduced a new application: battery pack/tab laser welding. Pulsed Nd:YAG lasers are well suited to address these battery tab and pack welding challenges. Already established in many other battery welding applications, pulsed Nd:YAG lasers are designed to perform cost-efficient tab and pack welding with minimal heat input. They offer an extremely fast and flexible joining method capable of welding many spots in under a second. Nd:YAG lasers are designed for joining high conductivity tab materials, and orientating the welds to match the strength requirements with no limitation on weld diameter or proximity.

Charging & Testing

Windows Based Battery Analyzer System Supports Up to 432 Channels Simultaneously

Energy Storage Instruments, Inc. has introduced a full speed USB 2.0 Windows interface battery analyzer model PCBA 5010-4 that provides up to 50 volts and 10 amps through four independent channels in a compact 200 W package. The system is expandable up to 108 units or 432 channels on a single USB port from a PC running the Windows 98, 2000, XP or Vista operating system. The Windows based application integrates Microsoft Access database technology for saving battery models, serial numbers, service programs and test results for NiCd, NiMH, Lead Acid, and Lithium Ion type rechargeable batteries ranging from one to 30 cells, and up to 100 amp-hour in size. Once configured, an analyzer can run independent of the PC/USB connection, incorporating a RTC, and storing up to 64 service records per channel in internal non-volatile memory.

The analyzer operates from 90 to 260 VAC, 50 to 60 Hz, with PFC input. The unit includes a 200 W discharge section so that each channel or sum of channels can charge or discharge up to 200 W of power, and energy from batteries on discharge is transferred to batteries on charge. The four channels boast extremely good accuracy with a current accuracy of +/- (0.1 percent +10 mA) from 0 to 10,000 mA with 10 mA resolution, and a voltage accuracy of +/- (0.1 percent +20 mV) from 0 to 51.673 volts with 1 mV resolution. Each channel includes an NTC thermistor input for temperature recording from -30°C to 96°C and a SMBus interface for reading smart batteries. The analyzer is aesthetically pleasing, quite and useful in either a laboratory or office setting.

Sakor Technologies, Inc. Introduces a Hybrid Vehicle Battery Test System

Sakor Technologies, Inc. has introduced its Hybrid Vehicle Battery Test system, a complete offering for high-voltage battery testing. The system is energy efficient and can effectively perform all types of performance and durability cycling, including complex profiles and road load simulations.

At the heart of the system lies a high-efficiency, line-regenerative DC power source. During discharge modes, absorbed power is regenerated back to the AC mains instead of being dissipated as wasted heat, which is common practice among other battery testing systems. This innovative method generates greater power efficiency and measurably reduces overall operating costs.

Driven by a DynoLAB EM controller, the Hybrid Vehicle Battery Test System inherits DynoLAB's ability to automate all types of performance, durability, and continuous cycling operations, including full road load simulation. In fact, the system can function both as a battery tester and as a battery simulator. Integration with a HybriDyne Hybrid Driveline Dynamometer creates a system capable of testing complete hybrid drivelines and subsystems with or without actual batteries in circuit. The system may be configured to provide dynamic response (i.e. voltage sags and current surges) just as would be seen in-vehicle. Unlike the performance of an actual battery, the simulator output remains repeatable from cycle to cycle, regardless of charge status, resulting in more consistent and accurate test data.

The Hybrid Battery Test system is available with voltages of up to 1,000 VDC. Typical systems range in size from +/- 200 amps to +/- 2,400 amps (continuous), and most units offer overload (surge) currents of up to 200 percent of the rated current.

Ask the Experts is a new feature to Battery Power Products & Technology magazine. It is designed to assist you in any battery/power related questions you may have.

We encourage you to send us your questions and we will find an industry expert to answer them. The questions and answers may appear in an upcoming issue of Battery Power magazine or in the Battery Power e-Report, a monthly e-newsletter that is issued the first Tuesday of every month.

Send questions to:
Shannon Given, Director of Content, at Shannong@infowebcom.com.

Q: Why are there so few lithium-ion secondary battery plants in the US? What are the US chances of succeeding in transitioning from an oil economy to renewable energy generation and electric drive vehicles when the bulk of our energy storage capacity will depend on massive scale lithium-ion battery production, 80 to 90 percent of which is overseas?

Peter Oppewall, Editor, http://EVtransPortal.com

A: It is a bit like the classic chicken and egg story. Or like they do in china, mandate it, and it will happen. Here in the US we have been supporting the oil industry for 100 years. The largest battery contact went to the auto industry over the past 25 years for technologies most scientists thought were doomed to failure (e.g. sodium sulfur). For the first time we may have a president that will mandate the transition from a foreign oil based transportation industry to a made in US electric transportation industry. If you go to our President Elects' Web site he is saying all the right things, ie. make the White House fleet plug in electric in 2009, provide tax credits for the plug in electric vehicle industry, mandate electric vehicles in all federal fleets, etc.

In China there are already millions of lithium powered vehicles (bicycles) on the streets every day. They did so, through mandate and incentive. That is, they allowed electric bikes to travel on the same roadway as a regular bike, yet disallowed gas scooters. There are already lithium powered buses in China, not because the government gave a bail out to the old bus companies, they did put out a RFP for buses to run the streets, and several innovative companies responded. Today, ZAP is now working with two different US companies to build practical, cost effective electric vehicles. This is because they have created the distribution network that is now creating the demand.

We need a Manhattan-type or Apollo-type project that demands electric vehicles in all federal and large fleets. During WWII, we put millions to work to build battle ships. Why not put millions to work to build electric vehicles and solar charge systems to build and retrofit millions of vehicles to electric? We would free ourselves from foreign oil, decrease the trade deficit, reduce global warming and provide a real stimulus to the economy by providing clean, green jobs. The mandate of the Apollo program created more orders for computers than ever before in history, and created the stimulus for everything from the solar cell industry to heat reflective paint. There are solid-state storage technologies that are in their infancy that show promise to exceed current lithium technologies. There are wheel motor technologies simply waiting for the order of magnitude that could increase the efficiencies of electric vehicles. Opportunity solar charge stations could greatly increase the useful range of all EV's. Small format lithium batteries have dropped dramatically in price due large orders from the PC and phone industry. The storage systems of the future are simply awaiting the demand.

Gary Starr, Founder, Director Business Development, ZAP

Q: Why are there no cutting edge battery technologies available in amp hour capacities suitable for the home alternative energy markets? We are still dealing with ancient lead acid battery technology for powering our RE systems. Also, why are Nickel Iron batteries priced out of reach?

EW Zuber

A: Lead acid batteries have been a proven reliable and economical solution for alternative energy storage systems for many years. Alternative technologies, such as nickel metal hydride, nickel iron, or lithium can offer distinct differences and some potential advantages for energy storage, but they still remain economically costly when compared to lead acid technologies. Demonstration, development and research projects continue to be initiated, but until a cost comparable solution becomes available to the mainstream, we would expect lead acid technology to remain the dominant solution for alternate energy markets.

Steve Vechy, Director of Marketing, UPS & Utility EnerSys

Ask the Experts continued on page 15

Battery Management System for Continuous Industrial EV Operation

Tony Gaskin, President, *Ever Corp.*
J. Darling, **M. Popovic**, *Optys Corp.*

Battery fuel-gauging in automated process control operations has advanced to provide real-time state-of-charge (SOC) and calculated run-time with an error below 5 percent for operational decision making. Experimental charge/discharge characteristics of high efficiency NiMH batteries under continuous operation with highly variable loads require sophisticated analysis of data to make usable capacity estimation. This article details factors influencing the design of battery-interfacing electronics for an EV Battery Management System (BMS).

Automated Guided Vehicles (AGV's) are increasingly used to transport materials in production and distribution environments where little or no human decision making skill is required. Free-ranging AGV's using inertial navigation, odometry, lasers and GPS systems are truly autonomous with vehicles making routing decisions based on real-time feedback of traffic, obstructions, production requirements and available power.

High efficiency batteries combined with rapid charge technology mean that plants can employ automatic battery refueling stations throughout the plant so vehicles are never removed from service. AGV's operate like a fleet of taxis, picking up and dropping off loads and refueling "on-the-go." In this scenario, the state of charge (SOC) of a battery becomes the key feedback mechanism to the traffic controller responsible for load movement and vehicle assignment to the task. Thus the accurate estimation of the SOC of the battery pack is the key factor in both managing system operation and batteries efficiently.

SOC estimation in continuous AGV operation presents specific challenges; to maximize battery life, batteries are operated within a 5 percent to 10 percent swing of a nominal SOC. Since they never receive a full charge or a full discharge, traditional means of tracking the SOC of a NiMH battery pack are not adequate, requiring a new methodology.

Development of an algorithm for estimating SOC of an AGV battery pack is a non-trivial undertaking. The algorithm must take into consideration the AGV's specific application environment. Depending upon the quality of the electrical model available for the chosen variant of the battery technology, extensive algorithm testing over a large number of charge/discharge cycles may be needed to create and verify the accuracy of the SOC algorithm.

To support an accurate SOC estimation, highly accurate voltage and current measurements are required. For example, since the voltage of a NiMH battery changes little as a function of SOC over the majority of the operating range, increased measurement resolution is essential to the algorithm. In a similar manner, accurate current sensing is required to minimize errors while coulomb counting. Due to the highly dynamic load nature of an AGV, fast sample rates of these measurements (in the order of 50 to 100 Hz) are necessary to enhance the quality of the SOC estimation. Finally, temperature sensing is required for algorithm support and safety purposes.

Instant Refueling

Maximizing cycle life under continuous operation requires operating within a narrow range of the battery's SOC. This results in a requirement for frequent refueling. Thus only a small percentage of overall battery capacity is utilized and replenished on each drive cycle. Since batteries will degrade over time, monitoring temperature and its rate of change provides a mechanism to track the state-of-health (SOH) of the batteries over time, in addition to preventing overcharging.

Lifetime

Most modern batteries are rated for several hundred to several thousand deep charge/discharge cycles (typically 30 percent to 70 percent SOC). Figure 1 shows the SOC of a battery system as a function of time where large SOC swings are encountered.

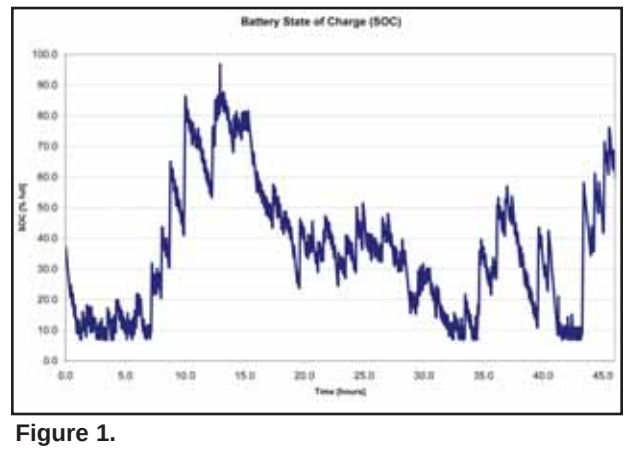


Figure 1.

Limiting the range of SOC contributes significantly to the life expectancy of the battery system. Figure 2 illustrates the SOC of a battery system which has been designed to operate over a much smaller range of SOC ranges. Limiting the SOC range can increase the lifetime of the battery to more than 100,000 charge discharge cycles.

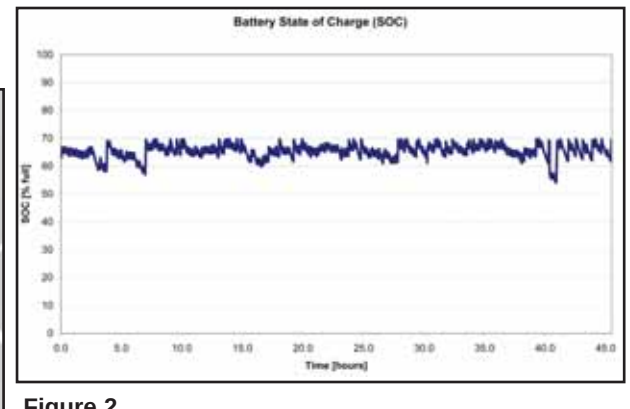


Figure 2.

BMS

A proprietary battery monitoring system (BMS) was developed to monitor, control and data log the system. A simplified block diagram of the system is shown in Figure 3. The system is partitioned into 3 major blocks:

BMS Controller

The BMS controller is connected to a number of charging stations and AGV robots. The controller coordinates charging activities as robots mate with

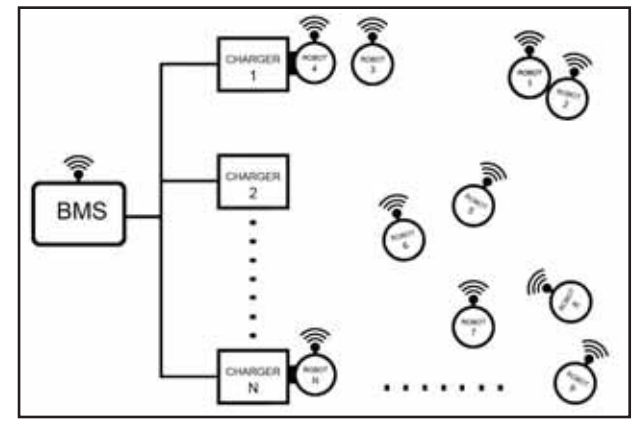


Figure 3.

the chargers, communicates with a scheduling/positioning system, determines the amount of charge required, monitors the state of the chargers and batteries, responds to error condition and provides data logs for maintenance purposes.

Charging Stations

The chargers are intelligent devices that can provide a programmable voltage/current source to the robots. As directed by the controller, they provide the charge while monitoring for error conditions such as loss of contact or excessive output voltage.

AGV Robots

The AGV robots contain the robot proper, a high performance battery pack and battery monitoring hardware.

The battery monitoring hardware measures currents from the charger and to the robot. As well, it monitors battery cell voltages and temperatures. Coulomb counting and SOC calculation algorithms are performed by this device. Cell voltage balancing hardware is included to assure that individual SOC levels of cells within the battery do not drift apart over time.

The firmware also supports local disconnect of the battery as an additional safety precaution to further minimize the risk of overcharging or depleting the battery pack beyond its safe levels.

The data represented here is drawn from an actual AGV drive cycle for a 24/7 operation material handling AGV. The system design employed a 24 V 35 Ah NiMH battery pack, variable load currents of up to 40 A of constant current from primary motors, and a 3C charge rate to replenish used energy in 10 to 60 second opportunity charge cycles. A typical run takes 2 to 3 percent SOC and proper vehicle assignment minimizes the SOC swing (from 2 percent to 15 percent) depending on the number of runs and charger availability.

Conclusion

A rugged BMS was developed, tested and deployed in a large fleet of AGV's, operating simultaneously in a single facility. This BMS provides controlled opportunity charging, battery equalization and an accurate SOC reporting, under continuous use.

While often overlooked, the battery power subsystem is of critical importance in the context of autonomous material handling applications. Here, the BMS demonstrated advanced capability in battery management under actual operating conditions.

Tony Gaskin is the president of Ever Corp. Canada Ltd. Ever Corp. develops and markets intelligent battery management systems for automated, guided electric vehicles (AGV's), mobile robotic vehicles, backup and remote power applications.

Contact Ever Corp. at www.evercorp.com.

Battery Manufacturing:

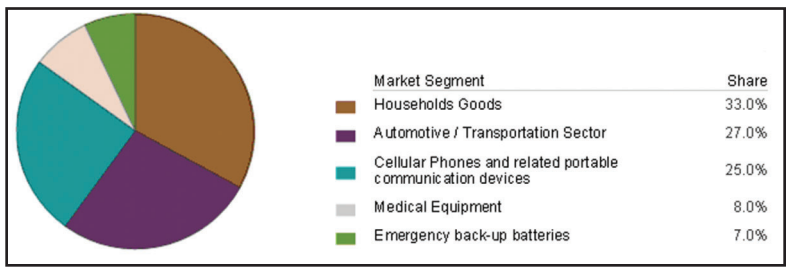
Market Overview, Conditions and Risk Factors

George Van Horn, Senior Analyst
IBISWorld

As raw material costs continue to rise and consumer sentiment declines, increasing uncertainty in the US economy threatens the demand for consumer durables. Although this may seem like doom and gloom for the battery manufacturing industry, hope is on the horizon as technology improves and the automotive industry is expected to make a recovery. Factoring upstream and downstream market performance, IBISWorld, an independent publisher of business intelligence research, takes an in-depth look at the issues affecting the domestic battery manufacturing industry within the next five years.

Major Market Segment Overview

There is an increasing trend for personal wireless electrical equipment, but batteries for household goods account for the majority of industry demand. With per capita disposable income expected to expand by 2.6 percent, it is highly likely that demand from households will continue to be positive until 2012.



Developments in electrically powered vehicles, with batteries replacing the combustion engine, are expected to gain acceptance and grow in the future as environmental concerns increase. Demand from the automotive segment is cyclical, however with relatively high oil prices; motor vehicle production was curtailed significantly in 2007. Countering this trend is the development of the fast growing hybrid electric vehicle (HEV) market, which would increase demand for high-power lithium-ion batteries.

Key Downstream Market Conditions

Consumers delaying purchases of cars and expensive personal electronic equipment is expected to dampen demand for batteries at the retail level. These postponements will also reduce the level of demand at the manufacturing level, where revenue is expected to increase by only 2.4 percent in 2008. However, it is estimated that there will be an increase in industrial demand as the production volume of durable goods increases.

Light Trucks and Utility Vehicle Manufacturing

Estimated to grow at an average annual rate of 1.8 percent until 2013, declined production and weak demand for light trucks will be the main cause of this meager growth. However, as newer, fuel-efficient, light trucks are introduced from domestic and overseas manufacturers in 2009, increased domestic demand is expected to resume industry growth. Growth in exports is forecast to be limited as US products tend to be over-equipped and expensive for developing automobile markets.

Car and Automobile Manufacturing

Forecasted to expand at an average annual rate of 1.8 percent over the five year period to 2013, as strengthening economic conditions across the period are expected to underpin a recovery in industry demand. Industry profitability is expected to improve considerably from 2009 onwards as General Motors, Chrysler and Ford

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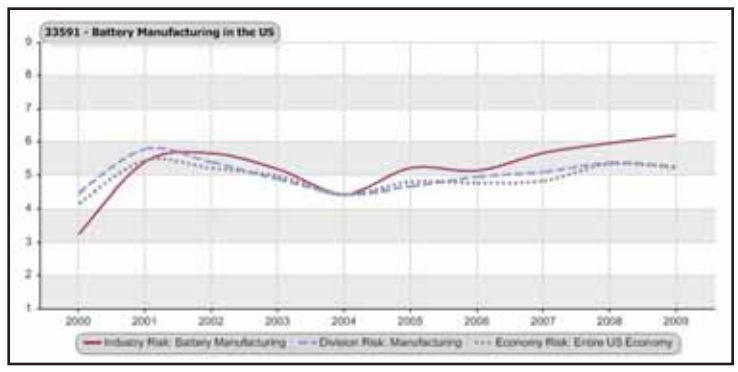
restructure themselves. But, forecasted appreciation of the US dollar should restrict export sales over the period.

Communication Equipment Manufacturing

Cellular handsets are but a sub-set of the communication equipment manufacturing sector yet demand conditions during the outlook period are promising. Moderate growth is expected to be supported by increasing wireless network subscribers, (US wireless subscriber penetration rates are expected to rise from 83 percent in 2007 to more than 89 percent by 2012) as well as increasingly important replacement sales. Demand for wireless handsets in the US will also be influenced by the degree to which consumers respond to an increasing number of products with color and multi-media messaging capability. While demand for handsets will expand, much of this expanded supply will likely be sourced from low-labor cost countries.



Key Upstream Market Conditions

Lead, zinc, plastic, inorganic chemicals and some other nonferrous metal products in general are expected to continue slowly rising through 2012, further placing efficiency pressures on battery manufacturers. Due to enhanced performance traits, alkaline batteries are expected to remain the dominant primary battery type, with zinc-air batteries accounting for an increasing share of demand.

Copper and Other Nonferrous Metal Refining

Following a period of extraordinary growth in 2007 at 18.2 percent, the outlook for this industry over the next few years is weak. Performance is expected to deteriorate in response to somewhat softer base-metal prices: the price of zinc is declining; lead is remaining static and copper is meagerly rising. Overall, the average annual decline in real industry revenue over the forecast period is expected to amount to about 5.8 percent.

Plastic Miscellaneous Products Manufacturing

IBISWorld forecasts that this industry will grow at an average annual rate of 2.0 percent over the five year period to 2013. The future of this industry is heavily dependent on downstream demand from manufacturing industries, particularly from automotive manufacturing. Residential construction is also an important driver for industry growth as the industry supplies building and flooring materials; and components for furnishing. Low residential construction activity is expected to cause low industry performance over the earlier stages of the outlook period. However, trends of continued high resin prices are anticipated to keep revenue growing at an average annualized rate of 2 percent in the next five years.

Inorganic Chemical Manufacturing

Expected to expand at an average annual rate of 2.8 percent over the next five years, cyclical supply and demand imbalances within both the industry, as well as downstream-user industries, will continue to affect this sector's performance. Moreover, prices will fluctuate with demand, changes in capacity utilization and foreign competition levels. At the same time, pressures from higher costs in the face of continued natural gas volatility and increased environmental regulations may also influence the performance of the industry in the immediate to near term future.

Industry Risk Factors

In the next 12 to 18 months business condition risk in the battery manufacturing industry is expected to be higher than that of the US economy and manufacturing division. The current higher-risk score primarily reflects the concentration of industry sensitivity to weak consumer drivers: disposable income, automobile sales and consumer electronic retailing.

Environmental Concerns

Every year in the US, more than 3 billion batteries are bought, used and thrown out. Not only does this add to landfills, but the un-recyclable nature of many of the components renders them toxic to the environment. With high consumption of lead and other toxic materials in both the manufacturing process and the end product, the battery industry is under much scrutiny in an increasingly environmentally conscience society. In the past, this has driven the development of the re-chargeable or storage batteries. In the future, these concerns are expected to continue driving innovations and new technical products, both within the battery and its related industries. For example, one area where batteries will be increasingly involved is the compliance of cars with environmental regulations.

Consequently, manufacturers of primary batteries, such as alkaline batteries, will have to re-position their product to an increasingly skeptical society. Primary battery firms will need to emphasize their product's reliability and utility, especially in emergency situations.

Firms will also have to increase their public relation campaigns and sell themselves as environmentally conscious corporate citizens to gain market share. Differentiating themselves along moral, ethical and other non-product lines remains the only method of gaining preferential purchases in a saturated market place selling a mature product.

Re-Structure Pressures

Consolidation and vertical integration in the distribution and supply channels are threatening the existence of smaller manufacturers. Through consolidation companies can offer lower prices and greater supply capacity, while also strengthening resources for marketing and R&D. Therefore, smaller companies will need to concentrate their efforts on niche markets. The markets for electric vehicle batteries, back-up batteries in photovoltaic applications, and medical application batteries are niche markets where supply is currently not meeting demand. Import penetration from low cost countries also may lead to industry restructure.

Interest rates are forecasted to stabilize in 2009, and are estimated to decline towards the end of the outlook period. Increases in employment levels are predicted for 2009, which will see consumer spending and sentiment increase. It is also predicted that secondary battery demand is expected to overtake primary battery market gains, with the use of portable electronic devices increasing. Therefore, industry revenue is expected to slowly recover, as growth rates of 1.3 percent and 2.3 percent expected during 2009 and 2010 respectively, driven by demand from both retail and manufacturing segments, and increased spending on infrastructure. Industry revenue is expected to further increase by 3.0 percent in 2011 and by 3.8 percent in 2012.

Conclusion

The next 18 months look tumultuous for the battery manufacturing sector, but those within the industry have reason to be optimistic towards the later part of the outlook cycle as revenue is expected to increase by 3.0 percent in 2011 and by 3.8 percent in 2012. Although innovation moves at an unexpected pace, advances in battery and battery manufacturing are expected to be the main factor driving growth in demand. Despite a reduction in per capita disposable income, total motor vehicle registrations are expected to improve slightly, while real GDP growth is forecast to begin to recover from the poor growth of 2008.

Contact IBISWorld at www.ibisworld.com.

Battery Power Products & Technology is pleased to announce the 2008 Innova Awards winners. These awards are designed to recognize companies that are striving for excellence and are achieving technology breakthroughs. Congratulations to Sandia National Laboratories, ZPower and Boston Power.

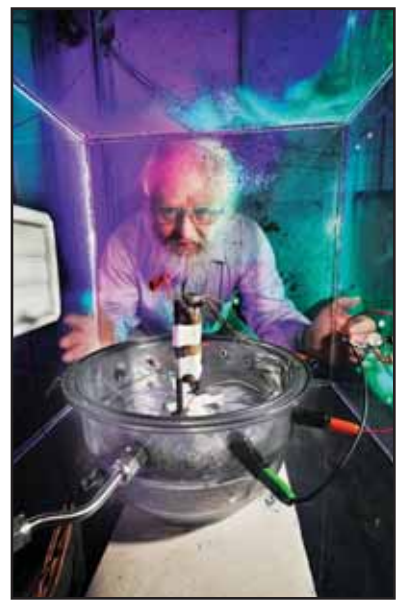
For more information on the winners, the Innova Awards and how to nominate a company for the 2009 awards, please visit www.BatteryPowerOnline.com.

Industry Leadership Award

As part of the Department of Energy-funded FreedomCAR program, Sandia National Laboratories' Power Sources Technology Group is researching ways to make lithium-ion batteries work longer and safer. The research has lead to quantifiable improvements in lithium-ion battery safety that will allow these batteries to be used in new hybrid electric vehicles beginning in the next few years. Current hybrid vehicles use nickel-metal hydride batteries, but a safe lithium-ion battery will be a much better option for hybrid vehicles.

The FreedomCAR program focuses on developing technologies for electric vehicles to help free the US from dependence on foreign oil supplies. Five national laboratories, Sandia, Argonne, Lawrence Berkeley, Idaho and Brookhaven are involved in the program, each researching different aspects of making hybrid electric vehicles a reality.

Sandia's FreedomCAR work centers on the areas of battery abuse tolerance and accelerated lifetime prediction, with abuse tolerance receiving most of the focus. Sandia's work is helping to develop batteries that have a graceful failure, meaning that if it's damaged, it won't cause other problems. To achieve this goal, Sandia has been able to comprehend and quantify mechanisms that lead to poor abuse tolerance, including heat- and gas-generating reactions. Understanding the chemical response to abuse points the way to better battery materials and domestic and foreign battery manufacturers are coming to Sandia for battery and battery module evaluations that are leading to improved, safer designs.



Sandia researcher Peter Roth prepares to blow up a battery to see how robust it is.

Sandia's unique facilities and expertise allow characterization of batteries and battery modules under abuse conditions in a safe, controlled environment. Comprehensive data acquisition and advanced diagnostics allow for detailed, quantifiable analysis of response to abusive environments that represent conditions automotive batteries will experience in hybrid and plug-in hybrid vehicle applications. Overcharge, short circuit, crush, water immersion, vibration, thermal cycling and over-temperature are among the customized test protocols that have been developed and applied to battery systems from nearly every foreign and domestic source of batteries for the automotive market.

The abuse test procedures developed at Sandia have led to lithium-ion test standards that the battery team has developed and published in a Sandia research report. The Society of Automotive Engineers has adopted these test procedures as a national standard (SAE/J2464 Electric Vehicle Battery Abuse Testing) and Sandia is playing a leadership role in continually improving and updating this test standard.

Best Technology

Demand for safe, high-performance, environmentally responsible lithium-ion notebook computer batteries is substantial. In a more than $5 billion market Boston-Power, Inc., a provider of next-generation lithium-ion batteries for notebook computers, has taken the lithium-ion battery technology the market knows today to the next level. Boston-Power's first product, Sonata, establishes a new benchmark in safety, cycle life, performance and environmental responsibility.

Sonata overcomes several significant notebook computer battery obstacles: cycle life, performance and recharge time, all while treating safety as non-negotiable. Sonata is the only battery developed to deliver "new battery" performance throughout the three-year design life of a notebook computer. Other batteries begin to "fade" or deliver less power in just three months, forcing users to spend $200 or more for replacement batteries. Sonata is also the first battery to recharge to 80 percent capacity in 30 minutes, half the time required by batteries in use today.

Specifically, Sonata features enhancements in both performance and safety; its proprietary safety features include slower chemical kinetics, novel current interrupt devices, new thermal fuses, unique pressure relief vents and safer pack configuration. In addition, its "drop-in" design enables Sonata to be used with existing notebook computers, requiring no design changes on the part of notebook computer original equipment manufacturers (OEMs) such as Hewlett-Packard.

Because Boston-Power's product solves notebook users' biggest concerns, the company has garnered interest from large OEMs including HP, and is currently working closely with HP as well as other top OEMs.

Product Development Excellence

Today's consumer has the ability to watch an entire movie on a palm-sized device, but the ability to power that portable device has not kept up. While mobile technology has advanced exponentially, power technology has lagged behind. To answer this call, ZPower is taking the leading role in launching the next generation of rechargeable, silver-zinc batteries for mobile electronics. This advanced battery offers 40 percent more runtime than traditional lithium-ion batteries and more than 95 percent of the primary elements can be recycled and reused. Financial incentives are awarded to consumers who recycle, and ZPower batteries contain no lithium and are inherently safe. All this adds up to a better battery that is significantly advancing mobile power.

Engineers admit that they are "hitting the wall" on lithium-ion and lithium-polymer performance. In addition to performance challenges, lithium-ion batteries cannot be recycled and reused. And unstable lithium-ion batteries causing notebook computer fires has resulted in high product recalls of notebook computers in recent years. As an alternative to lithium-ion, ZPower batteries feature a patented, rechargeable silver-zinc chemistry that delivers important benefits to mobile consumers.

Better Place Joins Subaru, Other Japanese Carmakers in Ministry of Environment Electric Vehicle Project

Better Place, a mobility operator, is joining Fuji Heavy Industries Ltd., maker of Subaru automobiles, and other Japanese carmakers in the first Ministry of Environment, electric-vehicle (EV) project in Japan. Better Place, the only foreign company participating, was invited by the Japanese Ministry of Environment to build a battery exchange station for EVs and showcase the technology in the world's biggest auto-manufacturing nation.

As carmakers focus on the future and developing next-generation vehicles, the government's project supports the move to sustainable transportation and includes various electric-car models and EV infrastructure in multiple cities to demonstrate feasibility. The EV project is scheduled to begin in January 2009 and last three to six months, encompassing municipalities in Kanagawa, Aichi, Osaka and Hyogo prefectures. Yokohama, a participating city in Kanagawa, will host the first location to demonstrate the ability to exchange a depleted EV battery for a fully charged one, a means of extending EV range under the Better Place model. Participation in the Japanese project is the latest example of the model's growing acceptance around the world.

Founded in October 2007 with $200 million in venture funding, Better Place builds electric vehicle networks powered by renewable energy. The company is currently working with partners to build electric vehicle infrastructure in Israel, Denmark, Australia and the US.

Better Place Japan will be led by Kiyotaka Fujii, the former president and CEO of retailer Louis Vuitton's Japanese subsidiary and SAP Japan. Based in Tokyo, Fujii also will lead the company's efforts in the Asia Pacific region.

Ener1 Announces Cooperative Partnership with Heavy Duty OEM and the Department of Energy to Develop Batteries for HEV Bus Applications

Ener1, Inc. has announced a cooperative partnership among EnerDel, Ener1's lithium-ion battery subsidiary, a heavy duty original equipment manufacturer (OEM) and the Department of Energy, to develop high-energy batteries for hybrid bus and heavy duty vehicle markets.

The partnership is a congressionally directed program with a total budget of $1.25 million, 80 percent of which will be funded by the National Energy Technology Laboratory at the Department of Energy, and the remaining 20 percent will be funded by EnerDel.

The program has been designed to test EnerDel's multiple hybrid electric vehicle (HEV) battery chemistries under real world conditions. Three of EnerDel's advanced chemistries have been selected for testing in extreme environments, ranging from hot and cold climates to operating the hybrid battery in full electric mode for extended periods of time. The significance of this would be to simulate long driving distances where the goal is to eliminate noise and pollution in tunnel and other city driving applications. The heavy duty OEM will identify and deliver drive cycle requirements for each environment. The program will partially complete the collection of testing and drive cycle data necessary to produce battery systems solutions for HEV bus and heavy duty vehicle markets.

The Renault-Nissan Alliance Enters Zero-Emission Vehicle Partnership in Sonoma County

The Renault-Nissan Alliance has announced that Nissan North America, Inc. is committing to working with the Sonoma County community of governments to develop solutions for zero-emissions mobility through the promotion of electric vehicles (EVs) and the development of an EV charging network throughout Sonoma County, in northern California.

Nissan as part of the agreement has committed to make available a supply of EVs to Sonoma County community of governments, as well as to work with the parties to develop plans for the creation of an EV battery-charging network in the county. The Sonoma County group will work with Nissan towards realizing these objectives, particularly through the development of methods that encourage the purchase or lease of EVs as well as the establishment of an EV charging network.

Nissan will introduce zero-emission vehicles (ZEVs) in the US and Japan in 2010 and will make them available to the mass market, globally, two years later. The Sonoma County community of governments has committed to a greenhouse gas reduction target of 25 percent, with the goal of bringing greenhouse gas levels to below those of 1990, by 2015. The encouragement of a transportation shift to smart transit, including EVs, is key to the plan's execution.

The Renault-Nissan Alliance has begun ZEV initiatives in Israel, Denmark, Portugal, Monaco, Kanagawa Prefecture (Japan) and with French electric utility company EDF. In the US, the Alliance also has agreed to a ZEV partnership with the State of Tennessee the Tennessee Valley Authority, and other partners, to explore ways to promote zero-emission mobility in Middle Tennessee. Nissan has also entered into a partnership with the State of Oregon in conjunction with utility company Portland General Electric.

Xcel Energy Selects GridPoint Software Platform for Wind-To-Battery Project

GridPoint, Inc., a clean tech company whose smart grid software platform benefits electric utilities, consumers and the environment, has announced that Xcel Energy selected GridPoint's software platform to control the flow of power between the grid and a NGK Insulators' sodium-sulfur battery storing wind energy. When fully charged, the one-megawatt battery will hold approximately 7.2 megawatt-hours of electricity, potentially powering 500 homes for more than seven hours. This is the first US application of the battery as a direct wind energy storage device.

The GridPoint Platform applies information technology to the electric grid to provide utilities with an intelligent network of distributed energy resources that controls load, stores energy and produces power. It will allow Xcel Energy to explore using real-time grid conditions and energy pricing to determine when the battery charges or discharges. Based on system regulation and pricing signals received by the software platform, the battery's charging behavior will be adaptively controlled. When the demand for electricity is high, as an example, stored wind energy could be automatically discharged to the grid, supplementing the power flow. When demand is low, the software platform could issue commands for the battery to store the available energy.

The project will take place in Luverne, Minn., about 30 miles east of Sioux Falls, S.D., adjacent and connected to the nearby 11-megawatt wind farm owned by Minwind Energy, LLC. S&C Electric Company will install the battery and all associated interconnection components. The battery is expected to go on-line in January 2009.

Altair Nanotechnologies Announces Successful PJM Market Acceptance of the First Grid-Scale, Battery Energy Storage System

Altair Nanotechnologies, Inc. has released that its one megawatt (MW), 250 kilowatt-hour battery storage system met requirements to participate in the PJM Regional Transmission Organization (RTO) control area. This milestone marks the first commercial acceptance of an advanced Lithium-Titanate battery to provide grid regulation services in one of the largest electricity markets in the US.

Altairnano is a provider of advanced materials and products for power and energy systems. The company has a joint development agreement with AES Energy Storage LLC, a subsidiary of The AES Corp., to develop grid-scale energy storage applications.

PJM Interconnection is a regional transmission organization (RTO) that coordinates the movement of wholesale electricity in 13 states and the District of Columbia, serving approximately 51 million people.

"Our advanced Lithium-Titanate battery technology will play an integral role in addressing

the utility power market's need for environmentally friendly and energy efficient solutions," said Terry Copeland, president and CEO for Altairnano. "This will create a more resilient grid, allowing for increased adoption of renewable generating resources, such as solar and wind."

Southern California Edison Announces Record Performance Results for Plug-In Hybrid Battery

As automakers work toward putting plug-in hybrid electric vehicles on the road, Southern California Edison (SCE) has announced a major milestone in advanced battery performance. Through ongoing evaluation and tests at its Pomona, Calif.-based Electric Vehicle Technical Center, SCE has demonstrated battery life performance equivalent to more than 180,000 miles in a commercial delivery van with minimal battery deterioration. These batteries could power tomorrow's plug-in vehicles.

The battery test, conducted in a laboratory setting, uses a Johnson Control-Saft lithium-ion battery subpack that is one-sixth of the actual battery size used in a plug-in hybrid electric vehicle. The subpack has been tested continuously for two and a half years, and testing continues to monitor the battery's remarkable performance.

Based on the results achieved with the battery pack, the US Department of Energy has provided SCE with a full-size lithium ion battery and has asked SCE to test and evaluate the battery's viability for passenger car application.

Edward Kjaer, SCE's director of electric transportation, said SCE has long advocated for the benefits of "plugging in" transportation. The company's technical center is a nationally recognized facility with broad-based capabilities. It is the focal point for SCE's work to test, evaluate and demonstrate advanced vehicle drive systems, battery types and charging infrastructure.

"As an alternative fuel provider, SCE takes pride in leading the way in electric transportation, both as a leading operator of electric vehicles and providing more than 20 years of technology evaluation and demonstration experience," Kjaer said.

SCE is conducting the battery test in support of the Electric Power Research Institute's (EPRI's) evaluation of plug-in hybrid electric vehicles. Vehicle modeling by EPRI indicates that plug-in hybrid electric vehicles may significantly reduce petroleum consumption and emissions while providing reduced operational cost for fleets.

Battery Solutions, Inc. Introduces New Convenient iRecycle Kits

Battery Solutions, Inc. (BSI) has introduced a new way for environmentally conscious companies, municipalities and households to conveniently and economically recycle used batteries and handheld electronics: the iRecycle Kit.

The iRecycle Kit from Battery Solutions is a fully inclusive recycling product that makes it easy for customers of all sizes, households to corporations, to simply, safely and economically collect and recycle dry cell batteries, rechargeable batteries and handheld electronics.

Each kit comes complete with everything needed to perform proper recycling: four UN-approved collection containers (two boxes and two pails to choose from) and pre-paid return postage and labeling. The user simply collects all dry cell battery types and handheld electronics together, without separating, then mails the filled containers to Battery Solutions. BSI then performs the sorting, logistics, shipping, receiving and recycling. No hassles. No fuss.

Customers can order their iRecycle Kits by calling BSI at 800-852-8127, or by visiting BSI's Web site. The site contains in-depth information about BSI's comprehensive recycling offerings, which include bulk battery and electronic scrap recycling, and uninterruptible power systems battery recycling.

Axion Power Signs $6.4 Million Manufacturing Contract

Axion Power International, Inc., a developer of battery technologies and advanced energy storage devices, has received a purchase order for 92,250 flooded lead-acid batteries that it will produce over the next 11 months under a toll-manufacturing contract with a major North American battery manufacturer. The purchase order is the first phase of a relationship that could expand to 50,000 units per month by mid 2009. This Phase 1 purchase order segment will generate $6.4 million in revenue over the next year.

Axion's primary business focus is developing new manufacturing processes for energy storage devices based on its proprietary PbC technology, which promises to deliver advanced battery performance at a price that approaches lead-acid. Restoring the flooded battery lines to production will not interfere with Axion's PbC activities on the AGM line and should give rise to significant economies of scale and training opportunities for new hires. Axion's CEO Thomas Granville said the new purchase order will help put under-utilized sections of the New Castle plant into production and provide an important source of new revenues to finance ongoing R&D and future growth.

Hybrid Electric Vehicle/Electric Vehicle Battery Market: *A Trend Analysis*

Dinkar Krishnan, Research Analyst
Frost & Sullivan

Global warming is posing a major challenge to the world's environment. One of the methods to handle this challenge includes limiting emissions from on and off-road vehicles. The widespread use of electric vehicles could be an effective way to limit emissions. Efficiency and performance of electric vehicles (EVs), however, are still in the development and evaluation stage and cannot compare with conventional gas-powered vehicles. As a result, the automotive industry has focused on advancing hybrid electric vehicles (HEVs) that operate on a combination of gas and electric power, powered through the battery. Since HEVs offer performance levels similar to gas-powered vehicles, the technology has gained market appeal amongst the passenger car segment. As the battery is a key component of HEVs and EVs, the current economic slowdown scenario coupled with enforcement of environmental mandates could significantly impact the market.

Global financial turmoil has created a negative impact on major automotive manufacturers, particularly in the US. However, with the current focus on governmental policies and regulations regarding energy usage and supply, as well as transportation emissions, auto makers must be prepared for change in this regard. Therefore, technology innovations and advancements are still expected to occur in the short term, despite the current economic situation and financial turmoil.

In terms of HEVs, regenerative braking and plug-in HEVs are key aspects of development. Similarly, EVs are powered through batteries such as advanced lead acid chemistry, nickel metal hydride chemistry, sodium nickel chloride chemistry and lithium-ion chemistry, as well as with fuel cells. HEVs and EVs have vast potential to be successful in reducing harmful emissions and increasing fuel efficiency. Major manufactures such as General Motors, Toyota Motor Corp., Ford Motor Company, Nissan Motor Company and Honda Motor Company are active in the HEV market and are working to launch new versions with improved battery capacity. Currently, there are nearly 50 models of HEV/EV passenger cars available in various developmental stages, and advancements continue to affect HEV/EV batteries in terms of performance.

Policies and Regulations Favoring the HEV/EV Market and the Impact on the Battery Market

Government entities across the world are promoting HEVs and EVs through policies, regulations and tax credits. Some of those initiatives include the US. Energy Independence and Security Act created in 2007 that aims to achieving fuel efficiency of 35 miles per gallon for fleets by 2020. This act also offers incentives for developing efficient plug-in HEVs.

The Energy Efficiency and Renewable Energy Division of the U.S Department of Energy has created technical goals for these vehicles. This includes electric drive energy storage of 15-year life at 300 Wh per vehicle with discharge power of 25 KW for 18 seconds and a cost of $20/KW. When the electric drive energy is available at $20/KW, it reduces the cost of HEVs and EVs thus promoting demand.

In the US, federal and various state policies also give incentives to vehicles with partial and zero-emissions, which include tax credits and parking fee waivers. These measures augment growth of HEV/EVs that promote the HEV/EV battery market.

The state of California has an active model of supporting efficiency and emission causes. It includes High Occupancy Vehicle (HOV) Lane Exemption, HEV/EV and Zero Emission Vehicle Parking Incentive, among others. This also includes Utilities and Private incentives such as Electric Vehicle Recharging Rate Reduction and Hybrid Electric Vehicle Insurance Deposit. Colorado, Connecticut, Georgia, New Jersey and other states have similar laws that provide parking waiver/exemptions and/or tax incentives or credits to HEVs and EVs. Some US states also provide grants to agencies and companies engaged in R&D of vehicles with higher fuel efficiency and lower emissions.

An Opportunity in the Offering

The HEV/EV battery market is witnessing significant developments, especially in the lithium-ion battery chemistry. Some battery manufacturers have formed strategic alliances with auto manufacturers and are currently involved in the development of batteries that offer improved energy density, more life, weight and cost effectiveness.

Notable among the alliances is the formation of Automotive Energy Supply Corp., a joint venture company formed between Nissan Motor Company and NEC Group, which is expected to power Nissan's foray into HEV/EV market. General Motors has been working with Compact Power, Inc., a battery manufacturer of the LG Chem Limited, to explore the possibilities of lithium-ion polymer battery technology. Sanyo Electric Company and Volkswagen AG have formed alliances to develop lithium-ion batteries to power HEVs manufactured by Volkswagen. These alliances are expected to achieve the objectives of making batteries which could redefine the future of the automotive industry.

With a sale of about 400,000 hybrid cars and the Toyota Prius model reaching one million cars sold in 2007, HEVs and EVs are expected to witness significant growth in the next couple of years. Battery and auto manufacturers involved in developing efficient HEVs and EVs with superior performance are therefore likely to witness lucrative growth opportunities.

Conclusion

Flexi-fuel vehicles and fuel cell vehicles are likely to take more development time to reach mass production owing to the shortcomings in technical aspects and infrastructure fuel issues. The present global situation of fluctuating fuel costs requires automobile manufacturers to develop vehicles with very high fuel economy and low emissions. This has lead to the increased development of HEVs and EVs that are environmentally friendly and fuel efficient.

Major vehicle manufacturers face a challenge with their current business plans and strategies amidst troubled financial conditions and the alternative strategy of committing more R&D resources to the HEV/EV market. They would be required to work more closely with their battery suppliers to provide improved technology and reduce the time-to-market.

For more information regarding this article, please contact Johanna Haynes at johanna.haynes@frost.com.

Ask the Experts continued from page 7

Q: We currently use rechargeable 'AA' NiCd batteries in some of the products we make. We are planning on making the switch to NiMH. I have been hearing more recently about a new NiMH 'low self-discharge' technology. These batteries also come pre-charged. The typical spec is for the battery to retain 85 percent of its charge after one year storage. This compares to a standard NiMH, which can lose all of its charge in 3 to 6 months. Both the low-discharge and pre-charged features appeal to me. Are there any trade-offs or disadvantages associated with these features, such as reduced 'low-discharge' ability after charge cycling?

Matt Young, Intercomp

A: The low self-discharge NiMH battery (LSD NiMH) was introduced to the market in 2005 by Sanyo. Since its initial introduction this technology has been implemented by other manufacturers including Gold Peak, Yuasa, Vapex and Uniross (taken from Wikipedia insert on '*Low Self-Discharge NiMH Battery*'). Although each manufacturer's LSD NiMH has their own advantages and disadvantages, there are some general rules. First, the major advantage is charge retention. This of course depends on the storage temperature of the batteries. The one major disadvantage is that the battery capacity is typically lower for LSD NiMH than original NiMH. However, it is most likely larger then your previous NiCd of the same size (This is manufacturer dependent.). Another advantage is that the number of lifetime charge cycles for the LSD NiMH is the same or better than standard NiMH.

When evaluating switching from a NiCd to NiMH one needs to consider the charging methods as they are different for the different battery chemistries. With multiple manufacturers and versions of the LSD NiMH, it is best to have specific questions answered by the manufacturer of the battery of choice, as each manufacturer's specifications, recommendations, 'trade-offs or disadvantages' associated with their batteries may differ.

Don Melnikoff, Biomedical Engineer, Alpha Source, Inc.

Q: How is End of Charge and End of Discharge calculated if you only know the nominal voltage of the battery?

Habibah Baffour, Project Engineer FMC Kongsberg Subsea AS

A: There is a very tight correlation between the battery open circuit voltage (OCV) and state of charge (SOC) under full battery relaxation. The SOC is defined as the ratio between the charge available in the battery and battery chemical capacity or design capacity Qmax given by the cell manufacturer. The OCV curve with SOC is fixed for a given chemistry even for different battery chemistry manufacturers as shown in Figure 1. If we know the battery voltage under relaxation, which the battery voltage change rate is less than 4uV/second at state A as shown in Figure 1, we can find the state of charge based on the correlation between the OCV and SOC. Once the SOC is known, then the End of Discharge QED will be SOC×Qmax if the discharge current is less than C/20 so that the voltage drop across the battery internal resistance can be neglected. On the other hand, the End of Charge QEC is (1-SOC) Qmax.

If the discharge current is greater than C/20, the voltage across battery internal resistance has to take into account. The battery reaches the end of discharge voltage earlier than lower discharge current. The higher the internal resistance, such as at the low temperature and with an aged battery, the more voltage drop across the battery internal resistance and lower end of charge capacity, which results in lower battery remaining capacity at the end of discharge. The battery internal resistance almost doubles after 100 cycles and it has higher resistance at low temperature than at high temperature. To accurately predict the battery end of discharge, the battery internal resistance must be known which could be accurately modeled or measured in a real time.

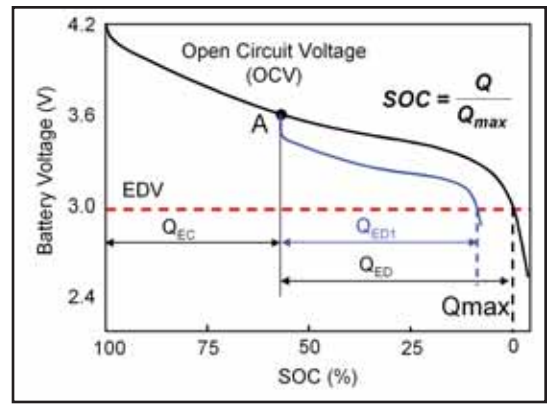


Figure 1.

The battery ages faster when it exposes to high ambient temperature, which is close to the heat source like CPU. Therefore, accurately modeling the battery internal resistance is very difficult or almost impossible since it is dependent on the aging and usage. Impedance Track technology measures the battery resistance in a real time, which is used to calculate the end of discharge voltage for accurately predicting the battery reaming capacity. Since the battery impedance is regularly updated and stored in the memory, any aging and temperature effects have been taken into account, which improves the fuel gauge accuracy in the battery life time. On the other hand, if the battery stays on the shelf for a long time, the battery capacity will be reduced due to its self-discharge, which is reflected in the battery voltage. In addition, the battery chemical capacity Qmax will be degraded by 3 to 5 percent after 100 cycles. The battery chemical capacity Qmax can be automatically updated with two OCV measurements. For more detail information about the Impedance Track Technology, please review the article of Theory and Implementation of Impedance Track battery fuel gauging algorithm at http://www.ti.com/lit/pdf/slua364.

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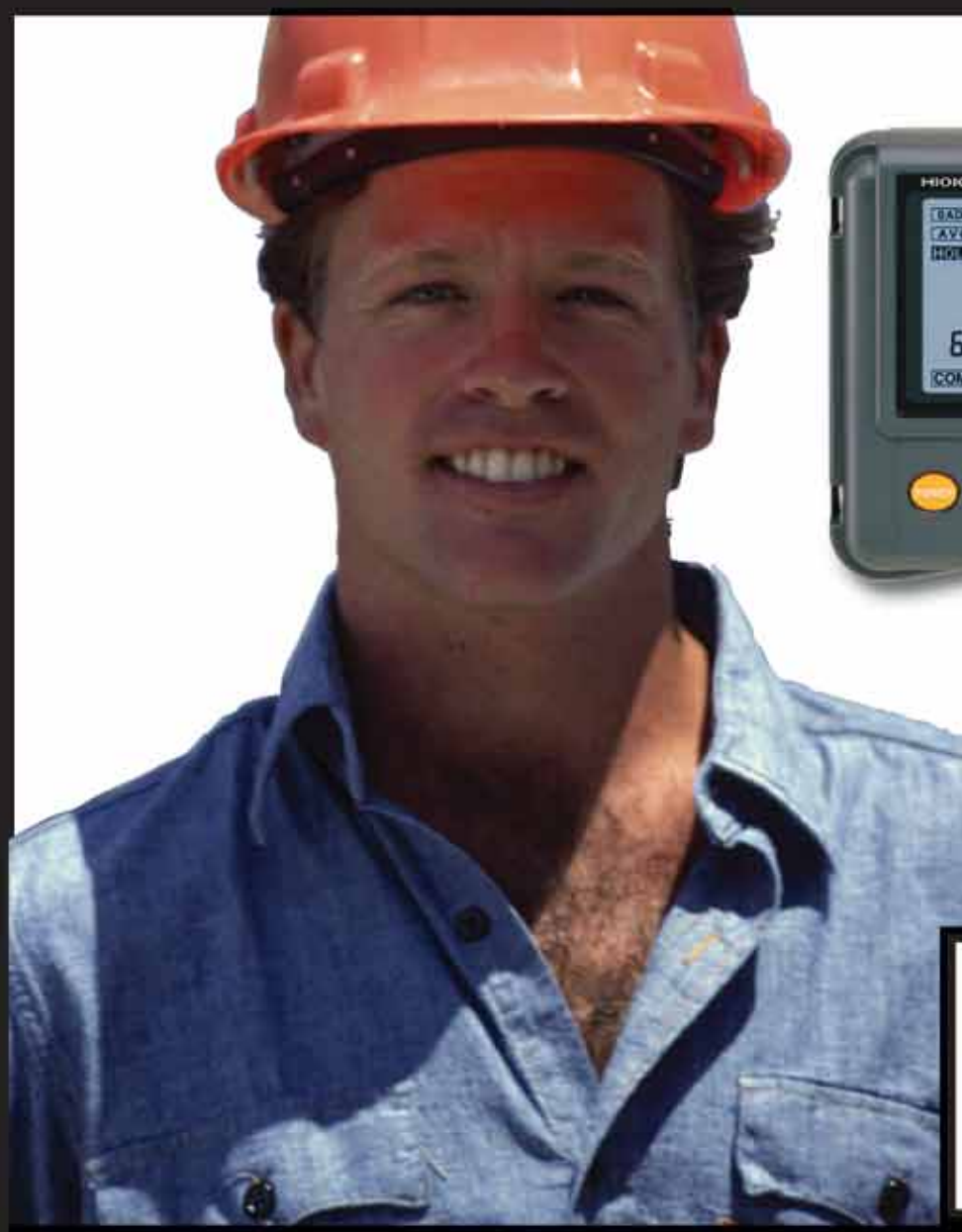

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