Battery Technology

Are lithium-ion batteries up to the task and is it realistic to think that in 2 to 3 years a car battery could be recharged in an hour?

By Jim Stegen, Auto Systems Architect, Analog Devices, Inc.

MIT scientists have developed a battery that can recharge a device in seconds. The researchers have already made a small prototype cell that charges fully in 10 to 20 seconds, compared with six minutes for cells made in the standard way. They project this technology will be available commercially within two to three years.

Looking at the market space, it would be hard to argue against the use of Lithium-Ion batteries in HEV/PHEV/EV applications. Governments around the globe are providing many incentives tied to the lithium-ion battery technology and the automotive press is full of announcements from major OEM's regarding their decisions to replace their NiMH applications with lithium-ion battery technology. We are seeing the examples already in the HEV/PHEV market, such as the Daimler S400 and the soon to arrive Chevrolet Volt.

There are 2 key challenges ahead for lithium-ion batteries to show that it is up to the task. First, can these new battery systems survive in the automotive environment for the expected life of a vehicle? Second, can they become more cost effective?

The desired calendar life of a Li-Ion battery pack in an automotive application is 10 to 15 years. Intelligent battery management systems will play an important role in ensuring that this battery life time goal is achieved by continuously monitoring the State of Charge and State of Health of the battery pack, as battery cell life is significantly reduced in over charge/discharge situations. In terms of cost, replacing discrete solutions for battery measurement with integrated functionality will help drive the system cost lower through lowering the electronics cost but more importantly through enabling more efficient and more accurate utilization of cell capacity. ADI is applying its signal processing expertise to help auto and battery companies make Li-Ion battery technology safer, more practical and cost effective by providing integrated battery measurement and backup monitor system solutions.

Regarding the question of fast charge capability, the Opel Ampera PHEV has

published a recharge time of 3 hours, so one can see the technology to achieve fast charge times is currently being developed for the automotive market. However, a key question is whether the infrastructure required to support it can be put in place and be readily accessible to the public in the defined timeframe. Charging your EV vehicle in a home which has a garage to support the charging equipment and ease of access would seem to be acceptable. However applications in the large city environment provide a greater challenge as personal garage space is limited. The issue of how to provide a safe environment to charge a large number of vehicles in a limited amount of space will need to be addressed.

Chris Turner, Director of Battery Technology, Nexergy

Headlines about "new battery technology" are more frequent because of renewable energy, electric vehicles and energy storage for the power grid. Actually, such headlines have been commonplace for some time. Of course, this is not to contend that MIT scientists haven't developed a battery that will allow charging in 10-30 seconds. The real issue is that the headline rarely tells the whole story.

Quite simply, no battery technology has ever become commercially successful based on a single metric. A battery or cell is an electrochemical system with a very complex system of tradeoffs. Optimize or maximize one parameter and likely another one (or two or more) will suffer. Important performance parameters that tend to work against one another as tradeoffs are energy density, charge rate, discharge rate, cycle life, calendar life, high-temperature stability, low-temperature performance, abuse tolerance and safety. Targeting an application's requirements and striking the right balance with cell chemistry to meet those requirements are what transforms a good "lab technology" into a successful commercial one.

Then there are practical considerations, the latest headlines notwithstanding. Fast charging is generally a desirable trait, but the practical discussion must focus on the charger and associated circuitry in the battery pack. Fast-charging lithium ion (Li-ion) technology has existed for some time now, with lithium iron phosphate technically being able to charge in about 10 minutes.

What many designers came to recognize after this technology became available was the reality of the cost of the higher power charger needed to achieve this charge time. In addition, designers had to acknowledge that additional costs linked to the required "beefed-up" battery management system (BMS) made this technology impractical, cost-prohibitive or both.

Consider the all-electric Nissan LEAF. Its battery is reported to be a 24-kilowatt hour (24 kWh) unit -- one of the smaller batteries in the coming wave of electric vehicles.

To charge this battery in 30 minutes would require a power supply capable of delivering nearly 50 kilowatts of power. That is just not the kind of power delivered from a typical household electrical outlet.

Nissan is offering LEAF buyers a "home assessment" to determine if a house is equipped to handle some type of 220V charging station from Nissan (details not available yet) that will charge their battery in 4 to 8 hours. To charge that same battery to 80% in ~30 minutes, Nissan is installing "quick charge" stations in select locations around the United States.

Given the challenges that a 30-minute charge presents with special infrastructure required, it is difficult to foresee a system capable of charging a battery in 30 seconds as practical soon.

That should be tomorrow's headline.