



Ultracapacitors to Find Use in Hybrid Powertrains

ENERGY
EFFICIENCY AND
RENEWABLE
ENERGY

OFFICE OF
TRANSPORTATION
TECHNOLOGIES



Transportation FOR THE 21ST CENTURY

Background

A new class of capacitors has been developed that can store enough energy and deliver enough power to be useful in advanced automotive powertrain applications. These high-capacity, "ultracapacitors" were an outgrowth of diverse applications of electrochemistry and electrochemical technology. By combining an electrochemical charge-discharge capability with capacitor technology, capacitors were created with a much higher energy storage capability than is usually found in normal electrical and electronics applications.

The Technology

Testing determined that ultracapacitors were capable of achieving the DOE-established technical targets of 5 Wh/kg and 800 to 1,000 W/kg. As part of this testing, the first multicell ultracapacitor bank was assembled and tested at the Idaho National Engineering and Environmental Laboratory (INEEL), and showed it was capable of delivering the power levels required by advanced vehicles. Subsequently, ultracapacitor technology has achieved performance levels that are useful for power assist hybrid vehicles and for use in buses, medium- and heavy-duty trucks, and other large vehicles. This initial developmental work on ultracapacitor technology led to the devices that are commercially available today for automotive powertrains.

Commercialization

On January 9, 2001, General Motors (GM) announced that it will use PowerCache™ Ultracapacitors from Maxwell Technologies, Inc. as part of its Allison Electric Drives™ family of advanced hybrid solutions for truck and bus applications.

PowerCache™ Ultracapacitors are a new energy storage technology ideally suited for applications needing repeated bursts of power for fractions of a second to several minutes. These ultracapacitors pack up to 100 times the energy of

conventional capacitors and deliver 10 times the power of ordinary batteries. They provide extended power availability, allowing critical information and functions to remain available during dips, sags, and outages in the main power source. In addition, ultracapacitors feature accessible terminals and an electrostatic storage capability that can cycle hundreds of thousands of charges and discharges without performance degradation.

PowerCache™ ultracapacitors are made up of advanced super capacitor technology that has a significantly extended lifetime compared to conventional batteries. Although sensitive to temperature, ultracapacitors used in appropriate temperature conditions are expected to last in excess of 6 years, thus making them cost competitive with conventional diesel power, yet with dramatic energy and emissions advantages. In addition, the super capacitors offer a reliable and durable energy source that is about one-third the weight and one-half the volume of conventional batteries.

The capabilities of ultracapacitors for efficient electrical energy storage and rapid discharge/recharge are integral to GM's industry-leading development programs for low-emission, fuel-efficient, hybrid powertrains and advanced electrical drive systems. By supplementing the primary engine with an electric motor that assists initial acceleration, and recaptures and reuses braking energy, fuel consumption can be reduced by more than 50 percent, particulate emissions by 90 percent, and nitrogen oxide emissions by 50 percent when compared to conventional diesel engines.

As the manufacturer of PowerCache™ ultracapacitors, Maxwell Technologies believes that with a target price of \$30 or less per cell in 2003, demand in the transportation market could reach one million cells in 2003, increasing rapidly to more than 100 million cells in 2008.

Benefits

- Obtain higher overall energy conversion efficiency (fuel economy) in power assist hybrid vehicles, especially during urban driving cycles.
- Offer up to 100 times the energy of conventional capacitors and deliver 10 times the power of ordinary batteries.
- Provide extended power availability, allowing functions to remain during outages in the main power source.
- Feature accessible terminals and an electrostatic storage capability that can cycle hundreds of thousands of charges and discharges without performance degradation.



PowerCache™ PC2500 Ultracapacitor produced by Maxwell Technologies, Inc.

Contacts:

Dr. Raymond A. Sutula
Office of Transportation Technologies
(202) 586-8064
raymond.sutula@ee.doe.gov

Dr. Kenneth L. Heitner
Office of Transportation Technologies
(202) 586-2341
kenneth.heitner@ee.doe.gov