WHITE PAPER

ULTRACAPACITORS ENABLE DISTRIBUTED AUTOMOTIVE POWER

Richard E. Smith

Maxwell Technologies, Inc.
Worldwide Headquarters
9244 Balboa Avenue
San Diego, CA 92123
USA
Phone: +1 858 503 3300
Fax: +1 858 503 3301

Maxwell Technologies SA
CH-1728 Rossens
Switzerland
Phone: +41 (0)26 411 85 00
Fax: +41 (0)26 411 85 05

Maxwell Technologies GmbH
Brucker Strasse 21
D-82205 Gilching
Germany
Phone: +49 (0)8105 24 16 10
Fax: +49 (0)8105 24 16 19

Maxwell Technologies, Inc. - Shanghai Representative Office
Rm.2104, Suncome Liauw's Plaza
738 Shang Cheng Road
Pudong New Area
Shanghai 200120, P.R. China
Phone: +86 21 5836 5733
Fax: +86 21 5836 5620

info@maxwell.com – www.maxwell.com

Faced with numerous challenges involved in satisfying the modern automobile's appetite for power and energy to support both static and dynamic electrical loads, automotive electronics designers increasingly are turning to cost effective ultracapacitor modules.

One constant and growing challenge is the average load of the automotive electrical system, which is increasing between 100W to 150W per year and is beginning to exceed the limits of the 14-volt alternator, which typically generates 1.25 kW to 2 kW. This increase in installed loads is driving the alternator generating capacity towards 200A (14V x 200A = 2.8 kW) with attendant increases in cable harness size, power distribution box complexity, relay and switch rating increases, and hence higher cost, weight, and reduced reliability. One thing is clear: The steadily escalating demand for power to drive these advanced automotive electronics functions is straining the capabilities of existing 14V electrical distribution systems.

While continuous electrical functions represent a burden on the vehicle power generation system and form the basis for the growth in installed loads, there is a second requirement for high power electrically driven functions that are intermittent with relatively short duty cycles in seconds. These dynamic loads are also dramatically increasing from 1 or 2 kW in the 1980s to over 6 kW today. If a short-term demand for power causes a voltage drop (ΔV = Amps x Resistance) on the boardnet (the power distribution supporting the logic boards), the control electronics may stop functioning due to low voltage cutoff. Because modern automobiles have from 50 to 100 control modules, this has become a major reliability and safety issue.

Reliability Concerns

Logic circuit faults have many negative consequences: safety functions may not work, electronic fuel controls may stop, causing the engine to stall, and lights and sound systems may fluctuate and cause confusion or distraction. Interestingly, it is option-laden high-end automobiles, which command premium prices for luxury and performance features that are most susceptible to such glitches. In a small, but not insignificant, number of control box shutdowns, the automobile must be towed to the service center to have the computer’s function restored.

This divergence between demanding owners’ expected performance and comfort and the seemingly random disruptions and “it just died” events has become prevalent enough to require immediate solutions. Designers have responded with stopgap measures such as adding a second battery to support the boardnet that powers the computerized control boxes, but this adds weight, cost, and complexity and still can’t eliminate all incidents.

This seeming dilemma has led designers to explore lighter, cheaper, more reliable, ultracapacitor-based solutions to bridge the power gap until the higher voltage 42V systems can be deployed.

Because their design cycles are shorter, sub-systems powered by distributed ultracapacitor nodes will be introduced before power train elements, such as future hybrid drives. Ultracapacitors long life and high cycle life make them ideal for sub-subsystems that demand highly variable power loading, such as steering, braking, air conditioning, entertainment, power seats, steering wheel, and seat heaters. Localized load levelling of pulse loads such as electric brakes, electric steering racks, electric heaters, door actuators, and electronically actuated parking pawls also will reduce the need to run high-current wires long distances within the vehicle.

Applications

Following are a few examples of practical applications for distributed power using ultracapacitors.

Boardnet stabilization is one of the best and easiest to implement applications for ultracapacitors. The short-term power demands that cause voltage dipping can be buffered with a 14-volt power module designed with enough energy storage to "ride through" or supplement peak power demands. This offers several advantages: It replaces the need for a second battery, takes less weight and space, is not a maintenance item, lasts the life of the car, and performs reliably at –40C.

The acquisition cost in high volume is about the same as a second battery and associated cabling, and the life cycle cost to the consumer is lower. The 15V module weighing 0.68 kg (1.5 lb) and taking up 690 cm^3 (42 in^3) shown below is designed for boardnet stabilization and is being tested by many automotive manufactures to handle voltage dipping.

Maxwell Technologies, Inc.
Worldwide Headquarters
9244 Balboa Avenue
San Diego, CA 92123
USA
Phone: +1 858 503 3300
Fax: +1 858 503 3301

Maxwell Technologies SA
CH-1728 Rossens
Switzerland
Phone: +41 (0)26 411 85 00
Fax: +41 (0)26 411 85 05

Maxwell Technologies GmbH
Brucker Strasse 21
D-82205 Gilching
Germany
Phone: +49 (0)8105 24 16 10
Fax: +49 (0)8105 24 16 19

Maxwell Technologies, Inc. -
Shanghai Representative Office
Rm.2104, Suncome Liauw's Plaza
738 Shang Cheng Road
Pudong New Area
Shanghai 200120, P.R. China
Phone: +86 21 5836 5733
Fax: +86 21 5836 5620

info@maxwell.com – www.maxwell.com