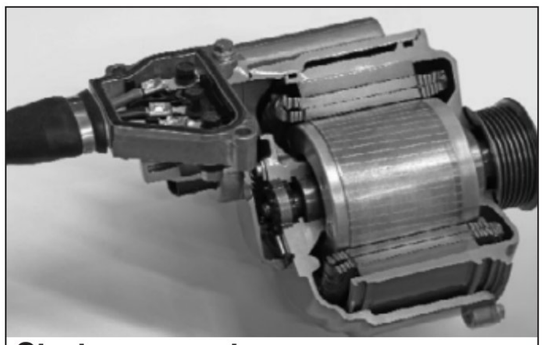
# Start/stop technology aids new fuel-saving systems

By A/C Delco

Step on the brake pedal, come to a complete stop, and the engine turns off, saving fuel and reducing emissions. Release the brake pedal and press the accelerator pedal, the engine starts again. It all happens seamlessly without interruption of any accessory operations.



**Starter generator.**

A start/stop system that automatically turns off and restarts the engine when the vehicle is stopped can deliver a substantial improvement in fuel economy by simply reducing the amount of time the engine idles. Many vehicles with a start/stop system are not full hybrid electric vehicles that have the added cost and complexity of powering a vehicle completely on battery power. These fuel-saving systems are becoming more commonplace on new vehicles, such as the new 2012 Buick LaCrosse, which will have start/stop technology as a standard feature on the base model.

**New eAssist system**

In addition to the 2012 Lacrosse, the 2012 Buick Regal also will offer a start/stop system. The new GM system is called eAssist™. The 2012 LaCrosse and Regal offer impressive 25 percent fuel economy gains over the 2011 models without eAssist. The start/stop feature of the system uses a state-of-the-art lithium-ion battery system and an electric induction starter generator.

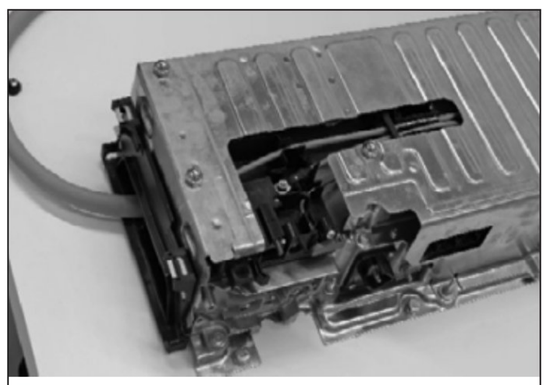
eAssist models feature:

- A 2.4L Ecotec 4-cylinder engine mated to a Hydra-Matic 6T40 automatic transmission
- A starter generator, or drive motor, mounted to the front of the engine in place of the alternator
- An air-cooled generator control module comprised of the eAssist powertrain control module, 14 volt power module and drive motor control module
- A hybrid/EV battery pack that stores 115V DC in two lithium-ion battery sections
- Lightweight 17-inch alloy wheels and tires with lower rolling resistance
- Regenerative braking, which provides up to 15 kW of electricity to charge the high-voltage battery
- A driver-selectable, fuel economy-optimizing eco mode for the air conditioning system, which enables more frequent and longer-duration engine Auto Stop periods

The liquid-cooled electric induction starter generator is a three phase AC induction machine that serves as a 115-volt AC generator and is used to provide engine power assist as well as to start the engine when in Auto Stop mode. As a generator, it provides up to 15 kW of AC power to the drive motor control module. As a motor, the starter generator provides up to 11 kW of electric power assistance and engine starting. The starter generator is connected to the crankshaft pulley using a specially designed serpentine belt and drive belt tensioner.

The eAssist generator control and battery module assembly contains the high-voltage lithium-ion battery pack, the integrated power inverter and 14V power module. It is located in the forward area of the trunk compartment and weighs about 65 pounds (29 kg). An electric fan cools the generator control and battery module, drawing air from a vent located in the package tray, behind the rear seat.

An auxiliary, electric-driven transmission oil pump has been added to keep the transmission fluid flowing and clutches applied when the engine shuts down during an Auto Stop.



**Generator control and battery module assembly.**

**Auto stop**

While driving, when the brake is applied and the vehicle comes to a complete stop, the engine will turn off, depending on operating conditions. This is referred to as an Auto Stop (the tachometer gauge will read AUTO STOP). The engine restarts immediately when the brake pedal is released or the accelerator pedal is applied. The maximum Auto Stop time is two minutes under ideal conditions.

There are several conditions that may cause the engine to remain running or restart when the vehicle is stopped.

These include:

- The engine, transmission or high-voltage battery has not reached operating temperature
- The outside temperature is less than -4 degrees F (-20 degrees C)
- The shift lever is in any gear other than Drive (D)
- The high-voltage battery state-of-charge is low
- The climate control system requires the engine to run based on the climate control or defog setting. Using the eco air conditioning mode will result in more frequent and longer Auto Stops
- The Malfunction Indicator Lamp (MIL) is illuminated

To view the parameter for an Auto Start, review the scan tool Hybrid Data list available in the engine control module. This list contains parameters that are directly related to the Auto Start/Stop feature. Look for Eng Auto Start Reason. This parameter will list the last command that caused the Auto Start feature to engage.

**Electric boost**

The eAssist system also uses power

stored in the 115V lithium-ion battery to provide an electrical boost in various driving scenarios.

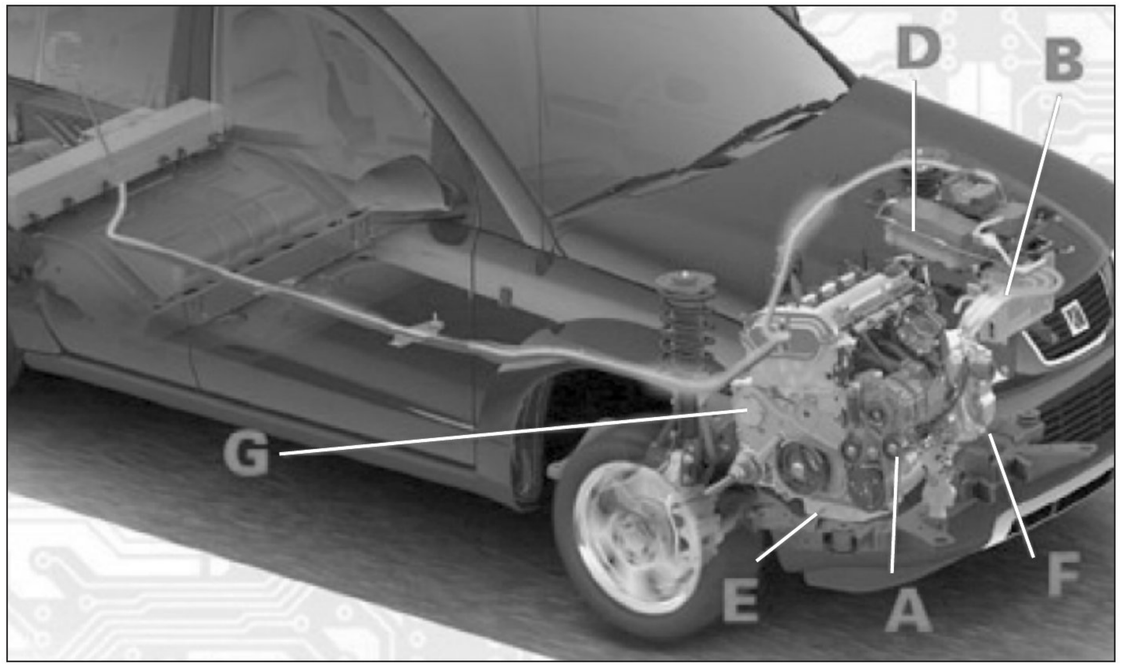
The high-voltage battery system is designed to provide power assistance to the internal combustion engine, rather than store energy for all-electric propulsion. While in fuel shut-off mode, the induction motor-generator unit continues spinning along with the engine to provide regenerative braking, torque smoothing and immediate takeoff power when the driver presses on the accelerator. Then, as the vehicle comes to a stop, the induction motor-generator unit spins the engine, bringing it to a smooth stop—properly positioned for an immediate restart when the driver releases the brake pedal or applies the accelerator pedal.

**Power electronics**

The power electronics provide three basic functions.

When the system is in the motoring mode, the power electronics invert the hybrid electrical power from direct current (DC) to 3-phase alternating current (AC), which is then passed on to run the generator with starter as a motor. This provides quick engine auto-starts, torque smoothing, and electric power assist as needed.

When the system is generating electricity for subsequent high-voltage battery storage, the power electronics rectify the 3-phase AC electrical power input to a DC electrical power output. In this mode, the energy required to drive the engine may come from either gasoline when accelerating or the kinetic energy of the moving vehicle when decelerating with the fuel cut off.




Finally, whether motoring or generating, the power electronics convert the hybrid battery DC electrical input to a low voltage electrical output that is used to provide both vehicle accessory power and to keep the 12V battery charged.

**A/C operation**

The air conditioning controls permit the driver to select between eco and normal operating modes.

Eco mode allows the engine to enter Auto Stop mode more often and for a longer duration. When this happens, the A/C compressor also stops, which may allow cabin temperature to rise, but fuel economy is maximized. To maintain cabin comfort in the eco mode, the recirculation button can be activated.

**First generation**

Earlier GM vehicles to use a start/stop system to improve fuel economy were the Saturn VUE Green Line Hybrid, Saturn AURA Green Line Hybrid and Chevrolet Malibu Hybrid models.

The Saturn VUE Green Line Hybrid, the first to debut the system, uses a 2.4-liter Ecotec engine, a modified 4T45E automatic transmission, and a starter generator assembly. The system also provides electric power assist while driving or during acceleration when needed. The system automatically maintains accessory functionality and passenger comfort when the engine is stopped.

The major components of the Saturn VUE Green Line Hybrid include:

A. A starter generator (3-phase, 65 Nm stall torque, 3kW continuous power) hard-mounted to the engine with a dual-tensioner assembly that combines a hydraulic tensioner and friction-based rotary tensioner on a common, pivoting arm, which ensures sufficient tension is available in both motoring and generating modes.

B. Generator control module with an inverter and power converter that controls the generator and provides 12V vehicle accessory power.

C. A 36V advanced, nickel metal hydride (NiMH) hybrid battery pack capable of delivering and receiving more than 10kW of peak power.

D. An engine control module with sophisticated Hybrid Supervisory Software to manage both engine and hybrid system operation.

E. An engine accessory drive with dual tensioner assembly and 7-rib Aramid cord belt that enables reliable transfer of torque for both motoring and generating.

F. 4T45-E electronically-controlled transmission that includes an auxiliary oil pump and unique hybrid controls to ensure seamless hybrid operation.

G. 2.4L 4-cylinder VVT Ecotec engine.



**Class 0 isolation gloves.**

**Safety considerations**

High-voltage hybrid systems produce voltages higher than a conventional 12V system, and even small currents can be dangerous.

All intermediate-voltage circuits are identified with blue wiring conduits.

Safety precautions are described in appropriate service information. Become familiar with these precautions and always observe them.

Some important safety practices:

- Remove or cover belt buckle
- Wear safety glasses
- Wear rubber-soled shoes
- It is recommended to wear class 0 isolation gloves (leather outside, rubber inside), which are rated up to 1000V
- Know where the components are located in the hybrid system and follow all precautions

**ACDelco training**

ACDelco offers a number of advanced technology training courses, including Web-based Training (WBT), Instructor-led Training (ILT) and seminars (SEM). Available ACDelco hybrid system training courses include:

- High Voltage System Safety, S-EL06-42.01WBT
- Advanced Technology Vehicle Power Electronics, S-EL06-55.01WBT
- Hybrid Technology, S-EL06-41.01SEM
- Hybrid Aftermarket Service, S-EL06-42.01SEM
- Hybrid Technology and Service, S-EL06-12.01ILT

*Thanks to Steve Bunce, Paul Ghanam, Mike Pontello and Irina Novikova.*

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