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DENSO's Stop/Start Technology

- DENSO's stop/start technology is featured on some Ford, Chrysler and General Motors vehicles
- DENSO's stop/start technology hit U.S. roads in 2012, first debuting as options on the 2013 Ford Fusion and the 2013 Dodge Ram 1500
- In 2013, DENSO's stop/start starter debuted on GM's 2014 2.5 L Chevrolet Malibu
- Produced at our DENSO Manufacturing Tennessee plant in Maryville, Tennessee, the new starters help improve fuel efficiency by cutting the engine when the vehicle is at a stop or in other idle traffic situations.
- The addition of the new stop/starter manufacturing line also resulted in an increase of over 100 new positions in the last two years.

Improved Fuel Economy:

- Stop/start systems stop the engine when the vehicle is idling at a stop light or in other traffic situations.
- Depending on automaker specifications, the technology can help improve fuel efficiency by approximately 3 to 5 percent.
- DENSO recently launched its lithium-ion battery pack specifically for stop/start equipped vehicles that further increases the fuel efficiency of vehicles with stop/start systems and can bump fuel savings to more than 7 percent, depending on the automaker's system approach.

Our Experience:

- DENSO's been working on stop/start technology since the 1980s.
- This experience, paired with our in-depth knowledge of powertrain and thermal management systems, gives us a unique advantage to provide automakers with an overall systems approach.
- The company understands how to seamlessly integrate stop/start components into the vehicle and can offer superior technical support that comes from decades of integration experience.

Stop/start Systems Approach:

- An integrated stop/start approach is more than just starter technology.
- There are many other products and components that can be added to any stop/start approach to improve comfort and convenience (air conditioning) and powertrain performance.
- Many of these products better manage energy in a vehicle, which translates into fuel efficiency.
- Some of these products include:

Lithium-ion Battery Pack	<ul style="list-style-type: none"> • Allows the stop/start system to use more regenerative power than current conventional systems that use a single lead-acid battery. • Reduces power generation required by the alternator, resulting in an overall load reduction on the engine to improve fuel economy.
Cold Storage	<ul style="list-style-type: none"> • Helps maintain the temperature of a vehicle equipped with stop/start when it's stopped and the air conditioning system is no longer powered. • Stores a cooled material and uses it while the engine is stopped to ensure the air conditioning is maintained.
Electric Water Pump	<ul style="list-style-type: none"> • Helps maintain the temperature of a vehicle equipped with stop/start when it's stopped and the heater is on. • The electric water pump is smaller and requires less power to operate.
In-rush Current Reduction (ICR) Relay	<ul style="list-style-type: none"> • At times when the engine is restarted, there could potentially be a "dimming" of lights or a reset of some devices due to the large electrical demand placed on the system by the starter motor. • The ICR relay reduces the system voltage drop that happens every time the starter cranks the engine.

DENSO also offer automakers three different stop/start starter solutions depending on their specific needs and requirements.

Stop/start Starter Technology Overview:

Advanced Engagement (AE) Starter	Tandem Solenoid (TS) Starter	Permanently Engaged (PE) Starter
<ul style="list-style-type: none"> • More durable, longer-life starter technology. • Helps to achieve approximately 3 to 5 percent in fuel savings. • Easiest to integrate, requiring no unique controls or engine modifications. 	<ul style="list-style-type: none"> • Allows automakers to achieve faster restart times than the AE. • Potential for more fuel savings if combined with expanded areas of fuel cut. • Compared to AE, the TS is <i>Change of Mind Capable</i>, which means it is able to re-engage into a moving ring gear/flywheel. • Includes same long-life features of the AE. • Requires engine control unity software modifications to control the dual solenoid design. 	<ul style="list-style-type: none"> • Is <i>Change of Mind Capable</i> and delivers the quickest and quietest restart times of all starter motor- based systems. • Bumps-up the overall fuel-saving potential depending on the overall system approach. • Starter and flywheel gears are permanently connected. • Jointly developed with Toyota Motor Corp.
How it Works:	How it Works:	How it Works
<ul style="list-style-type: none"> • Like a typical starter • Considered <i>Not Change of Mind</i> capable because the engine rpm needs to drop to zero before re-engagement. • Key design features include dual layer, long-life electrical brushes and a unique pinion spring mechanism that reduces ring gear/ flywheel wear by approximately 90 percent. 	<ul style="list-style-type: none"> • Uses unique dual solenoid to control the two functions of the starter solenoid independently. • Has spin-then-in capability, allowing the engine to be re-engaged by the starter motor when the engine RPM is falling from idle (~600 rpm) to zero rpm. • 1.5 seconds can be shaved off of some restarts, depending on the engine • Has almost identical packaging to the AE – and integrates easily to the engine. 	<ul style="list-style-type: none"> • Eliminates the pinion gear shifting mechanism and mounted to the engine so the starter is permanently engaged with the flywheel. • There is no waiting or delay since the starter gear is already mated to the flywheel. • Without having to consider gear engagement dynamics, the gear teeth profile can be optimized for low noise operation. • The flywheel does require a special clutching mechanism to disconnect it from engine rpm after engine start.

To learn more about Stop/start technology, watch [this](#) video