Stop/Start System

Achieving higher fuel efficiency by combining battery charge control and other systems

与充电控制等综合使用后，可进一步降低油耗
Products for Stop/Start System

Press the button to see your selected product.

- Tandem Solenoid (TS) Starter for Stop/Start Systems
- Lithium-ion Battery Pack
- Cold Storage Evaporator
Tandem Solenoid (TS) Starter for Stop/Start Systems

Stop/Start systems help increase fuel efficiency by automatically stopping the engine while the vehicle is waiting at stop lights or is stopped for other reasons to save fuel that would be wasted during idling. The Tandem Solenoid (TS) Starter enables the engine to restart more quickly and smoothly.

Conventional starters cannot restart the engine while the engine is running down even after the vehicle has stopped. The TS Starter, which features DENSO’s unique new mechanisms, can restart the engine during engine coasting, thus reducing the time needed before engine restart by up to about 1.5 seconds (a 80% decrease compared with DENSO’s conventional starters).

DENSO, which has been making starters since its foundation, started full-scale mass production of starters for Stop/Start systems in 1999. Based on its technologies accumulated over many years, DENSO will continue to improve product reliability and make vehicles more environment-friendly.

Solenoid: Consists of a current-carrying coil of wire and a moving iron core. The coil acts as an electromagnet when a current passes through it and the iron core slides along the coil axis. In starters, this component is used as an actuator to thrust the pinion gear forward and a switch to supply power to the motor.
Tandem Solenoid (TS) Starter for Stop/Start Systems

**Benefit**

Stop/Start systems automatically stop the engine when the vehicle is stopped, and also allow the engine to coast for a while when the engine is instructed to stop.

Conventional starters cannot restart the engine until the engine has completely stopped, whereas the TS Starter can restart the engine even while it is coasting. Compared with DENSO’s conventional starters, this advantage reduces the time needed before engine restart by up to 1.5 seconds (a 80% decrease in the time required to restart the engine compared with DENSO’s conventional starters).
**Tandem Solenoid (TS) Starter for Stop/Start Systems**

**Feature** The world’s first mechanism to separately control the forward slide of the pinion gear and the energization of the motor.

Conventional starters thrust the pinion gear (the gear on their front end) forward to engage the ring gear (the mating gear on the engine) to transmit the rotation of the motor to the engine via the pinion gear in order to start the engine.

- **Conventional starter**: Has a mechanism to shift the pinion gear and to energize the motor conjunctionally. In this system, the pinion gear cannot mesh with the ring gear until the engine (ring gear) has stopped completely.

- **TS Starter**: Has the world’s first mechanism to separately control the forward slide of the pinion gear and the energization of the motor. In this system, sliding the pinion gear forward according to engine speed and energizing the motor can be controlled independently, thus allowing the pinion gear to engage the ring gear while the engine (ring gear) is still rotating.

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**Tandem Solenoid Starter**

- Solenoid to shift pinion (SL1)
- Solenoid to energize motor (SL2)

**Current Product**

- Conjunctional control of pinion gear shift and motor energization by one solenoid

EMS: Engine Management System
### Engineering Key Point
Separately control pinion gear forward movement and motor energization according to engine speed

<table>
<thead>
<tr>
<th>Timing of engine restart requests</th>
<th>High engine (ring gear) speeds</th>
<th>Low engine (ring gear) speeds</th>
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</thead>
<tbody>
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<td>Flow of control</td>
<td><img src="chart1" alt="High engine (ring gear) speeds" /></td>
<td><img src="chart2" alt="Low engine (ring gear) speeds" /></td>
</tr>
</tbody>
</table>

**High engine (ring gear) speeds**
- Motor on $\rightarrow$ Pinion shift (Restart demand)

- **Energize the motor to increase the rotational speed of the pinion gear and then move the pinion gear forward when the pinion gear and ring gear are rotating at almost the same rate.**

**Low engine (ring gear) speeds**
- Pinion shift $\rightarrow$ Motor on (Restart demand)

- **Move the pinion gear forward and then energize the motor.**

*Engine restart requests: The driver’s actions identified as requests to restart the engine, such as releasing the brake pedal*
Lithium-ion Battery Pack

Fuel efficiency can be improved by combining a stop/start system with a regenerative deceleration and braking system which captures the kinetic energy of moving vehicle and converts it into usable electric power instead of being dissipated as heat. To improve energy regeneration efficiency, DENSO has developed a battery pack that can be used with a conventional lead-acid battery.

■ Overview

- Lithium-ion battery cells can store more regenerative electric power.
- The small, lightweight, naturally air-cooled design increases the flexibility of installation.
Lithium-ion Battery Pack

**Benefit**

- **Work for electric generation measured in NEDC test**

  - No fuel consumed
  - Fuel consumed
  - Acceleration
  - Idling
  - Deceleration and braking
  - Fuel efficiency: +1%

- **Battery charge control**
  - Constant speed
  - Deceleration and braking
  - Idling
  - Power generation increased
  - Power generation restricted
  - Charles
  - Discharge
  - Battery level maintained

Fuel efficiency can be improved by increasing the capacity to store regenerative electric power produced during deceleration and braking.

**Fuel efficiency improved by using DENSO’s lithium-ion battery pack: +3% (NEDC)**
Lithium-ion Battery Pack

Engineering Key Point

- Lithium-ion battery cells selected to match the lead-acid battery characteristics
- Improved regenerative efficiency by enhanced input-output characteristics

Internal configuration

Voltage characteristics

- Lead-acid battery characteristics
- Lithium-ion battery characteristics
- Range of the Lithium-ion battery SOC

Protected loads (navigation and audio systems, electric automatic-transmission-fluid, VSC solenoid, etc.)
Cold Storage Evaporator

Stop/Start is an effective way to improve fuel efficiency, but when the engine is at rest in this state, the air conditioning stops working too. To supply cooled air to the vehicle cabin while the engine is not running, DENSO has developed a new “Cold Storage Evaporator.”

**Overview**

- Cold energy is stored in the cold insulator in the heat exchanger of the evaporator while the air conditioning system is working, then cooled air is supplied while the engine is in the idle-stop mode.
- Thermal comfort is improved by limiting the rise in temperature of air supplied while the air conditioning system has stopped working and improving fuel efficiency by lengthening the duration of idle stop (the amount of time before the engine is restarted).

**Benefit**

**Comfort:** Doubling the time for which thermal comfort is maintained

**Fuel efficiency:** Fuel efficiency improved by approx. 2%

![Diagram showing comfort and fuel efficiency improvements with Cold Storage Evaporator]
Cold Storage Evaporator

■ Feature

Cold Storage Evaporator

- Cold storage case
  - Inclusion pipe
  - Inner fins
    - Improve cold storage capacity
  - Cold insulator (paraffin)
    - High-performance, non-corrosive
  - Plate
    - (two plates jointed together)

Conventional Evaporator

- Outer fins
- Refrigerant tube
- Cold storage case

Some parts of the fins used for the conventional evaporator are replaced with a cold storage case filled with a cold insulator, which is held by refrigerant tubes.
Cold Storage Evaporator

Engineering Key Point

Storing cold energy while the vehicle is running and discharging it while the vehicle is stopped

Mode A
Vehicle traveling (before the completion of cold storage)
Use refrigerant to cool the supplied air and the cold insulator.

Mode B
Vehicle traveling (after the completion of cold storage)
Use refrigerant to cool the supplied air.

Mode C
During Idle stop
Use the cold insulator to cool the supplied air.
怠速熄火系统用产品

请选择希望浏览的产品并按下按钮。

串联式双螺线管起动马达

锂离子电池包

蓄冷式热交换器
怠速停机系统用起动装置“串联式双螺线管起动机(TS起动机)”

怠速停机系统有助于降低油耗。在车辆停止等待绿灯的时候，如果自动停止发动机运转，则可节约因怠速而白白消耗的燃料。串联式双螺线管起动机可缩短再起动时间，实现平滑自然的发动机再起动。

传统的起动机，在车辆停止时，由于发动机在惯性作用下继续转动，在此期间，无法进行再起动。而电装开发的起动机利用新型结构，在发动机惯性作用下处于运转中时，串联式双螺线管起动机也可以进行再起动，且再起动前的等候时间最多可缩短1.5秒左右（与传统产品相比，再起动时间缩短80%）。

电装从创业时起就一直从事起动机的生产，从1999年正式开始怠速起停系统用起动机的批量生产。今后，电装将充分利用多年积累的技术经验，在保证产品高信赖度的同时，为提高汽车的环保性能作出贡献。

螺线管: 由电线卷成的圆筒状线圈和活动铁芯组成的部件。电流通过线圈时形成电磁铁，活动铁芯随之进行移动。在起动机中，螺线管的作用是推出小齿轮及电机的通电开关。
怠速停机系统用起动装置“串联式双螺线管起动机(TS起动机)”

效果

怠速停机系统，在车辆停止时发动机将自动停止运转。在通过怠速停机系统对发动机进行停止控制后的一段时间内，发动机仍将在惯性的作用下继续转动。

传统的起动机，在发动机完全停止转动前，不能进行再起动。但串联式双螺线管起动机(TS起动机)在发动机因惯性作用继续运转时也可以进行再起动，与本公司过去的传统产品相比，发动机再起动时的等候时间最大可缩短1.5秒左右（与传统产品相比，再起动时间可缩短80%）。

再起动时间（要求在发动机运转过程中进行再起动时）

发动机运转中的起动

再起动要求

开发产品

传统产品

最大1.5秒

过去

起动禁止区间

时间(s)

再起动时间

0

0.5

1.0

1.5

开发产品(TS起动机)

等候时间

传统产品

△80%
怠速停机系统用起动装置“串联式双螺线管起动机（TS起动机）”

■特征 采用了对小齿轮推出及电机通电系统进行单独控制的结构设计，为世界首创。

通常而言，起动机在发动机起动时，小齿轮（起动机前端的齿轮）将被推出，与齿圈（发动机侧的齿轮）咬合，将马达动力通过小齿轮传给发动机，从而达到起动发动机的目的。

●传统的起动马达：采用小齿轮的推出与让马达运转的通电联动的结构设计。如果发动机（齿圈）没有完全停止运转，小齿轮和齿圈就无法咬合。

●TS起动马达：采用了对小齿轮推出及电机通电系统进行单独控制的结构设计，为世界首创。根据发动机的转速，对小齿轮推出及电机通电系统进行单独控制，即使发动机（齿圈）处于运转过程中，小齿轮与齿圈也能进行咬合。

串联式双螺线管起动机

用于小齿轮推出的螺线管（SL1）

小齿轮

齿圈

发动机转动

EMS

通过使用两个螺线管，可以对小齿轮推出及电机通电系统进行个别控制。

传统产品

只使用一个螺线管。小齿轮推出与马达通电联动。

EMS：发动机管理系统 (Engine Management System)
### 手段
根据发动机在惯性作用下转动时的转速，对小齿轮推出及电机通电系统进行单独控制。

<table>
<thead>
<tr>
<th>发出再起动要求的时机</th>
<th>发动机（齿圈）转速较快</th>
<th>反向转速较慢</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>电机通电 → 小齿轮推出</td>
<td>小齿轮推出 → 电机通电</td>
</tr>
</tbody>
</table>

### 控制流程

<table>
<thead>
<tr>
<th>时间 (s)</th>
<th>转速 (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>0.2</td>
<td>400</td>
</tr>
<tr>
<td>0.4</td>
<td>600</td>
</tr>
<tr>
<td>0.6</td>
<td>800</td>
</tr>
<tr>
<td>0.8</td>
<td>600</td>
</tr>
<tr>
<td>1.0</td>
<td>400</td>
</tr>
</tbody>
</table>

向电机通电，加快小齿轮转速，在接近发动机齿圈转速时推出小齿轮。

先推出小齿轮，其后向电机通电。

*再起动要求：指的是解除制动等驾驶员作出的旨在让发动机进行再起动的操作。*
锂离子电池包

在急速停机系统中，通过整合车辆减速时的能量再生，可以进一步降低油耗。这是将车辆减速时作为热量废弃的运动能量转化为电能进行回收的结构体系。为了有效地进行能量回收，公司开发了与传统铅酸电池组合使用的电池包。

■概要

● 通过采用锂离子电池，便于接收再生电能。
● 具有小巧、轻便的特点，采用自然空气冷却，提高了车辆搭载的自由度。
锂离子电池包

通过锂离子电池包减少油耗，油耗减幅达3%（NEDC工况）
锂离子电池包

手段

- 根据铅电池的特性，采用相符的锂离子电池。
- 根据优越的输入输出特性，提高再生能力。

内部结构

电压特性

电压 (V)

铅酸电池特性
锂离子电池特性
锂离子电池荷电状态 (SOC) 使用可能范围

SOC (%)
蓄冷式热交换器

怠速停机系统有利于减少油耗，但发动机停止运转时空调系统无法工作。为此，开发了在发动机停止运行时也能向车厢内提供冷气的新型热交换器“蓄冷式热交换器”。

■概要

● 在热交换器的热交换部分安装蓄冷材料，空调运转时在此蓄冷，怠速停机时放冷。
● 通过对空调吹出冷气温度的控制，提高舒适性；延长怠速停机时间（发动机重新启动前的时间），有效降低油耗。

■效果

舒适性：将保持舒适性的时间延长到原来的2倍左右

油耗减幅：减幅约为2%

ISS：怠速停机系统
蓄冷式热交换器

特点

蓄冷式热交换器

蓄冷盒

内翅管
提高蓄冷性能
蓄冷材料(石蜡)
高性能、无腐蚀性
金属板
(2枚贴合)

外翅管
制冷剂管

采用将传统产品中的部分翅管换成封装蓄冷材料的蓄冷盒，并放入制冷剂管之间的结构。

传统产品

外翅管
制冷剂管

采用将外翅管放入制冷剂管之间的结构。
蓄冷式热交换器

手段

行驶时蓄冷，停止时放冷

模式 A
行驶时（蓄冷结束前）
使用制冷剂冷却送风空气和蓄冷材料。

模式 B
行驶时（蓄冷结束后）
使用制冷剂冷却送风空气。

模式 C
怠速停机时
使用蓄冷材料冷却送风空气。