Products for Electric and Hybrid Vehicles

Improving both the environmental and driving performance of electric and hybrid vehicles with DENSO’s state-of-the-art products
Products for Electric and Hybrid Vehicles

Electric and Hybrid Vehicles that reduce CO₂ emissions are equipped with some specific products not found in conventional gasoline powered vehicles. DENSO provides products based on its cutting-edge technologies. These include traction inverters for controlling electric drive motors and regenerating energy, and drive battery monitoring units for power electronics systems.

Traction inverters are critical to the control of electric motors. DENSO provides inverters boasting the world’s top discharge power density with a new cooling technology that limits temperature levels in built-in semiconductor power devices*. This cooling technology is based on both radiator cooling technologies and electronics technologies that have been developed through in-house production of semiconductor devices.

DENSO will continue to assist the advancement of hybrid vehicles by developing new technologies and products.

*Power devices are electronic components that act as switches to turn on and off the flow of high current.
Products for Electric and Hybrid Vehicles

Press the button to see your selected product.

- Power Control Unit
- DC-DC Converter
- Battery Monitoring Unit for Lithium-ion Batteries
- System Main Relay
- Battery Current Sensor
- Hybrid Vehicle Electronic Control Unit
- Electric Compressor
Power Control Unit

Outline

- Higher output power is required for luxury hybrid vehicles, as well as smaller packaging for full-line implementation of hybrid systems.
- DENSO has achieved 60% increase in power density (output power per unit volume) from conventional models by a dramatic improvement of cooling performance.

Feature

![Diagram of Power Control Unit]

- Double-Sided Power Module
- Cooling Tubes
- Power Chips
- Double-Sided Cooler
- Coolant
- Inlet
- Outlet
- Section A-A
- Section B-B

[View]
Power Control Unit

Engineering Key Point

● Newly developed double-sided power module for dramatically improved cooling.

● Newly developed stacked double-sided cooler for dramatically improved cooling.

● Newly developed diaphragm construction for dramatically improved adhesion of power module and cooler.

Benefit

<table>
<thead>
<tr>
<th>Power Density Ratio</th>
<th>Volume Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output power per unit volume: +60%</td>
<td>Miniaturization: -30%</td>
</tr>
</tbody>
</table>

- **New Design**
  - Power Density: 160
  - Volume: 70

- **Conventional Design**
  - Power Density: 100
  - Volume: 100

At the same output power.
DC-DC Converter

DC-DC converter designed to recharge the auxiliary battery.

- Reduced conversion loss by using DENSO’s original dual transformer system (fewer circuit elements, synchronous rectification)
- Simplified structure and reduced transformer winding loss by integrating magnetic parts
- Improved heat dissipation efficiency by optimally arranging circuit elements

<table>
<thead>
<tr>
<th>Specifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal input voltage</td>
<td>288V</td>
</tr>
<tr>
<td>Output voltage</td>
<td>13V to 15V Controllable</td>
</tr>
<tr>
<td>Max. output current</td>
<td>120A</td>
</tr>
<tr>
<td>Max. efficiency</td>
<td>96%</td>
</tr>
<tr>
<td>Dimensions</td>
<td>360mm × 95mm × 105mm</td>
</tr>
<tr>
<td>Weight</td>
<td>2.7kg</td>
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</table>
Battery Monitoring Unit for Lithium-ion Batteries

Outline

● It is expected for Battery Monitoring Unit to control the battery’s voltage highly accurately in order to operate lithium-ion batteries safely and efficiently.

● Compared to the conventional voltage control method, DENSO’s new method enables to control the voltage of each cell and eliminate the fluctuation among the cells at lower cost.
Battery Monitoring Unit for Lithium-ion Batteries

**Feature**

- **Compare the cell voltage with the average for cell’s discharge by using a simple circuit.**

- **Measure the voltage of each cell and detect the cells which have higher-voltage than the target level using a microcomputer and enable all cells to discharge at the same level.**

**Engineering Key Point**

The function of new voltage control method is to compare the single cell voltage with the average voltage of all cells for cell’s discharge by using a simple circuit.
System Main Relay (SMR)

High voltage relay for the safety and protection of hybrid systems.

- By arranging magnets opposite each other and lengthening the arc path with magnetic force, it allows the arc to be extinguished in a smaller space.
- Reduced size by using an unsealed contact chamber.

<table>
<thead>
<tr>
<th>Specifications</th>
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<tbody>
<tr>
<td>Contact rating</td>
<td>DC360V 60A</td>
</tr>
<tr>
<td>On-off cycle life</td>
<td>More than 100,000 times</td>
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<tr>
<td>Dimensions</td>
<td>40mm x 37mm x 50mm</td>
</tr>
<tr>
<td>Weight</td>
<td>0.17kg</td>
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</tbody>
</table>

Relays in the system:

- Main battery
- Relay
- Inverter

Diagram:
- Opposed magnet arrangement
- Arc path (Effect of magnets)
- Magnets for arc extinction
- Unsealed contact chamber
- Contact
Battery Current Sensor

Current sensor to detect the current flow and monitor the state of the main battery charge.

- Simple structure consisting only of a Hall IC and a core
- No printed board or soldering required
- Input and output terminals with capacitors for improved noise reduction

<table>
<thead>
<tr>
<th>Specifications</th>
<th></th>
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<tbody>
<tr>
<td>Supply voltage range</td>
<td>DC5.0 ± 0.5V</td>
</tr>
<tr>
<td>Measured current range</td>
<td>-200 ~ +200A</td>
</tr>
<tr>
<td>Accuracy after reliability test</td>
<td>3%FS</td>
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<tr>
<td>Dimensions</td>
<td>47mm × 37mm × 17mm</td>
</tr>
<tr>
<td>Weight</td>
<td>34g</td>
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</table>
Hybrid Vehicle Electronic Control Unit (HV-ECU)

ECU to control overall hybrid system in a hybrid vehicle.

- Control traction of motor and engine, HV battery, regenerative braking and other functions.

<table>
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<tr>
<th>Specifications</th>
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<tbody>
<tr>
<td>Nominal input voltage</td>
<td>12V</td>
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<tr>
<td>CPU</td>
<td>32Bit High-performance</td>
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<tr>
<td>Clock speed</td>
<td>128MHz</td>
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<tr>
<td>Dimensions</td>
<td>160mm x 150mm x 35mm</td>
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<td>Weight</td>
<td>0.3kg</td>
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</table>
Electric Compressor

Co-development product with TOYOTA INDUSTRIES CORPORATION

Outline

● A conventional compressor is hardly possible to be applied to EV and HV because it is driven by engine.

● It is not necessary to drive engine for air conditioning. → Fuel efficiency improved.

Feature

● The world first Mass-production electric compressor integrated inverter and motor.

● Compact size almost same as a conventional compressor.

● Minimizing mass increase for vehicle fuel/power efficiency.

● Low noise/vibration design for quiet environment.

● 3 varieties covering from small-class vehicle to luxury-class.
Electric Compressor

■ Engineering Key Point

■ Benefit

Electric compressor improves fuel consumption by maximum 19%, compared to conventional compressor (Belt-driven compressor) for HV.