

Advancing Automotive Innovation  
Hybrid & Electric Vehicle Systems



**DELPHI**

Innovation for the Real World

## Collaborating to Create More for Your Customers

Hybrid and electric vehicles are popular because they appeal to a wide range of consumers. The environmentally conscious can appreciate the ultra-low to zero emissions and amazing fuel economy, while the economically minded can appreciate the low vehicle depreciation and savings in costs at the gas pump.

At Delphi, we recognize the importance of vehicle manufacturers offering more comfort, more efficiency, more fuel economy and more environmentally friendly cars and trucks accessible to more consumers. We believe in working together to create the most value for our customers. Our systems knowledge, innovative automotive component design and integration skills extend through our entire organization. This helps us reduce costs, provide peak performance and offer a robust portfolio of hybrid and electric vehicle components and systems including:

Connection Systems  
Electrical Centers  
Energy Storage Systems

Power Electronics  
Powertrain Systems  
Thermal Systems

Service Solutions  
Wiring Assemblies



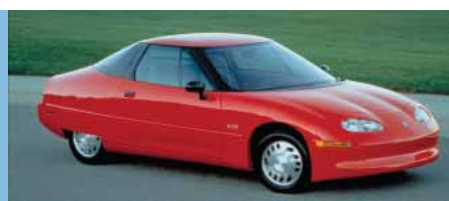
### Delphi Products:

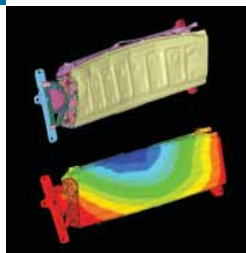
- |                                     |   |
|-------------------------------------|---|
| A - Vehicle Supervisory Controllers | B - Battery Management Systems            |
| C - Energy Storage Systems          | D - Battery Chargers                      |
| E - DC/DC Converters                | F - DC/AC Inverters and Motor Controllers |
| G - Power Distribution Center       | H - Thermal Cooling Systems               |
| I - Charge Port Coupler             | J - Evaporative Emissions Canister Module |

## Delphi, a Leader in Powertrain Electrification

Delphi continues its legacy of more than 100 years of creating innovations that advance the automotive industry. As a pioneer in the development of electric and hybrid electric vehicles, we provide vehicle manufacturers with more than 20 years of experience in architecting electric and hybrid electric vehicle propulsion systems. We are aggressively lowering the cost of powertrain electrification through system design and architecture, component design and development, controls and algorithm development and manufacturability.

Delphi designed and manufactured major powertrain electrification components in the first modern electric vehicle.





## Delphi – A Global, Integrated Hybrid Competence

Customers can leverage Delphi's global strengths and in-market capabilities to speed the development and availability of state-of-the-art systems without compromising quality or system optimization. Our dedicated, global engineering team is available to work with you, side-by-side, collaborating to create solutions for your issues and value for your customers.

We can provide complete component modeling, analysis and test capability. Our teams are leading the industry in vehicle systems integration, with computer-aided engineering, vehicle modeling and simulation, and system dynamometers. Our Velocity™ suite of design, analysis and simulation tools can optimize your entire vehicle electrical/electronic architecture. We also invested in technologically advanced development, simulation and validation test capabilities for our products for hybrid and electric vehicles. We accelerate real world conditions by imparting extreme environmental conditions to make sure we deliver robust designs. Some include:

|                     |                 |                      |
|---------------------|-----------------|----------------------|
| High Pressure Spray | Salt Spray      | Temperature Humidity |
| Mechanical Shock    | Thermal Age     | Thermal Shock        |
| Salt Fog            | Thermal Cycling | Vibration            |

And our value extends past the vehicle assembly line. We deliver safe, reliable solutions for your customers on and off the road. Our complete systems expertise understands electro-magnetic interference (EMI) issues to ensure your vehicles operate as intended. We provide special environmental sealing to high-voltage interlock systems that can help prevent potential thermal incidents or injury.





## Established Global Hybrid & Electric Vehicle Technical Capabilities

Delphi is ideally situated to help automakers navigate the requirements of next-generation hybrids and new electric vehicles. With major technical centers, manufacturing sites and customer support facilities in 30 countries, we can leverage the advanced design and manufacturing facilities around the world to provide our customers efficient electrified powertrain solutions.

Beyond component design, our mature engineering capabilities in the market both understand local dynamics as well as offer personalized support. Our localized, global presence gives a fresh perspective to our research and development, and added value to our products. Therefore, our understanding of market challenges can be more thorough, and collaboration with our customers can be easy and frequent.

Our team is currently developing and executing numerous production programs for global vehicle manufacturers. These OEMs are leveraging our global footprint to accelerate technology development and create more value for their customers – consumers.

## Customer-focused Design and Technical Support.



SYSTEM APPLICATION & ANALYSIS  
Bangalore, India



SYSTEM APPLICATION  
Yongin, Korea



SYSTEM APPLICATION  
Tokyo, Japan



COMPONENT DESIGN & MANUFACTURING  
Singapore



SYSTEM APPLICATION  
Wuppertal, Germany



DESIGN AND SYSTEM APPLICATION  
Paris, France



SYSTEM APPLICATION  
Luxembourg



MANUFACTURING  
Jelensia, Poland



SYSTEM APPLICATION  
Krakow, Poland



MANUFACTURING  
Szombathely, Hungary



DESIGN & SYSTEM APPLICATION  
Satillo, Mexico



DESIGN & SYSTEM APPLICATION  
Reynosa, Mexico



DESIGN & MANUFACTURING  
Anting, Shanghai, China



SYSTEM APPLICATION & ADVANCED ENGINEERING  
Wai Gao Qiao, Shanghai, China



MANUFACTURING  
Suzhou, China



SYSTEM APPLICATION  
Troy, USA



DESIGN & SYSTEM APPLICATION  
Kokomo, USA



DESIGN & SYSTEM APPLICATION  
Warren, USA



DESIGN & SYSTEM APPLICATION  
Lockport, USA



Customer Programs





## Manufacturing Close to Our Customers

Our team is dedicated to this goal: "Be recognized by our customers as their best supplier." Not only do we design, simulate, test, and validate the components and systems with a proven process for manufacturability, our local expertise in high-volume manufacturing gives our customers an advantage of having a high-quality, responsive supply at a cost-effective value. And, an experienced production team can exceed your expectations with on-time delivery and superior service.



## A Robust Hybrid & Electric Vehicle Product Portfolio to Address Unique Challenges

Hybrid and electric vehicles require an expertise in optimized solutions to daunting, new challenges. Delphi offers a robust portfolio of products and systems to address these unique challenges.

**Fuel Economy and Performance** With more than 100 years of automotive innovation, Delphi provides power electronics for hybrid and electric vehicles that are high-value and extremely reliable while offering peak performance. A strong technological foundation helps Delphi offer customers the products they need to succeed in the fast-growing hybrid and electric vehicle market. Key products include inverters, converters, battery management controllers, battery pack systems, and battery chargers.

**Safety, Shielding and Sealing** Hybrid and electric vehicles present unique challenges when it comes to E/E architecture. They have rigorous power requirements and demand robust component performance and additional safety features due to the

challenging environment in which they operate. Delphi is developing specific architecture technologies for battery-powered transportation, including harness protection systems such as bent aluminum tubes or molded channels, battery monitoring devices, charge port coupler, consumer battery charging solutions and a new series of connection systems that incorporates the shielding, sealing, and high-voltage safety interconnects required for high-voltage/high-power applications.

Delphi gasoline and diesel engine management systems are capable of being seamlessly integrated with hybrid vehicle architectures. Delphi has developed software that caters specifically to integration of the internal combustion engine with the additional propulsion and regenerative braking of a hybrid electric vehicle. Products like Delphi's variable valve timing, variable valve lift, energy-efficient air conditioning including compressors and electronic powertrain cooling play a powerful role in helping reduce fuel consumption.

**Reducing Emissions** At Delphi, we are working closely with manufacturers to produce hybrid and electric vehicles that will help reduce CO<sub>2</sub> emissions significantly. But even before those vehicles are commonplace, we are offering our customers



DC/DC Converter



DC/AC Inverter



Battery Charger



Battery Controller



High Voltage Battery Pack



Integrated Solution



Battery Cooling - Air



Battery Cooling - Liquid



Power Electronics Cooling

Some samples of the numerous products in our extensive HEV/EV portfolio.

(products shown do not reflect true size relationships)



products that can also improve emissions control for conventional vehicles. In addition to power electronics, these revolutionary products include Delphi's direct acting diesel common rail system, gasoline direct injection for spray stratified combustion, active scrubber technology, brushless fuel pumps, solid oxide fuel cell auxiliary power units, and alternative refrigerant HVAC technology.

**Mass** Although hybrid systems help increase full efficiency and reduce emissions by reducing reliance on combustion engines, they also add weight with increased system content and larger heavier gage cables required to handle the higher current. Delphi can help minimize this increase in vehicle mass by providing solutions to optimize both the traditional and hybrid E/E systems through custom electrical center designs that reduce system complexity, and the integration of new small gage cable technologies, insulation materials and lighter weight alternatives to copper such as aluminum or our special proprietary alloys.

**Recyclability** Delphi is quickly progressing the development of technology that helps keep products out of landfills or incinerators at the end of their lives. Recyclability has become an important part of our product development. Two examples of environmentally friendly Delphi products are ultra-thin wall halogen-free cable that can be recycled or incinerated unlike PVC or XLPE cable and a micro channel condenser that not only helps residential and commercial air conditioning manufacturers meet mandated energy efficiency ratings with less refrigerant but is also easily recycled.

**Value** Solutions to these challenges will advance automotive innovation for all vehicles. Delphi is ready to collaborate with you in creating more value for your customers, in not only your hybrid and electric vehicles, but all your cars and trucks.



Shielded Connections  
0-40 Amps



Shielded Connections  
40-145 Amps



Shielded Connections  
145-250 Amps



Un-Shielded Connections  
40-250 Amps



Shielded/Sealed Pass  
Through Connections



High Voltage Battery Systems



High Voltage/Shielded  
Wiring Asm. & Cables



Charge Port Coupler



Battery Monitoring Devices



High Voltage  
Electrical Centers



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