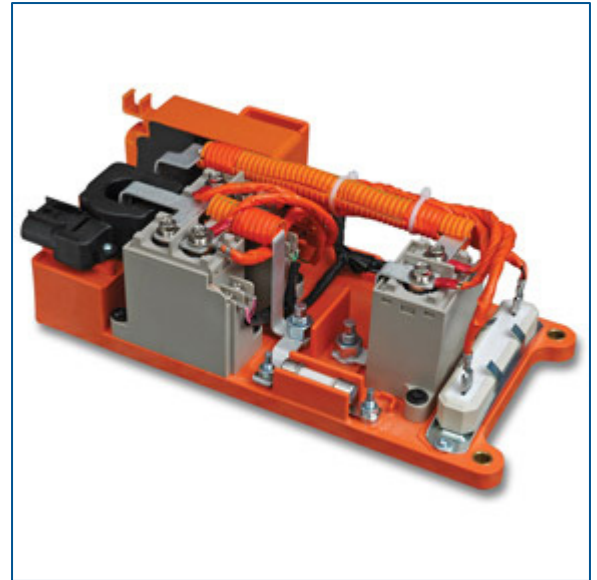


Delphi High Voltage Battery Pack Electrical Centers

Delphi's High Voltage Battery Pack Electrical Centers help provide safe operation of a battery in vehicles requiring high voltage and also during servicing, collisions or fault conditions. Delphi High Voltage Battery Pack Electrical Centers incorporate the following:

- Main contactors for connection and disconnection of the high voltage battery pack to the inverter, DC/DC converters, and auxiliary high voltage loads
- Battery isolation for safety and maintenance
- Current monitoring of the battery pack for state of charge
- Auxiliary high voltage circuit protection
- Pre-charging function for large capacitors, supporting the inverter and DC/DC converters



Delphi High Voltage Battery Pack Electrical Center

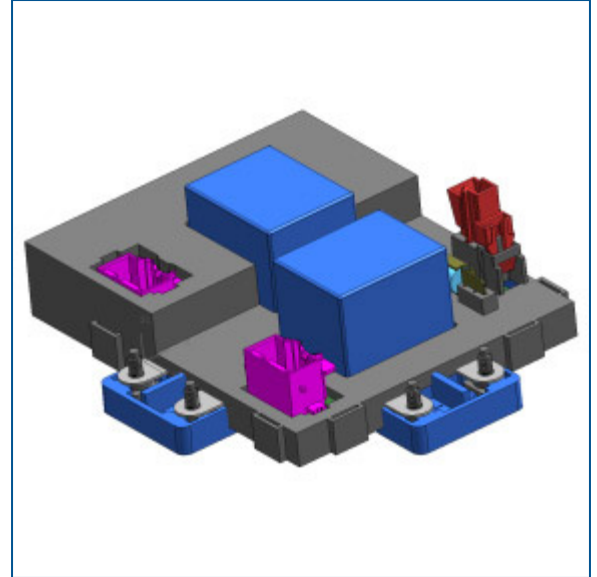
Specialized, high voltage contactors provide isolation of the battery from loads when the system is off. When engaged at power-up, the contactors initially perform a pre-charge operation, which safely charges the capacitors in the inverter and DC/DC converter sections. This is necessary to protect the main contactors from switching directly into a high current load (charge capacitors).

The pre-charge function can also be performed using solid state components instead of electromechanical contactors, such as high voltage Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) or Insulated Gate Bipolar Transistors (IGBTs), replacing large, costly high voltage contactors. The current sensor provides monitoring of current flow during battery charging, regenerative braking, electric propulsion motor and high voltage auxiliary load operations.

► **Benefits**

- Safe and reliable disconnect of the battery during servicing, collisions or fault conditions
- Cost effective pre-charging solutions
 - Substitute a semiconductor instead of a contactor
 - Pre-charge can be done with a surface mounted semiconductor
- High accuracy
 - Better than 1% current sensing
- High voltage circuit protection
 - < 750Vdc
- Enable reduced packaging size and complexity
- Design elements can reduce costs
 - Eliminate loose piece harnessing and associated labor by replacing it with a circuit board
 - Electronics for current sensors can be located on the circuit board
 - Use of pluggable components versus manual fastened components can save assembly time
 - Can be a host and place to mount the current sensor electronics
- Can provide monitoring points to ensure the contactors have closed/opened
- Provides monitoring for the current flow into the battery
- Excellent location for circuit protection for auxiliary loads
- Capable of electronics integration
- Enhanced electrical system performance and functionality

- Complies with the following:
 - Federal Motor Vehicle Safety Standards
 - FMVSS 305
 - SAE J1673
 - High-Voltage, Primary Automotive Wiring Assemblies
 - SAE J1742
 - Connections for High-Voltage On-Board Road Vehicle Electrical Wiring Harnesses
 - UL 508
 - Industrial Control Equipment
 - UL 1012
 - Power Units Other Than Class 2
 - VDE 0110
 - General Standards for Electrical Equipment
 - VDE 0831
 - Electrical signal System for Railroads
 - IEC60664 and IEC60950
 - Insulation coordination for Equipment within low voltage systems
 - UL 840
 - Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment



Delphi is continually evaluating additional advanced concepts for future electrical centers.

▶ Typical Applications

The Delphi High Voltage Battery Pack Electrical Centers are engineered for any high voltage battery (< 750 Vdc) application for the transportation market, including:

- Hybrid electric vehicles (HEVs)
- Electric vehicles (EVs)
- Commercial vehicles (CVs)

They are also suited for use in other energy storage applications where high voltage battery packs may be used, such as power substations, uninterruptable electric power units, etc.

▶ The Delphi Advantage

Delphi has designed and produced robust electrical centers since 1991 and the Delphi HEV/EV electrical centers have been in production for several years, demonstrating proven field use in vehicle applications worldwide. Delphi has a global reach, allowing the design and manufacture products around the world. With electrical integration experience, product/process capabilities and advanced development expertise, Delphi helps to enables enhanced and optimized electrical system performance.

Delphi offers a complete portfolio of electrical centers that improve performance, reduce packaging size and provide value. Delphi's High Voltage Battery Pack Electrical Center technology is constantly evolving, and additional advanced concepts are currently under development to make even greater functionality possible. Delphi possesses the proprietary design tools and the technology portfolio to deliver complete, optimized, expertly managed electrical/electronic architecture solutions.