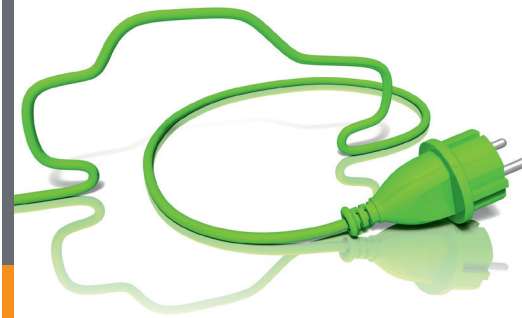
GREENER WITH 48 VOLT CONNECTIVITY



MOTIVATION

Regulations are driving car companies to reduce greenhouse gas emissions from 130 g/km to 95 g/km by 2021. A new solution with alternative hybrid concepts based on two-voltage electrical power (12/48 Volt) will soon enter the automotive market, especially in the urban cycle drive mode.

Solution providers are challenged to meet the safety requirements and electromagnetic compatibility (EMC) for operating voltages over 60 VDC. Electric vehicles (EV) also still have a limited mileage range and a low volume production rate, which increases cost.

A 48 Volt dual voltage electric system converts high power consumers to 48 Volt and existing applications in hybrid vehicles to reduce weight and fuel consumption. TE Connectivity offers a broad range of existing and new innovative products for high-performance electric drives, helping the automobile industry meet requirements for CO_2 reduction.

CHALLENGES

The VDA Recommendation 320 describes the requirements of the test conditions for electrical, electronic and mechatronic components used in cars with a 48 Volt electric system. It does not cover wire harnesses, connectors or relays, so they must be adapted and/or carefully selected due to the higher voltage level.

The new 48 Volt level reflects the requirements of the 42 Volt system introduced more than 15 years ago. Almost all requirements move into new specifications. The VDE low voltage limit does not require essential user protection measures against accidental contact. Arcing due to hot unplugging or electrolytic corrosion from water ingress in a 48-volt powered connector is challenging.

Safety measures are needed that make the separation impossible or provide a high-voltage interlock (HVIL) function to signal the separation and allows the shutdown of the powered electronics. Most of the applications do not need shielded wires, whereas an AC electrical motor requires shielded wires. Overall, 48 Volt is a manageable level that will help make the conversion of belt-driven applications to electrified versions possible.

TERMINALS & CONNECTORS

Some technical challenges come with the higher electric system voltage, including arcing and electrolytic corrosion. Standard automotive connectors that have been used for many years in automobiles (14 Volt) and trucks (28-volts) offer a cost-neutral solution for the 48 Volt electric system. High voltage connectors fulfill the technical requirements for 48 Volt, but use is limited due to cost and packaging.

It is important to ensure the compliance of the before mentioned connector systems to the clearance and creepage distances in accordance with DIN EN 60664-1 - insulation protection for electrical equipment in low-voltage systems – prior use in a 48 Volt electrical system. For calculation of the clearance and creepage, pollution class 2 and a height of 5,500 meters above sea level are required. Most waterproof connector systems meet these requirements, as they comply with the required distances between the contact pairs.

TERMINALS & CONNECTORS

For non-waterproof connector systems, especially when it comes to miniaturization, requirements are dependent on the connector housing design. To meet the requirements for clearance and creepage distances in these cases, use every second contact cavity without installed terminal or matched connector designs.

It is recommended to use waterproofed connectors in a 48 Volt electrical system and it would be an advantage to separate the contact chambers to seal both circuits separately to prevent electrolytic corrosion.

Example: 2-way MCON 12 connector system with individual sealed cavities.

EVERY CONNECTION COUNTS

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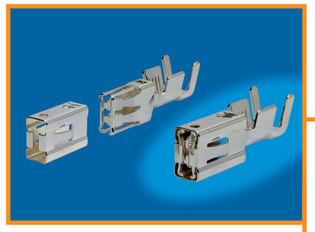
Terminals & Connectors

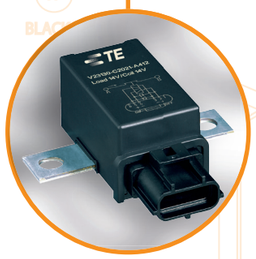
- **Carry over terminals** from 12 Volt offers highest quality and performance
- **No shielding** as long DC links is concerned; AC connections may require shielding (depends on system)
- **Single wire sealed connectors** are compliant with isolation coordination standards (ISO 60664 – air gap and creepage distance)
- **No interlock** once on system level a central protection stategy is in place
- **Robust design** of TE Connectivity's automotive connectors offer high reliability and resistance against chemical corrosion



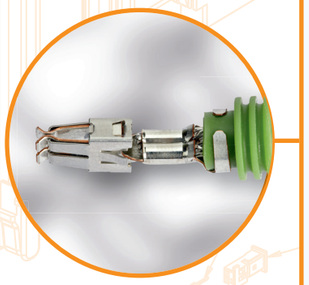
Relays & Contactors

When switching electrical loads under 48 Volt conditions with automotive relays, the quadrupled voltage requires that the contact systems be adapted as, in principle, steadily burning DC arcing can form.

This mainly depends on the contact spacing. If the distance is too small, the electric circuit might not be interrupted when the contacts open and the burning arc would destroy the relay. If single interruption with a given contact spacing is not sufficient to switch off the circuit, various options are available to increase the arc burning voltage.



TE Connectivity offers a series of relays that have been optimized to switch higher voltages for the 48 Volt on-board electrical system as well as products for use in hybrid and electric vehicles with nominal voltages of up to 450 Volt.



Terminals & Connectors 0 … 5 kW

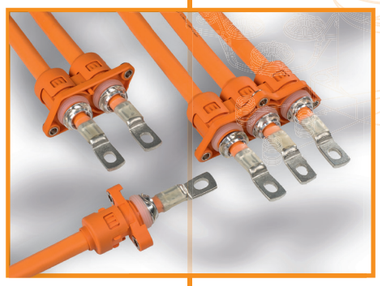
- **HDSCS product line** offers multiple variations of sealed combinations with power and signal contacts
- **AMP MCP, MQS and MCON contact systems** covering the range up to 100 A current carry capability
- **Sealed connector systems** with single wire sealed cavities are 48 volt compliant
- **Miniaturized connector systems** for 48 VDC with a pitch below 3.5 mm to be investigated

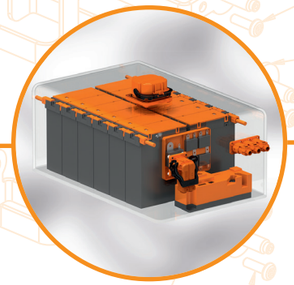
Terminals & Connectors 5 … 12 kW

- The **DTSK series** are single cavity connectors designed for high amperage, heavy duty applications. The DTSK connectors accept Ø 8 mm contacts, 2-4 AWG (25-35 mm²) wire
- **LV 800** two position connector design is based on 8mm round pin and socket for automotive LV applications
- **A new power flat contact** is under development to address larger wire cross sections up to 95 mm²

Terminals & Connectors … 20 kW

- **IPT termination system** is designed for shielded wires up to 120 mm² and addresses high continuous currents 400 A @ 105 °C with 95 mm² cable
- **Cable lugs** optimized to fit in small assembly holes
- **Sealing and 360° shielding features** designed for harsh environmental use (non-shielded variatns on request)
- **Bolt down terminations** are preferred to be used above 200 Ampere





Hybrid and Electric Mobility Solutions

TE Connectivity is working closely with lithium battery manufacturers to meet the challenges of the evolving 48 Volt E/E architecture.
The evolution to higher voltage is likely a game changer for improving power train efficiency since traditional mechanical shaft or belt-driven aggregates can be operated on demand.

Additionally, there is recuperation, where mechanically-produced energy can be converted to electrical energy and stored in batteries – all while braking the car. New 48 Volt systems compared to 12 Volt systems enable a much higher level of recuperation. Especially in city driving as the battery will dynamically be discharged and recharged.

This outcome requires innovative battery cell management and power measurement. TE offers a wide range of sensors, relays and high power cell termination solutions, as well as signal connectors to help lithium battery cell manufacturers build highly reliable and performing 48 Volt battery systems.