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FAST, NON-ELECTRICAL MALFUNCTION DETECTION WITHIN POWER ELECTRONIC CONTROL UNITS BY OPTICAL, FREQUENCY, TEMPERATURE AND GAS SENSORS

Verena Schwaiger
Bertrandt Ingenieurbüro GmbH

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Technical task:

In hybrid and electric vehicles, control units with a nominal voltage >60V are used, usually 400V to 800V DC. No malfunction detection is installed in these HV control units. The partially installed temperature sensors are mainly used for current-limiting power control.

Initial situation:

The temperature sensors used are very slow and slow in the control system. The time constants are in the range of a few seconds or minutes. Furthermore, the position of the temperature sensors is always in the immediate vicinity of the component to be measured or integrated in the component or at known hotspots. The temperature sensors are not able to detect unforeseeable hotspots or arcs or short circuits (high impedance).

An increasing number of electric and hybrid vehicles can currently be expected. Based on the forecast of the Progress Report 2014 - Balance of Market Research, approximately 500,000 electrically powered vehicles will be built each year in 2020.

This means that well over 2,000,000 HV control units per year have to be expected. Each electric vehicle is equipped with two power electronics for controlling the electric motors alone, as well as one power electronics each for the electric auxiliary heater and the electric HV air-conditioning compressor.

Solution:

Sensors are installed inside the electronic control unit on the circuit boards, e.g. gate driver board and control board, and at other locations. These can then, for example, detect the resulting arc. Electric arcs are very bright and very hot inside the arc.

Since the temperature can only be very selective, the built-in temperature sensors do not respond. During the time in which the arc is present, it acts as a light source. This light can be detected and evaluated super fast by sensors.

Advantages:

By switching off the applied system voltage (LV or HV) with the appropriate hardware and software, the arc is safely switched off or extinguished and the control unit is not destroyed.
By switching off and extinguishing the arc, an attack on the vehicle can be prevented.
By the use of different sensors also different errors can be recognized which can lead to a thermal destruction of the control unit.

Possible application:

Rapid corrosion (thermal destruction of connections) on busbars with poor screw connection

In the case of current- and voltage-carrying connections, which are produced with the aid of a screw connection, rapid corrosion and thus thermal destruction of the control unit can occur in the absence of head rests (n. i. O. screwing case). Small current flashes occur again and again over a longer period of time. The screw connection heats up and the contact resistance increases. This leads to a further rise in temperature at this point. As the screw connection is usually more massive, the temperature rise is not detected immediately. However, the small current flashes could be detected with the help of light and ionization sensors and thus the system voltage could be switched off and a transfer to the vehicle avoided.

Figure 1: Power electronics / pulse inverter for electric machines (average)

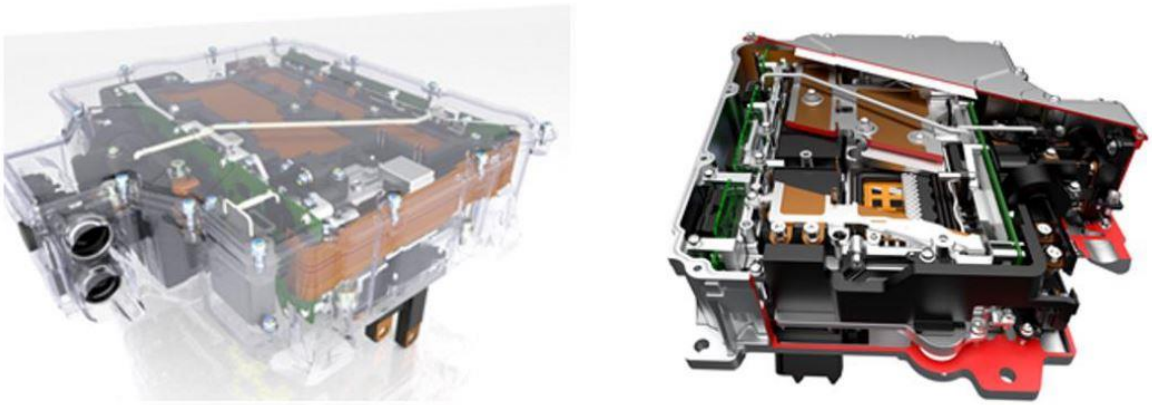

Figure 2: Power electronics / pulse inverters Component parts overview

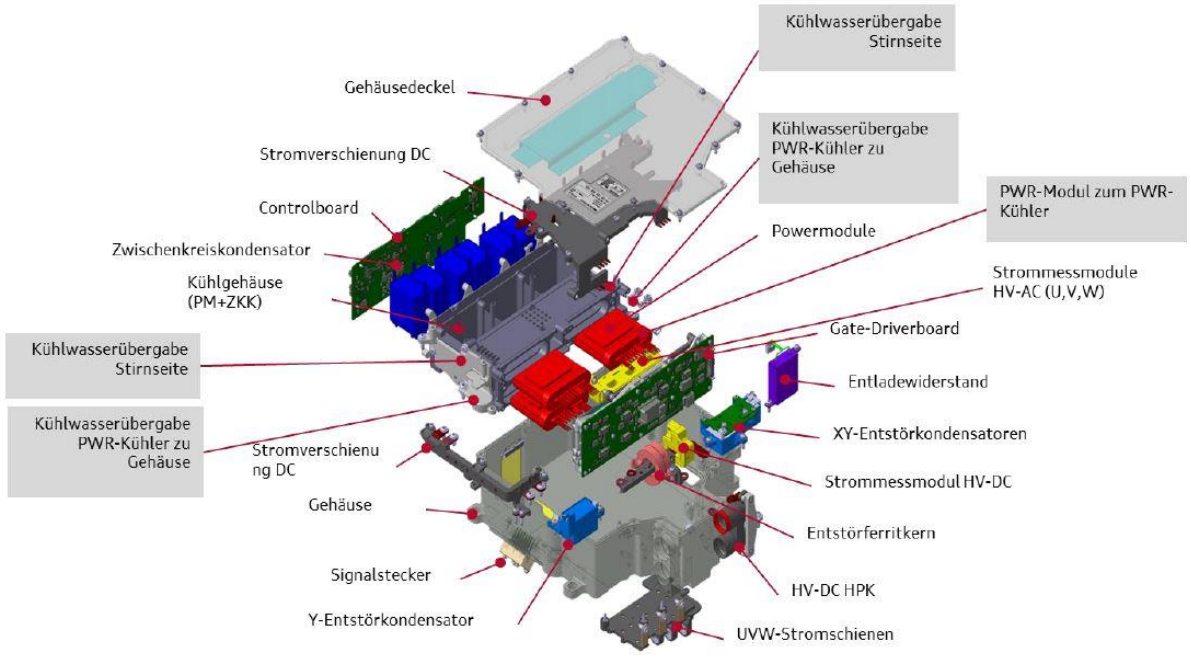

Figure 3: Power module / half bridge

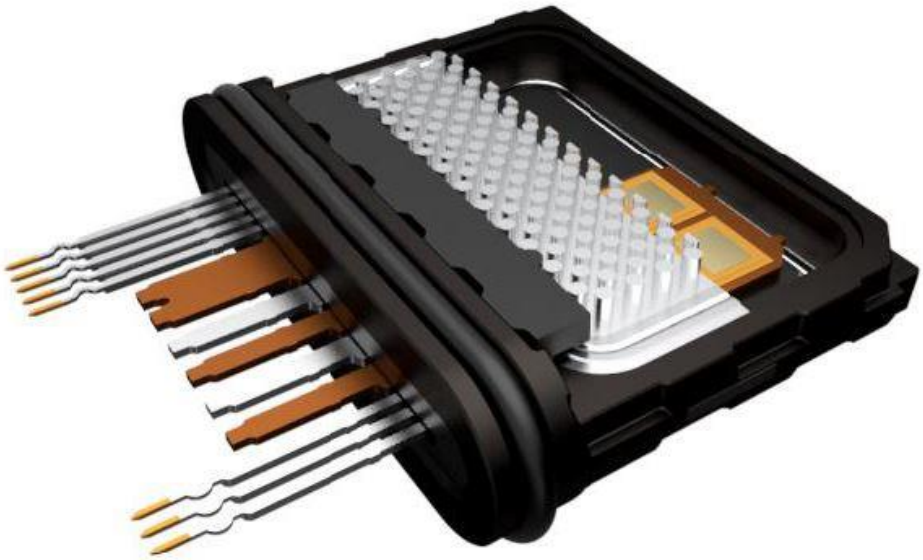

Figure4: Gate-Driverboard

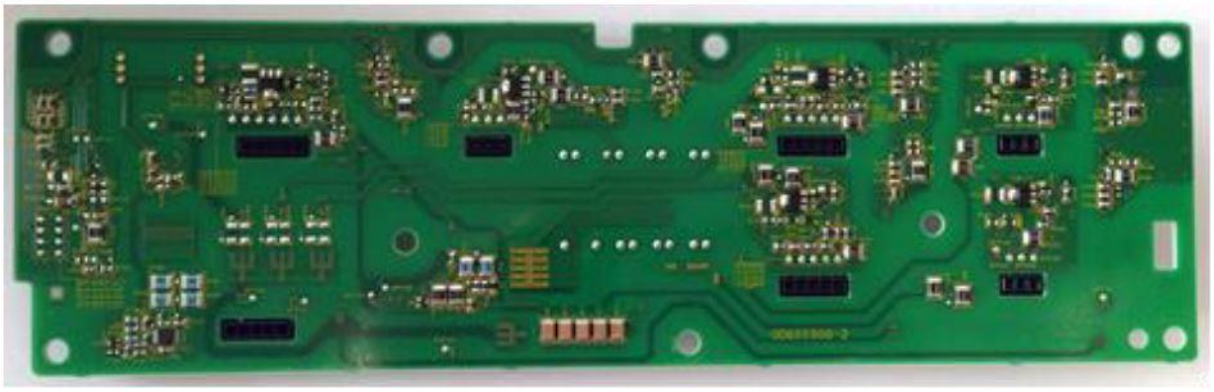

Figure 5: RK failure from validation C-BEV due to missing header support