Solder-free IGBT modules

Introducing a state-of-the-art breakthrough for inverters in hybrid and electric vehicles operating in the 22kW to 180kW range

In hybrid and electric vehicle powertrains, power inverters are exposed to considerable temperature swings that are caused by ambient conditions (passive temperature cycle) and by temperature due to the operation of the module (active temperature cycles). The operation temperatures limit the output power and reduce the service life of the power converter.

As a result, steps must be taken to ensure that power modules used in hybrid and electric vehicles are able to meet typical application requirements, such as being able to withstand more than three million active thermal cycles. Regarding the future development of hybrid and electric vehicles, semiconductor technology reliability is a key quality factor.

Sintered modules with no base plate offer a series of possibilities for boosting the temperature cycling reliability of inverters in hybrid and electric vehicles. The disadvantages of solder connections and expansion caused by the base plate are eliminated. The optimized chip layout ensures lower and more homogenous operating temperatures of the semiconductors inside the power module. This means in service life calculations, all three phases can be considered to have equal operating temperatures, facilitating more reliable life time predictions.

The reliability of the inverter, even under considerable active and passive temperature swings, is clearly improved. Testimony to this are the many different applications for sintered modules without a base plate, such as in electric powertrains in certain vehicles, as well as for harsher applications like racing cars.

SKiM, the three-phase IGBT module for DC/AC and AC/DC inverters in electric and hybrid vehicles, has a passive temperature cycling capability fifteen times higher than standard soldered modules. These modules have also been tested at levels beyond industrial test conditions and the results have shown that they are highly resistant to ambient temperature changes, cooling changes, and operational effects.

Sinter interconnects and the solder-free pressure contact technology ensures a 100% solder-free module, eliminating the solder failures that can occur at high temperatures. In addition, the pressure contact technology allows for low-inductance design of the internal bus bars, providing a 50% lower stray inductance compared with other six-pack devices. The inductivity of the DC-buses in the inverter leads to a reduction of voltage overshoots during switching operation. The safe operation area is expanded, and by exploiting higher DC-voltages, the customer can increase the power output of his system by up to 30%.

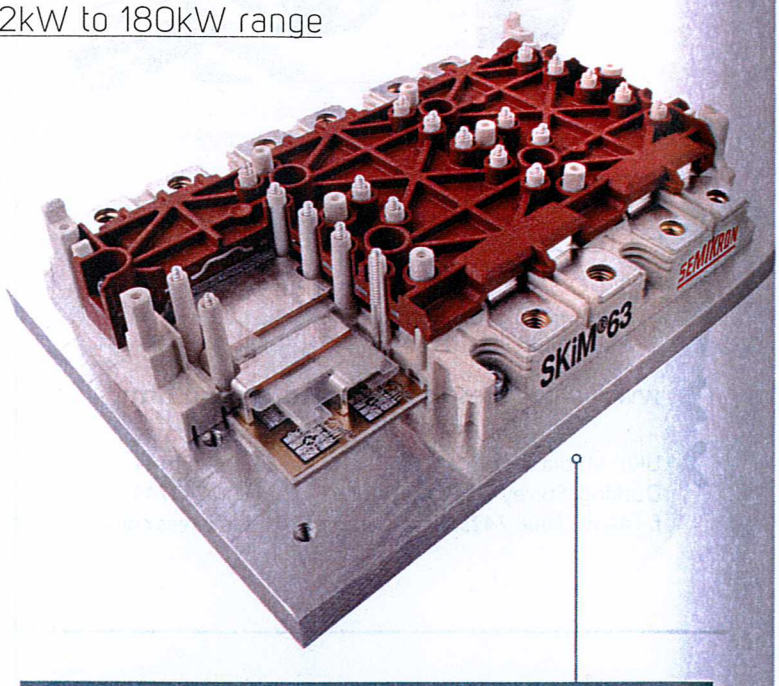

Figure 1: The solder-free SKiM module without base plate. The removal of solder joints eliminates solder fatigue, a common failure mechanism in power modules. In addition to this, the removal of the base plate also eliminates a large proportion of the thermal stresses, thus improving efficiency levels

Figure 2: SKiM, the three-phase IGBT module for DC/AC and AC/DC inverters in electric and hybrid vehicles, has a passive temperature cycling capability that's fifteen times higher than standard soldered modules

SKiM modules are characterized by proven mechanical stability at levels above standard industrial test conditions, reaching 10*g* compared with the industrial standard of 5*g* in the vibration test, and 100*g* compared with the industrial standard of 50*g* in the shock test. The total resistance is 0.3 milliohms compared with a typical industrial level of 1.1 milliohms. SKiM withstands stringent requirements for endurance during high acceleration and vibration stress.

SKiM modules are assembled quickly and easily onto the heat sink using screws. The modules are supplied with pre-applied thermal paste to ensure homogenous thickness of the paste. Power boards are assembled without any solder steps using spring contact technology. The combination of these packaging and connection technologies results in a cost-efficient and time-saving inverter assembly process.

SKiM 63 and SKiM 93 modules are available with blocking voltages of 600V, 1,200V and 1,700V and currents from 300A to 900A. Two case sizes are available: SKiM 63 measuring 120 x 160mm² and SKiM 93 measuring 150 x 160mm².

CONTACT

Dr. Volker Demuth at Semikron
E. volker.demuth@semikron.com
W. www.semikron.com

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