Lifts Away!

Reliability is a must

Power electronic systems are used in day-to-day applications. The sophisticated technology behind the scenes, however, goes unnoticed. Take elevators in office buildings or escalators in department stores for instance; the only time the systems that run these elevators or escalators are noticed is when they fail to work properly, say if an escalator comes to a standstill or if people get trapped in a stalled elevator.

By Melanie Gill, Product Manager SKiiP Subsystems, Semikron

Besides causing inconvenience to customers, system failure of this kind also results in repair and servicing costs. Not to mention the damage to your corporate image that system failure causes. Many elevator manufacturers provide their customers with a reliability guarantee on their products of over 99%. After all, reliability is what makes things work.

Quality

Before a new elevator model is put onto the market, it often undergoes as many as a million test runs. As a product quality guarantee, the product undergoes extensive testing in the product development centres. Given the tough competition on the market, the main quality criterion here is reliability. It goes without saying that in the event of elevator malfunction, defective parts have to be replaced and the elevator put back into operation promptly.

This is where SKiiP power electronics subsystems with SKiiP technology from SEMIKRON step in, which were specially developed to meet these very demands. For behind the frequency converter that controls the speed of the elevator motor are power semiconductors.

SKiiP technology was optimized to provide high load capability. Power electronic systems in elevators are exposed to different loads and consequently many load cycles, such as soft start and brake, regardless of weight and number of elevator passengers. SKiiP technology is a patented pressure contact technology that results in low thermal resistance and superior load cycle capability. Due to power dissipation during switching the power semiconductors briefly heat up very strongly. This load change results in high thermal stress to the chips and the bonding. In modules with baseplates this can cause thermal stress effects, especially on the solder layer between the ceramic substrate and the baseplate. The result is material fatigue, which will ultimately end in system failure. Therefore, to prevent failure in your power electronics system—in this case, a stalled elevator—it is imperative to opt for a power electronics system with high load cycle capability.

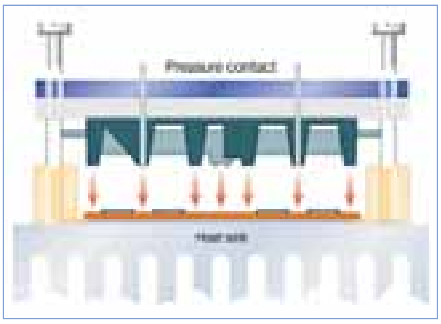

Figure 1. SKiiP technology.

Technology

SKiiP (Semikron intelligent integrated Power) power electronics subsystems provide the necessary high load resistance. A SKiiP subsystem comprises three perfectly matched components: IGBT halfbridges, driver and heat sink. The patented SKiiP technology used for the halfbridges, i.e. using mechanical pressure via the pressure plate and the bridge element, results in homogenous pressure distribution and consequently produces a thermal connection between the ceramic substrates carrying the semiconductor chips and the heat sink. The non-use of a solder layer and baseplate results in a module with lower thermal resistance. Due to the fact that the "failure factor"—i.e. the solder layer between ceramic substrate and baseplate—has been removed from the equation, a module based on SKiiP technology—and hence your drive—will have a longer service life than a baseplate module.

Another advantage is that a thinner layer of thermal paste can be used as it is applied directly onto the heat sink surface. For a given rated current this leads to a lower thermal resistance or lower temperature hub on the semiconductor chip, which increases service life. The benefits for the customer are less downtime and, therefore, lower costs for servicing and replacement parts.

In a same-sized module, the lower thermal resistance or lower chip temperature hub results in higher current density; logically, this also means that for modules with the same current density the module size can be reduced.

Figure 2. Exploded view of the IGBT halfbridge.

Consequently, for reasons of size restrictions, the compactness of the SKiiP subsystem is a much welcomed feature. In fact, the largest standard SKiiP, which has a rated current of 2400 A, measures (including air cooler) as little as 215x360x182?mm. To achieve a higher rated current per module with lower thermal resistance or chip temperature, the IGBTs are placed in parallel. This solution eliminates the problem of hot spots, in doing so allowing for higher current densities.

Integrated current sensors continue to be used to protect the SKiiPs, as are temperature sensors which are positioned directly beside the IGBTs. The integrated driver fulfils all drive, monitoring, and electrical and thermal protection functions. This intelligent driver monitors elements such as undervoltage, overvoltage and temperature and guarantees controlled and safe switch-off in the event of system malfunction.

Expansion possibilities

With SKiiP, the elevator manufacturer can expand his product portfolio in terms of useful load easily, quickly and safely, regardless of whether he wishes to increase or decrease the useful load or add a new load to his portfolio—an important advantage especially in view of reliability demands. In fact, it is as easy as ABC for the customer to select the right SKiiP for product expansion thanks to the fact that SKiiP modules are available in different sizes (2-fold, 3-fold or 4-fold), voltage and current classes and the SKiiPs are connected in parallel. Here, Semikron provides its customers with extensive support, for example with the help of simulation software. The simulation tool Semisel can be found at www.semikron.com. Simply enter the parameters of your application—from basis circuitry to cooling parameters—and decide on the basis of the figures and graphics shown whether the IPM (intelligent power module) you have chosen is suitable for your application. The tool will offer possible configurations from which you can

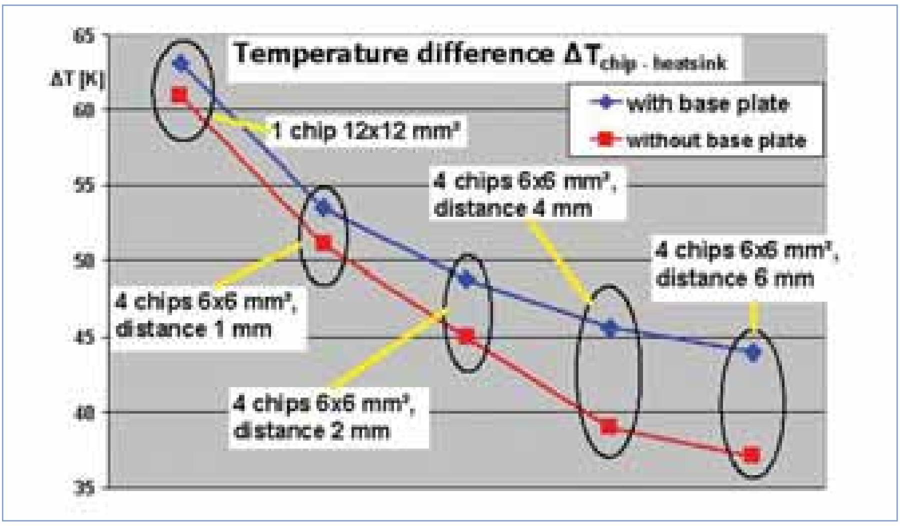

Figure 3. Chip temperature in modules with baseplate and modules based on SKiiP technology as a function of the chip clearance (simulated with $2W/mm^2$ power loss).

Figure 4a. SKiiP3 with 3 IGBT half-bridges, water-cooled.

Figure 4b. SKiiP3 air-cooled.

choose the optimum for your application. The simulation results can also be printed and saved. This modular system means that a customized solution is created to meet your individual requirements.

Focus on core tasks

The elevator manufacturer receives a subsystem that is developed and qualified to meet the requirements of the overall system. Once the IGBT half-bridges and driver have been tested separately, the overall system qualification is carried out. All of the components used in SKiiP subsystems are perfectly matched—driver, module and cooling elements. With modules bought separately and used in combination with customers' own drivers or drivers from other suppliers, this is not the case. For our customers the use of a SKiiP subsystem means lower costs (development engineers of power electronic systems, development and test equipment), and no time wasted on in-house developments. This ultimately means that developers can concentrate on their core tasks, i.e. the development of drive systems. The SKiiP subsystem has the added advantage that all of its components have been tested 100% at Semikron.

Reliability

More than 15 000 SKiiPs used every day in elevators produced by the biggest names in elevator manufacturing prove time and again that—thanks to their high load cycle capability—SKiiP subsystems are the optimum solution for the broad range of requirements and loads in this area. As for the future, the construction of elevators with no machinery room will mean that, besides reliability demands, space requirements for elevator drives (incl. power electronics components) will become increasingly important. Here, SKiiP is one step ahead, skilfully fulfilling the future space requirements in this field.

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