System-Oriented IGBT Module for High Power Inverters

Although IGBT modules with blocking voltages up to 6500V are available today, there are many applications that require the design of inverters with ratings close to or even beyond 1MVA with 1200V or 1700V devices. The recently introduced PrimePACK module housing, together with the new IGBT4 technology in 1200 and 1700V, fits this market by enabling a cost-effective and modular inverter design. **Piotr Luniewski and Uwe Jansen, Infineon Technologies AG, Warstein, Germany**

Applications like variable speed drives, UPS-systems, heavy-duty commercial vehicles, as well as grid connection of microturbines or renewable energy systems, like windmills or large solar farms, often imply system restrictions that do not allow designs with higher voltage levels. A converter design faces at least two problems: power part volume and efficiency. When a converter dedicated to high-power application is considered, then in most cases the power electronic equipment, consisting of IGBT modules, DC-link capacitors and heatsink, is usually installed in control cubicles having a height of 1.80 to 2.20m, airflow from bottom to top and being placed in front of a wall. An alternative approach uses racks where several heatsinks placed above each other are cooled by a horizontal airflow entering the cabinet at the front and leaving it at the back. In both cases, the most important dimension for the end user is the width of the cabinets.

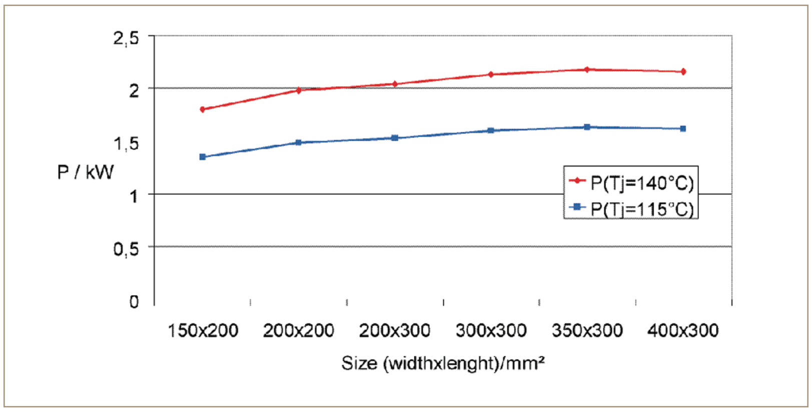

Figure 1: **Power dissipation of a 150mm x 150mm module at different junction operating temperatures**

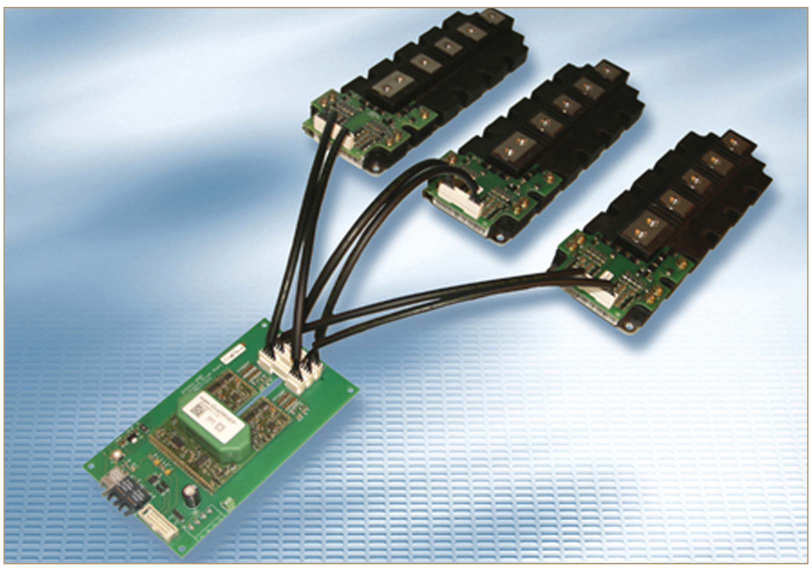

Figure 2: **Flexible driver system consisting of MA300Exx, 2ED300E12-SFO and 2ED300C17-S for 1200 and 1700V PrimePACK modules**

Reducing the inverter size

To limit overall equipment size, it is therefore advantageous to use a heatsink as long and deep as possible, but with limited width. Hence, a PrimePACK module with narrow and long baseplate helps to achieve the right heatsink dimensions and proper heat distribution. Further reduction in heatsink volume is possible by operating this module with extended junction temperature T_{vjop} = 150°C. Figure 1 shows that increasing operating junction temperature is a much more useful means to increase power dissipation than to increase heatsink size significantly beyond module footprint.

Converter efficiency is mainly determined by the semiconductor technology used for IGBTs and diodes. Hence, in recent years much effort has been spent in tailoring semiconductor technology to the different applications and power levels. To meet more recent growing requirements for 'Energy Efficiency,' the PrimePACK module is equipped with the new Trench-/Fieldstop IGBT4 generation. Thus, the module family comes as a product basically dedicated to two inverter power levels: medium (E4) and high power (P4) in 1200V [1] and 1700V class. Major focus has been set on further reduction of the forward voltage drop and switching losses. However, especially in high power applications, low dynamic losses are not the main target. To cope with over-voltages and EMI, appropriate controllability and a certain softness during module switching is required and seen as main development target [2]. Thanks to various current ratings, the PrimePACK modules provide a good match to converters with different power range without changing the module housing.

As most of the converters consists of several branches where each one has two IGBTs in series, the PrimePACK module is in half-bridge configuration together with FWD diodes embedded in one housing. This type of internal layout and connections reduces stray inductances in commutation loop compared to legs composed from single modules.

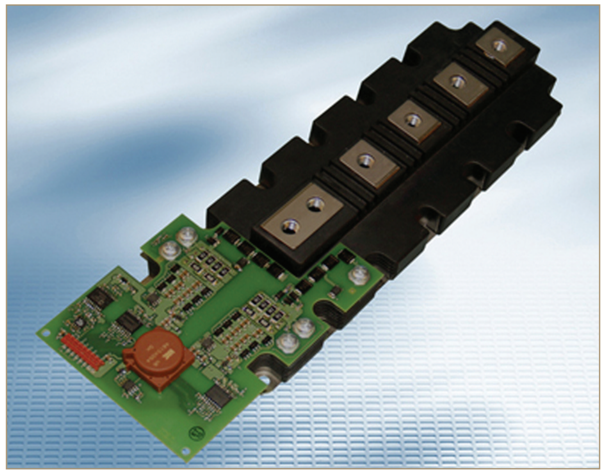

Figure 3: **The 2ED250E12-F evaluation driver board for 1200V single PrimePACK module**

Increasing output power

Increased power of the inverter system can be realised by parallel connection of smaller inverters or by paralleling modules in one inverter design. The long and narrow module shape and the half-bridge configuration are especially beneficial where paralleling modules in one inverter is preferable.

Modularity of the power inverter system on one hand is given by system oriented module design, but on the other hand, the IGBT driver must support the flexibility goals. Efficient use of modules in parallel connection with optimised current balance requires applying a suitable IGBT driver approach [3]. Figure 2 shows an example of where a driver system can be used for 1200V as well as for 1700V PrimePACK modules with minor changes. This driver kit is suitable for driving up to three modules in parallel. In any case, one EiceDRIVER 2ED300C17-S drive and one 2ED300E17-SFO adapter board is necessary. The number of module adapter boards MA300EXX is always the same as the number of modules [4, 5].

In a converter requiring only one high power module, modularity in parallel operation is not needed and the driving system can be optimised, resulting in reduction of cost and volume. The PCB driver designated 2ED250E12-F employing an EiceDRIVER-IC 1ED020I12-F [6] and dedicated to the 1200V devices of the PrimePACK family is depicted in Figure 3. Thanks to the Coreless Transformer technology [7] and protection functions implemented in the design, the 2ED250E12-F driver complements the PrimePACK module as a building block comparable to an IPM (Intelligent Power Module) in half-bridge configuration.

Conclusion

PrimePACK modules today are available in 1200 and 1700V class, various current ratings and two different IGBT technologies. This approach makes these modules mechanically universal and electrically suited for many high power applications. Finding a perfect match to final design by appropriate trade-off between static and dynamic loses is additionally supported by a modular driver approach [3].

References

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