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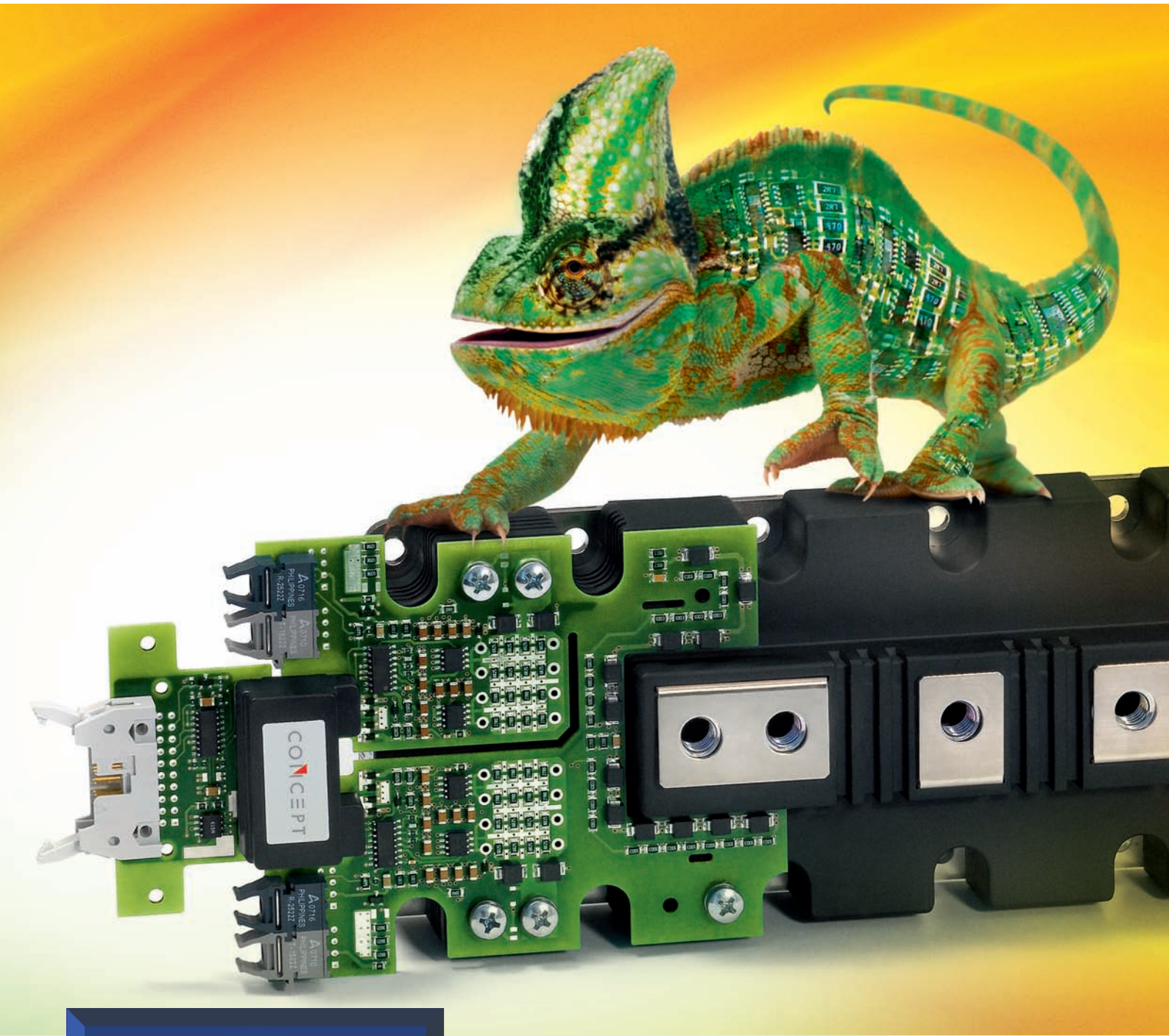
IGBT DRIVERS

Optimized Utilization of IGBTs by Plug-and-Play Drivers



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Also inside this issue

Optimised Utilization of IGBTs by Plug-and-Play Drivers

The extremely compact and high-performance IGBTs of the PrimePACK series from Infineon Technologies AG enable scalable power converter system solutions optimised for various industrial drives, windmills, elevators, traction and auxiliary drives. SCALE-2 IGBT drivers make a perfect match for scaling power and controlled efficiency. **Jan Thalheim, Olivier Garcia, Peter Wassmer, Sascha Pawel, CT-Concept Technologie AG, Biel, Switzerland**

Thanks to SCALE-2 technology, the new 2SP0320 family comprises complete and extremely compact two-channel IGBT drivers equipped with DC/DC converters, short-circuit protection, advanced active clamping and supply-voltage monitoring. Users need only mount them onto the corresponding IGBT module. The system can then be put into immediate operation with no further development or matching effort.

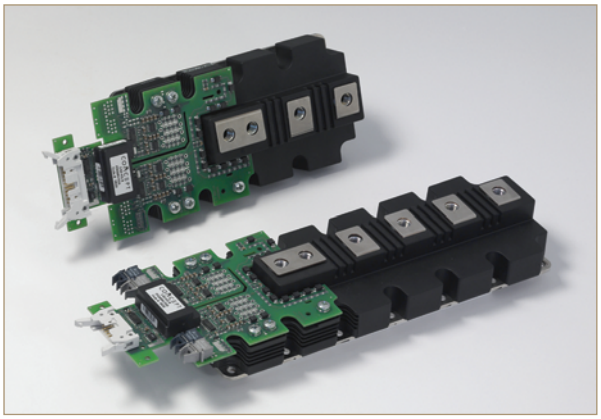

Figure 1: The modular layout of plug-and play drivers for PrimePACK allows several options to be implemented, including a signal transformer interface (background), a fibre-optic interface (foreground), leaded or surface-mountable gate resistors and dV/dt feedback

Driver chipset features

SCALE-2 is a further development of the SCALE technology already tried and tested since 1998 in large item numbers and in practically every conceivable application. SCALE-2 has a significantly higher degree of integration, thus reducing the number of components on the driver boards. This results in maximum reliability, a smaller space requirement and much lower costs.

The SCALE-2 chipset has integrated interfaces for signal transmission via optical fibers or transformers. In the latter case, the command and fault-feedback signals are transmitted via the same transformer. Thanks to a longer pulse duration, the fault-feedback signal dominates both the command signal and noise and can therefore be transmitted to the primary side within a microsecond. These drivers have an extremely short transit time of typically less than 80ns and a jitter of less than ±2ns. Parameter variations over the production process, temperature and supply voltage are widely compensated. The delay to shutdown after reporting a fault is also adjustable.

The SCALE-2 chipset inherently supports not only two-level, but also three-level and multi-level topologies and parallel-connected IGBTs. Optimised active clamping is integrated as in predecessor systems and is now also capable of directly controlling the rate of change of the collector current or collector-emitter voltage at the IGBT turn-off transition. The secondary-side gate driver chip has an integrated output stage for gate currents up to 6A. The output current can be increased to about 40A by simple means. The complete functionality of the DC/DC converter is integrated in the primary side interface chip. The user interface is compatible with all logic families from 3.3 to 15V.

The chipset provides high ESD and noise immunity, ensuring safe operation in rapidly switching systems and harsh environments.

Application options

Figure 1 shows the plug-and-play PrimePACK IGBT drivers with transformer and fibre-optic interfaces respectively. Upon request, the transformer and electrical interfaces are mounted on the underside to reduce the height of the driver.

For the PrimePACK drivers, the signal transformer version provides both direct driving mode and half-bridge mode with combined input and fault processing and an internally generated half-bridge dead time matched to the corresponding module. A command blocking time is also provided after a fault event to ensure proper reset and thermal stability of the system. These functionalities can be deactivated by connecting the corresponding pins to signal ground at the primary-side interface.

Although the superior noise immunity of the transformer version makes it first choice for reliable and low-cost systems, a dedicated fibre-optic version is also available. This stand-alone interface eliminates the transformer signal path and therefore outperforms the noise immunity of most other solutions available on the market. Each commmand is acknowledged by a short pulse of 650ns to monitor the fibre-optic connection. Any fault event is reported for a minimum of 8µs.

Switching behaviour

The easy adaptation of the drivers permits an optimum set-up to handle the special demands of a wide range of applications. The initial version allows 1700V IGBTs to be turned off at a DC link voltage of 1200V at DC link inductances of up to 65nH within the safe operating area. The DC link voltage may be increased up to 1300V and beyond by optional dV/dt or dI/dt feedback to enhance the power density or the safety margin.

This is made possible by keeping the MOS channel conducting during turn-off. The feedback signal is applied to both the driver input and the IGBT gate to improve the efficiency of the active clamping devices. This tried-and-tested architecture

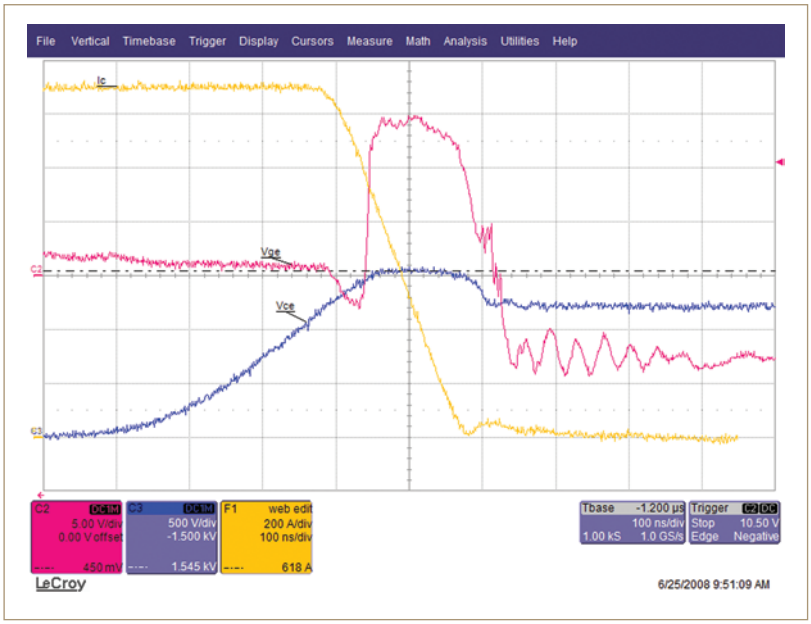

Figure 2: **Turn-off transition of a 1700V/650A FF650R17IE4 PrimePACK module at I_C = 1300A, V_{DC} = 1200V, L_S = 45nH and T_J = 150°C. V_{DC} can be further increased by optional dV/dt feedback**

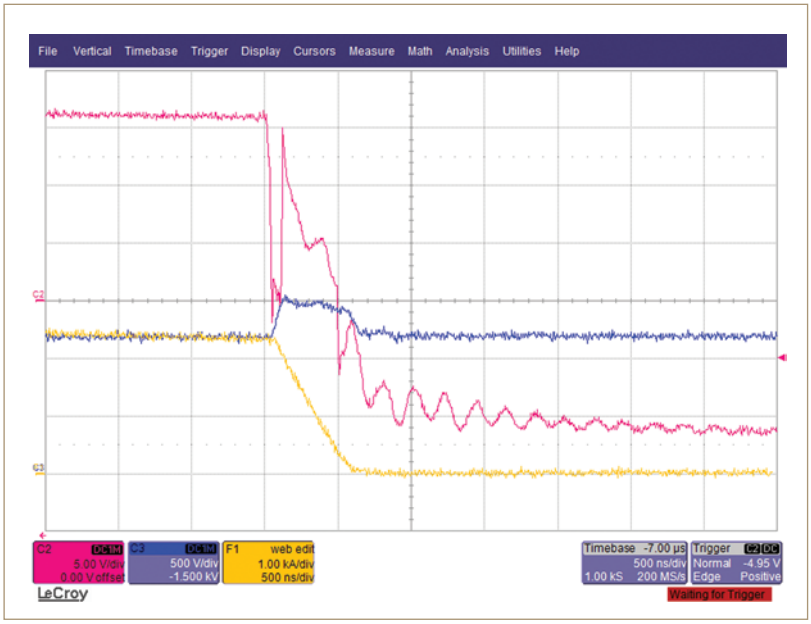

Figure 3: **Short-circuit turn-off of FF650R17IE4 at V_{DC} = 1200V, L_S = 65nH and T_J = 150°C**

has become a virtual standard ever since a plug-and-play driver solution for a high-voltage IGBT for the first time ten years ago has been presented. It should be noted that the use of simple gate drivers would exceed the safe operating area limit at DC link voltages beyond about 1000V for typical applications.

A gate capability of up to 4W and 20A per channel is available, which may be fully exploited by several design and application options depending on DC link voltage, switching frequency, number and type of gate resistors, IGBT internal gate resistance and components for active clamping. For the initial design using SMD components, switching frequencies of up to 15kHz are achieved by minimum gate powers of 3 and 2W at ambient temperatures of 70 and 85°C respectively. The operating ambient temperature range of the driver is defined as -40 to 85°C. Other operating ranges are available upon request. The driver chipset has been successfully verified for an operating ambient temperature range of -65 to 125°C and up to a junction temperature of 175°C.

High-performance turn-off transitions of a 1700V/650A PrimePACK module are shown in Figures 2 and 3, displaying the collector-emitter voltage V_{CE} (blue), the collector current I_C (yellow) and the gate-emitter voltage V_{GE} (red). Thanks to the advanced driver architecture with integrated active clamping, IGBT operation is kept within the safe operating area with a reasonable margin up to a total DC link inductance L_S of 65nH. This is verified for a collector current I_C of up to twice the nominal current, or under short-circuit conditions for the full operating range of the IGBT junction temperature T_J and a maximum permitted DC link voltage V_{DC} of 1200V, which can be further increased by optional dV/dt feedback.

The 1200V PrimePACK modules are controlled up to a V_{CE} of below 1100V for a maximum permitted V_{DC} of 800V.

Customised solutions

Samples will be available in Q4 2008. The initial design can be easily extended to provide direct paralleling of gate drivers and IGBTs, e.g. by a user-provided logic for the version with a transformer interface in direct driving mode, or by a factory-provided bus connector for the version with a fiber-optic interface. However, a series of dedicated gate drivers is also being developed to further improve the cost performance ratio for driving parallel IGBTs. Plug-and-play drivers and SCALE-2 ASICs are also offered in customised versions for applications produced in volume quantities.