

Gate Drivers for High Performance and Low Cost

Cost and performance are two fundamental cornerstones of any power system component. In the case of the gate drive module, the cost performance ratio strongly influences the make-or-buy decision for that small, yet crucial building block. Continuous advances in monolithic integration, as well as high voltage transformer technology, have now made it possible to combine advanced gate drive functions and high output power density at low cost. **Sascha Pawel and Wolfgang Ademmer, CT-Concept Technologie AG, Switzerland**

It is well known that the number of individual components interacting in a system is important for the overall system reliability. Fewer components means higher reliability in non-redundant systems, as long as the component failure rates are comparable. This principle is successfully applied to monolithic integration of electronic functions into ICs for nearly all application aspects. In power electronics, however, design cycles are considerably slower and the designers are more conservative in adopting technical advances. This risk minimising attitude has brought today's power systems to a very high reliability level. However, as the number of electronic functions is increasing, the reliability limitation due to the large number of discrete components and off-the-shelf ICs is becoming more and more severe.

Specialising in gate driver solutions

CONCEPT is focusing on gate drivers to overcome the obstacles of monolithic integration in this highly specific market. Monolithic integration requires considerable initial efforts. Thus, it is simple truth that the best price performance ratio can be achieved by a specialised company. Broad application coverage and the large combined quantity of CONCEPT drivers delivered to a great variety of customers makes it possible to merge all common functions of a driver into a platform of dedicated application specific ICs (ASICs).

SCALE, the first generation of dedicated chipset of ASICs for gate drivers, allows 70% reduction in component count for a complete gate driver core. Cores are driver modules including DC/DC conversion, bidirectional signal transmission, high voltage insulation, output stages, and advanced protection and monitoring functions.

The recently introduced SCALE-2 chipset

CONCEPT INTELLIGENT POWER ELECTRONICS	SCALE	SCALE-2	
	broad coverage	high performance	low cost
Component count (discrete = 100%)	25% - 35%	15%	10%
Availability	full production	full production	engineering
Fast switching	✓	✓✓✓	✓
High power	✓✓	✓✓✓	✓
Parallel operation	✓	✓✓✓	✓
Multilevel mode	✓	✓	✓
Dedicated MOSFET mode	○	✓	✓
Fiber optics	✓	✓	○
Planar transformers	○	✓	○
IGBT target range	all modules 1200V – 6500V	1200V / 450A 1700V / 3600A	1200V / 100A 1700V / 450A

Figure 1: SCALE technology overview

is continuing the successful SCALE philosophy with the improvements and additional capabilities of modern IC technology. SCALE-2 further reduces the component count by two thirds. Up to 90% of the discrete devices have thus been monolithically integrated into the ASICs. This reduction is directly visible in the very high reliability figures of the gate drive modules build with these drivers. The new chipset naturally complements the

SCALE technology and helps to implement significant cost saving options. The product line-up will therefore continue to rely on a balanced combination of both technology steps, where the specific advantages of each are fully utilised. Figure 1 shows an overview of the current SCALE technology options.

Two new SCALE-2 gate drivers are currently under development that will extend the application range of ASIC based



Figure 2: Half-bridge driver core 2SC0550P measuring 57 x 62 x 6.5mm



Figure 3: Half-bridge driver core 2SC0107T measuring 45 x 34 x 16mm

driver cores. The first one is following a rigid low cost approach while still maintaining full functionality. The second one targets applications where highest driver performance is required.

Half-bridge driver module with planar transformers

Driver performance is a complex parameter associated with gate drive power, maximum switching frequency, peak current capability and many more. The combination of newly developed planar transformer technology for 1700V class systems with the integrated SCALE-2 platform yields the highest density of power and functionality seen so far in a driver core. Figure 2 shows the half-bridge driver 2SC0550P. On 57 x 62mm board space, the driver delivers more than 5W output power per channel. The peak current capability reaches 50A, which is important for parallel operation of several high current IGBT modules. With its high maximum frequency limit of more than 200kHz the driver is ready to serve both today's resonant converter applications as well as prospective SiC and GaN devices.

Dedicated build-up of the driver PCB and careful optimisation of the whole production process have made reliable planar transformers for the 1700V class of insulation systems feasible. The apparent benefits are automated manufacturing with high reproducibility and low tolerances, a driver height of less than 7mm, high power density, and superior immunity to magnetic fields.

The driver targets fast-switching applications, high current modules up to IHM 1700V/3600A, and parallel connection.

Lower cost half-bridge driver

The cost saving capability of ASIC integration is fully exploited towards the lower end of the driver power spectrum. Figure 3 shows a picture of the low cost driver 2SC0107T. The PCB contains only 23 components, including transformer and ICs, to form a complete IGBT and MOSFET driver core with all functions known from existing SCALE drivers. The output power rating is 1W per channel at up to 7A maximum output current.

The driver core 2SC0107T is designed to control IGBT modules between 1200V/ 100A at 50kHz and 1700V/450A at 10kHz. The driver also features a dedicated MOSFET mode which allows faster switching at reduced gate voltage swing.

Pricing and availability

The pricing of the 2SC0107T is very competitive, thanks to the low production costs of the SCALE-2 platform. At quantities of 10,000 pieces, the driver will be priced \$20 (\$10 per channel). It thus compares very favourably with discrete solutions for bidirectional signal transmission, isolated DC/DC power, and gate drive output. The benefits of high reliability and tried and tested SCALE technology are also included. Samples of the two new driver cores will be available summer 2009.