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Pushing the IGBT voltage limit beyond 8000 V

Two decades ago, the launch of a seemingly simple variant of the silicon power MOSFET – the insulated gate bipolar transistor, or IGBT – began to change the power electronics landscape. This electronic power switch owes its success to the fact that only a very small amount of control energy is needed to change its operating mode from conducting to blocking, and vice versa. One way of seeing it is as a sensitive yet robust 'muscle', perfectly suited to executing commands it receives from a power electronics 'brain'.

As the blocking voltages and currents of the first commercially available IGBTs were limited to 300 to 600 V and currents of just a few amperes, development work began in the early 1990s aimed at increasing the power handling capability, which has risen continually in the meantime. Now, engineers and scientists at ABB in Switzerland have joined together to push the blocking capability of IGBTs to above 8000 V – a world's first in the history of this device.

First prototypes of the record-breaking 8-kV IGBT and diode chips (see photo) measure 17 mm by 17 mm. A chip thickness of close to 0.7 mm is required to achieve this very high blocking voltage. By optimizing the IGBT design for the base region and the cell, it has been possible to achieve low conduction losses with a typical on-state voltage drop of 4.55 V (25 °C) and 5.1 V (125°C) at a nominal current of 50 A (35 A/cm$_2$). For the irradiated diode chip, the on-state voltage drop is 2.8 V (25 °C) and 2.9 V (125 °C) at a nominal current of 100 A (70 A/cm^2). The temperature coefficients exhibited by both chips ensure excellent current sharing among paralleled dies operating in high-current modules.

The chip set is designed for operation at a DC link voltage of 4000 V with a very low cosmic ray induced failure rate. Although the flux of these very high-energy particles is infinitely small, it is responsible for a very important failure mechanism in all high-voltage power devices. In fact, it is the requirement for a low cosmic ray induced failure rate at 4000 V DC link voltage that has pushed the IGBT blocking voltage above 8 kV.

First electrical tests have demonstrated a turn-on and turn-off capability of 100 A (70 A/cm^2) under tough inductive switching conditions (ie, without protective 'snubber' circuits) at a DC link voltage of 4000 V. Even operational faults in which the IGBT turn-on leads to a short circuit across a voltage source of 4000 V are handled without failure. The IGBT chip limits the short-circuit current to about 4 times the nominal current and can be turned off safely within at least 10 microseconds. State-of-the-art controls, however, are able to detect a short circuit and respond to it

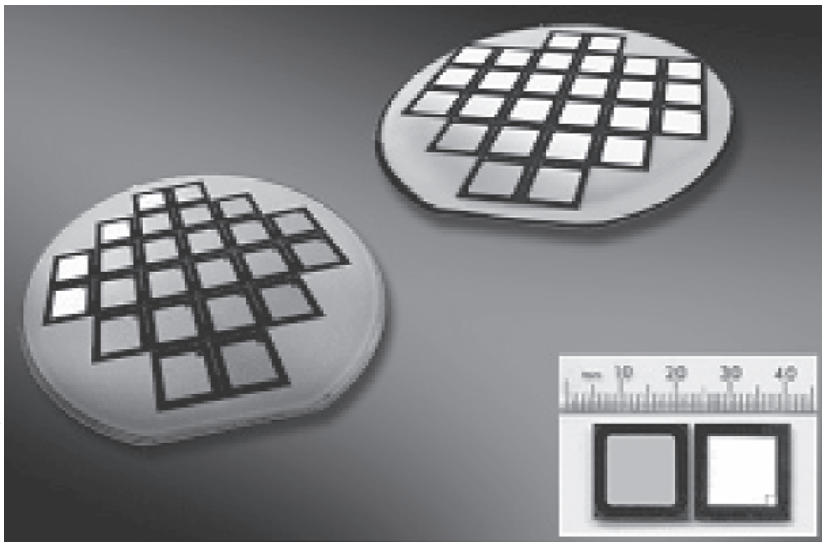

Photo: Diode chips

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within less than 5 microseconds. The term 'sensitive muscle' is therefore fully justified.

Further development of IGBTs aimed at even higher blocking voltages is being fueled by a number of applications in the fields of traction, industry and – for the first line – HVDC converters. Also, newly emerging high-voltage markets, such as pulse power applications, are starting to exploit the benefits of high-voltage IGBTs. In all of these cases, IGBTs can make a substantial contribution to improving the performance, size and cost of high-power electronics systems.

10,000 products certified to new industrial IT standard

ABB announced in mid-2002 that it has certified 10,000 products to its new industrial information technology standard. This takes the company one step closer to its year-end goal of certifying all 40,000 relevant products in its power and automation technology portfolio.

"Bringing our products and services into a single information framework is geared to making our customers more competitive," said Jörgen Centerman, ABB president and CEO. "At the same time, it allows us to sharpen our portfolio, improve the integration of products and services into solutions and strengthen the ABB brand."

Industrial IT is ABB's patented concept for linking products and services together with the information needed to run, service and maintain them. Open standard software allows operators or managers to click on any part of their value chain – from production devices to inventory components – and immediately call up the information needed to make crucial decisions. ABB had 'Industrial IT Enabled' some 900 products at year-end 2001 and 3,000 products in February 2002.

Each Industrial IT Enabled product offers uniform electronic tools for documentation, configuration and connectivity. The tools are bundled in a piece of software called an 'Aspect Object'. When this software is copied and pasted into a customer's power or automation system, a virtual version of the real product is enabled for use. Basically, this means an operator of a power plant or factory can click on the virtual product and get instructions, remote control and diagnostics, maintenance records and other asset management information.

ABB's 10,000th certified product, the Control IT Remote (Input/Output) System S900, manages signals between plant control systems, sensors and actuators. It can now be installed near plant devices to reduce wiring costs, and ensure quick access to all the aforementioned information. To date, more than 100 key customers have purchased ABB's Industrial IT products and services.

Industrial IT certification is mandatory for all ABB products. A number of third-party products have also been certified in cooperation with the company. For example, Bosch Rexroth, a German supplier of drive and motion control solutions, will certify its full line of pneumatic components.

(See also FAQ on www.abb.com)