After years of research, testing and simulation, ABB has successfully designed and developed a hybrid HVDC breaker. This breakthrough solves a technical challenge that has been unresolved for over a hundred years. The hybrid breaker combines mechanical and power electronics switching, which enables it to interrupt power flows equivalent to the output of a nuclear power station within 5 milliseconds – that’s as fast as a honeybee flaps its wing! But it’s not just about speed. The challenge was to achieve “ultra-fast” with minimal operation losses. This has been achieved by combining advanced mechanical actuators with ABB’s latest BiGT semiconductor technology.

The HVDC breaker is revolutionary since it removes a significant stumbling block in the development of HVDC transmission grids so planning can start now. These grids will enable interconnection and load balancing between HVDC power “superhighways” and power transmission across long distances with minimal losses. DC grids will enable sharing of resources such as lines and converter stations, providing reliability and redundancy in a power network in an economically viable manner with minimal losses. ABB’s new hybrid HVDC breaker will enable the transmission system to maintain power flow, even if a fault occurs on one of the lines. (continuation on page 6)
Editorial

We are happy to announce the re-introduction of ABB StakPak IGBT modules to our Product Catalogue 2013. They are quite popular in the market place for a number of applications like Statcom and HVDC, but also for industrial drives. In this newsletter issue, we are taking the opportunity to focus on our Stak-Pak IGBT modules. Accordingly, the cover story is about a milestone development: ABB’s hybrid HVDC breaker. This new HVDC circuit breaker is capable of breaking and blocking DC currents of thousands of amperes and several hundred-thousands of volts, and its key component is an ABB Semiconductors’ StakPak IGBT module!

The Product in Focus column summarizes the most important features and benefits of our Stak-Pak pressure contact IGBT modules. The Technology in Focus column provides some insight into the spring technology that assures uniform contact pressure on all IGBT chips in the module and thus highest product reliability. Last but not least, the Application in Focus features HVDC systems and reviews the different development steps, starting from the use of mercury arc valves in 1954 and leading up to today’s HVDC Light systems, which benefit from our latest StakPak IGBT module generation.

See the latest product information updates and get informed about products in the pipeline, new qualified products, phased-out and obsolete products on pages 3 and 4.

I wish you a Happy Easter and look forward to seeing you soon at PCIM Europe 2013 in Nuremberg (14—16 May) in our new location: Hall 9, Booth 203!

Yours,

Christoph Holtmann,
Head of Marketing and Product Management

Interview with Björn Jacobson
HVDC breaker project

Björn Backlund: What is your involvement in the HVDC breaker project?
Björn Jacobson: Throughout the whole process, I have been in charge of R&D for the HVDC portfolio, so I am leading the project managers who ran the HVDC breaker R&D project.

Björn Backlund: How can ABB customers benefit from these new HVDC breakers?
Björn Jacobson: HVDC breakers were initially designed for HVDC grids, where they can isolate faulted parts of a grid, for instance a line that has been struck by lightning. The HVDC breakers perform so fast that the rest of the grid remains in operation, which is a vital requirement for an HVDC grid. Recently, new applications in ordinary point-to-point HVDC connections have emerged, where the breaking speed of the HVDC breaker minimizes the impact on the AC network during faults on the HVDC line. Most important, ABB’s converters, combined with the HVDC breaker, have the lowest losses and lowest component count of all available technology, and this places ABB in a very good position on the market.

Björn Backlund: When can ABB’s customers benefit from this achievement?
Björn Jacobson: We invite our customers to already start implementation discussions with us. As usual with prediction in R&D it is hard to make a solid promise in advance, but technology-wise we have already proven the concept’s functionality and the ruggedness of the major components.

Björn Backlund: Why did it take 100 years to solve this electrical engineering puzzle and what enabled ABB to solve it first?
Björn Jacobson: To solve it, very powerful semiconductors – produced by ABB Semiconductors in Lenzburg – are necessary, of a type that has only recently been made available. In addition, the low-loss version of the HVDC breaker contains a newly designed, ultra-fast disconnector, which has also only recently been developed. Both these items were needed, along with the market pull, coming first from HVDC Grid visions and also from normal overhead line applications with HVDC Light (Voltage Source Converters).

Björn Backlund: Which ABB business units where involved in the invention?
Björn Jacobson: The basic invention of the hybrid HVDC breaker is from ABB Ludvika and the main inventor is Jürgen Häfner. To make it reality, HVDC in Ludvika, Semiconductors in Lenzburg, HV Breakers in Baden, Corporate Research in Baden-Dättwil, GIS in Zürich-Oerlikon and Corporate Research in Västerås were the main ABB contributors. There are also other suppliers, too numerous to mention, each adding their part to the whole.

Björn Backlund: How did ABB Semiconductors contribute to solving the puzzle?
Björn Jacobson: Although it is possible to build HVDC breakers with different types of semiconductors, the introduction of the IGBT StakPak gave us a compact, easily driven, high-performance device ideally suited for HVDC breakers.

Björn Jacobson, Leader of the HVDC breaker project
Products in the pipeline
BiMOS and Bipolar

2.5kV IGBT:
- Higher $T_{vj(op)}$ up to 150°C possible
- More current up to 1500A
- Suitable applications: Diesel Locomotives, Wind Power

5.5kV Diode
- Alloyed technology with excellent surge current ratings
- Operating temperature from -40°C up to 190°C
- Reduced clamping force requirements due to smaller diode diameter
- Suitable applications: Industry, Traction

New qualified products
BiMOS and Bipolar

<table>
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<tr>
<th>Part Nr.</th>
<th>Voltage</th>
<th>Current</th>
<th>Configuration</th>
<th>Housing</th>
<th>Samples</th>
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<td>Rectifier Diode</td>
<td>L Housing</td>
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</table>

Product features

4.5kV IGCT Diodes:
- $T_j$ up to 140°C
- Very soft switching
- Suitable for HPT-IGCTs

4.5kV Dual Diode:
- 1200A Dual Diode
- Suitable for companion diode for 5SNA 1200G450300 in 3 levels or chopper topologies

3.3kV IGBT:
- Higher $T_{vj(op)}$ up to 150°C possible
- Replacement for 5SNG 0250P330300
- Suitable applications: Electric Locomotives, Highspeed Trains, EMUs and Medium Voltage Drives

4.5kV StakPak
- 2000A Press-pack IGBT module
- Suitable for series connection in very high power applications such as HVDC and Facts

Portrait:
ABB Distributor
GvA Leistungselektronik GmbH

GvA, located in Mannheim, Germany, is specialized in the distribution of power electronics components as well as in development and production of high-end power electronics solutions tailored to demanding customer specifications. As distributor for many reputable manufacturers such as ABB Semiconductors, ABB France, MeccAl, Electronicon, CT Concept, Siebel und Scholl, Typhoon, we are a “full-line supplier”, capable of providing our customers with a comprehensive product portfolio ranging from power semiconductors all the way to heat sinks.

Our company’s experience and competence in implementing the exceptional instead of trying the impossible has been successful for almost two decades. Since its foundation in 1994, GvA Leistungselektronik GmbH has offered development and design services for all sectors of power electronics. These services are further complemented by distribution lines.

It is GvA’s goal to optimize every individual application, both technically and commercially. As a development and production center, we are able to offer customized solutions for almost all customer applications. Whether 100kVdc 120kAeff, Bipolar or BiMOS switched, controlled or uncontrolled, 2-level, 3-level, air- or liquid-cooled, whether connected in parallel or in series, we have the experience and know-how to make every possible switching topology or application possible.
Application in focus
HVDC Light®

HVDC systems are used for low-loss electrical power transmission over long distances and for the connection of incompatible AC power networks, e.g. connecting a 50 Hz grid with a 60 Hz grid. The first HVDC system using mercury arc valves, went into operation in 1954 and connected the island Gotland with the Swedish mainland. In 1967, thyristors were introduced and they are still used in HVDC systems referred to as HVDC classic.

In 1997, HVDC Light® was launched using voltage source converters (VSC) and having a power range between 50 and 1200 MW. This technology is used for grid interconnections and offshore links to wind farms and oil and gas platforms using environmentally friendly underground and subsea cables. Custom designed series connected press-pack insulated gate bipolar transistors (IGBTs) have been the cornerstone of the HVDC Light® technology since its beginning. The HVDC Light® converter technology has been refined and improved over the years. The original design, referred to as Generation 1, was a two-level converter switching the full voltage in a pulse-width modulation (PWM) pattern. To reduce losses, Generation 2 was developed using a three-level converter. Another step in loss reduction was taken in Generation 3 featuring a two-level converter with an optimized switching pattern and a more advanced IGBT design.

The current Generation 4 implements a cascaded two-level (CTL) converter. This converter design enables a nearly sinusoidal output voltage, which in combination with the low switching frequency per cell, significantly reduces station losses. A half-bridge cell configuration has been selected in order to minimize the number of components and thereby increase reliability.

Phased-out products
BiMOS and Bipolar

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Obsolete products
BiMOS and Bipolar

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<td>5SHY 35L4520</td>
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</tbody>
</table>

Lead Time Indicator

The table below shows our approximate current lead times. A detailed Lead Time Indicator was sent to our official distributors a few days ago. In general, there is no major change in lead times compared to December 2012.

- PCTS: 5-10 weeks
- Diodes: 5-14 weeks
- Welding Diodes: 3-10 weeks
- IGCTs: 5-6 weeks (some RC-IGCTs: 28 weeks)
- GTOs: 4-6 weeks
- HiPaks: 2-4 weeks (<1kpcs) *
- IGBT & Diode Dies: 2 weeks (10 weeks (<25kpcs) *)

* The lead times below are estimates and are not guaranteed. For exact lead times, please contact your ABB Semiconductors sales team or ABB’s local distributor in your country.

Pulsed Power

As previously announced in our Short Form Catalogue 2012, ABB Semiconductors no longer offers newly designed and engineered Pulsed Power stack assemblies for the open market. For any inquiries for Pulsed Power stacks or components, please contact our worldwide partners:
in Europe: Astrol Electronic AG (info@astrol.ch) or GvA Leistungselektronik GmbH (info@gva-leistungselektronik.de)
in North America: 5S Components Inc., info@5SComponents.com
in Asia: Pulsecon Co. Ltd. (dupal@pulsecon.co.kr).
Product in focus
StakPak

The term StakPak refers to a family of high power IGBT press-pack modules in an advanced modular housing that guarantees uniform chip pressure in multiple-device stacks.

Although the most common package for IGBTs is the insulated module, for applications requiring series connection, press-packs are preferred because of the ease with which they can be connected electrically and mechanically in series. Unlike standard IGBT modules, StakPak modules fail into a stable short circuit failure mode (SCFM). StakPaks are thus ideally suited for applications with series connections requiring redundancy. In such applications, additional devices are inserted into the series string so that a device’s failure will not interrupt converter operation. The failed device will continue to conduct current for a time period greater than the planned service interval of the equipment. This period of time, during which load current must flow in the failed device without external degradation of the housing or internal degradation of the electrical contact, is a function of the load-current time-dependence. ABB offers SCFM ratings for users requiring this feature and who are able to specify the load current waveforms and profiles.

Since IGBTs feature multiple parallel chips, there is a challenge - with conventional press-packs - in assured uniform pressure on all chips. ABB has solved this problem with a patented spring technology (see Technology in Focus).

The current portfolio of ABB StakPak modules consists of two voltage classes, 2500V and 4500V and a current range between 1000 and 2000 A. Typical Stakpak applications include FACTS, HVDC and heavy duty industrial drives.

Technology in focus
Press-Pin

The press-pin is the key element in ABB’s StakPak press-pack IGBT technology. Unlike the standard approach for pressure contacted semiconductors, the mounting force is not directly transferred to the sensitive IGBT emitter area, but decoupled from the spring of the press-pin. Thus, each chip gets its mounting force from an individual spring. The clamping force for each individual semiconductor is defined by the travel distance of the spring (defined by the frame height) and the spring constant. Surplus mounting force will be absorbed by the rugged frame. This makes the module design less dependent on material thickness variations of the material layers. Additionally introduced force inhomogeneity from outside, e.g. in case of large stacks, is decoupled from the chip.

Another important function of the press-pin is to ensure reliable electrical contact and, in case of device failure, a stable short-circuit state. In case of a chip failure, the specially selected materials and the design of the press-pin allows the pin and chip to alloy together and form a low ohmic path between collector and emitter. After such a failure, the whole current from up to 72 pins is flowing through one pin, thus limiting the lifetime of a press-pin in short circuit failure mode (SCFM). For this reason, the design of the module must allow current transition from one pin to another once the first pin reaches the end of its lifetime.

Process change notifications

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<td>IGCT 13-01</td>
<td>IGCT, GTO, FRD</td>
<td>Matrix code on devices</td>
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</table>
ABB’s hybrid HVDC breaker (cont.)

This is a major achievement for ABB’s global R&D team, who has worked for years on the challenge and has succeeded with this milestone development. This new HVDC circuit breaker is capable of blocking and breaking DC currents at thousands of amperes and several hundred-thousands of volts. It is comparable to stopping power capable of feeding a large city faster than the blink of an eye! This speed helps protect the DC transmission system and prevent power outages in new low-loss, compact power superhighways. The next step is to install the hybrid breaker in pilot installations.

HVDC transmission remains the technology of choice for bulk power transmissions over long distances with minimum losses. HVDC lines also require less space and can be implemented underground or underwater. HVDC applications using voltage source converters in embedded AC grids and for offshore connections have grown substantially, thanks to quantum leaps in power ratings and significant loss reductions. ABB pioneered HVDC transmission technology nearly 60 years ago. Approximately half of all HVDC installations worldwide are from ABB. With their new HVDC breaker, ABB writes the next chapter in the history of this technology, and marks an important milestone in electrical engineering.

Publications calendar

- Power Electronic Europe, July/August 2012, “Past, present and future of HPT-IGCT”
- Bodo’s Power Systems, September 2012
  “High Current Rectifier Diodes for Welding Applications”
  Released at 1st. week of January 2013
- New product flyers to be released at PCIM 2013

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