Successful PCIM for ABB

PCIM – The most important power electronics exhibition worldwide
In May, PCIM Europe 2014 – the most important power electronics exhibition worldwide – took place in Nuremberg, Germany. It provided a comprehensive market overview of the power electronics, intelligent motion, renewable energy and energy management segments. A focused and compact presentation of the latest developments of power semiconductors, passive components, products for thermal management, new materials, sensors as well as the wide area of power quality and energy-management was given. The international significance of PCIM Europe was reflected in more than 50 percent of the close to 400 exhibitors coming from abroad. Twenty-nine countries were represented with the USA, China, Italy and France having the largest contingents after Germany. PCIM Europe occupies an area of 20,000 square meters over three exhibition halls and more than 8,000 visitors were attracted this year, 2 percent more than in 2013.

The concurrent conference was a key meeting place for experts from science and industry. A practice oriented exchange between the developers and users of power electronics technologies was made certain with more than 220 presentations, three keynote speeches, six seminars and 10 tutorials that were given. Seven hundred and ten conference delegates took advantage and attended the conference this year, which was slightly less than in 2013.

Exhibition highlights
As every year ABB Semiconductors participated at PCIM Europe also in 2014 with its own stand. Very well positioned, directly at the entrance of the exhibition area, (continued on page 2)
Editorial

Football is connecting, particularly in these days. Power electronics too! HVDC systems (Newsletter January 2013) connect remote power sources with consumers living far away or traction converters for instances connect high speed train motors to the power (Newsletter September 2012). Soft starters, connecting machines to the power and at the same time protecting the power quality, is another example (Newsletter January 2012). PCIM, the premier event of the year in power electronics, is also connecting. People from all over the world met in Nuremberg. We had many technical and commercial discussions and experienced a great interest in our latest product developments and innovations … and we enjoyed the stand party toasts and discussions at our booth on Tuesday evening.

In this Newsletter, PCIM is the cover subject. On pages 1 and 2 we review our exhibition highlights, summarize one of our conference contributions – the Young Engineer Award winning paper from Vinoth Sundaramoorthy – and we compile some PCIM facts and figures. Other than in earlier Newsletters there are no focus articles on products, applications and technology this time, but on innovation: Innovation on bipolar technologies (page 3), Innovation on BiMOS technologies (page 5) and Innovation on Packaging technologies (page 6). With this Newsletter we introduce a new column in which we summarize one of our more than twenty application notes, starting with “Surge currents for phase control thyristors” on page 3. The full application note and all others as well can be downloaded from our website at www.abb.com/semiconductors.

What remains is to remind you not to miss our product and lead time updates on page 4 and to wish you a great summer!

Yours, Christoph Holtmann
PG Communications Manager

(continued from page 1)

ABB demonstrated its market leadership in high power electronics. The latest product developments, which attracted customers and competitors likewise, were:

• New 150 mm thyristors with highest power capability for high-voltage DC transmission (HVDC) systems.
• New enhanced rectifier diodes in 120 mm housing with an average current of 4,850 A and a blocking voltage of 5,500 V, optimized for high-power rectifiers (HPR).
• New fast switching thyristors in 102 mm housing with an increased current capability, optimized for induction heating.
• Improved HiPak IGBT modules in M & N housings featuring higher reliability and compliance to latest international Fire&Smoke standards (EN45545,R23/HL2)
• New 1,700 V SPT++ IGBT and diode chipsets performing full safe operating area (SOA) at operation temperatures of up to 175 °C.
• New Dual HiPak IGBT module with 3,300 V blocking voltage and 2x 500 A switching current for flexible AC transmission systems (FACTS).

Conference contributions

In parallel to the exhibition the user-oriented conference on power electronics was held. Specialists from all over the world reported in first publications on their latest products and applications thus giving an overview of the key technology development trends in power electronics. ABB was present with as much as six technical presentations which can be downloaded from our website at www.abb.com/semiconductors.

In addition to these technical conference presentations we also gave two commercial trade presentations at the forum in the exhibition hall. The first one was about our latest fast switching thyristors and its applications in induction heating and the second one was about our new 1,700 V SPT++ IGBT and diode chipset with a 175 °C full operation temperature. Both presentations, which attracted many visitors to attend and generated a great interest in ABB’s current and future products, can be downloaded from our website as well.

Young Engineer Award 2014

One of the conference highlights was when Vinoth Kumar Sundaramoorthy was honored by the members of the PCIM advisory board with the Young Engineer Award 2014. Vinoth is working as a Senior Scientist at the ABB Corporate Research Center in Dättwil since August 2008. He completed his PhD in Electrical Engineering from the University of Nottingham, UK in 2008. His research interests include design and characterization of silicon and wide bandgap semiconductor devices for power electronic applications. He was awarded with the Young Engineer Award for his paper entitled “Simultaneous Online Estimation of Junction Temperature and Current of IGBTs Using Emitter-Auxiliary Emitter Parasitic Inductance”. In this paper he presented a novel method for online estimation of the junction temperature (Tj) of semiconductor chips in IGBT modules. The method is based on the voltage drop (VVEE) across the parasitic inductor that exists between the main emitter (E) and auxiliary emitter (E) terminals. He found out that the peak amplitude of the voltage drop (VVEE) depends on the junction temperature at a known current and DC link voltage. He also showed that the collector current can be estimated simultaneously by integrating VVEE without the use of any additional sensors. In his work he implemented measurement circuits to estimate Tj and the current and discussed their results. (ch)
Innovation focus

Bipolar technologies

ABB is a technology and market leader in bipolar technologies which include a wide range of devices such as phase control thyristors (PCT), the integrated gate commutated thyristors (IGCT) and fast recovery and rectifier diodes. There is a long history of innovation in this field at ABB dating back to the 1950’s with continuous evolution since towards higher performance levels. As one of the first pioneers of high power thyristors, ABB continued the development trends for achieving higher power with increased voltage ratings up to 8,500 V. This was achieved in alignment with the gradual increase in wafer diameters up to today’s 150 mm PCTs for very high power line commutated high-voltage direct current (HVDC) systems with current ratings up to 4,200 A. Added functionalities were also developed with the introduction of the bi-directionally controlled thyristor (BCT) concept. Today, development efforts continue to further develop the PCT for increased power levels exceeding 6,000 A for 150 mm devices while future generations are also being developed targeting lower losses with further optimisation of the device cathode and bulk structures. ABB was also one of the first companies to pioneer the gate turn-off thyristor (GTO) which gained wide acceptance in traction voltage source converters (VSC) prior to the introduction of high power insulated gate bipolar transistor (IGBT) modules. Based on the GTO wafer, one of the main ABB innovations was the introduction of the IGCT concept in the 1990’s which enabled a wide range of applications to benefit from the IGCT’s low losses and hard switching capability especially in medium voltage drive applications. The IGCT continued on the path of innovation with development of the reverse conducting IGCT with the diode integration and, in 2007, the introduction of the high power technology (HPT) which enabled a wider safe operating area (SOA) with a 50 percent increase in turn-off current capability for devices rated up to 6,000 V. In the past 5 years, the IGCT technology has expanded to 10 kV with turn-off capabilities above 3,000 A for a 91 mm device. Furthermore, the 4,500 V 150 mm reverse conducting RC-IGCT was demonstrated with turn-off current capabilities exceeding 10 kA; a world record for a single discrete power semiconductor. For conduction loss reductions, the 1 V initiative for IGCTs targets modern multi-level VSC topologies operating at lower frequencies when compared to conventional 2-level and 3-level converters. The approach has been verified for 2.5 kV reverse blocking RB-IGCTs, 3,300 V RC-IGCTs and 4,500 V asymmetric IGCTs. Also, the recent successful demonstration of the bi-mode gate commutated thyristor (BGCT) rated at 4,500 V provides full IGCT/diode integration compared to the RC-IGCT for improved electrical and thermal performance. To match the improved IGCT performance, a new range of fast and soft recovery diodes with diameters up to 91 mm were developed with optimised designs and low temperature bonding technology resulting in a significant increase in diode robustness. Finally, a new range of enhanced rectifier diodes was recently introduced.

Application note

Surge currents for PCT

When using thyristors as protection elements, the peak current capability occasionally exceeds the datasheet’s specified maximum value. Accordingly, customers often ask “Where is the critical limit of the device?”, “How many times is it save to reach the specified maximum surge current?” etc. A clear knowledge of the critical surge current limits helps to optimize circuit designs, to sustain the required lifetime and to prevent unexpected failures. There are three different peak surge current limits:

1. **Destruction limit**
   The absolute maximum peak current capability is limited by the destruction limit of the thyristor. Operation already close to this limit may lead to permanent change in the device and should be limited to a very few times only in the thyristor’s lifetime.

2. **Electrical change limit**
   When staying below the second limit, no parameter drift, e.g. leakage current increase, is expected. However, due to intense thermal cycling a thermal fatigue effect still may occur when operated close to this limit.

3. **Reapplied voltage limit**
   Below the third limit the temperature of the semiconductor stays in a safe range and therefore allows for an immediately reapplied blocking voltage.

The surge current application note provides very valuable and helpful information in addition to the datasheet. Read more in SSYA 2102 “Surge currents for phase control thyristors” on www.abb.com/semiconductors.
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>
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<td>2,322 A</td>
<td>fast switching thyristor</td>
<td>H housing</td>
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<td>3,700 A</td>
<td>rectifier diode</td>
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<tr>
<td>SSD 55M5500</td>
<td>5,500 V</td>
<td>4,850 A</td>
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</tr>
<tr>
<td>SSNA 1500E25300</td>
<td>2,500 V</td>
<td>1,200 A</td>
<td>IGBT module</td>
<td>E housing</td>
</tr>
<tr>
<td>SSND 0500N33000</td>
<td>3,300 V</td>
<td>2x500 A</td>
<td>dual IGBT</td>
<td>N housing</td>
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</tbody>
</table>

Product features

2,000 V fast thyristors in H housing
- Special cathode pattern with amplifying gate structure and lifetime control enable to reach low turn-on and turn-off losses
- Low on-state voltage drop together with alloyed technology leads to excellent current rating
- Two optimised types: 2,700 A / 60 μs and 2,300 A / 40 us (I_{av}/t_{av})
- Target market: induction melting industry in 10 MW power range, pulse power and fast switching applications

5,500 V 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
- Target market: industry and traction

2,500 V HiPak2 single IGBT
- New 2,500 V IGBT with the latest SPT* in the improved HiPak housing, replacing the old SSNA 1200E250100 SPT module
- Up to 150 °C operation temperature for a very high power density
- Lowest loss 2,500 V IGBT module available on the market, ideally suited for demanding applications in traction, wind and industrial drives

Process change notifications

<table>
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<tr>
<th>PCN Nr.</th>
<th>Part Nr.</th>
<th>Subject</th>
<th>PCN issuing date</th>
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<td>IGBT 14-05</td>
<td>all 6,500 V IGBT dies</td>
<td>new Canon stepper, resist back end production line</td>
<td>22 Mar 2014</td>
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<td>PCT 14-03</td>
<td>SSTP 04D4200, SSTP 12F4200</td>
<td>back end production line</td>
<td>30 May 2014</td>
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New Application Engineer

We are pleased to announce the appointment of Vasilis Kappatos as new Application Engineer for ABB Semiconductors, effective April 1, 2014. He will support new design-ins by effectively cooperating with customers as well as providing first level support for them.

Vasilis holds a diploma in Electrical Engineering from the Polytechnic School of the University of Patras, Greece. He was working in the Photovoltaic Inverter industry as application engineer for the last 5 years.

Phased-out products
BiMOS and bipolar

<table>
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Obsolete products
BiMOS and bipolar

<table>
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<th>Replaced by</th>
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<tr>
<td>SSNA 1500E330300</td>
<td>5SNA 1500E330305</td>
</tr>
<tr>
<td>5SSG 0520P330300</td>
<td>5SSG 0520P330305</td>
</tr>
</tbody>
</table>

Lead time indicator

Compared to the values reported in March 2014, the lead times for PCTs, IGCTs, GTOs, StakPaks and dies remain short. For low power bipolar diodes and thyristors as well as for HiPaks, unfortunately, the lead times further increased due to the current market situation. For exact lead time information please contact your ABB Semiconductors sales contact or local distributor.
Simex – Trans Ltd. is a trade and engineering company, established in Bulgaria in 1995, with an experience of over 25 years in the railway and public electrical transport. “Simex – Trans” EOOD has its headquarter in Plovdiv and one subsidiary in Sofia, with a total of four professionals. The company is active in the following markets:

- Railway rolling stock, equipment and spare parts
- Spare parts for the public transport – trams and trolleybuses
- Materials for the railway infrastructure and tram lines
- Road building machines and spare parts
- Consultancy services in the fields of railway rolling stock and machine building

Simex – Trans Ltd. is the biggest distributor in the Bulgarian market of high power semiconductors. It has the certification and accreditation of the ISO 9001:2008. Some of the biggest clients are from electrical vehicles and Bulgarian energy companies.

Simex – Trans seeks for satisfying the specific needs of each customer. Our clients’ satisfaction and success is our prime goal. (st)

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Innovation focus
BiMOS technologies

During the 1990’s, ABB started research activities to develop insulated gate bipolar transistor (IGBT) and fast freewheeling diode technologies for a wide range of voltage source converter (VSC) applications in traction, industrial and grid systems. The accumulated in improved designs and technologies was moved to production in Lenzburg in 1998. The first IGBTs were employed in press-pack modules for ABB’s unique HVDC Light® systems at the time. Since, major ABB innovations took place with the introduction of the 1,200 V and 1,700 V SPT IGBTs on thin wafer technology. The save operating area (SOA) breakthrough, achieved in 2004 with the high voltage SPT range of IGBTs and diodes up to 6,500 V, enabled the expansion of the BiMOS product range for insulated modules targeting traction and industrial drive applications. In 2006, ABB’s enhanced planar EP-IGBTs or SPT® range enabled further loss reductions and higher SOA margins to compete with state-of-the-art trench IGBTs from other manufacturers. Since, the IGBT and diode technology platforms are continuously improved on many fronts. An increase of the operation junction temperature has been achieved up to 150 °C for 3,300 V rated devices with improved IGBT buffer and anode designs, diode lifetime control and low leakage junction terminations. An IGBT and diode single chip integration solution was developed referred to as the bi-mode insulated gate transistor (BIGT) to improve the power handling capability while promising a wide range of other advantages such as soft performance and increased reliability. ABB also continues to develop the standard two chip solution with lower losses and higher current ratings by introducing the next generation enhanced trench TSPT® IGBT and field charge extraction (FCE) diodes for very soft recovery performance. Future modules will be populated with either BIGT or TSPT®/FCE chips depending on the application requirements and target performance. Fast versions of IGBTs have also been demonstrated for special high frequency applications such as resonance DC/DC conversion or for combination with silicon carbide diodes in hybrid Si/SiC modules. For detailed information on SiC activities please refer to the newsletter September 2013 at www.abb.com/semiconductors, section Links and downloads. (mr)

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TSPT® cell cross section of next generation IGBTs.
Innovation focus
Packaging technologies

ABB introduced in the late 1990’s a wide range of innovative press-pack and insulated module concepts for insulated gate bipolar transistor (IGBT) and diode based applications such as high-voltage direct current (HVDC), traction and drives. The most innovative and unique solution is ABB’s StakPak concept developed originally for very high voltage IGBT stacks employed in ABB’s HVDC Light© and flexible alternating current systems (FACTS). The package has been designed for modular configuration with sub-modules having optimized pressure distribution through spring pins contacting all IGBT and diode chips in the StakPak. The StakPak is also designed with short circuit failure mode (SCFM) capability for withstanding very high fault currents in series connected devices. The latest StakPak employs the 4,500 V SPT+ IGBT and diode chipset with current ratings up to 3,000 A for the industrial version. For insulated modules, ABB’s industry standard HiPak range which was launched in 2004 with the SPT chipset was based on standard packaging processes in terms of joining and encapsulation processes albeit with optimum layout and terminal designs to achieve the best performance of the parallel chips with respect to controllability and high current capability. Since, a new improved HiPak module has been introduced with improved designs and processes for higher reliability and an improved manufacturing procedure. In parallel, next generation module process platforms have been developed including ultrasonic terminal to substrate joining, low temperature bonding for die attach to substrate and lead free soldering for the substrate on baseplate joining. Recently, a generation 2 HiPak module concept has been demonstrated with the newly developed processes, improved reliability performance and optimum module design with improved IGBT to diode area ratio compared to state-of-the-art HiPaks. Future package designs to accommodate next generation chip technologies with optimal configurations are currently on the drawing board to satisfy next generation power conversion requirements with respect to higher output power capabilities, lower losses and higher reliability. (mr)