No aluminum without power semiconductors

Aluminum, though it is the most abundant metal in the earth’s crust, it doesn’t occur naturally as a metal, but has formed compounds. One of the most common compounds is aluminum oxide (Al₂O₃) that is contained in large amounts as aluminum hydroxide (Al₂O₃·3H₂O) in an ore called bauxite. In the 1880s two important developments heralded the era of inexpensive aluminum: the invention of a process for obtaining aluminum from aluminum oxide (Charles M. Hall & Paul L. T. Héroult, 1886) and the invention of a new process that could cheaply obtain aluminum oxide from bauxite (Karl J. Bayer, 1888). The Hall-Héroult and Bayer processes are still used today to produce nearly all of the world’s aluminum. Bauxite is refined into alumina, which then becomes aluminum in an electrolytic reduction process known as smelting. Alumina is dissolved in a molten cryolite bath inside large, carbon-lined cells called pots. When a high electric current of tens to hundreds of kiloamps is passed through the bath, aluminum metal separates from the chemical solution, is deposited at the bottom of the pots and periodically siphoned off. The primary aluminum smelter process requires reliable, highly efficient DC power supplies and continuous availability is essential for a successful smelter operation. ABB offers state-of-the-art diode and thyristor rectifiers with a proven high reliability and performance in trouble-free operation for more than 25 years. Read more in the dedicated product, technology and application focus articles on pages 2 and 3.
Welcome to the 10th ABB Semiconductors Newsletter and the first issue of the year. In December 2011 we published the first newsletter as a response to our distributors’ request at the international sales meeting in Giessbach, Switzerland, to provide regular news updates. Along with the latest product and company updates every newsletter is devoted to a focus subject. The corresponding ‘Product, Technology and Application in focus’ articles in this newsletter feature our latest alloyed four inch rectifier diodes which are perfectly suited for aluminum smelting applications.

In just two months it will be PCIM Europe in Nuremberg, Germany. We will be there and love to welcome you at our booth in hall 9, stand 203, same as last year, right by the entrance of the exhibition. Besides our latest product highlights, we will also present a number of technical papers at the PCIM conference and two new product presentations in the Exhibition Forum. For your convenience, an entry voucher, the program and the exhibition floor plan is at your disposal on our website www.abb.com/semiconductors.

Last but not least don’t miss the opportunity of having a drink together at our booth party on Tuesday evening 5 pm.

Yours, Christoph Holtmann

Christoph Holtmann
PG Communications Manager

Application in focus
High power rectifiers

High Power Rectifiers are used for electrolysis applications demanding high DC current like aluminum smelters, copper winning and chlorine production. In addition they are used for DC arc furnace applications in the steel, ferronickel and ferrochrome industries. The typical DC current per rectifier unit goes from 20 kA to 150 kA and the voltage ranges from some 10 V to 2,000 V. When even higher DC current is needed, eg for aluminum smelters where today 500 kA dc or more is required, parallel unit connection is applied.

There are basically two types of power semiconductors used for high power rectifiers: diodes and thyristors. The reasons are the high current carrying capability, good reliability and high efficiency of these components. The semiconductors are connected in parallel depending on the DC current and voltage demand. There is always a fuse connected in series with a semiconductor to enable redundant semiconductor operation and housing rupture protection.

The rectifier topology normally used is a six pulse bridge connection. At lower voltage applications, an inter phase transformer (IPT) setup is the topology of choice. Although the IPT topology makes use of an additional reactor, it reduces the losses significantly.

An integral part of the high power rectifier system is a step down transformer, the rectifier transformer. The transformer has to be arranged as close as possible to the rectifier frame to reduce bus bar losses and to allow for a high power factor. Depending on the given harmonic limits of the utility’s grid, additional harmonic filters might be needed. They have to be designed to fulfill harmonic guidelines (eg IEEE 519 standard) and increase the power factor. Filters are connected either directly to the grid or to the tertiary winding of the rectifier transformer.

New Product Manager bipolar

We are pleased to announce the appointment of Christian Winter as Product Manager bipolar for ABB Semiconductors, effective February 1, 2014. Christian holds a degree in electrical engineering and an EMBA from University of Applied Sciences and Arts, Northwestern Switzerland. He joined ABB in 2000 and has since 2006 been Head of Systems Engineering for High Power Rectifiers in Turgi.

We wish Christian success and fulfillment in his new role.
Technology in focus
Alloying large wafers

There are two main power semiconductor press-pack packaging technologies – free floating silicon technology and alloyed silicon technology. In free floating technology the silicon wafer is pressed between molybdenum discs when the mounting force is applied to the hermetically sealed copper-ceramic housing. In alloyed silicon technology, by contrast, one of these molybdenum plates is alloyed to the silicon wafer. There are several advantages of the alloyed silicon technology compared to the free floating technology like an improved mechanical stability, the molybdenum electrode serving as an energy absorber and, in particular, a better silicon cooling especially at the edge of the wafer. The device overall is slightly more robust in terms of electrical parameters compared to its free floating counterpart.

While the alloying technology yields some advantages in comparison with the free floating technology, it may be slightly less resistant to thermal load cycling due to the possible change in flatness caused by alloying. Reliability, however, has been proven. In a typical application of alloyed welding diodes, i.e., spot welding in the automotive industry, the welding diode is exposed to extensive thermal cycling and the devices are typically qualified to withstand at least 10 million cycles.

The alloying technology – normally done at temperatures above 600 °C – works well on smaller devices, but was limited to 3 inch wafers for the mentioned mechanical reasons. By means of modified temperature profiles, tooling and solder material, we managed to develop a 4 inch alloying process. Taking advantage of this improved high temperature alloying technology we now proudly launch our L- and M-housing rectifier diodes (see “Product in Focus” on page 3) which offer an electrical performance similar to our free floating N-housing diodes.

Product in focus
Enhanced rectifier diodes

The oldest and widest spread type of converters is the rectifier with the rectifier diode as key element. ABB is producing diodes for sixty years and we briefly highlight in this “product in focus” our latest development: the enhanced rectifier diode.

When talking to customers, there is always the wish and need for power-electronic components being either smaller in physical size but still offering the same power or being of the same size but offering a higher power. In other words, there is the wish for increased power density. Directly alloying the silicon wafer on the molybdenum disk is a technology that allows for a decreased thermal resistance ($R_{thjc}$) and thus an increased power density. Although this technology offers several performance benefits, high voltage rectifier diodes still feature the free floating packaging technology due to the challenges of alloying large areas. ABB’s alloyed rectifier diode portfolio, which was limited to 76 millimeter silicon diameters is now expanded to 5.5 kV diodes with a silicon wafer of 91 millimeter and an external contact area diameter of 85 millimeter. Two options are offered: one diode in an M-housing with a height of 35 millimeters (5SDD 50M5500) and one in an L-housing with a height of 26 millimeter (5SDD 55L5500). The M-diode features a higher creepage distance which becomes more important in dusty industrial areas like production of aluminum by electrolytic smelting or other heavy metal industries.

The most important diode parameters are an extremely low forward voltage drop ($1.33 \text{ V} @ 5 \text{ kA}, 150 ^\circ \text{C}$), the capability to operate up to $150 ^\circ \text{C} (T_{jmax})$ and the high surge current capability ($67.5 \text{ kA} @ 10 \text{ ms}, 150 ^\circ \text{C}$). The diodes allow for more compact rectifier designs due to reduced diode sizes and they offer reduced clamping force requirements due to smaller diode diameters as well as reduced cooling requirements due to lower diode losses.

High-temperature alloyed 5.5 kV rectifier diode (5SDD 55L5500) with the corresponding 91 mm wafer.
### Products in the pipeline

#### BiMOS and bipolar

**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

**3,300 V 2x500 A dual IGBT**
- Two in one package IGBT module for low inductive phase-leg designs, fully exploiting the benefits of the fast low-loss SPT+ chip set
- Large clearance and creepage distance for operation in at least pollution degree 2 environment
- Based on the improved HiPak platform with $T_{j,op} = 150 \, ^\circ \text{C}$ and compliance with latest fire and smoke standards
- Target market: ideally suited for multi-level SVC/HVDC, medium voltage drives and traction main- and auxiliary converters

**2,500 V 1,500 A HiPak2 single IGBT**
- New 2,500 V IGBT with the latest SPT+ in the improved HiPak housing
- Up to 150 °C operation temperature for a very high power density
- Lowest loss 2,500 V HiPak, ideally suited for demanding applications in traction, wind-power and industrial drives

**2,000 V fast thyristors in H housing**
- Special cathode pattern with amplifying gate structure and life time 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 us and 2,300 A / 40 us ($I_{TAV}/\tau_q$)
- Target market: induction melting industry in 10 MW power range, pulse power and fast switching applications

### Phased-out products

#### BiMOS and bipolar

**5,500 V 5,370 A rectifier diode**
- L housing
- Samples: contact factory

**5,500 V 4,850 A rectifier diode**
- M housing
- Samples: contact factory

**2,000 V 2,322 A fast switching thyristor**
- H housing
- Samples: contact factory

**2,000 V 2,867 A fast switching thyristor**
- H housing
- Samples: contact factory

**2,500 V 1,500 A single IGBT**
- E housing
- Available

**3,300 V 2 x 500 A dual IGBT**
- N housing
- Available

### Product time features

**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

**3,300 V 2x500 A dual IGBT**
- Two in one package IGBT module for low inductive phase-leg designs, fully exploiting the benefits of the fast low-loss SPT+ chip set
- Large clearance and creepage distance for operation in at least pollution degree 2 environment
- Based on the improved HiPak platform with $T_{j,op} = 150 \, ^\circ \text{C}$ and compliance with latest fire and smoke standards
- Target market: ideally suited for multi-level SVC/HVDC, medium voltage drives and traction main- and auxiliary converters

**2,500 V 1,500 A HiPak2 single IGBT**
- New 2,500 V IGBT with the latest SPT+ in the improved HiPak housing
- Up to 150 °C operation temperature for a very high power density
- Lowest loss 2,500 V HiPak, ideally suited for demanding applications in traction, wind-power and industrial drives

**2,000 V fast thyristors in H housing**
- Special cathode pattern with amplifying gate structure and life time 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 us and 2,300 A / 40 us ($I_{TAV}/\tau_q$)
- Target market: induction melting industry in 10 MW power range, pulse power and fast switching applications

### Lead time indicator

The table below shows ABB Semiconductors’ approximate current lead times (Prague & Lenzburg facilities). Compared to the values reported in December 2013, IGCTs, GTOs, Diodes, StakPaks and Dies remain short. For Medium Frequency and Fast Switching Thyristors the lead times increased slightly and for HiPaks the lead times remain long (for HiPak sampling quantities please contact the factory).

For exact lead time information please contact your ABB Semiconductors sales contact or our local distributor. The detailed Lead Time Indicator was sent to our official distributors a few days ago.

- **PCTs**
  - 3 – 4 weeks*
- **Medium frequency & fast thyristors**
  - 10 – 12 weeks*
- **IGCT & snubber diodes**
  - 3 – 4 weeks*
- **Welding diodes**
  - 9 – 10 weeks*
- **other diode**
  - 6 – 10 weeks*
- **IGCTs**
  - 4 – 5 weeks*
- **GTOs**
  - 4 – 6 weeks*
- **HiPaks**
  - 14 – 20 weeks*
  - (sampling quantities: contact factory)
- **StakPaks**
  - 10 – 12 weeks*
- **IGBT & diode dies**
  - 2 – 10 weeks*

*) The lead times above are estimates and are not guaranteed. For exact lead times, please contact your ABB Semiconductors sales contact or our local distributor.

---

### Obsolete products

#### BiMOS and bipolar

<table>
<thead>
<tr>
<th>Material</th>
<th>Last deliveries</th>
</tr>
</thead>
<tbody>
<tr>
<td>5SNA 1200E250100</td>
<td>Okt. 2014</td>
</tr>
</tbody>
</table>

### Lead time indicator

The table below shows ABB Semiconductors’ approximate current lead times (Prague & Lenzburg facilities). Compared to the values reported in December 2013, IGCTs, GTOs, Diodes, StakPaks and Dies remain short. For Medium Frequency and Fast Switching Thyristors the lead times increased slightly and for HiPaks the lead times remain long (for HiPak sampling quantities please contact the factory).

For exact lead time information please contact your ABB Semiconductors sales contact or our local distributor. The detailed Lead Time Indicator was sent to our official distributors a few days ago.

- **PCTs**
  - 3 – 4 weeks*
- **Medium frequency & fast thyristors**
  - 10 – 12 weeks*
- **IGCT & snubber diodes**
  - 3 – 4 weeks*
- **Welding diodes**
  - 9 – 10 weeks*
- **other diode**
  - 6 – 10 weeks*
- **IGCTs**
  - 4 – 5 weeks*
- **GTOs**
  - 4 – 6 weeks*
- **HiPaks**
  - 14 – 20 weeks*
  - (sampling quantities: contact factory)
- **StakPaks**
  - 10 – 12 weeks*
- **IGBT & diode dies**
  - 2 – 10 weeks*

*) The lead times above are estimates and are not guaranteed. For exact lead times, please contact your ABB Semiconductors sales contact or our local distributor.

---

<table>
<thead>
<tr>
<th>Part Nr.</th>
<th>Voltage</th>
<th>Current</th>
<th>Configuration</th>
<th>Housing</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>5SDD 55L5500</td>
<td>5,500 V</td>
<td>5,370 A</td>
<td>rectifier diode</td>
<td>L housing</td>
<td>contact factory</td>
</tr>
<tr>
<td>5SDD 55M5500</td>
<td>5,500 V</td>
<td>4,850 A</td>
<td>rectifier diode</td>
<td>M housing</td>
<td>contact factory</td>
</tr>
<tr>
<td>5STF 23H2040</td>
<td>2,000 V</td>
<td>2,322 A</td>
<td>fast switching thyristor</td>
<td>H housing</td>
<td>contact factory</td>
</tr>
<tr>
<td>5STF 28H2060</td>
<td>2,000 V</td>
<td>2,667 A</td>
<td>fast switching thyristor</td>
<td>H housing</td>
<td>contact factory</td>
</tr>
<tr>
<td>5SND 0500N330305</td>
<td>3,300 V</td>
<td>2 x 500 A</td>
<td>dual IGBT</td>
<td>N housing</td>
<td>available</td>
</tr>
</tbody>
</table>

---

**Phased-out products**

#### BiMOS and bipolar

**BiMOS and bipolar**

**Material** | **Last deliveries**
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5SNA 1200E250100</td>
<td>Okt. 2014</td>
</tr>
</tbody>
</table>

**Obsolete products**

#### BiMOS and bipolar

<table>
<thead>
<tr>
<th>Material</th>
<th>Replaced by</th>
</tr>
</thead>
<tbody>
<tr>
<td>5SSNG 0250P30300</td>
<td>5SSNG 0250P30305</td>
</tr>
<tr>
<td>5SSHY 35L4512</td>
<td>5SSHY 35L4522</td>
</tr>
</tbody>
</table>
Ibérica Semiconductores de Potencia S.L. (ISP) was established in Spain in 2004, by a highly qualified team of experts with experience of over 15 years in the power electronics market. ISP has its headquarter in Madrid, two subsidiaries in Tarragona and San Sebastian and a network of professionals with a total of 11 employees.

ISP is the distributor of world leading power-electronic component manufacturers and provides integrated solutions to the energy control, traction, renewables and industry market. Our key accounts include: CAF, Ingeteam Group, GPtech, Power Electronics and GAMESA.

The offered services comprise the exploration and identification of the most suitable power components for the customer's projects, professional project assistance, execution and timely supply of components.

Providing solutions to the power electronics community means for ISP to
− offer expert knowledge
− evaluate and propose ideal partners enabling most innovative technology solutions
− enable most efficient supply at reduced cost and time.

Ibérica Semiconductores de Potencia S.L. has the certification and accreditation of the UNE-ISO 9001 by the Madrid Chamber of Commerce.

The mission of ISP’s technical engineers and sales team is to meet the specific needs of each customer.

Satisfaction and success of our client is our prime goal: “Your success guarantees ours”.

### New qualified products

**BiMOS and bipolar**

<table>
<thead>
<tr>
<th>Part Nr.</th>
<th>Voltage</th>
<th>Current</th>
<th>Configuration</th>
<th>Housing</th>
</tr>
</thead>
<tbody>
<tr>
<td>5STP 42L1800</td>
<td>1,800 V</td>
<td>4,170 A</td>
<td>Phase control thyristor</td>
<td>L housing</td>
</tr>
<tr>
<td>5SLZ 12J1700</td>
<td>1,700 V</td>
<td>150 A</td>
<td>Diode die 10.1x10.1mm²</td>
<td>J-size</td>
</tr>
<tr>
<td>5SMY 12M1730</td>
<td>1,700 V</td>
<td>150 A</td>
<td>IGBT die 13.6x13.6mm²</td>
<td>M-size</td>
</tr>
<tr>
<td>5SLG 0500P330300</td>
<td>3,300 V</td>
<td>2x500 A</td>
<td>diode phase-leg</td>
<td>P housing</td>
</tr>
<tr>
<td>5SLG 0600P450300</td>
<td>4,500 V</td>
<td>2x600 A</td>
<td>Diode phase-leg</td>
<td>P housing</td>
</tr>
</tbody>
</table>

### Product features

**3,300 and 4,500 V HiPak 0 diodes**

− new two-in-one package diode modules complete the line-up for HiPak0 IGBT modules
− Target market: the new diodes can be used as neutral point clamp diodes in 3 level inverters allowing a very compact solution for medium voltage converters

**1,700 V IGBT die**

− First 1,700 V IGBT-Diode chipset with $T_{jmax}$ up to 175 °C!
− Chip size allows efficient de-heating and highest output power per rated amp
− Target market: fast switching chip-set, ideally suited for low to medium power IGBT modules

### Process change notifications

<table>
<thead>
<tr>
<th>PCN Nr.</th>
<th>Part Nr.</th>
<th>Subject</th>
<th>Deadline for acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGBT 13-11</td>
<td>SSNA 1200E330100</td>
<td>Improved HiPak package</td>
<td>January 2014</td>
</tr>
<tr>
<td>IGBT 13-12</td>
<td>HIpak E-housings</td>
<td>Improved HiPak package</td>
<td>January 2014</td>
</tr>
<tr>
<td>IGBT 13-13</td>
<td>HIpak M- and N- housings</td>
<td>Improved HiPak package</td>
<td>January 2014</td>
</tr>
<tr>
<td>IGBT 14-01</td>
<td>HIpak, G-, J-, P-housings</td>
<td>new terminal supplier</td>
<td>February 2014</td>
</tr>
<tr>
<td>IGBT 14-02</td>
<td>5SMY 75M1280, 5SMY 86M1290</td>
<td>new wafer layout</td>
<td>March 2014</td>
</tr>
<tr>
<td>IGBT 14-03</td>
<td>HIpak E-housing</td>
<td>improved housing cover</td>
<td>March 2014</td>
</tr>
<tr>
<td>IGBT 14-04</td>
<td>5SMY 75J1280, 5SMY 86J1280</td>
<td>new wafer layout</td>
<td>April 2014</td>
</tr>
<tr>
<td>PCT 13-04</td>
<td>PC Ts</td>
<td>additional molybdenum supplier</td>
<td>February 2014</td>
</tr>
<tr>
<td>PCT 14-01</td>
<td>PC Ts</td>
<td>new gate lead supplier</td>
<td>March 2014</td>
</tr>
<tr>
<td>PCT 14-02</td>
<td>PC Ts</td>
<td>back end production line</td>
<td>April 2014</td>
</tr>
<tr>
<td>GTO 14-01</td>
<td>GTOs</td>
<td>new gate lead supplier</td>
<td>March 2014</td>
</tr>
</tbody>
</table>
ABBB Semiconductors at PCIM Europe
20-22 May 2014, Nuremberg

Technical papers to be presented:
Tues. 20th May, 11:30,
Room München 1
“New thyristor platform for UHVDC (>1 MV) transmission”,
Prof. Dr. Jan Vobecky

Tues. 20th May, 15:30,
Poster Session
“Reliability improvement of large area soldering connections by antimony containing lead-free solder”,
Dr. Harald Beyer

Wed. 21st May, 11:00,
Room Athen
“Resolving design trade-offs with the BIGT concept”,
Dr. Liutauras Storasta

Wed. 21st May, 14:30,
Room München 1
“Packaging technology platform for next generation high power IGBT modules”,
Dr. Samuel Hartmann

New Product Presentations:
Tues. 20th May, 15:40-16:00,
in the Exhibition Forum
“Improved performance of fast switching thyristors for induction heating”,
Ladislav Radvan

Thurs. 22nd May, 14:00-14:20,
in the Exhibition Forum
“The hottest 1,700 volt IGBT-diode chipset”,
Raffael Schnell

We look forward to seeing you in Nuremberg in the Hall 9, Stand 203!

Publications calendar

− Bodo’s Power Systems, September 2013
  “ABB IGCTs: Benchmark performance with developments on many fronts”
− Power Electronic Europe, September 2013
  “Improved HiPak modules from ABB for power electronic applications”
− Power Electronic Europe, December 2013
  “Quality test systems for high power semiconductors”
− New product flyers to be released in April 2014
− Bodo’s Power Systems, May 2014
  “Record performance with IGCTs, cool”

For more information please contact:

ABB Switzerland Ltd.
Semiconductors
Fabrikstrasse 3
5600 Lenzburg, Switzerland
Phone: +41 58 586 1419
Fax: +41 58 586 1306
E-Mail: abbsem@ch.abb.com

www.abb.com/semiconductors

Note
We reserve all rights in this document and in the subject matter and illustrations contained therein.
Any reproduction, disclosure to third parties or utilization of its contents – in whole or in parts – is forbidden without prior written consent of ABB AG.
Copyright © 2014 ABB
All rights reserved