

## A new RC-IGCT platform

ABB Semiconductors has developed a new technology platform for Reverse Conducting Integrated Gate Turn-off Thyristor (RC-IGCT) in two voltage levels, 4,500 V and 6,500 V.

The devices are optimized for the use in applications like industrial medium voltage drives (MVD), wind-power conversion, STATCOMs, power quality and railway interties, to name a few. The main advantages are the very low on-state losses provided by the thyristor structure, the negligible turn-on losses in the semiconductor and the high reliability of the devices.

The technology supports profound changes to the gate circuit, enabling much improved turn-off currents. Additionally, the HPT<sup>+</sup> IGCT cell leads to increased performance at high junction temperatures. The changes to the package led to a great reduction of the

thermal resistance as well as the inherent capacity for handling surge currents. The gate circuit impedance contact was moved to the periphery of the device for a greater area consumption and the centering tolerance of the gate contact on the wafer was much improved. Thus, despite the new contact has a larger diameter, the space consumption for the gate infrastructure could be reduced instead of increased.

The behaviour of the device at low forward current and high cell voltage over the whole temperature range is important. The switching behaviour can be improved by the increase of the diode thickness. Additionally, it is particularly important for RC-IGCTs to optimise the diode thickness due to the integration of the switch and the diode on the same silicon wafer. (continued on page 2)

### Highlights

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## Editorial

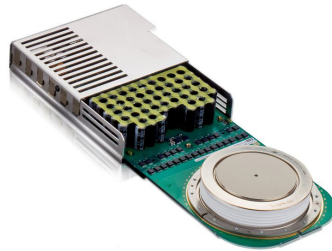
Dear reader!

Let's start with the article on page 5 and say Ni Hao instead of Guten Morgen – it was about time that Semiconductors also exhibited at PCIM Asia in Shanghai, the sister exhibition of PCIM Europe in Nuremberg! It was a great opportunity to be even closer to the Asian market, discuss with our customers locally and enjoy some Chinese specialties. In exchange, our visitors got the chance to taste the famous Swiss chocolate in the form of a LinPak. Speaking of our new BiMOS product: By the design freeze, we have reached another milestone in the development of the LinPak (page 2)! The cover story, however, is dedicated to our new technology platform for reverse conducting IGCTs. A summary on all products in the pipeline can be found on page 4. And don't forget to go to page 5 and read our application note about IGBT diode safe operating area. In our last article of our series about failure analysis techniques, we present the Scanning Electron Microscope on page 3, a powerful tool to make dimensions of less than 1 micrometer visible. On the same page, focusing on our Eastern European Distributors, we invite for the sales meeting at our location in Prague and present a preliminary program. Staying with good news about Eastern Europe, have a look at our success story from our colleagues in Prague about our welding diodes on page 6.

Going back to Asia, we are happy to announce that our collaboration with our long-term distribution partner in Japan after the merge of NIEC to KYOCERA continues. The full announcement can be read on page 5. In that sense, enjoy the last warm days in fall (at least in the northern hemisphere) and I close in Swiss German: En schöne Herbst!

Yours, Katja Fröhlich  
Marketing Communications

## A new RC-IGCT platform (cont. from cover page)



In summary, the improvements in wafer technology such as gate circuit impedance and removing thermal bottlenecks, the IGCT performance was improved significantly without increasing the size of the IGCT part.

The new device can be applied for a wide range of applications. An example for the use of the device platform is a Static Compensator (STATCOM) using Multilevel Converter topology (MMC) covering wide range of applications like industry, utility, rail-intertie and renewable applications in the range of 100 MVar. The device was regarded as optimal solution for this topology due to significant efficiency improvement compared to an IGBT option.

The picture on page 1 shows a Power-Electronic Building Block for STATCOM application containing MMC cells with RC-IGCTs. **(tw, cw)**

## LinPak design freeze



On September 9<sup>th</sup> 2016, an important milestone for our new product was reached: The first LinPak rating, the 1,700 V / 2 x 1,000 A module successfully passed our internal Gate4. Thus, the external and internal design of the LinPak is frozen and verified and we can provide engineering samples with the final design. A preliminary data sheet will be available in the soon.

In a next step the 1,700 V LinPak undergoes the qualification process. The final production release is planned in Q1 2017.

Also beginning of September Gate3 for the 3,300 V / 2 x 450 A LinPak was passed successfully. The final verification will be started and limited sampling for the 3,300 V version will be available in Q4 2016. The final release of the 3,300 V LinPak is planned for Q2 2017. **(rs)**

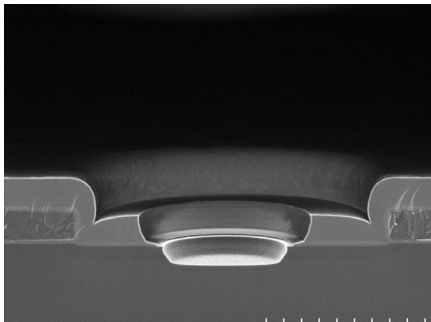
## Product change notifications BiMOS and bipolar

PCN nr.	Part nr.	Subject	PCN issuing date
IGBT 16-09	All StakPak modules	improved gate-wire bond connection	May 2016
IGBT 16-10	5SNA 3000K452300	2 <sup>nd</sup> source suppliers for housing materials and improved IOL	August 2016

## Special: Scanning Electron Microscopy (SEM)

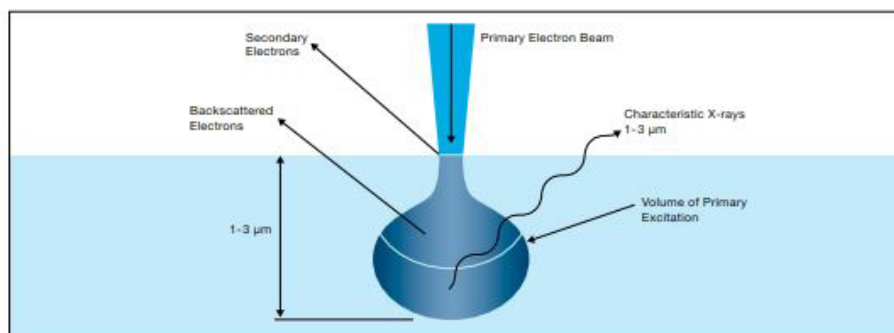
Following on from the information in the last Newsletter about some techniques used in Failure Analysis (Spreading Resistance, Surface Profilometry, and Hot Spot Measurements), here we present maybe the most important technique in semiconductor analysis: the Scanning Electron Microscopy (SEM).

Optical microscopes are limited to a magnification of about 1000x. However, the analysis of semiconductor devices requires the investigation of very small structures with dimensions of less than 1 micrometer. Therefore a microscope capable of much higher magnification is needed. A scanning electron microscope (SEM) uses a focused electron beam to create images of a sample's surface, providing magnification of up to about 200,000x. An example of the 10,000x magnification of a cell is shown in the picture below:



IGBT cell – SEM

The diagram below shows how the primary electron beam interacts with the material leading to different responses. Secondary electrons can be collected which come from only the top 100 nanometers of the sample, these then give information about the topography of the surface. Backscattered electrons

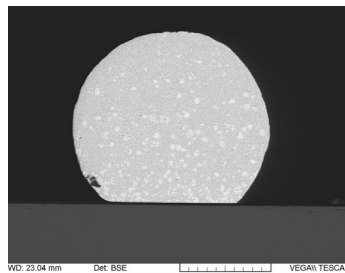


SEM / EDX technique

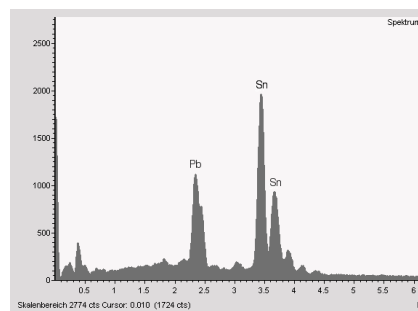
interact with the sample up to a depth of a few microns, and their energy reflects the material composition. In a backscatter image, heavier elements appear brighter than lighter elements.

### Energy Dispersive X-Ray Spectroscopy (EDX)

Energy Dispersive X-Ray Spectroscopy (EDX) is an analytical technique for element identification using the characteristic X-rays given off by a sample during SEM investigation.



Cross-section of a solder ball on a chip



EDX-spectrum of the solder ball on the left

The detected X-rays can be displayed on a spectrum as above, each element has a known pattern of peaks, so it is possible to identify the materials present, in this case lead (Pb) and tin (Sn), confirming that the structure seen in SEM is a solder ball. **(cl, tg, an)**

## Eastern European Distributors' Sales Meeting

On 26-27 October 2016, we welcome our Eastern European Distributors for a two-days Sales Meeting in Prague, Czech Republic. We expect about 15 people from the distributors side and 8 from ABB side to attend.

After a general introduction, individual meetings and an excursion on the first day, the second day includes presentations and discussions:

- Overview PG Semiconductors
- Update from the market and forecast
- Bipolar and BiMOS product update, Roadmap 2017
- Distributors presentations

We look forward to meeting all Eastern European Distributors at this special event! **(kf)**

## Publications calendar

- Power semiconductors product brochure, April 2016
- Power Semiconductors' product catalog in Chinese, April 2016
- Bodo's Power Systems Europe and China, May and June 2016 respectively, "Recent advancements in IGCT technologies for high power electronics applications"
- Bodo's Power Systems Europe and China, July and September 2016 respectively, "LinPak, the new standard expands to 3,300 V and shows excellent parallel operation as well as SiC readiness"
- Bodo's Power Systems, November 2016 "A new RC-IGCT platform"

All published publications are available for download on [www.abb.com/semiconductors](http://www.abb.com/semiconductors).

## Products in the pipeline BiMOS and bipolar

Part nr.	Voltage	Current	Description	Housing
5SNG 0450R170300	1,700 V	2 x 450 A	LoPak1: low profile phase leg module	LoPak1
5SNG 1000X170300	1,700 V	2 x 1,000 A	LinPak: ultra low inductive phase leg module	LinPak
5SED 0520S2240	2,200 V	450 A	dual diode module in 50 mm standard package	50Pak
5SED 0890T2240	2,200 V	890 A	dual diode module in 60 mm standard package	60Pak
5SED 0480T6040	6,000 V	480 A	dual diode module in 60 mm standard package	60Pak
5STP 27N8500	8,500 V	2,450 A	phase control thyristor	N
5STP 27Q8500	8,500 V	2,630 A	phase control thyristor	Q
5STP 45Y8500	8,500 V	4,260 A	phase control thyristor	Y

## Product features

### 1,700 V / 2 x 450 A LoPak1

- Industry standard compatible, compact and low-profile phase leg module with copper baseplate
- Excellent switching behavior
- 1,700 V SPT++ chipset featuring lowest losses and highest ruggedness up to 175 °C operation temperature
- Production ramp-up scheduled for 2<sup>nd</sup> half of 2017

### 1,700 V / 2 x 1,000 A LinPak

- Ultra low inductive module for fast low-loss IGBT/diode chipsets
- Modular thanks to easy paralleling with negligible derating
- 1,700 V SPT++ chipset featuring lowest losses and highest ruggedness up to 175 °C operation temperature
- Production start scheduled for Q1 2017

### 2,200 V and 6,000 V dual diode modules

- Pressure contact technology modules with the highest reliability and quality in terms of power cycling capabilities
- Insulated baseplate with aluminum nitride ceramic achieves excellent heat transfer and high insulation voltage

### 8,500 V phase control thyristor

- Latest high performance thyristor generation, developed with focus on minimizing the losses and maximizing the power rating
- Addressing demanding high-end industrial applications as pumped hydro, drives and SVC

## New qualified products BiMOS and bipolar

Part nr.	Voltage	Current	Description	Housing
5STP 48Y7200	7,200 V	4,840 A	phase control thyristor	Y

## Product features

### 7,200 V phase control thyristor

- Latest high performance thyristor generation, developed with focus on minimizing the losses and maximizing the power rating
- Addressing demanding high-end industrial applications as pumped hydro, drives and SVC

## A new era with our long-term distribution partner in Japan



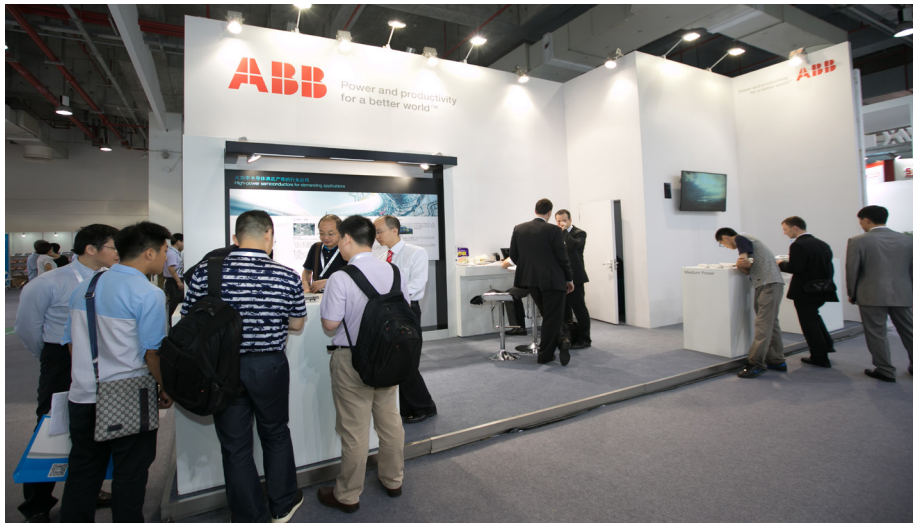
The 20+ year business relationship between Nihon Inter Electronics Corporation (NIEC) and ABB Semiconductors enters a new era. As of August 1, 2016, NIEC has fully merged into KYOCERA Corporation and publically traded shares of NIEC have become delisted from the Tokyo Stock Exchange, Inc.

The respective boards of directors agreed last May to merge NIEC into KYOCERA Corporation (“KYOCERA”). The former NIEC is now organized within Kyocera Corporation as “Corporate Functional Devices Group.”

KYOCERA determined that sharing its knowledge regarding various business domains from the components business to the finished product business and NIEC’s knowledge regarding power semiconductors will enhance the company value. The new circumstances will allow the new addition to KYOCERA to focus on expanding their businesses from the resulting synergy effects. In particular the Corporate Functional Devices Group will be part of a 14.5 MUSD international company with over 69,000 employees allowing it new chances to pursue growth and expand its market reach.

ABB looks forward to increasing the business relationship with KYOCERA as distribution partner in Japan. Our distribution partner is unique in that it engages in the manufacturing and distribution of power semiconductors within the discrete, module and product businesses along with the distribution of ABB’s high power product portfolio. **(rd)**

## ABB Semiconductors at PCIM Asia 2016



PCIM Asia, the sister exhibition of PCIM Europe, the largest and most comprehensive show in the field of power electronic components and applications industry, focuses on the Asian market and visitors. It takes place every year in Shanghai, China, where the latest products and solutions are shown and visitors can gauge industrial trends and explore business opportunities.

As an integral part of the exhibition, the technical conference is an important get-together for industry experts and academia to present and challenge each other over the next generations of power semiconductor technologies and systems with ever-increasing demand. ABB Semiconductors has, for the first time, officially exhibited at PCIM Asia, which has strengthened our market position in Asia to be among technology and product leaders in the very high power segment. Our booth attracted many visitors to have a closer look at our displayed products and technical discussions with our experts.

One of the highlights was the new ABB BiGT StakPak 4,500 V / 3,000 A, launched in time for Multi-GW VSC-HVDC with higher diode surge current. The 1,700 V 62Pak, the pioneer product of ABB's medium power series, positively surprised visitors with its SPT++ chipset featured with  $T_{vj}=175\text{ }^{\circ}\text{C}$ , offering higher transient overload capability. The interest for LoPak (1,200 V and 1,700 V) with similar performance was also evident.

ABB's 6" thyristor on the other hand, rated with up to 8,500 V / up to

6,250 A, reassured visitors that we continue to lead in the bipolar technology. 4,500 V IGCT, promoted as low losses & high reliability high power device, invited visitors to express design challenge and to inquire on the development of 6" IGCT for potential HVDC application.

Our new product, the 1,700 V LinPak has been well launched with three clear messages: low stray inductance, suited for paralleling and one footprint for all. The LinPak Stack, on display at Sunking's booth back to back to ours, served to convince the customers of the design simplicity offered by LinPak.

Semiconductors was not only present at the exhibition, but also contributed with technical expertise with 5 presentations and one private seminar to the conference. The seminar about the StakPak received active response, just in time to enhance ABB's position in the current Chinese VSC-HVDC quest.

As a highlight of the conference, our paper on the next generation high voltage package and IGBT/diode technologies, featuring state of the art module design adopted for LinPak and ABB's new generation Enhanced Trench chip technology (TSPT+) has been awarded with the "Best Paper Award".

In an industrial session, ABB was invited to deliver a key note speech on development of power semiconductors for high power applications with focus placed reliability and solution for higher power rating. **(mc)**

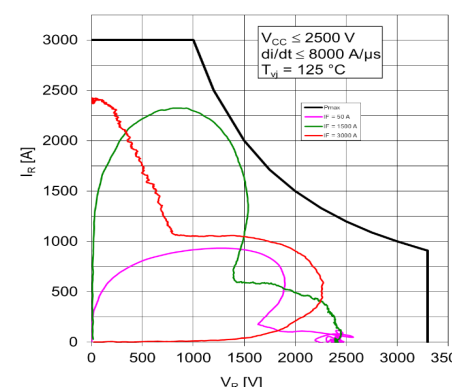
## Application note IGBT diode safe operating area (SOA)

Most of the IGBT applications require a reverse conduction mode, i.e. the IGBT should be accompanied by an antiparallel diode for bi-directional conduction, also called a freewheeling diode (FWD) or fast recovery diode (FRD). The rapid development of IGBTs in recent years led to the expansion of reverse blocking SOA, which also increased the demand for complementary robust diodes. The complementary diode has to match the active switching component and must fulfill the same or even higher SOA boundaries. This application note (5SYA 2057) describes the diode parameters listed in the IGBT or diode module data sheets.

The following topics are emphasized:

- the power diode design principles, explanation of On-state / Turn-off loss trade-off parameter deviation
- the chip paralleling issues
- the importance of the diode forward recovery specially when discrete diode modules are applied
- the diode SOA limitation factors
- the data sheet SOA definitions and graph explanation
- the high di/dt limitation
- the peak power failure, influence of  $I_F$ ,  $V_{CC}$ ,  $R_G$ ,  $C_{ge}$  clamp
- the low current snap-off

We strongly recommend reading the full application note which is available for download on [www.abb.com/semiconductors](http://www.abb.com/semiconductors) in the section 'Links and downloads'. **(et)**



Example of SOA diagram for diode

## Application in focus

### Welding diodes for Valmet Automotive



Valmet automotive, a Finnish contract manufacturer of premium specialty cars, intends to launch a new project in early 2017 for the production of sports utility vehicles (SUV) Mercedes Benz GLC and ordered 250 industrial ABB robots. This is the largest order for industrial robots ABB has ever closed in Finland and the total number of robots ABB supplied by Valmet Automotive increased to more than 500 pieces. The new robots will not only significantly increase production flexibility,

but also improve productivity and shorten the delivery times. Resistance welding equipment for this project will be provided by ARO, which is an important customer of Semiconductors. In collaboration with ABB robots, Semiconductors provides 500 housingless welding diodes to this order. Semiconductors has secured a market leadership position in this high runner product, with a market share of well above 60 percent. Their advantages are proven reliability and quality, ultimate design due to close relationship with customers and is the best performance welding diode on the market. ABB Robotics on the other side, guarantee our customers exceptional efficiency of production processes. They allow to produce automobiles with more accurate welds, minor variations and generally more accurate structures. The order included IRB 6700 robots with minimal maintenance, representing the class 150-300 kg robots with the lowest total cost of ownership, and IRB 8700 robots. With a range of 3.5 mA capability to handle loads weighing up to 800 kg these robots are historically the largest ABB robots.

This business case is a great example of collaboration between ABB units at various levels such as components and applications, where the success of one unit is the success of another as well. (dm)



ABB's welding diodes

## Phased-out products

### BiMOS and bipolar

Material	Last deliveries
5SMX 12/76/86E1280	Sep 2016
5SMX 12/76/86H1280	Sep 2016
5SMX 12/76/86K1280	Sep 2016
5SMX 12/76/86L1280	Sep 2016

### Impressum

The ABB Semiconductors Newsletter is published four times a year in English. It is available in the pdf format. The newsletter archive can be found at [www.abb.com/semiconductors](http://www.abb.com/semiconductors). Next issue: December 2016.

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