news

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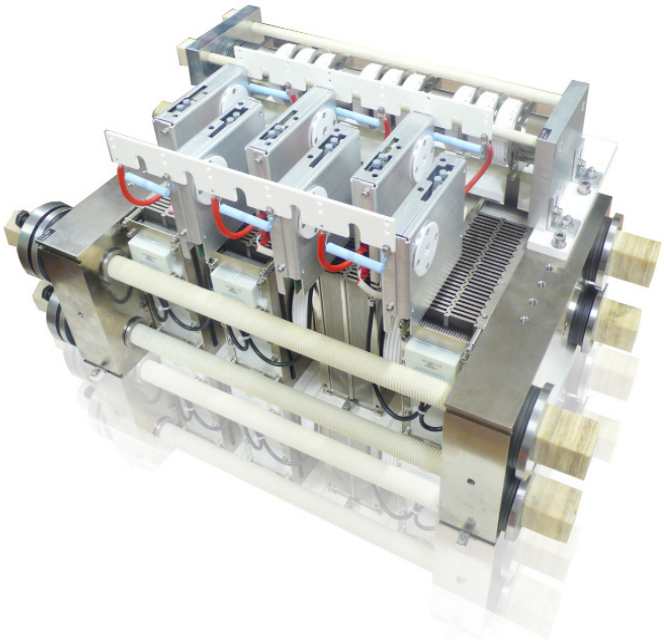
ABB Semiconductors
December 2014



BCTs for most powerful UPS

A complete power protection is of utmost importance in today's modern society which relies on the safe storage and ready availability of a vast amount of data as well as a stable and reliable power grid. The ever-increasing number of renewable generators, however, leads to an increase in power-quality-related challenges like spikes, swells, sags, noise and harmonics. They all pose a risk to power users. Large critical manufacturing processes, such as chemical or semiconductor manufacturing, require a lot of uninterrupted power. Poor quality of power from the electrical utility may result in high costs of lost production, down time, quality and ultimately lost profit.

These risks can be mitigated with uninterruptible power supplies (UPSs). Traditionally, these devices are fitted at the low-voltage (LV) level, but this can often pose a challenge if eg the space available is limited. The solution is to install the UPS at the medium-voltage (MV) level, where the UPS can be put in less-crowded spaces away from the target devices – in MV electrical rooms or plant substations, thus freeing up space for more important infrastructure, such as servers or manufacturing tools.

One of the key components in ABB's PCS100 Medium Voltage UPS is the innovative bi-directionally controlled thyristor, the BCT. It is assembled in a bi-directional static phase switch for 6.6 kilovolt and 600 ampere. The static phase switch's function is to disconnect the UPS from the utility.

(continuation on page 3)

Highlights

Editorial

After having celebrated 100 years of ABB power electronics last year, this year we celebrated 60 years of ABB semiconductor innovation. As early as in 1954, BBC – our predecessor company – fabricated its first semiconductor diode. Made of germanium, nota bene. An excerpt of the detailed review of ABB's history in semiconductors is given in this newsletter on pages 5 and 6. The full article can be read in ABB Review, the ABB corporate technical journal. It is available for download on www.abb.com/abbreview in English, German, French, Italian and Spanish (issue 3-14, pages 84ff).

One example of ABB's semiconductor innovations is the bi-directionally controlled thyristor, the BCT. It is a device that incorporates two monolithically integrated, anti-parallel thyristors in a single package and thus provides customers requiring such a functionality considerable volume, part-count and therefore reliability and cost advantages compared to using two individual thyristors. The cover article and the application note summary on page 3 highlight this innovational device and clearly demonstrate the advantages it offers.

Innovation does not come by its own. A continuous exchange of knowledge and expertise is imperative for a technology leader. Read more on page 4 where we briefly report on just one part of ABB Semiconductors' knowledge management program, the Expert Day, that was held in October.

And there are two more important contributions to this newsletter: Jürgen Bernauer's Review & Outlook and the announcement of our new semiconductor simulation tool SEMIS, both on page 2.

For now, best wishes for a Merry Christmas and a happy New Year.

Yours, Christoph Holtmann
PG Communications Manager

Jürgen Bernauer, Review and Outlook

Dear Readers

It's my pleasure to share with you my thoughts within this newsletter.

I had also in 2014 several opportunities to visit our customers in Europe, US and Asia. During these trips I enjoyed many factory tours and discussions about the customer application where our semiconductor devices play a key role. Talking to our clients on their expectations, I received in all regions more or less the same response. Customers expect a high service level concerning on-time delivery, product reliability & technical performance, quality and innovation.

Can we fulfill these expectations? Yes, we can. I will tell you why.

I think we demonstrated enormous progress on technology and product reliability when we presented during the PCIM 2014 our highlights with the improved HiPak IGBT module, the new fast switching thyristors, our enhanced rectifier diodes and the new SPT^{++} IGBT & diode chipset featuring 175° applications. And we are setting a new innovative record with our 150 mm thyristor targeting highest power rating capabilities. In addition, we staffed-up our team on application engineering and product management to better support our customers. ABB has unique technologies like StakPak, BCT or IGCT. Our customers need to understand the unique features and how these devices can add value in their application topology. Please use these resources.

Requested on-time delivery is one of the key performance indicators of ABB. And there we have room for improvement. It all starts with a good forecast from our customers and the associated actions in the factory but also with our sub-suppliers. Ramping-up and ramping-down is not an easy deal and this needs a close dialog along the whole chain of stakeholders.

Let me conclude with some words on quality. ABB is fully aware that most of our devices enter into critical applications like HVDC, transportation vehicles or industrial drives. As an electrical engineer, I know that things can happen. We try to simulate the worst case of exposures during our qualification tests, but sometimes even these tests can't simulate the reality in the field. Therefore, our engineers are working hard to improve our devices step-by-step. In case something happens our quality team takes leadership based on 8D or 4Q methods to identify sustainable solutions and communicate in a transparent way with our customers.

Looking forward to a successful and interesting year 2015.

Sincerely
Jürgen Bernauer,
Managing Director
Power Semiconductors

SEMIS – semiconductor simulation tool

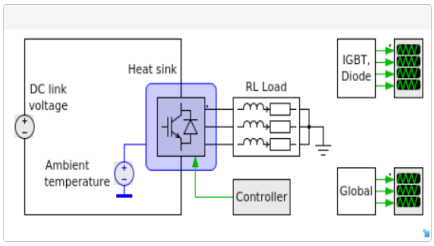


ABB Semiconductors is introducing its new web based semiconductors simulation tool SEMIS. It calculates the losses and temperature rise in ABB high-power IGBT modules for common converter topologies and it serves as a straight forward selection guide to evaluate the ABB HiPak IGBT module that is the best fit to your application.

The SEMIS tool is operated from the ABB website and is based on the PLECS software. HiPak product models in the XML file format are available for download from our website (www.abb.com/semiconductors).

The first SEMIS release includes all HiPak IGBT modules and the simulation is done for a standard 2-level voltage source inverter circuit with a passive load. Future updates will expand SEMIS with both additional converter topologies and further product families. **(vk)**

BCTs for most powerful UPS (cont.)

The technology used in ABB's medium voltage uninterruptible power supply PCS100 MV UPS allows a system design where the power converter and energy storage can remain at low voltage, with a transformer coupling these to medium voltage. Also at the medium voltage level is a thyristor-based utility disconnect switch which prevents backfeed into the grid in the event of a power loss or voltage sag.
The utility disconnect switch is an air cooled static switch that has an integrated gate unit and voltage monitor, an RC snubber and a passive overvoltage protection. The key component of this utility disconnect switch is the innovative bi-directionally controlled thyristor (BCT). The BCT allows for a very compact valve design, low losses and just one clamping system per phase as it consists of two monolithically integrated anti-parallel thyristor functions on one silicon wafer in a single housing. The two thyristor halves are individually triggered and have a separation region enabling the design of high voltage devices with the dynamic capability of discrete devices.
The BCT is designed, manufactured and tested using the same philosophy, technology and equipment as the well-established PCT, thus reaching the same levels of performance and reliability.
A table of replacement of PCTs by BCTs is given in the BCT application note summary on the right**. (ch,rl)**

Three static 6.6kV / 600A utility disconnect switches in ABB's PCS100 MV UPS, featuring the innovative bi-directionally controlled thyristor (BCT).

Publications calendar

- Bodo's Power Systems, May 2014
  "Record Performance with IGCTs, Cool"
- Power Electronic Europe, August 2014
  "Fast Thyristors for Induction Heating Solutions"
- Power Electronic Europe, October 2014
  "Thyristors for >10 GW Power Transmission"
- Bodo's Power Systems, December 2014
  "Enhanced Trench IGBTs and Field Charge Controlled Diode – The Next Leap in IGBT and Diode Performance"
- Application note:
  "High current rectifier diodes for welding applications"

Application note BCTs

The bi-directionally controlled thyristor (BCT) is a device that features two anti-parallel phase-controlled thyristors (PCTs) monolithically integrated on a single silicon wafer, packaged in a single housing. This concept enables designers of Static VAr Compensators (SVC), static switches, soft starters or motor drives to meet higher demands concerning size, reliability and cost for their end product.
ABB has published an application note which describes and explains in detail the BCT concept with its design criteria, special BCT features, surge current behavior, crosstalk & t_q as well as quality and reliability. The definitions and the characterizing parameters of a BCT are practically almost the same as those of a standard PCT.
Yet there are a few exceptions which are explained in detail in the BCT user's guide section of the application note.
The BCT has been developed as a complement to the ABB standard PCT product range with the target to reduce cost and thereby to increase the competitiveness of our customers in those areas where the common encapsulation of the two anti-parallel thyristors yields advantages. SVC, motor drives and soft starters are three application examples that are discussed in the application note. Comparisons are given between PCT and BCT assemblies for all three applications and it is clearly shown that BCT designs offer considerable volume improvements and part count reductions (both up to 35 percent) over conventional PCT ones.
The full application note is available for download on www.abb.com/semiconductors. **(ch)**

One BCT	≈	Two PCTs
5STB 24Q2800		5STP 24H2800
5STB 24N2800		5STP 24H2800
5STB 18N4200		5STP 18H4200
5STB 17N5200		5STP 17H5200
5STB 13N6500		5STP 12K6500
5STB 25U5200		5STP 25L5200
5STB 18U6500		5STP 18M6500

Products in the pipeline
BiMOS and bipolar

Part nr.	Voltage	Current	Description	Housing
5SDF 28L4521	4,500 V	2620 A	IGBT diode	L housing
5SDF 20L4521	4,500 V	1,950 A	IGBT diode	L housing
5SHZ 11H6500	6,500 V	1,100 A	Reverse blocking IGCT	H housing

Product features

4,500 V fast diode for IGBT operation

- Optimized for IGBT operation
- High RBSOA up to high di/dt
- Optimized for low switching losses
- Cosmic radiation withstand rating
- Target market: developed to operate safely in power-electronic circuits employing IGBT and IEGT press-packs, where di/dts up to 5 kA/µs are particularly required. This is possible thanks to a doping profile of the silicon wafer, optimized for a wide range of current densities and di/dts

6,500 V reverse blocking (RB) IGCT

- Capable of blocking reverse voltage (symmetrical IGCT)
- Optimized for current source inverter technology (CSI)
- Target market: The RB-IGCT is the power switch of choice for CSI eg for medium voltage drive systems as well as for breaker applications

Process change notifications

PCN nr.	Part nr.	Subject	PCN issuing date
IGBT 14-06	5SNA 3600E170300 / 5SNA 2400E170305 and adapted standards	substrate RG integrated in chip	5 Aug 2014
IGBT 14-08	all sawn wafer die products, e.g. 5SMY 86M1280	new black frame and alignment marks	19 Sep 2014
IGBT 14-09	4500V IGBT and Diode die	alignment marks for AOI	30 Sep 2014
PCT 14-04	5STP 03D6500, 5STP 08F6500	back end production line	19 Sep 2014
PCT 14-05	5STP 52U5200, 5STP 42U6500	additional housing supplier for PCTs in U housing	17 Oct 2014
PCT14-06	5SDF 13H4501, 5SDF 10H4503, 5SDF 08H6005, 5SDF 10H6004, 5SDF 07H4501 and adapted standards	additional housing supplier for diodes in H housing	17 Oct 2014

High voltage HiPaks UL recognized

Since autumn this year all high voltage HiPak housings with the package code P, J and G (eg 5SNA 0750G650300) are recognized under UL1557, File E196689.

The UL recognition facilitates the use of the HiPak products in industrial converters for the North American market.

As of mid-December the UL recognized products will feature the UL-sign on the module label and the datasheets of the affected products indicate the UL recognition in the feature section. **(rs)**

ABB Semiconductors Expert Day

As part of the knowledge management program initiated at ABB Switzerland Ltd., Semiconductors, the first Expert Day workshop was organized and took place in Lenzburg on the 21st of October. The full day workshop was attended by 70 technical experts and managers from ABB`s power semiconductor product group including invited experts from the corporate research center in Switzerland. The selected focus topic was in relation to high voltage related technologies with respect to the power semiconductor device, the package and the power-electronics application. More than 10 presentations were prepared and given by our specialists covering a wide range of high voltage related fields ranging from power device junction termination and passivation, HV encapsulation, test and characterization and the application requirements. An interactive Q&A session to the selected expert panel was then followed where the audience were engaged in a lively discussion with respect to presented subjects.The expert day provided an excellent platform for our experts and managers to share information and raise questions especially while taking into account the diverse technologies and technical backgrounds involved in our core business. The customer's demand for the highest reliability of high-power semiconductors that can withstand the toughest applications in the harshest environments were addressed and discussed. As a result, ideas were proposed for further improvements of our next generation technologies and products.The ABB Semiconductors Expert Day, covering different technical and market topics, is an annual event which contributes to our success as a leading power semiconductor manufacturer. **(mr)**

60 years ABB Semiconductors

This article is an excerpt of an article firstly published in ABB Review 3-14. To read the full article go to www.abb.com/abbreview.

Semiconductors have driven a revolution in the past decades – a revolution that is maybe not too visible but very significant for today's society: From the humble charging of mobile phones to the transmission of power over thousands of kilometers, power electronics has become a vital enabler of the modern lifestyle. ABB has over the past 60 years played a pivotal part in the development of power semiconductors and their power electronics applications. ABB's predecessor companies, ASEA and BBC, both commenced semiconductor development in the early 1950s. BBC's activities were based in Baden, Switzerland, and ASEA's in Ludvika, Sweden.

The diode

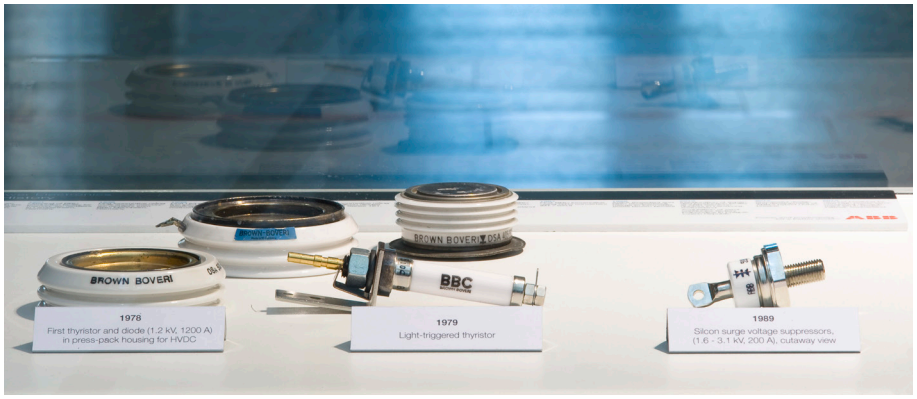
BBC created its first semiconductor diode in 1954. The first commercially available diode (100V / 100 A), targeted at rectification for electrolysis followed in 1956. BBC's early diode designs used germanium, but because of the material's thermal and blocking-voltage limitations, this was soon replaced by silicon. An early successful application for diodes was in traction with the type Re 4/4 locomotive (4,980 kW) built for the BLS railway (Switzerland) from 1964. These locomotives, still featuring their original rectifier circuits, remain in use today (see picture).

The thyristor

Moving beyond simple rectifier applications, a device was required that could be switched on at an arbitrary point in time. Thyristors are well suited for inverter (DC to AC conversion) applications in which the receiving network is strong enough (eg, through support of local generation) to enable forced commutation of the inverter. They are also well suited for rectifiers where they present the advantage over diodes that the phase angle can be controlled and hence the flow of power is regulated. BBC produced its first thyristor in 1961. In 1967, ASEA began producing a locomotive controlled by thyristors. This was the 3,600 kW type Rc for SJ (Swedish Railways). Again, many of this type remain in use today. The world's first commercial HVDC link, which dated to 1954, between the Swedish island of Gotland and the mainland was supplemented by an experimental thyristor valve in 1967. The first commercial application of thyristors for HVDC followed at the same location in 1970. Several records followed like the record-breaking Itaipu link in Brazil in 1984 (780 km, 500 kV / 6,300 MW). And still today the thyristor market continues to thrive, as the device remains the unchallenged semiconductor of choice for high-power HVDC links. In 2009, ABB introduced a 150 mm, 8.5 kV thyristor for such projects.

(continuation on page 6)

The RE 4/4 locomotive (1964) of BLS (Switzerland) uses BBC diodes.



Portrait: ABB distributor PPM Power

Pulse Power and Measurement Ltd. (PPM) was founded in 1994 as a specialist distributor for high voltage and power components and systems. PPM has a design and manufacturing division, branded ViaLite Communications which serves the communications and test markets with analogue high frequency links which use optical fiber as the transmission medium, rather than coaxial cables.

The PPM Power brand was established in the United Kingdom (UK) in 2005, and at this time PPM Power started to work with ABB Semiconductors, particularly for the large stacked assemblies. PPM Power is now a key supplier to the major OEMs in the UK for a broad range of market segments including high-voltage DC current (HVDC), marine drive and wind inverter markets.

Recently we have been successful with smaller medium voltage drive manufacturers developing IGBT based drive systems for subsea environments.

PPM Power's recent partnership with Amantys to supply their range of gate drive devices enables us to provide a comprehensive solution to IGBT users.

PPM is approved to ISO9001:2008.

60 years ABB Semiconductors (cont.)

The GTO

The major drawback of the thyristor is its need for auxiliary circuitry to support commutation when the receiving AC network is weak, or in a DC to DC conversion. This challenge was met by the gate turn-off thyristor (GTO). BBC introduced its first GTOs in 1980 (1,400 V), although available from as early as 1960. Despite this delayed start, ABB was in later years to become a world leader in GTO manufacturing.

The IGCT

In 1997, ABB launched a new GTO-based device: the IGCT (integrated gate-commutated thyristor). An IGCT is essentially a GTO with an integrated gate unit. Today, the IGCT has established itself as the semiconductor of choice for a multitude of demanding high-power applications like medium voltage drives, marine drives, co-generation, wind power converters, STATCOMs, etc for their versatility, efficiency and cost-effectiveness.

The IGBT

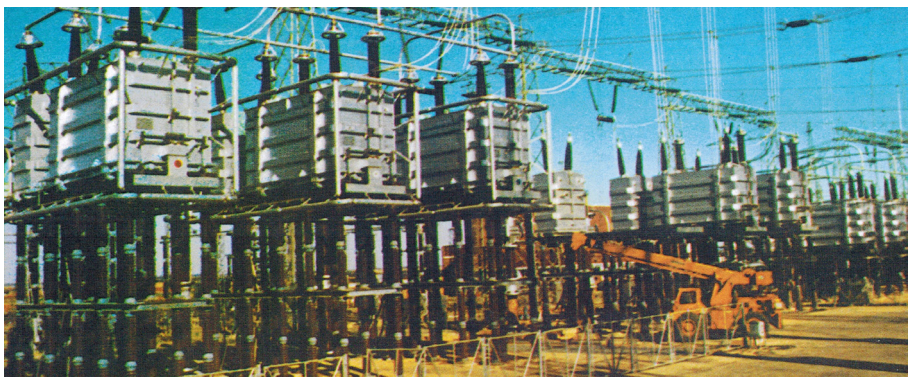
In 1992, ABB presented the first 4.5 kV / 600 A IGBT sample. As ABB's manufacturing facilities were initially not set up for the complexity of the IGBT manufacturing process, the company's early production relied on parts of the process being performed at external facilities. The 1998 completion of the BiMOS factory in Lenzburg, Switzerland, finally enabled ABB to handle the entire IGBT production process in-house. In the following years, with further technological improvements in terms of lower losses and higher robustness, ABB's HiPak IGBT modules entered many markets previously dominated by GTOs, such as marine drives and railways, but also new applications such as converters for wind power and power-electronics-based transformers. In 2000, ABB launched the 2.5 kV StakPak IGBT module for HVDC Light applications. This press-pack IGBT module was optimized to address eg redundancy requirements that may rely on failed modules going into and remaining in short circuit when mounted in massive stacks of series connected IGBTs.

The wide-bandgap semiconductor

Looking toward the future, ground was broken at the ABB Corporate Research Center in Baden-Dättwil, Switzerland, in 2013 for a research lab dedicated to wide-bandgap power-electronics material. SiC (silicon carbide) semiconductors, eg, offer lower losses than silicon and better tolerance to heat. ABB's predecessor companies had already researched SiC in the 1960s and 1990s, but understanding of the manufacturing techniques has since advanced to the point that such devices are genuinely becoming feasible.

Ready for the future

The chain of the delivery of electrical power, spanning transmission, conversion and delivery, is embarking on an era of exciting changes. On the demand side this is being driven by the growth and integration of renewable energies and the greater emphasis on efficiency. But these demands would remain wishful thinking were it not for the progress at the semiconductor level that is making this revolution possible. **(ch, am)**



The Cahora Bassa (Mozambique) HVDC project of 1970

Phased-out products BiMOS and bipolar

Material	Last deliveries
5SDD 10T1800	Dec 2014
5SDD 38F2000	Dec 2014
5SDD 17F6000	Dec 2014
5SDD 92Z0200	Dec 2014
5SDD 92Z0400	Dec 2014
5SDD 0105Z0400	Dec 2014
5SDD 0135Z0200	Dec 2014
5SDD 0135Z0400	Dec 2014
5SDF 90Z0400	Dec 2014
5SDF 0103Z0400	Dec 2014
5SDF 0131Z0400	Dec 2014
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

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