Conducting business

ABB's power semiconductor business in Lenzburg is making its mark on the energy industry

Sven Klaka

For more than 25 years, ABB has been manufacturing power semiconductors. What began with production of a limited number of products used mainly for in-house business at BBC grew into a strong power semiconductor business after the merger with ASEA in 1987. The technology of the ASEA entity that manufactured power semiconductors in Västerås, Sweden was transferred to ABB in Lenzburg, Switzerland. Within a short time, a broad and competitive range of products was developed and successfully brought to market.

ABB, in cooperation with the company International Rectifier, developed an insulated-gate bipolar transistor (IGBT) product line for traction and high-voltage direct current (HVDC) applications. In 1997, ABB began to invest in a wafer manufacturing facility (fab) for IGBTs at the Lenzburg site. This new BiMOS[1] facility was built directly adjacent to the existing bipolar[2] building. It is the first and only facility in the world where both of these technologies are manufactured under one roof 1.

The applications that use ABB's power semiconductor products are known to all.

Nowadays, the semiconductor division at ABB in Lenzburg consists of a bipolar wafer fab and assembly with an installed capacity of up to 150,000 wafers (100 mm in diameter) per annum, and a BiMOS wafer fab and assembly for 100,000 wafers (150 mm in diameter) per annum – and a well-filled order book. Heavy investments are being made to increase capacity for both technology branches in an effort to cope with the fierce growth fueled by today's strive toward energy efficiency.

Power semiconductor presence

While only experts in the power electronics industry might recognize ABB's power semiconductor product offerings, the applications that use these products are known to all. ABB has more than 30 percent of the market share for high-performance welding applications. The probability that one's car was welded not only with ABB robots but also with ABB diodes is therefore reasonably high 2a. Particularly in Switzerland and Germany, the probability is also very high that the train or metro one takes to work is powered by ABB's gate turn-off thyristors (GTOs) 2c. While these are not very modern devices, they are known and reliable, and still maintain their share of the market. Be it car or train, these vehicles are made primarily of steel, which surely has come across ABB integrated gate-commutated thyristors (IGCTs) during milling 2d 2e.

All the products mentioned so far have at least one thing in common: Each contains just one semiconductor 3. In some cases, this semiconductor can be up to 110 mm in diameter (this will be 135 mm starting in 2009) but it remains just one silicon crystal.

The other products are based on IGBT chips 2f. As the name suggests, the controlling electrode – the gate – is insulated from the bulk by a thin oxide layer. Control of the main current is achieved by a capacitive effect. The more complex lateral structure of these devices limits the size of these components to approximately 2 to 3 cm^2. However, the increasing need for higher power requires parallel connection of a large number of these chips. An ABB HiPak™ package contains up to 36 chips in varying topologies insulated from the heat sink 2e. Those who travel in a more modern train will most likely be softly accelerated by ABB's HiPak IGBTs.

With power electronics allowing for efficiency gains of up to 40 percent, a whole industrial segment is not only heavily growing but is ameliorating the effects of the high primary cost of energy.

Power semiconductors made by ABB also have a somewhat less visible but nevertheless important application. Transmission of energy over large distances is known to be inefficient but in some cases is necessary – consider large dams or offshore wind farms far removed from large, energy-thirsty cities, for example. Power semiconductors (ie, thyristors or StakPak™

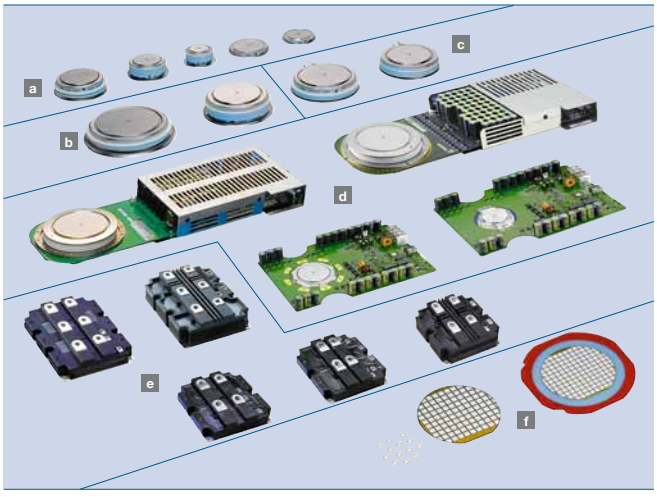
Footnotes

[1] Bipolar metal oxide semicondutor technology: The metal-oxide-semiconductor structure allows very low power control signals to control large currents. The underlying main semiconductor is bipolar.

[2] Bipolar semiconductor technology uses both carrier types (positive and negative charges) for current conduction, as opposed to unipolar devices, which use one type.

1 The factory that never sleeps. Production runs 24 hours a day, seven days a week at ABB Lenzburg.

2 ABB semiconductor product offering: diodes a, thyristors b, GTOs c, IGCTs d, HiPaks e and IGBT chips f

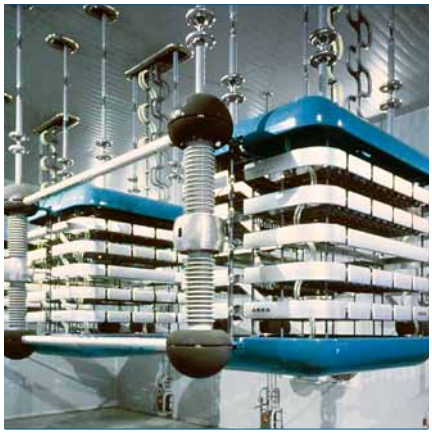


3 Power semiconductor applications

a Rolling mill

b Traction

c HVDC valve



IGBTs) convert the electrical energy into DC current, which can then be transmitted over long distances without incurring too many losses. At the destination, a second station converts the current back into alternating current (AC) and synchronizes it with the grid.

Energy efficiency via power electronics

While the future cannot be predicted, some trends are clear: Energy costs are not likely to come down. Just a decade ago, today's crude oil prices – more than $ 100 per barrel – would have resulted in a strong recession. One of the secrets of the current economic momentum is that high energy costs not only slow down growth, but to a certain extent, they trigger investment in energy efficiency. With power electronics allowing for efficiency gains of up to 40 percent, a whole industrial segment is not only heavily growing but is ameliorating the effects of the high primary cost.

Regenerative energies are increasingly gaining importance. For wind power, the trend is to rely on large offshore wind farms as most of the prime onshore locations are already occupied or are facing resistance from their neighbors. Offshore wind power is transformed up to four times by power semiconductors before it reaches the distribution grid. Regenerative energies are commonly generated where the particular energies are abundant, which is not necessarily where the energies are required. Large investments in transmission infrastructure will be required.

Other opportunities to minimize CO_2 emissions are currently being addressed by the energy industry. These initiatives cover a wide range, from hybrid or all-electric cars, to smart grids and carbon capture, and all of them require power semiconductors.

For more information on ABB's IGCT and IGBT products, see "Performance-enhancing packaging" on page 9, "A tiny dot can change the world" on page 15 and "Switching to higher performance" on page 19 of this issue of *ABB Review*.

4 Regenerative energy collected far from the next user

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Further reading

ABB Review 2/2007, Energy efficiency.