Power(ful) semiconductors

Power semiconductors are electronic switches that turn high current on and off at high voltage levels. They can flip between the two states in microseconds with very low losses, and are extremely compact.

This unique capability makes them the ideal component to transform the shape of electric current and voltage from alternating current to direct current and vice versa, and from one frequency to another.

Systems based on power semiconductors are used in power transmission. They are also used in electrical drives to make motors universal and efficient.

Three types of power semiconductor - thyristors, integrated gate bipolar transistors (IGBTs) and integrated gate commutated thyristors (IGCTs) - dominate high-power switching. Each one has been developed by ABB into unique systems that have revolutionized the transmission of electricity in the past half-century.

First used in 1967

Thyristor valves were first used by ABB for high-voltage direct current (HVDC) converter stations in 1967, and thyristor technology has become the basis of every HVDC project since, including the massive HVDC power superhighways in China linking the Three Gorges hydropower plant to industrial and population centers in the Yangtze Delta and Guangdong (see page x).

For the Three Gorges HVDC transmission links, ABB thyristors perform heavy labor. Each thyristor is capable of switching the power equivalent to three Formula One racing engines 50 times per second – a task they will perform for more than 30 years!

While thyristors can only be turned on, not off, their losses are the lowest among the different types of power semiconductors, and they remain the preferred and most cost-efficient alternative for the highest power levels.

Turn-off technology

In 1997, ABB started to use integrated gate bipolar transistors (IGBT) for high-voltage applications, and developed the integrated gate commutated thyristor (IGCT). These two power semiconductors, which can also turn off electrical current, opened up new applications and enabled ABB to develop new high-power transmission technologies.

Combining IGBTs with voltage source converter (VSC) technology, ABB was able to launch even more compact, environmentally friendly versions of HVDC and static var compensators (SVC). Both technologies – HVDC Light and SVC Light – remain unique to ABB.

The innovative ABB semiconductor housing called *StakPak*™ - which makes it possible to connect IGBTs in series simply by stacking them on top of each other - was a key leap forward in compact design.

Between the thyristor and the IGBT

The IGCT, invented by ABB in 1997, combines the rapid switching of the IGBT with the low conduction losses of the thyristor.

Compared to the gate turn-off thyristor, which was the alternative technology at that time, IGCTs reduce conduction losses by 40 percent and turn-off time by a factor of 30.

In the coming months, ABB is set to take power semiconductor technology into a new dimension with the release of the next generation of IGBTs.