

STMicroelectronics' Approach to Power Management

Over 100 years ago, the use of steam turbines to enable the generation of electrical energy at affordable cost revolutionized the world. More than a century later, electricity is at the very heart of our society and most of us would be helpless without it. It lights our streets and homes, it powers our factories, and hospitals would be unable to function without it. Without electrical power, there would be no TV, no mobile phones, no Internet.

According to the World Energy Council¹, global electricity generation, which was 21.5 billion MWh in 2010, will increase to around 50 billion MWh by 2050. Most of it, according to the same report, will still depend on burning fossil fuels. Efficient Power Management, which means making sure that no electronic or electrical application wastes any more power than is absolutely necessary, is therefore a critical part of any sustainable world scenario. Ever since its formation in 1987, ST has been a world leader in power management and continues to drive the market today, with a full commitment to helping the world to save energy, from the MegaWatts that could be saved in smart factories to MicroWatts that could be saved in billions of mobile phone chargers worldwide. In fact, ST's efforts have often anticipated and preceded local energy-saving regulations.

ST's approach to power management embraces all the three levels of the complex recipe that semiconductor companies use to make key contributions:

The Underlying Technologies

The first ingredient is at the basic technology level. Here, the aim is to make the basic building blocks of semiconductor devices such as diodes and transistors as efficient as possible. We know from the laws of thermodynamics that they can never be 100% efficient so the challenge is always to get a little bit closer to 100%. But this is not a single challenge because, for example, transistors – the switches that control the flow of electric current – come in all sizes. In a complex multi-million transistor circuit, some transistors are designed to handle very high voltages or currents while others are designed to be extremely small low-voltage devices. In every case, the aim is to minimize the power consumption while offering a price/performance trade-off that is compatible with market needs.

For instance, ST's FD-SOI (Fully Depleted Silicon-On-Insulator) technology offers the world's most power-efficient solution for highly integrated circuits, where millions of transistors are interconnected to perform complex computing-intensive tasks. At the extreme other end of the complexity spectrum, ST offers one of the world's most power-efficient ranges of discrete power transistors and diodes, including devices manufactured in Silicon Carbide (SiC) technology that boost efficiency in the end applications by several percentage points. These individual-transistor savings might seem small at first sight but with billions of these transistors in use, every percentage point or micro-amp saved in is important.

ST's expertise in "Smart Power" goes back nearly 30 years. In the mid-1980's, the Italian company SGS Microelettronica, which merged with the French company Thomson Semiconducteurs to create the present day ST, invented two revolutionary technologies, BCD and VIPower. BCD (Bipolar-CMOS-DMOS) is a family of silicon processes, each of which combines the strengths of three different process technologies onto a single chip: bipolar junction transistors for

¹ <http://www.worldenergy.org/publications/2013/world-energy-scenarios-composing-energy-futures-to-2050/>

highly accurate analog signal-processing functions, CMOS (Complementary Metal Oxide Semiconductor) for digital control-circuit design and DMOS (Double Diffused Metal Oxide Semiconductor) for power and high-voltage switching elements.

VIpower (Vertically Integrated Power) offers a complementary approach, where a single vertically integrated power transistor is enhanced by processing and control circuitry built into the surface layer of the silicon. This enables the design of devices that match the high-voltage/high-current and robustness characteristics of discrete power transistors while including additional functions that reduced the size, cost, and power consumption of the end application.

ST has continuously refined these pioneering technologies over the last nearly 30 years and they remain today at smart power's leading edge.

The Circuits That Exploit the Technology

The second ingredient concerns the electronic circuitry that uses the underlying semiconductor technology. Here, the task of the semiconductor supplier is to make it as easy as possible for customers to deploy industry-leading technologies in commercial solutions.

For almost 30 years, ST has been a world leader in offering integrated power-management devices that are precisely tailored to meet specific application requirements. Among these are power factor corrector controllers (PFCs), that counteract harmonic distortion to improve power quality; these will find increasing demand for the smart grid of the future. ST's zero-power standby converters drive standby power consumption down below 5mW², minimizing power used by equipment in standby mode (vampire power).

There are many other examples of ST's integrated approach to power management. These include ST's highly successful range of smart metering chips – for electricity, gas, and water – and smart-grid technologies that leverage ST's expertise in power-line communications and today play an important role in enabling the development of smarter homes and cities. Beyond the smart metering chips, ST's trailblazing STLUX lighting controllers and STNRG products have led the way to increasing end-applications' energy efficiency by building intelligence into existing circuits via the addition of microcontrollers to power management applications.

The key to ST's leadership in this sphere is the deep understanding that its engineers have of the many possible power-conversion circuit topologies and how to best deploy them in particular applications. From driving the AMOLED display of smartphones (where ST is a global leader) and mobile battery chargers to ICs for driving electric motors and for car electrification, from energy-harvesting ICs, to wired (power-over Ethernet) and wireless power, from industrial welding equipment to public and residential LED lighting, ST has ready-made solutions that meet all customer needs in terms of price/power/performance and physical size.

The third and last ingredient in this complex power-management recipe is met by ST's long-established expertise in housing its silicon devices in packages that are at the leading edge of combining small size and high power density.

Infrastructures

ST believes that the key to a sustainable future is smarter management of the power we use in our world. More than half the people on the planet now live in cities and this proportion is widely expected to continue increasing. Car ownership continues to grow, especially in emerging

² In the International Electro-technical Commission (IEC) standard 62301:2011, clause 4.5 for household and office appliances, which has pushed for initiatives to reduce standby power used by appliances to less than 1W in 2010 and 0.5W in 2013, standby power consumption below 5mW is rounded to zero.

economies. We need smarter driving, smarter cities, smarter homes, and smarter industry—all operating at peak efficiency.

In addition to pushing the boundaries on these technologies, ST is today working on digital power approaches that better meet increasing demand for efficiency, increased ruggedness and flexibility, and on-chip galvanic isolation for additional safety. We are finding ways to make power conversion even smarter through real-time decisions based on instantaneous knowledge of power-grid capacity and costs.

The semiconductor industry has a vital contribution to make in helping to develop and refine these smart domains because they will all rely on semiconductor devices. ST has, and will continue, to contribute its power-management knowledge to a wide range of bodies that are working on these key issues, including international standards organizations, major energy and automotive suppliers, and international consortia and research institutes. This sharing of expertise helps ST to develop new technologies and products that will most effectively contribute to the smarter world that we need.

Future developments

Communication, connectivity, and sensing are promoting the innovations that gather separate elements into a more powerful network for advanced applications. These pieces are uncovering new ways to make power conversion even smarter through real-time decision-making based on instantaneous knowledge of power-grid capacity and costs.

Using its leading position as a supplier of all the components required for this complex and interconnected scenario, ST continues to maintain its unwavering commitment to smart power technology by strategically investing in R&D and intellectual property to make this new wave of innovation happen seamlessly.

August 2016