

Drivers to Fuel POWER SEMICONDUCTORS Growth

Semiconductor power devices are the heart of power electronics. They determine the performance of power converters and allow topologies with high efficiency. With applications as diversified as hybrid cars, photovoltaic (PV) inverters, lighting, and energy – and with a voltage ranging widely from a few volts to a few thousands volts – power electronics will remain one of the most attractive branches of the semiconductor industry.

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The power devices are the semiconductor devices for the power handling and conversion, which includes the power diodes, power switching devices, and power integrated circuits. The power electronics technology is the foundation and core of the information technology, and it is the combination technology of the microelectronics and power electronics. The new power device representative is the electric field modulation power devices and smart power integrated circuits (Smart power integrated circuits (SPIC)).

Silicon based high voltage semiconductor devices continue to play a major role in modern megawatt power systems especially in the fields of traction, industrial and grid applications. The main development trend of power devices has always been focused on increasing the power ratings while improving the overall device performance in terms of reduced losses, increased robustness, better controllability and reliable behavior under normal and fault conditions.

Recently, IMS Research announced a forecast for power semiconductors with an expected compound annual growth rate of 8%. The demand for power semiconductors is mainly driven by environmental trends such as energy-saving and investment in clean energy. The efforts for more sustainability and more efficient use of electricity can be predominantly found in the industrial segment, the automotive segment but also in the consumer electronics industry.

Power semiconductor devices are key components in saving energy, and improvements of



performance are strongly demanded. Nowadays, Power MOSFET and IGBT those are the Si devices are improved by technological developments such as Super Junction and FS-IGBT, and the performance nears the limit. On the other hand, SiC and GaN those are the wide band gap semiconductor devices have potential that greatly exceed the performance limitation of the Si devices, but have still problems, such as long term reliability and costs.

Development of Power Semiconductor Devices

The substrate material of the semiconductor is the basis for the design and production of the power devices. A detailed overview of the development for the power devices is discussed in the following,

which includes the application and research of the silicon, SOI, and third-generation wide band gap semiconductor materials (SiC and GaN).

Silicon Power Devices

Silicon power devices are the first generation of the power semiconductor devices. The power devices including the thyristors, diodes, MOS, and IGBT are improved based on the research of the silicon, germanium, and oxide. Power diode is an important branch of the power semiconductor devices. Current commercial power diodes are mainly the PiN and schottky barrier power diodes (SBD). The former has the high voltage, high current, low leakage current, and low conduction losses. However, the turn-off speed is reduced due to lots of the minority carrier by the conductivity modulation effect in the drift region, which limits the power electronic systems developing to the high frequency. The schottky barrier diode with the majority carrier has the high switching frequency. However, the series resistance in the drift region has a contradiction relationship between the breakdown voltage and specific on-resistance, which restricts SBD application into the high voltage and large current. SBD has the poor characteristics including the large leakage current and soft breakdown, which makes the silicon schottky barrier diodes operating below 200 V.

Thyristor, also known as SCR, has the highest breakdown voltage and current capacity. The maximum current and voltage can reach 8 000 A and 12 kV, respectively. In addition, the light controlling thyristor can be up to 8 kV/4 000 A. The fast thyristors is 2 kV/800 A, and the highest frequency is 20 kHz. However, the gate electrode of the thyristor cannot be shut down by itself. A complex circuit is required to shut down the thyristor. Therefore, GTO, which is turned on and turned off by the gate controlling, is developed rapidly since the eighties of last century. GTO can be produced by Mitsubishi Electric Corporation, Sweden, ABB, and other Manufacturers in 6-inch wafers. Its development level has reached 8 kV/8 kA, and frequency of 1 kHz. But the GTO has still a complicated gate drive circuit, low tolerance of di/dt and dV/dt . So, a huge absorption circuit is required at work. The safe operating area (Safe Operating Area-(SOA)) is small in GTO. For the GTO's defects, the three kinds of the power device have come out in the nineties, and the two have been to the market. The first is integrated gate commutated thyristor (IGCT), which has been invented by the ABB Sweden and Japan's Mitsubishi

Electric Corporation. The second is MTO (MOS Turn-Off) thyristor, which has been proposed by the U.S. Silicon Power Corporation. The third one is Emitter Turn-off (ETO) thyristor, which have been improved by Professor Huang Qin. The three kinds of the power devices have a hard shut-down capability and can be controlled by the gate.

The power MOSFET significantly has reduced the switching time, so it is easy to switching frequency of 100 kHz, which has broken the 20 kHz application limit. The power MOSFET is the best power switching devices at the low application voltage range. But, in the high-voltage applications, the biggest drawback is the relation of the breakdown voltage and specific on-resistance. When the high voltage is applied, the resistance will rise sharply by the 2.5 power. In order to meet the system performance, the power MOSFET technology has entered to the sub-micron level and developed to the deep sub-micron. Two new MOSFET have been produced. The first is fifth-generation power MOSFET which has a small cell size and apply the spacer technology. The second is grooved gate MOSFET. The cell density of the eighth-generation MOSFET, which has been produced by the IR, has reached the 112 million cells. The maximum operating temperatures of the IRF1704 product is up to 200°C. In the field of the power MOSFET, a new MOSFET has broken the theoretical limit of the conventional structure, which had been invented by professor Xing-bi Chen in 1998. This new MOSFET has been a landmark of the power MOSFET in the international. The new MOSFET, called as CoolMOS or SJ MOSFETs, has a very low conduction losses. It keeps almost all the advantages of the power MOSFET at the same time.

IGBT has many merits including the high-input impedance, simple driving circuits, fast turn-on, and low conduction losses. Compared with MOSFET, IGBT has the high current density and high power capacity, and the higher switching frequency and wider safe operating area than the power thyristor. The IGBT advantages prompt it as a mainstream power device over the 600 V range. IGBT is gradually developing to the high voltage-current areas. It is crowding out the traditional SCR and GTO's market shares. In the device research, the researchers are focusing on the collector project by controlling the minority carrier concentration and distribution in the drift region. The new work, including the short circuit safe operating area and press-fit package, also has

been carried out.

Lateral Double diffused MOS (LDMOS) is easy to integrate with the low-voltage circuit because its drain, source, and gate are on the chip surface. So, it is suitable for the high-voltage power devices in the High-Voltage integrated circuits (HVIC) and SPIC. The terminal technology of the field plate and REduced SURface Field (RESURF) is commonly used in LDMOS. A device with 1200 V breakdown voltage is produced in the 5- to 8- μm thin epitaxial layer using the traditional integration technology. In the recent development of the terminal technology, in order to meet the HV-MOSFET integrating with the low-voltage circuits in the ultra-thin active layer, a new technology of Educed BULk Field (REBULF) is proposed to reduce further the electric field of the drain. By this technology, the high voltage can be obtained in the ultra-thin active layer to realize the new PIC.

Silicon-on-insulator Power Devices

SOI is a new semiconductor material developed rapidly in the 80s. SOI HVIC based on SOI high-voltage devices, as a new branch of SPIC fields, has been developed rapidly in recent years. SOI-HVIC combines the SOI technology, microelectronics, and power electronics technology. It is a new circuit and provides a high-speed, high integration, low power, and radiation hardness system for a variety of power conversion and energy processing device. SOI-HVIC has a very wide range of applications in the industrial automation, weapons equipment, aerospace, and other fields.

SOI LDMOS is a cornerstone of the SOI HVIC. It is developing toward a stage of the practical application and industrialization. SOI high-voltage device is a core of the SOI SPIC. Its breakdown voltage depends on the lower one of the horizontal and vertical breakdown voltage.

The substrate of the SOI structures cannot bear the

voltage because the buried layer in the conventional SOI structure limits the depletion region extending to the substrate. Based on the isolation and thermal considerations, the thickness of the top silicon and buried oxide layer cannot be too thick. Therefore, the vertical voltage of the SOI device restricts the SOI technology applying to the power-integrated circuit fields.

SiC and GaN Power Devices

With the development of the microelectronics technology, the traditional semiconductor materials of Si and GaAs show their shortcomings in the high power, high temperature, high frequency, optical, and so on, which results from their structures and properties. A series of new semiconductor materials, such as SiC, GaN, diamond, AlN, and other third-generation semiconductors, have drawn increasing attention. For SiC and GaN, unique characteristics including the large band gap, high critical breakdown field, high electron mobility, high thermal conductivity, and other properties, they can be applied to fabricate special devices with the high-power, high-temperature, high-frequency, radiation, short wavelength light-emitting, and optoelectronic integrated devices in the microelectronics, optoelectronics, and other fields. SiC and GaN materials have the higher band gap and critical breakdown electric field compared with the traditional first- and second-generation semiconductor materials.

The critical breakdown electric field of the SiC material is 10 times than that of Si, and thermal conductivity is three times than Si. The critical breakdown field of the GaN material is ten times than that of Si. Therefore, the power devices based on the SiC and GaN materials can be produced using a thin and highly doped drift region to reduce the resistance. In theory, the specific on--

Silicon based devices	Wide band-gap (SiC, GaN) based devices
<ul style="list-style-type: none"> - Well establish technology with proven reliability - Devices up to 8.5 kV available and higher voltages in development [4]. - Single devices available with 5500 A turn-off capability. - Mass production of devices as Diodes, Thyristors, IGCT and IGBT in many different packages and configurations. 	<ul style="list-style-type: none"> - Potential for low statics and switching losses for high switching applications - High junction temperatures capabilities. - Gaining market share in recent years for special applications such as PFC with uni-polar diodes rated up to 1200V. - Current ratings still below 100A in productions.

Table : Features for Silicon, Silicon Carbide and Gallium Nitride based devices

resistances of the SiC and GaN power devices are lower than that of the Si power device for the four or five times with the same breakdown voltage.

The switching losses can be reduced by the low resistance, thus greatly improving the device's switching frequency. The radiation hardness of the SiC and GaN materials are larger than those of GaAs and Si for 1 to 2 orders, thanks to the large band gap. Therefore, the performance of the SiC and GaN power devices is better than the first-generation semiconductors Si, Ge and second-generation semiconductor GaAs, InP. Currently, it is a hot to research the devices with the 600°C high temperature, power density 10 W/mm, anti-radiation capacity of 10⁶ -10⁷ rad. The SiC and GaN semiconductor electronic devices can meet these requirements for the high temperature, microwave, and high power.

WBG semiconductors

WBG semiconductors (see table below) permit devices to operate at much higher temperatures, voltages, and frequencies—making the power electronic modules using these materials significantly more powerful and energy efficient than those made from conventional semiconductor materials.

WBG materials also emit light in the visible color range, an optical property useful for applications in solid-state lighting. Gallium nitride (GaN), for example, is an enabling material behind the ultra-high efficiency of light emitting diodes (LEDs).

WBG semiconductors are expected to pave the way for exciting innovations in power electronics, solid-state lighting, and other diverse applications across multiple industrial and clean energy sectors. Realizing the energy-saving potential of WBG semiconductors will require the development of cutting-edge manufacturing processes that can produce high-quality WBG materials, devices, and modules at an affordable cost.

WBG materials and devices are rapidly gaining acceptance. However, a number of manufacturing challenges must be addressed to make WBG materials cost effective in more applications.

Substrate size and cost: While the quality of GaN and silicon carbide (SiC) wafers is improving, the cost of producing larger-diameter wafers needs to be reduced.

Device design and cost: Novel device designs that effectively exploit the properties of WBG materials are needed to achieve the voltage and current

Wide bandgap semiconductors (shown in green) are materials that possess bandgaps significantly greater than those of silicon

Semiconductor Materials		
Material	Chemical Symbol	Bandgap Energy (eV)
Germanium	Ge	0.7
Germanium	Ge	0.7
Gallium Arsenide	GaAs	1.4
Silicon Carbide	SiC	3.3
Zinc Oxide	ZnO	3.4
Gallium Nitride	GaN	3.4
Diamond	C	5.5

ratings required in certain applications. Alternative packaging materials or designs are also needed to withstand the high temperatures in WBG devices. Architectures that improve manufacturability and affordability are needed to spur commercialization. *Systems integration:* WBG devices are not always suitable drop-in replacements for Si-based devices. The larger, more complex systems must be redesigned to integrate the WBG devices in ways that deliver unique capabilities.

Applications

As manufacturing capabilities improve and market applications expand, costs are expected to decrease, making WBG-based devices competitive with less expensive Si-based devices.

Industrial Motors: WBG materials will enable higher-efficiency, variable-speed drives in motors—pumps, fans, compressors, and HVAC systems—used across manufacturing.

Electronics: WBG materials are already used in large, high-efficiency data centers and show promise as compact power supplies for consumer

electronics.

Grid integration: WBG-based inverters can convert the DC electricity generated from solar and wind energy into the AC electricity used in homes and businesses—while reducing losses by 50%.

Utility applications: WBG have the potential to reduce transformer size by a factor of ten or more. WBG-based power electronics could also accelerate development of high-voltage DC power lines, which will operate more efficiently than existing high-voltage AC transmission lines.

Electric vehicles and plug-in hybrids: WBG materials are expected to cut electricity losses by 66% during vehicle battery recharging. They also offer greater efficiency in converting AC to DC power and in operating the electric traction drive during vehicle use.

The ability of these electronics to tolerate higher operating temperatures could reduce the size of an automotive cooling system by 60% or even eliminate the secondary liquid cooling system.

Military: WBG semiconductors have great potential as an enabling material in high-density power applications, satellite communications, and high-frequency and high-power radar.

Geothermal: WBG-based electronic sensors can withstand the harsh, high-pressure, and high-temperature environments of geothermal wells.

Lighting: At today's energy prices, LED lighting is expected to save \$250 billion in cumulative energy costs by 2030.

Market Overview

Senthil Srinivasan, Director (Industrial Power Control Division, Power Management & Multi-market Division) Infineon Technologies India

"The growth of power semiconductors is driven by key applications in renewable energies segment such as wind and solar power generation.

Worldwide demand for PV inverters is on the rise as a CAGR of 15 percent in GW installations is expected from 2012 – 2016. This is according to IMS Research update in July 2013. Furthermore, growth in industrial motor controls over the same period is expected at CAGR of 8.2 percent in key areas such as



Senthil Srinivasan,
Infineon Technologies

pumps, compressors, general purpose drives and fans.

Power semiconductors are also used for drive control of train systems. Deployment of metro systems and high speed train railway networks are driven by increasing urbanization especially in Asia. These electric powered trains use between 1MW to 10MW power per train. In addition, the electrification of powertrain in cars will also fuel demand for high power semiconductors.

On the consumer end of the spectrum, smart phones, tablets and cloud computing servers are also growth segments for power semiconductors even as PCs and notebooks are expected to decline (Gartner Update July 2013)

In India, the nascent electronics design and manufacturing industry is growing faster than the world average in order to meet the rapidly ballooning local demand for electronics products. Gartner Research has indicated that semiconductor consumption in India is expected to grow by about 20 percent in 2013 relative to 2012."

Arvind Ravishunkar, Strategic Marketing Manager, Fairchild Semiconductor

"The power semiconductor market grew by 3-4% in 2012 and is expected to show double the growth by the end of 2013. The growth in 2012 was strongly influenced by the growth of insulate gate bipolar transistors (IGBT's) driven by power modules, industrial motor drives and automotive applications in hybrid electric vehicles. Inverterized home appliances were also a market driver for power semiconductors in 2012. According to IMS Research's report 'The World Market for Power Semiconductor Discretess& Modules 2012', there remains cautious long-term optimism, with the market projected to grow at a compound annual growth rate (CAGR) of 8% over 2011-2016, to \$26.2bn."

Key Trends

Senthil Srinivasan, Infineon Technologies

"Amid growing concerns regarding the environmental and geopolitical consequences of the continued use of fossil fuels and nuclear energy, an increasing number of countries worldwide are generating electric power from renewable sources. However this may not be sufficient as urbanization and the rise of the middle income group in emerging markets drive energy demand and ultimately energy cost. High efficiency solutions for

the generation, distribution and consumption of electricity are becoming important.

By far drives remain the biggest application segment for power semiconductors. About 300 million electric motors are in use worldwide responsible for about two-third of the total industrial power consumption. Today just 15 percent of all electric motors are based on energy efficient variable speed drive (VSD) technology, offering huge energy savings potential

As a result of India's recent growth, primary energy and electricity requirement have been rapidly increasing with the outcome that supply is falling well short of demand. According to the 2011 Indian census, 1/3 of Indian households (~80M) don't have electricity for lighting and World Bank reports that around 400 million people in India have no regular access to grid electricity. The economic impacts is also significant with reliance on coal for electricity and oil / gas imports accounting for 7% of the Indian GDP and with the govt. of India spending large amounts of funding on subsidies for lighting based on liquid fuels (kerosene & fuel oils). Improved power generation capacity (e.g. renewable energy from solar & wind), reduced loss during transmission (e.g. HVDC) and efficient power consumption (e.g. LED lighting, high efficiency power supplies, electric transportation in cars, e bikes & locomotives) would be essential in order to meet the Indian energy requirements and mitigate current problems."

**Arvind Ravishunkar,
Fairchild Semiconductor**

"The current global megatrends of 'Energy', 'Mobility', & 'Cloud' are driving investment decisions in this market. There are many opportunities to change the world by providing high efficiency and intelligent power management solutions in industrial, consumer, automotive and clean energy markets.

In the Indian market, growth in population will increase the demand for automotive two wheelers. The irregular power supply availability is driving the sales of UPS's systems. The higher need for energy efficiency in this market is driving the need for new type of ceiling fans using brushless DC motors and induction heating based rice cookers."

**Driving Applications
Senthil Srinivasan, Infineon Technologies**

"Renewable energy requires considerably more power semiconductors per gigawatt than

conventional power stations. For example, €9M (~75Cr) worth of semiconductors is required per one gigawatt of generation capacity to run a high-power wind turbine. €12M (~100Cr) per gigawatt for a state-of-the-art solar park, and €25M (~200Cr) per gigawatt for the inverters of a modern rooftop installation. These figures represent many times the amount needed per gigawatt in conventional power plants.

Higher efficiency in the conversion and the use of electric power is another long-term growth driver of the power semiconductor market. Rising energy prices and higher carbon emission levels are fuelling public interest in efficient, intelligent electric power management solutions. Better management means lower energy costs and reduced carbon emissions. Data centres are an impressive example of the implications. In 2010, 27 gigawatts of electric power were required to operate all of the data centres worldwide. A one-percent improvement in efficiency not only leads to reducing energy consumption by a total of 270 megawatts, it also diminishes the complexity and cuts down the space needed to house one of these data centres. A study conducted by Stanford University estimates that the total annual energy consumed in data centres worldwide has increased by 56% between 2005 and 2010 and that it is currently approaching the amount required to cover the entire energy needs of Australia! In view of these dimensions, even minor improvements in the energy efficiency of data centres can have a meaningful impact when seen on a global scale.

Further down the horizon, the same concerns of rising energy prices and carbon emissions will impact transportation. In the electrification of powertrain, high power semiconductors are vital components for driving the electric motors of battery powered vehicles or the over-head/3rd rail powered trains and metros. The semiconductor value of a hybrid or electric car (of which a major portion is power semiconductors) is approximately double that installed in conventional combustion engine vehicles."

**Arvind Ravishunkar,
Fairchild Semiconductor**

"The phenomenal growth of in the Asia-Pacific sector especially India and China will drive the volumes of power semiconductors in the home appliance, communications and computing market. The growth of Cloud computing will drive new power architectures in datacenters and smaller

form factor computing solutions (servers) that address this market. Increased telemetry requirements and lower total cost of ownership will drive the growth of intelligent and efficient power supplies in this market. In Mobility, small and more efficient computing form factors will drive the need for highly integrated products. Automotive demand remained strong throughout 2012 and the increasing content of electronics within vehicles is projected to drive growth in all power semiconductor markets. The recovery in 2013 and the inventory correction in the renewable energy sector, especially solar power, will also drive demand for power semiconductors across the spectrum."

Barriers to Growth

Senthil Srinivasan, Infineon Technologies

"Macroeconomic situations (for e.g. currency exchange rates, economic difficulties) play a role in the power semiconductor market as infrastructure projects like railways and metros, manufacturing localization, renewable power (solar & wind) installations are heavily influenced by such considerations.

A key challenge prevalent in Asian countries is the development of solutions that not only meet the requirements for improved energy efficiency but also at competitive cost. Infineon helps our customers address such trade-offs by offering a wide selection of devices, modules, sub-systems and even solutions and advising them on the possible options to reduce their system costs and make their products commercially competitive."

Arvind Ravishunkar, Fairchild Semiconductor

"The worldwide financial uncertainty, especially in Europe, will affect consumer buying decisions which in turn may slow down the global growth of power semiconductors. China's policies on incentives for inverterized motors and global policies for incentives in the renewable energy sector could also move this market in either direction."

Infineon Solutions

Infineon Technologies focuses on the three central challenges facing modern society: Energy Efficiency, Mobility and Security and offers semiconductors and system solutions for automotive and industrial electronics and chip card

and security applications.

According to IMS Research, Infineon continues its decade long global market leadership in Power Semiconductors. Infineon delivers semiconductor innovations playing a valuable role in minimizing power loss and maximizing power savings along the entire energy supply chain, extending from generation through distribution to actual consumption. Our products are the basis for intelligent and optimal use of energy resources in application segments like drives, renewable energy generation (solar & wind), transportation (electric vehicles & locomotives) as well as in consumer & computing segments such as power supplies & lighting.

With a global presence, Infineon operates through its subsidiaries in the USA from Milpitas, California, in the Asia-Pacific region from Singapore, and in Japan from Tokyo. In the 2012 fiscal year (ending September 2012), the company reported sales of 3.9 billion Euro.

Infineon has consistently maintained market leadership in power semiconductors by virtue of providing the best-in-class competitive technologies, products and solutions to meet our customers' and thereby the end-markets' needs.

Fairchild Solutions

Power modules are the fastest growing products in the power semiconductor market and Fairchild has an expansive portfolio of power modules to address the industrial, home appliance, UPS and automotive markets. Our vertically integrated manufacturing and design activities provide the economies of scale and the performance optimizations needed for this product in these markets.

Fairchild's investment in the 8-inch fab in Bucheon is a part of Fairchild's Asia strategy to provide high performance cost optimized semiconductor technology and the fab's proximity to the fast-growing China market increases its strategic value. Fairchild continues to push the envelope in performance by investing in next generation wide band gap semiconductors, specifically Silicon Carbide (SiC). Our SiC Bipolar Junction transistors have the best cost performance figure of merit in the industry and are targeted for mass production next year.

In the mobility and cloud markets, our investments in sensor technology will allow Fairchild to be a strong player in cellular phones and tablets.

Our continued investment in highly integrated low

voltage form factors such as the smart power stage (SPS), TinyBuck® devices and power stage will allow Cloud, mobility and networking customers to achieve higher power densities.

ROHM Semiconductor offers The Industry's First* SiC Power MOSFET with Internal SiC SBD

Significantly reduces power loss in inverters and requires fewer components

ROHM has recently announced the development of a 2nd generation high-voltage (1200V) SiC (Silicon Carbide) power MOSFET designed for inverters and converters in power conditioners for industrial devices and photovoltaic power generation. Features include low power loss and high reliability, reducing power consumption and enabling support for smaller peripheral components.

The SCH2080KE is the industry's first SiC power MOSFET to successfully integrate an SiC SBD into a single package. Forward voltage (VF) is reduced by 70% or more for less power loss and fewer components are required.

Current Si IGBTs commonly used in 1200V-class inverters and converters cause power switching loss due to tail current or recovery of the external FRD, bringing a need for SiC power MOSFETs capable of operating with low switching loss at high frequencies. However, conventional SiC power MOSFETs were plagued with numerous reliability problems, including characteristic degradation due to body diode conduction (e.g. increased ON resistance, forward voltage, and resistance degradation) and failures of the gate oxide film, making full-scale integration impossible.

ROHM has succeeded in overcoming these



problems by improving processes related to crystal defects and device structure and reducing ON resistance per unit area by approximately 30% compared to conventional products, leading to increased miniaturization.

ROHM has also succeeded in integrating an SiC SBD, which previously had to be externally mounted, in the same package using proprietary mounting technology, minimizing forward voltage that was problematic in previous SiC power MOSFET body diodes. As a result, the SCH2080KE reduces operating power loss by 70% or more compared to Si IGBTs used in general inverters. This not only provides lower switching loss, but also enables compatibility with smaller peripheral components by supporting frequencies above 50 kHz.

Key Features

1. Integrates an SiC power MOSFET and SiC SBD in a single package

The SCH2080KE integrates an SiC SBD, which conventionally was externally mounted, in the same package, reducing forward voltage along with the number of external components, saving space.

2. Excellent current and voltage characteristics with no voltage rise

Optimized process and device structure reduces ON resistance by approximately 30% per unit area compared to first-generation products. These new types of SiC power MOSFETs feature no voltage rise common with Si IGBTs had, ensuring low switching loss even during low-load operation.

3. 70% lower forward voltage minimizes switching loss and requires fewer external components

SiC power MOSFET body diodes typically feature a higher rise voltage (2.5V or more) due to SiC characteristics, possibly resulting in increased switching loss during inverter operation.

In response, the SCH2080KE integrates an SiC power MOSFET and SiC SBD into a single package for significantly reduced forward voltage, minimizing switching loss along with the number of external components.

4. No tail current enables low switching loss

Unlike Si IGBTs, ROHM SiC power MOSFETs cause no tail current, reducing turn-OFF switching loss by 90% for significantly greater energy savings. In addition, switching frequencies above 50 kHz are supported, contributing to smaller, lightweight devices.

