onsemi EliteSIC M3e MOSFET

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CONTEXT

onsemi's new EliteSiC M3e MOSFETs address the growing demands for more efficient, reliable, and cost-effective power solutions across various industries. The increasing global focus on mitigating climate change and transitioning to renewable energy sources necessitates significant advancements in power semiconductor technology. onsemi's latest generation EliteSiC M3e MOSFETs are a major step forward.

This Research Note examines the technical aspects of the EliteSiC M3e MOSFETs, their applications, and their strategic importance in the broader context of global electrification efforts.

BACKGROUND: WHAT IS SILICON CARBIDE?

Silicon Carbide (SiC) technology involves the manufacturing of semiconductor devices using silicon carbide, a compound of silicon and carbon. Due to its superior properties to traditional silicon-based devices, SiC has emerged as a significant material in the power semiconductor industry.

The technology enhances the efficiency, performance, and reliability of electronic systems across various applications, particularly in high-power and high-temperature environments.

KEY PROPERTIES OF SILICON CARBIDE

1. **Wide Bandgap**: SiC has a wide bandgap of 3.26 eV compared to silicon's 1.12 eV. SiC devices operate at higher voltages, temperatures, and frequencies.
2. **High Thermal Conductivity**: SiC exhibits high thermal conductivity, which helps in efficient heat dissipation. This property is crucial for maintaining the performance and longevity of electronic devices in high-power applications.
3. **High Breakdown Electric Field**: The breakdown electric field of SiC is about 10 times higher than silicon's. This enables SiC devices to handle higher voltages without breaking down.

4. **High Saturation Electron Velocity**: SiC has a higher saturation electron velocity, allowing faster switching speeds. This is beneficial in applications requiring high-frequency operation.

ADVANTAGES OF SIC TECHNOLOGY

1. **Enhanced Efficiency**: SiC devices have lower conduction and switching losses than silicon devices, resulting in higher efficiency in power conversion applications.
2. **Higher Temperature Operation**: SiC can operate at temperatures up to 600°C, significantly higher than silicon's limit of about 150°C. This makes SiC suitable for applications in harsh environments.
3. **Compact System Design**: The superior electrical and thermal properties of SiC allow for more compact and lighter system designs. This is particularly advantageous in automotive and aerospace applications where space and weight are critical.
4. **Increased Power Density**: SiC's ability to handle higher voltages and currents in a smaller area leads to increased power density, which is beneficial for applications like electric vehicle powertrains and renewable energy systems.

NEW: ONSEMI'S ELITESIC M3E MOSFET

The EliteSiC M3e MOSFETs are a next-generation silicon carbide (SiC) technology platform developed by onsemi, designed to significantly improve the performance, efficiency, and cost-effectiveness of power semiconductor applications.

Here are the key features and characteristics of the EliteSiC M3e MOSFETs:

TECHNICAL INNOVATIONS

Reduction in Losses

The EliteSiC M3e MOSFETs significantly reduce both conduction and switching losses. Specifically, turn-off losses are reduced by up to 50%, while conduction losses are decreased by 30%. These improvements are achieved through On Semi's unique design engineering and manufacturing capabilities, utilizing a trusted planar architecture.

High Performance and Efficiency

The EliteSiC M3e MOSFETs are designed to operate at higher switching frequencies and voltages, minimizing power conversion losses. This capability

is essential for next-generation electrical systems, enabling them to meet the demands of advanced applications such as electric vehicle powertrains, DC fast chargers, solar inverters, and energy storage solutions.

Advanced Packaging and Integration

onsemi's state-of-the-art discrete and power modules feature the 1200V M3e die, which delivers approximately 20% more output power in the same traction inverter housing compared to previous generations. This efficiency gain allows for the design of smaller, lighter, and more reliable systems, reducing costs and enhancing performance.

Specific On-Resistance and Short Circuit Capability

The EliteSiC M3e MOSFETs offer the industry's lowest specific on-resistance (RSP) with short circuit capability, making them ideal for the traction inverter market. This market is a significant consumer of SiC volume, highlighting the importance of these advancements.

APPLICATIONS

The EliteSiC M3e MOSFETs are ideal for various high-power applications, including:

Automotive Industry

Electric vehicle (EV) powertrains can significantly benefit from the increased efficiency and power density provided by the EliteSiC M3e MOSFETs. These improvements translate into longer driving ranges and faster charging times, addressing critical consumer concerns and accelerating EV adoption.

Industrial Sector

The technology also suits DC fast chargers, solar inverters, and energy storage solutions. These applications require efficient power conversion and high reliability, which the EliteSiC M3e MOSFETs deliver, supporting the integration of renewable energy sources into the grid.

Data Centers

With the exponential growth in data and the increasing demands of artificial intelligence and machine learning, data centers require higher power densities and improved efficiency. The EliteSiC M3e MOSFETs enable the development of more efficient, higher-power data centers, supporting sustainable growth in this critical sector.

Broader Market Adoption

Beyond automotive and industrial applications, the EliteSiC M3e MOSFETs are suitable for various other sectors, including banking, insurance, media and entertainment, healthcare, science, business, government, and consumer markets. The versatility and performance of the EliteSiC M3e MOSFETs make them a preferred choice for any application requiring reliable, high-performance power solutions.

ANALYSIS

onsemi’s introduction of the EliteSiC M3e MOSFETs is a significant advancement in the evolution of power semiconductor technology. By substantially reducing conduction and switching losses, enhancing power density, and improving overall efficiency, the EliteSiC M3e MOSFETs address critical challenges in a wide range of high-power applications.

onsemi's competitive differentiator is anchored in its advanced SiC technology, comprehensive power solutions portfolio, and accelerated development roadmap. The EliteSiC M3e MOSFETs exemplify onsemi’s ability to deliver superior efficiency, performance, and reliability, setting a new standard in the power semiconductor industry. This combination of technical innovation, market responsiveness, and strategic vision keeps onsemi well-positioned as a leader in driving the global transition to sustainable energy and electrification.

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