PROJECT PROFILE

19009

Intelligent power module will increase efficiency, reliability and compactness of power systems [GaNext]

The Next Generation GaN Power Module project (GaNext) aims at removing the barriers to adopting Gallium Nitride (GaN) semiconductors and fully demonstrating the higher efficiency and compactness of GaN-based power systems. The main project deliverable will be an intelligent GaN power module where the gate drive, control and protection circuits are integrated or co-packaged with the power device.

Gallium Nitride (GaN) transistors are wide-bandgap compound semiconductor devices that enable compact power electronic systems with efficiencies and power densities that are impossible with today's silicon (Si) devices. This is due to the lower on-state resistance, shorter switching times and drastically reduced switching losses of GaN compared to today's silicon-based devices. These features enable much higher operation frequencies up to the MHz range. A higher frequency directly translates into smaller passive components, such as inductors and capacitors. And this leads to much smaller power electronic systems.

Furthermore, reductions in size and costs are achieved because the cooling system can be shrunk dramatically, due to the reduced losses and improved efficiency. Cooling solutions that today consist of a large heatsink and fans can be changed to a small heatsink with convective cooling only. This reduction in size and weight are particularly beneficial for many portable and mobile solutions, such as electric vehicles (EVs) or on-board chargers.

However, there is a downside to deploying GaN. Current state-of-the-art GaN devices have certain characteristics, such as the low gate-threshold voltage, as well as, electromagnetic interference (EMI) and oscillations caused by the fast switching that make them challenging to use. This is one of the main reasons these GaN devices do not have a larger market share yet, and the innovations from GaNext aim to solve these drawbacks.

Towards next-generation GaN power systems

The aim of GaNext is to remove the barriers to adoption for GaN, and to fully demonstrate the higher efficiency and compactness of GaN-based systems in a range of power systems. The heart of the project is the development of an intelligent GaN power module where the drive, control and protection circuits are integrated or co-packaged with the power device.

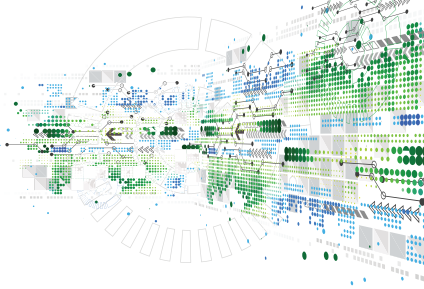
The proposed integrated power module will fundamentally improve the key issues with today's GaN-based circuits. Firstly, end-users currently lose part of the advantages of GaN since it is required to slow down the switching speed to avoid high-frequency oscillations. However, these oscillations can be drastically reduced by integrating part of the passive components into the module and the reducing EMI at the origin.

Secondly, the tailored design of the GaNext gate driver and the intimate integration in addition to the integration of auxiliary devices on the GaN integrated circuit (IC) will minimise any gate voltage distortions, which currently are a source of unreliable switching of the transistors. Furthermore, the full potential of GaN is unlocked by the added high-speed control IC with sophisticated safety features, in addition to an advanced heat- extraction technique.

Finally, integrating current and temperature sensors directly in the power module will significantly enlarge the safe operating area of the system. This multifaceted overall solution will position the GaNext module at the centre of next-generation GaN power systems.

All this will be achieved through the following:

- A GaN-on-Si power IC (650V) with integrated sensing and driving elements;
- Si and GaN low-voltage logic, control and level-shift silicon-on-insulator (SOI) gate drive circuitry;
- A dedicated package for the power module that will include the (GaN) power, control, and drive circuitry;



KEY APPLICATION AREAS

- Energy
- Transport and Smart Mobility
- ECS Process Technology, Equipment, Materials & Manufacturing

ESSENTIAL CAPABILITIES

- Systems and Components Architecture, Design & Integration
- Connectivity & Interoperability
- Safety, Security & Reliability
- Computing & Storage
- ECS Process Technology, Equipment, Materials & Manufacturing

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- Netherlands
- United Kingdom

PROJECT LEADER

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KEY PROJECT DATES

01 February 2020 to 31 December 2022

- Demonstrating competitive advantage of the power module in power systems, such as EV charger, lighting, motor drive and PV inverter applications; featuring optimised magnetic components.

Well-suited project consortium

The project consortium will cover the entire technology chain required for developing the intelligent GaN power module. A deep synergistic and interdisciplinary approach is indeed key to achieving the GaNext objectives, and the consortium has been carefully assembled to satisfy this need. Its experience and expertise cover a large part of the power electronics and power devices market value-chain: from semiconductor device design to sales of power conversion systems. Crucially, it includes such areas as: semiconductor chips and devices; semiconductor packaging and integration; magnetic components (such as inductors and transformers, key components for any power electronic system); and power electronic systems and products.

Green issues and other market drivers

The market for GaNext-related products can be divided into the following sub-segments:

- GaN power devices and GaN power modules;
- Gate driver and control-IC;
- Packaging;
- Magnetics;
- Power electronics (which is further divided into the specific market segments addressed in GaNext).

Now, every electronic or electrical device today contains at least one power electronic system. Crucially, GaN technology has the potential to improve the energy efficiency of the largest part of these systems. This means that the GaNext project will help to reduce greenhouse gas emissions and energy consumption in Europe and beyond. Significantly, demonstrating this intelligent technology would be a breakthrough that will strongly support the clean-growth mission and electrification revolution that has started worldwide.

Environmental policy and regulations will further drive this market. Regulations set by Energy Star – an initiative of the U.S. Environmental Protection Agency and U.S. Department of Energy – that have also been adopted by the EU and Japan, are imposing higher energy efficiencies and therefore promoting GaN technology. Several governments have also announced ambitious targets for EV uptake in the next ten years, including the UK, Norway and Denmark. In addition, EV and the associated charging infrastructure are predicted to be strong drivers of GaN technology. Furthermore, the new JEDEC standard JC-70.1 on GaN devices will provide universal standards, another significant step forward in the adoption of GaN technologies.

This means that the overall power-electronics market this technology will address looks promising at over US$200 billion. More specifically, the GaN power-devices market, which is growing at an impressive CAGR of 91%, is expected to reach US$500m by 2022 with power supplies for EV and photovoltaic inverters sharing 60% of this market.

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