Project result

Cluster for Application and Technology Research in Europe on NanoElectronics

CA402 | Innovative power technology gives industry and the environment a huge boost [THOR]

The THOR project has developed highly efficient, integrated and reliable power electronics technologies, offering major European industries new opportunities, steep growth in silicon carbide devices and increased competitiveness. Crucially, this project exploits new technologies for discrete power components and power cores, and systems – currently one of the most promising areas of electronics – while reducing CO_2 emission.

Innovative technology developed by the co-labelled CATRENE-EURIPIDES THOR project has produced a steep increase in silicon carbide (SiC) devices in the market and delivered solutions for packaging, cooling and electromagnetic compatibility. More compact power conversion solutions are expected in the key automotive, aeronautics and healthcare application areas. Importantly, all of this helps industry transform the SiC market from a device to a power modules business.

In modern power converters, most of the volume is taken up by cooling components and electrical filters. Now, SiC-based power devices take up less space, something THOR exploits in its development of high-temperature packaging, compact cooling systems and smaller filters. In addition, compact power-conversion systems with very high power density have been demonstrated in all three application areas.

THOR's main deliverables were:

- Highly reliable, design-oriented prototypes of miniaturised high-voltage, high-frequency and high-temperature power modules based on new wide bandgap semiconductors, like SiC;
- High-temperature SOI or SiC drivers and DC/DC converters using improved silicon-based power devices.

Market, environmental and societal spin-offs

In its goals to develop highly efficient, integrated and reliable power electronics technologies for automotive, aeronautics and healthcare applications, THOR worked widely with end-users from these three industries, together with European semiconductor, packaging and cooling manufacturers associated with technology developers, as well as European academic partners. Such broad collaboration was made possible by the unique assistance provided by two large European support-programmes: CATRENE and EURIPIDES.

THOR is expected to make all these technologies – ranging from power electronics components to complete systems – available in Europe, thus improving the robustness and reliability of high power electronics in the process, and facilitating their miniaturisation. This will also create new applications in the automotive, transport and healthcare sector. Critically, it will also increase the competitiveness of the major European industries in these fields, together with the European industry of power electronics, currently one of the most promising areas. In particular, THOR will contribute in sustaining a competitive environment for the European automotive industry by speeding up the

ENERGY-EFFICIENT DEVICES AND ENERGY CONTROL SYSTEMS

Partners:

Airbus Group Innovations
Ampère Insa Lyon
Bruco Integrated Circuits
Cirtem
Epsilon Ingénierie
Labinal Power Systems (Safran)
NXP
Philips
Prodrive
Soitec
ST Microelectronics
Thales Microelectronics
Université de Versaille Saint-Quentin en Yvelines
TU/e
Valeo

Project leader:

Mark van Helvoort
Philips

Key project dates:

Start: October 2010
End: March 2014

Countries involved:

France
The Netherlands

Project website:

http://www.thor-project.eu/

PROJECT CONTRIBUTES TO

Communication	
Automotive and transport	✓
Health and aging society	✓
Safety and security	✓
Energy efficiency	✓
Digital lifestyle	
Design technology	✓
Sensors and actuators	
Process development	✓
Manufacturing science	
More than Moore	
More Moore	
Technology node	

time-to-market and reducing costs for end-users. In general, the transformation of the SiC market from a device to a power modules business will lead to a jump in growth of SiC devices: from 26% to 39% by 2015.

Away from the technology and economic spotlight, there are important societal issues which THOR addresses. For instance, these compact and highly efficient converters can be effectively deployed in meeting such environmental challenges as dealing with CO_2 emission and over-reliance on fossil fuels. Power converters will also reduce significantly the weight of cabling in an aircraft, thus reducing fuel consumption. And an additional 30% fuel is saved by storing transient energy during braking. In the medical area, more compact systems at a lower cost help to deal with health challenges in the ageing society.

Scoring commercially

Key to THOR's success is the way it leverages economy of scale by addressing its full supply-chain – from semiconductor-device producer to power system-integrator – in all three application areas. The commercial advantage is a stronger competitive environment for the various industrial partners, because recent advancements in power electronics technology provided by its academic partners have been integrated into advanced applications. This ranges from SiC and silicon-on-insulator (SOI) technology to full compact power converters integrated in large systems.

Encouragingly, THOR's industrial partners have already started reaping the fruits of their labour:

- The first products based on THOR technology are already available on the market. In September 2012, SiC diodes for photovoltaic converters were released. In 2014 this range will be extended to additional applications, and SiC Mosfets will follow soon;
- A new SOI process is in place, facilitating the design of high temperature drivers, and the integration of low-voltage and high-voltage integration at a lower cost;
- In the area of electric vehicles, a compact air-cooled high-voltage DC/DC-converter with an efficiency of 93% and 95% over a very broad output power range was demonstrated. The vapour chamber and heat sink have been designed such that the cooling capabilities of the converter are independent of the mounting orientation, thus offering wide flexibility to car designers;
- Four partners were able to offer a compact power converter which covers a very large temperature range, thus ensuring it can be suitably located on aeronautic engines and airplane brakes (which generate very high temperatures);
- Two other partners demonstrated the capabilities of full digital control for power electronic: among others, a compact high-voltage power supply with an ideal topology for introducing SiC components. Pilot tests in hospitals are already ongoing. In addition, a feedback system was developed which can correct up to 10 dB variations in amplifier gain.

Broad collaboration

Information sharing and cross-fertilisation – crucial to the success of the wider effort and future of a project such as THOR – was excellent and worked well within the project consortium: more than 70 reports (including results), have been internally exchanged; and new, long-lasting, collaborations have been established. Furthermore, the key project players in THOR have guaranteed their efficient and effective cooperation with other related European projects.

THOR also shared its newly acquired knowledge externally with those in industry and academia: more than 30 papers have been written; some 25 presentations were given; and 12 patent applications have been submitted. In addition, a book on the electromagnetic compatibility (EMC) of large systems and installations has also been published in Dutch and is currently being translated.

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CATRENE (Σ! 4140), the EUREKA **C**luster for **A**pplication and **T**echnology **R**esearch in **E**urope on **N**ano**E**lectronics, will bring about technological leadership for a competitive European information and communications technology industry.

CATRENE focuses on delivering nano-/microelectronic solutions that respond to the needs of society at large, improving the economic prosperity of Europe and reinforcing the ability of its industry to be at the forefront of the global competition.