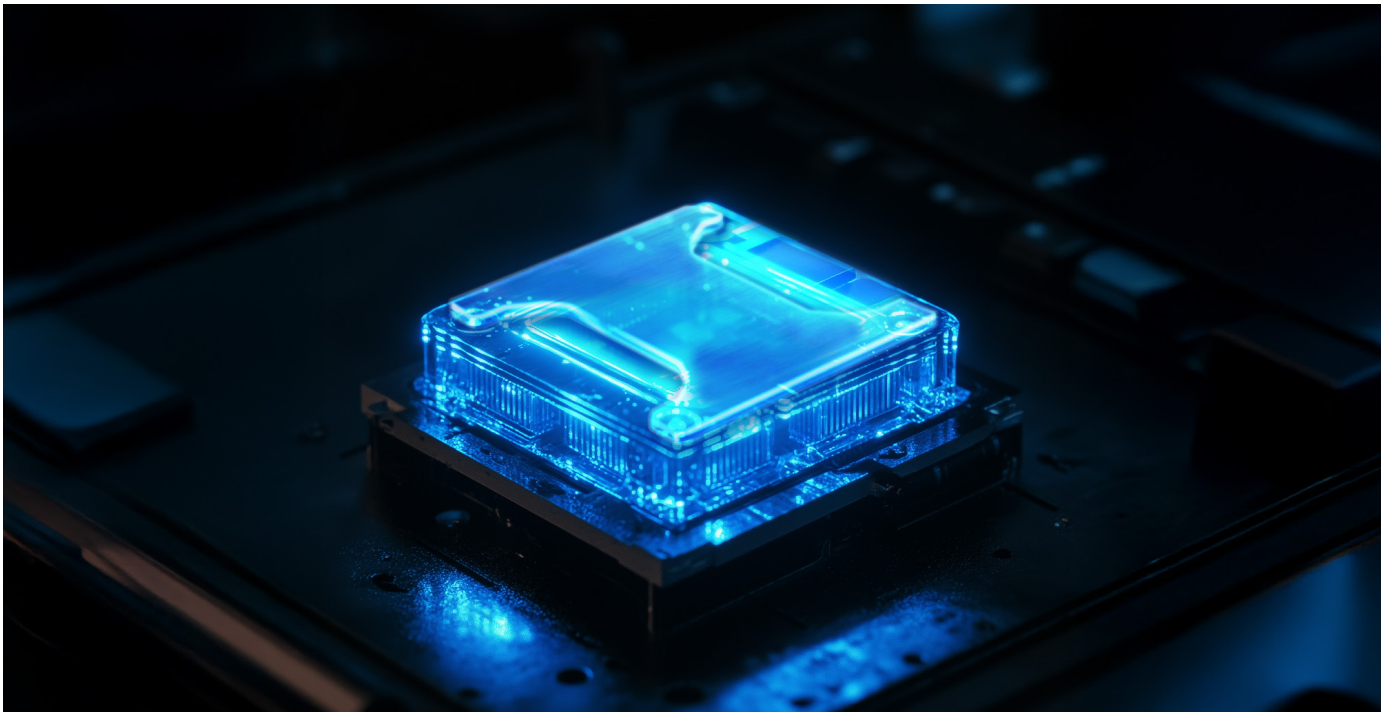

New power technologies for industry modernization!

Industrial modernization is not just a buzz phrase, and with the implementation of new technologies required by Industry 4.0, many companies are migrating from traditional process control and infrastructures to networked types, including more communication, and with better utilization of energy must consider either upgrading existing equipment or buying brand new. When considering the installed base, taking into account the cost of a new installation and downtime, then upgrading and refurbishing is often considered an attractive solution. However, adding new functionality into existing packaging and enclosures can be very challenging. In a single article it is almost impossible to cover the wide variety of business cases when upgrading industrial equipment, but it is interesting to consider a dilemma faced by system architects: to get more power into a form, fit & function (3F) package, or to add more functionality to it while maintaining full compatibility with the installed equipment (Figure 01). So, what are the latest innovative power solutions that make this possible?

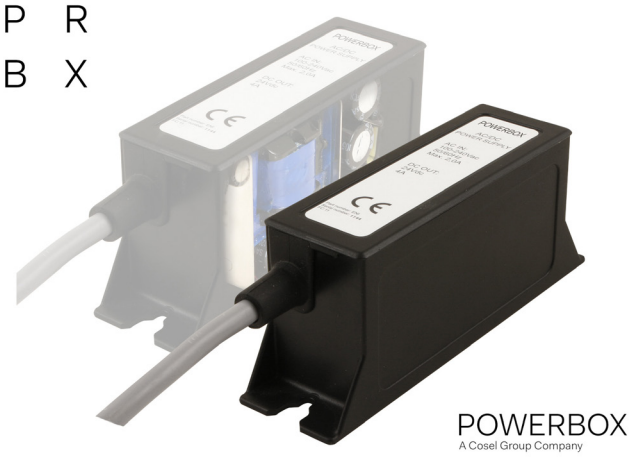

Figure 01: Example of industrial power supply, which could benefit from new technologies to double the output power from 100W to 200W matching the 3F (Source: PRBX)

The benefits of the Wide Band Gap technology?
For decades, improvements in energy efficiency levels of power supplies have been made possible by technological evolutions. Moving from linear to switching technology was probably the major one, followed by several more minor leapfrogs until digital power came to market followed by the Wide Band Gap (WBG) semiconductors (Gallium Nitride (GaN) and Silicon Carbide (SiC). Despite it having been on the market for several years, with the emerging WBG technology and the possibilities offered by those components, digital control becomes an absolute must and a major building block for power designers when developing new products, especially when addressing 3F as associated with industrial modernization. Component wise, WBG transistors are without doubt the ones that will prevail in the coming years.

What is interesting with WBG semiconductors is that we see a similar situation to when the first power MOSFETs were launched. Some immediately considered the benefits of WBG, and that despite early products not being very user friendly due to them being based on a depletion mode that requires very specific drivers, it didn't take too long for power semiconductors manufacturers to provide 'easy-to-use' versions and solutions.

It is now couple of years since manufacturers began promoting the benefits of that technology, but if the Go-To-Market is ready, in industrial applications the Go-To-Application for mass users still requires a certain amount of time. We are all familiar with the 'camel-back' curve reflecting new technology adoption and crossing the chasm (Figure 02). Experienced power designers have crossed that technological chasm many times, with the latest one being the migration from analog control to digital and adopting WBG followed the same pattern, but first driven by consumers' applications e.g., USB chargers and the automotive industry implementing WBG in powertrains where on-board and out-board chargers boosted adoption in those segments.

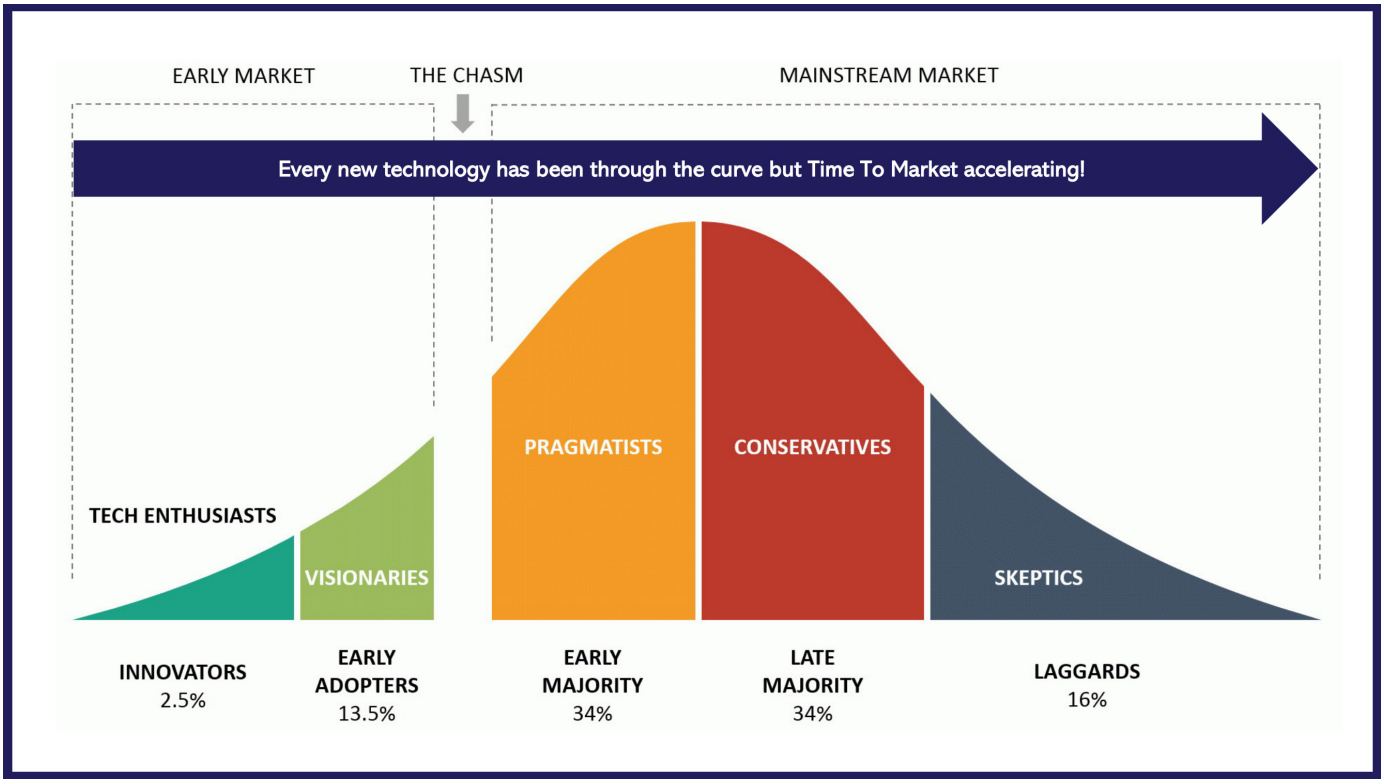

Figure 02: the 'camel-back' curve reflecting new technology adoption and crossing the chasm (Source: PRBX / Geoffrey A. Moore)

WBG technology offers the benefit to increase switching frequency with high efficiency making it possible to reduce the size of the power supply and to pack more power into a similar packaging, but by itself this is not enough to meet 3F requirements. For sure, the evolution of semiconductors is very important but, in the quest to increase power density, to reduce power losses and to offer space for more functionality, power designers must consider the transformer aspect and how to make them smaller and better integrated.

In that respect power designers have explored the potential of advanced planar transformers with interleaved multi-core technology. Not all power supplies require megahertz switching but considering the potential of WBG semiconductors and the gain in power density, power designers will have to consider new types of transformers and new winding techniques. This points to a situation where more research is required rather than ready for mass production, but the situation is being helped by ferrite manufacturers developing new materials and also by Artificial Intelligence software shortening time to design and test new transformer types (e.g., Frenetic, Simba).

One specific example of that is the research we conducted at PRBX, combining digital control, WBG-GaN, and multicore transformers with advanced wiring and auto-tuned performance within the wide operational range that we see in some industrial applications that require extremely wide input voltage ranges, as well as outputs subject to repetitive peak loads. Final products are actually at the design stage although preliminary results we achieved are very encouraging and would not have been possible without the combination of digital control, WBG technology and advanced magnetics (Figure 03).

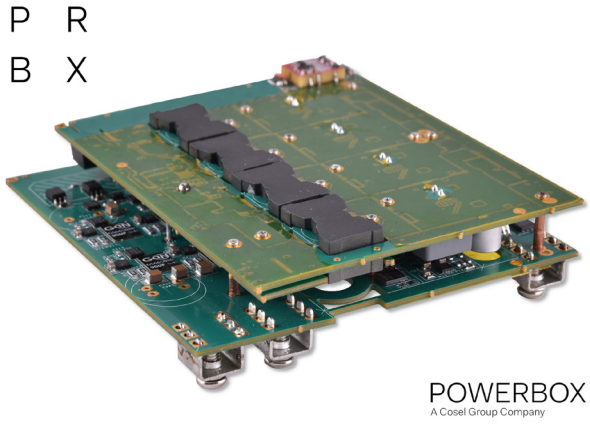

Figure 03: High power density PSU benefiting from planar magnetics, WBG and digital control. (Source: PRBX)

At this point we can joyfully ponder the level of integration and how much could be gained by combining the three aforementioned technologies: digital-control, WBG and integrated transformers. To illustrate that, the EPC9159 module demonstrated by Efficient Power Conversion (EPC), using the 40V GaN EPC2067, is very interesting and the combination of the three technologies has made it possible to shrink a power converter to an unprecedented size of 22.9 x 17.5 mm, reaching a power density of 5kW/inch cube in a small matchbox format (Figure 04).

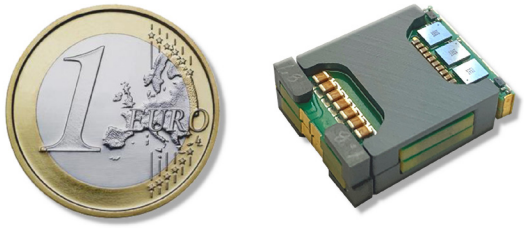

Figure 04 : EPC Reference design 1kW LLC power converter (Source: PRBX/EPC)

From research to applications

Reaping the benefits of the three aforementioned technologies, as long as five years ago USB Charger manufacturers were the early adopters, developing and commercializing high-power density power supplies, which many of us are probably already using when charging our phones or laptops. In the curve of market adoption, the industrial segment is more conservative and is taking a longer time to evaluate new technologies, to verify performance levels and reliability in operating conditions (which are clearly more demanding than a USB charger), verifying robustness, securing supply chains and long-term sustainability.

It's not possible to cover all examples but it is interesting to mention the modernization of a microelectronics factory that uses many power supplies to power sensors, transmission systems and alarms. Originally powered by a 50W single output in a conventional open frame format, the modernized architecture required a very compact power solution three time smaller than the conventional products, to fit into a smaller packaging, originally hosting

a 25W power supply. For simplification, the Upgrade Manager in charge of the project required the 50W power solution to fully comply with the 3F of their referenced solution, no compromise possible and mandatory to be qualified.

Based on the laws of physics, the only way to reach such power density was to increase the switching frequency, to integrate magnetics and to use an optimized power topology (Figure 05), all of those and reducing the power consumption of the overall system.

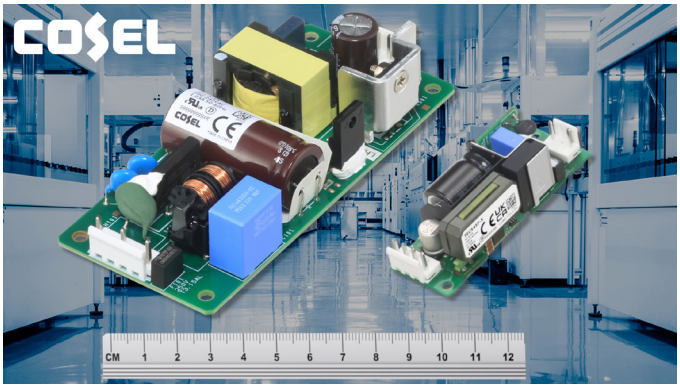

Figure 05 – Example of size reduction, in a 50W power supply, offered by the new power technologies combining WBG, Digital Control and Integrated magnetics developed by COSEL. (Source: PRBX/COSEL/Shutterstock/ssguy)

Conclusion:
The given example is one of many but as in the consumer and automotive segments, the implementation of the three combined technologies: Digital Control, WBG and integrated magnetics will become preponderant when developing power solutions for industrial applications. It's a very exciting time for power designers to participate in industrial modernization, and to implement technologies contributing to reduce energy consumption.

About Powerbox
Founded in 1974, with headquarters in Sweden and operations in 15 countries across four continents, Powerbox serves customers all around the globe. The company focuses on four major markets - industrial, medical, transportation/railway and defense - for which it designs and markets premium quality power conversion systems for demanding applications. Powerbox's mission is to use its expertise to increase customers' competitiveness by meeting all of their power needs. Every aspect of the company's business is focused on that goal, from the design of advanced components that go into products, through to high levels of customer service. Powerbox is recognized for technical innovations that reduce energy consumption and its ability to manage full product lifecycles while minimizing environmental impact. Powerbox a Cosel Group Company.

Patrick Le Fèvre
Powerbox Chief Marketing & Communication Officer

About the author
Chief Marketing and Communications Officer for Powerbox, Patrick Le Fèvre is an experienced, senior marketer and degree-qualified engineer with a 40-year track record of success in power electronics. He has pioneered the marketing of new technologies such as digital power and technical initiatives to reduce energy consumption. Le Fèvre has written and presented numerous white papers and articles at the world's leading international power electronics conferences. These have been published over 450 times in media throughout the world. He is also involved in several environmental forums, sharing his expertise and knowledge of clean energy.

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