2022 - a year of technology innovations!

As is the case in many industries, power electronics has been affected by the Covid-19 pandemic, although paradoxically we have seen a boost in new technologies and opportunities for power designers to capitalize on the benefits of E-learning. It's always difficult to derive trends from large industries but if we look back to the major events such as the Applied Power Electronics Conference (APEC), Power conversion Intelligent Motion (PCIM) or the international exhibition Electronica, as a power engineer it is interesting to take a minute to ponder and consider what contributed to making power supplies more efficient, more reliable and exciting to design in 2022.

Overall trends and technology

The so-called 'electrification' and transition from fossil fuels to renewable energy is a major trend that we are all aware of. This segment requires a lot of technological innovation to reach the carbon neutral level expected by the European Commission, US DOE and similar initiatives in Asia. If we focus on what most of the power supplies companies are developing, I can see that four trends and one technology development influenced the power industry in 2022: Reducing energy consumption; Power supplies becoming part of the Machine-to-Machine eco-system ; Enhanced energy storage solutions ; Acceleration of harvesting energy solutions, with all of them benefitting from the implementation of Wide Band Gap Semiconductors.

In the quest for reduced energy consumption, from harvesting energy to the grid, the power electronics industry is permanently seeking new ways to improve efficiency. International and local regulations have forced power supply manufacturers to innovate but we are seeing more stringent regulations under discussion that might require the power industry to explore new topologies, components and materials.

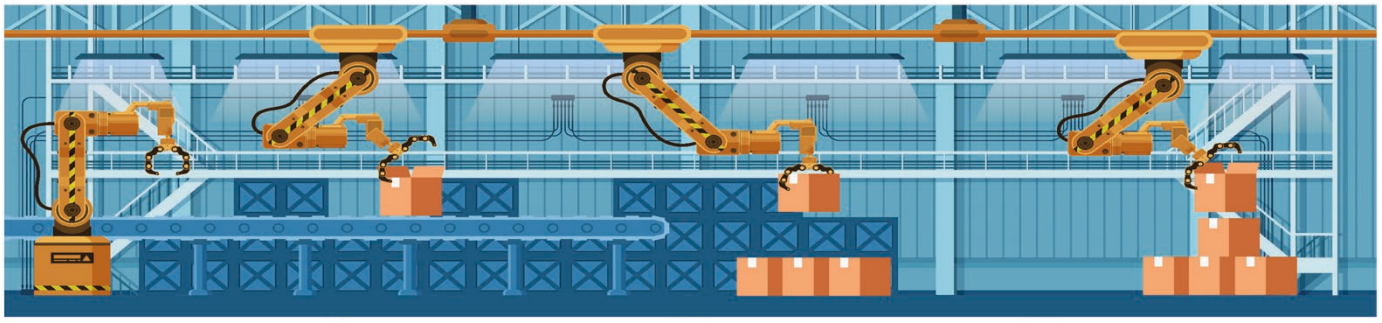
I would like to illustrate that trend with one example that will include and benefit from them, E-commerce.

E-commerce was already growing before Covid-19, but as consequence of curfews, working at home, and the drastic reduction of physical interaction, it has grown exponentially, putting a high demand on shipping hubs, computerized storage and the overall supply chain. Before we even mention the associated datacenters required to manage the E-commerce process, shipping hubs and warehouses have become gigantic and consume lots of energy. Making handling and shipping hubs more energy efficient has been on the agenda for all the major players, though the 2020-2021 peak on demand was a strong a signal for them to reconsider the way to use and manage energy.

Power supplies as such are not consuming most of the energy, but when considering their strategic position in the operational chain they become a key-point in the overall process to optimize how energy is used in the complete chain. In 2022 we have seen very advanced power supplies used in E-commerce handling and shipping hubs to replace conventional power supplies. The new generation not only integrates higher levels of communication, but is able to store and restore energy from supercapacitor banks, reducing peak disturbances on the grid and consumption. Already experimented with in 2021, the power supplies have been integrated into a complete eco-system with Machine-to-Machine communication (Figure 01). They not only deliver power to a load e.g. conveyor motors, but they are able to sense and adjust the level of energy to store in local supercapacitor banks (Figure 02).

Figure 02 – PRBX S-CAP BOOST supercapacitors bank with digital control and communication interface able to deliver peak energy to load and to store backward energy (Source: PRBX)

Almost invisible, from the RFID inserted in the shipping box that will get power from RF signals, to sensors placed on motors or moving elements powered by vibration, micro-systems powered by harvested energy are developing very fast. Here also, the nanotechnology such as nanotubes made it possible to develop very small supercapacitors storing enough energy to power sensors and transmitters.



Power unit example	First handling	Following handling	Overall
	• Conveyer, or arm, sensor scale the parcel and sent weight information to hub process control (HPC) • HPC sent power profile to PSU with energy profile • Supercap charged in advance • Recycled energy stored back	• Load sensing and cross-check with HPC • Power profile for next handling station send directly from station one (check with HPC) • PSU configure to manage load • Energy profile sent to next station	• This process is repeated as many as the number of handling stations • Overall energy consumption per line/process analysis for billing and predictive maintenance • More PSU integration within process management

Figure 01 – Smart Power operation in Smart Factory with machine-to-machine communication (Source: PRBX)

To make that possible the implementation of digital power and communication is a must, but the level of performance will require power electronics engineers to design new power solutions with the so called 'Wide band gap' semiconductors. Depending on the application and voltage they will select GaN or SiC types but the benefits of WBG will contribute to making E-commerce more energy efficient and to a lowering of the CO2 footprint.

Critical building blocks!
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 a number of more minor leap-frogs until digital power came to market.

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 I strongly believe that will be a major building block for power designers when developing new products.

Component wise, the WBG transistors are without doubt the ones that prevailed in 2022. That said, conventional Power FETs have also made big progress and power designers will have to achieve new levels of business assessment and acumen when selecting the most appropriate technology for their applications.

The third building block, one that I consider as an important contributor to the 2022 technology evolution, is the advanced planar transformer with interleaved multi-core technology. Not all power supplies require megahertz switching but considering the constant quest for smaller power supplies with higher efficiency, power designers will have to consider new types of transformers and new winding techniques. In that respect they will be helped by ferrite manufacturers developing new materials but also by Artificial Intelligence software shortening time to design and test new transformer types (e.g., Frenetic, Simba).

One specific example of that is research currently being undertaken at Powerbox, combining digital control, 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 not yet ready but with the combination of digital control, WBG and advanced magnetics, it should soon be a physical reality (Figure 03).

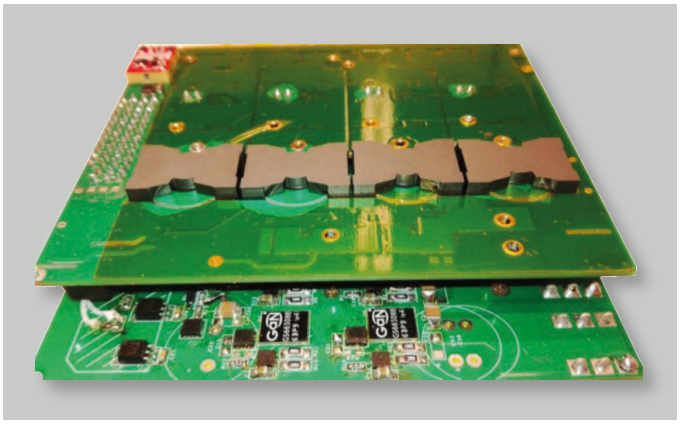


Figure 03 – PRBX multi-cores auto-tuned power converters with advanced digital control and GaN FET transistors (Source PRBX)

I believe many of the new products that we will see in 2023 and onwards will be based on those three building blocks, which I'm sure will also include more communication to become part of a Machine-to-Machine ecosystem.

In WBG we trust!
What is interesting with the Wide Band Gap semiconductors is that we see a similar situation to when the first power MOSFETs were launched. Some immediately considered the benefits of the 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' solutions.

It is now more than five years since manufacturers were promoting the benefits of that technology but if the Go To Market is ready, the Go To Application for mass users is requiring a certain amount of time.

We are all familiar with the 'camel-back' curve reflecting new technology adoption and crossing the chasm. Experienced power designers have crossed that technological chasm many times, with the latest one being the migration from analog to digital control, and it

taking more than 10 years to reach a significant level of adoption (Figure 04).

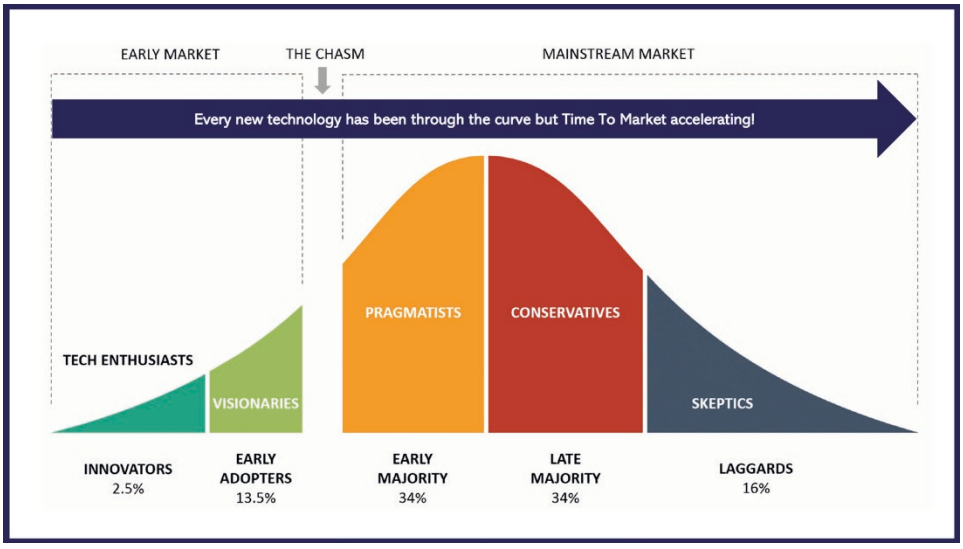


Figure 04 – Experienced power designers have crossed that technological chasm many times, with the latest one being the migration from analog control to digital (Source: PRBX)

In the case of WBG - and especially Gallium Nitride (GaN) - early adopters entered the fray much quicker than some predicted a few years ago. It is no surprise that the PC and Mobile/ Nomad industries were some of the early adopters. The number of USB-C chargers using GaN semiconductors announced in 2020-2021 is very impressive. Particularly worthy of mention is Navitas' next-generation GaNFast power IC that will drive the 120W ultra-fast charger supplied 'in-box' with vivo's iQOO-brand flagship iQOO 9 Pro mobile phone, demonstrating the rapid adoption of GaN by the 'nomad' industry. But not just its electrical performance, using GaN reduces the physical size by 26%, reaching a stunning 1.3W/cc power density, which is quite incredible (Figure 05).

Figure 05 – Navitas' next-generation GaNFast power IC that will drive the 120W ultra-fast charger, contributing to reduce its size by 26% (Source PRBX/Navitas)

If it took 10 years for digital power to become a de facto technology, it took only five years for WBG to reach a similar level.

What is interesting in the development of the WBG semiconductors is that due to the specificity of this technology, that's very low internal resistance and ability to switch very fast, the packaging is very important and we see a lot of innovation from manufacturers to offer optimized solutions. Technology wise the Efficient Power Conversion (EPC) approach is very interesting, minimizing interconnection losses, and making it possible to shrink a power converter to an unprecedented size (Figure 06).

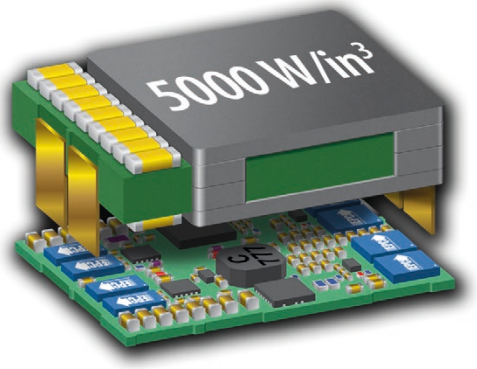


Figure 06 – Efficient Power Conversion (EPC) approach is very interesting, minimizing interconnection losses, and making it possible to shrink a power converter to an unprecedented size (Source: PRBX/EPC)

Something to mention is the amazing number of technical webinars proposed during the Covid-19 era, which set the base for a new way of learning and accelerating new technology adoptions. Many companies have taken that as an opportunity for their power designers to attend online training, and as a result some power-semiconductor companies have reported shipping up to 10 times more evaluation kits than before the pandemic days and that trend was confirmed at Electronica 2022.

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If we simplify the market into two segments: High voltage (using SiC) and Low voltage (using GaN), we see two different patterns. High voltage applications e.g. electric vehicles and solar are familiar with SiC transistors, and for that segment it is no big revolution for power engineers to undergo a learning phase for the relatively new low voltage technology.

In conclusion

In many different ways we have all been affected by the pandemic, although looking back it has contributed to boost new technology learning and to speed innovation. After lockdown and all the restrictions, who could have imagined that APEC, PCIM and Electronica would enjoy such huge levels of success and that so many new products would be released? WBG is probably the technology that caught the highest levels of attention, but overall, power electronics has benefited from an impressive number of innovations. 2022 has been an amazing year for power designers, and 2023 is set to be even more exciting with projects moving to high volume production and many more to come.

References:

Powerbox (PRBX):
https://www.prbx.com/

Navitas Semiconductors:
https://navitassemi.com/

Efficient Power Conversion (EPC):
https://epc-co.com/epc

Frenetic
https://frenetic.ai/

SIMBA
https://simba.io/

Applied Power Electronics Conferences (APEC)
https://apec-conf.org/

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.

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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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