DC-DC converters for Next Generation Electric Vehicles

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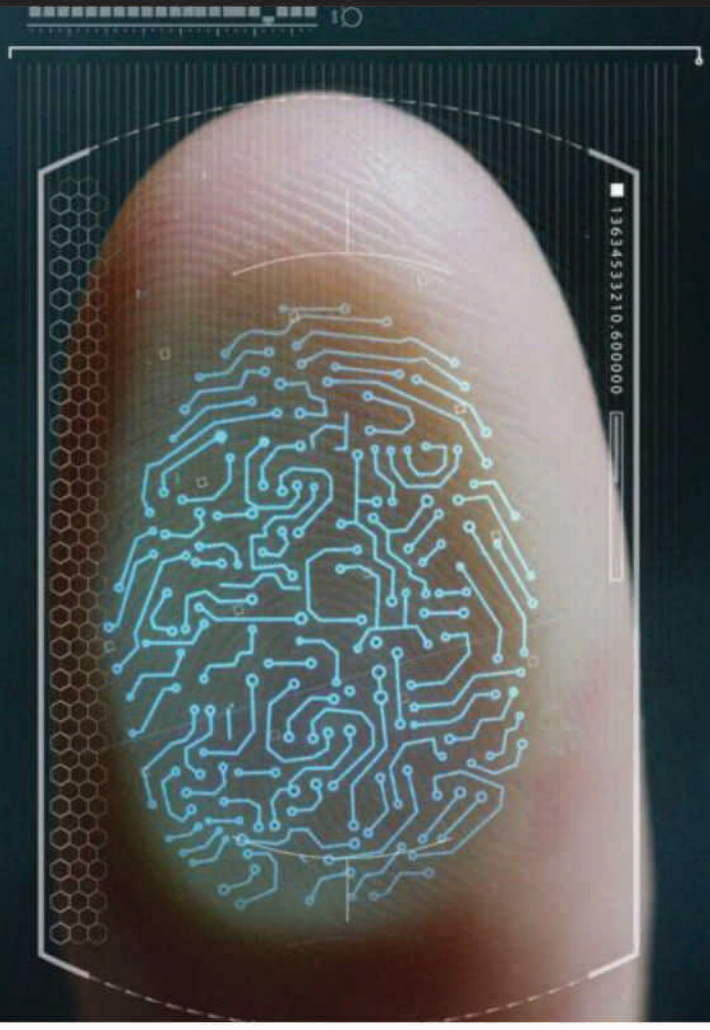

The Future of IoB is Exciting

- Top Manufacturers in Silicon Carbide
- A New Wave of IoT solutions lead the way to more sustainable farming
- The Future of Power Needs to be Exotic
- Technology Outlook for Silicon Carbide Semiconductors
- What lies ahead in 2022 for Robotics
- NanoEdge AI Studio

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CONTENTS

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and much more....

Deep Learning, AI Used to Advance X-ray Data Technology

Scientists from the United States Department of Energy's (DOE) Argonne National Laboratory are using deep learning and artificial intelligence strategies to upgrade the current Advanced Photon Source (APS) and visualize X-ray data in three dimensions.

Researchers have developed a new computational framework called 3D-CDI-NN. The framework has demonstrated it can create 3D visualizations from data collected at the APS significantly faster than traditional methods.

Coherent diffraction imaging (CDI) is an X-ray technique that bounces ultra-bright X-ray beams off samples. The beams of light then are collected by detectors as data and are turned into images. According to Mathew Cherukara, leader of the Computational X-ray Science group in Argonne's X-ray Science Division (XSD), the current detectors only capture some of the beam's information.

Scientists rely on computers to fill in missing data. However, the process can take a significant amount of time. The solution, according to Cherukara, is to train artificial intelligence to recognize objects and the changes they undergo directly from raw data, without having to account for missing information.

The team trained the neural network with simulated X-ray data. The neural network is a series of algorithms designed to teach computers to predict outcomes based on the data it receives.

After testing 3D-CDI-NN's ability to fill missing information, scientists saw that the network can reconstruct images with less data than typically required to compensate for information that was missed by the detectors.

The incorporation of this new technology has the potential to advance 3D imaging technologies regarding biological structures.

Facebook AI Open-Sources CO3D

3D object reconstruction is a significant computer vision problem with AR/VR technology applications, such as telepresence and the generation of 3D models for gaming. New emerging technology for photorealistic 3D reconstruction can seamlessly mix real objects with virtual ones on traditional smartphones, laptops, and even augmented reality glasses of the future. To summarize, the current 3D reconstruction methods rely on learning models for various object categories, which are limited since there is a lack of data sets containing videos of real-world objects and accurate 3D re-creations. Since models use these examples to create adequate reconstructions, researchers typically just used synthetic objects with approximate matches in nature.

Facebook AI releases a large-scale data set containing real videos of common object categories with 3D (CO3D) annotations. The new CO3D has 1.5 million frames from nearly 19,000 videos capturing objects from 50 different types in the widely used MS-COCO dataset for increased accuracy and coverage over previous alternatives to improve research efforts around this field.

Infineon launches a new SECORA™ Pay portfolio on 40 nm technology

In recent years, there has been a noticeable trend toward contactless payment. Infineon Technologies AG has been the market leader for payment ICs for the last eight years, with a current market share of 48 percent*. To complement the payment offering based on the latest 40 nm technology platform Infineon now launches a new portfolio of SECORA™ Pay payment solutions.

The plug-and-play solutions are leveraging the extensive expertise in contactless payment technology and utilizing Infineon's SOLID FLASH chip platform, which addresses new payment card and device

solutions while meeting the latest requirements. The offering includes new applets and customized value-added products for standard payment cards (SECORA Pay S), as well as multi-application cards (SECORA Pay X) and components for off-the-shelf solutions that can turn any device into a payment device (SECORA Pay W). In addition, the product portfolio provides applets of global (Visa, MasterCard, Discover, and American Express) and domestic networks. It offers state-of-the-art contactless and personalization performance, allowing MasterCard contactless transactions of 200 ms.

Smartphone based road mapping to prevent Accidents in India

Researchers from India and Japan are working on the smartphone-based mapping of road health in both the countries to reduce the accidents caused due to damaged roads
The joint project by the Indian Institute of Technology (IIT), Roorkee and the University of Tokyo is aimed at developing an affordable and deployable solution for automating the monitoring of road conditions and ultimately enhancing road safety.

The team also has inputs from Alexander Mraz, a data scientist from Luxembourg in Europe. According to road safety experts, the key to road surface condition monitoring is to detect road surface anomalies, such as potholes, cracks and bumps, which affect driving comfort and on-road safety.
IIT-Roorkee professor Durga Toshniwal, who is supervising the Indian team in the ongoing research, said the road infrastructure holds critical socio-economic importance for providing vital transportation services to people and commodities worldwide.

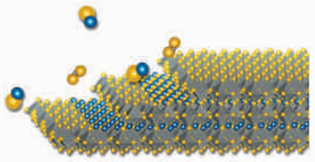
Quantum chip can outperform classical computers in two years

International Business Machines on Monday said it has designed a new quantum computing chip that its executives believe will let quantum systems start to outperform classical computers at some tasks within the next two years.
IBM said that its "Eagle" computing chip has 127 so-called "qubits," which can represent information in quantum form. Classical computers work using "bits" that must be either a 1 or 0, but qubits can be both a 1 and a 0 simultaneously.
That fact could one day make quantum computers much faster than their classical counterparts,

but qubits are exceedingly hard to build and require huge cryogenic refrigerators to operate correctly. While Apple Inc's newest M1 Max chip has 57 billion transistors - a rough proxy for bits - IBM says that its new Eagle chip is the first to have more than 100 qubits.
But IBM said that new techniques that it learned in building the chip, which is manufactured at its facilities in New York state, will eventually produce more qubits when combined with other advances in the quantum computer's refrigeration and control systems. The company said Monday it plans an "Osprey" chip in 2022 with 433 qubits and a "Condor" chip 1,121 qubits.
At that point, the company says it will be close to what is called "quantum advantage," the point at which quantum computers can beat classical computers.

High-quality thin films of a new family of semiconductor materials

MIT engineers report creating the first high-quality thin films of a new family of semiconductor materials. The feat, which lead researcher Rafael Jaramillo refers to as his "white whale" because of his obsession in pursuing it over the years, has the potential to impact multiple fields of technology if history repeats itself. The ability to create high-quality films of other families of semiconductors led to computers, solar cells, night-vision cameras, and more.



When introducing a new material, "the most important scientific breakthroughs are enabled only when we have access to the highest-quality materials available," says Jaramillo, the Thomas Lord Associate Professor of Materials Science and Engineering at MIT. "Studying materials of low quality often results in false negatives with respect to their scientific interest and technological potential."
The new family of semiconductors, known as chalcogenide perovskites, could have applications in solar cells and lighting, Jaramillo says. He notes, however, that "the history of semiconductor research shows that new families of semiconductors are generally enabling in ways that are not predictable."
Jaramillo is excited about the new materials' potential because they are ultrastable and made of inexpensive, nontoxic elements. The thin films his team created are composed of barium, zirconium, and sulfur in a specific crystal structure, "the prototypical chalcogenide perovskite," Jaramillo says. "You can make variations by changing the composition. So it is indeed a family of materials, not just a one-off."

Scientists Just Widened the Gap With New Tiny Chips

A team of researchers just made a breakthrough in semiconductor materials, creating a chip that could push back the "end" of Moore's Law and further widening the capability gap between China and U.S.-adjacent efforts in the

field of 1-nanometer chips, according to a recent study published in the journal Nature. The breakthrough was accomplished in a joint effort, involving the Massachusetts Institute of Technology (MIT), National Taiwan University (NTU), and the Taiwan Semiconductor Manufacturing Co (TSMC), which is the world's largest contract manufacturer of advanced chips. At the core of the breakthrough is a process that employs semi-metal bismuth to allow for the manufacture of semiconductors below the 1-nanometer (nm) level.

The Future of IoB is Exciting

Recent advancements in the internet of things are transforming the human body into a new technology platform.

Do you think tech could hack your brain, reflect all your memories, and measure your behaviours and future plans? The world is facing an emergence and fast expansion of the "internet of bodies" (IoB) - the network of human bodies and data through connected sensors - which will allow people to communicate with some machines and artificial intelligence tools, and might help to read and know many of our behaviours and actions.

Recent technological advancements have ushered in a new era of the "internet of bodies" with an unprecedented number of connected devices and sensors being affixed to or even implanted and ingested into the human body. This has turned the human body into a technology platform. The IoB generates tremendous amounts of biometric and human behavioural data. This is, in turn, fuelling the transformation of health research and industry, as well as other aspects of social life, such as the adoption of IoB in work settings, or the provision of new options for entertainment - all with remarkable data-driven innovations and social benefits.

IoT and self-monitoring technologies are moving closer to and even inside the human body. Consumers are comfortable with self-tracking using external devices (such as fitness trackers and smart glasses) and with playing games using augmented reality devices. Digital pills are entering mainstream medicine, and body-attached, implantable, and embedded IoB devices are also beginning to interact with sensors in the environment. These devices yield richer data that enable more interesting and useful applications

What is the Internet of Bodies (IoB)

The Internet of Bodies (IoB) term was coined in 2016. It describes connected devices that monitor the human body, collect

physiological, biometric, or behavioral data, and exchange information over a wireless or hybrid network. Standalone mobile apps that analyze physical activity and health-related data, such as heartbeat, blood pressure, and sleep cycles, can also be considered part of the IoB cohort. However, we've deliberately excluded them from our classification to avoid confusion with mHealth.

The Internet of Bodies falls under the broader IoT solutions umbrella. But as the name implies, IoB devices ensure an even closer synergy between humans and gadgets than connected thermostats, refrigerators, and curtains.

IoB products come in various forms, ranging in complexity from smartwatches and fitness trackers, which are used by approximately 21% of Americans, to implantable insulin delivery systems, ingestible sensors, and brain stimulation gadgets.

The benefits of implementing IoB solutions at scale include better diagnosis and treatment of health conditions, personalized insurance plans, increased productivity, and improved public safety, to name a few.

But the growing Internet of Bodies adoption could also result in unauthorized access to sensitive information by third parties, income-based health disparities, and the installment of a global surveillance state.

Development of Internet of Bodies (IoB)

The Internet of Bodies(IoB) is created when the Internet of Things (IoT) connects with your body. In another words, the IoB is an extension of IoT that connects the human body to a network via devices that are ingested, implanted, or otherwise connected to the body. Once the connection has been made, data can be exchanged as well as the body and device can be remotely monitored and controlled.

Although, the concept has developed over several phases, there are three major phases of IoB development:

Phase I: This phase included the usage of wearable devices such as Apple Watches or Fitbits that could connect our bodies to collect and analyse data.

Phase II: In this phase devices which were internal to the body such as pacemakers, cochlear implants, and digital pills that are ingested in our bodies to monitor or control various aspects of our health parameters.

Phase III: In this emerging phase technology is being embedded within the human body (implanted microchips) leading to the creation of cyber-physical systems having human bodies to connect with a remote machine on a real-time basis.

Examples of Development on Internet of Bodies Devices

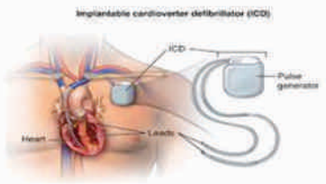
Health Tracking Device

The "phase I" IoB devices consisted of bracelets, watches, rings, and smartphone apps that can track steps, heart rate, sleep patterns, and other physical data, such as alcohol consumption. These devices operate by using advanced accelerometers and other sensors that can translate movement into digital measurements.

These devices have become the mainstream in the last decade or so. The adoption of these devices was rapid as they offered user-friendly analytics, giving individuals greater visibility into their health.

Since the volume of personal data that these devices collect along with their security vulnerabilities; the potential of hackers using such data poses quite a bit of risk.

Implantable Cardiac Devices



The most recognized example of the Internet of Bodies is a defibrillator or pacemaker, a small device placed in the abdomen or chest to help patients with heart conditions control abnormal heart rhythms with electrical impulses.

The new generation of cardiac pacemakers and implantable cardioverter defibrillators can provide real-time and continuous information about a patient's cardiac fluctuations. These devices can also regulate heart rates in patients whose hearts beat too fast or too slowly and can help prevent heart failure.

When such devices become part of IoB, they transmit the data related to heart conditions

to a recording device located either at the patient home or connected to their physician. However, in such cases, Internet connectivity introduces the potential risk for these devices to be hacked and the data they transmit to be compromised.

Digital Pills

One of the Phase II, IoB devices are digital pills. The digital pills are embedded with sensors that record the medication that was taken.

The pill's sensor sends a message to a wearable patch that transmits the information to a mobile app so that patients can track the ingestion of the medication on their smartphones.

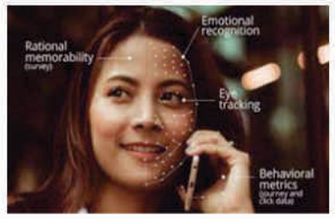
Through IoB patients can grant caregivers and physicians access to information through a web-based portal. This can help health care providers confirm whether patients are following their treatment plans.

Smart contact lenses

Currently, several types of contact lenses are being developed that integrate sensors and chips to monitor health diagnostics based on information from the eye and eye fluid.

One smart contact lens in development aims to monitor glucose levels that will hopefully allow diabetics to monitor their glucose levels without repeated pinpricks throughout the day.

Brain Computer Interface(BCI)



This is a development of a phase III IoB device called the Brain Computer Interface. In BCI application a person's brain is merged with an external device for monitoring and controlling in real-time. The ultimate goal is to help restore function to individuals with disabilities by using brain signals rather than conventional neuromuscular pathways.

Another example of IoB technology is its interface with Artificial intelligence (AI). Some of the developments in this area include systems that can detect and collect data on human emotions by analysing facial expressions, voice intonations, and other audio and visual signals.

As a result of these technologies, vehicle accidents might be reduced, firms could learn how consumers feel about their material, and youngsters could be taught empathy. Although these technologies are relatively new, there is still much to be done before they can be considered practical Challenges Faced by the Internet of Bodies Technology

IoB devices can pose challenges across three areas: data privacy, cybersecurity, and ethics.

Data Privacy

IoB devices already in use and those in development can track, record, and store users' whereabouts, bodily functions, and what they see, hear, and even think.

Data privacy is a major concern. Many questions remain unanswered regarding who has access to the data generated by IoB devices and for what purpose. A cochlear implant, for example, may restore hearing but may also record all audio in a person's environment. The regulations are required to maintain privacy of such data.

Cybersecurity

IoB devices may be vulnerable to the same cybersecurity flaws as IoT devices or any other technology that stores data in the cloud.

Given the nature of IoB devices and the data they collect, the stakes are particularly high. Vulnerabilities could allow unauthorized parties to leak private information, tamper with data, or lock users out of their accounts.

Hackers may be able to control implanted medical equipment to cause bodily injury or even death. Any IoB-collected data might disclose sensitive information, which can raise national security concerns.

Ethics

Data privacy and cybersecurity concerns raise ethical concerns for those whose data has been compromised. Furthermore, the IoB raises additional ethical concerns, such as inequity and threats to personal autonomy.

Since the IoB is still in its early days the fundamental questions such as whether individuals have ownership over their personal data or have the right to opt-out of data collection. These need to be resolved through proper policy framework.

How regulatory Policy frameworks can Mitigate IoB Risks

As the IoB technology evolves, regulatory and legal issues need to be addressed and policies to be formulated for the proper use of the technology. The policy makers should consider :

- establishing data transparency and protection standards for IoB device data. They should also consider how to give IoB users control over their personal information, such as the ability to opt-out of data collection.
- promoting cybersecurity best practices for parts of the IoB ecosystem. They could also create cybersecurity certifications to encourage the use of secure devices and raise consumer awareness.

Future Trends: Evolving IoB Ecosystem

Advances in internet technology and connectivity will allow many more IoB and IoT devices to communicate with one another at much faster speeds. The development of the fifth-generation mobile

telecommunications network, 5G, has the potential to support orders of magnitude more devices per square foot than the previous 4G network.

Wi-Fi 6, the next generation of Wi-Fi technology, is also expected to improve connectivity by enabling more devices to transmit data and communicate with one another.

Further, the advancement of satellite internet will increase internet availability in remote areas.

These advancements will allow consumer IoT technologies, such as smart home systems, to connect to IoB devices, allowing one's smart thermostat, for example, to be linked to one's smart clothing and automatically regulate the temperature in their home.

Some IoB devices in development, such as augmented-reality contact lenses or direct brain-writing, have the potential to significantly alter social life by allowing the recording and replay of all a person's interactions.

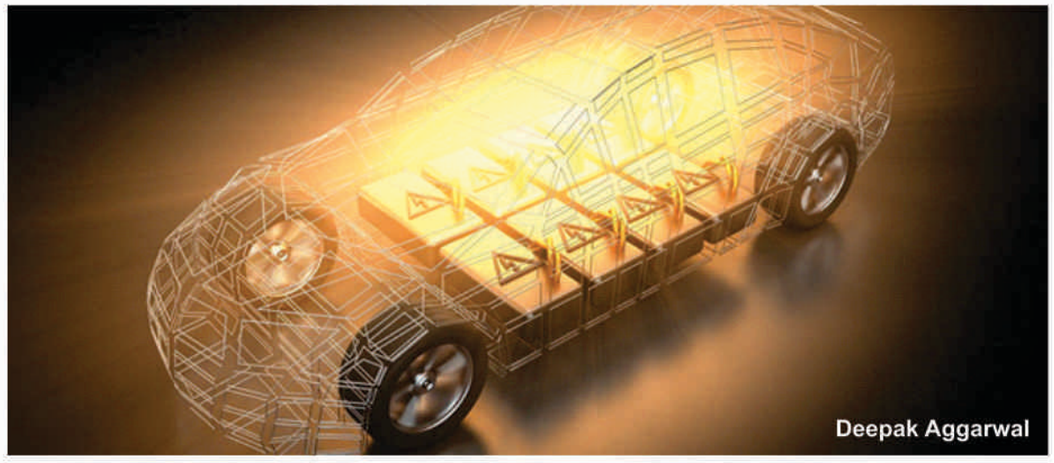
Brain-reading and signalling neuro-devices are already available, but improved brain technology interfaces could improve cognition, memory, and control.

Defence forces have expressed interest in IoB technologies to track service members' health and well-being, improve cognitive and physical abilities, improve training, and enable enhanced warfare capabilities - for example, with augmented-reality headsets or technology-infused exoskeletons that track war fighters' physical characteristics and possibly also their mental state.

Conclusion

The ecosystem around IoB technologies is rapidly evolving. The IoB devices are used in a variety of situations, ranging from fitness and health management to job settings and entertainment, as well as in medical scenarios. In future, as associated technologies make substantial advancements, the IoB devices are more intertwined due to the convergence of technologies. ■

DC-DC converters for Next Generation Electric Vehicles



Deepak Aggarwal

DC-DC converters play a key role in helping one choose the voltage variation of the devices and in controlling the power flow in each of the devices used in the EV powertrain.

It will be obvious to anyone who's looked at buying a car in the past few years that things are changing significantly. A decade ago, the only real fuel choices were fossil fuels, diesel or petrol. But now there's also mild hybrid electric vehicles (MHEV), hybrid electric vehicles (HEV) and battery electric vehicles (BEV) to consider.

From the consumer's point of view these vehicles are different; they don't travel as far as conventional vehicles, they can take hours to recharge and they contain a lot more technology. However, there are more changes in vehicles, many of which won't be visible to the casual observer - but, nonetheless, have a significant impact on the vehicle design.

Changing architectures drive different power needs

The vast majority of internal combustion engine (ICE) vehicles have had a relatively simple architecture with a 12V battery powering the electrical components, replenished by an alternator. Several key components, such as water pumps, power steering pumps and fans have been belt-driven and therefore required no electrical power.

However, with the move to hybrid and electric vehicles (xEV), there's less opportunity to belt-drive these ancillaries. This, coupled with the need for efficiency means modern vehicles (xEV and even some ICE vehicles) are replacing these electro-mechanical devices with electrically-driven alternatives. These new versions are smaller, lighter and more reliable - they also facilitate more efficient operation. For example, the air-conditioning pump doesn't need to run constantly, but a belt-driven pump presents a constant load to the ICE, while one driven by an electric motor is only powered as needed.

However, many of the pumps and motors in a vehicle require relatively high levels of power - in the kilowatt region (see Figure

COMPONENT	PEAK POWER (W)
PTC heater	≤ 4 kW
AC compressor	≤ 3.5 kW
Electronic roll control (ERC)	≤ 3 kW
Smart cooling pump	≤ 400 W
Fluid pumps	~ 200 W
Front windshield heating	≤ 700 W
EH-brake system	≤ 900 W
E-compressor	3 kW - 7 kW
E-steering	≤ 2 kW

Figure 1: Power consumption in xEV systems

1 below). As a result, along with devices such as heated seats, which are similarly power-hungry, these applications aren't suited to being driven from the 12V battery common in most vehicles.

The relatively low voltage in a 12V system results in high currents that require substantial cabling, which is expensive, heavy and difficult to route through the small spaces in modern vehicles. The weight of the cabling, and the losses associated with the high currents, have a negative impact on the efficiency of the vehicle.

In order to address this, automakers are gradually introducing 48V systems to drive the higher power fans, motors and heaters. As they require one-quarter of the current, the cable size can be reduced, which has a positive impact on the cost of the wiring and the efficiency of the vehicle.

However, as there has been so much invested in 12V systems over the years, the 48V systems will run alongside the existing 12V systems, so that existing low-power systems (such as infotainment, driver assistance, ECUs and others) can remain unchanged.

Bi-directional DC-DC converters for xEV - design considerations and challenges

In a typical vehicle architecture, the 12V and 48V systems remain relatively separate and are generally segmented on the basis that the lower power applications are connected on the 12V side, while the higher power applications (generally those requiring motors and / or heating elements) are connected to the 48V.

Many of the modern systems being implemented in vehicles such as active chassis management, adjustable suspension and electric superchargers / turbochargers are being designed for the 48V bus. Additionally, the 48V bus can support engine-starting in ICE vehicles, making start-stop operation smoother.

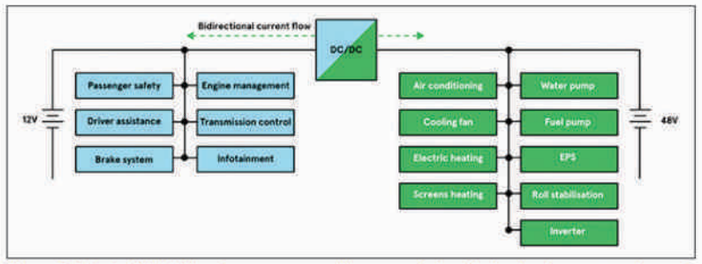


Figure 2: Mixed 48V / 12V systems are generally segmented on the basis of power requirements

At the heart of these mixed voltage systems, and providing the bridge between the two voltages, is a bi-directional DC-DC converter. This important sub-system is both a step-down ('buck') and step-up ('boost') converter that allows either battery to be charged from the other. In the early stages of this technology, two separate DC-DC converters were used, one for each direction. However, the bi-directional approach allows the same external components (including passive devices such as inductors and capacitors) to be used for both the step-up and step-down conversions. As a result, size and weight are reduced which improve the efficiency / range of the vehicle and lower the manufacturing cost.

The bi-directional DC-DC converter is also able to combine energy from both systems to provide as much power as possible when current draw is at its greatest - for example, when starting the vehicle.

There is little need for galvanic isolation in automotive systems, as all voltages are separated extra low voltage (SELV), part of the reason that 48V was chosen. So bi-directional DC-DC tend to be non-isolated to avoid the weight and cost of a transformer. Therefore, a non-isolated multidevice interleaved bi-directional DC-DC converter (MDIBC) is a common solution.

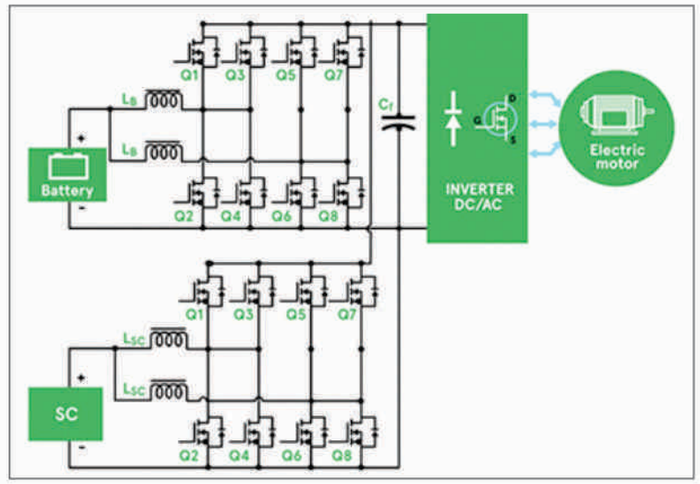


Figure 3: Schematic of a typical MDIBC

The 12V power is derived from a sealed lead acid (SLA) battery while the 48V source can be either a battery or a supercapacitor or, quite often, a combination of both, which gives the ability to deliver peaks of current when needed.

The multi-phase approach of the MDIBC shown, which relies upon the gate drive signals to be interleaved, reduces the input ripple. In fact, acceptable levels of input and output ripple can be achieved without increasing the value (and therefore, size and cost) of the passive components. The trend towards using wide bandgap (WBG) semiconductors is allowing operating frequencies to increase, which reduces the size of the passive components.

Unlike many conventional topologies, the MDIBC has commonality with the control circuit, thermal management and also the DC link capacitor, all of which add to the overall reliability. The ability to allow power to flow bi-directionally means that it can accommodate systems such as regenerative braking that return power to the battery and increase overall efficiency and range of the vehicle.

Standards applicable to 48V systems

While there are many standards and regulations applicable to the design of electronic systems for vehicles, as the technology evolves, the standards will need to be reviewed and updated. While many of the existing standards (such as ISO 7637) cover the 'traditional' vehicle voltages of 12V and 24V, as well as much higher voltages, there is something of a gap around 48V.

There will be wholesale changes in the electrical architecture as a result of the introduction of 48V to vehicles. The voltage will be four times higher and currents will not necessarily reduce, as 48V will be used to power systems requiring more energy. This could mean additional loads will be placed on system components including fuses and relays, leading to increased risk of arcing. The move to 48V will enable further system changes, including the replacement of mechanical relays with solid state devices, introduction of smart fuses, optimised wiring harnesses and fault tolerant features - all leading towards fully autonomous vehicles.

The new ISO 21780 now provides a single global standard for 48V automotive systems, which simplifies design and lowers costs for automakers in international markets. The standard was recently finalised, and the first ISO 21780 compliant DC-DC converters were released in late 2019.

Mission-critical passive components for automotive DC-DC converters

While much is written about the switching semiconductors such as IGBTs and MOSFETs, as well as the advanced controllers available, passive components have an equally important role to play in automotive DC-DC conversion.

Both inductors and capacitors are used extensively for applications such as energy storage, filtering, decoupling and noise reduction. In fact, it's common for the cost of passive components to far outweigh the cost of semiconductors within a DC-DC converter bill-of-materials (BoM).

The automotive environment is harsh, with high temperatures, transients, noise, and other hazards present. In selecting the appropriate components for an application, both electrical and mechanical parameters have to be considered.

A variety of capacitor

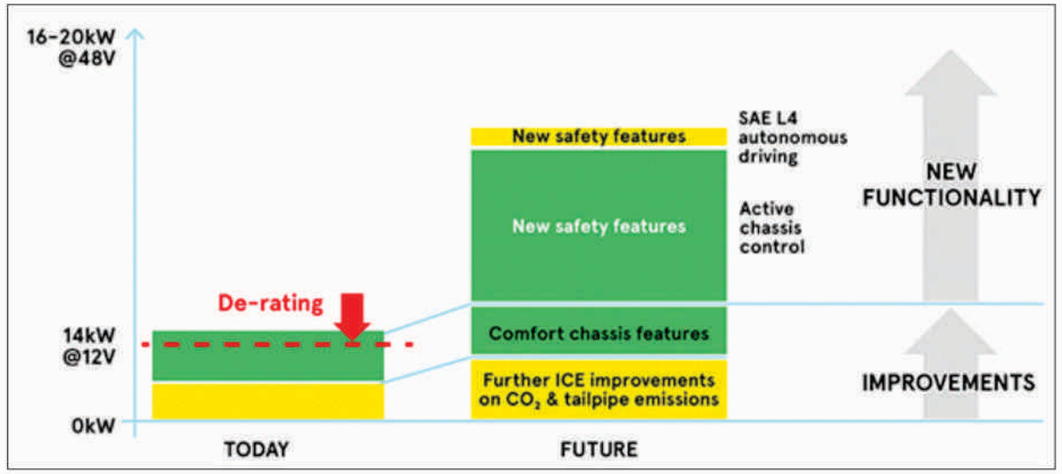


Figure 4: 48V will improve existing systems and enable new comfort and safety features

types will be needed, including the simple multi-layer chip capacitors (MLCC) that are used for applications such as decoupling, smoothing and snubbing. Film capacitors, such as polypropylene film, offer high voltage capability and are often used for filtering unwanted EMI. And some types offer the ability to self-heal, which adds robustness for automotive applications.

Magnetic components such as inductors are also used in a variety of power applications, from filtering to providing energy storage in buck converters. Current handling capability is an important factor, from the perspective of saturation as well as the amount of current the winding is able to carry. Many types of inductor are available including some with thick strip-wound copper wire that minimises DC resistance and the associated losses. Shielding is another important consideration, especially in switching applications where the generation of, and susceptibility to, electro-magnetic interference (EMI) must be considered.

Other magnetic components include common-mode chokes, current sense transformers for system monitoring and control, and small PCB-mount transformers that are used in the drive circuitry for switching semiconductors such as IGBTs and MOSFETs.

As automotive systems are mostly modular in nature, allowing for servicing and repair, connectivity forms an important part of the system. As currents and voltages increase, so the specification of connectors must be considered carefully so they don't introduce losses into the system. The mechanical properties of connectors and their resistance to heat are also important, as they're often used in under-the-hood applications such as start-stop systems and electric turbos / superchargers.

Summary

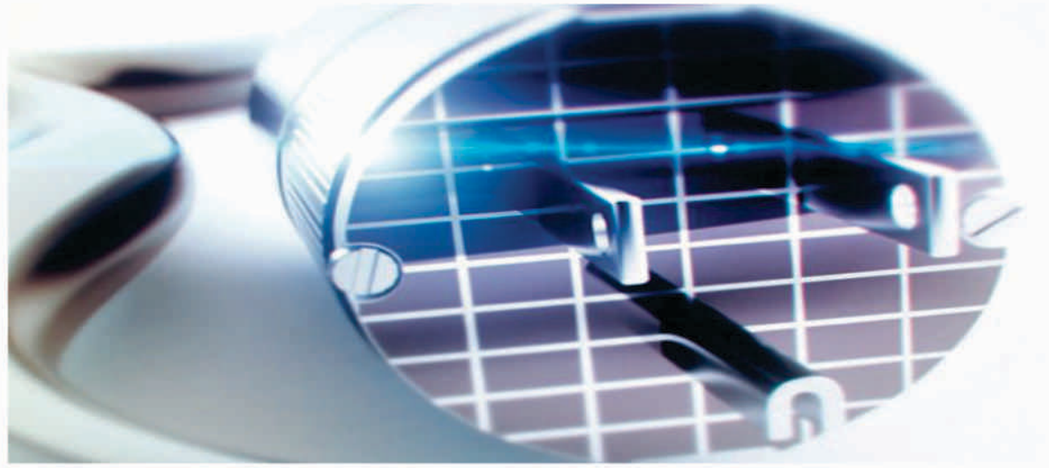
While it's not something that will be immediately apparent to many buyers of vehicles, the fundamental power architecture is changing, even in ICE vehicles. As more hydraulic and mechanical components transition to electrical / electronic alternatives, the existing 12 V architecture is being augmented (and eventually replaced) by 48 V systems. This approach brings greater efficiency and also saves cost as cabling can be thinner and lighter.

The 48 V is generated from a battery or supercapacitor (sometimes both) by a DC-DC converter that is required to work bidirectionally, meaning that energy recouped during braking can be returned to storage, thereby increasing the electric range of the vehicle.

As the voltage increases, components that can withstand the additional stresses of 48 V operation (as well as tolerate the harsh automotive environment) must be selected by designers of these DC-DC converters. Given the high level of electrical / electronic content in modern vehicles, many component manufacturers are now offering devices specifically for these new applications, including inductors, capacitors, filters, chokes, current sensors and connectors.

Top Manufacturers in Silicon Carbide (SiC)

A next-generation semiconductor that traveled 4.6 billion years to get here.



The technological revolution has pushed many industries to new heights. It can truly be said that technology plays a key role in making life easier. From smartphones, vehicles to the internet, every type of technology has pushed mankind further. Not only individuals but the organizations also are being benefited by the technological innovations. It has made the world a small village. Everything is available at fingertips. To understand the concept of technology, we must first look at the core of technology - silicon carbide as a semiconductor.

Silicon Carbide Semiconductor application revolves around improving the electrical efficiency of the devices along with enhancing the life of the instruments. The demand for the latest technology has elevated the commercial aspects of silicon carbide semiconductors. Factors such as small size and higher performance have pushed the demand of the SiC devices. The meteoric rise in its demand can be owed to the improved electrical performance, power management, and assembled to gain high reliability as compared to the older devices. The market's forecast reveals steady growth in the upcoming years. Silicon carbide semiconductor devices have revolutionized the tech sector. Due to this factor, the silicon carbide semiconductor materials market has seen an elliptical rise in demand.

SiC Industry Outlook

Looking at the dominating players of the silicon carbide semiconductor materials market, we get an idea of the increasing importance of SiC devices in everyday lives. Previous decade's technology (and the benefits associated with it) is diametrically opposite to the current ones. SiC's increased traction has paved the way for newbies to try their hands in this promising market segment. As the Silicon Carbide Semiconductor Market was valued at USD 459.58 million in 2019, it is clear that the world has started relying on this technology heavily.

Leading SiC Manufacturers

STMicroelectronics

STMicroelectronics introduced its first SiC diodes in 2004, after several years of research and development on silicon carbide technology. SiC MOSFET were introduced in 2009 and entered mass production in 2014. Today, ST's portfolio of medium- and high-voltage power products based on SiC technology is among the widest in the industry.

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ST is actively engaged in capacity expansion and development of a reliable and robust SiC supply chain able to meet demand growth and ensure continuity through extended longevity programs. ST manufactures its SiC products to the highest standards to ensure reliable performance and efficiency gains for electric vehicle (EV) applications, solar inverters, energy storage, industrial motor drives, and power supplies. Our technology exceeds industrial and automotive application standards and is preparing to target more extreme aerospace applications.

ST's portfolio of silicon carbide (SiC) devices incluses STPOWER SiC MOSFETs ranging from 650 to 1700 V with the industry's highest junction temperature rating of 200 °C for more efficient and simplified designs, and STPOWER SiC diodes ranging from 600 to 1200 V which feature negligible switching losses and 15% lower forward voltage (VF) than standard silicon diodes.

ST recently completed qualification of its third-generation SiC technology platform. Planar MOSFETs based on this platform set new industry-leading benchmarks for transistor efficiency, power density, and switching performance.

Infineon Technologies

Infineon is a pioneer in the commercial use of Silicon Carbide technology. As the first company worldwide SiC based diodes were introduced in the market in 2001 already, followed by the worldwide first commercial power modules containing SiC components in 2006. Meanwhile the 5th generation of such parts is available as discrete devices. In power modules Infineon offers solutions based or empowered by SiC mainly for solar applications and selected motor drive applications . The product design was strongly oriented on a careful cost performance evaluation in order to use the new technology in systems and circuits where a tangible system advantage could be identified.

Infineon CoolSiC™ semiconductor solutions are the next essential step towards an energy-smart world. Being the #1 in power semiconductors, we have an extensive application know-how resulting in the right SiC product portfolio, enabling our customers to develop radical new product designs with best system cost-performance ratio. Based on proven, high quality volume manufacturing, Infineon CoolSiC™ solutions combine revolutionary technology with benchmark reliability - making our customers successful today and tomorrow.

ROHM Semiconductor

ROHM began pioneering the mass production of SiC power devices in the 1990s. At the time, high-quality SiC wafers were quite scarce, and in the absence of a well-equipped research environment, ROHM went on daily excursions to research facilities through-out the country to conduct experiments. But ROHM engineers continued to persevere, and even as the state of the global economy worsened they dedicated themselves to improving the production line and creating original testing

methodology while increasing processing accuracy, culminating in the world's first successful mass production of SiC DMOS in 2010.This moment was a perfect example of passion coming to fruition for the betterment of society.

ROHM will continue to meet new challenges. As a leader in SiC power devices, we are committed to reaching even higher standards of quality and expanding research over a broad range of fields.

Onsemi

onsemi is in mass production with SiC Technologies since 2015 and has now released its third generation SiC MOSFET technology. This leading edge technology features a ultra thin wafer technology, highest cell packing density and application specific design options optimized for motor drives or high-speed switching for DC/DC conversion.

Our large product portfolio in SiC Technology ranges from Diodes via MOSFET's to Modules:

- Diodes with voltages from 650V, 1200V up to 1700V in packages from through hole TO247, D²PAK, DPAK as well as PQFN88 and D2PAK-7L for SMD mounting
- MOSFET from 650V , 900V up to 1200V. They offer a 10x higher dielectric breakdown field strength, 2x higher electron saturation velocity, 3x higher energy bad gap, and 3x higher thermal conductivity. All onsemi SiC MOSFETs include AEC-Q101 qualified and PPAP capable options specifically engineered and qualified for automotive and industry applications.
- Modules in 900V and 1200V integrate SiC MOSFETs and SiC Diodes to provide lower conduction and switching losses, while enabling designers to achieve high efficiency and superior reliability.

https://www.onsemi.com/products/discrete-power-modules/silicon-carbide-sic

System benefits include highest efficiency by lowering power loss, greater power density, higher operating frequency, increased temperature operation, reduced EMI and reduced system size and cost.

Technology Outlook for Silicon Carbide Semiconductors

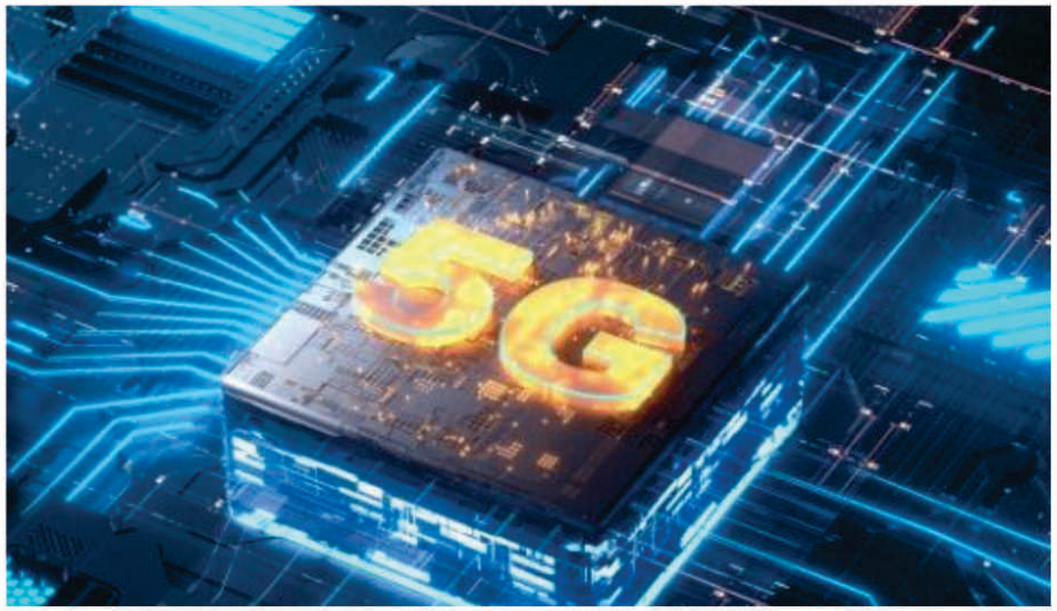
Brandon Becker, onsemi

As wide-bandgap technologies continue to penetrate traditional and emerging power electronics applications, semiconductor companies have been developing their product offerings at an extraordinary rate. Some have already announced multiple generations of their technology. With its proven Silicon Carbide (SiC) MOSFET device performance and best-in-class customer support, ON Semiconductor is a leader in this space. For example, ON Semiconductor recently expanded its range of wide bandgap (WBG) devices with the introduction of its 650 volt (V) SiC MOSFETs, creating new opportunities for higher efficiency in a powerband that was previously under-serviced. In this blog, we discuss what the market trends will be in 2021, and how OEMs will benefit from the efforts of leading semiconductor manufacturers.

Q: Wide bandgap semiconductors, such as SiC and gallium nitride (GaN), are becoming mainstream and associated with high-growth application areas, such as electric vehicles (EV) and 5G base stations. However, traditional silicon-based MOSFETs have the cost advantage and are still being used in most applications. How do you see the trend for third-generation semiconductor materials developing in 2021?

SiC and GaN will continue to expand into applications that require higher efficiency or higher power density than traditional silicon devices can offer. The cost differential means that, right now, wide bandgap devices will be mostly used if they can reduce the overall system cost. This can be achieved through the elimination of cooling systems or reducing the size and cost of passive devices, for example. These reductions are possible because of the higher switching frequencies used with WBG devices. In the short-term, we can expect to see solutions based on a combination of technologies. For example, inverters may pair a traditional silicon IGBT with a SiC diode, to realize a lower system cost than moving over to all-SiC, while still increasing efficiency and reliability.

Q: In the 5G era, what are the new application opportunities for SiC MOSFET, and are you seeing a significant increase in the number of SiC MOSFETs used in this application area?



5G is likely to reach speeds 20 times faster than 4G LTE. In order to operate faster, you need devices that handle more power, have better thermal efficiency so the hardware does not overheat, and are optimized for power efficiency. The performance targets of these new platforms are a perfect match for the strengths of SiC MOSFETs, not least because SiC is well suited to operating in demanding environments. These strengths will mean SiC will also be instrumental in the way cloud services and AI is delivered. Demand is increasing exponentially in these applications and the need for higher power density is a primary focus for design engineers.

Q: What competitive advantages does ON Semiconductor offer and how have these led to products being launched this year?

ON Semiconductor has multiple competitive advantages, such as its internal supply chain, manufacturing expertise, proven and documented SiC MOSFET device performance at the best price, and highly rated customer support. ON Semiconductor is ranked #2 in power semiconductors worldwide and has close relationships with its customers, providing a crucial role in the design of their systems. We have been expanding 900 V and 1200V SiC MOSFETs family. We released our 650 V SiC MOSFET technology in 2021 and are working in the early engineering phases with customers to implement it. Once our technology is publicly released, we focus on ramping up production capacity so we can offer the short lead-times customers need. We continue to work with our customers across various applications, including automotive traction inverters, onboard charging, EV charging, photovoltaic, solar inverters, server power supply units (PSU), telecoms and uninterruptible power supplies (UPS). We are also seeing an increased push to bring WBG technology to professional audio, professional lighting, medical, power tools, appliances, aux motors and more.

Q: Have products from ON Semiconductor been used in EVs? Are there any cooperation projects with car companies, and at what stage?

Yes we have SiC MOSFETs and SiC Diodes used in EVs today. We have multiple cooperation projects with automotive OEMs in every region of the world. The stages vary from production, qualification, evaluation, and development. We also offer various EV reference designs to the customers.

Q: What makes the new 650 V SiC MOSFET a competitive proposition?

The new automotive AECQ101 and industrial-grade qualified 650 V SiC MOSFET employs a novel active cell design combined with advanced thin wafer technology, which enables a best-in-class figure of merit Rsp (Rdson*area) for a device with a 650 V breakdown voltage. The NVBG015N065SC1, NTBG015N065SC1, NVH4L015N065SC1 and NTH4L015N065SC1 also have the lowest Rdson (12 mOhm) in the market of any device in D2PAK7L and To247 packages. This technology is optimized around energy loss figures of merit, to optimize performance in automotive and industrial applications. An internal gate resistor (Rg) gives engineers more design flexibility, by eliminating the need to slow devices down artificially using external gate resistors. Higher surge, avalanche capability and short-circuit robustness all contribute to its enhanced ruggedness that delivers higher reliability and longer device lifetimes.

Q: What is the next step for silicon (Si), SiC and GaN? Will they be successively replaced?

WBG devices (SiC and GaN) are instrumental to the future of power electronics. These technologies are creating devices that were previously impossible to create, due to the physics of the material. With that said, the SiC MOSFET has been perfected over five decades and continues to undergo improvement. The next step for ON Semiconductor will be in customizing the technology for certain applications. The next steps for customers will be to keep pushing the limits of what they thought was possible and challenge these state-of-the-art devices to help them achieve their desired results.

Q: What will the most promising markets be for SiC and GaN over the next two to three years?

A: We expect to see the market share for SiC to continue to grow steadily in industrial power and energy generation applications, with more rapid growth in automobile traction inverters. GaN is now showing signs of largescale adoption in applications such as consumer power supplies, where power density is a critical design objective. While GaN is also applicable to other, more demanding applications, we don't expect to see it reach the same level of adoption for around three years.

Q: What are the industry challenges associated with the development of SiC MOSFETs and what is ON Semiconductor's strategy?

SiC substrate development is the biggest bottleneck right now, and semiconductor manufacturers including ON Semiconductor are focused on solving this. The SiC substrate is very different from a traditional boule of silicon. Everything involved with its production, from the equipment used, the processes, and how it is handled and the way it is cut have all been developed specifically for SiC. ON Semiconductor has put a lot of research and development into this advancement in order to decrease defect density, which in turn has enabled a better cost structure. Those efforts have helped accelerate SiC MOSFET adoption amongst our customers. Other bottlenecks include but are not limited to epitaxial growth, fab processing and packaging. Each of these individual supply chain steps has unique engineering challenges that are being solved on a daily basis.

Q: How has COVID-19 affected the supply of SiC raw materials and manufacturers' ability to continue with SiC MOSFET design, manufacturing and supply?

The supply of every raw material is closely monitored under this current epidemic. ON Semiconductor can guarantee supply continuity and rapid response because we can rely on multiple, approved sources. We have an expert team that qualifies our products at multiple locations internal and external to our company, to ensure our SiC manufacturing is not subject to disruption in any one location. ■

NanoEdge AI Studio

2 New Algorithm Families in 1 Comprehensive AI Solution

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ST NanoEdge AI Studio V3 is an automated machine learning tool that features two additional machine learning algorithm families, simplified data logging, and a revamped user interface. The new software thus grows its reach by covering more use cases and becoming more straightforward to embedded developers. Our teams are also offering Edge AI Sprint Packages. The bundle helps teams bootstrap their projects thanks to training sessions and tech support, among other things. Therefore, today's release is a testament to ST's desire to make machine learning at the edge accessible to all.

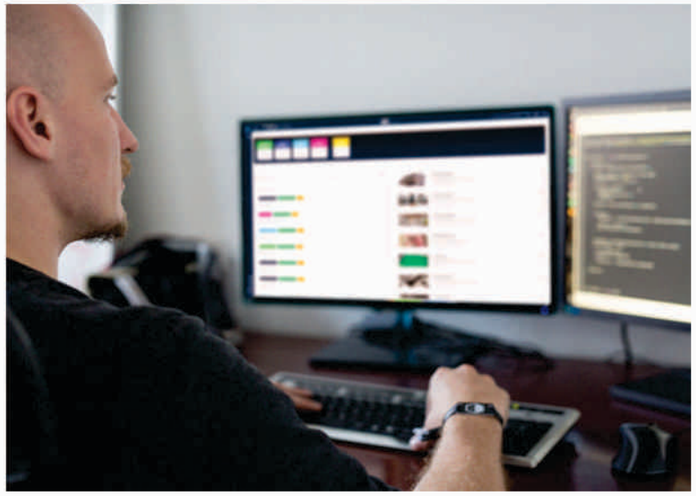
What is NanoEdge AI Studio?

In 2019, the ST Blog sat with the creators of NanoEdge AI to better understand its first machine learning application. Traditionally, large companies looking to benefit from machine learning must hire one or more data scientists to collect a massive amount of data for months, clean them, and create AI models. Embedded developers then port the implementation on microcontrollers or use tools like STM32Cube.AI to convert neural networks into optimized code for STM32 MCUs. When a company wrestles with tight budget constraints, hiring one or more data scientists may be out of the question. Additionally, it may not be possible to outsource the job. Some situations are sensitive, while others require someone to be constantly on staff.

Even with the right people and all the time in the world, obtaining quality data is still an issue. Despite all the advances in machine learning, getting reliable training samples can be a severe problem. For instance, if an application tries to detect abnormal behaviors, data may be unavailable. Indeed, while many datasets work for classification problems, such as anomaly detection, they're useless when trying to detect new situations. It is also critical to obtain good quality data, which is far from obvious. When samples aren't plagued by typos or missing information, recording clean sets and precisely labeling them can demand serious investments.

The Solution to Bringing Machine Learning Everywhere

NanoEdge AI Studio is a utility that speaks to embedded developers, even to those with no data science expertise. The magic lies in running the training



phase that learns a complex nominal behavior and the inference on the same device. The entire process can thus run on the same STM32 microcontroller. Additionally, the end-user interaction can be simple, like pushing a button. As a result, engineers can customize their system to its local environment, making it more robust and easier to install.

NanoEdge AI Studio runs on Windows 10 or Ubuntu and is the best way to process data as well as find the most pertinent AI libraries. The application's design focuses on embedded development and seamless integration in C applications. Put simply, NanoEdge AI Studio considers basic specifications like CPU, memory, sensors, and searches for the best NanoEdge AI library. It then outputs a library running on STM32 MCUs that developers can directly integrate into their embedded applications. And with today's update, the utility offers more libraries as well as data logging capabilities.

What's New in NanoEdge AI Studio?

Two New Families of Algorithms

Before today's launch, NanoEdge AI Studio supported two major machine learning algorithms: anomaly detection and classification. With NanoEdge AI Studio V3, these two families now benefit from a more significant number of libraries. Moreover, we also optimized current algorithms to increase performance on existing use cases. Hence, embedded developers may experience better resource management or faster execution times when switching to the new software version.

The application also offers two new families of algorithms: extrapolation and outliers. The former helps anticipate behaviors in untested conditions. Also called regression, it maps the relation between multiple variables. For example, data sets could measure a fan's behavior at 100°C, 110°C, and 150°C. Now, thanks to a regression algorithm, the machine learning application can extrapolate the behavior at 160°C. The extrapolation algorithm in NanoEdge AI Studio doesn't only cover linear regressions. Indeed, it also offers more advanced analysis techniques to tackle complex situations. As a result, developers can now create new applications that monitor things that data scientists cannot test themselves.

The second algorithm is an outlier detection system that rests on a single class of values. Indeed, the system only learns normal behavior. Anything that deviates from it becomes an anomaly. Previously, when using the anomaly detection system, developers would record normal behavior, then simulate one or more problems. As mentioned, it was possible to learn all behaviors on the same microcontroller, thus vastly simplifying operations. However, in some cases, reproducing anomalies is simply impossible. Hence, outlier detection can use data from routine operations to infer an anomaly in such a situation.

New Effortless Data-Logging Features

Data scientists may run against the imperative to release the final product to market and may be stuck. Indeed, while there's no better data than the one from real-world usage, it is not always available. Additionally, many are time-constrained. Hence, the new data-logging feature turns any STWIN SensorTile wireless industrial node into the most straightforward data collection tool. Users connect the board to their PC and use NanoEdge AI Studio to switch to data logging. Afterward, recording data becomes automatic. Engineers can fix the STWIN board to their

equipment to monitor it. The sensors will record data that developers can then label and parse to create more accurate applications.

New Graphical User Interface

Another vital improvement in the new version of NanoEdge AI Studio is the user interface. With the arrival of new algorithms and data collection features, it was critical to improve the user experience. It was also crucial to optimize developers' workflow. Indeed, NanoEdge AI Studio targets teams looking to bring machine learning to the edge. The libraries are tiny - as little as 1 KB - and highly optimized. It was thus necessary to also improve access to algorithms to ensure developers can easily select their project category and rapidly generate their libraries.

Experiencing NanoEdge AI Studio on Embedded Systems

Automating Machine Learning with NanoEdge AI Studio

Before the advent of NanoEdge AI Studio, engineers had to contact software vendors, go over their hardware configuration, and the behavior to monitor. Today, the tool enables developers to customize, generate, and validate their machine learning library. The utility first asks users to select their Cortex-M architecture and the sensor in the system. They then import a file with values describing the equipment's typical behavior. It can be data from an accelerometer on a fan or the electrical information of industrial equipment. Afterward, NanoEdge AI Studio automatically tests, optimizes, and sorts the best algorithmic combination among hundreds of millions of possible combinations and produces a customized library that developers can validate using the embedded emulator.

NanoEdge AI Studio V3 now supports all ST development boards right from its user interface. The availability of optimized and free libraries thus means that running a proof-of-concept is straightforward. For instance, in the smart vibration sensor tutorial, users can grab the NUCLEO-L432KC to capture a fan's normal behavior. They then feed the data to NanoEdge AI Studio and obtain a library that they can call in the main loop to run a minimum number of training cycles previously defined by benchmarks within the new software before engaging in inference. Hence, NanoEdge AI libraries can rapidly help create applications that use predictive maintenance, smart security operations, and more.

Bootstrapping Projects with Edge AI Sprint

Many customers fail to assess and demonstrate the benefits AI will bring to their application. Hence, to jumpstart applications on the right foot, Edge AI Sprint brings more than just a utility but a whole support system of experts that can guide developers through the minefields inherent to their application and use case. Edge AI Sprint is thus a bundle that includes training sessions, a NanoEdge AI Studio license, and technical support. Teams can select from various license duration, depending on their projects' complexity, to ensure they can reach production. Meant to bootstrap a project's first steps, Edge AI Sprint thus limits risks and investments while increasing the chances of success.

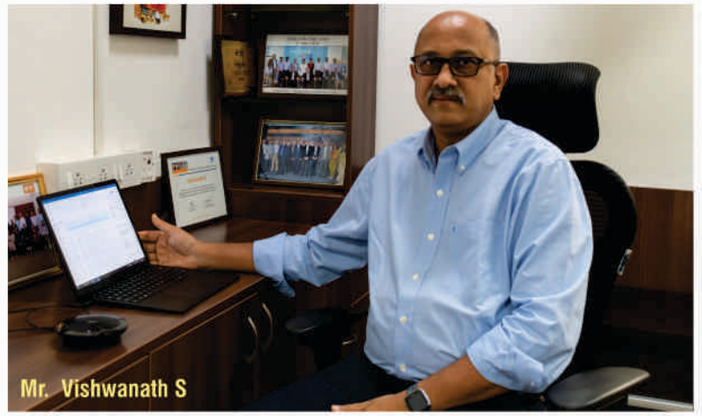
- Download NanoEdge AI Studio

https://www.st.com/en/development-tools/nanoedgeaistudio.html

- Contact your sales representative or authorized business partners to order a license for NanoEdge AI Studio and Edge AI Sprint

Sensor market in India to be the fastest growing in Asia Pacific

Connectors and Sensors form an integral part of Digital ecosystem. Today's digital ecosystem requires empowering engineers by designing and manufacturing sensor and connectivity solutions for a safer, sustainable, productive, and connected world. As a global technology leader, TE Connectivity provides sensors and connectivity essential to today's increasingly connected world.
Mr. Vishwanath S, General Manager, TE Connectivity India spoke to Electronics Maker more about these solutions and market growth.


Mr. Vishwanath S

Q How is TE Connectivity empowering industry 4.0 with state-of-the-art sensor and connectivity solutions?

The Fourth Industrial Revolution or Industry 4.0 as we call it, is the ongoing automation of traditional manufacturing and industrial practices, using modern smart technology such as Machine-to-Machine (M2M) communication and Internet of Things (IoT).

In industrial facilities and on offshore platforms around the world, a bold vision for automating and integrating complex production processes is taking shape. Increasingly, manufacturers are looking to integrate digital technologies that increases flexibility, improves efficiency, prevents unexpected downtimes, and accelerates production. At the center of this evolution, known at Industry 4.0, is interoperability, an opportunity to create customer value by enabling reliable machine-to-machine (M2M) capabilities, deep learning from manufacturing processes, and greater control of innovative technology, including robotic systems and automated guided vehicles (AGVs).

At TE Connectivity we solve the complex problem of connecting machines in the Industrial Internet of Things and M2M communication sphere. We have the ideas to build a standardized interface device such as connectors and integrated solutions to connect devices that can be described as a gateway from the physical to a digital world. For instance, we are focusing on building connectivity for a high-power charging. We are taking a new approach to devise a realistic and wire and component dimensioning to meet the industry's required charging performance. To do so, an establishment of link between thermal and electric models along with analysis of the current relationship of the current profile to the temperature profile is being undertaken.We have sensors for thermal monitoring as well.

Q What are some of the next gen technologies that will define the era of smart factories?

Smart factories are set to leverage industrial equipment communicating with users and other machines and automated

processes will facilitate real-time communication between the factories and users. Here, technologies play an integral role to maximize efficiency and enhance product quality. A few next gen technologies that will define the era of smart factories are:

Predictive Maintenance: Monitoring sensor output signals over a period can offer insights into equipment failure. From bearing vibration to rising temperatures, as properties change, the decline in performance or need for part replacement can be predicted to avoid catastrophic failure, downtime, and cost. Filtration is another area of maintenance; as an example, differential pressure sensors can be used to monitor pressure across a filter to predict hydraulic or pneumatic filter maintenance.

Asset Monitoring: Certain manufacturing operations require assets and raw materials to build products. Sensors help confirm availability of raw materials in inventory. A shortage in material can result in production downtime and potential loss down the supply chain. In many cases, assets in factories are stored in a liquid state. These liquids can be corrosive in nature, requiring special handling and management. If the sensor comes into contact with the liquid, it is required to be manufactured from compatible materials. Whether it is the factory or supplier of the chemicals that monitors the liquid level, submersible pressure transducers can be used to measure the hydrostatic level of the storage tank.

Security: Security of data continues to be a high priority related to Industry 4.0 and all elements of the Internet of Things. While the sensors provide the data, the transmission of the data through gateways and the cloud requires greater care. High security data storage enclosures require reliable and effective means to detect and protect the system and its data against physical tampering. TE Connectivity (TE) tamper detection sensors offer a high security solution for physical data protection. We are also focusing largely on adoption of the 5G technology which will be a great support in creating the next generation of cloud data centers. This will elevate the technology edge on a large scale.

Cobots: As Industry 4.0 evolves, the use of more sophisticated robots, as well as advanced automation and control systems within industrial applications has become more common. The advancement of automated technology has helped drive the development of collaborative robots. Collaborative robots, or Cobots, are robots that can work alongside or with humans. These Cobotsare intended to interact and assist workers as opposed to being standalone automated equipment with little to no human interaction.

Technology relying on cleaner forms of energy: Technology relying on cleaner forms of energy is need of the hour. With the rising environmental concerns this type of technology has gained primary value today and is he need of the hour. We also believe in devising and using such technology for our customers. Manufacturers have partnered with us to assess major aspects such as liquidity pressure, quality and temperature sensors used to reduce pollution. We are also working with brands to design hydrogen-powered electric trucks.

Q What is the outlook on the connectors and sensor market in India?

Today, the growth of automation in India's manufacturing sector has led to the sensor market in India to be the fastest growing in Asia Pacific. Sensors help in reducing energy consumption and wastage, while also reducing maintenance costs, prompting manufacturers to increasingly install them in their manufacturing units.We will continue to see accelerated growth of the sensors and connectors with trends such as:

- Electrification of power train
- 5G networks
- Internet of Things
- Metro and hi-speed rail
- Advanced healthcare systems
- PPP for defense market
- Smart cities
- Creating an emission less future

Q What are the sectors that will drive growth for TE Connectivity in India?

There are a host of sectors that we are looking at from a consumer point of view In India. Passenger vehicle sector, two wheelers and railways are some of the industry verticals we cater to. Given the recent push towards self-reliance in defence manufacturing, TE Connectivity is well positioned to help the Indian defence ecosystem with state-of-the-art products and solutions. TE Connectivity is also developing solutions to cater to the global human health. The company is involved in developing technology to address the trends in the MedTech space largely. ■

Design guidelines for high power server and telecom power supplies use-cases

Technology perspective and value-added features of wide bandgap power semiconductor devices

Dr. Gerald Deboy, Distinguished Engineer Power Semiconductors and System Engineering, Infineon Technologies Austria

With the recent introduction of active wide bandgap(WBG) power semiconductors on a broad commercial scale, the number of use cases is rapidly increasing. High power applications such as power supplies for server and telecom have been among the first adaptors driving acceptance and early success stories.

For server power supplies, the rapidly increasing power demand of modern artificial intelligence (AI)-assisted processors drives power requirements per server continuously up, reaching now more than 2.5 kW. As the form factor of power supplies being mounted directly onto the motherboard remains the same, power density has massively increased to 85W/in^3 and beyond. Similarly, power for remote base stations is rapidly increasing in the wake of the roll-out of the 5G infrastructure. To avoid costly cabinets on the floor, equipment such as the AC-DC power supplies must move up on the pole, closer to the antennas. In these applications, ultra-flat designs (1/2 U height) and passive cooling pose stringent requirements for the power supply's density and efficiency. Finally, hyper-scale data centers, with their continuous striving to optimize total cost of ownership, have pushed efficiency both for 48V and 12V eco-systems to hitherto unreached limits.

This article aims to provide guidelines regarding the value and best use cases for GaN- and SiC-based power semiconductor devices compared to their silicon counterparts. The analysis derives key performance indicators from a device-physics-based view and discusses their potential for further improvement from a technology perspective [1].

We follow the typical design considerations in a switch-mode power supply (SMPS), starting with device selection for the power factor correction stage, the primary side isolating DC-DC converter, and, finally, for the synchronous rectification on the secondary side.

Key performance indicators for wide-bandgap semiconductor devices

We use for the comparison of devices rated at 600V blocking capability four key

performance indicators, namely RDS(on)*Qrr, RDS(on)*EOSS, RDS(on)*Qg, and RDS(on)*QOSS as outlined in Table 1a.

The following figures-of-merits (FOM) can be linked directly to switching transitions in SMPSs:

- RDS(on)*EOSS is a measure for the switching losses in hard switching single-ended circuits,
- RDS(on)*QOSS is an indicator for the amount of current needed for soft switching transitions, and
- the sum of Qrr and QOSS represents the switching losses in a half-bridge circuit in case of hard commutation [2].

GaN HEMT devices (such as Infineon's CoolGaN™ technology), with their absence of a blocking pn-junction, have zero reverse recovery charge, which is a unique advantage in applications such as motor drive PV inverter, and totem-pole PFC stages. Depending on the modulation scheme, hard commutation of the load current may occur in every switching cycle in these applications. Also, SiC MOSFETs (such as Infineon's CoolSiC™ technology) are excellent concerning commutation losses in a half-bridge circuit. Here, the extremely short ambipolar lifetime of electrons and holes reduces the electrically visible Qrr contribution on the device's terminals. In silicon devices, ambipolar lifetime adjustments, employing Pt-diffusion or ion-irradiation, are limited by the increase of drain-to-source leakage currents. However, this is not the case for wide bandgap devices, which can offer a much broader optimization range.

Table 1a Key performance indicators of silicon (Si)-based superjunction technology CoolMOS™ C7 compared to SiC MOSFET CoolSiC™ and GaN HEMT technology CoolGaN™

DEVICE	$V_{(BR)DSS}$	$R_{DS(on)}*Q_{rr}$	$R_{DS(on)}*E_{OSS}$	$R_{DS(on)}*Q_g$	$R_{DS(on)}*Q_{OSS}$
CoolMOS™ 7	600 V	100 %	100 %	100 %	100 %
CoolMOS™ 7–fast diode	600 V	10 %	104 %	108 %	104 %
CoolGaN™ Gen. 1	600	0 %	84 %	6 %	13 %
CoolSiC™ Gen. 1	600 V	2 %	133 %	41 %	21 %

Table 1b Key performance indicators of Silicon-based shielded-gate technology OptiMOS™ 5 compared to GaN HEMT technology CoolGaN™.

DEVICE	$V_{(BR)DSS}$	$R_{DS(on)}*Q_{rr}$	$R_{DS(on)}*Q_g$	$R_{DS(on)}*Q_{OSS}$
OptiMOS™ 5	100 V	100 %	100 %	100 %
CoolGaN™ Gen. 1	100 V	0 %	18 %	41 %

The large reverse recovery charge of superjunction (SJ) devices does not allow continuous hard commutation of the body diode even in fast diode versions with reduced ambipolar lifetime. Nevertheless, from an application perspective, two solutions exist.

First, the so-called triangular current modulation scheme (TCM), where the load current reverses its direction. In this case, the load current discharges the switching node capacitance allowing both ZVS operation of the switch to be turned on as well as complete removal of the Qrr charge of the switch previously conducting on its body diode. The regulation requires variable switching frequency with load and input voltage and precise detection of the zero-current crossing.

A second approach is the injection of a current pulse into the switching node, momentarily overriding the load current and pre-charging the device, which previously conducted on its body diode, to a low voltage of, e.g., 20V [3]. This solution allows fixed-frequency operation with continuous-current modulation (CCM) through adding few components for the auxiliary current injection circuit.

It is noteworthy to take a closer look at this concept from a technology perspective. Figure 1 shows a representation of

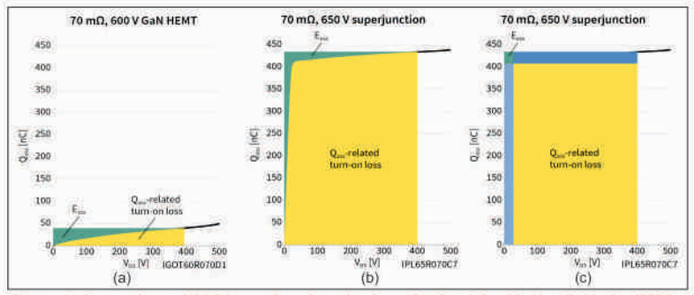


Figure 1: Comparison of QOSS as a function of voltage for Gen1 CoolGaN™ (left), CoolMOS™ C7 (center and right). The blue shaded areas represent the resulting losses when a novel current injection method is used

QOSS as a function of the voltage for the Gen1 GaN HEMT (Fig. 1a), the latest SJ technology CoolMOS™ C7 (Fig. 1b), and a graphic visualization of the loss saving potential for SJ devices with the current injection method (Fig. 1c).

The areas colored in yellow represent the QOSS-related losses at turn-on.This is the contribution of charge flowing from the device previously conducting into the device turning-on while operating in linear mode at DC link voltage level. The green area is the amount of energy stored in the output capacitance of the device previously blocking. This energy will be dissipated as Joule loss inside the device by opening the channel and have the electron current discharge the output capacitance. In a hard commutation event with the high side device conducting on its body diode, the yellow-colored area represents the losses associated with the high side device, and the green area represents the losses associated with the low side device turning on. The sum of both areas indicates the total losses.

The GaN technology is a prime candidate for hard commutation with its factor 10 lower QOSS charge and its very balanced loss contributions from EOSS and QOSS, respectively. Specifically, in the light of the large QOSS contribution, SJ devices seem not to be able to compete. However, this is exactly where the current injection scheme overcomes hitherto-seen limitations: pre-charging the switching node from a low voltage source removes both Qrr and a large portion of the QOSS contribution. As this charge is extracted to a low voltage supply, the light blue area represents the associated losses. Consequently, the remaining QOSS contribution creates only a fraction of the original losses; this loss is shaded respectively in blue in Figure 1c.

From a technology perspective, the extreme non-linearity of the output capacitance of SJ devices leads in combination with the current injection method to an optimization path with continuously decreasing pre-charging losses and at the same time ever lower commutation losses in the half-bridge circuit.

From a loss balance view, the current injection allows SJ devices to be on par with GaN in single-ended applications and half-bridge-based circuits. With the progress to smaller cell pitches, SJ devices benefit both from a lowering of the depletion voltage of its inner pn-column structure - making the light blue shaded area more narrow - and from a reduction of the remaining QOSS contribution between the depletion voltage and the DC link voltage - making the blue shaded area flatter. In comparison, the GaN HEMT technology can benefit from reducing its active area, which likewise improves the QOSS contribution being derived from the drain-to-substrate portion of the output capacitance.

In the class of 100V-rated devices, Qrr and QOSS contributions are typically in the same order of magnitude for modern shielded-gate power transistors. The GaN technology clearly showssignificant advantages in both parameters lowering half-bridge commutation losses to less than one-fifth of its silicon counterpart. Also, the gate charge is by more than factor 5 lower, which are perfect pre-requisites for high-frequency operation. Table 1b shows the comparison.

Technology positioning for high power applications

PFC stage

Compared to their silicon counterparts, the attractiveness of wide-bandgap technologies depends mainly on the application's requirements concerning efficiency and density. For power factor correction stages below 98.5 percent efficiency or power supply efficiencies below titanium level, the solution dominating the market is AC rectification with a diode bridge followed by a boost circuit.

In this segment, the combination of SJ technology with a SiC Schottky barrier diode will prevail in the market. Both the rich portfolio of devices allowing near unlimited fine-tuning of conduction losses and the consequent optimization of the switching losses make CoolMOS™ the prime choice. The switching transition from a conducting SiC diode to the Superjunction device at hard turn-on creates losses from the diode being proportional to Qc*VDC with Qc being the capacitive displacement charge of the SiC diode and losses in the switch turning on, which are proportional to EOSS. The extreme optimization of the EOSS contribution in SJ devices has brought this parameter now

on par with GaN and even below SiC power devices. With upcoming progress in the cell pitch in the CoolMOS™ C8 family, EOSS can be further reduced. The non-linearity of the output capacitance helps at the turn-off to shut down the channel current effectively before the voltage across the switch rises, thus enabling a loss-less turn-off.

For power supplies at titanium level efficiency and beyond or stringent power density requirements as, e.g., in telecom base stations [4], (semi-) bridgeless PFC solutions take continuously higher market share. Here, we see the totem-pole configuration with CCM or TCM control using wide-bandgap or silicon power devices, respectively, in its high-frequency leg and very low-ohmic SJ devices in its low-frequency leg.

The key argument for wide bandgap power devices is the simplicity of control using typically fixed frequency trapezoidal current modulation schemes. Both GaN HEMTs and SiC MOSFETs are used in recently released designs. Specifically, SiC MOSFETs have an advantage as their very low-temperature dependence of the RDS(on) allows using relatively high-ohmic and, hence, cheaper power devices [5].

SJ devices may be used in totem-pole circuits either by applying TCM control with variable frequency or by using the current injection scheme discussed in the previous chapter [3]. All solutions surpass 99 percent efficiency in the PFC stage.

DC-DC stage

Again, efficiency and power density requirements guide the designer towards choosing the best fitting device technology.

For primarily efficiency-driven applications such as power supplies for hyper-scale datacenter, ultra-low ohmic SJ devices combined with precise dead-time control and a careful resonant tank design of the LLC converter are the first choice. With resonant switching frequencies around 100 kHz, the inevitable (relatively long) dead times of modern SJ devices are not yet limiting and do not lead to a substantial increase of RMS currents.

When the power density approaches 70 W/in³ or more, and the LLC converter's resonant frequency is designed to 300 kHz and beyond, both SiC MOSFETs and, specifically, GaN HEMTs create clear value. The key argument in favor of wide-bandgap devices is their lower RDS(on)*QOSSFOM enabling shorter dead times. Also, control schemes such as 3-level modulation, which effectively limit the LLC's frequency range, induce hard commutation transitions, especially during a light load operation. In this case, a very low or even zero reverse recovery charge is an advantage. At very high switching frequencies such as 600 kHz and higher planar magnetics become a favorable design option as they create even lower losses than conventionally wound transformers. In this design space, GaN technology is clearly the preferred choice due to its better dynamic figure-of-merits and significantly lower gate charge

The choice of devices for synchronous rectification depends mainly on the switching frequency. During the secondary side switching transition from a (synchronously) conducting state to blocking, the Qrr charge creates additional losses, whereas the charging and discharging of the output capacitance is basically loss-less as long as lumped resistances in series with the output capacitance are negligible.

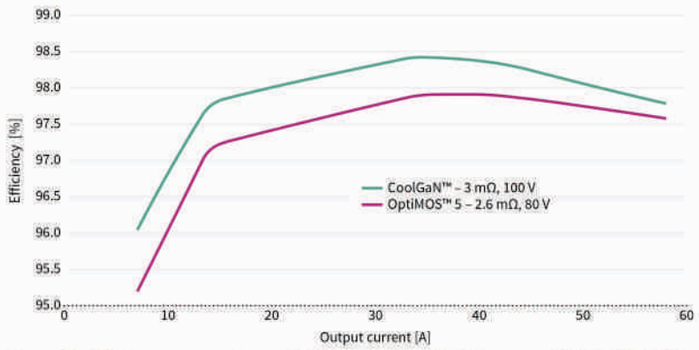


Figure 2: Efficiency comparison of 100V-rated CoolGaN™ versus 80V-OptiMOS™ 5 devices used as synchronous rectification switch in a 3.6 kW LLC converter

Hence, the use of, e.g., 100V-rated GaN HEMTs with their zero reverse recovery charge creates a significant benefit when being used as synchronous rectification switch. Figure 2 shows the comparison of OptiMOS™ 5 to CoolGaN™ in an LLC converter delivering 3.6 kW at 52V output. The design uses two secondary-side paralleled stages in full-bridge configuration, with two devices being paralleled in each position. The converter runs at 270 kHz with 97.9 peak efficiency using silicon devices and at 340 kHz at 98.5 percent peak efficiency with GaN HEMTs.

In a nutshell

High power applications such as power supplies for server or telecom may use a wide range of topologies, modulation schemes, and power devices.

Depending on efficiency and density requirements, several combinations will prevail in the market. Below titanium-level efficiency, the "all-silicon" designs using SJ devices both in "classic" boost type PFC and LLC stages with silicon-based synchronous rectification devices on the secondary side will dominate the market.

For efficiency-driven applications at moderate power density requirements of around 40 W/in³, hybrid combinations using wide bandgap power devices in a bridgeless PFC configuration and a subsequent "all-silicon" LLC converter will gain share. SJ devices in bridgeless PFC circuits are enabled both by triangular current modulation and through a relatively simple current injection circuit.

Finally, in high-density applications at or beyond 70 W/in³ "all-GaN" designs or hybrid combinations with SiC in the PFC stage and GaN in the LLC stage will win. Figure 3 shows Pareto front optimization [6] for a 7 kW power supply unit delivering 54V. Clearly, the "all-GaN" design wins both in power density and efficiency.

With its complete technology portfolio strategy offering both SiC MOSFETs, GaN HEMTs, and leading-edge silicon power devices, Infineon Technologies is ready to support high-power applications always with the best fitting selection of power devices. Drivers and control ICs complement the portfolio. To find out more, please visit www.infineon.com/power

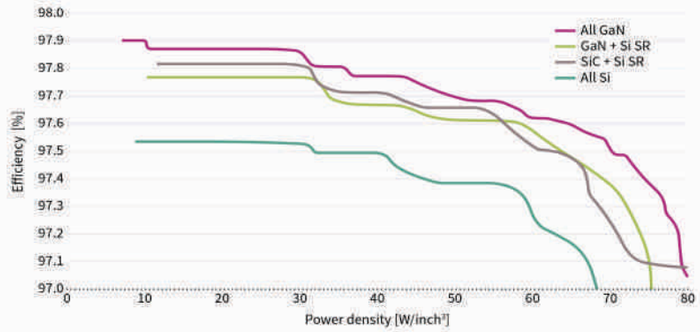


Figure 3: Pareto front optimization of a 7 kW power supply delivering 54V

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Responsive LED Lighting Lowers Energy Costs

Energy-Efficient Building Control Systems Maximize Savings

Alex Pluemer, Mouser Electronics

Energy efficiency is the driving force in the growth of the LED lighting market, whether it's private enterprises trying to reduce cost or public entities imposing regulations intended to scale back energy consumption and lower the burden on existing resources. The LED lighting market's residential and commercial sectors are expanding rapidly as LED lighting surpasses older technologies in energy and cost efficiency.

LEDs and luminaires made up about 19 percent of the total amount of installed lighting units in the U.S. in 2017, but that number could jump to 84 percent by 2035, according to the Department of Energy (DOE). The DOE expects almost 80 percent of the total LED lighting stock in 2035 to be in the residential sector, but the commercial sector is expected to yield far greater energy savings. Despite accounting for 17 percent of the total LED market in 2035, the commercial sector could be responsible for 39 percent of the total energy saved, according to DOE projections.

The gap between the percentage of total LED installations and the percentage of energy savings is attributable to lighting-control methods implemented increasingly common in large commercial settings. Lighting-control systems can reduce energy consumption by automatically turning off lights in unoccupied buildings or dimming them when natural light is available. In the following, we'll examine how LED lighting-control systems can be used to limit a commercial or residential building's energy consumption by adjusting the internal lighting when natural lighting or high/low occupancy prompt it to do so.

Implementing a Responsive Lighting System

The major components of a responsive lighting system include:

- LED light sources,
- Power control devices
- Sensors and microcontrollers implemented to provide the distributed intelligence required to control the lighting and communicate with the system's various sensors.

These system-edge microcontrollers also communicate with the higher-level, sub-system controllers-usually implemented with more powerful microprocessors-as more complex algorithmic and storage functions are required at the sub-system level. Wireless communications from these sub-systems to the main building controller make placement and expansion of the system relatively simple. The main building controller usually requires an industrial-grade computer programmed for fault tolerance to provide building safety and reliability, and communications between buildings on a campus (and to the cloud) can be used/analyzed by advanced adaptive and/or predictive algorithms.

Daylight harvesting is one of the primary ways that companies can save energy (and money) in big office buildings. Although it sounds like a process involving solar cells and batteries, daylight harvesting is simply using natural light and heat to illuminate and/or warm a building when it's available. For instance, a lighting-control system can dim the lights on the east side of a building in the morning, when the sun is presumably shining through the windows, and then bring them up in the afternoon when the sun shines on the building's west side.

The amount of energy that can be saved with daylight harvesting varies based on how a building is situated relative to the sun (north/south vs. east/west) and on geography. Silicon Valley in northern California has more natural daylight to be harvested than Seattle.

Natural light levels can be adjusted with tinted or shaded windows to meet the needs of a given workplace scenario. A conference room during a PowerPoint presentation might not need as much light as an employee working at his or her desk might. Occupancy sensors are another commonly employed technology in lighting adjustment. Motion sensors in a particular room or on a particular floor of a building will automatically request that the lighting-control system dim the lights if it has been unoccupied for a predetermined period. Occupancy sensors are often employed in conjunction with a timer function that dims all the lights in the building after its occupants have typically left for the day and brings them back up in the morning when employees arrive for work. It's difficult to calculate how much energy a specific business might save by using lighting control systems equipped for daylight harvesting with sensors and timers (variables include building size, operating hours, types of LED technology being implemented). The DOE does project that, if the rate of LED penetration continues at its current pace, the energy savings nationwide will amount to 4.8 quadrillion British Thermal Units (BTUs) annually by 2035, approximately half of the total energy lighting consumed in the U.S. in 2017.

Integrated Building Control Systems and the Cloud

A building's lighting-control system is a part of a larger control system that includes environmental controls such as heating, air conditioning, air circulation, and air quality in addition to building security and safety. Because of the close relationship between lighting and heating, it can be important for the building control system to consider heating, cooling, and lighting needs to optimize building comfort and energy efficiency. Letting sunlight in through the windows can help illuminate the building's interior, but it might also raise the internal temperature. If cooling the building is the goal (and the energy it takes to regulate the internal temperature exceeds the energy the LED lighting requires), a better balance might be struck using additional LED lights for

illumination while minimizing external sunlight. Air circulation and air quality requirements might also need to be balanced with ambient lighting. In some cases, creating small temperature differences between portions of the building could create convection currents that naturally help with air circulation, cutting the need for energy-draining fans to circulate air.

Finding a way to balance these competing needs and requirements might seem complex, but a modern control system can use the building's history to simplify the process. Previous settings and results can be stored in the cloud and analyzed to see what combinations were most cost- and energy-efficient. The system might experiment by tweaking the settings to explore the solution space for optimal comfort and energy consumption-and to discover even better algorithms. The control system could then select the optimal algorithm based on expected weather conditions, building occupancy, available solar energy, and/or other expected conditions. Deviations from expected results might indicate excessive wear or aging of motors or sensors, allowing predictive maintenance algorithms to flag potential failures and repair or replace them in time to avoid an outage.

Light Temperature and Light Loss Factors

Commercial LED lighting implementations can often adjust the light temperature to meet specific needs. The LED Kelvin temperature (K-temp) rating measures the relative warmth of light from various points on the spectrum. A warmer, orange/red light has a K-temp of about 2000, while cooler, blue light checks in at about 6000. Offices will typically use warmer light, the type most like natural daylight. Cooler light might be a better fit for retailers or supermarkets with display merchandise. Supermarkets might want to use a different K-temp to display produce than boxed or canned goods. Clothing and furniture retailers might prefer different temperatures of artificial light to display their products depending on color and material type.

LED lighting systems for both residential and commercial should account for Light Loss Factors (LLFs). LED lighting typically depreciates in quality far slower than incandescent and halogen bulbs, but they will lose strength over time. It can be difficult to accurately measure the degree to which LED lighting has diminished over time because of the various types of technologies that LED lighting systems employ. Still, the Illuminating Engineering Society (IES) uses the Lamp Lumen Depreciation (LLD) factor as a catch-all to approximate how LED lighting deteriorates from the point it is installed until it needs to be replaced. An LLD factor of 0.70-meaning an LED unit is emitting 70 percent of the light you'd expect a brand new unit to produce-is considered the threshold at which individual bulbs or lighting arrays need to be replaced. LED lighting requires replacement far less frequently than older technologies, saving companies energy (and money) over time. Light depreciation can be a bigger factor in some implementations more than in manufacturing settings because low-light levels can be dangerous for the human workforce. Streetlights and other forms of outdoor lighting also require maintaining high performance levels, making LED lighting a better long-term solution in these settings than more conventional lighting methods.

Conclusion

Reducing energy consumption is one of the few areas where public and private sectors seem aligned. Companies and governments are seemingly investing more in LED lighting and other forms of energy-saving technology. In the commercial sector, the adoption of LED lighting and lighting control systems could result in cutting the amount of energy consumed by lighting in the U.S. by as much as half in the next 15 years, according to the DOE. With the smart home revolution fast approaching, it might not be long before you see residential buildings designed with LED lighting-control systems that adjust the lighting in different rooms to match the levels of natural light those rooms are exposed to throughout the day. If you wonder whether you remembered to turn off the light on your vanity before you left for work in the morning, don't worry. The motion sensors in your bathroom will tell your home's lighting-control system to dim it after you've walked out of the door. ■

Unleashing Sales Effectiveness in the Semiconductor Industry Using Technology

Use Cases, and Benefits

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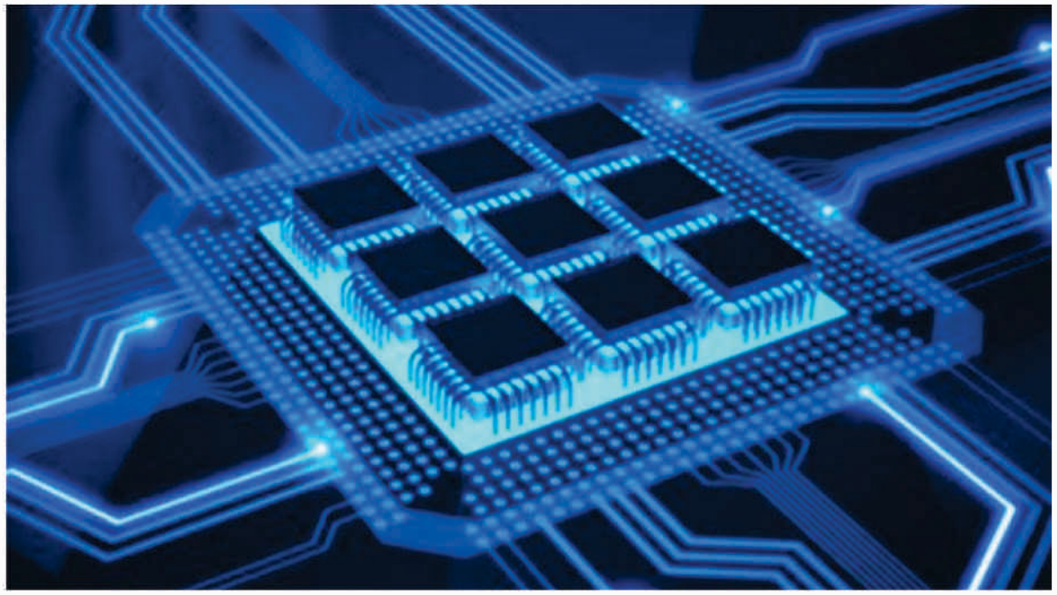

In 2020, The semiconductor market size was valued at $427.6 billion and is expected to reach $698.2 billion by 2026 at a CAGR of 5.9% during the same period. Along with this, increased investments in memory devices and Integrated circuit components are driving technological improvements in the semiconductor sector. While this is good news, semiconductor and component manufacturers still face challenges related to managing complex networks of multi-tiered original design manufacturers (ODM) relationships, distributors, contract manufacturers, and so on. Hence, to flourish in this highly complex market, sales teams need to capture every possible socket with solution selling, identify additional addressable opportunities, ensure a clear understanding of customer needs and improve forecast accuracy for improved pipeline and product planning.

The Case for Sales Force Transformation in the Semiconductor Industry

When we talk about the semiconductor sales funnel, there is always a constant flux about who the end customer is. Additionally, the growing research, testing, and compliance requirements significantly stretch the sales pipeline to as long as 8-10 years. Semiconductor companies need to track these tests and chips in those tests to know their pipeline and arrive at the potential forecast for the next few years. This not only needs continuous efforts around relationship management but also poses a challenge in terms of keeping track of all activities, data and prospect information. New-age technology tools like good customer relationship management (CRM), can help capture the entire sales process,

and can also reflect on the client's history whilst suggesting the next steps for the salesperson.

The Rescue Act by Technology: Use Cases

The deployment of the right technology tools can empower semiconductor companies to increase top-line revenue by capturing every socket through solution selling, improving sales effectiveness, and reducing sales costs. These tools also assist companies in global price and quotation management.

Here are the top 6 use cases which semiconductor companies can adopt for long-term benefits:

- Customer Segmentation for a Focused Sales Approach: Customer segmentation can play a critical role in helping release sales bandwidth for exploring newer opportunities. For this, semiconductor companies should segment their customers (and their divisions in case of large customers) into multiple tiers based on revenue and margins as well as current and potential wallet share. They will then be able to focus on the ones with high revenue, margin, and potential to gain wallet share.
- Business Forecasting: A robust salesforce monitors the entire business with a complete view of the total pipeline. It also aids in forecasting for complex sales teams, which is especially the case with semiconductor manufacturers. Sales teams can leverage artificial intelligence (AI) tools to make forecasts highly accurate. Factors such as forecast type, adjustments, time, and currency, can help in determining the near-accurate forecast. Overlay Splits, can further facilitate crediting the right amounts to sales overlays by revenue, contract value etc. This can help organizations gain confidence in their services, and enable business leaders to flourish in this highly competitive market
- Cross-functional Collaboration: Usually customers take a long time moving through the funnel in the semiconductor industry due to the projects and products being invariably technical and spread across different locations/time zones, involving several key decision-makers. Longer sales cycles with multiple divisions can help keep a complete track of all activities and submissions as well asa strong collaboration between sales, marketing, technical teams. A CRM platform can also be the cross-functional collaboration tool between multiple teams to reinforce the value message at the correct points, ensuring that the prospect is well-informed on key differentiators, value adds, and new developments
- Onboarding: Semiconductor companies find it challenging to efficiently train and onboard new clients while sustaining the same personalized experiences they could offer during the initial phase of their journey. A standard automated onboarding journey can enhance the client experience and bring in the respective teams as per the need to ensure no bottlenecks in the future. A good CRM system can build in the onboarding process to ensure a complete link with upstream opportunity closure and downstream fulfillment to ensure a smooth onboarding journey and complete visibility to both sales and service
- Sales Effectiveness: Sales teams spend a bulk of their time either facing the customers/prospects or preparing for sales calls. A smooth sales call needs proper preparation and any related information about the customer/prospect, stakeholder and opportunity can be invaluable. A strong CRM can help the sales team view the required information and planactivities. It can also provide guided business process flows to standardize the sales process and ensure recommended sales steps are completed along with the capture of reasons for win/loss. It can hence, help in realizing optimal value for the time spent on customer calls/preparations
- Key Account Management: With a focused selling approach, sales teams need to drive repeat as well as new business from key accounts and increase their wallet share as well. This requires a complete view of the customer and astrong planning exercise to break down targets by accounts, product lines, and divisions, look at competitor presence, target sales, and marketing activities at key stakeholders. A strong CRM system can help the sales & marketing teams to plan and execute account management activities with a complete view of the customer information

Final Words

The semiconductor industry operates through multi-level sales channels, which multiplies the complexity of tracking opportunities, forecasting, managing quotes, managing samples, etc. Factoring all these challenging scenarios, knowing that there is no one-size-fits-all, companies need to evaluate their needs and evaluate in detail before investing in a solution to reap tangible long-term benefits! ■

What lies ahead in 2022 for UAV and Robotics to support insatiable global demand?

Ultra-Dense Power Delivery Networks are re-shaping the future UAV and Robotics design and development

Tom Curatolo, Senior Director, Applications Engineering, Vicor

It is estimated by the year 2030 there will be a global skilled labor shortage of up to 85 million jobs, which equates to $8.5 trillion, according to a recent Korn Ferry report. Many of these jobs will be in the industrial and service sectors where the Covid pandemic has exposed weaknesses in global supply chains and labor pools. Unmanned aerial vehicles (UAVs) and robots can alleviate this situation by efficiently automating manual tasks.

Today, UAVs are being quickly ushered into service for a host of unique and mission-critical applications, including security/surveillance, parcel delivery, agriculture, defense and even natural disaster recovery and humanitarian aid delivery missions. As we look a few years into the future, we can see UAVs assuming greater roles in more hazardous types of applications such as high-voltage wire inspection, bridge/tower inspection and commercial shipping hull inspection/repair. Using UAVs for these types of applications has several benefits, including faster response times and real-time data gathering. More importantly, the use of unmanned systems for high-risk activities currently performed by human workers eliminates the risk of employee injury, collateral damage and associated liability costs.

As the global economy becomes more integrated and interdependent, the demand for consumer and durable goods is growing exponentially. As a result of this explosive demand, today's factories are finding it difficult to source, manufacture and deliver goods in a timely fashion. That's where enlisting the services of robots comes in. Robots excel at routing tasks that require limited decision making. Robots can operate for weeks on end with predictable and repeatable results, dramatically improving efficiency and increasing throughput. The rapid adoption of robots and other automated systems is being driven by consumer demand with no end in sight.

Figure 1 For UAV and robotics applications to continue to innovate, they require compact, light weigh power supplies that can deliver more power than today. Power modules are power dense, thermally adept power supplies that are easily configured and simple to scale as more power is needed.

In order for UAVs and robotics to realize widespread deployment, we need to rethink their most impactful limitation-power. How to power them to achieve longer flight times while carrying heavier payloads or stay online to meet production demands using a variety of power sources ranging from onboard batteries, tethered power sources or alternative energy sources like hydrogen fuel cells and renewable energy like solar, wind and wave power.

When we speak with customers, they typically are trying to fit the power supply into a very small space. Size and weight are always a priority for them. So, power modules are a great solution. They are thermally-adept, compact and deliver a lot of power for mobile applications.

That's where dense power delivery networks come into play. If power is a limiting function of many mobile applications, then it can also be an enabler to innovation if it is used properly.

Module-based solutions offer a high-level of integration at extremely high efficiencies, making it possible to squeeze the most out of your power source using a much smaller footprint than conventional power topologies. This paradigm shift in power delivery means UAV and robotics designers can accommodate more features, functions and higher operating voltages in their designs without having to make any compromises.

The Future of Power Needs to be Exotic

Llew Vaughan-Edmunds

This increased demand for more data, faster communications, and wider connectivity brings along an exponential increase in power requirements.

Moore's Law follows the continual advancement of smaller silicon transistors, which is ideal for faster operating speeds in processors and increasing memory size density.

However, not all solutions require smaller transistors, and not all are made on silicon wafers. LEDs are made from gallium arsenide (GaAs) and lasers use indium phosphide (InP), while power devices are transitioning to silicon carbide (SiC) and gallium nitride (GaN) for better performance. These exotic materials deviate from silicon properties and provide superior performance with higher reliability.

A FASTER, SMARTER WORLD

Electronic equipment is becoming smarter: smartphones are scanning faces for identification and moving into augmented reality (AR) applications. Electric vehicles (EVs) are learning how to become autonomous through sensors and cloud computing, while maximizing battery life between each charge. The Internet of Things (IoT) is connecting everything and everyone, from house thermostats knowing their owners' whereabouts, to distribution warehouses tracking packages in real time.

All this extra data will need to be transferred quickly using the 5G cellular network as the communication backbone. 5G is like pressing the light-speed switch, enabling download of a two-hour movie in three seconds, compared to six minutes on a 4G link.

This increased demand for more data, faster communications, and wider connectivity brings along an exponential increase in power requirements.

NEW REVOLUTION IN SEMICONDUCTORS

Silicon has been the work horse for over 50 years, but we now see the growth of compound semiconductors which support possibilities that silicon cannot provide (figure 1). These materials combine two or more elements, and allow electrons to flow much faster, in some cases supporting processing speeds 100 times faster than silicon. They emit and sense light, generate microwaves, are sensitive to magnetism and are resistant to heat. They do all this and use only a fraction of the energy of a silicon-based solution.

These materials never went into serious volume production over the last 30 years due to challenges in manufacturing, such as compound crystal growth, high defectivity, and breakability. The cost and complexity were simply too much to compete with silicon-based solutions.

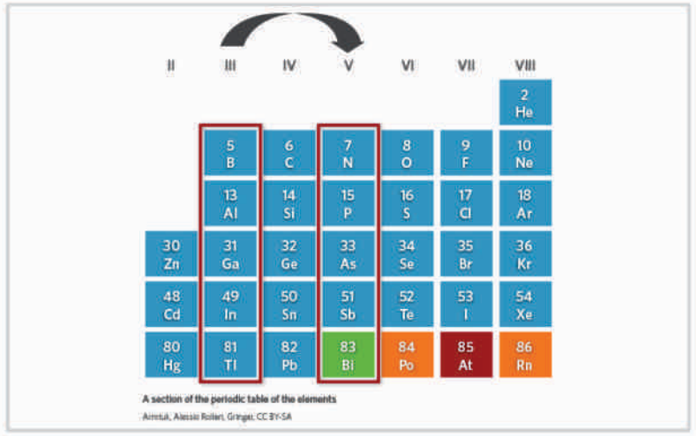

Figure 1. Gallium arsenide (GaAs), gallium nitride (GaN), and indium phosphate (InP) are compounds created from groups III-V, which enable high carrier mobility and direct energy gaps, ideal for emitting/receiving light and switching at radio frequencies <60GHz. (Source: Armtuk/Alessio Rollen, Gringer)

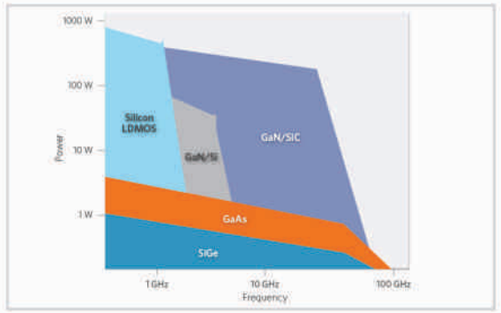

Figure 2. GaAs metal-semiconductor field-effect-transistors (MESFETs) are limited to low power, while GaN-on-SiC high-electron-mobility transistors (HEMTs) offer both high frequency and high power. (Source: Analog Devices)

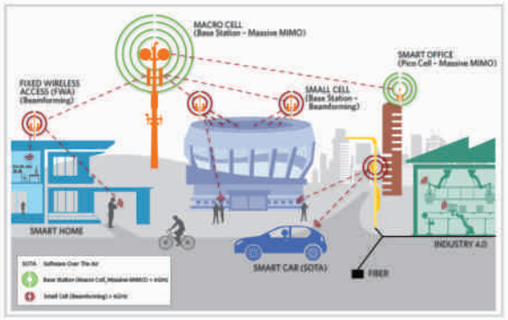

Figure 3. 5G is expected to have download speeds of 10 Gbps, more than 1000x faster than 4G. A completely new infrastructure will be required to effectively transmit and receive that level of data reliably. (Source: Infineon Technologies

More recently, however, compound semiconductors have advanced as high-volume production, continuous material improvements, and new processes combine to bring down costs to levels where customers are starting to accept them over silicon. As higher-end solutions such as those for EVs or 5G emerge, requiring levels of performance that silicon cannot achieve, system designers increasingly are choosing compound semiconductor-based devices, and the extra cost becomes justifiable.

NEED FOR SPEED

All smartphones and wireless communication systems transmit and receive signals in the radio frequency (RF) spectrum. To convert an electrical signal to a radio frequency, RF amplifiers are needed. These use a range of III-VI materials including GaAs, GaN, and InP devices.

The main advantages of 5G are superfast data rates (<10 Gps), ultra-low latency (<1 ms), and highest reliability (~99.99%)—all demanded by a data-hungry society seeking fast movement of data to the cloud, reliable live video streaming, AR/VR, and the fast response times required for the IoT and autonomous transportation.

Currently the main power switches for RF communications are made on silicon (often a laterally diffused MOSFET [LDMOS] process) and GaAs. However, as 5G frequencies go to 100 GHz, these materials start to lose steam. Silicon LDMOS cannot run higher than 3.8 GHz, therefore GaN-on-SiC will start to dominate this higher frequency and power band, typically focused on base stations. GaN-on-SiC supports very high-power densities, about 5X the power output compared to its GaAs counterparts, which makes GaN-on-SiC ideal for smaller solutions at the same power levels or for higher power levels at the same size (figure 2).

As 5G ramps into high volume in the next years, the amount of amplification will exponentially increase. Micro cells, massive multiple-input and multiple-output (MIMOs[1]), and beam forming are just some of the new infrastructure that 5G will require to provide reliable levels of signal and bandwidth (figure 3).

Currently 5G requires approximately 4X more system power than 4G, and the additional power requirements—beyond what is possible with GaAs solutions—make GaN-on-SiC increasingly attractive.

CARS GET CLEVER

The evolution to self-driving cars is in full swing, though it will probably take a decade or more to pass legislation before we start seeing them in volume on the roadways. There are five levels of autonomy, where Level 5 is a completely self-sufficient, driverless, car.

Figure 4. Levels of human vs. machine driving control. To become autonomous, the car needs to key where it is going, what is around it, and what to do in every possible scenario. (Source: http://www.businessinsider.com)

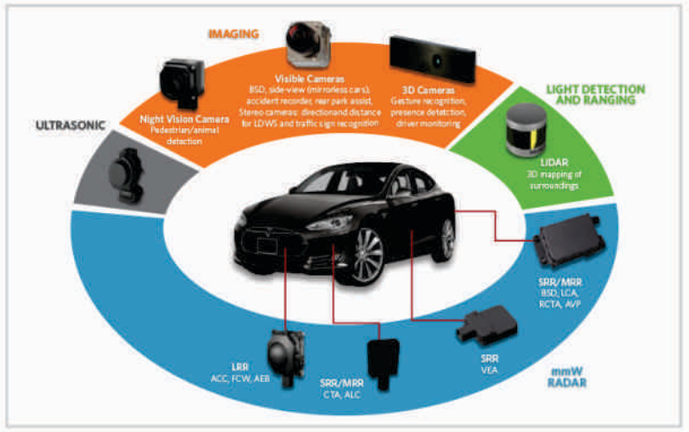

Figure 5. A number of mechanisms will likely be combined to provide vision functions in autonomous cars. (Source: Yole Développement)

Currently the industry provides support for Level 2 functions, such as emergency steering, acceleration and braking functions, using multiple data sources. These advanced driver-assistance systems (ADAS) are designed to increase road safety and enable autonomous driving (figure 4).

For the car to have "vision," a number of possible technologies are being developed, such as image cameras, radar, light detection and ranging (LiDAR), and ultrasonic sensors. All have their advantages and disadvantages, and it is likely that cars will instead incorporate a "sensor fusion" approach, combining two or more of these technologies (figure 5).

LiDAR

LiDAR systems are designed to measure the distance to a target, using lasers to pulse light and a sensor to measure the reflected pulses. The pulsed lasers are typically rotated 360 degrees to create a 3D image of the surrounding area.

GaAs and InP laser diodes are the current choice today, depending on the range (figure 6). These lasers require high pulses of surge current at a very fast frequency. Today's silicon MOSFETs are not able to provide that level of performance, therefore GaN high-electron-mobility transistors (HEMTs) are now the preferred choice. They can switch 10X faster with less noise than silicon transistors, providing superior resolution and faster response times.

Figure 6. GaN HEMTs are necessary to provide high-resolution imaging for LiDAR by enabling high surge currents at fast frequencies. (Source: EPC Corporation)

TRACTION INVERTERS

Electrical motors have existed for over 150 years, and there are many types optimized for different applications. For EVs, typically an AC induction motor or permanent magnet motor is used. Permanent magnet motors have higher efficiency and power density, but are more expensive to manufacture than induction motors.

Most industrial motors today use insulated-gate bipolar transistors (IGBTs) co-packed with a diode, however IGBTs are minority-carrier devices which behave similarly to a bipolar transistor by injecting holes into the drift region. While this is good for lowering resistivity, it increases switch-off time due to the recombination of minority carriers. This leads to higher switching losses due to slower tail current recovery. SiC MOSFETs are majority-carrier devices which have no discernible recovery time and transition significantly faster. This leads to lower power losses and higher system efficiency (figure 7).

Tesla was among the first EV makers to use SiC devices in the traction inverter. SiC solutions will provide an estimated 10-15% additional mileage range, which makes SiC attractive for longer range EVs (figure 8).

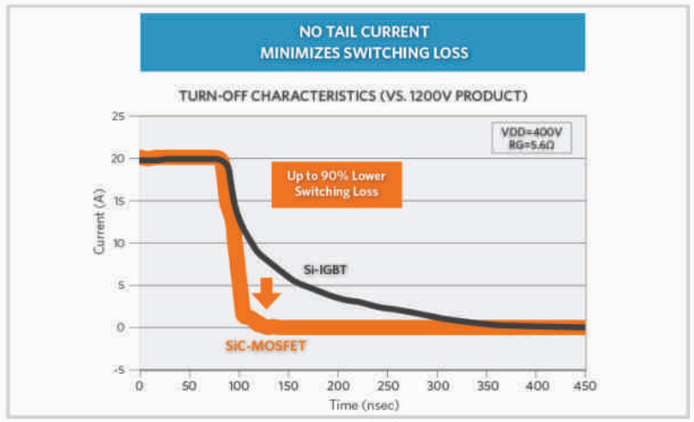

Figure 7. Compared to conventional silicon IGBTs that utilize a high-voltage switching element, SiC devices can reduce the power lost during switching by over five times. (Source: ROHM Corporation)

DEVICE PRODUCTION OF SiC/GaN

SiC is a very hard material that requires special tooling and technologies for grinding, dicing, etching, and implanting. Typically, higher energies and higher temperatures are needed to manipulate the material characteristics.

Also, GaN-on-Si and GaN-on-SiC need precise layers of material stacking to ensure good lattice alignment, a buffered coefficient of thermal expansion between the GaN and the substrate, and the lowest-charge trapping between interface materials.

Applied Materials has a selection of released and in-development technologies to support the processing of wide bandgap (WBG) materials, such as high-throughput CMP, deep reactive ion etch (DRIE), high temperature implant, and deposition.[2]

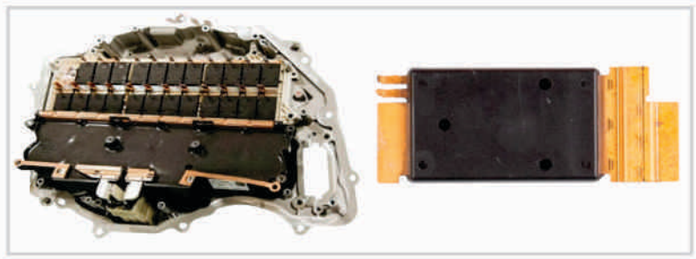

Figure 8. Tesla Model 3 traction inverter showing the SiC MOSFET power modules from ST Microelectronics.

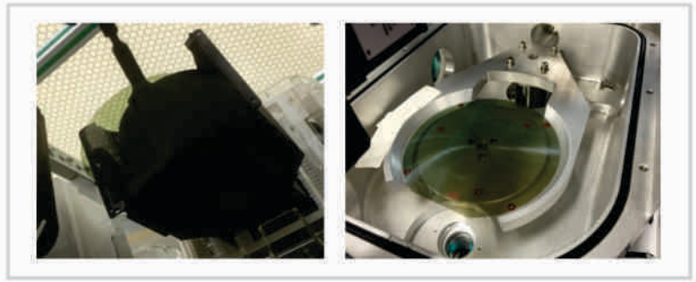

Figure 9. Endura PVD wafer mapping and orientating a 150mm SiC wafer. (Source: Applied Materials)

One of the main considerations was the handling of SiC wafers. These are transparent wafers that current sensors are not able to detect. Therefore, a completely new approach and system kit was required to handle these types of wafers (figure 9).

CONCLUSION

The evolution of end systems is changing to become faster, smarter and more autonomous. This has energized the need for extra sensors, faster data transmission and significantly more power. Compound semiconductors such as GaAs, GaN, and SiC have now become one of the fastest growing markets for the foreseeable future, as 5G and EVs hew a path toward a new landscape.

Llewellan Vaughan-Edmunds is Director of Strategic Marketing for Power Technologies in Applied Materials' newly formed ICAPS group, which is focused on enabling MtM technologies through the development of new materials and unit processes delivered via Applied Materials production toolsets on 300mm (=28nm) and =200mm wafer sizes. For additional information contact him at llew_vaughan-edmunds@amat.com.

[1]https://en.wikipedia.org/wiki/MIMO

[2] See related information at http://www.appliedmaterials.com/nanochip/nanochip-fabsolutions/april-201...

ANSCER Robotics, a Bangalore based Robotics Company that believes in building world-class mobile robots that are proudly Made in India. Launched in July 2020, it is a homegrown company that develops efficient, flexible, user-friendly, and safe robotic solutions to help companies skyrocket the efficiency of their operations. Recently, ANSCER Robotics, launched Next-Gen AMRs at India Warehousing Show held at Pragati Maidan, New Delhi from 16 to 19 December, 2021. Here is the exclusive interview with ANSCER Robotics team to know more about their products and technology.

Our robots are proudly Made in India and we work super hard on our cutting-edge technology and design to make our country stand out as a leader in the robotics space.

Q What is the scope of the company's work in India and how can it contribute to Make in India?

ANSCER Robotics is a completely homegrown company that helps businesses skyrocket internal logistics and mobility with our efficient, user-friendly, and safe Autonomous Mobile Robots (AMRs). It can work in virtually any indoor environment, whether it is a warehouse, factory, or even hospitals, hotels, and

restaurants, to transport material up to 1250 kilograms.

Our vision is to democratize robotics so businesses of all sizes can reap its benefits. To this end, we also have a product called the ANSCER Engine (AE). We will explain this later, but essentially the AE is a platform for the development of a multitude of service robots that can be used across industries, regardless of payload or application, thus making it possible for companies to create their own mobile robot solutions and contributing directly to the needs of Indian manufacturers.

Our robots are proudly Made in India and we work super hard on our cutting-edge technology and design to make our country stand out as a leader in the robotics space.

How ANSCER Robotics is democratizing robotics technology in various industrial sectors in India?

The first wave of robotics was all about automating large-scale manufacturing. Therefore, the machinery was also big in size, complexity, and even price. As a result, only a small number of players had the operational scale and capital to be able to deploy them. By focusing on the internal logistics segment with small modular units, we aim to make industrial robots more accessible. Our AMRs are more affordable and versatile than most other players in the market, with state-of-the-art algorithms developed in-house. Also, the ANSCER Engine enables people to easily develop tailor-made mobile robot solutions that can be used in for virtually any application, irrespective of the size of their operation.

Please throw some light on the products offered by ANSCER Robotics and the technology behind it? How can it help the electronics industry excel?

Our platform is completely modular, and can easily be customized to be used in pretty much any industry requiring material transportation, including electronics. As a showcase of this adaptability, we have created a range of Autonomous Mobile Robots (AMRs), based on our ANSCER Engine (AE). The AMR range includes the AR 250, AR 650, and AR 1250 - each named after the payload it can carry - and they can autonomously transport payload around sites like factories and warehouses.

They can be used in the electronics industry to safely transport huge volumes of delicate components between general storage and individual workstations without any human guidance, thus cutting down on manufacturing bottlenecks and warehouse accidents. In the pandemic, we've seen many sectors within electronics growing rapidly, e.g. personal computers and laptops, mobile phones, etc. as there is an increased number of people working from home. Using AMRs can help efficiently manage supply chains during periods of high demand, improve ergonomics for employees by handling heavy-lifting, and help companies combat working with a reduced workforce.

What is an ANSCER Engine and how can they be implemented in India?

A completely unique product, the ANSCER Engine is Asia's first (and one of the world's first) AMR 'heart and brain'. It is not just the core for all ANSCER robots, but also a robust combination of state-of-the-art software and hardware that serves as a platform for the development of bespoke service robots. Developers can use this as a ready-made foundation to create their own tailor-made AMR solutions without having to worry about computer vision, planning, telematics, or security.

Essentially, this means you can create virtually any type of mobile robot with the ANSCER Engine, even if you're not a robotics expert. An example is one of our customers in Bangalore, who created a cotton-picking robot to combat labor shortages in agriculture.

Our AE powers our own AMRs, and we've even used it to develop a UV disinfectant robot to sanitize surfaces and curb the risk of COVID-19 contagion. Some of our customers have created their own robots within just 90 days with the help of the Engine! Thus, the AE is lowering the barrier of entry towards industrial automation and robotics in general.

How can MSMEs/SMEs benefit with this technology? What is the cost of each product?

MSMEs and SMEs stand to benefit from our AMRs because they user-friendly, modular, affordable, and easy to implement. The exact cost varies as company has unique needs which may sometimes require special customization. But what all small and medium companies stand to gain is an automated logistics system that combats labor shortages, ensures safety in product transportation, and reduces ergonomic risks - all contributing to a safer, more efficient work environment. Even if none of our current models suit the needs of their particular enterprise, customers can always use the ANSCER Engine to create their own custom service robots.

Keeping the current scenario in mind, how can the healthcare industry benefit from this technology, share examples?

COVID-19 is obviously big challenge for the healthcare industry, as the virus mercilessly puts everyone at risk, including the patients, doctors, and even the maintenance staff running our hospitals. Our AMRs can help address these safety concerns by transporting medicines and/or food around hospitals to reduce risk of contagion. We have even used our ANSCER Engine to make an award-winning UV disinfectant robot that can work around the clock to help mitigate the risk the disease poses for sanitation workers. Similarly, companies in healthcare can develop their own mobile robot using the Engine to solve the challenges they face in mobility.

Our products can also be used by sectors within healthcare such as pharmaceuticals and medical equipment to safely transport material within factories and warehouses, thereby contributing to a robust supply chain in a time of high demand and constant uncertainties.

Due to the boom of the e-commerce industry in this COVID 19 era, how do you think your product AMRs is an optimal solution to help businesses to meet surge in demand?

Another year, another COVID wave, and the curfews and restrictions that come with it. This is a truly unique time for the e-commerce industry, as it is witnessing a massive boom in demand from people stuck at home, while also going through an unprecedented shortage of labor as a result of the mass labor migration of 2020 and social distancing regulations. Leading e-commerce players in the country are looking for solutions to bridge these gaps, and ANSCER Robotics is more than happy to help them keep their promise of 1-2 day delivery. Our AMRs are uniquely positioned to take on the hurdles of safely transporting thousands of packages within massive warehouses and small fulfillment centers alike, and maneuvering around ever-changing environments safely and intelligently

How do you plan to handle ergonomics in India? Share a success story or an upcoming plan that is finally getting executed?

It's very simple - the human body was not made to handle repetitive heavy-lifting, and operations within internal logistics and general manufacturing are often fraught with tasks that are dull, dirty, dangerous, or difficult. This causes mental and physical fatigue, often even with long-term impacts on the mind and body. With ANSCER's products, these dangers are easily avoided, and employees can instead be upskilled or moved to more fulfilling tasks. We want people to understand and reap the benefits that robotic technology offers so India can truly move ahead and further our rank as a leading global manufacturer.

We launched our all-new AMR range and also showcased our ANSCER Engine India Warehousing Show (IWS) in December 2021 in New Delhi to help the industry learn about using AMRs to deliver value and ensure a strong supply chain, even in an era filled with uncertainties. ■

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

A Unified LTspice AC Model for Current-Mode DC-to-DC Converters

Wei Gu, Analog Devices

When a power supply designer wants to gain a general understanding of a power supply's feedback loop, they turn to Bode plots of loop gain and phase. Knowing the loop response can be predictive, helping to narrow the field of feedback loop compensation components. The most accurate way to produce the gain and phase plots is to put the supply on the bench and use a network analyzer, but in the early stages of design, most designers prefer turning to a computer simulation, which can help them quickly settle on a rough range of components-and help build an intuitive understanding of the loop response to parametric changes.

This article focuses on a feedback control model for current-mode control power supplies. Current-mode control is popular in switch-mode DC-to-DC converters and regulators because it has a number of advantages over voltage-mode control: better line noise rejection, automatic overcurrent protection, easy parallel operation, and improved dynamic response.

Designers already have access to a significant number of current-mode power supply average models. Some are accurate to half the switching frequency-matching the increasing bandwidth of converters-but only for limited topologies, such as buck, boost, and buck-boost (not 4-switch buck-boost). Unfortunately, 3-terminal or 4-terminal average models for use with topologies such as SEPIC and ?uk are not accurate up to half the switching frequency.

In this article, we present an LTspice® simulation model that is accurate up to half the frequency (even relatively high frequency), for a wide range of topologies, including:

- Buck
- Boost
- Buck-boost
- SEPIC
- Ćuk
- Forward
- Flyback

Simulation for piecewise linear system (SIMPLIS) results are presented to confirm the validity of the new model, and specific applications of the model are shown in examples. For some examples, bench results are used to validate the model.

Current-Mode Control Modeling: A Very Brief Overview

Here, we'll revisit some of the highlights of current-mode control modeling. For a more complete understanding of current-mode modeling, turn to the publications noted in the References section at the end of this article.

The purpose of the current loop is to make the inductor current follow the control signal. In the current loop, averaged inductor-current information is fed back to a modulator with sensing gain. Modulator gain Fm is derived by geometrical calculations, assuming a constant inductor current ramp and an external ramp. To model the effect of the variation of the inductor current ramp, two additional gains are added to the model: feed forward gain (kf) and feedback gain (kr), as shown in Figure 1.

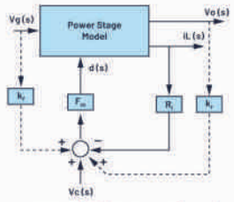

Figure 1. Average model for current-mode control by R. D. Middlebrook.

In order to extend the validity of the average model as shown in Figure 1 into the high frequency range, several modified average models are proposed based on the results of discrete-time analysis and sample-data analysis. In R. B. Ridley's model (see Figure 2), sample-and-hold effects are equivalently represented by the He(s) function, which is inserted into the feedback path of the inductor current in the

continuous average model. Due to its origination from the discrete-time model, this model can accurately predict subharmonic oscillations.

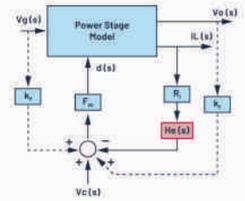

Figure 2. Modified average model for current-mode control by R. B. Ridley.

Another modified average model is proposed by F. D. Tan and R. D. Middlebrook. In order to consider the sampling effects in the current loop, one additional pole must be added to a current-loop gain derived from the low frequency model, as shown in Figure 3.

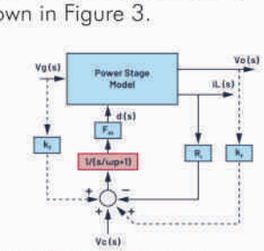

Figure 3. Modified average model for current-mode control by F. D. Tan.

In addition to R. B. Ridley's model, the current programmed controller model introduced by R. W. Erickson is also very popular. The inductor current waveform is illustrated in Figure 4.

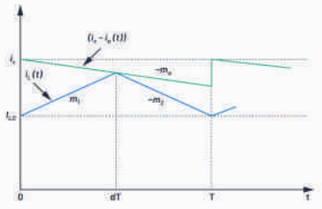

Figure 4. Steady-state inductor current waveform with an external ramp.

The average inductor current is expressed as:

$$\langle \hat{i}_L(t)\rangle_T = \langle \hat{i}_c(t)\rangle_T - M_a dT - \frac{d^2T}{2} m_1(t) - \frac{(1-d)^2T}{2} m_2(t) \quad (1)$$

where iL is the sensed current, ic is the current command from the error amplifier, Ma is the artificial ramp slope, and m1 and m2 are the upward and downward slopes of output inductor current. Perturbation and linearization results in:

$$\hat{d}(t) = \frac{1}{M_a T}\left[\hat{i}_c(t) - \hat{i}_L(t) - \frac{D^2T}{2}\hat{m}_1(t) - \frac{(1-D)^2T}{2}\hat{m}_2(t)\right] \quad (2)$$

Based on this equation and the canonical switch model, current-mode converter models can be obtained.

A New Modified Average Model

R. W. Erickson's model gives power supply designers excellent physical insight, but it is not accurate up to half the switching frequency. In order to extend the validation of the model to the high frequency range, a modified average model (see Figure 5) is proposed based on the results of discrete-time analysis and sample-data analysis.

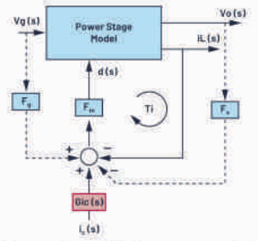

Figure 5. Proposed modified average model for current-mode control.

Sampled-data modeling of inductor dynamics establishes:

$$\frac{\hat{i}_L(s)}{\hat{i}_C(s)} = \frac{1-\alpha}{1-\alpha e^{-sT}} \frac{1-e^{-sT}}{sT} \quad (3)$$

where T is the switch period and

$$\alpha = \frac{1-\frac{m_1}{m_2}}{\frac{1-D}{D}+\frac{m_1}{m_2}} \quad (4)$$

Gic(s) of the model shown in Figure 5 can be derived:

$$G_{ic}(s) = \left(1+\frac{s}{\omega_c}\right)\frac{1-\alpha}{1-\alpha e^{-sT}}\frac{1-e^{-sT}}{sT} \quad (5)$$

where ω_c is the crossover frequency of the inner current loop Ti as shown in Figure 5, with the values ω_c of various topologies derived and shown in Table 1.

Table 1. Inner Current Loop Crossover Frequency (ω_c) by Topology

Topologies	Current Loop (ω_c)
Buck	$V_g/L/M_2/T$
Boost	$V_o/L/M_2/T$
Buck-boost, Cuk*	$(V_g + V_o)/L/M_2/T$
SEPIC*	$(V_{in} + V_o)/L/M_2/T$
Flyback**	$(V_{in} + V_o/(N_{sp})/L/M_2/T$
Forward**	$V_{in} * N_{sp}^2/L/M_2/T$

A Buck Converter Example

In Figure 5, we treat the Fv feedback loop and iL feedback loops in parallel. We could also draw the Fv feedback loop as internal to the iL feedback loop. A complete buck converter model with the added Gic(s) stage is shown in Figure 6.

In Figure 7, calculated loop gain based on the new current-

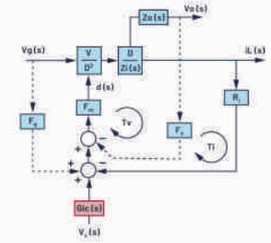

Figure 6. Block diagram of the modified average model for a buck converter.

The control-to-output transfer function $G_{vc}(s)$ is

$$G_{vc}(s) = Z_o(s)\frac{T_i(s)}{1+T_i(s)}G_{ic}(s) \quad (6)$$

The current loop gain $T_i(s)$ and voltage loop gain $T_v(s)$ are calculated by:

$$T_i(s) = \frac{R_i}{Z_o(s)F_V}\cdot\frac{T_v(s)}{1+T_v(s)} \quad (7)$$

and

$$T_v(s) = F_m\frac{V}{D}\cdot\frac{Z_o(s)}{Z_i(s)}F_v \quad (8)$$

where,

$$F_v = \frac{(1-2D)T}{2L},$$
$$F_m = \frac{1}{M_{ci}T},$$
$$Z_o(s) = \frac{R_o}{1+sC_{out}R_o}, \text{ and}$$
$$Z_i(s) = \frac{R_i}{1+sC_{out}R_o} + sL \quad (9)$$

mode model agrees well with SIMPLIS results. In this example, VIN = 12 V, VOUT = 6 V, IOUT = 3 A, L = 10 ?H, COUT = 100 ?F, and fSW = 500 kHz.

A 4-Terminal Model with LTspice

A 4-terminal model is built based on the modified average model shown in Figure 5. This 4-terminal model can be used to analyze any PWM topology for DC and small-signal characteristics using a standard electronic circuit analysis program, such as the free LTspice, in closed-loop operation.

Figure 8 shows LTspice simulation schematics for various topologies using the same model for each. The feedback resistor divider, error amplifier, and compensation components are not drawn here. To use the model with a real DC-to-DC converter model, the output of the error amplifier should be connected to the VC pin.

The various LTspice behavioral voltage source directives in Figure 8 are shown in Table 2. E1 is the voltage across the inductor when the switch is on, E2 is the voltage when the switch is off, V3 is the slope compensation amplitude, and Ei is the inductor current.

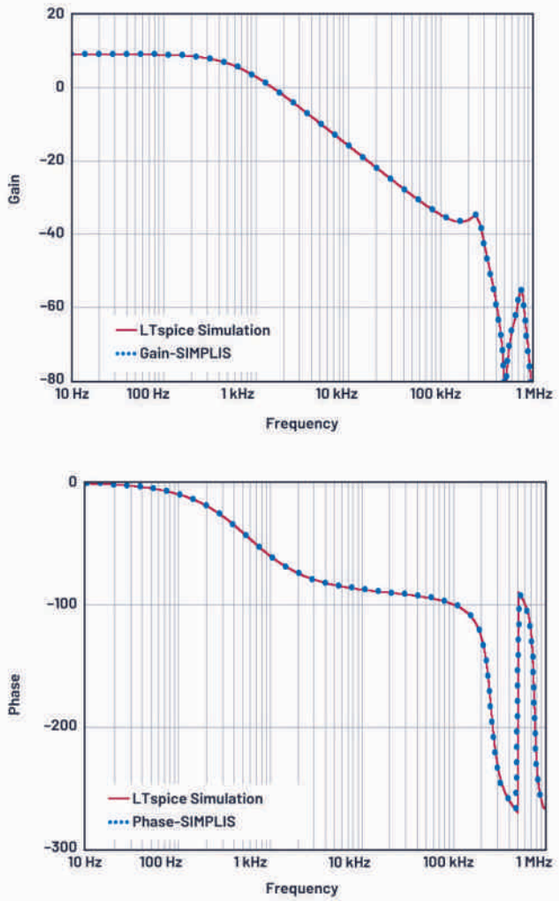

Figure 7. MathCAD results vs. SIMPLIS results (fSW = 500 kHz).

The simulation results for a SEPIC converter with two separated inductors are shown in Figure 9, which match the SIMPLIS results up to half the switching frequency. In this example: VIN = 20 V, VOUT = 12 V, IOUT = 3 A, L = 4.7 ?H, COUT = 120 ?F, C1 = 10 ?F, and fSW = 300 kHz.

Bench Verification of the New Models

The new LTspice models in Figure 11 were bench verified for topologies previously unsupported by traditional models, including ?uk, and 4-quadrant and 4-switch buck-boost.

Verifying the Ćuk Regulator Model on the Bench

The LT3580 is a PWM DC-to-DC converter containing an internal 2 A, 42 V switch. The LT3580 can be configured as either a boost, SEPIC, or Ćuk converter, and its AC model can be used for all of these topologies. Figure 10 shows a Ćuk converter with fSW = 2 MHz and VOUT = -5 V. Figure 11 compares the LTspice simulation Bode plots with bench results-they match well up to half the switching frequency.

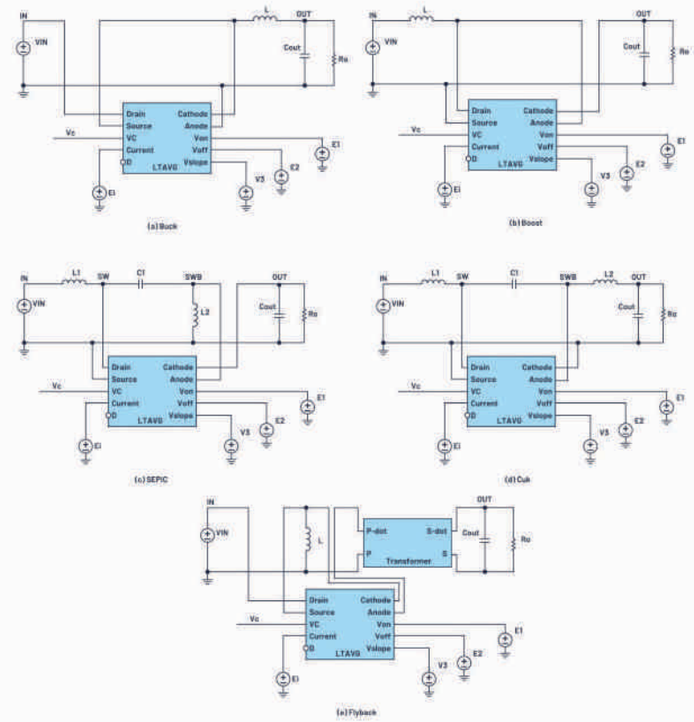

Figure 8. Using the LTspice model for various topologies: (a) buck, (b) boost, (c) SEPIC, (d) ?uk, and (e) flyback.

Table 2. LTspice Behavioral Voltage Source Directives for the Circuits in Figure 8

Topology	E1	E2	V3	Ei
Buck	V(IN) – V(OUT)	V(OUT)	Ma/fsw	i(L)
Boost	V(IN)	V(OUT) – V(IN)	Ma/fsw	i(L)
SEPIC	V(SW) – V(SWB) + V(IN)	V(OUT) + V(SW) – V(SWB) – V(IN)	Ma/fsw	i(L1) + i(L2)
Ćuk	V(SW) – V(SWB) + V(OUT) + V(IN)	V(OUT) + V(SW) – V(SWB) – V(IN)	Ma/fsw	i(L1) + i(L2)
Flyback	V(IN)	V(OUT)/Nsp	Ma/fsw	i(L)

Verifying a 4-Quadrant Regulator Model on the Bench

The LT8714 is a synchronous PWM DC-to-DC controller designed for a 4-quadrant output converter. The output voltage cleanly transitions through zero volts with sourcing and sinking output current capability. The LT8714 is ideal for regulating to positive, negative, or zero-volt outputs when configured for the novel 4-quadrant topology. Applications include 4-quadrant power supplies, high power bidirectional current sources, active loads, and high power, low frequency signal amplification.

Based on the CONTROL pin voltage, the output can be positive or negative. In the example shown in Figure 12, when the pin voltage is 0.1 V, the output is -5 V, and when the pin voltage is 1 V, the output is 5 V, VIN is 12 V, and the switching frequency is 200 kHz.

Figure 13 compares the LTspice simulation Bode plots with those produced on the benchtop-they match well up to half the switching frequency. The control voltage (CONTROL) is 1 V, which sets VOUT (OUT) to 5 V.

Figure 14 compares the LTspice simulation Bode plots with bench results-matching well up to half the switching

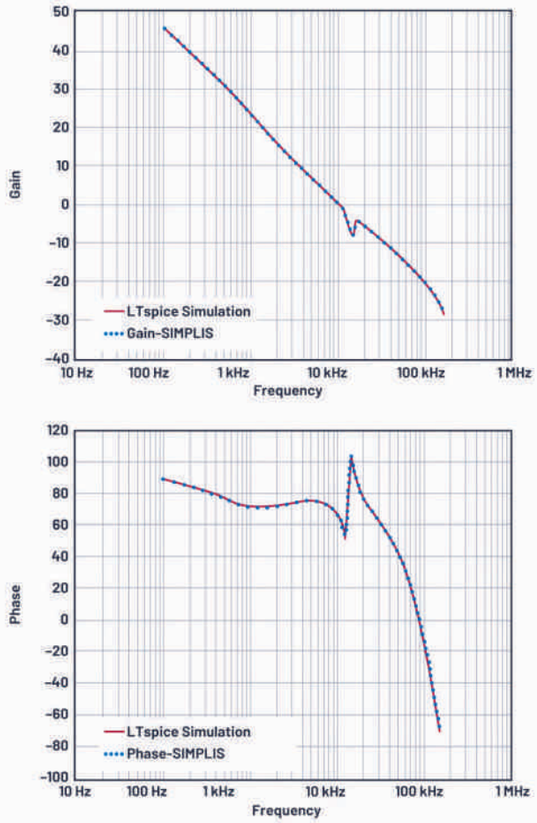

Figure 9. LTspice results vs. SIMPLIS results for a SEPIC converter (fSW = 300 kHz).

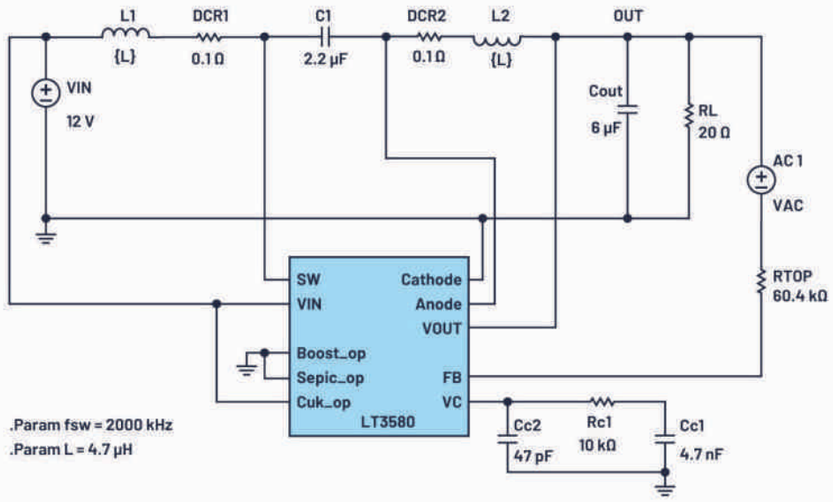

Figure 10. LT3580 LTspice model.

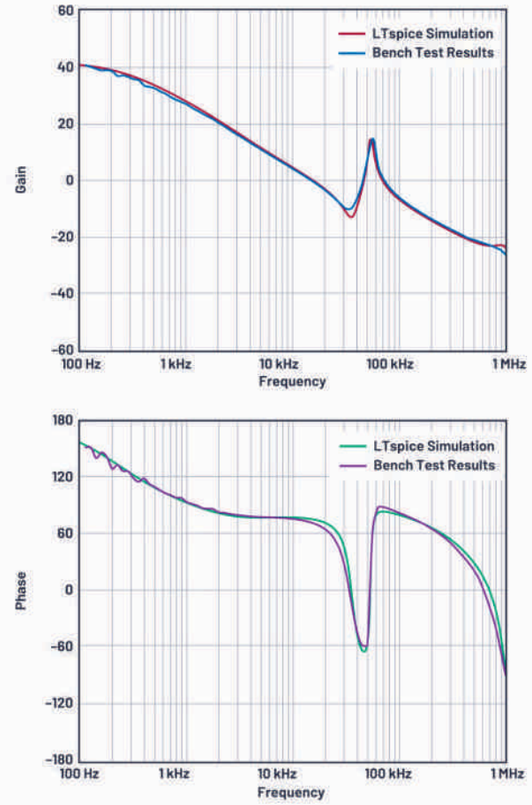

Figure 11. Bode plot (fSW = 2 MHZ

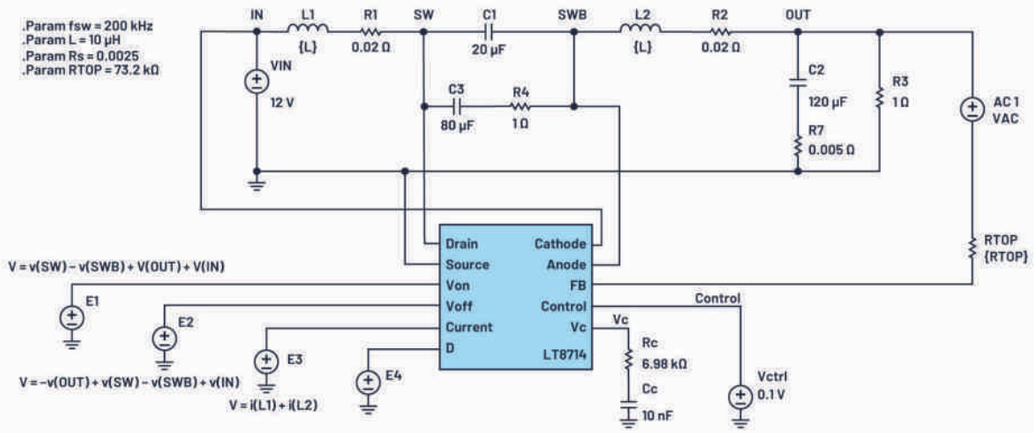

Figure 12. A 4-quadrant regulator LTspice model using the LT8714.

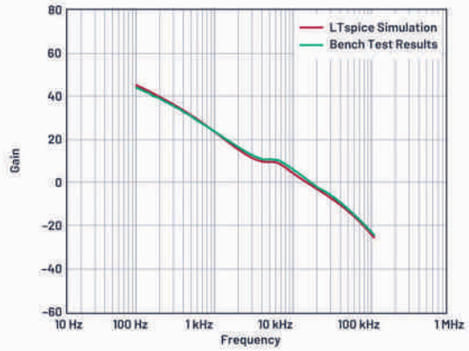

Figure 13. Bode plot (fSW = 200 kHz).

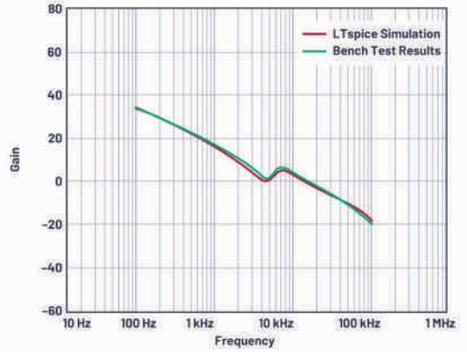

Figure 14. Bode plot (fSW = 200 kHz).

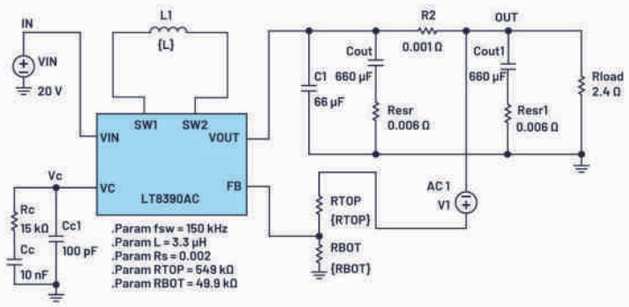

Figure 15. LT8390 LTspice model.

frequency. The control voltage (CONTROL) is 0.1 V, which sets VOUT (OUT) to -5 V.

Verifying a 4-Switch Buck-Boost Model on the Bench

The LT8390 is a synchronous 4-switch buck-boost DC-to-DC controller that can regulate the output voltage (and input or output current) from an input voltage above, below, or equal to the output voltage. The proprietary peak-buck/peak-boost current-mode control scheme allows adjustable fixed frequency operation.

The LT8390 LTspice AC model monitors the input and output voltages and automatically picks one of the four operation modes: buck, peak-buck, peak-boost, and boost. An LT8390 example circuit is shown in Figure 15. The LTspice simulation and bench results are shown in Figure 16 and Figure 17 for buck and boost mode, respectively. The curves match well up to half the switching frequency.

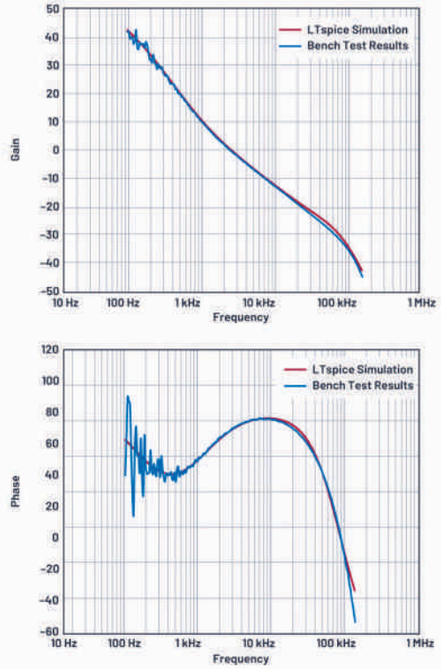

Figure 16. Bode plot (fSW = 150 kHz). VIN = 20 V, VOUT = 12 V, and IOUT = 5 A.

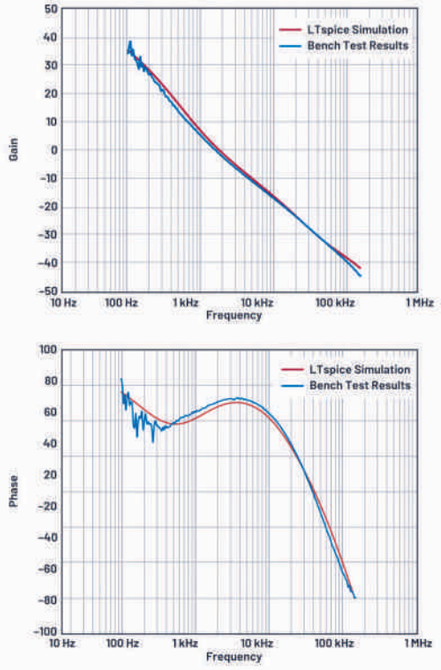

Figure 17. Bode plot (fSW = 150 kHz). VIN = 8 V, VOUT = 12 V, and IOUT = 5 A.

Summary

A current-mode control model is established to provide both the accuracy of the sample-data model and the simplicity and versatility of a 4-terminal switch model. A unified LTspice model-accurate up to half the switching frequency-for buck, boost, buck-boost, SEPIC, ?uk, flyback, and forward topologies is presented. The LTspice results are validated by bench data. The model is intended for loop analysis in design of current-mode converters in continuous conduction mode.

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Internet of Things and Airlines A Match Made in Heaven?

Courtesy: Onio

The coronavirus pandemic has no doubt wreaked utter havoc on the global economy. However, you don't have to look very far to understand that the ramifications of this global crisis has left the global airline industry in complete shambles. Airline companies all over the world have been left scratching their heads in despair as they struggle to find ways to keep the lights on. Given this background, it is as good a time as ever to examine the ways in which IoT is being used in the aviation industry.

For quite some time now, it has been clear as daylight that IoT technology is not just a passing tech-fad that is going to give way to the next big thing. Although adoption was slow at first, more and more industries are fast embracing the fact that if they are to survive in the brutally saturated marketplace of today, they are going to have to radically harness the power of the internet in ways never imagined before. The aviation industry is no exception - consumer aviation, with its numerous verticals and all its allied sectors has steadily been adopting state-of-the art technologies like machine learning and IoT to improve customer service, safety and ease of use.

In this article, we are going to take a thorough look at the various applications that IoT technology has within the aviation space as well as future applications and use-case scenarios that are in the pipeline. We'll take a look at the rationale behind some of these applications, the advantages they bring to the tabe and also check out some of the coolest real-world use cases.

Tremendous opportunity

The aviation space comprises several moving parts - a system of systems if you will. There are airline operators, airports, flight controllers etc. Furthermore, each player within this space often has multiple sub-structures working independently - say, the processes and workflows involved in ticketing are radically different to those involved in aircraft maintenance. Needless to say, these areas demand different approaches. What works in one almost definitely does not work in the other.

Regulation is another key feature of this industry. Aviation has never been the breeziest of businesses - companies have to contend with stringent regulations, ever-tightening standards and severe punitive legislation.

On the other hand, no matter how complex and intricate an industry is, the main objectives when it comes to tech-adoption remain the same - driving significant revenue increases, cutting costs, streamlining operations and improving customer experience. The last part is especially significant for the aviation industry. In the aviation game, passenger loyalty is worth its weight in gold. Airline operators have always made customer engagement, at every level of the journey lifecycle, a top priority.

This presents a tremendous opportunity for new technologies like the Internet of Things (IoT). IoT-based technologies are already being deployed by aviation's top players to exceed customer expectations in offering a seamless and integrated experience. According to a recently published study by Deloitte, 86% of the leaders in the industry expect tangible benefits from IoT within the next three years. Moreover, the study goes on to suggest that over 37% have already started implementing IoT improvements to their processes, in order to keep rising costs in check.

But there is another side to this - as we mentioned before, the airline space contains many moving parts working in tandem with one another. Each of these stakeholders has their own ecosystem and operation protocols. Nevertheless, they need to work together in order to function smoothly. This, along with the investment-heavy nature of the industry presents a steep challenge. In order to truly usher in a new hyper-connected era, a

radical overhaul of the entire environment is needed. An IoT-driven environment is required for innovation to truly blossom and take hold within this space. Airlines are already beginning to take note of the fact that they are going to have to make profound and far-reaching changes to their business models if they are to continue being viable in what looks to be an increasingly difficult market. If aircraft operators are to truly benefit from increased connectivity, they must upgrade their systems to increase the amount of data that can be run through the network.

Key Areas for IoT implementation

The digital transformation that is presently underway in aviation can broadly be broken down to a number of key areas. Some of these applications are already being employed while a few others are in the pipeline.

The internet of things, no matter the area or industry, offers nearly unlimited scope for innovation, connectedness and optimisation. More than offering a comprehensive list of potential solutions, this section is meant to highlight just how wide the breadth of opportunity for IoT within aviation is.

1. Air Safety

Keeping planes airborne without anything untoward happening to them, is no mean feat. Huge quantities of data are harnessed and communicated to pilots in order to ensure the safety of the passengers and the aircraft.

IoT technology offers a tremendous amount of promise in this area. IoT powered sensors, when embedded across various parts of the plane, can provide rich streams of real-time data. The types of IoT sensors we have at our disposal today offer us the possibility to track airplane velocity, airplane angle, weather conditions etc. with a high degree of accuracy.

Moreover, improved data connectivity means that this information can be relayed back and forth between land and air. IoT devices can go a long way in averting avoidable air accidents. Dramatic changes to the weather will no longer need to be looked at as grave threats to air safety. Airplanes will be able to communicate with weather stations and obtain real-time information about weather conditions and shifts. Additionally, in a "connected flying" paradigm, airplanes could share data in real time with other planes, reducing the likelihood of mid-air collisions.

2. Minimising ground time

As far as airlines are concerned, a plane that is grounded is not making money. It is in a carrier's best interest to keep their planes airborne for as long as possible and find ways around having to keep their aircraft grounded any more than is necessary.

Runway maintenance and a high volume of traffic are the two biggest obstacles to reducing grounding time. This is where IoT technology can help in a big way - An IoT system could track the running condition of the various moving parts in a plane in real time.

Having processed this data, the system can then offer engineers valuable insights about the health and operating status of various components within the plane, including the engine. This information could prove invaluable to the engineers in saving time by prioritising which maintenance jobs they need to attend to. This helps cut down on the time spent on runway maintenance.

IoT can also help with the second issue of volume. An IoT-based system can track the live whereabouts of planes, which can enable it to know which planes are coming in and which ones are to leave. Artificial Intelligence (AI) can be used to crunch this data and lay out the most efficient way for the air traffic to be dispersed. This system, in tandem with air-traffic control can help ease congestion in busy airports. As far as the companies are concerned, this represents lower costs and higher profits - what's not to like?

3. Improving in-flight experience

As we looked at earlier, airlines have identified offering an engaging and hassle-free customer experience as priority number one. IoT technology can make a huge difference in every step of the flying experience - from curb to gate to destination.

Airlines are now famously employing beacon technology to offer their flyers a more immersive flying experience where there is a seamless flow of information between the carrier and passengers. IoT-enabled beacon technology adds value to the traveler in every step along the way - finding the right gate, getting alerts about departure time, customising the in-flight experience, personalised recommendations.

Beacon technology also promises to cut down on security checks and make the famously derided chunk of the traveling experience a less cumbersome affair.

Moreover, over a period of time, the troves of gathered data about passenger preferences and complaints can help airlines create an effective feedback loop. This can help implement effective and relevant modifications to the flying experience, with the passenger's demands being held front and centre.

4. Aircraft manufacturing

Aircraft manufacturers have been employing IoT modalities, in one form or another, for many years now. The last few years, however, have witnessed paradigm-altering advancements being made in big data, AI and IoT.

Big players like Airbus are now looking to IoT technology in a bid to cut down their manufacturing and operating costs and speeding up production times. This is no trivial concern - there is a decade-long waiting list of open orders for aircraft; Faster production times could help aircraft manufacturers to work through this backlog faster.

5. Cockpit connectivity

Cockpit connectivity is a hot term in aviation at the moment. Cockpit connectivity basically refers to communication between the cockpit and the ground-based team. Airplanes which have cockpit connectivity enabled offer great benefits - the team in charge of operating the flight could benefit from intelligence collected on the ground and conversely, the control team could be made privy to the decisions made in the cockpit, which could help them prepare for what kind of actions will have to be taken once the aircraft lands.

It is estimated that cockpit connectivity could save airlines up to $15 billion every year and more importantly, cut down on carbon emissions by up to 21 million tonnes.

6. Smart airports

Much like smart-city or smart-home technologies, the airport of the future will be IoT-based. Smart airports could spell the end of the painful airport security experience that we have all come to dread.

An IoT-enabled smart airport would help passengers drop their bags off quicker, cut down on long queues for passport control and help locating gates a breeze. Baggage handling and retrieving lost baggage could be a breeze.

In a nutshell, smart airports can help enable passengers to make more informed choices at various stages of the experience and seamlessly interact with the airport to receive a more customised travel experience.

Instances of IoT use by airlines

1. Virgin Atlantic

Virgin Atlantic has deployed a fleet of 787s that are connected to each other and their respective cargo equipment using Internet of Things technology. This setup is being used to collect gargantuan amounts of data which is then scoured for actionable insights.

The system has already started delivering substantial benefits - a 20% cut in delays, 15% reduction in airplane defects and about 2 hours of maintenance time saved per engineer. With this setup, Virgin has been able to preempt operational issues well before they happen.

2. Airbus connected experience

Airbus has instituted a connected-cabin system, which they call the "Airbus connected experience". By connecting disparate elements within the airplane cabin, such as luggage bins, seats, and toilets, they have been able to study intricate patterns using large amounts of data.

These insights are used to provide the cabin crew real-time updates on a variety of parameters including food availability, passenger behaviour etc.

3. Delta's baggage tracking system

Lost baggage retrieval is a massive pain point for airline consumers. No flyer wants to spend hours filing paperwork upon arriving at their destination and finding that their luggage has been misplaced.

Delta has made a huge step towards alleviating this problem by using an RFID-tag based baggage tracking system. The system allows Delta passengers to track the location of their bags in real-time, from the plane all the way to the airport. This makes for a high degree of transparency which in turn makes for higher levels of customer satisfaction.

The future of flying is connected

IoT-based aviation services are in their infancy. Industry-wide adoption is being touted as a certainty, for most of these technologies and solutions.

It's a no brainer really that the aviation industry needs to dig deep and try any possible solution in a bid to survive through these testing times. The sheer scope for innovation is breathtaking and practically infinite! ■

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New Semiconductor Materials to raise EVs to the next level

Automakers like Tesla and GM urged to ditch traditional silicon in race to increase charging speeds and driving distance

As automakers scramble to make electric vehicles with longer ranges and speedier charging times, the chip industry has a message for them: You're doing it wrong.

Semiconductor companies are urging EV makers to ditch traditional silicon chips and embrace materials that will make cars more efficient, helping ease consumers' "range anxiety" and someday making recharges as quick as a gas-station fill-up. But there isn't an agreement yet on which approach to use. Silicon carbide is the front-runner, with gallium nitride emerging as a key contender.

What are these new materials? Well, silicon carbide - as the name suggests - is a combination of two elements, silicon and carbon. And it does a better job as a power converter, meaning chips using the material can move energy around with less of it getting lost along the way. The same is true of gallium nitride, which is made of gallium and nitrogen and - like silicon carbide - has a distinct edge over traditional silicon. Proponents say it could cut charging time in half.

Choosing the right technology has especially high stakes as the auto industry undergoes its biggest transformation in more than a

Deepak Aggarwal

century. Manufacturers around the world are racing to ditch internal combustion engines, and even icons of the gasoline age like Ford Motor Co.'s Mustang and the GMC Hummer are getting versions with batteries.

Along the way, chips have become ever more critical to how a vehicle works, spanning everything from the powertrain to the airbags. That's become painfully apparent this year as carmakers have had to limit production and leave dealer lots empty because they can't find enough silicon. But getting automakers on board with the newer technologies is critical to raising EVs to the next level.

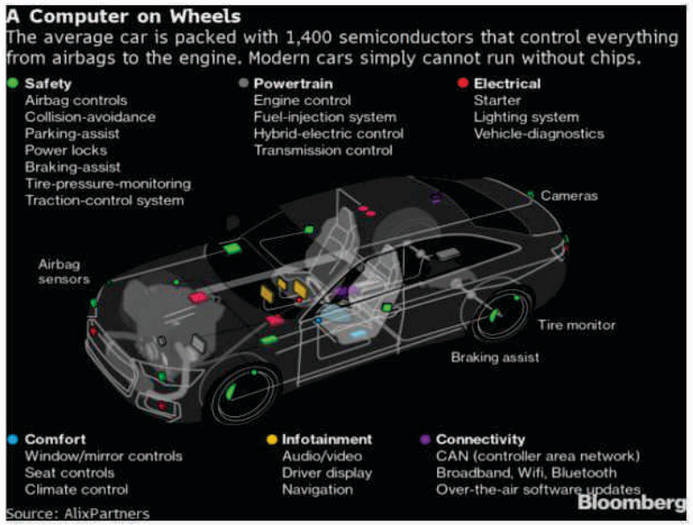
"It's a big learning curve for the carmakers," said Jean-Christophe Eloy, head of Yole Développement, a semiconductor analysis firm in France. "A good battery, a good inverter and a good electric motor doesn't give you a good electric car."

A Computer on Wheels

The average car is packed with 1,400 semiconductors that control everything from airbags to the engine. Modern cars simply cannot run without chips.

The good news, Eloy says, is that Tesla Inc. - a company that prodded the industry to embrace EVs in the first place - could help spur this transition as well.

Tesla is one of the first major adopters of silicon-



carbide chips, supplied by STMicroelectronics NV, Eloy said. And Chief Executive Officer Elon Musk has touted the technology as a key advantage of his cars.

With silicon carbide, watts of power can be crammed into the battery much more quickly, cutting charge times. And it provides for longer ranges because there's less leakage - wasted power - as a car taps the energy needed to drive motors. Infineon Technologies AG, the biggest maker of automotive chips, expects silicon carbide to exceed more than 30% of the market in electric-vehicle power chips by 2025.

"Silicon carbide can bring a significant advantage, literally a 5% to 10% improvement in range," according to Stephan Zizala, the head of Infineon's automotive high-power solutions group.

Some manufacturers are already sold on the concept. General Motors Co. is using silicon-carbide devices in its Ultium EV battery platform, the basis of all of its future electric vehicles. Toyota Motor Corp., which pioneered hybrid vehicles with the Prius, uses silicon carbide in the hydrogen-powered Toyota Mirai, and its supplier Denso Corp. has built the chips into other vehicle lines.

Stellantis NV, formed from the merger of Fiat Chrysler Automobiles NV and French rival PSA Group earlier this year, said recently that it may use silicon carbide in power inverters that will be key to mass manufacturing a new generation of electric vehicles globally.

Gallium nitride is a newer entrant - and it's not yet clear what role it will play. Infineon expects it to complement other technologies. Others are positioning it as more of a rival to silicon carbide. BMW AG earlier this month signed a deal to secure $250 million of such chips from GaN Systems Inc.

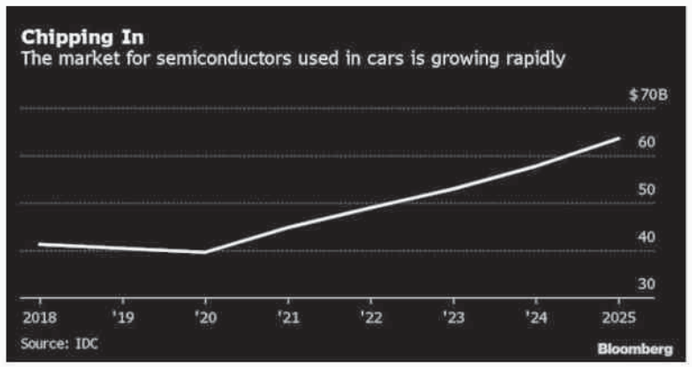
Gallium-nitride chips can cut the time it typically takes to charge a car to 4.7 hours from 11.3 hours, saving 70% on energy in the process. It also could boost the vehicle's range by 5% and use fewer batteries. That's according to startup Navitas Semiconductor Inc., which is telling investors that gallium-nitride chips will account for 16% of the power semiconductor market by 2026, up from less than 1% last year.

Carmakers have taken years to warm up to the new technologies. When silicon carbide was first offered to auto manufacturers more than a decade ago, they shunned it as "horribly expensive," said Michael Duhaime, vice president of JJE North America, a Chinese-owned maker of electric drivetrains in Troy, Michigan.

Chipping In

The market for semiconductors used in cars is growing rapidly

The typical reaction at the time: "Why would I do that? It's crazy," he said. Now it's making its way into premium vehicles, where cost is outweighed by the performance benefits.



There are still some painful trade-offs, though. Traditional silicon-based chips are made in the billions each year, and the technology's 50 years of dominance has created a massive global infrastructure to produce it. That's brought costs down. Silicon-carbide wafers, the basic material on which the new chips are built, are produced by only a few companies, such as Cree Inc., in a process that's still difficult and expensive.

One obstacle is the material itself, which has to be grown from seed crystals in a chemical process. There are relatively few crystals available that will produce the purity required. Any impurities can result in wafers and chips that are less efficient. In a sign of how scarce the materials are, Cree rival On Semiconductor Corp. agreed to pay $415 million last month for GT Advanced Technologies, acquiring its supplier of silicon carbide. That deal lets it secure access to the raw material.

Silicon-carbide components could add an extra $200 to the cost of a vehicle, according to an estimate by Cree. But boosters of the new technology say the cost will quickly be recouped because cars won't need as many batteries.

And that speaks to the need for carmakers to put more thought into the chips they use, Eloy said.

"If you want to save costs, if you want to increase range, if you want to do all of this optimization, you

BCU: Power Solutions for Commercial Energy Storage Systems

With more attention placed on sustainability, renewable energy sources are becoming increasingly relevant in the global energy production field. As a consequence, energy storage systems have also become a matter of interest for their ability to stabilize the energy grid.

In particular, the market of energy storage power solutions is expected to spike to $5.1 billion by the year 2024 from the $720 million of current worth. In this article, we will review some application challenges of commercial energy storage.

Commercial Battery Energy Systems

Commercial battery energy storage systems enable electricity storage for later uses whenever and wherever needed. They are usually integrated with various components, which can be grouped based on their functions as shown here below.

Battery Pack

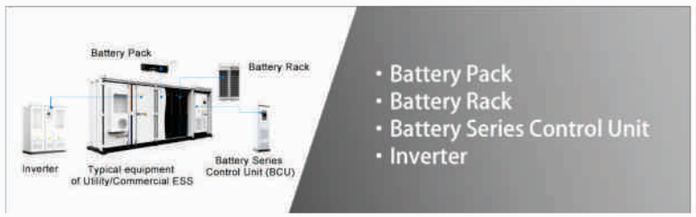
The battery pack of commercial battery energy systems protects cells from hazardous current, temperature, and voltage operations to ensure safer and more reliable operations. It also balances the different states of charges of the cells within the connection also by relying on its internal battery management system.

Battery Rack

In energy systems applications, the battery rack refers to a structure on which individual batteries are installed. It is usually formed by a group of series-connected battery modules; each battery rack controls, protects, and manages each level of battery modules through its integrated battery management system.

BMS

As the name suggests, Battery Management System (BMS) refers to a management scheme with the function of monitoring, controlling, and optimizing the individual and overall performance of the battery modules included in an energy storage system. The BMS can monitor individual cells included in the battery pack and battery rack of a BESS to reduce the causes of degradation and improve the system's overall performance.



Inverters

AC/DC power inverters are classified by the waveform category they produce or their ability to connect with the electrical power grid and the final application.

Benefits of Battery Energy Storage Systems

Many are the benefits of using commercial battery energy storage systems. Here below we have listed some of the main ones:

Energy Demand Management

Energy storage systems can be utilized to store energy that was purchased or generated at lower rates. They can also be switched on when the energy demand is higher or configured to deliver an uninterrupted power supply.

Stable Power Supplement

Power supplement is essential for keeping sufficient and steady electricity supply at hand in case of power outages or natural calamities.

Environmental-Friendly Option

Commercial battery energy storage systems increase the capacity and efficiency of the electric grid, resulting in lower GHG emissions and a reduced carbon footprint. Moreover, the grids can be made more flexible to integrate different energy sources for higher resource capacity.

Challenges Associated With Battery Energy Storage Systems

Battery energy storage systems represent an efficient, flexible, and effective way of storing large amounts of energy. However, BESSs can become a serious safety risk or result in high maintenance costs if incorrectly designed, installed and operated. Therefore, design engineers working on BESSs projects should pay particular attention to their safety and maintenance costs.

Below we will review more in detail the repercussions of each challenge on a BESS's design.

Safety Threats

Battery energy storage systems can become potentially dangerous as there are serious risks associated with their improper installation and handling, a malfunctioning battery management system, or other similar circumstances.

In particular, the security threats associated with BESS can be divided into three main categories: damage to the equipment, an unsafe system integration, and a compromised environment. Below we will review each type more in detail.

First of all, battery energy storage systems can become potentially dangerous when the equipment is flawed or damaged for either intrinsic or extrinsic reasons. A key element that guarantees the safety and reliability of a BESS is its battery management system (BMS). A battery management system is a battery monitoring device that can take actions to protect the battery from certain usage and other conditions that could damage or shorten the life of the cells in a commercial battery energy storage system.

The risks associated with flawed or damaged materials are only one side to consider. Increased security risks can also generate from overly complex design setups that include a complex net of wires to store energy in the BESS.

Besides an overly complex and poorly-assembled circuit design, another cause of potential danger is associated with improper handling and installation of this equipment. The consequences can be space from electric shocks, fire, flash burns to explosions and exposure to hazardous chemicals.

A compromised environment is one of the other elements that could impact a BESS' performance and security levels. This often takes the form of the excessive heat generated within the battery module as a consequence of Li-ion batteries exposed to high temperatures, short circuits, or electrical/mechanical problems. If unprotected, this can cause the release of gases that are toxic and flammable, possibly resulting in a person's physical harm or asphyxiation. Other potential risks include electric shock or electrocution through accidental touching or arc flash events.

In particular, higher equipment resistance and electrical insulation can be guaranteed with high-insulation DC/DC converters. MORNSUN has designed a series of DC/DC converters for supplying power to BCU in photovoltaic energy storage systems. This collection of DC/DC converters is characterized by high isolation voltage, reinforced insulation, and high levels of safety.

Unnecessary Costs

Energy storage systems can effectively enhance usability and reduce the operating costs associated with the power grid.

However, this type of equipment comprises a series of installation and maintenance costs that should not be overlooked.

In fact, energy storage systems with overly complex designs can raise the maintenance costs of the whole equipment. Reducing the wiring and construction costs is not only beneficial for the projects' owners but can also impact the overall performance and safety levels of the energy storage systems.

MORNSUN has designed a series of power supply solutions that streamline the circuit design of the energy storage systems projects for which they are employed. These reliable power supplies ensure the higher security of the whole BESS system and each of its components. With fewer incidents and malfunctions associated with the compromised security of this system, it is possible to decrease the long-term costs associated with BESS maintenance.

How is MORNSUN Helping

MORNSUN has over 23 years of experience in the power supply industry and we have applied for more than 1300 patents for inventions. We have helped electrical engineers across a plethora of industries to design reliable, efficient, and high-performing power supplies for their projects.

MORNSUN is familiar with the design challenges associated with battery energy storage systems, both for commercial and residential applications. We can provide a series of economic, efficient, reliable power solutions designed especially for battery energy storage systems and all their related components. Our power solutions have already been used in power plants, utilities, as well as commercial and residential buildings.

Our DC-DC solutions are designed for a higher efficiency of 93%, which promises a reduction in the working loss of the battery energy storage system. In addition, they deliver an isolation voltage of 4000VAC, and they are highly insulated to deliver better safety standards.

In the AC-DC solution, this power supply adopts the reinforced insulation design. It can withstand isolation voltage up to 4000VAC to promise secure insulation between the AC and BCU power grids. MORNSUN also optimizes the temperature range of -40-degrees Celsius to +70-degrees Celsius to comply with the IGBT temperature rise, different climatic conditions, and location altitude.

Besides being able to provide reliable power solutions for energy storage systems, we can also help to make your electrical project even more stable and safer thanks to our BCU power solutions. As we have described above, the battery control unit plays a key role in ensuring the smooth and dependable employment of a battery energy storage system, especially in solar photovoltaic power generation applications.

For this reason, you will need reliable power modules for the BCU in the battery container of your energy storage system. Our BCU power solutions for energy storage systems are known for their high-isolation voltage, high reliability, reinforced insulation, and multiple protections. With BESS, it's always better to invest upfront in the most reliable power components rather than dealing with the detrimental consequences on the safety of the people and equipment involved.

Contact us to know more about our power supply solutions designed for BESS and BCU applications.

For more information, please visit www.mornsun-power.com ■

A New Wave of IoT solutions lead the way to more sustainable farming

FREDRIK STÅLBRAND

Global demand for agricultural products is on the rise. By applying advanced technologies in agricultural production, farmers are able to measure and manage the variability of crops in a field and animals within a herd. Connected equipment, sensors and controllers are being deployed across farms worldwide to increase yield in order to meet the growing demand for food driven by population growth and urbanisation. According to Berg Insight's research in the space, the agricultural sector is significantly underpenetrated by IoT technologies but set to experience a wave of technology adoption.

Farmers look to boost crop yield with data-driven decision making

Growers have for a long time known that variations in their fields exist and today modern technologies enable detailed measurements of such variations. The introduction of GPS technology in the mid-1990s marked the advent of precision agriculture, as it allows for precise positioning of agricultural machines driving in the field. Today, farmers utilise sensors mounted on GPS-guided equipment along with satellite imaging, soil sampling and in-field sensor systems to collect a wide range of data from their fields. The collected layers of geocoded data form a digital representation of their crop fields and are used for decision support.

Every growing season, farmers have to make about 40 to 50 decisions on each individual field. Across large farms this can easily amount to several thousand decisions per season, which makes it very challenging to stay informed when making those decisions. Farm management software enables analysis and visualisation of field data and is also used to create prescription maps that describe how much product to apply at specific locations across a field. Telematics systems in tractors and combine harvesters allow for seamless wireless data transfer of field and machine data to and from the machines.

Advanced technologies enable far greater precision in agricultural tasks

One of the most widely adopted solutions in arable farming comprise auto-guidance systems, which have the capability to automatically steer the machine across the field according to a preselected pattern. Auto-guidance systems allow operators to focus on the task performed rather than the steering operation. The technology provides greater accuracy and reduces overlaps compared to manual steering, leading to a reduction in fuel consumption, working hours and use of inputs.

The use of precision farming technologies and practices aims to optimise the application of seeds, fertilisers and crop protection chemicals according to conditions in specific zones of the field. For

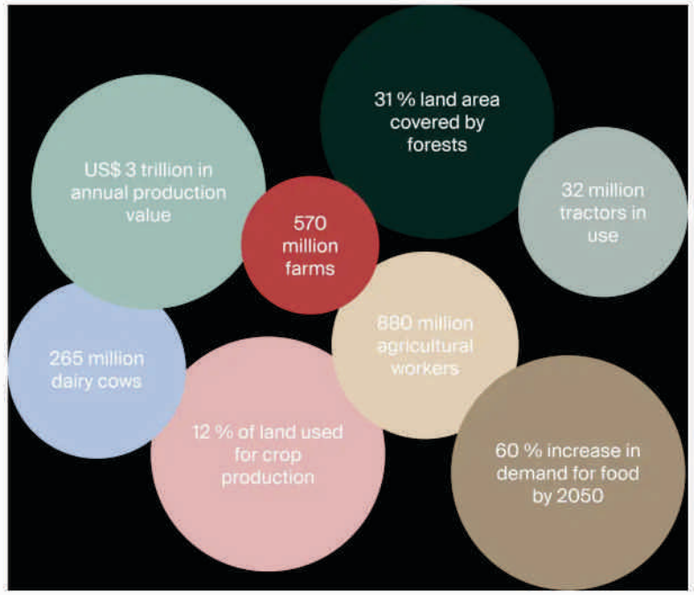


Figure: Global agriculture in numbers

example, it is estimated that uniform application of fertilisers across a field leads to over-fertilisation of roughly 40 percent of the area, while also causing a reduction in yield by 10 percent. In precision fertilising operations, higher application rates are used in parts of the field where nitrogen run-off occurs, while lower application rates are employed in other areas. Thus, farmers are able to reduce the consumption of fertilisers as well as increase the yield by 10-15 percent.

There is an explosion of new sensing solutions

Software and services built on top of sensing hardware have attracted the attention of venture capital firms and input manufacturers which are investing heavily in the space. According to AgFunder, companies in the farm management software, sensing and IoT segment received US$ 464 million in funding in 2017, up 28 percent from the previous year. These companies mainly focus on providing solutions for measuring and modelling various environmental parameters in the field to monitor for example weather, soil moisture content, crop performance, diseases and pests.

Historically, farmers have primarily relied on regional weather forecasts from airport weather stations that were infrequently updated. Modern in-field sensor systems can measure 40 environmental data streams of weather, soil and crop conditions at frequent intervals. Local weather monitoring may for example provide insights into fertilisation timing, as heavy rainfall can wash away the applied fertilisers. In addition, weather data can be used for crop management, yield forecasting and disease modelling.

Another area targeted by a number of start-ups comprises remote pest monitoring. Agricultural pests are responsible for significant losses to the world's annual crop production. Traditional pest management is typically a labour-intensive undertaking as it requires manual scouting throughout the crop fields. Moreover, satellite imaging is typically also insufficient due to its infrequency. Modern solutions utilise connected insect traps and data modelling for risk evaluation to time the application of pesticides.

Machine uptime critical in forestry operations

Forestry shares many of the characteristics of agriculture but differs by the multi-year lifecycle of the crops. The industry encompasses a range of activities including forestry management, harvesting and forest planning and the tasks often require specialised machines such as harvesters, forwarders, bunchers and excavators. Therefore, machine uptime is one of the most critical factors to ensure productivity and profitability.

Modern forestry equipment integrates telematics systems that provide functionality for remote diagnostics and maintenance planning. The attachment rate of telematics systems in forestry equipment is markedly higher compared to that of agricultural equipment. Many of the industry incumbents are also active in the construction equipment market and have offered their systems as standard on their range of equipment for many years.

Farm consolidation drives technology adoption in dairy farming

Increased demand for meat and dairy products has resulted in larger herds per farmer, making livestock management and manual observations challenging. In large-scale dairy operations, the ratio of cows per worker is often greater than 200. Large farms have typically made necessary investments in barn infrastructure, automation and RFID to create a stress-free environment that supports larger herd sizes and reduces the need for manual labour.

In dairy operations, precision livestock farming technologies are used to optimise the milk yield from each animal. Apart from keeping the herd healthy, a high fertility rate is crucial to maximise efficiency as a large number of non-lactating cows results in lower production volumes along with high costs of feed and other inputs. Each additional day a cow remains dry can cost a dairy producer up to US$ 6 in reduced profitability.

Body-mounted sensor systems together with herd management software are used to achieve satisfactory herd health and timely insemination when a cow is in oestrous. A wide variety of wearable technologies are commercially available to measure a range of parameters in individual dairy cows. The devices can be used for monitoring of behaviour, lameness, mating, calving, rumen function and position.

The installed base of wireless IoT devices in agriculture reached 22.5 million in 2020

Berg Insight estimates that the installed base of wireless devices for applications in agricultural production amounted to 22.5 million connections worldwide in 2020. Growing at a compound annual growth rate of 8.1 percent, the number of connections is expected to reach 33.3 million in 2025. Wireless sensor systems fitted on livestock account for the vast majority of all connections due to their wide adoption in dairy cow monitoring applications. For data transmission, these systems typically employ 802.15.4-based network technologies, while cellular networks are used in some niche applications. The main application areas for cellular communications comprise telematics and in-field sensor systems. Among the network technologies, LPWA technologies are expected to achieve the highest growth rate and realise a significant market position in the remote monitoring and control segment.

All major equipment manufacturers have initiatives related to precision agriculture and telematics

Most high horsepower machines are today standard fitted with GNSS receivers and field computers. Yield monitors which collects data on crop yield and moisture content are furthermore present in almost all new combine harvesters. Deere & Company became the first manufacturer to launch a telematics system in 2002 and a number of manufacturers are today offering factory-fitted telematics systems as standard on new agricultural machinery. Telematics has however a long way to go before it becomes mainstream in the industry.

Leading vendors of precision agriculture solutions include the world's largest manufacturer of agricultural equipment Deere & Company, followed by the US-based precision technology vendors Trimble, Topcon Positioning Systems, Raven Industries and Ag Leader Technology. Hexagon holds a strong position in the positioning segment through its subsidiary NovAtel. Among the top agricultural equipment manufacturers, AGCO and CLAAS have also developed proprietary solutions, while CNH Industrial and SDF collaborate with third-party companies to integrate precision technologies into their range of agricultural equipment.

Manufacturers of agricultural inputs such as seeds, crop protection chemicals and fertilisers have expanded their software offerings notably in recent years, predominantly through acquisitions. The market for data-oriented applications and agronomic services are also targeted by a host of start-ups. Major providers include the Monsanto subsidiary The Climate Corporation, Canada-based Farmers Edge and the newly formed DowDuPont with its Encirca services.

A group of companies have emerged as leaders on the nascent market for in-field sensor systems that are used for remote monitoring applications. These include Davis Instruments, Pessl Instruments with its METOS brand, Semios, Hortau, AquaSpy and CropX. Although shipment

volumes in this segment is still low, the pace of adoption of sensor systems has increased significantly in recent years, predominantly in the specialty crop segment. While the specialty crop segment is small on a per hectare basis, the market value is large. The return on investment of remote monitoring solutions has thereby proven to be high.

Dairy equipment manufacturers partner with specialist sensor providers

The traditional dairy equipment OEMs including DeLaval, GEA Group, Lely and BouMatic offer comprehensive portfolios of milking robots and feeding systems that enable farmers to scale their milk production through process automation. In order to sell technology to dairy farms, local presence is a necessity and the large manufacturers are supported by distributors and local sales representatives in markets worldwide.

Most OEMs have chosen to partner with smaller, specialised companies to provide advanced sensor technology along with their milking equipment and farm infrastructure solutions. An exception is Swedish DeLaval, which provides a comprehensive portfolio of integrated remote monitoring solutions for herd management along with its dairy equipment. Important providers of sensor systems for herd management include Netherlands-based Nedap and The Allflex Group subsidiary SCR which both sell their systems to a number of leading dairy equipment manufacturers and genetics companies. Other significant players include Fullwood, Dairymaster and Afimilk which acquired Silent Herdsman in February 2016.

The traditional industry boundaries in the agricultural sector are beginning to blur

Partnerships and consolidation among agricultural equipment manufacturers and precision technology companies marked the theme of the last decade. Alliances are now expanding in scope among OEMs, input producers, software companies and agronomic services providers. These relationships take many forms, ranging from transactional agreements based on APIs to more formal and complex relations with contracts and service-level agreements in place. Trimble has for example a long-standing technology partnership with CNH Industrial, but also has integration agreements in place with additional OEMs such as AGCO and Deere & Company as well as the input manufacturer DowDuPont.

Moreover, input manufacturers are actively participating in private market investing through their corporate venture capital arms. These investments are predominantly driven by strategic objectives rather than financial. With extensive knowhow in plant biology, input manufacturers are positioned to become important providers of crop modelling and prescription maps by incorporating farm management software as part of their offering.

By partnering with companies with complementing capabilities, leading players aim to transform from selling equipment and inputs to selling complete yield optimisation solutions to farmers. Berg Insight is of the opinion that groups of companies working together in ecosystems will be able to capture the most value from precision farming data. Investments in APIs and microservices along with an open IT architecture will be key to developing a technical platform to support the flexibility needed in the digital ecosystem that is emerging within the agricultural industry.

The agricultural sector is significantly underpenetrated by IoT technologies

Most farms are still family-run businesses and often employ an informal style of management. The adoption of precision farming solutions and software is demanding growers to learn new farming practices and become more organised. In addition, the increasingly complex technological environment that farmers operate in demands dealerships to offer a greater extent of services to integrate and support the range of technologies that are utilised in precision farming. This is however increasingly addressed by established precision technology companies such as Deere & Company, Trimble and Topcon Positioning Systems that are actively investing in their channel partners to offer enhanced support for their precision farming portfolios. Berg Insight expects that the on-going trends of farm consolidation and increased professionalisation of the industry is likely to continue and result in stronger focus on yield maximisation and cost efficiency, which are proven advantages with using precision technologies.

INDUSTRY UPDATE

THE INDUSTRY NEWS FROM THE ENTIRE ELECTRONICS & BUSINESS INDUSTRIES

Allegro Announces Wheel Speed and Distance Sensor for ADAS

Allegro MicroSystems announced its new A19360 wheel speed and distance sensor for use in emerging applications in advanced driver assistance systems (ADAS). The cutting-edge giant magnetoresistance (GMR) sensor provides automakers with the signal resolution and reliability required for advanced levels of automation in passenger vehicles and mobility-as-a-service applications.

Automated and autonomous vehicles require superior wheel rotation information for accurate low-speed control. The A19360 provides high-resolution information to automotive systems by generating extra output events per magnetic cycle with a special protocol that's compatible with electronic control units (ECUs). It includes an 8-event-per-magnetic-cycle mode targeted at ADAS applications, providing an increment for every ~5mm of tire roll. It also includes a 4-event-per-magnetic-cycle mode that doubles the number of outputs per magnetic cycle (compared to a normal wheel speed sensor). This allows designers to halve the number of poles on in-wheel ring magnets to save costs, or increase the air gap and still obtain the same number of increments per revolution.

The A19360 was developed for ISO 26262 ASIL B(D), and is built on Allegro's monolithic GMR technology with ultra-low jitter and large air gap capabilities. The company's SolidSpeed Digital Architecture™ provides the widest dynamic range of operating air gap and highly adaptive performance that eliminates flatlining due to thermal drift and system dynamics.

Anritsu Launches Interference Waveform Pattern Software for 5G

Anritsu Corporation is pleased to announce the launch of its new Interference Waveform Pattern for 5G NR Receiver Test MX371055A and Interference Waveform Pattern for LTE Receiver Test MX371054A software. These tools generate 3GPP interference waveform patterns for testing the receiver sensitivity and throughput of both 5G and LTE user equipment (UE) and modules using the Vector Signal Generator MG3710E. Installing these tools in the MG3710E used in combination with the Radio Communication Test Station MT8000A and Radio Communication Analyzer MT8821C facilitates easy interference evaluation tests required by the 3GPP RF Compliance Test.

The tools are designed to support both in-house pretesting for confirming compliance of Sub-6 GHz 5G and LTE UE and modules before the official 3GPP Compliance Test as well as for R&D to improve receiver sensitivity and throughput performance.

Automotive dual high-side gate driver EiceDRIVER™ 2ED4820-EM

Battery systems for 48 V are used in multiple, growing market categories including Mild Hybrid Electrical Vehicles, trucks, e-wheelers and battery packs for solar panels. These Li-ion battery systems need to be protected against negative and positive voltages. In addition, these batteries must be able to quickly and reliably disconnect from loads within microseconds, in

the event of an overcurrent. Since a battery unit may not be dedicated to one vehicle, status diagnostic and protection threshold configurability are key.

To address these requirements, Infineon Technologies introduces the EiceDRIVER™ 2ED4820-EM, a smart gate driver with SPI interface. The gate driver is an ideal companion to Infineon's 80/100 V OptiMOS™ MOSFETs. It is also a perfect option for switching high-current loads in a 48 V board net.

https://www.infineon.com/cms/en/product/power/gate-driver-ics/automotive-gate-driver-ics/2ed4820-em/

element14 Launches N-Gaged Remote Monitoring Design Challenge

element14 launched the N-gaged Remote Monitoring Design Challenge featuring Omega's Wireless Layer N EcoSystem. 10 successful applicants who propose a project with the best use of Omega's IoT system will get a Layer N Ecosystem free of charge to build and blog about their project.

element14 Community members can use the Layer N EcoSystem to develop a wide range of IoT applications, including predictive maintenance, roadside pollution monitoring, remote monitoring, factory management, and production line management. Omega's Layer N is an ecosystem of smart devices that gives users a simple, smart, and flexible way to monitor and control applications remotely. Temperature, humidity, light, and barometric pressure readings are captured, stored, processed and transported in real-time to the cloud via Layer N's wireless smart sensors and gateways so reports can be accessed from anywhere at any time.

Applications for the N-gaged Remote Monitoring Design Challenge are open now through February 11. Challengers will be announced on February 18 and projects will be due in May 2022. Winners will be announced later that month. To enter the challenge, community members can visit: https://community.element14.com/challenges-projects/design-challenges/n-gaged-design-challenge//w/documents/27423/

MediaTek shows the World's First Live Demos of Wi-Fi 7 Technology

MediaTek announced the world's first live demo of Wi-Fi 7 technology, highlighting the capabilities of its forthcoming Wi-Fi 7 Filogic connectivity portfolio. MediaTek is currently showcasing two Wi-Fi 7 demos to key customers and industry collaborators to demonstrate the technology's super-fast speeds and low latency transmission.

MediaTek's demo shows how its Wi-Fi 7 Filogic technology can achieve the maximum speed defined by IEEE 802.11be and demonstrates its multi-link operation (MLO) technology. MLO technology aggregates multiple channels on different frequencies bands at the same time to highlight how network traffic can still flow seamlessly even if there is interference or congestion on the bands. MLO technology will be critical for delivering faster and more reliable video streaming, gaming and anything else that requires constant, sustained and real-time throughput.

Micron Ships the Industry's First 176-Layer QLC NAND in Volume

Micron Technology announced it has begun volume shipments of the world's first 176-layer QLC NAND SSD. Built with the most advanced NAND architecture, Micron's 176-layer QLC NAND delivers the industry's leading storage density and optimized performance for a broad range of data-rich applications.

Designed for use cases spanning client and data center environments, Micron's transformative new NAND technology is now available with the introduction of the Micron 2400 SSD, the world's first 176-layer PCIe Gen4 QLC SSD for client applications. The new 176-layer QLC NAND will also be incorporated into select Micron Crucial consumer SSDs, and available as a component for system designers.

New generation of OptiMOS™ Source-Down (SD) power MOSFETs

High power density, optimized performance, and ease of use are key requirements when designing modern power systems. To offer practical solutions for design challenges in end applications, Infineon Technologies launches the new generation of OptiMOS™ Source-Down (SD) power MOSFETs. They come in a PQFN 3.3 x 3.3 mm 2 package and a wide voltage class ranging from 25 V up to 100 V. This package sets a new standard in power MOSFET performance, offering higher efficiency, higher power density, superior thermal management and low bill-of-material (BOM). The PQFN addresses applications including motor drives, SMPS for server and telecom and OR-ing, as well as battery management systems.

Compared to the standard Drain-Down concept, the latest Source-Down package technology enables a larger silicon die in the same package outline. In addition, the losses contributed by the package, limiting the overall performance of the device, can be reduced. This enables a reduction in R DS(on) by up to 30 percent compared to the state of the art Drain-Down package. The benefit at the system level is a shrink in the form factor with the possibility to move from a SuperSO8 5 x 6 mm 2 footprint to a PQFN 3.3 x 3.3 mm 2 package with a space reduction of about 65 percent. This allows for the available space to be used more effectively, enhancing the power density and system efficiency in the end system.

More information is available at www.infineon.com/source-down.

ST Expands Connectivity for Smart-Metering with FCC Certification

ST has extended the certification of its ST8500 G3-PLC (Power-Line Communication) Hybrid communication chipset, now covering the US FCC (Federal Communications Commission) band plan from 10kHz to 490kHz, in addition to the CENELEC-A 9kHz-95kHz European band. The move enables higher data rates, enhances design flexibility, and eases end-product approval in accordance with specific national regulations.

The G3-PLC Hybrid profile enables smart, connected devices to select powerline or wireless communication autonomously, and change dynamically to ensure reliable connectivity and optimum performance. ST's ST8500 G3-PLC Hybrid chipset comprises the ST8500 protocol controller System-on-Chip (SoC), which supports RF mesh for reliable long-range wireless communication, the STLD1 PLC line driver, and the S2-LP low-power IEEE 802.15.4 RF transceiver.

In addition to smart electricity meters, the chipset delivers robust and reliable connectivity for gas and water smart meters, environmental monitors, lighting controllers, and remote sensors in contexts

such as smart cities, smart infrastructure, smart buildings, and smart factories.

The EVLKST8500GH868 and EVLKST8500GH915 kits are available now, from ST's e-store and distributors, starting from $294.00. For more information, please go to www.st.com/powerline.

STMicroelectronics Launches Cost-Effective NFC Type 2 Tag IC

STMicroelectronics' ST25TN512 and ST25TN01K NFC Forum Type 2 tag ICs deliver a new balance of cost and performance for high-volume use cases like consumer engagement, product information, and brand protection.

Also suitable for smart-city applications and access control, the ST25TN512/01K NFC tag ICs support multiple user-protection and privacy mechanisms including a 7-byte unique chip-identifier code, TruST25™ digital signature, NFC Forum T2T permanent write locks at block level, and a configurable kill mode that permanently deactivates the tag.

Certified to NFC Forum Type 2 specifications, the ST25TN512 and ST25TN01K leverage ISO 14443 standards and can be used with NFC-compatible mobiles or a dedicated short-range reader. The embedded device memory includes up to 208 bytes (1664 bits) dedicated to user content.

For more information, please go to www.st.com/en/nfc/st25tn-series-nfc-tags.html

TI buffer amplifier increases signal bandwidth tenfold in data-acquisition systems

Texas Instruments (TI) introduced the industry's widest-bandwidth high-input-impedance (Hi-Z) buffer amplifier, capable of supporting frequency bandwidths as high as 3 GHz. The wider bandwidth and high slew rates of the BUF802 enable higher signal throughput and minimal input settling time. Designers can leverage this faster throughput to measure higher-frequency signals more accurately in test and measurement applications including oscilloscopes, active probes and high-frequency data-acquisition systems. For more information, see www.ti.com/BUF802-pr.

The bandwidth achieved by the BUF802 was previously only possible by using application-specific integrated circuits (ASICs) that can increase system design time, complexity and cost. By eliminating ASICs, designers who use TI's buffer can get to market faster while achieving a wide dynamic range at a fraction of the cost.

Vicor adds new Global Automotive Segment Director

Vicor Corporation announced the appointment of Chinmaya Joshi ("CJ") as Global Automotive Segment Director. Chinmaya joins Vicor from the Jaguar Land Rover group where he served as a Senior Manager for powertrain power electronics.

Chinmaya brings deep automotive industry experience, leading DC-DC converter design and development teams for HEV, PHEV and BEV vehicle platforms for over ten years. His primary role at Vicor will be to support the expansion of the OEM customer base, tier-one suppliers and automotive system partners through high-density modular solutions for electrification. ■

The New Products From The Entire Electronics Industries

BMR350 quarter-brick, non-isolated DC/DC converter

Flex Power Modules is introducing the BMR350, a quarter-brick, non-isolated

DC/DC converter rated at 860 W continuous and 1200 W peak power, ideal as an intermediate bus converter for powering processors and ASICs with peak power demands. The product features an input of 40-60 V (80 V/100 ms) and a fully regulated output of 12 V at 100 A maximum, adjustable from 8 V to 13.2 V. An innovative transformer-coupled, non-isolated topology reduces component count and current stress and yields an efficiency level peaking at > 97.8% at half load 48 V input voltage. Derating for the BMR350 is characterized by the innovative Flex Power Modules 3D thermal data graphs which specify available output power for given real-world pin and baseplate temperatures up to 100°C, with the user's airflow rate. This enables maximum power to be extracted without stress to the converter.

For higher power levels, active current sharing between paralleled modules is an option. The BMR350 meets EMI standard EN 55032/FCC part 15J 'Class B' with a recommended external filter.

The BMR350 is in the standard quarter-brick format of 58.4 x 36.8 mm footprint with a height of just 12 mm, which includes the integrated baseplate with its threaded fixing holes. Terminations are via through-hole pins, suitable for pin-in-paste reflow, wave or manual soldering and positions are compatible with similar products on the market.

The product will be available in OEM quantities in the end of quarter 1/2022 and more variants will follow during 2022.

Further information can be found at flexpowermodules.com

New PhotoMOS® app

Panasonic Industry launches a mobile app to offer developers easy and valuable orientation within a range of more than 400 available types of photo-coupled MOSFET relays - for any kind of application.

In the field of photo-coupled MOSFET relays - undoubtedly the proven and modern alternative to their electromechanical predecessors - there is some valuable orientation in sight as Panasonic Industry has just launched its PhotoMOS® app for free download.

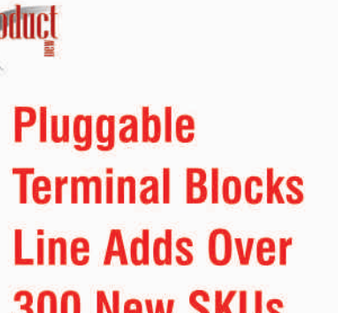
Finding the most suitable types among the 400 variants is now very easy With just a few taps, designers can save their results as favorites, directly download the datasheet, or immediately request some samples from Panasonic Industry.

For anyone curious to learn more about the technology, the integrated MOSpedia offers answers on specs, features and benefits of PhotoMOS® relays - and more than a dozen application notes will provide answers to common design-in questions.

https://industry.panasonic.eu/products/components/relays/photomos-relays/photomos-app

Pluggable Terminal Blocks Line Adds Over 300 New SKUs

CUI Devices' Interconnect Group announced the expansion of its line of pluggable terminal blocks with the addition of 17 new series and over 300 new SKUs. These highly economical models boast industry-best lead times and feature 2 to 24 pole counts as well as new pitch options of 3.5 mm, 5 mm, and 7.62 mm. Ideal for a variety of industrial control, automation, and test equipment applications, the TBP family of pluggable terminal blocks offers plug and receptacle connector types, horizontal or vertical



orientations, and wire gauge ranges from 28 to 12 AWG.

These pluggable terminal block models carry UL current ratings of 8 or 15 A and IEC current ratings of 7, 8, or 10 A as well as UL voltage ratings of 300 Vdc and IEC voltage ratings from 250 to 1000 Vdc. Two of the series in this line extension, the TBP03R12-350 and TBP03R3-350, also feature extended operating temperate ranges from -40 to 130°C for dealing with harsh environments.

CUI Devices' pluggable terminal blocks are available immediately with prices starting at $0.14 per unit at 1000 pieces through distribution. Please contact CUI Devices for OEM pricing.

Visit: www.cuidevices.com

PoE enabled SERIAL EXTENDER

The Serial (RS232) Extender allows you to increase the distance of your RS232 Serial connection by up to 1200 meters, giving you the ability to connect serial peripheral devices more than a kilometre away from your system i.e., 65x distance greater than normal RS232 serial cable length restrictions would permit.

The device is also PoE enabled. The Extender is a cost-effective serial extension solution and completely hardware-based, eliminating the need to install additional software, allowing for a completely plug and play installation.

The hardware can be setup in minutes, using existing or new Cat 5 or better Ethernet cabling which makes it perfect for use in industrial monitoring, control, POS, security, medical, and traffic flow applications. The RS232 Serial Extender maintains the RS232 standard with support for data transfer rates of up to 115 Kbps.

The Serial Extender is powered by IEEE 802.3af standard compliant PoE making it extremely easy to install and use in a data centre environment.

Contact:

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TE Connectivity launches its DBAS 9 connector

TE Connectivity (TE), a world leader in connectivity and sensors, is adding the DBAS 9 connector to its family of connectors. The DBAS 9 connector is specifically designed to offer increased configuration options providing additional design flexibility in the harsh environments of military and space applications. This

push pull connector is built on time-tested technologies by combining the extreme reliability of the DBAS 7 connector with the flexibility of standard D38999 inserts. DBAS 9 connector also provides cost-effective solutions using AS39029 signal and power contacts.

TE's DBAS 9 connector is engineered for extremely harsh environments featuring:

- Visual and sensitive push-pull locking system for blind mating applications
- Leading clip help prevent accidental unmating on demand
- Easy locking/unlocking (in heavy duty lanyard configuration)
- Scoop-proof
- Wide range of arrangements configurations of D38999 inserts: high density, hybrid signal and power layout and high-speed
- Rack and panel feature
- Large range of backshells and accessories

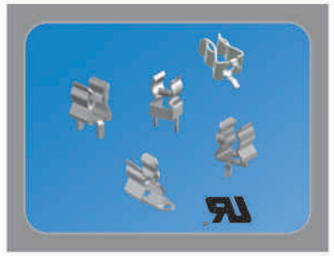
The wide range of inserts and large range of shell types and accessories with multiple surface-finishing options makes integrated solutions for custom designs possible, such as integrated backshells, fiber optic and high-speed solutions. Finally, if requested DBAS-9 connectors can also be manufactured according to European Space Agency (ESA) procedures to improve traceability and quality insurance requested for critical space applications.

For more information, visit http://te.com/Deutsch-dbas9

UL Recognized Fuse Clips for Cylindrical Glass Fuses

Keystone Electronics Corp. offers UL recognized Fuse Clips with end stops to ensure safety and design integrity.

Available for use with 1AG thru 8AG size Cylindrical Glass Fuses, these low profile, space saving Fuse Clips can accommodate any product design requiring UL



components, including the use of Solar Protection Fuses (SPF). Clips are suitable for applications from 6 to 30 Amps in a variety of environments.

These fuse clips are manufactured from Brass with Tin or Nickel Plate to ensure low contact resistance, and ease of use on PCBs. Designed to mount easily and retain a stable position during wave soldering, UL Recognized clips are available in "Snap-in" and "Press-in" Thru-Hole mounting configurations as well as Rivet and Surface Mounting styles.

Keystone manufactures a broad selection of fuse clips and holders for a variety of fuse sizes and styles as part of its large family of interconnect components and hardware.

Keystone's capabilities include Stamping, Machining, Assembly, CNC and Injection Molding services. Application and Engineering team assistance is available for product modifications and special designs. Keystone is ISO-9001:2015 certified and RoHS compliant with headquarters in the USA and offices in Canada, Europe, Australia and Asia.

For complete details and specifications contact Keystone Electronics Corp., 55 South Denton Ave, New Hyde Park, NY 11040; Tel: (800) 221-5510 or (516) 328-7500; Fax: (516) 328-1080; E-mail: kec@keyelco.com; website: www.keyelco.com

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