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DESIGNING ELECTRONICS NORTH AMERICA

JANUARY/FEBRUARY 2023

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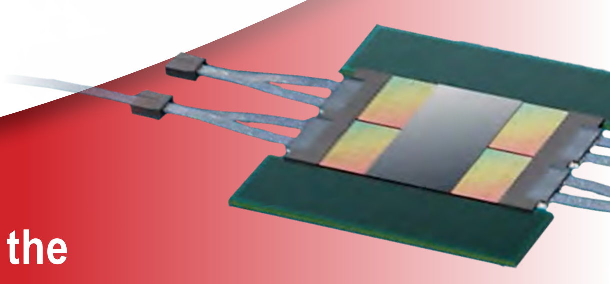

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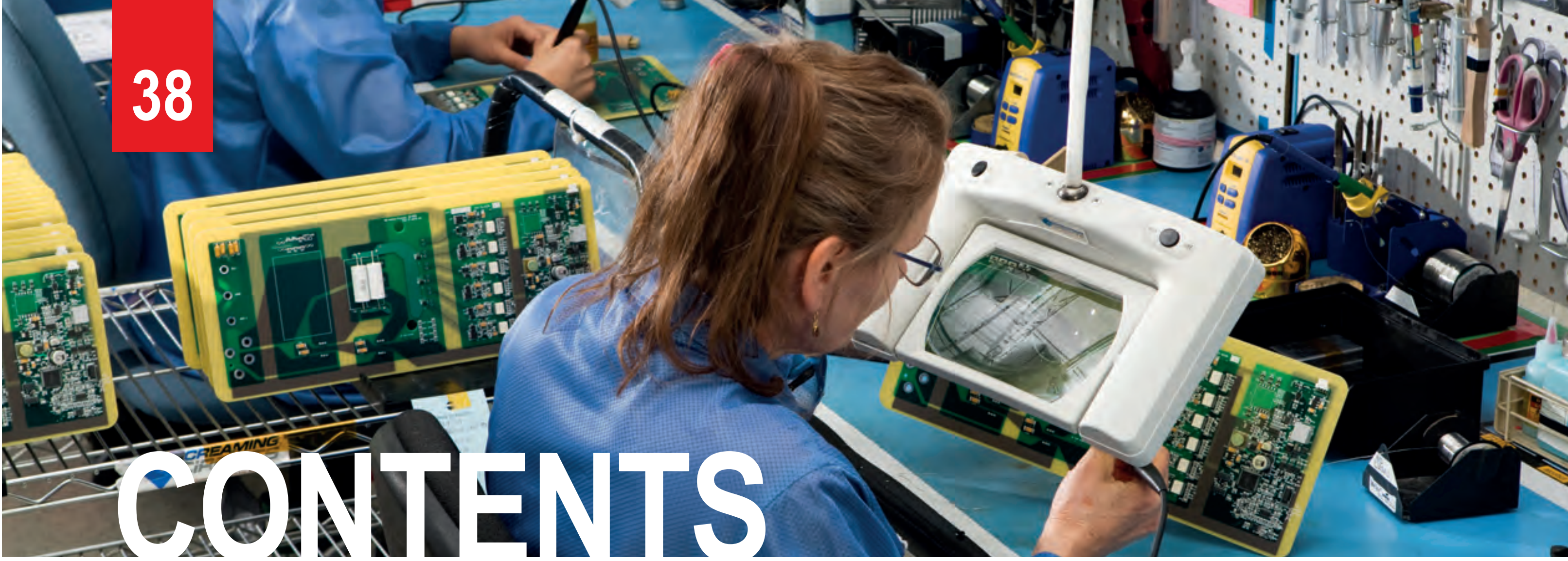
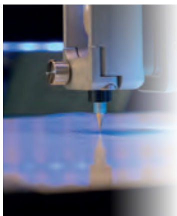
ALSO FEATURED ON PAGE 30 - **Unleashing the full potential of today's processors with in-package optical I/O**



CONTENTS



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EDITORS WORD

Welcome to the future!

I graduated from high school in England in the summer of 1975. That was the year we had two weeks of glorious sunshine without a cloud in the sky (people in the UK talk about it to this day).

My friends and I had a few short weeks before heading off to university. A group of us hung out in a local park, lying on a grassy bank basking in the sun talking about what the future might hold.

One of the things we discussed was the year 2000, which was still a quarter of a century in our future. Now, it's but a distant blur in the rearview mirror of my life. In fact, it just struck me that we are almost a quarter of the way through the 21st century already! I'm too young for all this excitement.

Recently, a student asked me how engineers would be designing electronic products in the future. When I started my first job in 1980, we captured our designs as hand-drawn schematics using pencil and paper. So, as far as I'm concerned, we are already in the future with respect to the amazing tools and technologies designers now have at their fingertips.

On the other hand, things continue to evolve. We are currently seeing the early deployment of artificial intelligence (AI) capabilities in design and verification tools for both software and hardware. Also, augmented reality (AR) is beginning to make its presence felt. Are you thrilled or terrified by these technologies? Either way, as always, you can rely on everyone here at DENA to keep you informed as to the latest and greatest developments.

Max Maxfield

CLIVE 'MAX' MAXFIELD
Editor, DENA

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TOP STORY

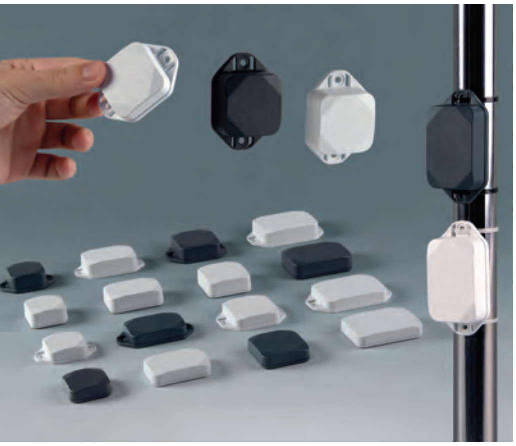
Bosch launches cost-effective motion sensor

Tiny MEMS motion sensors are all around us. They make consumer products easier to use and improve how our smartphones and other gadgets interact with us. These sensors are precise, compact and power-efficient, however, until now, they have been overly complex for basic applications. To address this issue, Bosch Sensortec has launched the BMI323, an affordable Inertial Measurement Unit (IMU) with excellent performance and integrated features enabling a shorter development time.

The BMI323 is a general-purpose, low-power IMU that combines precise acceleration and angular rate (gyroscopic) measurement with intelligent integrated features that are triggered by motion. The 6-axis BMI323 has a self-calibrating 16-bit triaxial gyroscope, a 16-bit triaxial accelerometer, and a 16-bit digital temperature sensor housed in a miniature 2.5 x 3.0 x 0.83mm3 (14-pin) LGA package.

The BMI323's combination of simplicity, low price, and high performance will open up new applications for IMUs, including consumer products, such as toys, gaming controllers, remote controls, wearables, fitness trackers, smartwatches, tablets, and laptops.

www.bosch-sensortec.com



OKW introduces smart MINI-DATA-BOX

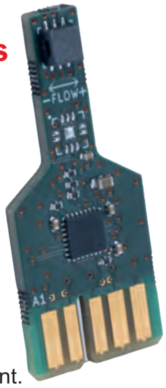
OKW has extended its wide range of sensor enclosures with the launch of tough, elegant new MINI-DATA-BOX intended for miniaturized go-anywhere electronic devices. Its different versions, sizes, colors and optional flanges offer 32 possible permutations—all available as standard.

The innovative and compact MINI-DATA-BOX is ideal for applications including IoT/IIoT, automation, security and surveillance technology, environmental monitoring, measurement and control, smart logistics, peripherals, interfaces and ICT. Its small size also makes it suitable for wearable electronics.

MINI-DATA-BOX can be specified in two shapes: Square and Edge (rectangular), either with or without flanges for screws and cable ties, enabling fast mounting to walls, ceilings, rails and masts. Each enclosure offers plenty of flat surfaces for interfaces. The lids have distinctive beveled corners—a 'diamond cut' design which reduces weight and further enhances the housings' stylish, modern aesthetics.

www.okwenclosures.com

Flusso launches FLS122 sensor evaluation kit



Flusso's FLS122 was launched in May 2022 as the world's smallest air velocity sensor and supports bidirectional flow sensing for real-time air speed and temperature measurement. It has a footprint of just 3.5 mm x 3.5 mm, an air speed range of 0 to 20 metres per second with measurement accuracy better than 5 per cent, and a temperature range from -40 C to +85 C. The FLS122 measures air velocity directly and can be calibrated to report air flow rate with near-zero pressure drop.

Now, Flusso has launched the FLS122 flow sensor evaluation kit to help engineers quickly evaluate its new air velocity sensor's performance and capabilities within their own applications. The new evaluation kit, which combines an FLS122 velocity sensing module with plug and play hardware and a PC GUI, allows users to easily connect everything together with their laptop to assess the sensor's performance.

www.flussoltd.com

Kandou delivers next-generation USB4 retimer

Kandou has begun volume production of the next generation in the Matterhorn family of USB-C multiprotocol retimers solutions for

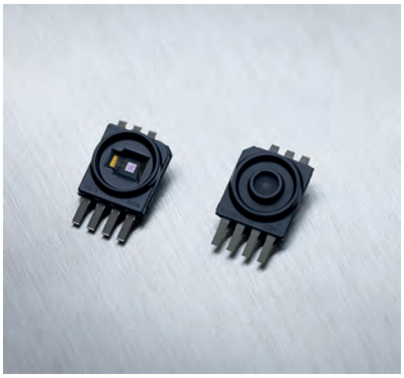
USB4, adding support for DisplayPort 2.0 functionality to target mobile, tablet and desktop PC applications.

Matterhorn KB8010 extends the feature set of earlier Matterhorn retimers and reinforces Kandou's USB4 innovative leadership in high-speed, energy-efficient chip-to-chip link solutions to improve the way the world connects and communicates.

By adding support for DisplayPort 2.0 functionality to KB8010, Kandou is meeting the industry's demand for increased bandwidth and higher data rates. The DisplayPort 2.0 standard pushes 77.4 gigabits per second of data, which means DP2.0 handles 16K resolution with HDR at 60Hz or a 10K resolution with HDR at 80Hz. In addition to support for DP2.0, KB8010 supports the optional USB4 low-power (CLx) states, USB3.2 Gen 2x2 (20Gbps), supports 1.8V IO logic and doubles the number of I2C device addresses, enabling system designers to reduce components on the motherboard and decrease system cost.

www.kandou.com

Melexis unveils the most accurate automotive pressure sensor ever made



Melexis has launched a new series of PCB-less pressure sensor ICs intended for use in automotive engine management that deliver the highest degree of accuracy over lifetime. The MLX90824 determines the absolute pressure, then delivers a digital output signal using the SENT protocol. By comparison, the MLX90822 provides an analog output voltage. These factory calibrated devices measure pressure spans from 1 to 4 bar.

The MEMS, sensing element of the MLX90824 and MLX90822, consists of a micro-machined diaphragm that is bonded around a cavity that has been etched into a silicon substrate. This cavity contains a reference vacuum. The diaphragm reacts to any change in the ambient absolute pressure. An accuracy of +/-0.5 %FS (full scale) is maintained over the course of the sensor's working lifespan. This accuracy is not impacted by the sensor integration thanks to the PCB-less packaging. Very accurate and stable pressure measurements allow optimal engine management to guarantee fuel savings and emission reductions.

The MLX90824 and MLX90822 have been developed as a Safety Element out of Context (SEooC) in accordance with ISO 26262. It supports ASIL B system integration for the MLX90824 and ASIL A for the MLX90822.

www.melexis.com

Lumotive and Gpixel announce lidar sensor platform

Lumotive, the developer of Light Control Metasurface (LCM) beam steering chips enabling the next generation of lidar sensors, and Gpixel, a leading provider of high-end CMOS image sensor solutions, has announced the availability of the M30 Reference Design Platform to speed the adoption of next generation 3D lidar sensors for mobility and industrial applications such as autonomous navigation of robots in logistics environments.

The M30 Reference Design Platform comprises Lumotive's LM10 LCM beam steering chip and Gpixel's GTOF0503 sensor. Unlike traditional flash illumination solutions, lidar sensors based on LCM electronic beam steering have numerous advantages, including superior outdoor range performance compared with flash illumination, software-defined scan modes for increased and application-specific performance (range, field of view, frame rate, resolution) only where it matter, reduced multipath effects resulting in better point cloud quality, optimization of illumination across the field of view in high ambient light levels and for varying levels of reflectivity, and significantly improved interference mitigation from other sensors.

The first version of the M30 Reference Design Platform is currently being evaluated by a number of leading lidar systems developers, ToF camera makers, and industrial OEMs. The next generation of the platform with enhanced performance and optimized for volume manufacturing is expected to be available by mid-2023.

www.lumotive.com
www.gpixel.com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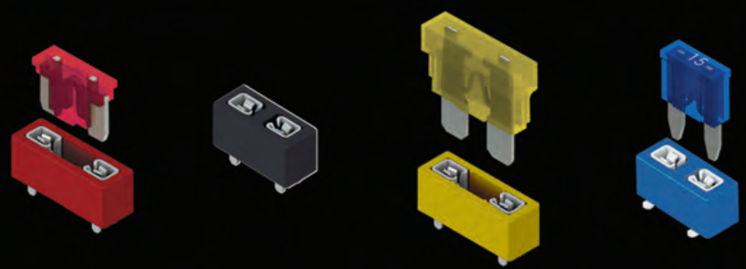
15

Increasing visibility into assets with the IoT

Marc Pégulu, VP of IoT and GM, Semtech

The need for accurate, cost-effective, and long-lasting tracking solutions is strong

In today's constantly evolving supply chain landscape, there are many complexities, one of the most pressing of which is asset tracking. Research shows that nearly 70% of companies don't have complete visibility into their supply chains. And it's not just the supply chain where tracking valuable assets is critical. From monitoring cattle on a ranch to equipment at a construction site, asset tracking enables a plethora of use cases.

Building the right asset tracking solution

Many asset tracking solutions rely solely on device Global Navigation Satellite System (GNSS) hardware to calculate locations. While these solutions are capable of providing accurate real-time outdoor location information, it's not the optimal choice for most applications. With so many assets also residing indoors or traveling between indoor to outdoor locations along their journey, many of these solutions don't work because they aren't capable of providing location information in these environments.

The emerging alternative is built on long range and low power technology, that leverages geolocation-based IoT solutions for smooth and accurate monitoring, no matter where the asset is located. How does this work? Rather than relying only on GNSS, these solutions combine Wi-Fi and GNSS, scanning to obtain the latitude and longitude of devices for accurate location data. Added to that is a connection directly to the cloud, ensuring that continuous coverage is obtained at nearly all times.

Another layer for even more advanced and accurate location tracking is multi-band connectivity on a single device. By extending coverage to new bands, be it satellite communications or sub-GHz, IoT deployments are better able to reach remote areas where it would normally be impractical and too expensive to send workers to collect sensor data.

Enabling new use cases

More precise asset tracking solutions opens the door to new and emerging use cases that could lead to significant cost and efficiency savings for businesses and industries. According to Proximity Directory, the combination of people and asset tracking could save hospitals hundreds of thousands of dollars a year with an immediate ROI of 275%. Tracking could extend to medical equipment to know where and when different devices are in use or to wheelchairs, so no patient ever needs to wait for help because personnel don't have line of sight into where they are.

With expanded connectivity via satellite, the monitoring of assets in remote or dangerous environments such as deep in the forest or on top of mountain becomes much easier and safer too. This could be the case when tracking animals for their own protection, for example.

Finally, with the holiday season quickly approaching, buyers will soon be flooding malls and stores to get the perfect gift for their family and friends. Location-based asset tracking aids in inventory management, to ensure products leave the warehouse and wind up on store shelves. Upon arrival, with sensors placed on priority or higher-priced items, store managers can breathe a little easier knowing they are protected should someone try to remove those items from the store.

The path forward

According to Juniper Research, there will be a 27% increase in the number of businesses using asset tracking between now and 2025, reaching 114 million by 2025. With the stakes so high, the need for accurate, cost-effective, and long-lasting tracking solutions is strong, and long range and low power IoT technology is emerging as a front runner.

www.semtech.com

"According to Juniper Research, there will be a 27% increase in the number of businesses using asset tracking between now and 2025"


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Boosting efficiency in automotive heat pumps

Is free source energy the secret to tripling electric vehicle (EV) passenger heating system efficiency?

Gabe Osorio, Director in TBU Marketing, TTI

EVs have historically implemented positive temperature coefficient (PTC) heaters to raise the cabin temperature in heating mode. These devices generate heat by printing conductive ink onto polymer-based substrates. Its material properties allow the PTC heater to regulate the temperature without passively needing external controls. As a result of thermal self-regulation, PTC heaters deliver an efficiency of around 100%, comparable to that of an electric heater.

While this current state is a marked improvement over traditional fixed-resistance heaters that use coils and wires for heat generation, diverting electric energy to heat the cabin is parasitic to the cold-weather driving range, a critical hurdle for manufacturers. As a result, the industry searched for solutions to improve this limitation and landed on a solution initially developed for stationary heating: the heat pump.

Heat pumps and EVs

Heat pumps take heat from ambient air (outside the vehicle or waste heat from the battery or drivetrain) and transport it where needed. Internal combustion engine (ICE) vehicles do not need heat pumps due to the waste heat available from the ~70% of fuel energy lost in converting chemical-to-thermal-to-mechanical energy to drive the car.

There are two critical advantages the heat pump offers over a traditional system with a PTC heater. First, it is bi-directional, able to manage both heating and cooling cabin climate efficiently. Second, scavenging ambient heat enables up to three units of output energy for one unit of input energy, diverting more of the battery's power toward vehicle propulsion vs. cabin climate, thereby extending the driving range.

Heat pump trends and innovations

In addition to the components required for basic vapor-compression refrigeration (compressor, condenser, expansion valve, evaporator), automotive heat pump systems have additional electronics that enable the technology. These are the PTC heater and electric expansion valve (EXV).

PTC heaters are still needed to kickstart heating at extremely cold temperatures in heat pump systems. They are also the current standard, as heat pump vehicles are still several years from mass adoption. One innovation from Mahle is a high-voltage PTC heater, offering improved safety, lower cost, smaller packaging envelope, and higher efficiency through intelligent electronics that constantly monitor and adjust the PTC element resistance to optimize temperature delivery. The improved efficiency of the Mahle unit can increase driving range by 20% when combined with a heat pump and operates down to -40°C.

Sanhua produces an EXV for fluorinated R-134a HFC and R-1234yf HFO refrigerant systems that embeds the control board and integrates the onboard diagnostics while operating between -40°C and 120°C. This combination delivers precision flow control, boosting COP by more than 10% while maximizing the heat exchangers' effectiveness with precision superheat control. In addition, this improved accuracy can reduce excessive heat exchanger sizing to account for flow variability, reducing system cost while decreasing mass to extend the driving range.

Takeaways and future development

EVs are compelling the industry to look at thermal management holistically, using all available heat sources and demands to optimize the system for performance and range at all operating conditions. As a result, once they roll out systems with parallel heat pumps and battery/electronics cooling loops, OEMs will likely begin work to fully-integrated the two circuits. This approach will require innovation in (at least) sensors, control valves, heat exchangers, and sealing technology to manage the complexity. However, with the energy around EVs and the opportunity for market leadership at stake, it's certainly a problem worth solving.

www.tti.com

Hand-tuning your ISP may degrade your CV performance

Algolux Atlas maximizes image quality and computer vision results

We are surrounded by cameras and displays, from those in our pockets to security cameras to our cars, and we've enjoyed the benefit of amazing improvements in image quality with each new generation of these systems. Those benefits come from ongoing innovations in camera sensors, display technologies, and the image signal processing (ISP) pipelines that take the RAW sensor data and convert it to something pleasing to view.

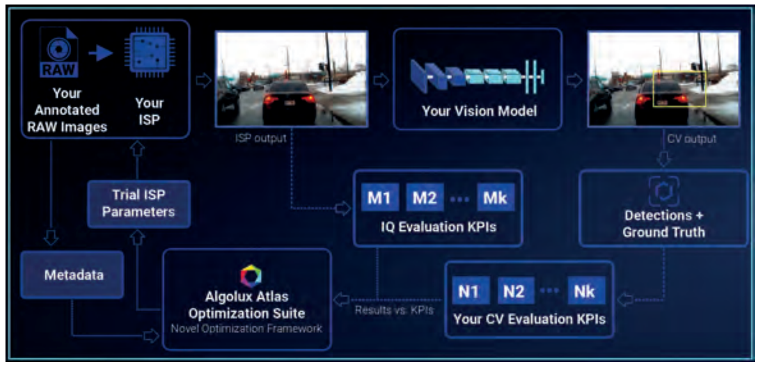
ISP parameters are traditionally hand-tuned by expert imaging teams over many months to produce visually good images, something done for every new lens and sensor configuration. Of course, these subjectively good results are determined by the imaging team, the product owner, and—ultimately—everyone who looks at the images or video being displayed.

But what about computer vision (CV), such as in the systems that can prevent a car crash, identify people, or enable your phone to put a mustache filter on your face? These CV models use the same ISP output, but the accuracy of the vision models is actually being negatively impacted by the hand-tuning of the ISP.

ISPs are designed based on our understanding of the human eye and limitations of display devices, essentially removing information from the rich RAW sensor data. But CV models are not limited like the human eye, with dynamic range being one good example. Based on the CV model's architecture, training, and function (e.g., object detection, segmentation, depth sensing, etc.), each model expects certain image quality characteristics that result in optimal vision results. The only way to achieve this is through objective optimization of the ISP parameters to maximize the vision model accuracy metrics (KPIs) rather than manually tuning for the "best" subjective image quality.

This multi-object ISP hyper-parameter optimization problem has been very difficult to solve. The ISP parameter space is massive and highly non-convex (e.g., having a great many local minima) with which stochastic and other solvers struggle. Algolux has cracked this problem with a cloud-based tool and workflow called the Atlas Camera Optimization Suite.

Atlas enables camera imaging and perception design teams



Algolux Atlas enables automated workflows that optimize ISP parameters in days to maximize image quality and computer vision results

to automatically optimize sophisticated ISPs to maximize vision results in their vision systems in a matter of days. It can also be used by those teams to significantly reduce the time and effort of tuning camera systems for visual image quality, so the teams can focus on the final subjective fine-tuning.

The process starts with your team capturing and annotating a small dataset of RAW images from the lens/sensor module being used for the vision system representing the application (e.g., object classes, illumination, etc.). This can typically be done using a couple of hundred images for the optimization dataset and a few thousand for the validation dataset. If visual image quality is being optimized (or both CV and image quality), then RAW lab chart captures are required.

Atlas first pushes the optimization dataset through the ISP vendor's bit-accurate model integrated with Atlas. Atlas directs the processed images to your target pre-trained computer vision model(s), and results are evaluated against the CV's KPIs. Atlas then determines a new parameter set and repeats the process, intelligently searching the rugged ISP parameter space to find an optimal set that maximizes the KPIs.

This process can be applied to any vision system and has been proven in many customer engagements, resulting in significant improvement in computer vision performance vs. hand-tuned ISPs. Learn more from this case study and by connecting with Algolux.

www.algolux.com

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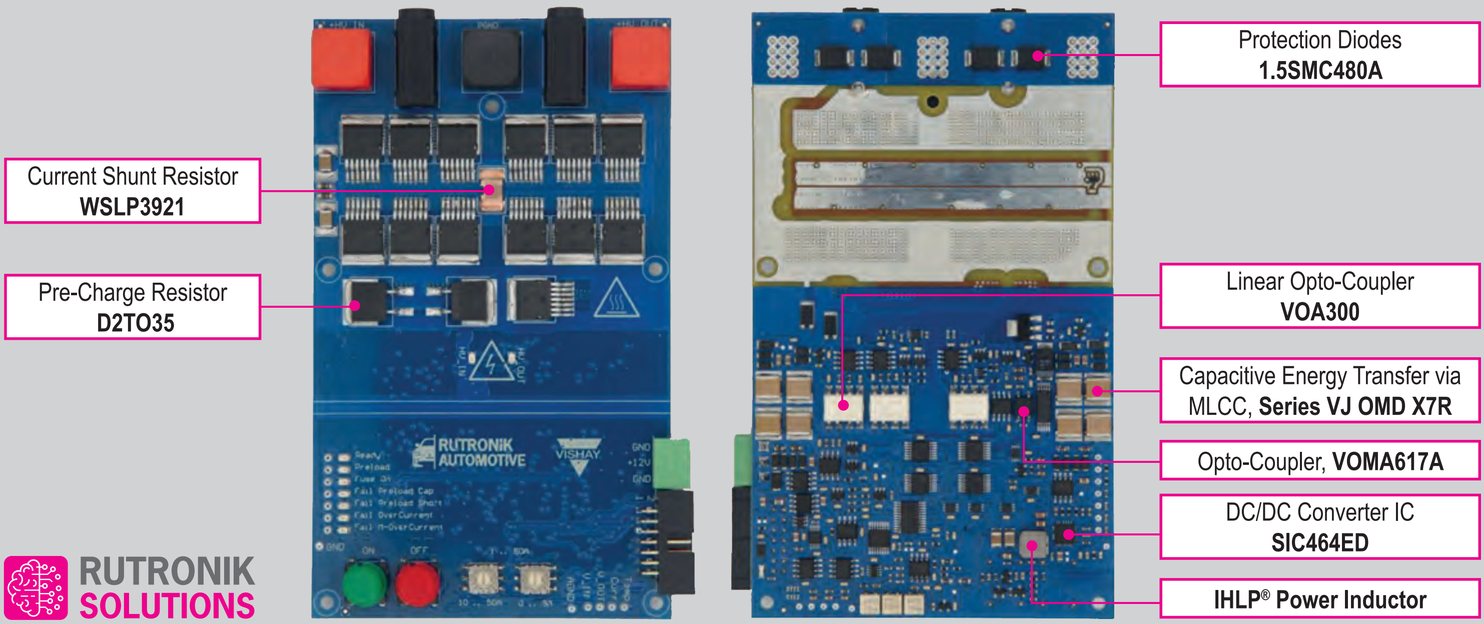

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ecia MEMBER

An update on stacked ceramic capacitors for defense applications

MIL-PRF-32535 for discrete MLCCs has led to the discussion of stacked ceramic capacitors based on BME technology

Stacked ceramic capacitors are multiple discrete multi-layer ceramic capacitors (MLCCs) terminated onto a common lead-frame for through-hole or SMT operations. They capture many of the inherent benefits of MLCC technology, like a low-loss material set, low ESR (equivalent series resistance), and higher reliability.

Typical applications like switch mode power supplies need larger capacitance values and current capabilities. Stacked MLCCs compete with discrete electrolytic capacitor technology in terms of capacitance range but have an advantage in terms of voltage and temperature capability, which naturally increases their reliability, thereby making this a preferred technology for defense applications despite its higher price point compared to electrolytics.

The Military Performance (MIL-PRF) standard for stacked ceramic capacitors is MIL-PRF-49470. Suppliers can build to this specification and provide their devices for predominantly defense and aerospace applications. They are manufactured using precious metal electrode (PME) MLCCs, which employ a combination of palladium, silver, and/or platinum as the bulk of the electrode system. This has been used for decades and has established a strong reputation for PME devices.

More recently, however, MIL-PRF-32535 was released, and this features base metal electrode (BME) technology, predominantly nickel. It's intuitive to focus on the cost efficiency of BME over PME devices, but there are other ramifications in the manufacturing process that are not immediately apparent, but are helpful for designers, component engineers, and program managers in the defense sector to consider.

MLCCs must be sintered to create the monolithic block of dielectric and electrode layers. The temperature profile for firing BME devices is significantly different to PME devices. PME processes are more concerned about evaporating the PME materials than are BME processes. Because of this, there is more flexibility for ceramic engineers creating BME devices to develop a dielectric material that can be sintered at higher temperatures that will realize a much larger capacitance value in the finished MLCC that is smaller than an equivalent PME device, which has huge implications for defense applications.

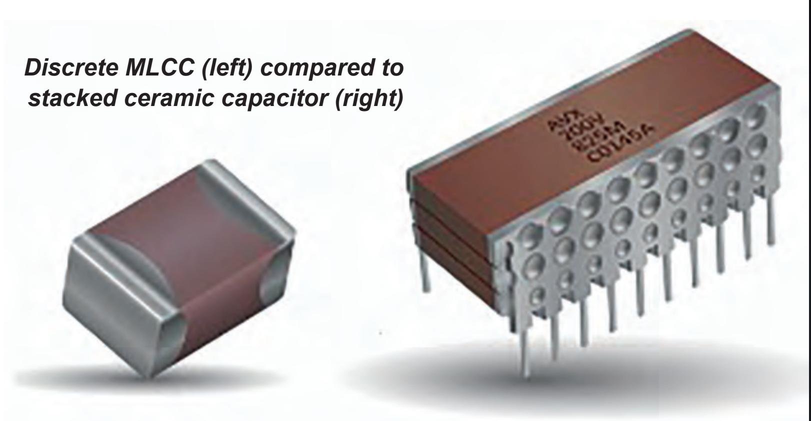
The development and acceptance of MIL-PRF-32535 was made possible largely by the help of a few key suppliers in this field, and it's interesting to note that new slash sheets are coming out for low inductance versions of these discrete MLCCs that can keep up with the high-speed decoupling demands of powerful FPGAs, for example.

The MIL-PRF-32535 for discrete MLCCs has led to the discussion of stacked ceramic capacitors based on BME technology. These would be similar to devices created under the existing M49470 standard, but with higher capacitance densities, following closely with the progression of high performance SiC and GaN HEMTs for commercial, automotive, and high-reliability applications.

Moving from a lead-less to a lead-frame assembly conveniently packages an array of MLCCs into a smaller footprint to conserve PCB surface area, but there are other benefits that may not be readily apparent. For example, MLCCs can potentially be prone to cracking from mechanical strain caused by PCB flexure, high shock and vibration environments, and thermal coefficient of expansion (TCE) mismatch from assembly, rework, temperature cycling tests, or even operating conditions, to name but a few. Although there are numerous sources of strain, their lead-frames provides relief to stacked ceramic capacitors.

In summary, stacked ceramic capacitors based on BME technology are a great fit for applications with tough mechanical, thermal, and electrical design constraints.

www.kyocera-avx.com



Discrete MLCC (left) compared to stacked ceramic capacitor (right)

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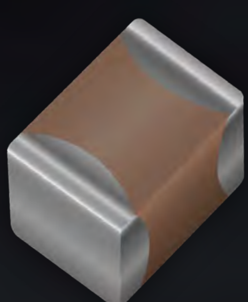

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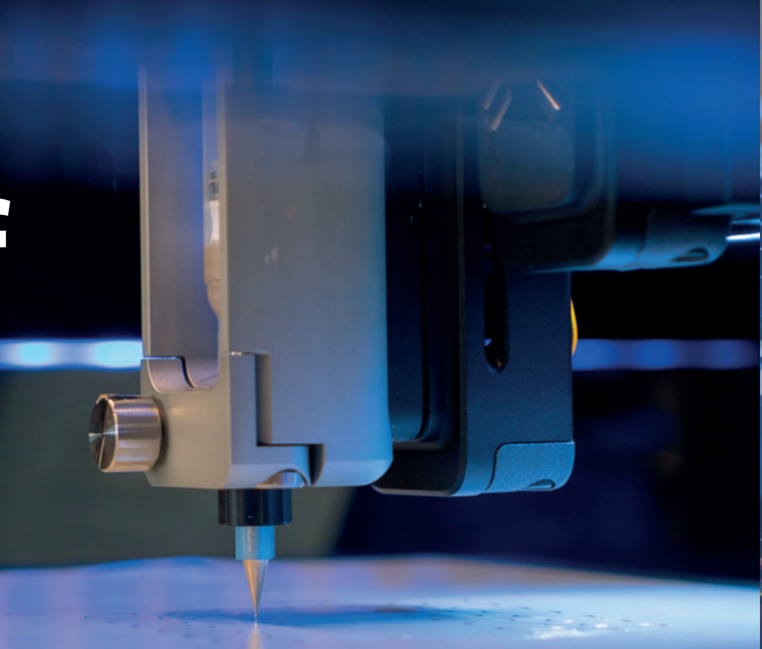

The future of electronics is flexible

With NOVA you can print electronics on everything

The electronics industry is going through a paradigm shift. For the past 60+ years, electronic design has been centered around subtractive technology, with limited materials options—primarily FR4 or Kapton substrates—with copper for connecting together the powerful silicon components that have been the driving force behind electronics advancement. Electronics products are smaller, faster, lighter, and exponentially more powerful nowadays, but they are still limited by their form factors—innovation has been limited by materials.

The emerging field of flexible hybrid electronics (FHE) is changing the way we think about electronics design. It has the potential to transform the way we interact and interface with devices in our daily lives. The promise of FHE is the ability to create traditional electronics but in new form factors. From devices that move, stretch, and bend with the user, to electronics that can be embedded into injection molded parts.

FHE is a combination of printed elements with traditional semiconductor components, bridging the gap between what we *can* do with traditional electronics and what we *wish* we could do. Imagine the possibilities if stretchable, flexible, biocompatible electronics could be printed onto almost *anything*.

Advancements in both materials and technology are making it possible to print conductive ink directly onto substrates like thermoplastic polyurethane, Kapton, glass, paper, carbon fiber, biodegradable materials, curved surfaces—almost anything you can conceive. Researchers are already experimenting with smart garments that can go through the washing machine, medical sensors that interface organically with human skin, and electronics printed directly onto the curvature of a rocket.

Working with flexible and stretchable inks and materials opens the door to functionality that was not previously possible with traditional electronics. Stretchable ink can function as a strain sensor, for example, a functional property that can be applied to medical prosthetics, remote-controlled devices, robotic skin, aircraft, automotive design, and more.

Until recently, innovating in flexible hybrid electronics has been a very elusive pursuit, encumbered by barriers like time-consuming processes, an incohesive value chain, extremely expensive equipment, inadequate technological solutions, and a general lack of knowledge around materials compatibility. Basically, it's been the Wild West of electronics design.

In October 2022, Voltera launched NOVA, the world's first benchtop printer for soft, stretchable, flexible, and conformable electronics. NOVA extrudes conductive paste materials (also called screen-printable inks) using Voltera's Smart Dispenser to print circuits on almost any surface, including surfaces with up to a 30-degree curvature.

The *only* option for mass-producing flexible hybrid electronics utilizes screen printing technology, so prototyping on NOVA, which uses screen-printable inks, is the easiest method for scaling to the production stage.

Compared to inkjet inks, screen-printable inks are more viscous and yield higher conductivity. They are more durable, too. Inkjet technology uses low-viscosity, water-like inks.

Matt Ewertowski, Product Manager at Voltera

This enables high-resolution printing, but the traces are thin and delicate, resulting in lower conductivity and lower durability. While inkjet technology is perfectly suited to some uses, like diabetes test strips, it's not ideal for more robust applications. You can't use thick materials with inkjet printers, it just clogs up the whole system.

When developing NOVA, Voltera conducted extensive market research and beta testing. User feedback was thoughtfully integrated into the design of the printer and

Continue on page 18 >

modules, acknowledging many of the challenges faced by innovators in the field.

When you're working on novel ideas, there's a lot of trial and error involved. Being able to prototype and iterate at your desk allows you to experiment at your own pace and avoid outsourcing-related delays. Rapid iteration can lead to strides in engineering innovation and speed up your time to market. Keeping your work in-house has the added advantage of protecting your intellectual property.

The benefits of rapid iteration are being optimized by the Massachusetts Institute of Technology (MIT). There, the Velásquez Group is using NOVA to print carbon nanotube field emitters, sensors, and other space componentry for satellites. Because the group has a NOVA in their lab, they have been able to cycle through thousands of prototypes within the span of a few months. Rapid iteration allows the team to make leaps in progress, achieving extreme performance thresholds like sub-10-micron printing precision.

"Working with NOVA has been fascinating," said Alex Kashkin, Graduate Researcher, Velásquez Group at MIT. "We've been able to construct devices that we would not be able to do conventionally without expending enormous time and resources. It's just a remarkable improvement in our work, both in terms of surface mapping and optical alignment. And it's greatly enabled us to construct new devices, and be able to do so much quicker than we have before in order to reach the iteration cycles we need."

At York University's Electronics Additive Manufacturing Lab, under the supervision of Professor Gerd Grau, Yoland El-Hajj et al. recently conducted a study on printed biomedical electrodes using silver flexible conductive inks and tattoo paper. The study analyzes various properties of the electrodes printed with a customized inkjet printer, compared to electrodes printed with NOVA's Smart Dispenser. These kinds of electrode sensors can be applied to a patient's skin as a temporary tattoo, interfacing organically with the human body.

"I think where this sort of technology will shine is in applications that were not possible before. You shouldn't fight or try to compete with silicon chips or PCBs. You should try to make something that's impossible with those technologies," said Professor Grau.

Sometimes the equipment and materials that are accessible to researchers and product developers during ideation and iteration are incompatible with the technologies and materials necessary for mass production. If you've hacked a solution to iterate with an inkjet printer, you'll have to go back to the drawing board if and when you want to scale up production, because screen printing isn't compatible with watery inkjet inks.

Andrew Bambach, Production Manager at ACI Materials, is a key player in the effort to make flexible hybrid electronics into a more accessible industry. As Andrew notes, "I've printed frequently with NOVA and use it to develop characterization techniques for further product development for us. NOVA is very different from any other product. The user interface is very friendly. It's the type of machine that I would feel comfortable handing off to technicians, knowing that they're going to be able to run the right recipes and figure out how to use it relatively easily."

The future of electronics is flexible, and with the right tools at your fingertips, the possibilities are almost limitless.

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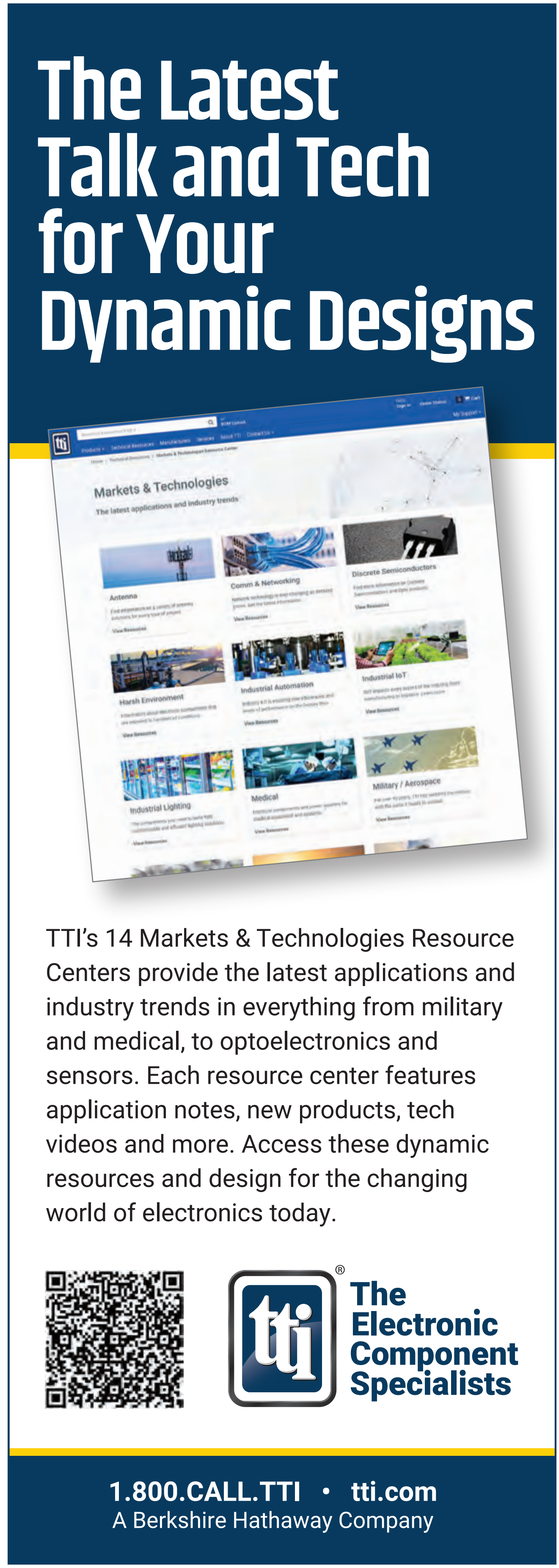
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USB-C meets monitors

Monitors that support USB-C have found an important niche in the display ecosystem

The USB-C connector has made inroads for its use as a good interface for monitors. This trend started with the introductions of the USB-C connector, USB Power Delivery, the USB 3.2 interface speed, and the DisplayPort Alt Mode. This combination allowed USB-C to act as a universal connector with enough power delivery to drive a laptop and sufficient speed to drive a display. The lure of having just one connection to support a laptop with a monitor proved irresistible to some consumers.

Multiple monitor suppliers including Acer, Apple, ASUS, BenQ, Corsair, Dell, HP, Gigabyte, LG, MSI, Razer, and Sony have delivered monitors that support USB-C. A chunk of the more recent monitors support USB-C power delivery, many with enough power to supply a laptop. Until recently, these monitors have supported USB 3.2 and nearly all support the USB-C DisplayPort Alt Mode.

A few recent 5K monitors have come out that support 5K daisy chain operation. To sustain this, these monitors have two USB4-enabled USB-C ports that support the DisplayPort Multi-Stream Transport specification. The Display SoC (system-on-chip) supports this method of dividing the flows between the monitors. This daisy chain mode of operation is a capability that other video interfaces such as HDMI do not support, and it is a powerful reason to consider buying and using a monitor that contains a USB-C connector, given that a single connector can power a laptop and drive two or more large monitors.

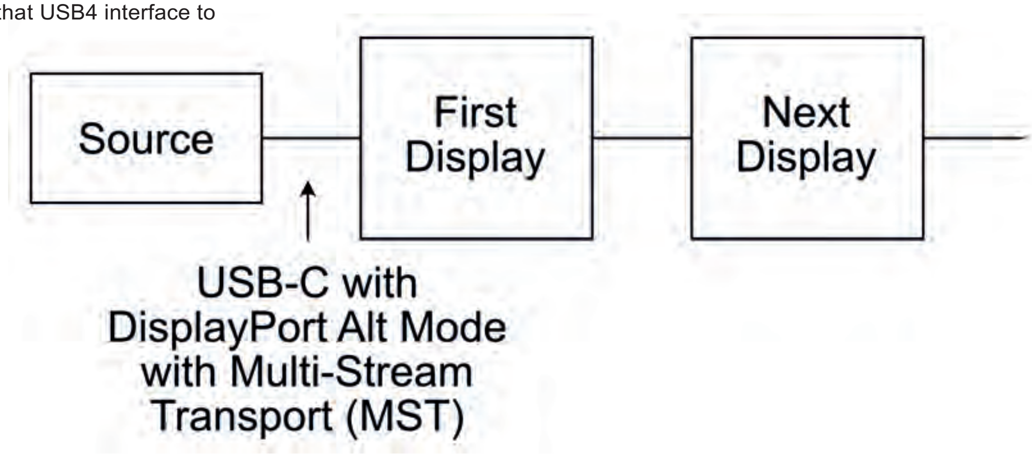
DisplayPort 2.1 introduced the ability to have all four pairs within each USB-C connector operate in a single direction, which is what displays need. This allows up to 4 x 20 Gb/s or 80 Gb/s of bandwidth to be utilized over a single connector. This allows even higher resolution setups to be supported.

USB4 rate signals can only be driven about two to three inches from the SoC across a conventional loss printed circuit board (PCB) to the connector without violating the USB4 specification for the outgoing signal. This limits the placement of that USB4 interface to right next to the SoC within the monitor. This is fine in some form factors, but it is a significant limitation in others. Numerous monitors have put their interfaces in creative places for their user's convenience. In this situation, a USB4 retimer device can be put close to the connector. The retimer will clean up the signal from the SoC.

The future looks bright for monitors that support USB-C. They have found an important niche in the display ecosystem that is likely to expand over time. And USB4 retimer technology from Kandou is available to support these USB-C monitor deployments if required.

www.kandou.com

Brian Holden, Vice President of Standards, Kandou



Silicon Carbide Pushes Power Electronics to Center Stage

Wide bandgap semiconductor materials like GaN and silicon carbide have emerged as the top solution to many of the power management challenges facing segments of the electronics industry

Power electronics engineers are amongst the hottest stars of today's OEM design world.

Thanks, in large part, to wide bandgap semiconductor materials that are finally offering innovative solutions to some of the knottiest power design and management challenges engineers have struggled to overcome over the last decades.

Of course, conventional silicon still rules the semiconductor world, accounting for the largest share of the industry's 2021 revenue of $555.9 billion. Silicon remains King of the chip market and this is unlikely to change anytime soon.

But not in any market where a more efficient and resilient power management system is required. For automotive, aviation, medical, military, and industrial applications, electronic companies are turning to alternate materials from the wide bandgap group, especially gallium nitride, (GaN) and silicon carbide, (SiC).

Forecasters estimate the global power semiconductor market will increase by 2030 to $50 billion, up from $40 billion, at the beginning of the decade. Driving the growth will be demand for wide bandgap semiconductor materials, which are seeing surging use in electricity generation and management as well as in storage and various market segments.

"The transmission and distribution of power across great distances are two common uses [of power semiconductors]," said analysts at Straits Research, in a report. "These high-performance components can handle several gigawatts of electrical current, voltage, and frequency. Silicon Carbide is used for high-power applications because of the wide bandgap offered. The increase in R&D activities that target enhanced material capabilities is expected to provide a strong impetus for market growth."

As semiconductor adoption has spread across most segments of the economy, the amount of energy required to power electronic devices has exploded. The new economic opportunities need massive amounts of energy, however, while society is trying to move away from fossil fuels and exploiting non-traditional power sources such as solar, according to observers.

Design for environment

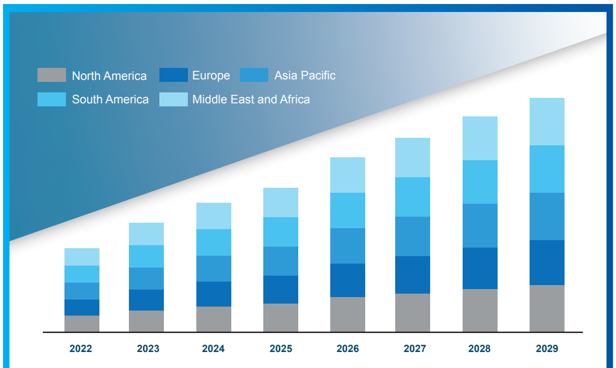
In this environment, manufacturers, governments, and communities are seeking cleaner, more efficient, and resilient power management systems. Semiconductors are key to the achievement of the long-term objectives of all the parties involved and SiC is increasingly the first option for many designers, analysts said.

"Increasing use of non-conventional energy sources such as tidal, solar and photovoltaic and growing need for more efficient power management and new safety features in the automotive industry have increased the adoption of power semiconductors in the IT & consumer electronics industry, automotive, power distribution, and rail transportation sectors," said Allied Market Research analysts, in a recent report. "Increasing demand for compact products has enabled companies to adopt collaboration strategy to offer industry-specific products. Market players have focused on innovation in new technologies such as silicon carbide-based devices to expand their market presence."

Factors that have pushed wide bandgap semiconductor materials to the fore of power designs have proliferated as designers try to reduce system footprint or meet stringent demands for cleaner energy systems. With demand for cleaner and more environmentally friendly energy sources climbing, pushing aside fossil fuels, the electronics industry has responded with innovative solutions based on newer and more resilient semiconductor materials, according to industry analysts.

"Power electronics play a key role in shifting electrical energy patterns to renewable energy with higher energy efficiency," said Markets and Markets, in a report. "At present, several countries are shifting from electricity generation using fossil fuels like coal and gas to renewable energy sources and a simultaneous decline for non-renewable ones."

The result is the emergence of a new power electronic design environment. Energy systems used in electronic devices nowadays must help OEMs achieve their desire for faster, smaller, and more efficient devices. The larger society, in turn, wants to reduce the harmful effects of global warming and has identified fossil fuels as energy sources



Silicon Carbide market

that must be eliminated to attain this objective.

Engineers are offering wide bandgap semiconductor materials as the perfect agents for achieving objectives shared by electronic OEMs and society, according to industry executives and analysts.

"Nowadays, wide bandgap-based solutions are rapidly gaining importance," said Infineon Technologies in a report discussing the company's plans for the power market. "Silicon carbide and gallium nitride complement and expand the possibilities of silicon and can offer cost benefit advantages for various use cases. Several applications have reached or surpassed their tipping points, and market researchers are predicting very dynamic growth. We have a clear strategy for capturing this growth and the value associated with it."

Silicon vs. Silicon-Carbide

The design engineering community is today actively playing up the numerous advantages wide bandgap semiconductor materials like silicon carbide has over regular silicon.

SiC is especially useful for complex devices where factors such as size, weight, stability, extreme temperature, high voltage, shock, and resistance are considered critical. Due to its resilience – hard and strong – SiC is favored for systems used in automotive, aerospace and defense, industrial and renewable energy.

It is in power consumption, though, that SiC has gained prominence over the last several years as manufacturers race to overcome production, yield and supply challenges. Manufacturers who want to reduce power consumption in SoCs, CPUs and GPUs, increasingly favor SiC and GaN nowadays.

"Companies use wide bandgap semiconductor materials to accommodate the increased power and frequencies involved in new power designs for electric vehicles, optoelectronics, and other applications that present severe operating conditions," said Market and Market analysts. "The players operating in the power electronics industry are focusing on integrating multiple functionalities in a single chip, which results in a complex design."

While SiC has emerged as a favored material for power devices nowadays, it is not a new discovery. In fact, it has been in use for more than one hundred years although its history in the semiconductor area is more recent. The initial use, because of its resilience, was as an abrasive.

The use of SiC in the electronics market was complicated by production and integration challenges. Companies like STMicroelectronics, Infineon and WolfSpeed have been working on SiC for many years, trying to overcome issues related to production yield and adaptability for various applications.

Many of those challenges remain today.

SiC is tough to produce but the supply chain supporting it is also not as well developed as for regular silicon. Investments in the market has also been limited to a handful of companies, although billions of dollars are now being poured into the segment to beef up production, secure raw materials and ensure adequate supply to meet surging demand.

Manufacturers have responded to the recent automotive IC shortages with plans to expand current production facilities in Europe and North America.

Semiconductor materials supplier Coherent, formerly II-VI, plans to invest about $1 billion in SiC over the next 10 years in response to rising customer demand, according to company executives.

"Our customers are accelerating their plans to intersect the anticipated tidal wave of demand for SiC power electronics in electric vehicles that we expect will come right behind the current adoption cycle in industrial, renewable energy, datacenters, and more," said Sohail Khan, head of new Ventures & wide-bandgap electronics technologies at Coherent, in a statement announcing plans by the company to expand its factory in Easton, Pennsylvania.

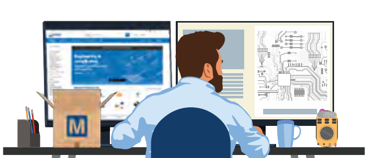
In September, Infineon opened its latest power electronics fab in Villach, Austria. Construction on the fab started in 2019 and is expected to boost sales by $2 billion when operational. The fab will produce parts for OEMs serving the EV, data center, solar and wind energy markets, the company said.

Infineon followed up in November with plans to construct another 300mm power semiconductor manufacturing facility in Dresden. Other manufacturers are making similar moves. Last year, WolfSpeed, for example, opened what it termed the world's largest 200mm SiC fab in Marcy, New York. Company executives said the new fabs will increase the supply of SiC to customers by improving wafer quality and yield.

Later in the year, WolfSpeed said BorgWarner had agreed to invest $500 million in the chipmaker to secure supplies. The investment would guarantee BorgWarner up to $650 million in annual SiC capacity, the companies said.

"Silicon carbide-based power electronics play an increasingly important role for our customers as our electric business continues to accelerate," said Frédéric Lissalde, president and CEO of BorgWarner, in a statement announcing the agreement. "We believe this agreement helps ensure that BorgWarner will have a reliable supply of high-quality silicon carbide devices, which are significant to the company's inverter growth plans."

Adds Gregg Lowe, president, and CEO of WolfSpeed: "BorgWarner has been a strong partner with WolfSpeed for many years, and we are pleased to secure the investment from them which will be used to support our capacity expansion efforts and ensure we have a steady supply of products for their customers. This agreement, combined with our most recent announcement of a multi-billion-dollar materials expansion in North Carolina, confirms the industry transition from silicon to silicon carbide is well underway."



MCX delivers the next generation of MCU capability

Low power, low cost, high performance, wireless connectivity? MCX has a family for that!

The adoption of 32-bit microcontrollers (MCUs) in a market previously dominated by 8- and 16-bit devices has surged over the past two decades. The market size of 32-bit MCUs surpassed that of either 8- or 16-bit products a decade ago, and sales of 32-bit devices continue to grow strongly compared to those lower-performance devices. The reasons are clear: there are many applications that call for the increases in memory capacity and processing speed that 32bit architectures such as the Arm® Cortex® -M family continue to deliver.

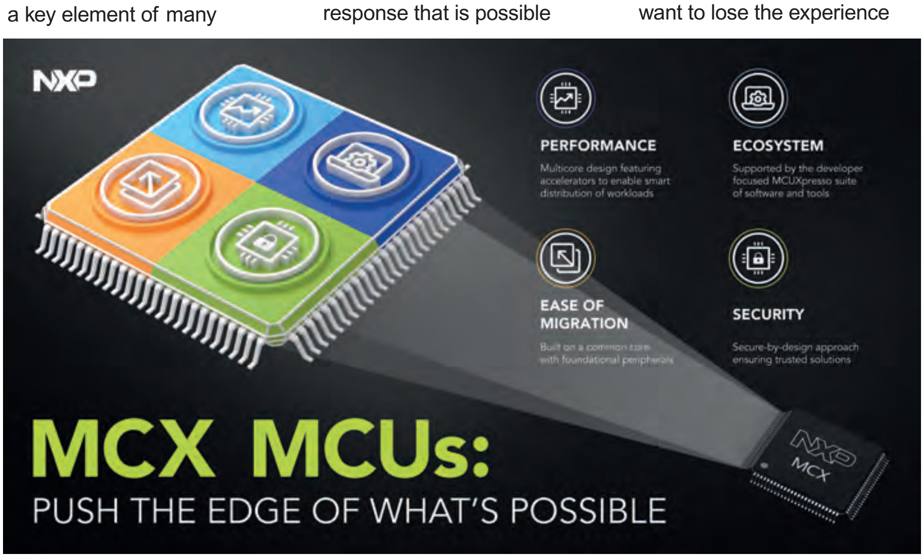
Connectivity has become a key element of many product designs so that, in addition to reporting report their status and receive commands remotely, they form part of a larger system of systems in which multiple devices on the internet of things (IoT) collaborate to enable sophisticated applications. That not only drives demand for integrated wireless communications capability, but also for a security framework that ensures devices cannot be compromised by remote attacks or by malicious users.

Built-in performance is also crucial. The arrival of commercially successful artificial intelligence (AI) and machine learning (ML) in the server space is now driving the evolution of the same technologies at the edge. Consumers and industrial users alike want the rapid response that is possible only with local intelligence. That means not having to rely on large quantities of data being relayed to the cloud, especially if the embedded devices have access only to unreliable or low-bandwidth connections. Privacy concerns have also emerged in recent years, providing another reason for performing ML functions locally to avoid potentially sensitive data being transmitted over the internet. An on-chip secure subsystem provides the necessary protection for a secure boot, preventing malicious code from hijacking the system.

Although they need more features and performance, when migrating to a new platform, longstanding users of MCUs such as those from NXP's large LPC and Kinetis families do not want to lose the experience amassed over many years of using these devices. These considerations drove the specification of not just the MCX series of MCUs, but also the software and supply-chain infrastructure around them.

In designing the MCX hardware, NXP set out to build a series of devices that can handle the huge range of demands that now feature in the 32-bit MCU space. As its starting point, NXP took the powerful but efficient Cortex-M33 core. Around this core are peripherals that are tuned for each target application and market space. The products range from low-power devices in the MCX L series and low-cost MCUs in the MCX A series, up to the advanced features of the MCX N series with as much as 4MB of onboard flash and 1MB of SRAM. Another example of this internal differentiation lies in the security features that each family offers.

Designed for high-performance embedded systems, the MCX N Series features the EdgeLock(R) Secure Subsystem that provides a root-of-trust implementation in silicon. The hardware includes cryptographic acceleration engines protected against side-channel attacks that are increasingly being used against MCU



based products to obtain access to the private keys held in the system.

Only code blocks that carry the correct cryptographic signature will be loaded and made ready for execution. This ensures that even if an attacker finds a way to load a compromised binary either over the network or using local memory access into flash—the MCU will reject this binary and fall back to an authentic version of the boot code if it is available.

Similarly, the MCX A series, which is optimized for real-time applications such as motor control, offers essential security features. These include the ability to control on-chip memory access and product life cycle control, supporting options for field upgrade and control over the debug port.

Backing all this up is a supply-chain initiative that not only ensures security credentials are specific to each manufactured device, but which can be used to protect OEMs against threats such as overbuilding by contract manufacturers. For the MCX portfolio, NXP provides support for key management and device attestation, making it easier for OEMs to build IoT systems that can automatically connect to application servers and prove their authenticity. The implementation of these pre-configured security and key management policies enables device makers to simplify the path to certification, avoid costly mistakes, and save development time.

As MCX represents the follow-on architecture to the existing LPC and Kinetis portfolios of Arm Cortex-based MCUs, a key attribute of the new portfolio is the continued use of a unified development environment that lets developers carry their engineering investment in those earlier families into successive designs.

Both the LPC and Kinetis were distinguished by their rich portfolios of peripherals. Many of these peripherals are carried through into MCX, allowing embedded developers to leverage their experience in using them in their new projects. In addition, the extension of the two legacy families into the next generation MCX allows customers to access a wider range of peripherals. Both migration and fresh development for device-level code are supported by the continuation of the MCUXpresso suite of software and tools, which combines development and configuration tools with firmware and middleware that eases the job of porting embedded software.

MCUXpresso provides options to use leading integrated development environments (IDEs) from IAR and Arm, or NXP's free IDE based on the open-source Eclipse codebase and highly customized for its MCU families. SDK builder tools and configuration tools enable customers to quickly select software options and configure pins, clocks, and drivers for their own custom boards, generating initialization C code and register settings so that they can move to working firmware as quickly as possible. On top of this, middleware is provided by NXP and its broad network of partners to support the complex application environments that many designs now need, such as support for wireless communications through the Bluetooth Low Energy (BLE) interface built into the MCX W family devices and others.

The software support extends to the eIQ environment for ML development. Developers can utilize the easy-to-use tools offered by eIQ to train ML models that can run on the core M33 processor or, in the case of the MCX N series, take advantage of a built-in neural processing unit (NPU). Designed by NXP, the NPU is optimized for performing the inference computations needed to run high-performance local ML models and can deliver 30 times the throughput of code compiled for the M33. This additional ML performance makes possible AI functions that would otherwise need to be offloaded to cloud servers and incur the cost and latency that those data transfers would entail.

If applications call for even more performance, the extension of MCUXpresso and eIQ support to the i.MX RT crossover MCUs provides developers with an easy and effective migration path. With the MCX series now joining the NXP offering of embedded microcontroller solutions, developers have an easy way of migrating to the latest features and continue to innovate in response to market demands.

www.nxp.com/mcx

NoC NoC!

Today's SoCs are so complex they need a network-on-chip (NoC)

By Clive "Max" Maxfield, Editor at DENA, CTO of LogiSwitch, and freelance technical writer and consultant.

In the same way that "there's no point reinventing the wheel," there's no reason for the developers of system-on-chip (SoC) devices to redesign well known functional blocks like application processors (APs), encryption engines, video codecs, and communications functions (Ethernet, I2C, SPI, USB). Instead, the developers prefer to acquire these functions from third-party vendors, leaving them free to focus on designing their own "secret sauce" IP that will differentiate their device from their competitors' offerings.

IP blocks must be connected in some way so they can talk to each other. When SoC developers first started to use third-party IP, a typical design might contain only a few handfuls of such blocks. A common approach circa the 1990s was to use a bus-based architecture. This remains a useful technique for today's simpler designs involving only one (or very few) initiator blocks talking to a limited number of target blocks, where all the blocks employ the same interface (i.e., the same bus widths running at the same frequency with the same protocol).

As designs started to include more and more initiator and target blocks, bus-based architectures began to run out of steam. Circa the 2000s, many design teams transitioned to using crossbar switch-based interconnect architectures. In this case, any initiator block can talk to any target block and multiple transactions can be in flight at the same time. Furthermore, in the case where multiple transactions arrive at the same switch, that switch has the ability to prioritize transactions, buffering those with a lower priority while handling those with higher priority.

Not so long ago, an entire SoC might boast only 20,000 to 50,000 logic gates and registers. Today, by comparison, a high-end SoC can contain hundreds of IP blocks, each of which may comprise hundreds of thousands (sometimes millions) of logic gates and registers. In fact, I was recently introduced to an SoC design containing more than a billion gates!

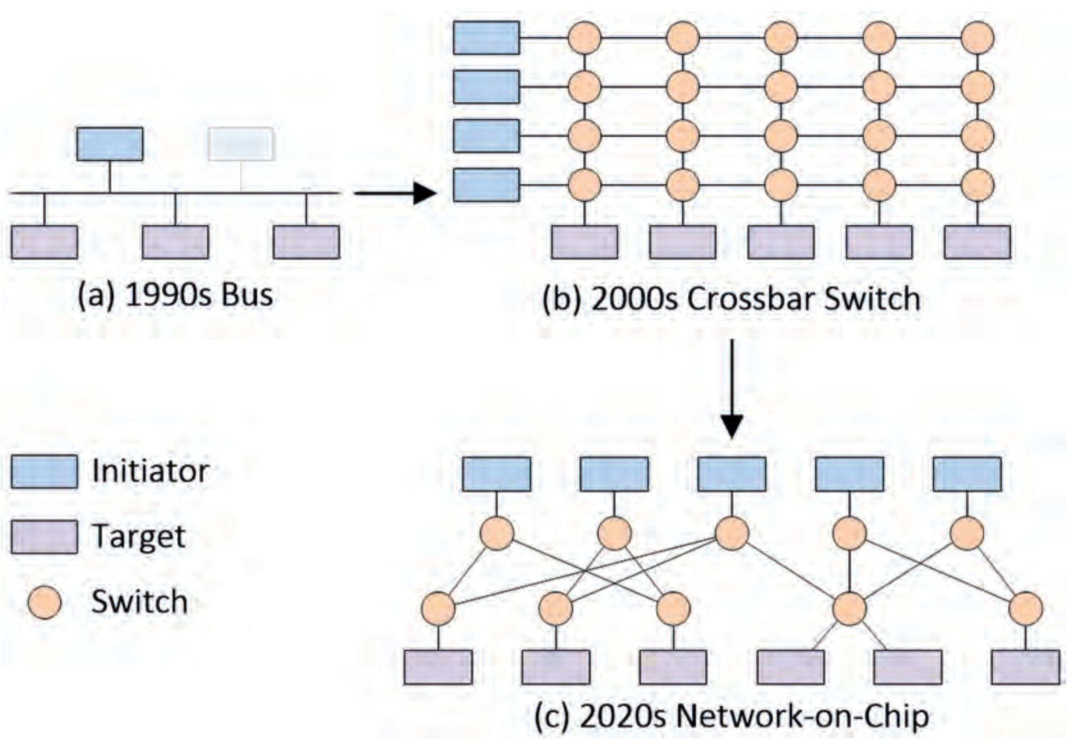
When it comes to this class of design, even crossbar switches are starting to bite the dust due to the amount of silicon real estate they consume and the routing congestion resulting from their underlying architecture. An even bigger problem is that the various IP blocks may support different interfaces (widths, frequencies, protocols).

One solution that is increasingly being adopted by today's high-end design teams is to employ a network-on-chip (NoC). In this case, the IP blocks communicate by passing packets back and forth, where each packet contains its destination and its payload data. Each IP block interfaces with the NoC by means of a "socket," which handles things like width conversion, protocol conversion, command translation, and clock domain crossing (different IPs can be running at different frequencies).

Unfortunately, creating a NoC from the ground up is a non-trivial task. In fact, it could take as long to develop the NoC as it does to design the rest of the device. Happily, off-the-shelf solutions are at hand in the form of third-party NoC IP, such as FlexNoC from Arteris IP.

All I can say is that things have come a long, long way since I was a young designer.

www.designing-electronics.com



Circular connectors evolve to meet industrial demands

Mark Patrick, Head of Technical Marketing, Mouser

An innovative alternative to the traditional M12 screw locking arrangement.

As technology advances and establishes footholds in new market sectors, it brings a host of dependencies and requirements. For example, as computer networking evolved, many different networking protocols and topologies vied for market dominance. Over the years, Ethernet emerged as the information technology (IT) preferred networking method. Alongside the technology choice came a practical but equally important decision—establishing a connector standard from the many different types of competing formats. Today, the RJ45 Ethernet connector is ubiquitous.

Operational technology (OT) adoption for industrial process control and factory automation experienced a similar connector evolution. Unlike most IT environments, industrial environments present many challenges for connectors, including mechanical forces such as vibration, shock, and stress; environmental factors such as temperature and humidity; the potential ingress of liquids or dust; and exposure to hazardous chemicals and contaminants. The continued advancement of automation and technology deployment also introduces the requirement for connectors to conform to established electromagnetic standards for immunity (EMI) and compatibility (EMC).

For industrial OT applications, the circular M8 (8 mm) and M12 (12 mm) locking connectors emerged as the defacto method of connecting everything from actuators to sensors. Their compact yet versatile construction provides a variety of pins, pin arrangements (termed coding), voltage and current ratings, and data bandwidths.

The M12 connector, in particular, has become the world standard for connecting data, signals, and power. It perfectly balances the demands of use in an industrial environment while also meeting the space constraints of high-density control cabinets. For example, A-coding and B-coding suit Fieldbus, DeviceNet, and Profibus connections, while D-coding connectors are specifiedfor Industrial Ethernet, EtherCat, and PROFINET.

M12 Connector Evolution

As industrial operational performance initiatives—such as Industry 4.0 and the industrial internet of things (IIoT)—result in further technology deployments, there is an increased need for connectivity. M12-based applications need installers to spend more time screwing in sensor, actuator, and power connectors. The requirement for more M12 connector sockets in control equipment also involves more manufacturing time and connector density challenges. Responding to market demands, Phoenix Contact has developed and standardized (IEC 61076-02-010) an innovative alternative to the traditional M12 screw locking arrangement.

The new M12 connectors from Phoenix Contact feature an internal push-pull locking mechanism for cable connectors and enable a new flush-mounted female push-pull socket for efficient & smooth device connection and integration The new M12 socket securely accommodates both existing threaded connectors and the new push-pull connector.

The internal push-pull arrangement offers a tool-free and straightforward approach to performing a fast, secure connection, even in a confined space. Compared to conventional M12 device connectors, the push-pull connector can play to its strengths in space-critical applications where a slightly higher connector density is possible. It is also suitable for multi I/O designs and those where frequent disconnect/connect cycles are necessary, such as maintenance and reconfiguration.

Phoenix Contact has established a comprehensive portfolio of M12 through-hole reflow (THR) and surface-mount technology (SMT) device connectors. The Phoenix Contact M12 surface-mount device connector is available for the hybrid power and data Y-coding, and the Gigabit X-coding. Surface-mounted connectors are particularly suitable for data and signal applications and typically accommodate low current power connections. For high power and current applications, the through-hole connector is recommended.

www.mouser.com

Compact high pin count mezzanine connectors

New 0.8mm pitch connectors target high-density industrial systems

Harwin is a globally recognized leader in high-reliability (Hi-Rel) interconnect solutions that can deal with the most challenging application demands. Harwin's connectors are pivotal in modern avionics, defense, space, motorsport, oil and gas, medical, and industrial systems. For almost 70 years, the company has been setting new benchmarks in terms of innovation.

Expanding their product offering for industrial markets, Harwin now announces the Archer .8 series. With a 5mm stack height, these dual-row 0.8mm-pitch board-to-board connectors are intended for uses where there is very limited available space and cost-effectiveness is equally important. These include factory automation and environmental monitoring equipment, smart meters, point-of-sales units, servers/data center hardware, and battery management systems in electric vehicles.

Archer .8 connectors have all the attributes necessary for modern industrial equipment. The phosphor bronze contacts can carry a current of 0.5A each. Available in 30, 40, 60, 80, 100, and 120 pin count versions, these connectors satisfy a broad range of design requirements. Polarization helps with orientation and alignment and prevents mis-mating, while shrouded housings protect contacts from accidental damage. To facilitate automated assembly processes, the connectors are supplied in tape and reel packaging, with locating pegs fitted.

Operating within a wide temperature range of between -40°C to 125°C, this newly extended .8mm range of connectors are compact, reliable, and in-stock ready to order now from Harwin's global distribution network.

www.harwin.com

Unleashing the full potential of today's processors with in-package optical I/O

In-package optical I/O is the breakthrough technology needed to satisfy today's computational workloads

Today's computational workloads are growing in both size and sophistication at an unprecedented rate. An emerging solution is to employ the composability capabilities provided by disaggregated architectures. However, the full potential of disaggregated architectures can be achieved only by means of state-of-the-art in-package optical input/output (I/O) technology.

Disaggregation and composability

A modern data center can contain tens or hundreds of thousands of cabinets or frames called racks. Each rack can contain anywhere from 10 to 40+ bays or shelves. In a traditional architecture, each shelf contains a server, and—in turn—each server features a motherboard containing one or more XPUs (CPUs, GPUs, FPGAs, ASICs, SoCs), memory in the form of DDR DRAM modules, and storage in the form of solid-state drives (SSDs).

Problems have emerged with this traditional architecture since computational workloads for tasks like AI and high-performance computing (HPC) have evolved to be larger, more complex, and more diverse than ever before. The solution is to use a disaggregated architecture, in which each shelf in the rack specializes in one type of component: CPUs, GPUs, RAMs, SSDs, etc. Using this form of disaggregated architecture leads to the concept of composability, in which virtualized resources are automatically composed in near real-time to meet the computational and memory requirements of each task on an application-specific basis. Once an application has completed its task, these resources are released back into their respective pools, at which point they can be provisioned to future applications in different ratios.

Introducing in-package optical I/O

For disaggregation and composability to work, it is necessary for data to be able to pass from shelf-to-shelf and rack-to-rack at lightning speed. Unfortunately, these bandwidth requirements far exceed the capabilities of traditional copper-based electrical interconnect technologies.

The solution is to use optical-based interconnect, but it is not sufficient to simply take existing devices (CPU, GPU, memory, etc.) and augment them with external optical interconnects. To achieve the necessary transmission speeds and bandwidths, it is required for the optical interconnect to be incorporated inside the device packages.

Fortunately, in-package optical I/O is now possible due to two recent developments from Ayar Labs in the form of TeraPHY optical I/O chiplets and SuperNova advanced light sources.

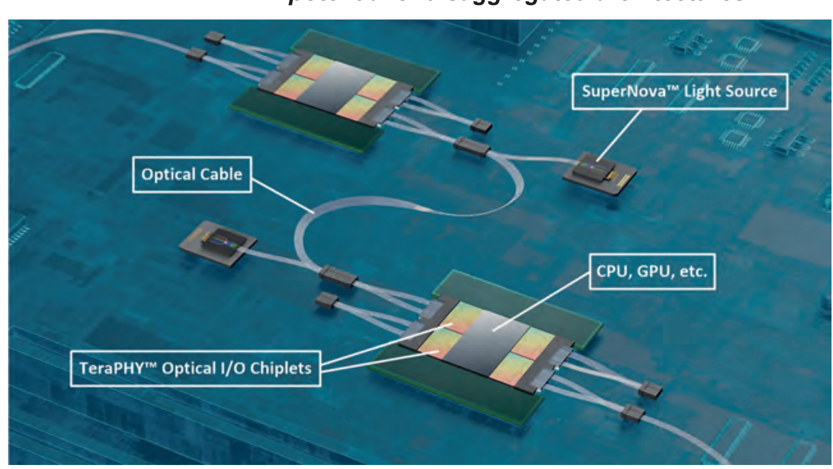
Chiplets are small integrated circuits, each containing a well-defined subset of functionality. Multiple chiplets can be combined with the main silicon die by means of a base layer called an interposer, with everything being presented as a single package to the outside world. By combining silicon photonics with standard CMOS manufacturing processes, TeraPHY optical I/O chiplets allow the core device to communicate with the outside world at the speed of light.

Each TeraPHY chiplet supports 2 terabits per second (Tbps) with a roadmap to 8Tbps. The remaining piece of the puzzle is provided by the SuperNova light source. The combination of TeraPHY chiplets and SuperNova light sources delivers up to 5X higher data rates with an 8X improvement in power efficiency compared to traditional copper-based electrical interconnect technologies. The Ayar Labs solution enables devices to communicate with each other across a wide range of distances, from millimeters to kilometers.

Almost unbelievably, it's now possible for disaggregated racks of CPUs, GPUs, memory, and storage to be located tens, hundreds, or even thousands of meters from each other.

www.ayarlabs.com

TeraPHY optical I/O chiplets and SuperNova light sources unleash the potential of disaggregated architectures



Elegant esthetics are crucial for your electronics

Enclosures do more than contain and protect your electronics

Odd as it may seem, electronics encased in a handcrafted wooden box would once have been seen as cutting edge. Now, such enclosures are ancient history—a curio from a bygone age. If you see a well-worn housing today, you assume the circuits inside are equally antiquated.

And that's a crucial point. In the world of technology, where devices must be perceived as being cutting edge, enclosures don't just contain and protect your electronics: they *sell* them. First impressions count. Users buy with their eyes. Enclosure aesthetics play a key role in determining whether people will buy your products… or ignore them.

Today, you'd have to look hard to find PCBs housed in wood. Plastic and metal have for decades dominated as the enclosure materials of choice. However, even as recently as the last 10 years, there has been a subtle but significant evolution in the materials used and how they are finished.

Plastic and metal enclosures typically sit in two distinct camps—never the twain shall meet. However, some models, such as OKW's SMART-TERMINAL and the award-winning SYNERGY range, have combined the two materials to create a smart new look with enhanced technical benefits.

These standard and customizable enclosures are aimed at high-end electronics. Both models feature extruded anodized aluminum bodies with plastic top and bottom sections (SYNERGY) or end covers (SMART-TERMINAL). SYNERGY's pillar-based construction system means no fixing screws are visible. Meanwhile, SMART-TERMINAL's fixings are concealed deep within recessed end covers that combine two types of plastic (adding IP 54 ingress protection and a dash of color). Welcome to the future!

www.okwenclosures.com


An enclosure from yesteryear

Breakthrough AI robustly perceives in the dark and bad weather

Cameras can achieve accurate 3D perception that can range out to a kilometer

The promise of broadly deploying safe and effective automated driving is a game-changer that can reduce road fatalities, more efficiently deliver goods, and enable new business opportunities, with the most critical enabler being robust dense depth perception in all conditions.

From a safety perspective, the problem is urgent. The US hit a 16-year high in traffic deaths in 2022 and pedestrian fatalities reached their highest level in 40 years, with nighttime pedestrian deaths rising by 41% since 2014. Road accidents continue to be a leading cause of death (1.3M) and injuries (20-50M) estimated worldwide.

Automation also has economic benefits, such as to help address the worldwide truck driver shortage. Today there are an estimated 2.6M unfulfilled driver positions across the 25 countries surveyed, with shortages of 80,000 in the US, nearly 400,000 across Europe, and 1.8M in China. This is expected to significantly grow due to a lack of skilled workers, an aging driver population, and waning interest in the profession due to quality-of-life issues.

The perception stack is the most crucial element of the AV or ADAS system for improving vehicle safety. It ingests sensor data and interprets its surroundings through an ensemble of sophisticated algorithms that must provide robust detection and accurate distance estimation of objects in all lighting and weather conditions (including rain, fog, and snow) and in city or highway routes. It must have sufficient range to provide time for the system or driver to respond to an issue. At highway speeds, this needs to be out to 300m for passenger vehicles and over 500m for Class 8 trucks for them to safely brake or maneuver to avoid an accident. The stack then delivers the information needed for the vehicle to warn a driver or make good control decisions itself.

These perception systems use cameras, radar, and—increasingly—lidar sensors, which all have pros and cons. Cameras are the most dominant sensor and provide rich high-resolution information at low costs but require lengthy manual ISP tuning and struggle with low light. Radars are mature sensors and provide active distance and velocity measurement, but have low resolution, field of view, and a range of about 200 to 300m. Lidars are also active distance sensors robust to low light with higher resolution than radar, but are the most expensive sensors, are impacted by fog, rain, and snow, and have a practical range of about 200m.

While there won't be one "magic" sensor, what if you could get cameras to achieve robust accurate 3D perception that can range out to a kilometer with dense depth estimation, real-time adaptive online calibration for multi-camera configurations, and low system development and deployment costs vs. other much more expensive sensors?

Algolux is a recognized pioneer in the field of robust perception software for ADAS and AVs and applies deep learning artificial intelligence (AI), computer vision, and computational imaging to deliver dense and accurate multi-camera depth and perception. It has validated and deployed solutions for both car and truck configurations with leading OEMs and Tier 1 customers.

The recently announced Eos Robust Depth Perception Software from Algolux has been recognized as addressing the range, resolution, cost, and robustness limitations of the latest lidar, radar, and camera-based systems combined with a scalable and modular software perception suite.

www.algolux.com

Dave Tokic, VP Marketing and Strategic Partnerships, Algolux

"There is an increasing truck driver shortage worldwide. This is expected to significantly grow due to a lack of skilled workers, an aging driver population, and waning interest in the profession due to quality-of-life issues"

Redefining military electronic systems

Diving into the new X9 Spider architecture

Next-generation military platforms such as aircraft, vehicles, unmanned aircraft systems (UAS) and sensor systems require data-driven capabilities to maximize computing resources in lean, flexible, and cost-effective ways. Unfortunately, today's military applications typically rely on centralized computing architectures such as COM Express, PC104/PCIe-104, and VPX/OpenVPX (also known as VITA 46/65). With these systems, all comprised of bus-based boards gathered in a single chassis, there is no simple process to swap units from different suppliers. As a result, they are inflexible and expensive to upgrade and maintain. Even worse, every few years, military customers must discard the entire systems and start anew as needs change and the supply chain (or technology) evolves.

US military entities have been quite clear in recent directives, demanding computing systems that are smaller and lighter with more artificial intelligence (AI) at the node so information can be gathered, analyzed, and sent back in near real time. They also want all new military systems to be interoperable and common across key hardware and software. In 2017, the Sensor Open Systems Architecture (SOSA) consortium was formed under the Open Group to define an open sensor environment for Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance, and Reconnaissance (C5ISR) systems. In 2019, the US Department of Defense (DoD) called for a Modular Open Systems Approach (MOSA) for future weapons systems.

The OpenVPX standard is one approach being pushed by customers. However, OpenVPX systems have fewer functions per slot and need more boards in the chassis, requiring complex wiring between the slots as functions "spill over," and generally use more power, generate more heat, and cost more due to backplanes, complex chassis, and mechanical "overhead."

A better alternative

Fortunately, there are better, faster, and less expensive options that still meet the demands of the US military while future-proofing systems for years to come. A new decentralized computer system, based on Apple/Intel Thunderbolt technology offers promise with design headroom. With Thunderbolt technology, small connected distributed compute modules break the outdated and needlessly expensive, centralized ATR-style board-and-chassis paradigm and allows customers to upgrade any portion of their systems as needed.

Called X9 Spider, this modular, scalable, distributed architecture empowers designers to decentralize, distribute, and rapidly upgrade computing, networking, storage, AI, and video resources wherever and however the program demands. It gives designers ruggedized, as-needed capabilities to solve any compute problem in any environment—from the smallest enclosure to the largest C5ISR system. Rugged X9 Spider modules are small (around the size of a cell phone) and modular, plug-and-play, and emphasize flexibility over ATR chassis' physical and electrical constraints.

Unlike traditional ATR-style boxes using VME or OpenVPX cards, where the box can't be opened or modified without a requalification, this new interoperable architecture lowers costs and decentralizes computing, power distribution, and heat dissipation while improving fault tolerance through redundancy or merely by physically separating critical functions. In addition, its high-speed 100Gb Ethernet and 40Gbits/s Thunderbolt interfaces are open standards, allowing other vendors to create their own modules, a definite plus for the military applications that must adhere to SOSA and MOSA mandates.

Chris Ciufo, CTO, General Micro Systems

As a result, the X9 Spider architecture provides what the industry demands: smaller, lighter, cheaper and more flexible technology that enables applications to collect data and make decisions in real time at the site so solders and vehicles can win the modern battlefield.

www.gms4sbc.com

"It gives designers ruggedized, as-needed capabilities to solve any compute problem in any environment"

Designing a vision sensor for a world in motion

Mehdi Asghari, SiLC Technologies Founder and CEO

Direct imaging of movement and depth brings human-like vision to machines

Human vision has evolved to focus on the detection of movement. This has been critical to our survival in a hostile and dynamic environment, making the difference between catching food or being food. More than 90% of our eye's resources work to recognize motion. These resources are hardwired to enable fast subconscious reactions, hand-eye coordination, and the ability to undertake predictive behavior. The eye enables these by processing images and sending these not only to the brain for visual perception but also to critical muscles in the human body via our subconscious.

In contrast, today's machine vision systems are based on camera systems that have been developed for image recording and not processing. These work by taking a series of still images, each of which captures only a fraction of the available information, and then using very expensive and power-hungry computing to stipulate lost information. For example, frame-by-frame comparisons of pixels are used to analyze motion. In order to get machines out of factories and integrated into our society, we need to enable them with human-like vision. This requires image sensors with a high level of intelligence built into them, like the human eye. These sensors must be able to capture motion directly and provide real-time, accurate information that enables rapid reactions.

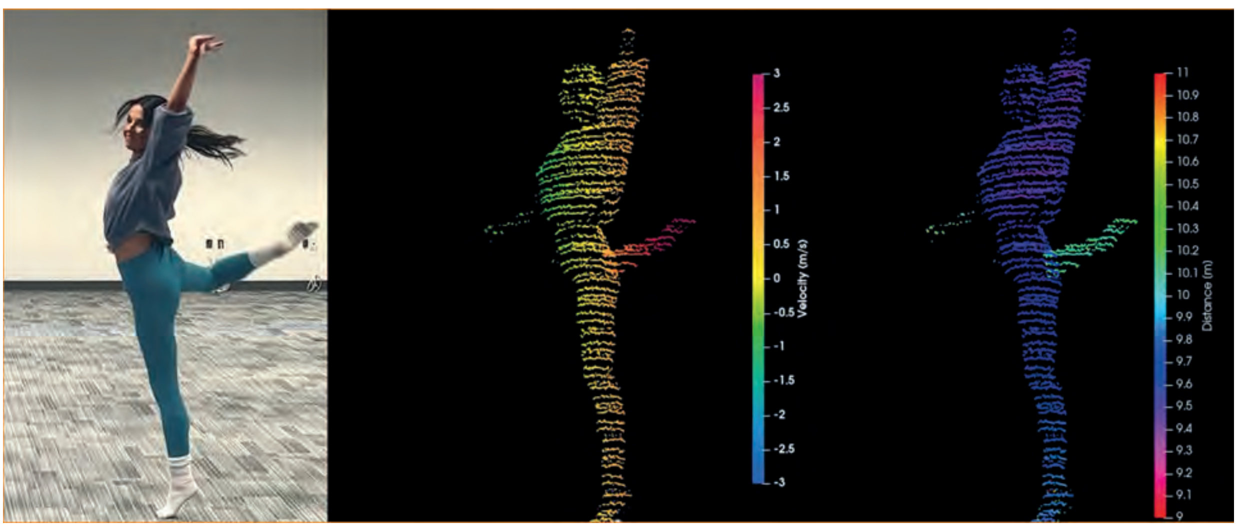
True machine autonomy requires human-like vision

Today's industrial infrastructure is based on utilizing machines in human constructed and highly controlled environments where they are dealing with predetermined, well-orchestrated movements. Here, standard camera vision suffices, and any depth sensation required can be achieved through any number of known (typically geometrical) techniques.

However, we are entering the Golden Age of AI where we enable machines/robots to get far more involved in our society and economic growth. To get machines out of the controlled environment of the factories and into our everyday lives where complex and unpredictable movements come in abundance, human-like vision, with direct motion sensing, is necessary.

Despite the critical role of motion in perception, to date the key approach to extracting movement information has been based on computationally expensive, slow, and inaccurate methods that rely on analysis of still images (typically taken from multiple angles). Very few, if

The Eyeonic Vision Sensor directly images motion and distance on a pixel-by-pixel basis



any, companies are focused on direct perception of motion. No one has demonstrated a cost-effective and accurate implementation for direct measurement of velocity and movement. This is due to the complex nature of capturing accurate motion information from moving objects.

The Eyeonic Vision Chip

SiLC, which stands for "Silicon Light Chip," is the only company that has demonstrated the ability to directly capture motion and depth with a fully integrated optical chip in silicon. SiLC's recently announced Eyeonic Vision Sensor utilizes a unique silicon photonics technology, which is able to get the cost and size of this solution to a point where it can be a true companion to the widespread CMOS imager inside every camera.

The best method for the direct measurement of velocity utilizes doppler shift in the frequency of sound or light (EM) waves as they reflect from moving objects. Radar technology has successfully deployed this method to measure the velocity of large objects, such as airplanes and cars, but this approach suffers from very low image resolution and an inability to perceive stationary objects accurately. The use of light can offer much higher resolution (close to human-level perception), but the required components and devices are complex and require very high-performance specifications. This is beyond what today's optical technology, deployed in data communication or military applications, can offer cost effectively.

This is where SiLC's Eyeonic Vision Sensor comes in. SiLC's unique integration technology enables it to integrate the complex optical functionalities needed for optical-based doppler motion perception. SiLC can do this with a single silicon chip made using standard CMOS manufacturing processes. The Eyeonic Vision Sensor can also measure the shape and distance of objects with high precision at great distances. The key here is that SiLC can perform this complex integration and still achieve the very high level of performance required. SiLC's unique and patented technology and manufacturing process have been specifically developed and optimized for this purpose. This means that its technology achieves 10 to 100X better performance across a range of key metrics that are important to this application as compared to other available technology offerings.

SiLC recently introduced a full solution around its Eyeonic Vision Sensor chip. The Eyeonic Vision System is the industry's most powerful and compact FMCW LiDAR solution. The system features the highest resolution, highest precision, and longest range, and is the only LiDAR solution to offer polarization information. The Eyeonic Vision System brings the highest levels of visual perception to applications that need to perceive and identify objects even at distances of greater than 1 kilometer, and yet, remains eye-safe and free from multi-user interference and background light.

Since the Eyeonic Vision Sensor also uniquely offers polarization intensity data, it can be used to help with material detection and surface analysis. Its ability to do this in a small, cost-effective silicon chip, which is manufactured using silicon wafer processes similar to CMOS imaging chips, enables it to complement the functionality offered by existing cameras. It does this at a size and cost point that can reinvent the camera as we know it today, enabling next-generation cameras to function in a way that closely resembles the human eye.

There are many use cases for the Eyeonic Vision System across a wide range of markets. Examples include self-driving cars, household and delivery robots, cameras that analyze motion to automatically generate statistics, gesture control, and applications in VR and AR. All of these applications and many more require the capture and analysis of motion and will have a major impact on our lives and future economic growth.

www.silc.com

> ***"In order to get machines out of factories and integrated into our society, we need to enable them with human-like vision"***

The Eyeonic Vision Sensor

How will engineers design electronic products in the future?

Predicting the future is always risky, but it's certainly going to be exciting!

A few weeks ago, I was chatting with an electrical engineering student. It seems his class has been learning about some of the tools we use to design integrated circuits (ICs) and printed circuit boards (PCBs). He asked, "How will engineers design electronic products in the future?"

How things were

When I started my career as a hardware design engineer in the early 1980s, the only design tools available to me were pencils and paper. We created our schematic (circuit) diagrams as netlists of logic gates and registers.

When it came to timing verification, we identified the critical paths by eye and then summed the gate and wire delays by hand (no one I knew could afford even a 4-function handheld electronic calculator).

In the case of functional verification, you gathered the rest of the team, who sat around the table perusing and pondering your schematics while asking probing questions about your design along the lines of "What does this bit do?" and "Why did you do things this way rather than that way?"

How things are

Engineers designing electronic products today are equipped with an array of sophisticated design, analysis, and verification tools. At the PCB level, for example, design engineers have access to incredibly sophisticated schematic capture technology integrated with tools like search engines that aggregate parts from distributers and inform the designers as to component availability in real time.

For those designing application-specific integrated circuit (ASIC) and system-on-chip (SoC) devices, some amazing tools are available, including high-level synthesis (HLS) in which designers essentially describe what they want at a high level of abstraction and the tool translates this into the netlist of gates and registers that will achieve the specified requirements (size, performance, power consumption...).

As far as I'm concerned, compared to the way things were, we're already living in the future, but much more is to come.

How things will be

I think one of the biggest changes we will see going forward is the integration of artificial intelligence (AI) and machine learning (ML) into existing software and hardware design tools and flows.

For example, the internet hosting platform for software development and version control, GitHub, has developed something called Copilot. This uses artificial intelligence that has been trained on billions of lines of existing code to help software developers create their programs.

Using their favourite editor, the developers can start typing comments or code and Copilot will immediately start making suggestions. I have one C/C++ programmer friend who says Copilot has boosted his productivity by an order of magnitude. Another friend who creates field-programmable gate array (FPGA)-based designs says that Copilot also works with hardware description languages (HDLs) like Verilog and VHDL, which are used by FPGA, ASIC, and SoC designers to capture their design intent.

Similarly, we are starting to see the first toes being dipped into the waters of AI-enabled hardware design. Also, we are starting to see the early use of augmented reality (AR) systems as interfaces into our hardware and software design, analysis, and verification tools. Predicting the future is always prone to error, but I think it's safe to say that—if nothing else—it's going to be exciting!

Clive "Max" Mayfield, Editor at DENA, CTO of Logiswitch, and freelance technical writer and consultant

www.designing-electronics.com

From design to finished PCB

Manufacturing is a process that is ripe for error. Don't get caught out!

When I first burned myself with a soldering iron, getting prototype electronics built was a relatively simple process: a) buy some parts and a perf board from Radio Shack, b) wire up the circuit point-to-point, and c) drop the hot soldering iron on my foot, tip first. Things are a bit more complicated these days, but it's not as difficult as it sometimes seems.

Well, maybe it is not that difficult in concept. In practice, however, manufacturing is a process that is ripe for error. I should know. I have made all of the errors. I've worked for an electronics manufacturer (ScreamingCircuits.com) since 2005. We build custom prototypes and un-forecasted volume production lots, which gives us a window like no other into the world of electronics. Seeing so many designs from pretty much all industries gives us exposure to just about any problem an engineer might run across.

What this boils down to is that I have something in my head that will someday be a brilliantly working printed circuit board assembly (PCBA). In between the thoughts in my head and that finished PCBA are a website, a dozen people, software systems, pick-and-place (PNP) robots, and inspection tools.

I could write all day about specific problem areas (and I often do), but the fundamental challenge of manufacturing is in getting all the details out of a designer's head and into a form that the system I have described can effectively use. Assembly is the easy part. Getting a clear understanding is not. Heading into the manufacturing phase with that thought in mind, you will be well ahead of the game.

Your goal as a designer is to produce and deliver a documentation package that has every bit of information a company like Screaming Circuits needs to produce your product. Do not make assumptions. Ambiguity is the enemy of quality.

Your manufacturer often starts when given a set of specifications for a design. There are two types of specs: those needed for quoting and those needed for building. The former will vary from manufacturer to manufacturer. The latter is the same for everyone and the most important of the two.

The build documentation package has three key parts:

Duane Benson, Director of Marketing at Screaming Circuits

the bill of materials (BOM), the PCB fabrication files, and the assembly information.

By far the most frequent problems we see come in the BOM. Check and double check that the part numbers are correct, including every single digit and character. They are all significant digits. Make sure that the manufacturer name is correct and that the reference designators for the PCB are listed. Some manufacturers want to see

Prototype assembly machine setup

additional information, such as a description or the part value to use as a secondary validation if necessary.

One mistake I have made more than once is to make a last-minute substitution and forget to update the part number in the BOM. Don't make this mistake. Speaking of substitutions, different manufacturers often want your alternate approved parts in their own format. You'll have to ask for their preferred system but, regardless, make sure your sub has the full part number, the manufacturer, and the PCB reference designator.

A related mistake is to pick a part by value, like a bypass capacitor, and forget to find a specific part and list it in the BOM. In my head, it's a simple 0.01uf bypass cap. Why do I need to choose? Here's where the fallacy of assumptions comes in. I know that 0.01uf will be fine for my simple microcontroller (MCU) design. I know that a 6V part will be fine and that ESR doesn't matter. I know that the standard temperature range is fine and it's an 0402 package. I know what matters—it's in my head—but my manufacturer does not. Select a part and put it in your BOM.

I reached out to our PCB fabrication provider, Sunstone Circuits, and asked for their thoughts on the fab process. Information is the big hitter there too (are you starting to see a common theme?). Matt Stevenson from Sunstone.com said that limited or unclear specifications is a very common area where they see a lot of ambiguity, especially when related to tighter tolerances or special requirements.

Some CAD packages don't do a good job of calling out high-end specifications. For example, we sometimes get requests for assembly of a flex-circuit board, but the PCB CAD files make no mention of it being a flex board! Getting a standard rigid green PCB when you are expecting a folding flex board is a big disappointment. Again, make such things clear. If the fab files don't clearly spell out non-standard or mission-critical requirements, add a separate set of fab instructions.

Assembly is the last stop on the path. By this point, the parts and bare boards have been procured. Any errors that happen in those two steps will be compounded here, so hopefully, there are none. Again, information, or lack thereof, is the single greatest challenge in on-demand manufacturing.

The long-standing Gerber file format is known and used by everyone in the industry, but it has some significant limitations. It works fine for PCB fab when accompanied by fab instructions, but it really is inadequate for the assembly phase. Most CAD packages can now output intelligent CAD files, like the IPC-2581 or ODB++ formats. These files contain much more information about the assembly requirements than does a Gerber. You may still need an assembly drawing to cover any special requirements, but our machine programming will be much quicker and more accurate when using intelligent files.

With a conventional EMS (electronics manufacturing service), the manufacturing company will spend 30 days to several months with a team from the customer getting ready to build. This new product introduction (NPI) phase irons out all the details and finds all the potential problems. In on-demand manufacturing, the service provider doesn't have that amount of time nor that level of interaction with the customer.

Our fastest turn time for a kitted job (where a customer sends us a complete parts kit) has us returning finished boards the day after we receive the kit. To do that, we must condense the 30 to 90-day NPI process down to 30 to 90 minutes. You can imagine how little margin for error this leaves and why I spend so much time emphasizing clarity of information.

Make sure your BOM is complete, clear and up to date. Include fab drawings for anything not 100% clear. Then include intelligent CAD files if at all possible and document anything that is ambiguous, even if it seems obvious to you. With that, send off your files, have a coffee, and get ready to bring up your amazing design.

www.screamingcircuits.com

"Between the thoughts in my head and the finished PCBA are a website, a dozen people, software systems, pick-and-place (PNP) robots, and inspection tools"

Taking a look at CAPSTONE's mono-propellent propulsion system


Jacob Beningo, Beningo Embedded Group

One of CAPSTONE's purposes was to test new and unproven technologies

At 7:39 p.m. EST on 13 November 2022, a microwave-sized CubeSat named CAPSTONE completed its sixth engine burn to place itself into a near-rectilinear halo orbit (NRHO) around the Moon. Launched as the first in the Artemis missions on 28 June 2022, the spacecraft spent more than four months journeying to the Moon. The trip was not without perils. Shortly after launch, CAPSTONE stopped responding to mission control due to an ill-formed communication packet. Later, during the third engine burn, a valve in the propulsion system became leaky, causing the spacecraft to lose attitude control and spin up into a tumble. A month of collecting telemetry, troubleshooting, and benchtop simulations resulted in the successful recovery of the spacecraft.

While there are many exciting technologies aboard CAPSTONE, I'm particularly fond of the Stellar Exploration propulsion system. Over the past two years, I've worked as a consultant with the Stellar Exploration team to help them design, implement, and test their propulsion controller's flight software.

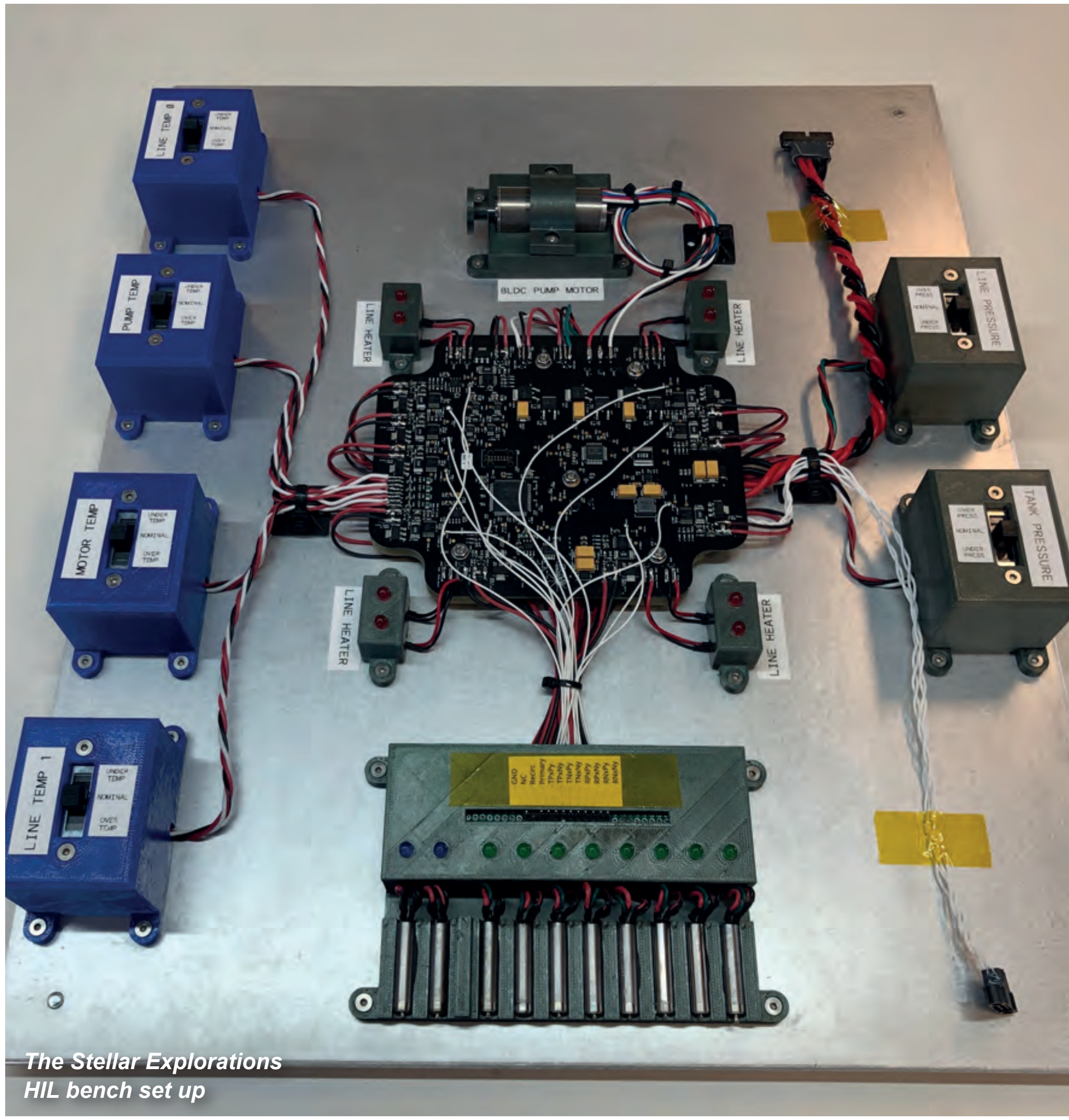
The Stellar Exploration propulsion system is an innovative and unique solution in spacecraft propulsion design. Typically, the pumps, valves, and heaters are directly controlled by the flight computer. Stellar Exploration decoupled propulsion control by separating the electronics and flight software for the propulsion system into its own subsystem. As a result, the flight computer could send guidance and control information to the controller, which then managed the pumps, valves, and thermal controls independently. Separating the two facilitates the ability to inexpensively embed intelligence into the propulsion system while freeing up the flight computer.

Flight software (FSW) development for the propulsion system was also innovative and modern. The FSW leveraged a task-based architecture like microservices. This architecture allowed the software to be built and tested off-target in isolation without the electronics. When the hardware did become available, a hardware-in-loop (HIL) bench setup was used to simulate and test all aspects of the system. This setup allowed aberrant conditions to be simulated and to verify that the flight software behaved as expected.

In addition to rigorous testing, the FSW was developed using modern embedded software processes such as test-driven development, thorough code reviews, and static analysis. Any function that reached a McCabe Cyclomatic Complexity greater than ten was refactored into simpler code because simple software is less likely to have defects. In addition, modules and interfaces were carefully designed with specific contracts, allowing them to be unit tested and integrated successfully.

CAPSTONE's journey to the moon wasn't without its hiccups, but one of its purposes was to test new and unproven technologies. These technologies have now been tested and lessons have been learned that will improve and enhance their future capabilities. As a result, CAPSTONE now orbits the moon with at least a six-month mission ahead. During this time, CAPSTONE will explore the stability of its quasi-stable orbit and provide positioning around the lunar environment that will be used to keep Gateway (a planned Moon-orbiting outpost that is part of NASA's Artemis program) and other future spacecraft in orbit around the moon. Stellar Exploration's propulsion system helped get the spacecraft there and will help CAPSTONE maintain its NRHO orbit around the moon for the foreseeable future.

www.stellar-exploration.com
www.beningo.com



The Stellar Explorations HIL bench set up

Sustainable power solutions for high-power industrial applications

The latest high-performance programmable power sources and loads are enabling greener solutions

Semiconductor wafer fabrication and electrochemical electrolysis processes have always been big electrical energy consumers. Ironically, testing "green" energy components like electric vehicle battery arrays and solar panel inverters also consumes lots of energy. Fortunately, advanced programmable power sources and electronic loads are now available for industrial-scale applications. These systems dramatically reduce the total energy expended while providing highly stable and reliable power.

High power density

Industrial rack-mount, bi-directional programable power supplies are utilized in numerous manufacturing processes. Typically offering a wide input voltage range, these systems can be programmed to deliver currents to simulate sources like solar energy arrays and battery charging systems, and to perform fuel cell systems testing, battery pack testing and battery recycling. They can also be used to power furnaces for semiconductor wafer fabrication and electrochemical electrolysis processes.

Advances in high electron mobility transistor (HEMT) technology have enabled dramatic improvements in the power efficiency and power density of these systems. For example, the EA-PUB 10000 6U utilizes GaN technology to deliver 60KW of power output in a single 6U package.

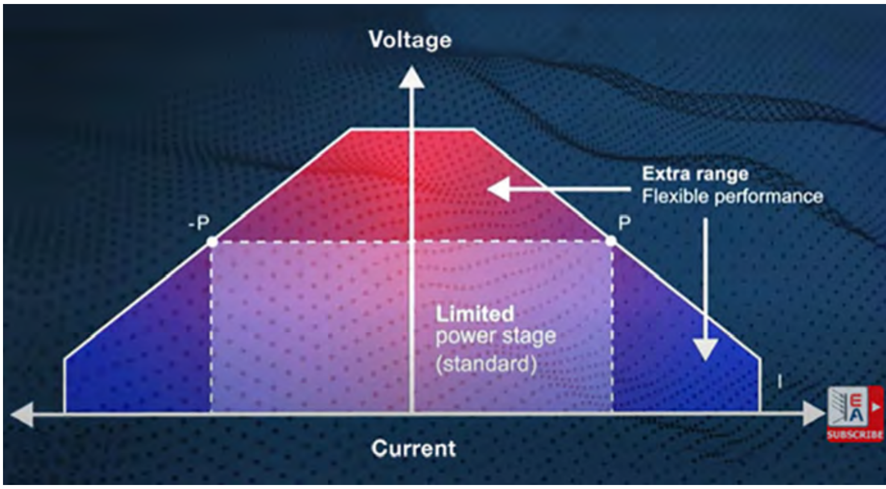
Bidirectional regenerative systems

Bi-directional programable power systems provide both source and load capabilities and return up to 96% of the power consumed back to the local power grid. In a sense, they "borrow" the power to perform the tests and then return most of the power to the utility.

In many applications, a programmable power system delivers the prescribed voltage/current profile to the system under test and the power utilized is then burned off utilizing load banks.

Regenerative electronic loads (ELRs) dramatically reduce the wasted energy and other problems that load banks create by redirecting the load power back to the utility using an inverter stage, synchronized to the power line input.

This ELR approach also has a significant effect on a unit's size, cooling requirements, and audible noise. In applications where the power is "borrowed" to conduct testing, a 300KW rack system uses only around 20KW of total power for the entire process. In addition to dramatic reductions in direct energy costs, the use of regenerative load technology can also reduce supporting energy costs for things like air conditioning.



True auto-ranging increases the utility of a programmable power system

True auto-ranging

The maximum power specification for many programmable power supplies applies only at the maximum output voltage. If lower voltages are required, the output current is unable to increase, thus lowering the deliverable power. Similarly, such systems are unable to increase voltage above their specified maximum value.

This problem is solved with auto-ranging, a feature of advanced programmable power sources that enables the maximum power to be delivered over a wide range of output voltage and/or current conditions. True auto-ranging expands the range of voltage/current options over an exceptionally wide scale.

Source and load characterization

In addition to providing a sustainable, green solution, programmable power systems must be capable of simulating the characteristics of various devices such as solar cells, batteries, charging systems, and fuel cells, to name a few. While many of these functions can be programmed and uploaded to the system, some offer optional built-in function generators to create complex signals.

For example, the advanced industrial systems described here provide special functions, such as maximum power point tracking (MPPT) and EN 50530 solar panel inverter testing. By means of optional EA Power Control software, users can simplify the task of simulating various devices and creating sequences of outputs (or inputs) to comply with key test standards, such as the LV123, LV124-, and LV148-standard-based test sequences for the testing of automotive components and systems, thus eliminating the need for external waveform generation instrumentation.

Conclusion

It seems counter-productive to waste substantial amounts of energy to fabricate and test products that are designed to save energy. To address this problem, advanced power conversion HEMT technologies are now enabling higher-efficiency, higher-power-density power supplies. In addition, innovative techniques—including regenerative programmable electronic loads and true auto-ranging supplies and loads—are moving the technology in the direction of sustainability.

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