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Reducing energy waste in battery charging applications


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EDITORS WORD

Feel the power!

I'm fortunate that I don't have many regrets in my life. If there's one thing I do lament, it's the fact that, when I wore a younger man's clothes, my attention was principally focused on low-power digital electronics. As a result, there were many topics to which I didn't give the in-depth consideration they deserved. I now wish I had paid more attention to my lecturers when they were waffling on about motors and generators, analog electronics, and the generation, storage, and transportation of power.

Battery technology, for example, has made tremendous strides since the days of my youth. On 3 April 1973, when Martin Cooper made the world's first mobile telephone call using handheld equipment, his prototype phone measured around 9" x 5" x 2" and weighed in at 4.4lb (about the size and weight of a house brick). The battery took 10 hours to charge, after which it provided a talk time of just 30 minutes. Compare this to the smartphones of today.

At the other end of the scale, I was recently introduced to the concept of grid-scale, high-voltage, (1,500V) rechargeable batteries presented in form factors comparable to shipping containers 8 feet wide, 9 feet tall, and 45 feet long. Balancing a multi-cell battery pack of this size and capacity requires some very special electronics indeed.

What does our power future hold? That's a tricky one. As Mark Twain famously noted: "Prediction is difficult—particularly when it involves the future." One thing we can safely predict, however, is that whatever the future does hold, we will be covering it here at DENA.

Max Maxfield

CLIVE 'MAX' MAXFIELD
Editor, DENA

DENA
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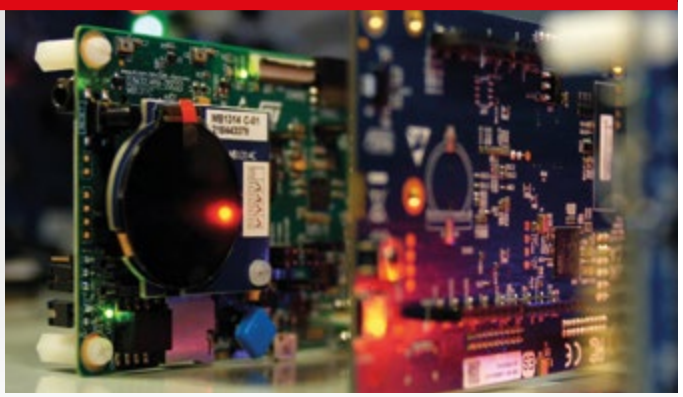
TOP STORY

STMicro unveils world's first MCU edge-AI developer cloud

STMicroelectronics is continuing to expand its solutions for embedded AI developers and data scientists with a new, industry-first set of tools and services to get edge AI technology on the market faster and with less complexity by aiding hardware and software decision-making.



The STM32Cube.AI Developer Cloud is a free-of-charge online platform and services allowing the creation, optimization, benchmarking, and generation of AI for the STM32 microcontrollers. It is based on the STM32Cube.AI core technology.

It includes (a) an online interface to generate optimized C-code for STM32 microcontrollers, without requiring prior software installation, (b) access to the STM32 model zoo, a repository of trainable deep-learning models and demos to speed application development (hosted on GitHub, these enable the automatic generation of "getting started" packages optimized for STM32), and (c) access to the world's first online benchmarking service for edge-AI Neural Networks on STM32 boards. The cloud-accessible board farm features a broad range of STM32 boards, refreshed regularly, allowing data scientists and developers to remotely measure the actual performance of the optimized models.

www.st.com

New anodized-look custom paint for METCASE enclosures

METCASE (a division of OKW Enclosures) has announced that its aluminum electronic enclosures are now available with an elegant new anodized-style powder coating that provides a cost-effective alternative to the traditional electrochemical anodized finish.

This smart new custom paint finish gives the enclosure front/rear panels an anodized look at a price that is viable for low-volume custom orders (where the panels are to be punched and printed to customer specifications as well). The new powder coating dries in a deep matt finish giving the panels a luxurious satin feel. It is resistant to weathering and chemicals, and there are no toxic ingredients.

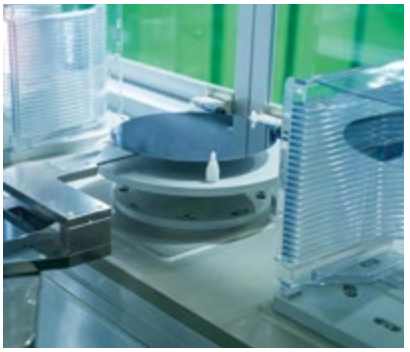
This anodized-look powder coating is the latest new paint finish to be added to METCASE's now 42-strong range of 'always in stock' custom colors. Recently, METCASE added eight new colors: violet blue (RAL 5000), cobalt blue (RAL 5013), pigeon blue (RAL 5014), yellow (Pantone 1235C), medium dark orange (Pantone 159C), salmon orange (Pantone 2027C), teal (Pantone 2238C) and anthracite (Pantone 432C).

Other customization services offered by METCASE include bespoke sizes, CNC machining, and photo-quality digital printing of legends, logos, and graphics.

www.metcaseusa.com

AI enables legacy fabs to upgrade to smart fabs

Industry 4.0 and its intelligent use of data is revolutionizing the way many companies manufacture their products more efficiently. Until now, however, chip fabs—which are the most complex manufacturing environments in the world—have been slow to adopt artificial intelligence (AI) software that has the power to make them smarter by automating decisions and optimizing production.



Flexciton offers an intelligent advantage platform to enable streamlined wafer fabrication. Flexciton's core product is the first autonomous scheduling software for wafer fabs that generates optimized production schedules in minutes to deliver specific objectives defined by the users.

Flexciton's AI software already knows how to operate a fab, so it does not need the time-consuming, rule-writing phase for a new fab installation or the replacement of existing scheduling software. It has the intelligence and pre-programmed knowledge to look at the data from all the tools and work out how to run them effectively and efficiently, all in real-time.

www.flexciton.com

New eBook explores the future of automotive design

The automotive industry is currently experiencing a broad range of technological innovations. As automotive manufacturers invest in electric vehicle design, the way in which we power our vehicles is changing. At the same time, new technologies and components are enabling the design of the connected vehicle. These advanced automobiles contain more safety features than their predecessors, while also supporting a variety of new entertainment and information possibilities for those traveling as passengers.

Mouser Electronics, in collaboration with Qorvo, has announces a new eBook that provides a detailed collection of articles exploring the products and solutions underpinning the innovations that are reshaping automotive design. In *The Future of Automotive* (https://bit.ly/3IssTIy), subject matter experts from Qorvo and Mouser offer rich, practical analyses of technologies including vehicle-to-everything (V2X) architectures, ultra-wideband (UWB) communications, and on-board chargers (OBC) for electric vehicles.

www.mouser.com

KYOCERA AVX introduces automotive-qualified supercapacitors

The company's first automotive-qualified supercapacitors, which are also known as cylindrical, electrochemical, double-layer capacitors, have been announced by KYOCERA AVX.

These five new automotive-qualified SCC Series supercapacitors are tested and qualified to the stringent AEC-Q200 standard, which proves their ability to reliably withstand test conditions designed to replicate challenging mechanical and electrical conditions common in automotive applications.

SCC Series supercapacitors have a ruggedly constructed form factor, deliver high-reliability performance, and exhibit very high capacitance, very low ESR, and excellent pulse power handling characteristics. They can be used alone, or in conjunction with primary or secondary batteries, to extend backup times and battery life and leverage instantaneous pulse power. Ideal applications for the five new automotive-qualified supercapacitors include electronic mechanical latching, emergency calling, electronic recording, regenerative braking, power, and backup power systems.

The five new automotive-qualified SCC Series supercapacitors are rated for 25F and 2.7V, 100F and 2.7V, 10F and 3V, 35F and 3V, and 100F and 3V. They also comply with UL 810A, RoHS, and REACH requirements.

www.kyocera-avx.com

18.5-inch TFT displays for demanding industrial applications

Display solutions and embedded systems provider Review Display Systems (RDS) has announced the introduction of a new 18.5-inch TFT display module from industrial display manufacturer Tianma. The P-series P1850FHF1MB01 features Full HD resolution (1920 x 1080 pixels), a wide 16:9 aspect ratio, and in-plane switching (IPS) technology, which provides excellent optical performance.

These display modules have been designed and developed to deliver high levels of optical performance and meet the demanding needs of industrial, medical, and in-vehicle display markets and applications where reliable and consistent operation is considered essential.

The 18.5-inch display features Tianma's proprietary SFT (Super Fine TFT) wide viewing technology, which enables viewing angles of 88 degrees in all viewing directions (left, right and up, down). A contrast ratio of 1000:1 and a white LED backlight, with an integrated driver and 50K hour half-brightness lifetime, provide a specified brightness rating of 400cd/m^2 and ensure that the 18.5-inch P-series TFT module produces display images that are colorful, bright, and highly consistent.

www.review-displays.com

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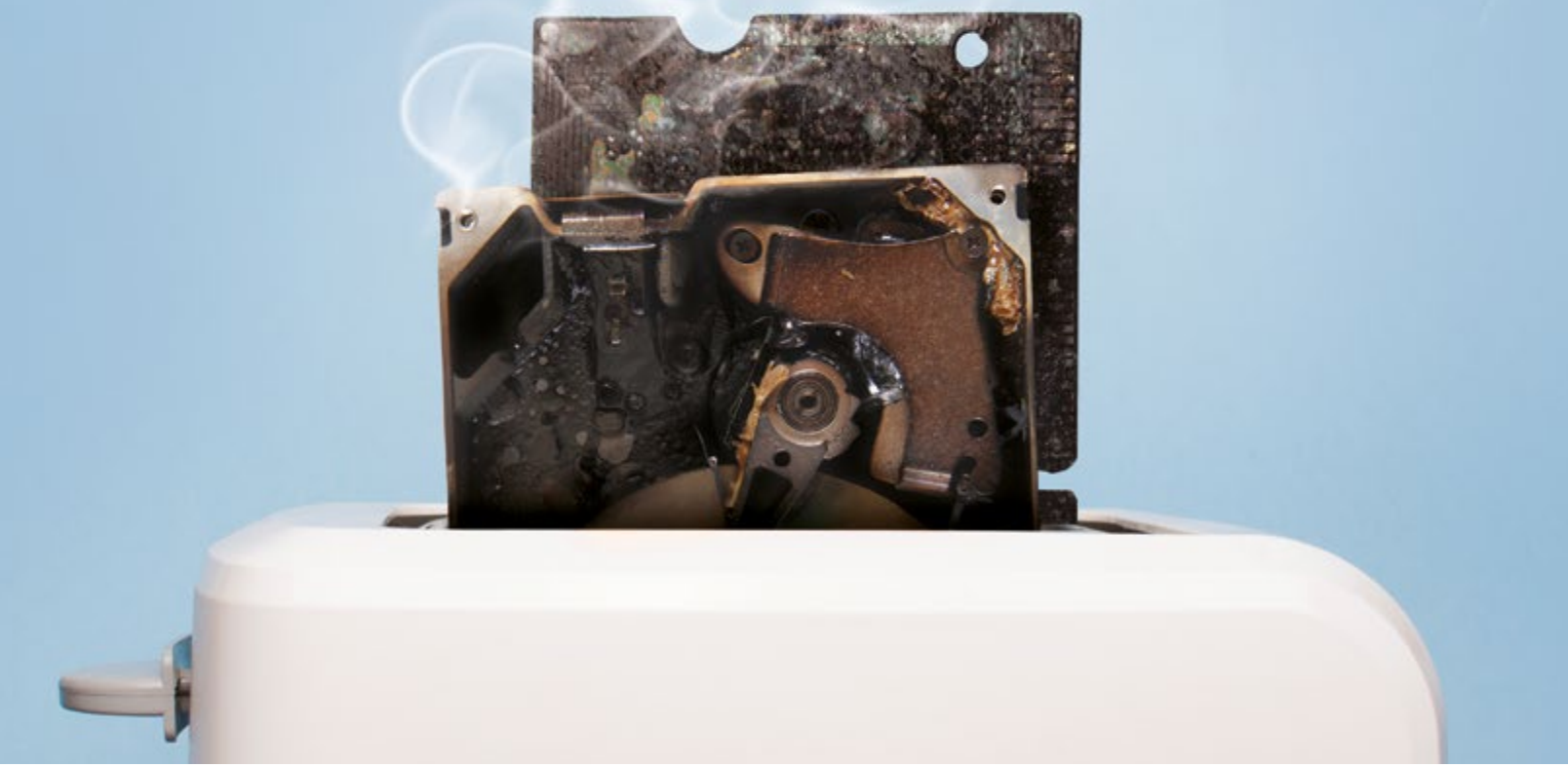

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Made in America PCAP touchscreen solutions

California-based SCHURTER Inc now offering in-house production of PCAP touchscreens

The manufacturing of things like displays has largely moved offshore over the years, so it's great to be able to tell a different story. For example, SCHURTER Inc has announced the opening of a new, high-end production room in its Santa Rosa, California location. For the first time in 40 years, SCHURTER Inc will be known to its American customers as a manufacturer of projected-capacitive (PCAP) touchscreens in addition to its well-established reputation for distributing electronic components.

The Swiss based global electronic component supplier looks forward to providing its North American customers with locally manufactured, complete PCAP touch solutions from its newly constructed PCAP production suite. In addition to state-of-the-art machines, a well-trained staff will oversee the manufacturing of small to large touchscreens and will be fully equipped to handle the most complex PCAP projects, from prototype to pre-test to finished product.

Why PCAP?

SCHURTER Inc has enjoyed longstanding success in the design, development, and manufacturing of membrane, resistive, and capacitive input system solutions. Originating in SCHURTER Inc Germany, touchscreen production and sales in Europe evolved to other locations in the region and—more recently—production was implemented in China. Based on these successes, the company decided to expand into the North American market.

Conventional user interfaces are increasingly being replaced by advanced display technologies. Touchscreens are rapidly becoming the preferred technology for interfaces in industries such as medical and industrial automation.

PCAP multi-touch functionality is preferred over other types of touchscreens such as resistive or surface capacitive because it offers superior touch sensitivity, accuracy, and durability. PCAP touchscreens can detect multiple touch points simultaneously and respond quickly to gestures such as swiping, pinching, and zooming. They also have a longer lifespan and are less prone to wear and tear, making them ideal for demanding environments.

In the White Room

To ensure consistency in the quality of finished PCAP touchscreens, compliance with highly exacting processes for assembling the display materials is key. SCHURTER Inc's PCAP production operates in a standard, dust-free "white room." Since a dust-free environment is critical at every stage of the production process to prevent contamination of any of the materials used in the process, the production area contains a special tent with an ISO-7 rating that covers and protects the laminator machine from dust particles.

Lamination and autoclave

A special laminator machine is used to assemble the customer-facing part of the display, so aesthetics are critical at this stage. The laminator comes with unique cameras to optimize accuracy in alignment and

Stephanie Elliott, Marketing Communications Coordinator, SCHURTER Inc

guarantee that there are no stray dust particles that may have been overlooked.

The next major step is the autoclaving of the laminated display. The heat, combined with the compression system, further solidifies the bonding process to eliminate residual air gaps.

Human + cobot = team

Collaborative robots (cobots) have many functions and are used not only for assembling, loading, and fixing, but also for laminating, potting, and quality inspection. A cobot assists in the assembly to peg the parts together in perfect alignment. With its six or seven axes and intuitive programming, new tasks can be learned quickly, which benefits fast-moving and constantly evolving production conditions.

The integration of cobots into the assembly process leads to an increase in quality, lower tolerances in the positioning of components, constant

parameters in processing due to defined press-in forces, and controlled volumes in potting. Extremely short changeover times to produce different customer-specific products are a significant advantage.

Applications and customer successes

PCAP touchscreens for use in ATEX (equipment for potentially explosive atmospheres) environments, outdoor applications, vending and point-of-sales machines, food processing systems, heavy-duty machinery, and medical devices, all fall in the realm of SCHURTER Inc competences.

As one example, a company known for developing medical devices for over fifty years partnered with SCHURTER Inc to develop the world's first device that can read and program the control unit that communicates with a medical device implanted in a patient in a completely wireless manner using SCHURTER Inc components with low electromagnetic radiation.

During the development process, SCHURTER Inc-specific knowledge played an important role in reducing the customer's production costs. SCHURTER Inc's support endures with continuous optimization of materials and production processes—a constant feature at SCHURTER Inc as customers iterate their next generation of products.

Another customer turned to SCHURTER Inc for quality and unique innovation in the early stages for a design renewal of their interoperative nerve monitor, where automated and intuitive technologies ensure the highest level of user-friendliness and maximum efficiency in a future-oriented everyday operating environment. Based on the customer's requirement for an innovation that enables fast and intuitive operation of the device in the operating environment, SCHURTER Inc developed a qualification plan adapted to the specifications. Samples were produced for qualification tests, and the prototype was further developed iteratively until it was set for series production.

Other industry areas of expertise are water-resistant PCAP touchscreens designed to safely withstand liquids that can otherwise cause malfunctions, such as outdoor applications, marine equipment, food automation equipment, medical devices, and sanitary applications.

Working with our team

In close cooperation with our customers, SCHURTER Inc designs and develops optimum solutions that are tuned and programmed to their needs. If you choose to work with SCHURTER Inc, your PCAP touch solution will be a perfect fit in your application. From the outset, you will be assigned a dedicated engineer to work with you to customize your design. Our engineers consider the long-term benefits of every single component selected for your device to anticipate and eliminate product shortcomings, avoid integration roadblocks, and prevent failures down the road.

SCHURTER Inc's competence and expertise make us the ideal partner for your new human-machine interface (HMI) project. The earlier we are involved in your project, the more value we can add, and the more likely we can help you to avoid problems down the line.

www.schurter.com

Avoiding performance-killing NPU design pitfalls

Steve Roddy, Chief Marketing Officer, Quadric

Quadric's general-purpose neural processing unit (GPNPU) future-proofs ML designs

Nearly every new system-on-chip (SoC) design start is incorporating machine learning (ML) inference capabilities. The applications are widespread—smartphones, tablets, security cameras, automotive, wireless systems, and more. Silicon design teams are scrambling to add ML processing capabilities to the central processing units (CPUs), digital signal processors (DSPs), and graphic processing units (GPUs) that they're already deploying. However, they've hit a wall with current processors and are now looking at neural processing units (NPUs).

Why is this so challenging? ML workloads are very different from the workloads that run on existing processors. CPUs are good at running many simultaneous threads of random control code with random memory accesses. DSPs are designed for performing vector mathematics on 1D and 2D arrays of data. GPUs are designed to draw polygons in graphics applications. However, ML inference workloads do not neatly fit into these older architectures. This is because ML inference workloads are dominated by matrix computations (convolutions) on N-dimensional tensor data.

What is an NPU?

Typically, design teams and IP vendors have tried to solve this problem by force-fitting the new workloads onto the old platforms. By analyzing existing ML benchmarks to identify the most frequently occurring major computation operators in ML workloads, they have built offload engines (accelerators) that efficiently execute those select compute building blocks. These offload engines are often called NPUs but, unlike CPUs, they are not software programmable. Instead, they are essentially large arrays of hard-wired, fixed-point multiply-accumulate (MAC) blocks running in parallel.

The idea behind these accelerators is that, if the 10 or 20 most common ML graph operators represent 95% to 98% of the computational workload, then offloading these common operators allows the fully programmable CPU or DSP to execute the rest of the graphs, including any rare or unusual operators in the ML graph. This division of labor is often called "Operator Fallback" because the vast majority of computation runs on the non-programmable NPU, while the program "falls back" to the fully programmable CPU or DSP as required.

The Biggest Pitfall

The biggest pitfall—actually, the fatal flaw—of this approach is the huge assumption made that Operator Fallback is rare and not all that important. However, this discounts the upfront engineering effort required to manually partition these tasks. Additionally, it discounts the performance hit involved. By taking a closer look at this approach, it becomes obvious that Operator Fallback actually needs to be avoided at all costs.

Consider the example of an SoC with a large, general-purpose CPU, a vector DSP engine for vision processing, and a 4TOP/s ML accelerator (where TOPS means tera, or trillion, operations per second). The compute resources available in each engine are shown in the table.

A matrix operation running on the accelerator is screaming fast, taking advantage of all 2048 multiply-accumulate units in the NPU accelerator. However, similar operators running on the DSP are 32X slower. On the CPU, with only 16 MACs, these operators are 128X slower.

A Huge Performance Bottleneck

Even if only 5% of the total computation of a ML workload needs to fall back onto the CPU, that small 5% becomes a huge performance bottleneck for the entire inference execution. If 98% of the computation blazes fast on the accelerator and the complex SoftMax final layer of the graph executes 100x or 1000X slower on the CPU, the entire inference time is dominated by the slow CPU performance.

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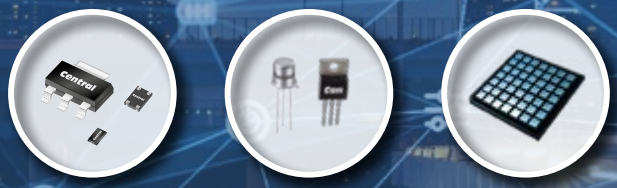

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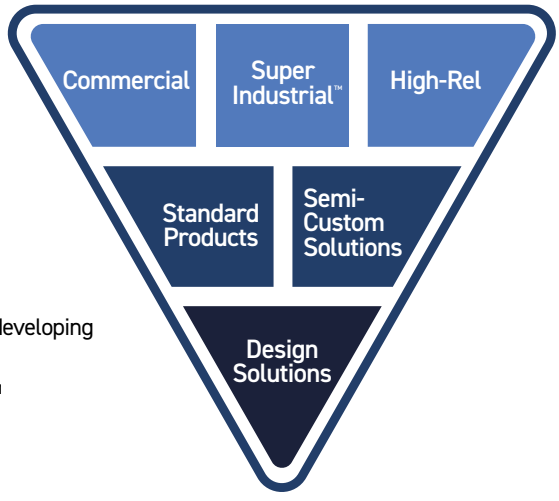

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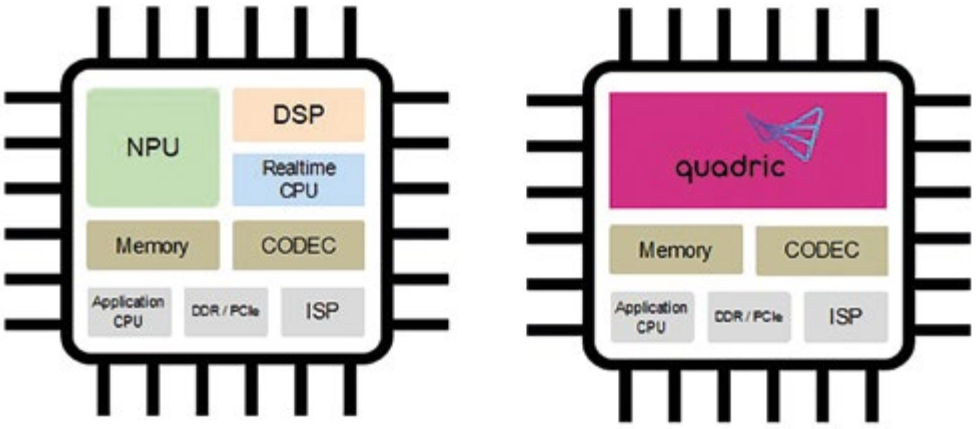
Fallback only gets worse over time because machine learning is rapidly evolving. While the silicon being designed today will enter volume production in 2025 or 2026, today's reference models will be replaced by newer, more complex, and more accurate ML models. Those new models, in three years' time, will likely feature new operator variants or new network topologies, necessitating even more fallback onto the slow CPU or DSP. Total performance will degrade even more, making the chip design underperform or maybe even inappropriate for the task.

But that's better than going without an NPU, right? Well, yes, but there is a different approach that needs to be considered. This approach eliminates the aforementioned pitfalls by making the NPU accelerator just as programmable as the CPU or DSP. Furthermore, it must be programmable in C++, so engineers can easily add operators as ML tasks evolve.

Making a NPU Programmable

Designing a programmable NPU is not for the faint of heart. It's incredibly more complex than just designing a hardware accelerator for the most common operators. It must be able to execute diverse workloads with great flexibility—all on a single machine. Ideally, it makes having a CPU and/or DSP unnecessary, as it can execute those code streams efficiently.

Quadric's Chimera general-purpose neural processing unit (GPNPU) enables hardware developers to instantiate a single core that can handle an entire ML workload, along with the typical DSP pre-processing and post-processing, signal-conditioning workloads that are often intermixed with ML inference functions. Dealing with a single core dramatically simplifies hardware integration and eases performance optimization. Furthermore, system design tasks such as profiling memory usage to ensure sufficient off-chip bandwidth are greatly simplified.



A comparison of the traditional approach (left) and the Quadric GPNPU approach

Simplified Software Development

The Chimera GPNPU also significantly simplifies software development since matrix, vector, and control code can all be handled in a single code stream. ML graph code from common training toolsets (TensorFlow, PyTorch, ONNX) is compiled by the Quadric toolset and merged with signal processing code written in C++, all compiled into a single code stream running on a single processor core. The Chimera SDK enables the mixing and matching of any data parallel algorithm, irrespective of whether it is expressed as a machine learning graph or as traditional C++ code.

The Chimera GPNPU, which is available in 1 TOPS, 4 TOPS, and 16 TOPS variants, is fully C++ programmable by the software developer. New ML operators can be quickly written and run just as fast as the "native" operators written by Quadric engineers. The result is no Fallback, only fast execution! This future-proofs ML designs, no matter what new forms of operators or graphs the future brings.

www.quadric.io

Engine Type	Number of Available MACs	Performance on Matrix-oriented ML Operators
ML Offload Accelerator – 4 TOPs	2048	Excellent
Wide Vector DSP – 512-bit	64	Poor
Application Class CPU with 128-bit vector extensions	16	Abysmal

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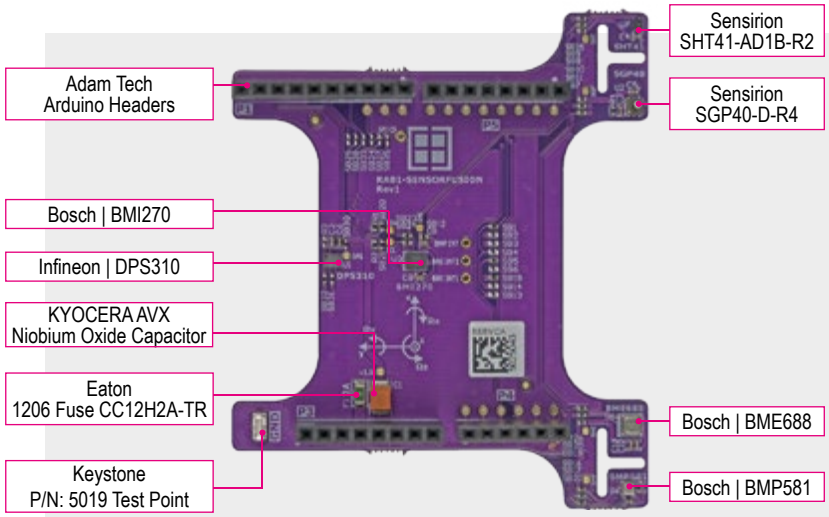

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Shedding Further Light on LED Terminology

Roger Neal, Commercial Manager CML Innovative Technologies

The last 10 years has seen an incredible shift in lighting technology as LEDs continue to dominate the market and penetrate new applications and industries.

This has bought a range of challenges, one of which is how to choose the correct supplier and product for your company's lighting needs.

The first step, inevitably, involves unpicking the myriad of terms which LED product suppliers use to describe their products.

Product design engineers and professionals involved in the procurement or who specify lighting products will have observed the transition from the use of the Watt (a measure of electrical power) to the Lumen (a measure of emitted light). However, there is a further range of concepts and terms that are also essential to understanding products that emit light. What follows is a brief explanation of two of the most useful.

LED Life & Lumen Maintenance

Historically, the longevity of traditional light sources was classified using 'average life'. In incandescent filament lamps this was the average time for 50% of the lamps under test to catastrophically fail under laboratory conditions.

It is important to note that this means that some of the lamps would have failed before the quoted figure for their average life.

LEDs tend not to fail catastrophically. Instead, LED light output degrades gradually over time. In many applications therefore, it is essential to understand what happens to the light output of a product over time.

This leads to the concept of lumen maintenance which, for an LED, is the elapsed operating time over which an LED light source maintains a given percentage of its initial life output. Lumen maintenance can vary based upon many factors including operating temperature and drive current. It can also vary between manufacturers due to the selection of different materials and packaging methods. This makes it increasingly difficult for engineering and design professionals to compare and select products, however, the need for a standardisation of how such information is presented has long been recognised by the lighting industry. The Illumination Engineering Society of North America (IESNA) has published guidelines regarding the testing of LED components and LED lighting products.

IESNA LM-79-19 details the approved methods for taking electrical and photometric measurement of solid-state lighting products.

IESNA LM-80-08 details the approved methods for measuring lumen maintenance of LED packages, arrays and modules. As it is not reasonable to expect LED and lighting manufacturers to test products for years prior to release, IESNA also published TM-21-11. This document provides guidance on projecting long term lumen maintenance based upon initial test results.

In combination, these 3 documents have led to many leading LED manufacturers providing "L" values for their product. For example, an LED module with a rating of L70 = 25,000 hours indicates that the luminous flux of the module will be 70% of the initial value after 25,000 hours.

Whilst such data may not be available for legacy products, many LED users - such as CML Innovative Technologies - now insist upon receiving the aforementioned data for lighting products to be considered in new designs.

www.cml-it.com

Magnificent MEMs

It's hard to believe a 9-axis sensor can fit in such a small package

Are you as amazed as your humble narrator by the ongoing development of micro-electromechanical systems (MEMS) sensors and actuators?

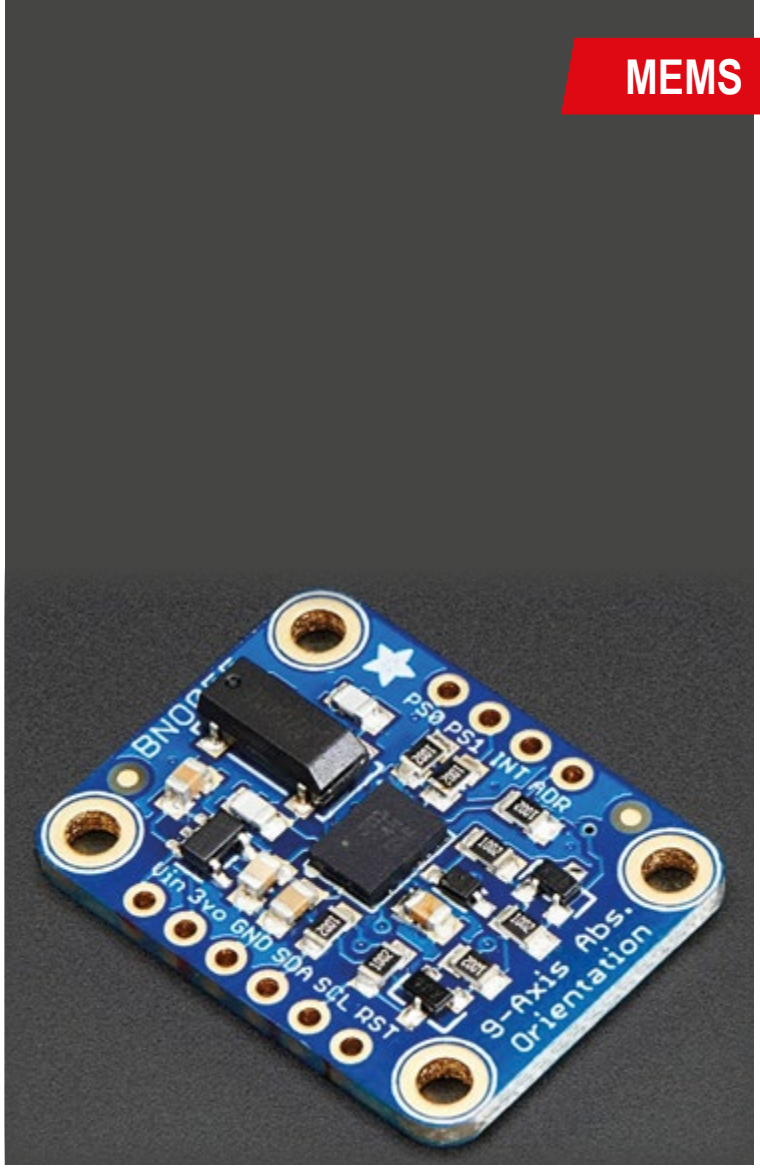
Recently, I built a 12 x 12 array of ping pong balls, each illuminated with a tri-colored light-emitting diode (LED). Why? It seemed like a good idea at the time. When I was a kid, my parents gave me a toy involving a maze in a wooden box. By means of knobs mounted on the sides of the box, you could tilt the maze to guide a marble without it falling through one of many inconsiderately places holes.

I decided to replicate this concept with my ping pong ball array. For this, I needed an appropriate sensor. I opted for a BNO055 MEMS sensor from Bosch, which was conveniently presented on a small breakout board (BOB) from Adafruit (product #2472).

The BNO055 boasts a 3-axis accelerometer, a 3-axis gyroscope, and a 3-axis magnetometer, all in one teeny-tiny package. It also contains a 32-bit Arm Cortex-M0+ processor that performs sensor fusion for you.

It's not so long ago that a regular electromechanical version of a 3-axis gyroscope for military use would have been the size of a small barrel and cost hundreds of thousands of dollars. It boggles the mind that you can now get a MEMs version of this sensor, along with its accelerometer and magnetometer counterparts, all presented in one tiny package for just a couple of dollars. We truly do live in interesting times.

www.designing-electronics.com



BNO055-based 9-axis breakout board from Adafruit

More than just a temperature sensor

In addition to measuring temperature, thermistors can be used for surge protection, flow detection, and more

Thermistors are widely used as the sensing element of a temperature sensor, and rightly so. They are easy to implement, they have a little variety when you are shopping for one (being available in varying levels of accuracy and form factors), and they have a number of other uses if one is so inclined.

For example, in addition to temperature measurement, they can be used for surge protection, liquid level or flow detection, time delay, and temperature compensation. Once thermistor technology is understood, these applications seem intuitive, but these devices are still somewhat obscure, even in the passive electronic components industry.

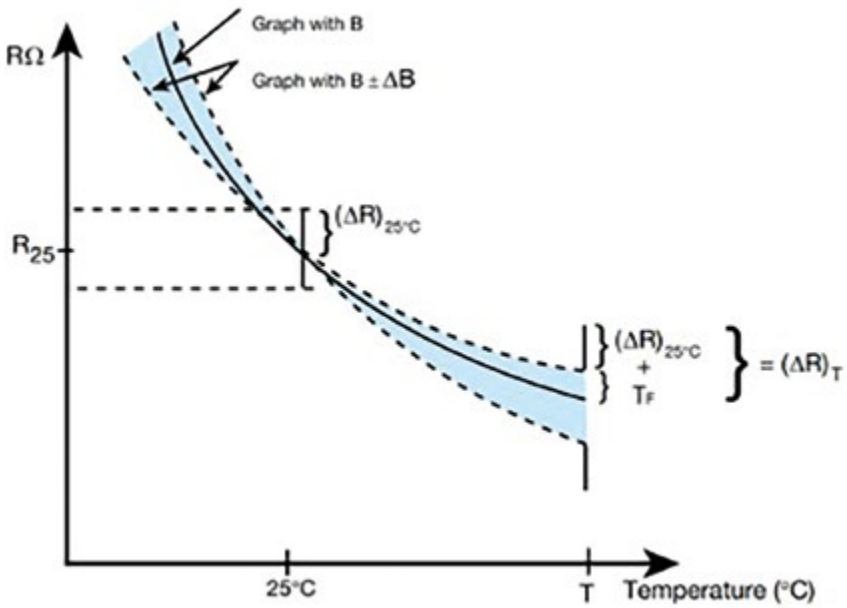
The name thermistor is simply a combination of the words “thermal” and “resistor.” This refers to a device that has a resistance value that varies with temperature. Commonly, the resistance has an inverse relationship with temperature, resulting in the negative temperature coefficient (NTC) appellation. Having said this, positive temperature coefficient (PTC) thermistors are also available.

Each thermistor will have a characteristic Resistance vs. Temperature curve based on an intrinsic property known as beta (β), which is—by far—the most critical parameter associated with the device. By applying a known current to a thermistor and observing the resultant voltage, we can determine the temperature using a look-up table based on the R vs. T curve (and Ohm’s law, of course). Other parameters like beta tolerance and the resistance value at 25°C are also important and may need to be finely tuned for an application, but typically at a premium.

When the accuracy of the resistance value is not paramount, we can start using thermistors for some additional applications by exploiting the fact that they respond quickly to temperature changes and that resistors heat up with increasing current. A thermistor subjected to a surge current will heat up and then cool off as the surge subsides. This means the thermistor will limit surge currents in the beginning because the thermistor is “cool” and will have relatively high resistance. It will then let more current pass as it heats up to a more usable value. Expanding on the high resistance to low resistance theme, thermistors can be used as a time delay or current limiter in charge control applications where IC solutions are not needed. The drawback of using thermistors as a circuit protection or charge control device is, of course, efficiency. In ambient conditions, the thermistor in these circuits will be drawing power constantly.

In the case of liquid level/flow measurement, the set up would be very similar to temperature measurement. What is good to note here is that lead-less form factors of these devices exist for unique size constraints, hybrid applications, or if a low-profile array is needed, perhaps in a power electronics stack. Typically, thermistors are packaged in radial leaded or SMT chip form factors, but there are options for niche projects. As wide band gap semiconductors continue to gain traction, accurate and speedy temperature measurement capability will be required, and thermistors will be there.

www.kyocera-avx.com



Characteristic Resistance vs. Temperature curve for a given NTC thermistor

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IoT

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How IoT devices are transforming the smart building industry

Smarter buildings make for better sustainability and the wellbeing of occupants.

The number of internet of things (IoT) connected devices worldwide is on a steady incline and hasn't shown any signs of slowing down. Statista reports that IoT devices worldwide are expected to triple in 10 years. The number is projected to grow from 9.7 billion in 2020 to over 29 billion in 2030.

IoT devices touch every industry. From agriculture and healthcare to sustainability, supply chain, and more, the IoT drives transformation, enabling each industry to become smarter, safer, and more efficient. This is especially relevant for smart buildings, an industry that hinges on the efficient use of limited resources like space and energy.

Let's look at how low power, long range IoT sensors are revolutionizing the smart building industry.

The IoT-enabled smart building

Homeowners, property managers, and facility managers can deploy low power, long range solutions to achieve a variety of benefits. IoT-based solutions allow building managers to track and automate everything from utilities to air quality, occupancy, and energy use. By offering greater visibility into processes, smart sensors contribute to increased safety and streamlined operations.

These are attractive qualities to current tenants and employees. Property managers and recruiters can also showcase smart building elements to prospective residents who may be used to automation and have expectations for smart working and living environments. Younger generations who are used to digitalization are beginning to take over the workforce and move out into the real world. It's crucial for building owners to make their buildings stand out among the rest.

Easy install, deep-reaching signal

IoT devices with built-in low power wide area networks (or LPWANs) are ideal for building environments since they can run on battery power and the signal can penetrate dense building materials.

Integrating a system based on low power, long range IoT devices is easy for facility managers: they are cost-effective and can be installed easily, minimizing disruption for tenants.

A long battery life has benefits beyond easy installation and maintenance. With ultra-low power consumption, they don't have to be plugged in all the time or need frequent battery replacements. This is great for minimizing time spent changing batteries. The long battery life is also critical for return on investment (ROI).

It's also important for building owners to consider that signals need to reach deep within buildings. This could be the basement or other hard-to-reach areas where many smart building operations may be located. Another benefit of smart solutions is the ability for them to be on a completely private network. This means there is no need for a contract with a network operator and no need to coordinate with corporate IT infrastructure. This adds to the fast and easy installation process that these sensors are known for.

Case Study: Smart sensors in action

Two organizations that have made great strides in the smart building industry are Intent Technologies, a leading service platform for smart properties, and Nexity Group, a French real estate services provider. The two are working together to integrate long range, low power devices into the Intent Platform.

Tom Mueller, Executive Vice President and General Manager, IoT System Products Group

The goal is to optimize performance, improve quality of service, and reduce the carbon footprint in residential and commercial properties. The groups have already seen a 10% savings in building operational costs. They also span over 1.2 million residential units and over 6 million square meters of offices. The platform works by giving building managers and real estate professionals a holistic view of the facility. This makes it easy to see operational shortcomings, helping improve operating performance.

Continue on page 20 >

The smart sensors exchange data with over 180 service suppliers and digital software vendors. All the data is then displayed on a dashboard. From there, the sensors can notify the property managers of any inefficiencies, all on a single Cloud platform.

Case Study: AI-driven HVAC

Nordic Propeye, an IoT solutions provider, is leveraging low power, long range solutions to optimize building management systems. Their goal is to help customers make their buildings sustainable and clean. Nordic Propeye integrates low power, long range sensors into their HVAC optimization solution to reduce energy consumption, using an AI-driven platform to make automatic adjustments.

The result is a solution that achieves 15-30% energy savings for the organization's European customers. The wireless sensors track in-building environmental conditions, including CO2 levels, temperature, humidity, and real-time room occupancy. Once a rapid change is detected, the solution sends a signal to the HVAC systems. The systems can then adjust for the shift or notify building operators if an irregularity in the system is detected.

The Nordic Propeye solution incorporates artificial intelligence to predict the temperatures or temperature changes in the HVAC zones. This predictive maintenance and operations feature keeps occupants safe and energy use efficient. It also lets building managers prevent equipment failures, saving time and money.

Case Study: Air quality monitoring

IQnexus, a building automation IoT solutions provider in New Zealand, integrated low power, long range smart sensors into its Indoor Air (IAQ) and Environment Quality (IEQ) solutions. Battery-powered and long-range, these smart sensor solutions are easily integrated into the existing platforms and structures.

Air quality is vital for creating a safe environment for occupants, while real-time monitoring is crucial to inform decision-making. As conditions change, occupants and building managers can make adjustments before measurements drop to an unsafe level.

IQnexus' solutions also keep building owners compliant with the WELL and RESET standards. These key standards encourage the prioritization of the health and safety of residents. Improved air quality enhances the quality of life for many, and contributes to making the world a smarter, better place.

Building a better tomorrow

Smarter buildings make for better sustainability and the wellbeing of occupants. Building owners and managers can achieve these goals through the combination of the IoT and smart sensor technologies. With greater insight into utilities, operations, air quality, and more, building owners can make informed decisions that benefit all.

The smart building landscape will continue to grow and transform, and low power, long range solutions offer a cost effective, easy to deploy solution that will grow with it. It will be exciting to see how smart sensors will continue to revolutionize the smart building industry.

www.semtech.com

Meet the magnetic position sensor of the future

The new MLX90376 from Melexis is an absolute magnetic position sensor IC, handling 360° rotary automotive applications with strong stray field immunity (SFI). Its dual-stacked die PCB-less version is unique to the market. The device supports system integration up to ASIL D level functional safety, offering state-of-the-art sensing for steering and valve applications. The blend of robustness and performance it offers will be of value for vehicle electrification.

Based on proprietary technology, the MLX90376 is especially designed for demanding steering wheel angle, throttle valve, and thermal management valve applications. In can be housed in either SMP-4 PCB-less or surface-mount device (SMD) packaging. The MLX90376 offers output options to suit various applications: Analog, PWM, SENT, or the specific SENT Short PWM Code (SPC).

www.melexis.com

Thermal computer vision for automotive apps

Owl Autonomous Imaging has announced the availability of an evaluation kit for its new Thermal Ranger ADAS and Autonomous Navigation Development Platform.

This hardware and software kit enables Tier 1 and OEM automotive companies to easily evaluate Owl AI's Thermal Ranger imaging solution for use in their Pedestrian Automatic Emergency Braking (PAEB) and other ADAS applications supporting L2, L2+, and L3/L4 requirements. Owl's monocular thermal camera solution enables 2D and 3D perception for object classification, 3D segmentation of objects, RGB-to-thermal fusion, and highly accurate distance measurements.

The world's only Monocular 3D Thermal Ranging Solution, the Thermal Ranger platform not only enables cars to see at night, but it also enables the vehicle to know how far away the living object is and what it is.

www.owlai.us

Chipmakers Raise R&D Expenditure as Competition Intensifies

Semiconductor companies are spending more on R&D to the delight of their design engineering crew as they jostle for technology market leadership

Technology companies have jacked up their budgets for research and development activities over the last several years as the competitive environment toughened and amidst further digitalization efforts by many segments of the economy. OEMs, semiconductor suppliers – both IDMs and fabless vendors – chip equipment manufacturers and other players in the global electronics market have in general raised R&D spendings by high single-digit to even higher double-digit levels since 2021 and industry observers believe this trend may continue for several more years.

All the Top OEMs and semiconductor manufacturers reviewed appear to be investing in both capital equipment and R&D for longer-term advantages. Capital expenditures have soared to ease supply shortages that cropped up in 2020 or to improve market share in response to expectations of further penetration into adjacent or new markets. While OEMs are looking to establish a beachhead in new markets, many chipmakers are responding to the swiftly changing needs of their customers and also beefing up new product development activities as competition intensified in the segment.

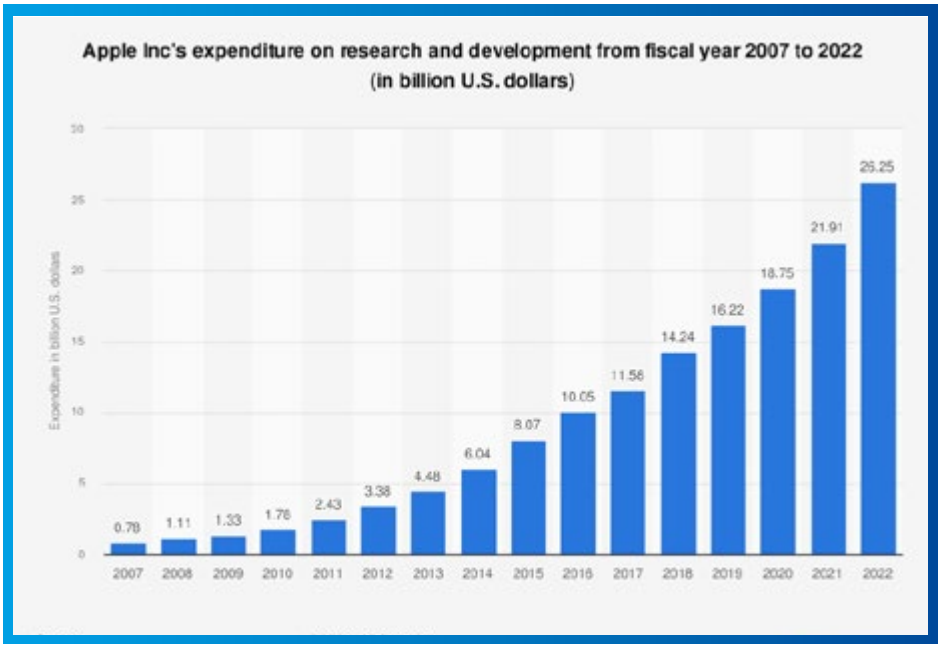
Apple Inc.'s latest financial results demonstrate the company's determination to keep leaping ahead of the competition. The company has increased R&D at a double-digit rate over the last several years. It spent a record $27.65 billion on R&D in the 12 months ended December, up 20 percent from the prior year. On a fiscal basis, the company spent $26.3 billion on R&D, in the year ended Sept. 29, up 19.8 percent, from $21.9 billion, in fiscal 2021.

Apple has increased its R&D expenses by more than $10 billion since the end of its fiscal 2019 period. The company is expected to further raise the expenses in fiscal 2023 as it ratchets up pressure on the competition in the smartphone segment and as it explores opportunities in other markets, including in the electric vehicle segment where it is believed to be developing a vehicle.

"At Apple, creativity and collaboration have always been at the core of who we are," said Timothy Cook, CEO of Apple, while discussing the company's latest annual report. "That spirit of ingenuity and teamwork helped us provide our customers with incredible innovations this year and led to another yearly revenue record. In fiscal 2022, Apple achieved revenue of $394 billion, representing 8% annual growth. We set records for iPhone, Mac, wearables, home and accessories and services while growing double-digits in emerging markets and setting records in the vast majority of markets we track."

Apple may be just getting started. The company has spent approximately $100 billion on R&D in the past 5 years but this pales beside what it has set aside for new products and innovation activities over the next decade. In 2021, Apple updated its 5-year investment plan and said it will spend $450 billion on many innovation programs. Areas of focus include "next-generation silicon development and 5G innovation" in the US and the construction of a new engineering hub in North Carolina, according to Cook.

"Apple is doubling down on our commitment to US innovation and manufacturing with a generational investment reaching communities across all 50 states," Cook said. "We're creating jobs in cutting-edge fields — from 5G to silicon engineering to artificial intelligence — investing in the next generation of innovative



new businesses, and in all our work, building toward a greener and more equitable future."

Spending more

Many other companies in the semiconductor segment are developing comparable long-term plans. Taiwan Semiconductor Manufacturing Co. Ltd., (TSMC), the world's biggest contract chipmaker, has said it will spend $100 billion over a 3-year period on the construction of new fabs at its Taiwan headquarters and in various parts of the globe. The company is opening new fabs in North America and Japan while exploring similar opportunities in the European Union.

TSMC's R&D budget is no less impressive. Starting in 2021 and through the end of 2022, it spent more than $13 billion on R&D and expects to increase the budget for 2023 by as much as 20 percent from the 2022 level of $5.5 billion, according to Wendell Huang, chief financial officer. The projected capex for 2023 will be lower, however, and is expected to be in the range of $32 billion to $36 billion, compared with $36.3 billion, in 2022. The company had initially said it would spend up to $44 billion on capex last year but trimmed this as the market swooned due to a slowdown in the larger economy.

"R&D expenses accounted for 7.2 percent of our net revenue in 2022," Huang said, at a presentation to financial analysts. "In 2023, as we increase our focus on technology development and add more resources, we expect R&D expenses to increase by about 20 percent year on year and account for 8 percent to 8.5 percent of our net revenue."

American chipmakers have been increasing R&D expenses for years, even raising budgets during periods of market downturns. The Semiconductor Industry Association, (SIA), said American chipmakers in 2021 spent $90.6 billion on R&D and capital equipment, helping to keep the industry's compound annual growth rate at 5.9 percent between 2001 and 2021.The industry has always maintained a healthy investment culture even during its cyclical downturns, noted the SIA.

"To remain competitive in the semiconductor industry, firms must continually invest a significant share of revenue in both R&D and new plants and equipment," the SIA said, in a report. The pace of technological change in the industry requires that companies develop more complex designs and process technologies, as well as introduce production machinery capable of manufacturing components with smaller feature sizes. The ability to design and produce state-of-the-art semiconductor components can only be maintained through a continual commitment to keeping pace with industry-wide investment rates of roughly 30 percent of sales."

There are compelling reasons for why chipmakers are keeping R&D as well as capex at record levels. Innovation changes are taking place at breakneck speed across the industry and in new markets. The infusion of semiconductors into new markets and economic segments is forcing chipmakers to find ways to upgrade existing products so they can have wider applications. These efforts require higher R&D spending and the addition of new engineering skills – both hardware and software – and expansion of existing facilities.

Qualcomm Inc. has traditionally been one of the semiconductor industry's biggest spenders on R&D. Its R&D budget flattened, however, at approximately $5 billion between 2016 and 2019 before climbing in 2019 to $6 billion and then rising in the next two years to $7.2 billion, and $8.2 billion, respectively. While rising each year in dollar amounts between 2019 and 2022, Qualcomm's R&D expenses have started trending lower as a percentage of sales. It fell in 2021 to 21 percent of sales, from 25 percent of sales, in 2020, and dropped again in 2022, to 19 percent. The company's revenues have almost doubled in the last four years, though, jumping to $44.2 billion, in the fiscal year ended Sept. 29, from $24.3 billion in fiscal 2019.

"The overall long-term growth opportunity for Qualcomm remains unchanged as demand for technology extends to virtually every device at the edge," said Cristiano Amon, president and CEO of Qualcomm, while presenting fiscal 2023 first quarter results in February. "Our track record of innovation provides a unique perspective and capability to be at the forefront of the digital transformation across new and diverse end markets."

Like its peers in the semiconductor industry, Qualcomm will have to maintain a strong R&D budget to keep its competitive edge. Companies like Micron, NXP, Nvidia, Samsung, and ST have all increased their R&D spending in recent years. Even Intel Corp., which has faced strong headwinds that clipped sales in 2022, raised rather than lower R&D expenses during the last several years. The company spent $17.5 billion (28 percent of sales) on R&D in 2022, versus $15.2 billion (19 percent of sales) in 2021. Intel's sales in 2022 dropped to $63 billion, down 20 percent, from $79 billion, in 2021.

Intel is spending more on R&D and capex as part of ongoing efforts to stabilize the company and catch up with market leaders in leading-edge process technology. The company lost grounds to Samsung and TSMC over the last years and has embarked upon a reorganization plan that includes the addition of new fabs and efforts to establish a strong foothold in the foundry market. For 2023, Intel declined to provide sales guidance beyond the first quarter but said it would keep operating expenses below $20 billion while investing in the key segments that would help propel future growth.

"We are very focused on the appropriate level of investment necessary for the long-term strategy of IDM 2.0 while being very thoughtful around how much capex we spend to manage our free cash flow," said David Zinsner, chief financial officer at Intel, while presenting December quarter results. "We take a very disciplined approach to the capital allocation strategy, and we're going to remain committed to being very prudent around how we allocate capital for the owners."

5 Technologies streamlining new product development and contract manufacturing in 2023

Take full advantage of the cloud, AI/ML, AR/VR, PLM integration, and registered designs.

In a climate of unconstrained innovation and impatience for development timelines, manufacturers constantly search for tools to improve mass production's quality, speed, and economics.

Two processes, new product development (NPD) and design for manufacturing (DFM), are well-positioned to leverage technology advancement for their outputs. These improvements transform how designers and engineers think about how they develop products and how the design can translate to an external manufacturer.

These enhancements are as follows:

- Cloud-based design and analysis
- Artificial intelligence (AI) and machine learning (ML)
- Virtual reality (VR) and augmented reality (AR)
- Expanded PLM integration
- Registered design tools

All five of these enhancements share common themes: they aid in collaboration between the design team or manufacturing functions to clarify the design intent and provide more accurate inputs to the next process step. This improved collaboration delivers significant innovation coupled with quality, cycle time, and cost improvements that business leaders seek.

Cloud-based design and analysis

Computer-aided design (CAD) is the preferred method of product design. First, a designer converts a concept into a digital 3D model that defines the dimensions and form of a product to inform the process team of what the product should be. Then, computer-aided engineering (CAE) simulates performance to optimize the design virtually before moving to the prototype phase.

There are three requirements associated with these computer-aided functions that limit their use and speed:

- [Often] expensive software package licenses.
- Availability of skilled designers to create and modify the models in the desired software.
- Computational capacity to solve CAE analyses consumes substantial bandwidth on the network or local machine.

Moving to cloud-based platforms addresses each of these limitations and adds additional measures like boosted security and software management. Furthermore, the cloud offers design collaboration support for CAD models and virtually unlimited solving capability for CAE. In addition to improving the model and analysis outputs, it frees up your internal team and network to focus on specialized tasks in parallel.

AI and ML

Converting a design from a prototype manufacturing process like casting, 3D printing, or CNC machining to a high-volume format is not trivial. Software engineers integrate AI into CAD to reduce design iterations and improve dimensional accuracy through suggested design changes.

In addition, AI can assess the CAD model for variances in the design, reducing the number of manual inspection cycles. It is also adept at handling repetitive tasks, such as removing tolerance gaps when prepping a CAD model for finite element CAE analysis.

VR and AR

These new realities are bringing product design to life through improved visualization. One of the most effective design strategies is for the design team to see physical parts firsthand to conceptualize how the product should look and develop additional features that improve the initial model.

VR and AR create this benefit and add visualization to develop virtual prototypes so that the designers and engineers experience the part in 3D—albeit virtually. In addition, this approach accelerates and optimizes design loops with the benefit of 3D. Finally, the team can easily share the file(s) with remote or supplier contacts to convey key design features.

Enhanced PLM integration

Product lifecycle management (PLM) manages a product

from concept to disposal at the end of life. As products increase in complexity through digitalization and integrated functions, collaboration between the functional teams is essential. Rather than one lead entity approving the entire complex product, integrated PLM empowers each team member to own their portion in concert with the rest of the team. This shift improves efficiency by letting teams play to their strengths and increases ownership of the product within the group.

PLM can also integrate with contract manufacturing partners, streamlining the design handoff and reducing iterations of design and process questions.

Registered designs

Like US design patents, EU and UK-registered designs protect a product's appearance. Therefore, this exercise is an intellectual property (IP) step covering how a product looks along with its design features. In addition to the CAD software mentioned above, several other tools can aid in the design registration process.

These systems include IP management software to follow the IP through the registration process, document management systems, legal services, and virtual patent databases. Prior art searches on patent databases inform of the white space for an invention and the freedom to operate (FTO) in a given segment.

Scanners, graphics tablets, digital cameras, or design software like Adobe Illustrator capture and communicate the product's shape to aid in design registration.

Takeaways

These five technologies—cloud-based design and analysis, AI/ML, VR/AR, improved PLM integration, and registered design tools—enhance product development and contract manufacturing through increased collaboration. They also provide deeper insights into the design intent and use technological advancement in manufacturing and product development to modify tasks logically. In addition, the partnership leverages the strengths of the team members.

Changing how businesses view product development is critical to realizing the significant advantages improved collaboration through technology can provide. Historically, the process was linear:

Concept > Drawing > Model > Prototype > Design > Manufacture

This approach prevented the team from uncovering design or human errors earlier in the manufacturing process, causing highly-disruptive iteration cycles that instantly wrecked the project timeline.

Companies can employ the tools reviewed above for the appropriate tasks with clear deliverables, such as repetitive, non-specialized, and well-understood functions. Implementing them can foster innovation while delivering crucial speed and efficiency for both new product development (NPD) and design for manufacture (DFM). Finally, taking tedious tasks off your specialists' desks can free them up to innovate and execute the next generation of technology.

www.tti.com

By Adam Kimmel, MarketEYE contributor

Harwin's latest 5 Star Awards recipients announced

Once again recognizing those who have achieved supply channel distinction

Showing gratitude to the individuals involved in the supply channels supporting its extensive portfolio of products, Harwin has named the latest winners of its 5 Star Awards.

These annual awards highlight the commendable work that distribution professionals do on the company's behalf, in terms of demand creation, customer coordination, product promotion, order fulfilment, etc. Through their efforts, Harwin's high-reliability (Hi-Rel) connectors, industrial-grade interconnects, EMI shielding cans, and board-level hardware solutions are getting greater market uptake.

The individuals that have been recognised for an award are as follows:

Sheila Daniels, TTI: Over an extensive period, Sheila has exhibited incredible dedication to grow the business throughout TTI's US distribution operations.

Andy Waller, Farnell: Having worked on the Harwin account for many years, Andy has now taken on a global role within the Farnell group.

Hemanth Kumar, iConnexion: Hemanth has been pivotal for Harwin to make further inroads into the increasingly important Indian market.

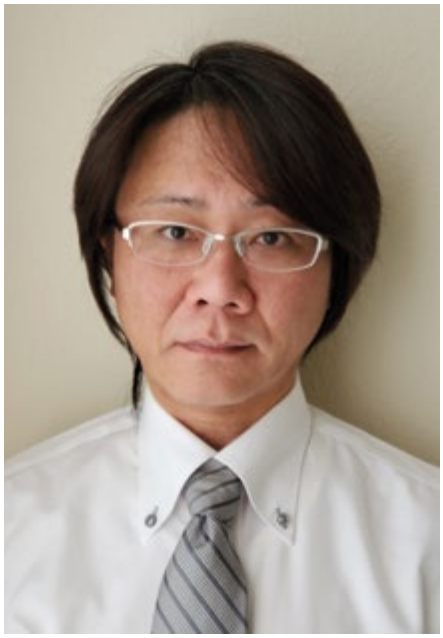
Claudia Daimer, Mouser: This is the second time that Claudia, whose work ethic is second-to-none, has been bestowed with a Harwin 5 Star award.

Greg Ettlin, TTI: Serving the Maryland territory, Greg has successfully grown Harwin's business with an impressive 13% increase in sales revenues coming from Harwin products within the state.

www.harwin.com

Integrating intelligent power devices

Intelligent power devices provide increased protection and performance



Nobuyuki Ikuta, Sr. Design Engineer Manager, ROHM

What is an intelligent power device?

Power MOSFET switches are used in myriad systems with applications spanning consumer, industrial, and automotive spaces. These circuits perform functions like PWM dimming of light-emitting diodes (LEDs), display backlight drivers, headlight switches, and high voltage relay controllers. In all of these examples, the power MOSFET must be protected from overcurrent and overvoltage conditions to prevent catastrophic and potentially unsafe failure conditions.

Intelligent Power Devices (IPDs) integrate the power MOSFET switch, along with all of these discrete protections, into a single chip. This provides a lower cost solution along with enhanced protection performance against overheating, overvoltage, overcurrent, and load short circuiting.

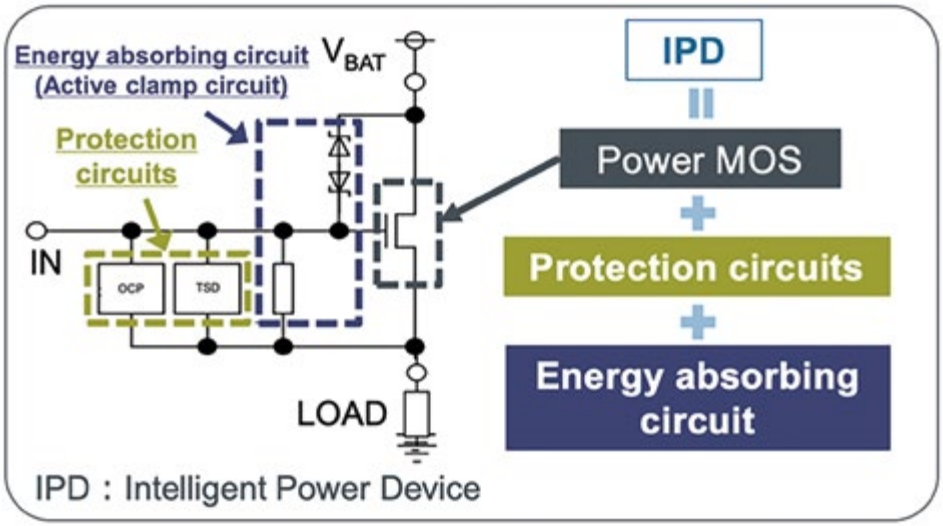
Owing to ROHM's state-of-the-art IC fabrication capabilities and vertical manufacturing process, low On resistance vertical MOS switches can be built on the same die as the CMOS protection devices. This includes the overcurrent sensor, temperature sensors, and—in some cases—logic level flags for microcontroller monitoring.

The IPD advantage

Traditional power switches are protected by a series of discrete sensors for current, temperature, and the like, along with either a fuse or mechanical relay to disengage the switch and prevent catastrophic failure. Fuses are problematic in real world applications because they require replacement and must be carefully chosen for proper overcurrent timing requirements. The combination of in-rush current and standard operating current can result in a fuse trip current profile that leaves a significant margin of unprotected operation. An IPD, in comparison, has an ideal L-shape protection curve that offers a very tight current envelope and does not require replacement after activation.

Another protection option often employed in traditional power switch designs is the mechanical relay. Unlike fuses, relays need not be replaced and can turn on and off reliably under a wide range of current and timing requirements. Unfortunately, relays do suffer from mechanical wear out over time and have a limited operating life. In addition, the mechanical action of relays exhibits noticeable acoustic noise that can be unacceptable in many designs. In contrast to the way in which a mechanical relay wears out over time, a semiconductor IPD suffers

Example IPD structure



"IPDs provide a lower cost solution along with enhanced protection performance against overheating, overvoltage, overcurrent, and load short circuiting"

no such deterioration, even under large loads.

IPDs outperform fuses, relays, and discrete semiconductor solutions in reliability, design flexibility, and ease of use. Owing to the collocation of CMOS circuitry with the power switch, they can also offer advanced features not seen in other protection schemes. These features include under voltage lockout, slew rate control, and even dynamic or variable over current adjustment. As a result, IPDs can be tightly tuned to the application, thereby yielding the best performance in the smallest package and at the lowest cost.

Low side IPDs for switching ground connections

For circuits where the ground connection is being switched, such as LED dimming, low side IPDs are a natural choice. In this case, the IPD can be inserted between the virtual ground rail and the supply ground rail. The duty cycle of the PWM signal will control the brightness of the LEDs, while the IPD manages all of the required driving signals and protections.

The BV1LF080EFJ is one representative example of an IPD designed for low side switching. It contains a power NFET with active clamping protection and an additional NFET for a TSD diagnostics status output. Both of these NFETs have built-in gate drivers along with circuitry for under-voltage lockout, over-current protection, thermal protection, and slew rate control.

The slew rate control pin uses an external fixed resistor to set the slew rate of the output switch, in turn adjusting the rise and fall time of output voltage during transitions. This can be very important in applications where excessive dv/dt can result in current spikes and noise issues. Implementing the correct slew rate limit reduces the output current spike during the switching event.

High side IPDs for switching power rail connections

For circuits where the power rail connection is being switched, a high side IPD can be used. This configuration is commonly applied when an entire power domain must be turned off, often for energy saving or simply on/off control.

ROHM's BV1H /J045/ JC45L045/LC45EFJ-C is a single-channel high side IPD that is representative of the entire high side lineup. The device integrates a power NFET with a parallel NFET for self-testing purposes. With discrete devices, NFETs can be difficult to drive in the high side configuration due to the dynamic gate-source voltage. The IPD solution includes a dedicated floating gate driver to alleviate these challenges.

The on-chip circuitry of the IPD provides advanced protection features, including over current (OCP), over temperature, and under voltage lockout. Dynamic OCP with the BV1HD045EFJ-C allows for a delay tuned in-rush current followed by a lower operating current. This reduces the margins required in a fixed current design and enhances the steady state protection capability.

ROHM's expansive portfolio of IPDs

IPDs combine intelligent protection sensors, drive circuitry, and self-testability with a low On resistance power MOSFET using ROHM's vertically integrated manufacturing process. The result is a high-performance switching device that can be used in both high and low side configurations across a variety of application spaces including automotive and other harsh environments.

ROHM offers a broad portfolio of IPDs, including multi-channel options, slew rate control, and dynamic over current protection to match any design requirement in myriad package options.

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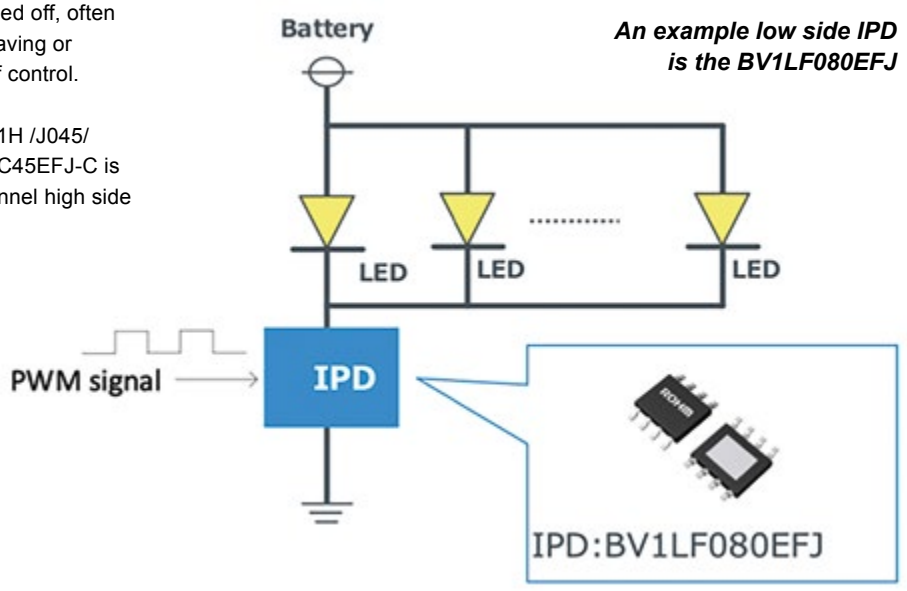
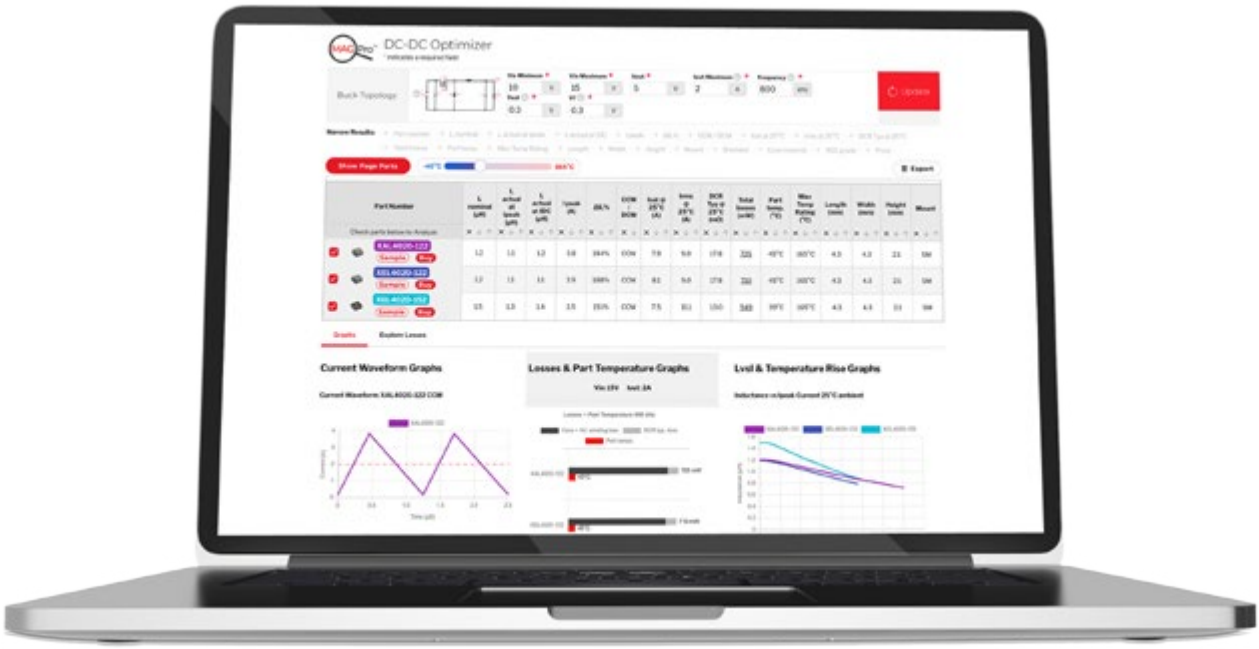


An example low side IPD is the BV1LF080EFJ

Find the Right Part Faster



Designed by Engineers for Engineers, our MAGPro™ DC-DC Optimizer helps you find the optimal power inductors for your converter designs quickly and easily, reducing your design cycle time.

Coilcraft's MAGPro suite of online inductor analysis tools are designed to enable inductor selection and circuit optimization based on sound engineering principles and measured data.

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The tool identifies optimal inductors for buck, boost, and buck-boost converters. With just a few clicks you can go from V_{IN}/V_{OUT} converter requirements to inductor selection complete with losses and saturation analysis, all based on verified inductor data.

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Reducing energy waste in battery charging applications

Darrel Kingham, CEO, Pulsiv

Pulsiv OSMIUM technology is the answer to your battery charging problems

As technology evolves, equipment manufacturers continue to develop innovative products that offer greater convenience and improve overall user experience for consumers. Battery innovation has increased energy capacity and reduced charging times so that a growing number of portable devices can deliver similar performance to mains-powered alternatives. Vacuum cleaners, garden tools, and grooming products are just a few examples. Regular charging is typically required and the process of transferring electrical energy into the battery can be hugely wasteful. This has a direct impact on consumer electricity bills, global energy demand, and CO_2 emissions.

What's the problem?

Battery chargers are designed to inject power and preserve battery life by following a charge profile tailored for each different cell chemistry. The conventional power electronics technology used in most battery chargers will generate heat throughout the charge cycle due to inefficiencies when converting AC to DC. To illustrate this problem, Pusiv randomly selected a commercially available battery charger for testing and found some interesting results.

The charger delivered a peak efficiency of 74% but operated at 50% for much of the time. Half of the power was wasted over an extended period after the initial fast-charging phase. The charger claimed to be 100W rated and only delivered 74W maximum output. The on-board fan was running at all times. Assuming daily use, the estimated avoidable annual waste for a single unit was £166 (~$200) and 150kg of CO_2

Pulsiv OSMIUM technology

While existing techniques can help to reduce system losses during the battery charging process, they generally involve more expensive components. This leaves equipment manufacturers with a difficult choice between minimising their one-off production costs or reducing ongoing electricity bills for the consumer. Pulsiv OSMIUM is a new and innovative technology that makes it possible to do both.

Pulsiv OSMIUM uses a unique method of converting AC to DC that delivers an unrivalled flat efficiency profile using commodity system components. Regardless of whether a battery charger operates in standby mode, at full power, or anywhere in-between, it remains efficient at all times to minimise the amount of wasted energy.

When tested under the same conditions as the Legacy Charger, a 150W Salom design based on Pulsiv OSMIUM technology produced an impressive set of results. In fact, >90% efficiency was achieved during the fast-charging phase, and wasted power reduced by 96% at all other times. A side-by-side comparison shows many other advantages.

Launched in September 2022, this ground-breaking technology provides manufacturers with a cost-effective method for delivering consistently high efficiency in power electronics circuits to reduce overall energy consumption. It offers engineers complete flexibility to adapt and scale for virtually any application from just 20W to several kW, with evaluation boards and document packages available online to simplify the design process. Both generic and application-specific reference designs were released in February 2023, including variations optimised for USB-C charging to support recent EU legislation.

A range of battery charging applications that can benefit from Pulsiv OSMIUM technology include: USB-C chargers and adaptors, e-bikes and scooters, mobility scooters, vacuum cleaners, portable kitchen appliances, garden and power tools, grooming products, laptops, portable speakers, and… the list goes on.

For any manufacturer seeking to improve efficiency in their battery chargers, the Pulsiv team is standing by ready to support you. You can read more about this technology on our website, or contact us directly at sales@pulsiv.co.uk

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Improve time to market with confident quality

Experts at IAR Systems have identified the 12 fundamentals of embedded software development

Is it possible to speed time to market, secure quality, and—at the same time—stay within the budget? Companies must weigh which investments lead to a clear return on investment (ROI) and a reasonable total cost of ownership (TCO), particularly when developing embedded software.

From consumer electronics to automotive and industrial products, consumers constantly seek more innovative features in ever-shorter cycles. These requirements directly impact any embedded software, which is instrumental in the development, differentiation, and even a product's success.

Today, embedded applications are becoming more complex than ever, built by large and often distributed teams with different skills, and include ever-changing requirements. Developers must address these challenges while focusing on innovation to deliver a product that meets or exceeds expectations and stands ahead in the market.

Experts from IAR Systems have been guiding and supporting embedded developers for more than 40 years. The company's tools are an integral part of developers' working routines and have become a de facto standard in terms of increased productivity, efficiency, and quality, reduced costs, and accelerated time-to-market. These experts have identified the 12 fundamentals of embedded software development, which are explained in detail in a newly released e-book *tinyurl.com/3p38srxj*.

The 12 fundamentals of embedded software development

Taking the 12 fundamentals of embedded software into account provides a tangible, positive impact on ROI and TCO for developers working with professional tool solutions.

1. An ideal development environment should be an all-in-one IDE with project management tools and an editor.

2. Device support can come from many vendors, including 8-, 16-, 32-, and 64-bit cores connected to various projects in parallel and with different requirements.

3. By optimizing the code size and application, companies may save money by using a smaller device.

4. Code performance is essential for faster code and a better user experience.

5. Code quality achieved by following best programming practices results in better products.

6. Debugging is the key to enabling full control of the application in real-time to remove bugs and improve quality.

7. Easy licensing and management enables customers to pay for exactly what they need from single users to license pools.

8. Access to support is an essential factor that ensures programmers can focus on their code and get assistance and training when needed.

9. DevOps and scalability are critical factors in addressing growing demand and an organization's need to modernize their infrastructure towards automated CI/CD workflows.

10. Compliance and safety are mandatory to prove that companies comply with specific requirements in their sectors.

11. Developing an ecosystem and partners benefits customers and provides the assurance that new devices, middleware, and integrations will be supported in the future.

12. Security is mandatory. Companies are looking for ways to implement security in the early and even late stages of development.

Use case studies in the complete e-book illustrate exactly how developers can leverage these benefits.

Using commercial tools with an upfront investment versus "free" tools offered to lower barriers to entry for using specific chips in product designs is an effective way to stay on schedule and reduce the overall cost of developing a product. With commercial tools, companies and developers are "buying" a faster time-to-market and delivering high-quality, competitive products within budget.

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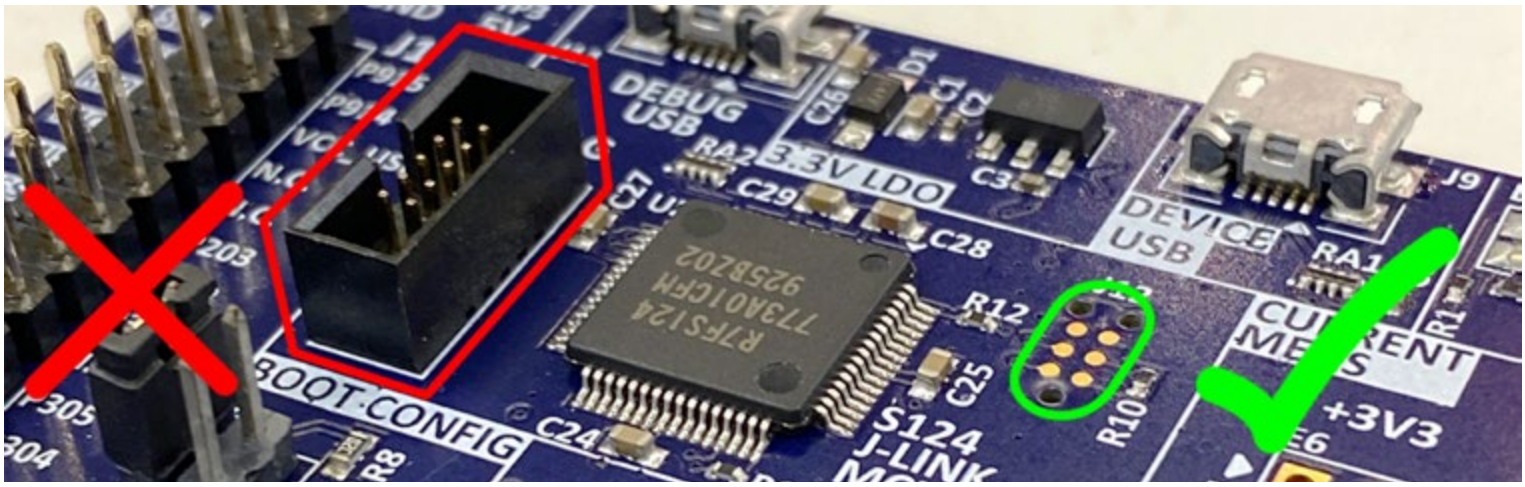

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Testing auto-generated code for safety-critical systems

Mark Richardson, technical specialist, LDRA

Prevent systematic faults by adopting third-party test tools now!

Model based development (MBD) is seeing greater adoption rates among embedded software teams to simplify the production of complex applications. By abstracting software architecture, design, and behavior into commonly understood visual representations (the model), MBD helps developers collaborate and maintain software more effectively while identifying potential system issues earlier in the lifecycle.

As many MBD tools support automatic code generation and testing, embedded software teams also see increased productivity. The challenge for safety-critical systems, however, lies in the verification and validation of auto-generated artifacts in environments with strict functional safety requirements. Many software standards require source-code level testing and compliance and some mandate validation down to the object code.

To reduce the uncertainty around testing MBD-driven code artifacts, development teams must go beyond the capabilities of the MBD platform to leverage independent and automated test built to support functional safety certification.

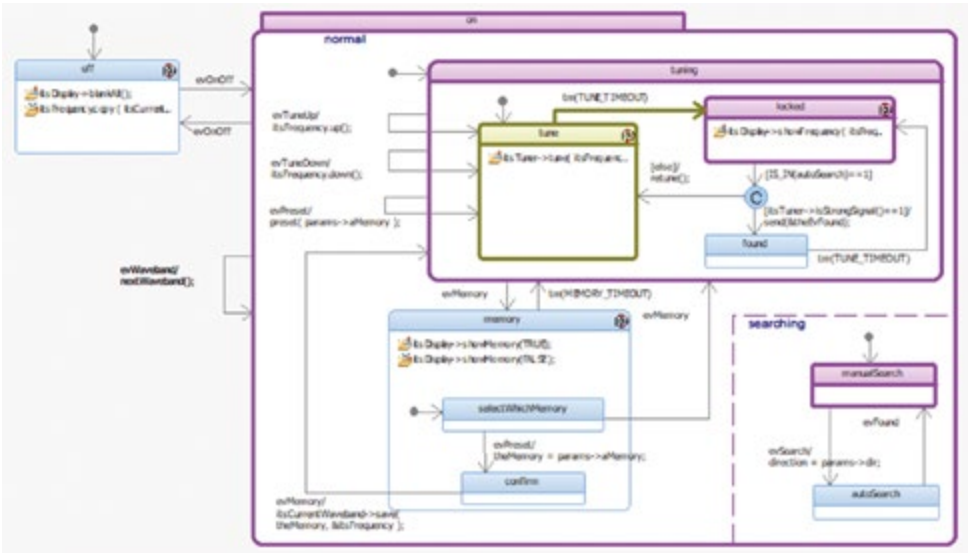
Model based development and functional safety

MBD enables developers to specify software components, relationships, and behavior using well-defined syntax and semantics. A popular example is the Unified Modelling Language (UML), a set of notations for real-world software elements like classes, objects, and interfaces that are assembled and connected onto diagrams that represent the architectural and behavioral aspects of the system.

MBD tools generally include automatic code generation based on the visual model. The code generation process usually involves a transformation from the visual model to an intermediate implementation model that accounts for language, compiler, and other environment-specific characteristics. This model generates the source code that is fed into the compiler and linker to create the object code and executables.

For systems concerned with functional safety, such as automotive, medical, and aerospace products, these transformations from model to object code raises two questions: “How to detect and prevent potential issues introduced by the MBD tool?” and “Does the application still meet requirements?” This is why ISO 26262, “Road vehicles—Functional safety,” and the aviation standard DO-178C (through the DO-331 supplement) include sections for MBD.

An example of a UML state chart from the IBM Engineering Systems Design Rhapsody tool



MBD and ISO 26262

The ISO 26262 standard calls out the potential for MBD to introduce unforeseen issues in application code:

“The potential benefits of this [MBD] approach (e.g., continuity information sharing across the software life cycle, consistency) are appealing but this approach may also introduce issues

causing systematic faults." – §B.2.3, "Potential impact of MBD on the software lifecycle", ISO 26262

ISO 26262-6 §9.4.2 further states that development teams must provide evidence to show the compliance of source code to its design specification, including cases where developers use MBD.

MBD and DO-178C

In civil aerospace, DO-178C is the primary standard used by certification authorities to approve commercial software-based systems and DO-331, "Model-Based Development and Verification Supplement to DO-178C and DO-278A" covers MBD specifically.

To meet the objectives of the highest design assurance level (DAL) specified in DO-178C, DAL A, a developer must verify that any differences the compiler introduces between source code and object code are valid, justified, and documented. This traceability ensures that every line of code is there for a reason and puts a magnifying glass on the outputs of code generators and compilers.

A question on compilers

Developers use compiler code optimization features to improve the performance of their systems, but they typically avoid these optimizations for safety-critical development. As these features reorganize the order of instructions, data, and memory, they often eliminate instructions and defensive code on the assumption they're not needed.
The potential differences between source code and object code present challenges for any developer seeking certification, as DO-178C specifically requires they be identified and validated. An independent verification and validation mechanism must be employed to reduce the risk of missing systematic faults introduced by code generation or a compiler.

Improving testing with third-party tools

Third-party tools bring "a fresh pair of eyes" to verification and validation that is independent of any mechanism in the code and build toolchain. Acting as a complement to the existing developer tool stack, they are a necessary feature of safety-critical processes seeking to achieve compliance and improve code quality. These tools reduce functional safety risks in a couple ways:

Supplementing SIL and PIL testing:

Software in the loop (SIL) and processor in the loop (PIL) testing have long been essential components of verification and validation programs. SIL testing operates on a model or simulated environment while PIL testing integrates physical devices into the mix. While their intent is to ensure correct functionality of the system under different conditions, it's difficult to prove code coverage for complex applications without specialized tools. Third-party test tools ease this burden by performing code coverage tests on the source code and object code, with some tools auto-generating stubbing functions to exercise a range of inputs and outputs.

Performing control and data coupling analysis:

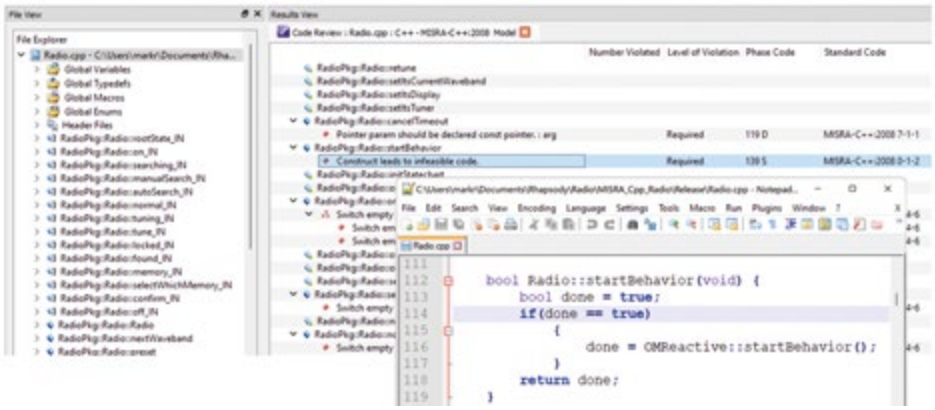
Control and data coupling is one of the structural coverage types found in DO-178C and similar standards, used to measure the reliability of software architecture based on the interdependencies between its components

Control coupling analysis determines the degree to which a software component influences the execution of another component (e.g., an interrupt handler that calls a supporting function). Data coupling analysis determines the dependence of a software component on data not exclusively under the control of that component (e.g., two functions that share global and local data through passed parameters)

An independent test tool can perform control and data coupling analysis on both auto-generated and handwritten code.

Reviewing auto-generated code

The report illustrated in the figure identifies several violations, with the example in the inset image showing the inclusion of an if() statement that is always true in the auto-generated code, meaning there is some infeasible code.



Results of a third-party tool's assessment of auto-generated code against the MISRA-C++ 2008 coding standard

Prevent systematic faults by adopting third-party test tools now!

Model based development tools do a good job of stemming the pressure of complex embedded software development, but they pose significant risks for safety-critical systems. Ensuring the model to code transformation process doesn't introduce systematic failures, or the compiler introducing undesirable behavior in object code, requires independent test tools that can analyze both auto-generated and handwritten code.

Such tools act as a supplement to techniques common in the verification and validation of safety-critical systems, providing a sanity check that improves the automated testing process and reduces the risk of faults entering the field.

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Ultraminiature capacitor trends and circuit performance

Advanced capacitors can have a significant impact on system size, performance, and reliability

Passive components have experienced a massive evolution in recent years, and the rate at which these technologies continue to advance is accelerating. Results include ever-smaller sizes and weights, along with improved individual part reliability and electrical performance. These advances have permeated virtually all capacitor offerings, but two specific capacitor technologies—multilayer ceramic capacitors (MLCCs) and polymer electrolytic capacitors—have achieved unrivaled progress. And since approximately 80% of the components on a printed circuit board (PCB) are passive, and a large percentage of these are capacitors, these advanced capacitors can have a significant impact on system size, performance, and reliability.

Capacitors

Modern integrated circuits (ICs) employ more transistors than older devices. They require power supplies with much higher currents and current transitions (di/dt) and, as such, higher capacitance IC power distribution networks to support these increased di/dt demands.

Higher capacitance power distribution networks can be achieved with smaller, higher density capacitors placed closer to the IC. This placement reduces the time needed for the capacitor to deliver current to the load and boosts effectiveness.

Smaller case size capacitors (e.g., 0402, 0201, 01005, and 008004) are available with multiple practical and low-cost attachment methods that allow them to (a) be placed in close proximity to the IC die and (b) optimize the circuit.

Multilayer ceramic capacitors

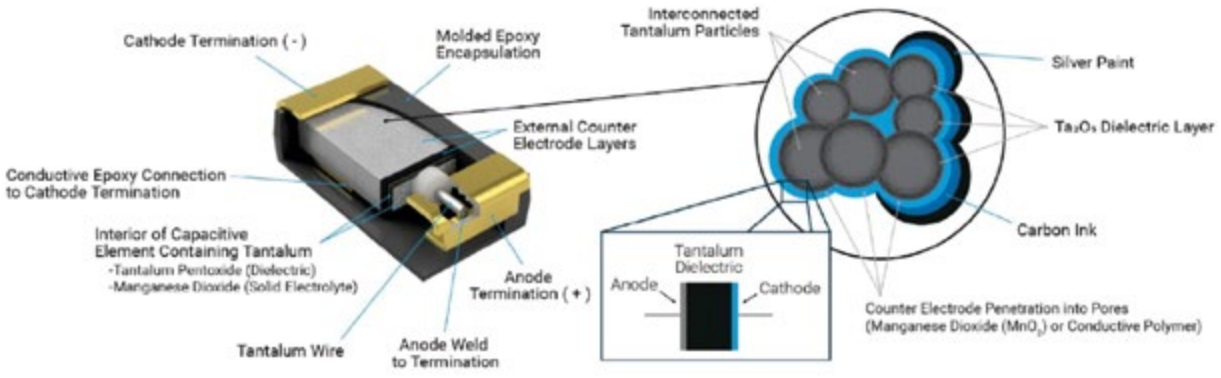
Advances in MLCC technology offer designers a high-capacitance alternative to traditional electrolytic capacitors. This results in the ability to deliver higher capacitance values, along with low ESR and ESL, in small packages. The same technology that enables a 100µF, 6.3V 0805 X5R MLCC also enables an ultraminiature 100nF 008004 MLCC. As such, MLCCs offer effective solutions that span the gamut from high-CV bulk capacitors to the microminiature MLCCs typically used in high-frequency filtering and decoupling applications.

Recent MLCC technology developments are the result of various factors, including ceramic material advances, improved thin metal electrode and ceramic layer processing technologies, and enhanced miniature stacking, dicing, and testing capabilities.

This combination of material advances, improved electrode and dielectric thickness control, and manufacturing capabilities results in MLCCs with a high capacitance per unit volume (high CV). For example, a cross section of a typical high-C/V 22µF 0402 MLCC could reveal 500 dielectric layers that each have a height profile that measures less than just one hundredth the thickness of a single human hair.

The process accuracy and control needed to make high-CV 0402 MLCCs also enables the development of

A cross sectional structural diagram of a tantalum conductive polymer capacitor



Size	Typical Chip Size (mm)	Mounting Area Ratio	Weight (g/100pcs)	Weight Down Ratio
0805	2.0 x 1.25	100.0%	2.346	100.0%
0603	1.6 x 0.8	56.0%	0.901	38.4%
0402	1.0 x 0.5	25.7%	0.281	12.0%
0201	0.6 x 0.3	12.0%	0.043	1.8%
01005	0.4 x 0.2	7.1%	0.010	0.4%
008004	0.25 x 0.125	4.2%	0.001	0.1%

How MLCC case size and weight reductions impact PCB mounting area requirements.

ultraminiature case size MLCCs ideal for use in applications with stringent size and weight restraints, including smartphones, wearables, and other portable electronic devices.

A typical smartphone has more than 1,000 capacitors in it, and the total volume of those capacitors is roughly equivalent to that of a penny. But portable electronics manufacturers are always looking to reduce size and weight while maintaining or even increasing power. So, we conducted a study to evaluate the impact of MLCC case size on weight and PCB mounting area (see the table).

The first step in the PCB mounting area study was to calculate the area occupied by 100 0805 MLCCs mounted in a 10 x 10 array with 0.2mm spacing and to define that board area as 100%. We then placed 100 smaller case size MLCCs, ranging from 0603 to 008004, in a similar 10 x 10 layout with 0.2mm spacing and compared the resulting PCB areas. The benefits of miniature and ultraminiature case sizes were readily apparent, with the smallest case size (008004) MLCCs occupying just 4.2% of the area that the 0805 MLCCs occupied. The weight reduction benefits of the smaller case size MLCCs proved equally appealing, with the 008004 to 0805 case size comparison achieving an approximate weight reduction of 99.9%.

Other useful comparisons can be extracted from the table as well. For instance, if a design using 100 0603 MLCCs was retrofitted to use 0402 case size MLCCs, the manufacturer could achieve 54% board space savings or place 271 additional 0402 MLCCs in the same area that had been occupied by 100 0603 MLCCs.

However, it is important to note that miniature MLCCs with certain dielectrics can potentially exhibit instability in circuit. Tantalum polymer capacitors eliminate those concerns.

Tantalum polymer capacitors

Tantalum polymer capacitors are miniature bulk capacitors that are available in a variety of voltages, case sizes, height profiles, and quality levels, which supports maximum placement efficiency, and they also exhibit very low ESR and ESL. Key features include the fact that they exhibit approximately one eighth the ESR of standard MnO_2 tantalum capacitors, and can therefore handle much higher ripple currents; also, they can exhibit ESL as low as 1nH. Tantalum polymer capacitors also exhibit improved energy density and virtually no aging, voltage bias, or temperature instability effects. These features provide designers with the flexibility to find reasonably sized bulk capacitors in case sizes as small as 0402 with height profiles as low as 0.55mm.

Tantalum polymer capacitors feature a conductive polymer in the cathode. They are formed by capping the tantalum anode wire with a porous pellet of tantalum powder, sintering that structure into a monolithic block to form a Ta_2O_5 dielectric, depositing a conductive polymer layer onto the monolithic block structure to reduce ESR, and some added processing.

Summary

Modern MLCCs and tantalum polymer capacitors exhibit parameters desired in future circuitry. Both deliver a variety of small, high-density capacitance solutions that support multiple practical and low-cost attachment methods and can be placed close to ICs to optimize the circuit.

Advanced MLCCs deliver high-CV, low ESR, and low ESL, easily accommodate mounting configurations spanning embedded to board mounted, and are ideal for high-frequency IC decoupling and filtering applications.

Advanced tantalum polymer capacitors are available in miniature packages that deliver low ESR and ESL and effectively address gaps in the existing bulk capacitor market.

Continued size reductions are expected for both types, with MLCCs progressing down a known path all the way down to 008004 case sizes and tantalum polymer capacitors continuing towards smaller case sizes with the potential for added disruptive case size evolution.

www.kyocera-avx.com

Improving the safety and lifespan of bridges

Adam Kimmel, Mouser Electronics

AI, ML, sensors, the IoT, and the cloud come together to monitor and maintain bridges

Exponential global population growth—set to reach 8.5 billion by 2030—coupled with global macrotrends like urbanization and electrification are elevating the need for reliable transportation infrastructure. Increasing numbers of people will be driving heavier vehicles on roads and bridges, increasing the number of maintenance cycles.

Bridges are vital pieces of infrastructure, moving people and goods over water and land more efficiently. Therefore, maintenance and repair of bridges are essential to prevent failure, and sensor technology is well suited to predict when a bridge needs repairing.

Structural health and monitoring of bridges

The American Society of Civil Engineers issued a report citing current statistics on bridge health. Among these are the following: There are 617,000 bridges across the United States, 42% of all bridges are at least 50 years old, 46,154 (or 7.5%) of US bridges are considered structurally deficient, and Americans make 178 million trips daily across bridges in poor condition.

The study indicates the impracticality of completely refurbishing the bridges. But among the innovative solutions to failing bridge health is the use of networks of sensors to monitor the structural well-being and condition of existing bridges to better anticipate failure.

Historically, bridge monitoring has consisted of a prescribed frequency of visual inspections. The challenge with this approach is that when an inspector visually identifies a problem, the bridge has likely already undergone significant damage. To mitigate this, engineers implemented structural health monitoring (SHM), adding sensors and enhanced technology such as artificial intelligence (AI), machine learning (ML), and remote monitoring.

To keep bridges operational, civil engineers employ sensors to collect data in two main areas: failure repairs and preventative maintenance. In addition, AI and ML have accelerated the move toward continuous monitoring to collect the massive amounts of data required for those technologies.

Parameters that indicate bridge health

Several conditions help engineers understand a bridge's structural health. These include the following:

External loading from wind and traffic. Wind affects the bridge cables' vibration profile, while traffic tonnage can identify pressure cycles that negatively impact the bridge's structural integrity.

Structural deformation like stress, strain, and material displacement. Stress is a measure of force per unit area, and strain quantifies material deformation resulting from stress. Displacement measures how far a material has moved from its initial state. Monitoring changes in these parameters can indicate the likelihood of failure.

Environmental effects like temperature, wind, humidity, oxidation, and local salinity. Rising temperatures modify metal properties and durability, and excessive salinity or oxidation can degrade or corrode the material faster than the design predicted.

Bridge monitoring sensors

Several sensor types can measure the parameters presented above as follows:

Accelerometers measure the vibration from the element over which they are placed and then convert that signal into measurable electrical output. An accelerometer can measure three-axis bridge tilt induced by a wide range of persistent environmental conditions, including wind and traffic. Vibration-based monitoring as part of ongoing data collection can paint a clear picture of the overall structural integrity of the bridge. These sensors can also assess the effect of a dramatic change in operating conditions (e.g., an earthquake) on bridge function.

Strain gauges can monitor steel, reinforced concrete, and other materials on bridges. A common type of strain gauge has a metal

foil pattern that, when under strain, deforms and changes its electrical resistance. Measuring this change gives users a measurement of the stress on the structures.

Inclinometers measure how much a bridge has moved beyond its initial designed and constructed mode. An inclinometer functions much like a spirit level with a bubble that indicates how off-center the element is.

Fiber optic sensors measure a variety of parameters, such as temperature, pressure, and humidity. The transmission of light and its subsequent behavior as it passes through materials is the foundation for estimating these parameters. In addition, different materials have unique light refraction and reflection properties.

Force sensors and load cells enable measurement of vehicle weight on bridges.

Crackmeters and jointmeters have a sliding element that measures the gradual growth of a fracture, which allows engineers to measure the movements of cracks and joints.

The future: IoT and cloud-based solutions

Bridge engineering is moving toward a more technology-driven approach to routine maintenance through AI and internet of things (IoT) technologies. Engineers can use AI to accurately predict breakdowns or identify abnormal behavior patterns, leading to a revised approach toward collecting and processing sensor data.

Bridge engineers can create a digital twin from all the data inputs to understand how the different parameters affect each other and how modifying one parameter could affect the others. Sensors can also leverage harvested, stored, or solar energy to conserve energy. New construction can integrate sensors into bridge materials for a more seamless and aesthetic product.

One of the advantages of such a continuous sensor solution based on IoT technology is that problems are spotted early and can be fixed at less expense and disruption than if they were to lead to breakdowns and potential loss of life. Cost savings, ability to manage regulatory compliance, and extended asset life also appeal to governments on a tight budget. Another advantage is that continuous monitoring can function remotely, eliminating the need for expensive on-site support.

Conclusion

As evidenced by the 2021 US Infrastructure Investment and Jobs Act, upgrading infrastructure maintenance is a high priority for governments at every level. Advanced sensors can deliver essential data to optimize investments for current repairs and predictive maintenance monitoring.

Historically, bridge monitoring was a systematic and visual process, often leading to reactive measures to address uncovered issues. Today, sensor technology can measure a wide range of factors to predict where failures will happen in the future through near-continuous data collection and analysis. In addition, sensors can help to alleviate critical constraints like the pressure to deliver sustainability targets and maintain infrastructure budgets. By means of technologies such as machine learning and artificial intelligence, coupled with a wide array of sensors, bridge engineers are increasingly adopting cloud-based, IoT-driven monitoring solutions.

www.mouser.com

"Maintenance and repair of bridges are essential to prevent failure, and sensor technology is well suited to predict when a bridge needs repairing"

New trends in enclosures for medical electronics

New technology, superior plastics, and a wider choice of standard enclosures address challenges set by the medical sector

Healthcare has always been a demanding area of business for the electronics industry, not least because human lives are at stake. This sector expects excellence as standard—setting the bar high for all medical devices—no matter what their function.

Hospitals and other clinical environments may take wonderful care of their patients, but the electronic devices that aid in their recovery may be destined for a much tougher time. They may be used around the clock by multiple clinicians, including those still undergoing training.

As a result, products (and their enclosures) must be tough and reliable, and they must continue to look new, modern, and dependable throughout their operational life. After all, who would want to be treated in a hospital with old and battered equipment?

And, as if these challenges were not enough, the healthcare sector always keeps a close eye on its budgets. So, hospitals want the best of both worlds: new technology at keen prices. In the past, this posed an issue where enclosures were concerned; bespoke plastic housings can be expensive because of the tooling costs.

Fortunately for product designers, there are now more standard and customizable enclosures than ever to choose from. Many are highly specialized, with technical features designed to meet specific requirements, yet versatile enough to suit multiple applications.

Thanks to their smart designs, they require very little customization, and new technology means that whatever minimal modifications they *do* require can be carried out quickly and in lower volumes. This makes them perfect for the medical sector.

The hospital bedside is a key location for many medical devices. Adjustable beds need remote controls, usually wired. OKW's SMART-CASE is perfect for this application. SMART-CASE (IP 65 optional) continues to be one of the manufacturer's most popular models, selling particularly well last year. It is robust, comfortable to hold, and is supplied with a choice of either a pre-fitted cable gland or a battery compartment. Most of these enclosures are molded from ABS, but infrared-permeable PMMA is also available for wireless remote-control applications. There is also a range of hospital-centric accessories such as bedrail clamps, wall holders, and belt/pocket clips.

Desktops are another important location, especially for larger instrumentation. MEDITEC is designed specifically for this role, and it takes the brief a stage further by offering a version with a bail arm. This adjustable arm doubles as a desk stand, making it easy to position the enclosure at the perfect angle for viewing and operation.

MEDITEC's four plan sizes accommodate Eurocard-sized PCBs (double and extended), and side panels can be added to increase enclosure height and capacity. Clip-in side trims in a choice of colors make it easy to specify added ventilation if needed.

Meanwhile, SMART-CONTROL (IP 55 optional) exemplifies a whole host of developments in the world of plastic enclosures. Wedge-shaped SMART-CONTROL is designed for corner-based electronics but—thanks to some smart design—these enclosures are also suitable for desktop use. (A wall suspension element and a desktop stand are both available as accessories.) And then there are two big clues that this is a newer model…

The first clue is the material. Rather than ABS,

SMART-CONTROL is molded from ASA+PC-FR as standard. This high-performance plastic combines the UV stability of acrylonitrile styrene acrylate (aka acrylic styrene acrylonitrile) with the strength of polycarbonate, which is used in riot shields and CDs. ASA+PC-FR's flammability rating is also higher: UL 94 V-0 versus UL 94 HB for ABS.

The second clue is the fact that these enclosures are assembled with tamperproof Torx screws as standard. This a key requirement for medical electronics. But it's not a dealbreaker for enclosures that don't have them as standard because they're easily specified as a custom option.

Handheld and wearable devices play a widespread and crucial role in clinical settings. The sheer number and diversity of applications has prompted the development of a wide range of models for these purposes.

Award-winning BLOB (IP 54 optional) handheld housings challenge a key design rule—that standard enclosures should not be too distinctive. The BLOB range's three amorphous shapes—UNIT, CONTROL and PANEL—are a world away from the conservative square boxes of traditional enclosures. These unusual but highly ergonomic shapes are designed to guide the user's fingers towards controls, making the devices they house very easy and intuitive to use. For this reason, BLOB is ideal for users with reduced grip or limited dexterity.

Another award-winner is MINITEC—personal electronics enclosures that can be worn around the neck or wrist, clipped to a belt or pocket, attached to a key ring, or carried loose. This model combines a top and bottom section with a choice of soft-touch intermediate rings to create a huge range of standard combinations based on shape (teardrop D or rectangular E), size, color, material (ABS or PMMA) and ring type (including USB).

Meanwhile, ERGO-CASE (IP 54 optional) can be worn on the arm, chest, wrist or around the neck—courtesy of a range of enclosure sizes and accessories that include belt straps, a wrist strap, lanyards, and belt/pocket clip. The enclosures can also be attached to walls.

As OKW Enclosures VP Marketing Robert Cox says: "The last few years have seen significant developments in enclosure design, giving a wider choice of new housings and rejuvenating popular existing models. Customizing services now include machining, lacquering, decor foils, laser marking, digital printing, and special materials. These services are now often available in lower volumes, thereby making customization more viable."

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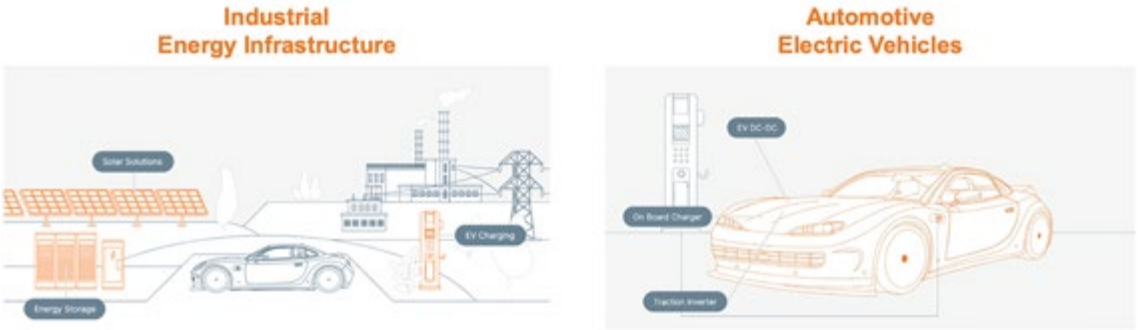
Meeting the ongoing challenge for SiC devices

Wide-bandgap devices such as SiC are essential to modern applications



Multiple applications require the benefits of SiC technology

Technology is accelerating rapidly with different drivers across a multitude of application sectors. Looking at two of the most important markets—industrial and automotive—the key trends that dominate are increased efficiency, form factor, and improved sensing using image sensing.

In the industrial sector, advances in MOSFETs and power modules are being deployed to improve the energy efficiency and system cost of a wide range of industrial systems. Two areas that have a particular benefit are EV charging infrastructure and alternative/renewable energy applications such as Solar.

Cost and performance are common threads in many industrial applications. Designers are being challenged to deliver more power from solar inverters without increasing size or to reduce cooling costs associated with energy storage. Affordable charging is seen as a gateway to the proliferation of electrified passenger vehicles. However, what is critical is the enablement of faster charging capability via DC wallbox or DC Fast charging without requiring additional cooling.

In the automotive arena, efficiency is inextricably linked to the range of the vehicle as well as the size, weight, and cost of the on-board electronics. Here, the deployment of SiC solutions over IGBT power modules in EV/HEV is providing significant performance improvements, alongside the benefits gained from enhanced power management in automotive CPUs, LED lighting, and body electronics.

The traction inverter is a key focus as it impacts overall efficiency of the vehicle and therefore defines the range. Considering driving profiles, the majority of the time a light passenger vehicle operates under light load conditions and—as such—the efficiency improvement benefits with SiC over IGBT solutions are well understood. Additionally, the on-board charger (OBC) needs to be as small as possible. Smaller form factors are achieved only with wide bandgap devices that enable high switching frequency. Every ounce of energy saved enables the vehicle to improve the overall mileage and mitigate range anxiety.

Benefits of SiC technology in modern applications

Every power conversion in automotive and industrial applications relies upon semiconductor-based switching devices and diodes to be efficient and reduce the losses of conversion. Consequently, the semiconductor industry has worked to advance the performance of silicon-based semiconductor devices used in power applications; in particular, IGBTs, MOSFETs and diodes. This, along with innovation in power conversion topologies has resulted in better performance than ever before.

With incumbent silicon-based semiconductor devices reaching the limit of their ability to continue to increase efficiency, a new material is required. So-called wide bandgap (WBG) materials such as SiC and gallium nitride (GaN) hold much promise for the future. The electrical system demand for higher performance, density, and reliability is pushing the technology envelope for SiC technology.

Whether it's the mission profiles of automotive traction or solar inverters or electric vehicle chargers, SiC based MOSFET and diode products offer better performance and system level costs than incumbent Si-based IGBTs and rectifiers. The wide bandgap nature of SiC enables higher critical fields than silicon, translating into higher blocking voltage capability such as 1,700V and 2,000V. In addition, SiC has inherently higher electron mobility and saturation velocity than Si devices, resulting in operation at significantly higher frequency and junction temperatures, both of which are highly beneficial. Additionally, SiC-based devices can switch with relatively low losses at higher frequencies, reducing the size, weight, and cost of associated passive

components, including magnetics and capacitors.

Their significantly lower conduction and switching losses mean that SiC-based power solutions generate less heat. This, along with the ability to operate at junction temperatures (T_j) as high as 175°C means that the need for thermal mitigation such as fans and heatsinks is significantly reduced, saving system size, weight, and cost as well as ensuring greater reliability even in challenging, space-constrained applications.

The need for higher voltage devices

The wide-bandgap nature of SiC enables higher critical fields than silicon, translating into higher blocking voltage capability. For a given wattage, increasing voltages would reduce the overall current capability requirements and thus overall copper losses. In renewable energy applications such as solar photovoltaic (PV) systems, the DC bus voltage from the PV panels has increased from 600V to 1,500V to enhance efficiency. Similarly, there is a transition from a 400V bus in light passenger vehicles to an 800V bus (in some cases a 1,000V bus) to drive efficiency and reduce charging times. In the past, 750V-rated devices were used for 400V bus voltages, but now higher voltages such as 1,200V and even 1,700V are required to ensure reliable operation in these applications.

Latest technology

To meet this need for increased breakdown voltages, onsemi has developed a range of 1,700V M1 planar EliteSiC MOSFET devices that are optimized for fast switching applications. One of the first devices available is the NTH4L028N170M1 that has a V_{DSS} of 1,700V and an extended V_{GS} of -15/+25V. This device has an excellent typical $R_{DS(ON)}$ value of just 28mΩ.

The new 1,700V MOSFETs can operate with junction temperatures (Tj) as high as 175°C, allowing any heatsinking to be significantly smaller or removed entirely.

The NTH4L028N170M1 includes a Kelvin source connection on the fourth pin (TO-247-4L package) that improves turn-on power dissipation and gate noise. Also available is a D2PAK–7L configuration, which further reduces package parasitics in devices such as the NTBG028N170M1.

Soon to be available is a 1,700V 1000mΩ SiC MOSFET in TO-247-3L and D2PAK-7L packaging for highly reliable auxiliary power supply units within EV charging and renewable applications.

Alongside the MOSFETs, onsemi has also developed a range of 1,700V SiC Schottky diodes. With this rating, devices in the D1 family will offer more voltage margin between VRRM and the peak repetitive reverse voltage of the diode. In particular, the new devices will deliver lower VFM, maximum forward voltage, and excellent reverse leakage current, even at high temperature, thereby allowing designers to achieve stable high voltage operation at elevated temperatures.

The new devices (NDSH25170A & NDSH10170A) are available in a TO-247-2L package and as bare die, along with a 100A version that is not available packaged.

Supply chain considerations

With component availability hampering supply chains in some sectors, it is very important that—when selecting new devices/technologies—the ability to supply is taken into consideration. To ensure reliable supply to customers to support rapid growth, onsemi recently acquired GTAT. Not only does this bolster its supply chain, but it also allows onsemi to leverage GTAT's technical experience.

Currently, onsemi is the only large-scale supplier with end-to-end supply capability, which includes volume SiC boule growth, substrate, epitaxy, device fabrication, best-in-class integrated modules, and discrete package solutions.

To support the anticipated growth in SiC over the next few years, onsemi plans to increase the capacity of substrate operations fivefold and make substantial investments in expanding the company's device and module capacity to double across all of its sites by 2023. This will be followed by nearly doubling capacity again by 2024, with the capability to double capacity again in the future.

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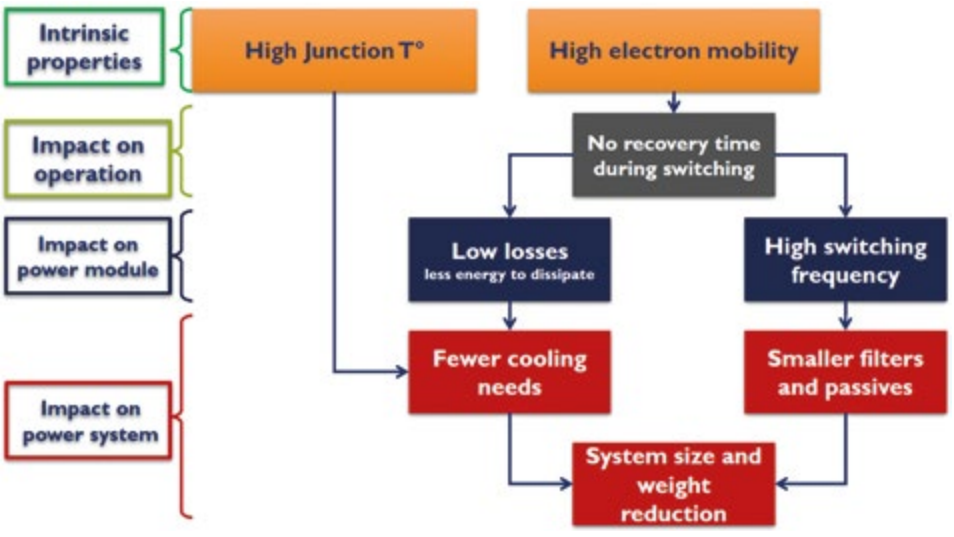
by Ajay Hari, Director of Applications Engineering, onsemi

Wide bandgap materials such as SiC offer multiple benefits in power systems (Source: ONSAR2992)



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