The Portenta X8’s hybrid combination of MPU and MCU offers developers unprecedented flexibility.
The excitement mounts!

September is going to be an exciting month for me this year, not the least that it sees the publication of this issue of DENA. Another reason for my excitement is that on Wednesday 7th September I will be giving the keynote presentation at the FPGA Forum in Norway. It’s been 10 years since I last spoke at this event, which is the premier conference for anyone who has anything to do with FPGAs in Norway and nearby countries, including designers, managers, and vendors.

Whilst there, I’ve also been invited to give a guest lecture to the students on the MSc course in embedded engineering at the Norwegian University of Science and Technology (NTNU). I always feel its important to have an overall theme for this sort of thing, otherwise the audience might think I was making it up as I went along, so my theme for this talk is going to be “change.” For example, we will consider how much has changed with respect to technologies and design tools since I started out in my career, after which we will contemplate some of the changes that are to come, such as software development tools and electronic design automation (EDA) tools that are augmented with artificial intelligence (AI).

These tools are already starting to appear, but there’s no need to worry because you can be assured that we will be covering anything you need to know about such topics in future issues of DENA.

Max Maxfield

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September/October 2022
Industrial grade 3D ultrasonic collision avoidance sensor

With the autonomous vehicle industry booming and mobile robots (such as automated forklifts, AMRs, and AGVs) experiencing exponential growth levels, the safety of humans and machines is kept at the forefront of manufacturing efforts. The market has come to realize that 3D collision avoidance is a necessity, since the obligatory 2D safety LiDARs can only deliver two-dimensional data output not matching highest safety needs.

The Toposens 3D Ultrasonic Echolocation Sensor ECHO ONE and Toposens PROCESSING UNIT address the unmet need for higher safety of mobile robots in industrial settings. Based on the principle of echolocation as seen in bats, the sensor sends the obtained data in a 3D point cloud format to the processing unit, which is equipped with easy-to-configure advanced 3D collision avoidance software.

toposens.com

BLE TPMS for automotive OEMs

Interest in Bluetooth Low Energy (BLE) tire pressure monitoring system (TPMS) implementations is on the rise as vehicles become more connected, electrified, and autonomous. While common in consumer applications like speakers and headphones, BLE is relatively new in the TPMS space for vehicle OEMs and is enabled by newer vehicle system architectures that can support BLE functionality.

Sensata’s new BLE TPMS leverages its field proven tire pressure monitoring sensors by replacing the ultra-high frequency (UHF) radio with BLE radio to enable two-way communication. These new BLE TPMS solutions are available in both clamp-in and snap-in configurations, are optimized for long battery life and deliver the same pressure, temperature, and auto-location capabilities as Sensata’s existing UHF TPMS solutions.

www.sensata.com

Wireless gap measurement probe for rotating machinery

MTI Instruments, a US-based manufacturer of advanced test and measurement equipment, has announced the introduction of its Accumeasure Wireless Gap Measurement Probe System. The system consists of up to four battery-powered, wireless capacitance probes paired via Bluetooth to their receiving device. The wireless capability and compact form factor of the battery-powered probes are designed specifically to measure gaps in difficult-to-reach or inaccessible locations.

WURTH ELEKTRONIK MORE THAN YOU EXPECT

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Reduce and eliminate EMI with reliable EMC components from Würth Elektronik. In partnership with One Tree Planted, Würth Elektronik will plant one tree for each sample order placed in the USA, Canada, and Latin America in 2022.

www.we-online.com
inaccessible locations. Unlike eddy current probe systems, capacitance probes are not susceptible to temperature drift, have built-in calibration, and are immune to magnetic field interference.

The capacitance probes transmit displacement (gap) readings ranging from 0.1 to 2.0mm from fixtures to the rotating machine surface. Measurements are optimized for machines with a surface velocity of 6,000 SFM. Data from the receiver via RS-485 Modbus RTU interface protocol can be used for real-time monitoring of vibration and bearing health.

mtinstruments.com

Compact preamplifier measures signals up to 22GHz

Obtaining useful results from EMC measurements often fails because the measurement levels are too low or because the measurement tools used are not sensitive enough. These issues are addressed by Langer EMV-Technik’s PA 2522 preamplifier with its amplification of 25dB. The PA 2522 amplifies low measurement signals over an extremely wide frequency range from 10MHz to 22GHz with very low noise and a constantly high dynamic range. This means that sources of interference with very low levels can now be clearly detected on measuring equipment.

The signal amplifier, which is handcrafted in Germany, is a consistent further development for EMC applications. In combination with a matching near-field probe (from Langer EMV-Technik, for example), it is possible to perform harmonic measurements of high-frequency signals up to 22GHz. With its compact design, the PA 2522 can be integrated into development environments in a versatile way. Directly connected to the S0D output of a spectrum analyzer or oscilloscope, the preamplifier simultaneously protects sensitive measuring equipment from overvoltage.

www.langer-emv.de

Designed for automotive

Bridgetek have just released their 4th generation EVE Graphics controller IC from the EVE series of devices, including capacitive touch control supporting up to 5 touches and audio output. This generation supports displays with higher resolutions of up to 1280 x 800 pixels and with non-square pixels. The BT817A has a range of enhanced features to support smoother display rendering and improved performance. It supports Unicode strings and has a dedicated port for off-chip flash which can be used to store images and other display assets. BT817A with EVE (Embedded Video Engine) technology simplifies the system architecture for advanced human-machine interfaces (HMIs) by providing support for display scales, and touch as well as an object-oriented architecture approach that extends from display creation to the rendering of the graphics.

BT817A is Bridgetek’s 4th generation embedded video engine chip (EVE4) targeted at automotive applications to generate high-quality human-machine interfaces (HMIs).

Applications include:

• Vehicle instrument dashboards
• Automotive smart displays
• Vehicle charging stations
• Infotainment

For any queries, please feel free to browse our website: www.brtchip.com or email us at marketing@brtchip.com

www.brtchip.com
Crystal applications with USB4 retimers

With some high-speed signals, it’s necessary to augment redriver functionality with retimer capability.

The first crystal oscillator, which was implemented using a piece of Rochelle salt, was created by American scientist Alexander M. Nicholson in 1917 while working at Bell Telephone Laboratories. A key initial use of these early components was in stabilizing the frequency of amplitude modulation (AM) radio transmitters in the 1920s. In the past few decades, crystals have been used to create accurate transmit frequencies for all of the key computer interfaces, including USB, PCIe, and Ethernet.

Of course, things are more complicated that they used to be in the 1920s. Today’s high-end interfaces may require the use of both redrivers (a.k.a. repeaters) and retimers. Since the quality of a signal degrades as it propagates down a wire, redrivers are used to regenerate signals, thereby boosting the signal quality of high-speed interfaces. Unfortunately, simply boosting the signal is no longer sufficient in the case of modern high-speed protocols in which both the data and the clocking information are encoded in a single differential signal. Although a redriver amplifies the signal and “sharpens its edges,” it fails to address jitter, which refers to any deviation from true periodicity of a signal. Thus, in the case of some high-speed signals, it’s necessary to augment redriver functionality with retimer capability.

USB4 is the latest version of the 25-year-old USB family of interfaces. USB4 is particularly useful in high-bandwidth display and storage applications. However, the advent of USB4 has brought the need to use retimers in all but the smallest form-factor systems. This is because the higher speed of USB4 as compared to earlier generations causes excessive frequency dependent loss when traversing the system’s printed circuit board. Earlier generations of USB could often get by using analog redriver circuits, but these have been found to be insufficient for USB4 because redrivers improve only the eye height and not the eye width.

Crystals are used in USB4 retimers because these circuits must generate a clean transmit clock when operating in certain modes. USB4 retimers must operate in a long list of different modes that are determined during operation via negotiation. This is because the USB-C connector over which USB4 operates is sometimes known as “The one connector to rule them all.” The USB-C connector supports all the speeds and widths of USB as well as the DisplayPort and Thunderbolt protocols, among others.

New EA-10000 series: Superior functionality, accuracy and performance specifications

- Yes to more models – bidirectional & regenerative
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- Yes to easy communication – swappable interfaces
add/drop opportunities found in the protocol. USB3 and USB4 operate in half-duplex mode with a continuous signal, so the opportunity arises to use lower-latency bit-level retiming based on the recovered clock signal. The crystal source is also used for the link for all operating speeds in certain training and calibration modes as well as in some test modes. The crystal also typically provides the clock to internal portions of the retimer device.

Crystals create an accurate and stable frequency because their oscillation results from the flexing of the physical crystalline material in an electric field. Since a crystal has a specific size, shape, and mechanical stiffness, it can flex only within a specific small frequency range. Efficient sustaining crystal oscillator circuits for USB4 applications include both single-ended and differential crystal oscillator structures. With differential oscillators, capacitively coupling the two sources adds DC stability.

The crystals that are used in USB4 retimers are the same as, or similar to, those that are used for USB4 sources. They must be cost-effective as they carry the economics of the retimer device instead of that of the source device. These components typically have small form factors with an example being a 2mm x 1.6mm part. Typical specifications for such a crystal would have a nominal frequency of 25 MHz, would operate in a fundamental mode, and would have a clock accuracy of +/- 300 parts per million (PPM) or better.

The drive for ever smaller and less expensive future solutions will likely see the oscillator integrated or otherwise brought inside the package via a microelectromechanical system (MEMS) device or small crystal. The possible use of retimers in USB-C cables further heightens the need for size-constrained and low power solutions.

To address a wide variety of use models, Kandou is currently shipping USB4 retimers in volume. www.kandou.com

All great things begin with a single step – or in Sager’s case a single storefront. Recognized as the first distributor in the industry, Sager opened for business one hundred thirty-five years ago in downtown Boston, Massachusetts, servicing the growing interest in radio technology.

Under the vision and leadership of Joe Sager, the company established a thriving business that put the needs of its customers first. Since then Sager has grown into a North American distributor of interconnect, power, thermal and electromechanical products and a provider of custom design and manufacturing solutions.

And after 135 years, Sager still operates just as Joe envisioned – based on a commitment to exceeding expectations and keeping the customer at the center of its business philosophy.
Considerations when designing for power

System designers often have to choose between standard, custom, and modular power supplies. When designing a system that requires some form of power conversion, the power source (power supply or battery) is often one of the last items to be considered. In some ways this makes sense because the total power requirement for the system and the different voltages used within the system must be identified first before the power supply is selected. However, that may not leave enough time to properly choose the power supply that best meets all the needs of the system. Let’s look at some of the key considerations when choosing a power supply in the design of your end system.

The type of output current limit required to power the system load(s) affects the type of power supply that needs to be selected. A constant voltage output with a hiccup-mode over-current limit protection scheme is designed for a more resistive type of load, such as the controls or displays within a system. A hiccup-mode over-current limit will shut down the output once the over-current point is reached, and then turn back on after a short time to see if the load has fallen below the over-current point. If it has, the power supply will continue to provide power. If it has not, then the output will shut down again and repeat the cycle until the load is reduced, thereby causing the output to “hiccup.”

By comparison, a constant current output is designed to reduce the output voltage and maintain the output current until the output voltage reaches a low limit and the output is shut off. This type of over-current protection is designed for highly capacitive loads or battery charging.

Sager Electronics recently worked with a customer who required both a constant current output for charging batteries and a constant voltage output to power their system load. We identified the PBA series power supply from Coilcraft’s XGL Family of molded power inductors is available in a wide range of inductance values (from 82 nH to 470 µH) and current ratings up to 43 Amps. With up to 60% lower DCR than previous-generation products, they are the most efficient power inductors available today!

Their ultra-low DCR and higher Ims also allow XGL Family inductors to operate much cooler than other components. All XGL Family inductors are qualified to AEC-Q200 Grade 1 standards (with a maximum part temperature of 165°C) and have no thermal aging issues, making them ideal for automotive and other harsh environment applications.

Download the datasheets and request free samples at www.coilcraft.com/XGL.
DESIGNING FOR POWER

COSEL to power both output requirements—constant voltage or constant current. Working with Sager’s electrical and mechanical engineers to design a custom control board, a sheet metal enclosure, and DC/DC converters to regulate the battery voltage to the load, the customer was provided with a custom power solution using standard AC/DC and DC/DC power supplies.

Another consideration when designing your end system is its peak and steady state power requirements. Steady state refers to the power the system needs on a regular basis to perform its basic tasks, while peak refers to the power needed for a short period to perform a special task for the system. Driving a pump, a motor, a print head, or a highly capacitive load are examples of systems whose peak power needs may be substantially more than their steady state requirements. These items need extra power to begin moving or operating at start-up, after which they revert to require significantly less power to maintain their operation. If the power supply is designed to constantly meet the peak power requirements for the load, then you may be using a power supply larger than is necessary. Power supplies with peak/boost capability, or supplies that have both convection and air-cooled ratings, can be used to power these types of loads.

Rather than sizing the power supply for the worst-case peak current, a better option is to use a power supply that can provide the peak current while being designed for the non-peak operating power. For example, some power supplies are designed to meet peak power requirements two to three times their normal output ratings. In this case, the peak power rating will be specified with a maximum duty cycle and for a limited period. Calculations need to be made to ensure the power supply can meet the peak power requirements while maintaining an average power level below the steady state power capabilities of the power supply. If the peak power requirements are for a short enough duration with a reasonable duty cycle, the power supply can be designed for the lower steady state power requirements and still provide the power needed for the peak power requirements. This allows the system to use a smaller, less expensive power supply that still meets all the system power requirements. Sager stocks the leading manufacturers of peak power supplies such as Cinson, MEAN WELL, RECOM Power, TDK-Lambda, and others.

Another common design challenge is to decide between a single output supply in conjunction with multiple DC/DC converters vs. a custom power supply. Suppose your power supply needs to provide multiple output voltages to run all the different loads within your system. In that case, a single output supply with multiple DC/DC converters may not be the best solution due to space and complexity of the design. A custom power supply may be able to meet all your needs, however: such a device may have a long design cycle with high costs for non-recurring engineering (NRE) and agency approvals, and perhaps have minimum quantities that do not match your requirements. Even if a custom power supply does appear to offer the best choice, it may be that the system design is still in flux, the final output voltages and currents are not set in stone, but you still need power supplies to work out the final design, so what do you do?

One option is to consider a modular/configurable power supply. A modular power supply provides the ability to have up to 24 different outputs in a variety of sizes and power levels with low minimum quantities, no long design cycle, and no additional NRE charges or safety agency approvals. The modular power supply can be configured to provide the output voltages and currents your system needs to operate all of its different loads. Some of these outputs can even be configured for constant current operation or have peak power capabilities. The latest generation of modular products offers size, price, performance, features, and quality enhancements, making them attractive and reliable solutions. With an expansive inventory of power modules and chassis, coupled with our years of applied experience and expertise, Sager can provide a configured solution that meets your precise power requirements.

What if you take the power supply outside the system and employ an external power supply? This removes the heat the power supply produces and eliminates the space required for the power supply from the system enclosure. How the consideration becomes how the power supply connects to the system enclosure and the loads within the system. One of the critical issues here is choosing an appropriate connector for the system before choosing the external power supply. External power supplies have a designated standard output connector based on the power level and the manufacturer of the power supply. If the connector in the system does not match the connector on the power supply, a modified standard version of the power supply may be required to have the proper mating connector attached, with minimum order quantities and potentially higher costs.

A final consideration is whether a design relies on batteries as a primary or secondary power source. Batteries, which accept, store, and release electricity on demand, power everything from small electrical devices to medical devices, robotics, electric vehicles, and more. As automation and electrification becomes increasingly common across all industries, a design engineer will need to consider recharageability, energy density, power density, shelf life, safety, form factor, cost, and flexibility when deciding which battery solution to use. Sager Electronics’ growing line card of battery solutions and custom battery pack capabilities can help solve your battery design requirements.

With a world-class line card in interconnect, power, and electromechanical products, and expert technical sales and support, Sager has the standard, custom, and modular power products, and solutions for any power system design.

www.sager.com

“A common design challenge is to decide between a single output supply in conjunction with multiple DC/DC converters vs. a custom power supply”
Pre-switching beats hard-switching and soft-switching

One of the core tasks performed by power conversion systems is switching, which is implemented using semiconductor devices like BJTs, thyristors, MOSFETs, and IGBTs. When these devices are turned on or off, the transition time is short, but it is not instantaneous. The time taken to transition between states results in wasted energy, which occurs at the intersection of voltage and current waveforms and is known as switching loss.

The traditional switching approach, known as hard-switching, involves simply forcing the device on or off by using the current or voltage signal to directly control the device. In addition to being hard on the device and resulting in switching loss, hard-switching also generates noise in the form of electromagnetic interference (EMI).

Soft-switching, which involves using the current or voltage signal to directly drive a device to turn on and off (commutate) by achieving zero current or voltage, is minimal overlap of current and voltage waveforms of the switching devices. This method eliminates switching losses and EMI. However, traditional soft-switching forced-resonant circuit topologies have limited adaptability across varying input conditions and load ranges.

Pre-Switch, Inc. has solved the issues of computational limitations, cost, and complexity that previously prevented forced-resonant soft-switching from achieving widespread success. Known as pre-switching, this technology is based on the use of an embedded artificial intelligence (AI) integrated circuit (IC) called Pre-Flex, which precisely controls and adjusts the timing of a very small and low-cost resonant circuit to ensure that there is minimal overlap of current and voltage waveforms of the switching devices.

The Pre-Flex IC learns and adapts in-circuit on a cycle-by-cycle basis to guarantee optimal soft-switching despite any changes in input voltages, output loads, system temperatures, and manufacturing tolerances. In addition to eliminating up to 95% of total switching losses, pre-switching technology also significantly reduces EMI because there is virtually no power radiated during transistor commutation. Furthermore, the technology can be used to enable virtually any desired dv/dt per switching cycle, which is a large enabler for newest faster-switching, wide-bandgap (WBG) devices.

The Vox Power VCCS300 module provides cooling techniques. For example, the Vox Power technology markets. The Vox Power VCCS300 fan-less power supply series delivers a silent 300 watts of continuous output power in a rugged and miniature 4” x 2” x 1.61” package, which can be cooled using conduction, convection, or forced air cooling techniques.

The Vox Power VCCS300 meets the latest international medical (BF Rated) and ITE safety approvals and is perfectly suited for use in ventilators and lab equipment as well as battery charging and PoE applications in addition to the more established industrial, IT, and medical markets. The product is suitable for Class I or II equipment and carries multiple immunity and MIL-STD compliance including MIL-STD 810G, MIL-STD 461F and MIL-STD 704F making it perfect for applications in rugged and high-vibration environments.

www.vccs300.com

The Vox Power VCCS300 modular power supply with extended output voltage ranges.

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www.vccs300.com

The Vox Power VCCS300 modular power supply with extended output voltage ranges.
Memory Suppliers See Innovation Opportunities – and Challenges

The semiconductor memory business thrives on innovation, strategic alliances, and production efficiencies, but the challenges are legion too.

In the semiconductor memory business, every innovation counts as does every penny invested in technology and manufacturing advances. Recent investment and divestiture actions at the top memory vendors and their smaller competitors point to the significance of combining innovation with strategic initiatives to thrive in the marketplaces. According to analysts and industry executives.

Memory suppliers are being compelled to couple innovation with other strategic initiatives, including the addition of software suites and other IPs, collaboration with customers and mergers and acquisitions that can help boost scale and create new opportunities for stakeholders. The M&A actions have led to the forced exit of some manufacturers, allowing survivors to hone their competitive edge by adding design engineering teams, technical employees, and production facilities.

Semiconductor Memory

Intel Corp. showed this trendline in the second quarter. Rather than doubling down on a losing business amidst high technology challenges, the company announced plans to exit its Optane memory business, adding to other actions it had previously taken in the highly competitive market.

By 2025, the company would have completely wound down most of its memory operations, depending instead on former rivals for its internal needs.

“We further sharpened our focus in the second quarter [by] setting our core business and making the difficult decision to wind down our efforts in Optane, as we embrace CXL, a standard which Intel pioneered,” said Patrick Gelsinger, Intel’s CEO, during a call with analysts. “These assets are actions last year in NAND and the sale of McAfee.”

While Intel is exiting the memory market, other suppliers are digging in and expanding research, design, and other development activities, including the expansion of existing production facilities and plans to build new ones as in the case of Micron Technology. The company recently unveiled plans to spend as much as $150 billion over the next 10 years on new fabrication plants.

memory-makers are planning to add new fabs because they see opportunities to build competitive advantages through design engineering and collaboration with customers seeking innovative solutions in a wide range of product areas, including in AI, connectivity, data cloud infrastructure and PCs.

SK Hynix is a prime example of a memory manufacturer that appears focused on setting the innovation agenda in the business. The company agreed in 2020 to acquire Intel’s NAND business for a total of $9 billion as a spin-off of that deal will close in 2025. That is when SK Hynix expects to take over all of Intel’s remaining NAND assets, including certain IP related to the manufacture and design of NAND flash wafers, R&D employees and the Dalian fab workforce,” according to Intel when it updated the details of the transaction last December if the deal closes in March 2025 as expected. SK Hynix would need to pay Intel the final bill of $2 billion, the company said.

New opportunities, new business

Reflecting the opportunities it sees in differentiated technology solutions, South Korea-based SK Hynix did not pool the Intel acquisitions into its existing business. Instead, the world’s second largest memory chip maker, floated a new business named Solidigm to explore what it calls “advancements in storage technology that are critical to unlocking data’s unlimited potential.”

Solidigm is owned by SK Hynix but based in Silicon Valley and headed by Robert Cooke, formerly head of Intel’s non-volatile memory solutions group. It formally began operations in December 2021 to focus on creating what the company described as “next-generation SSD solutions.”

Those opportunities should widen as Solidigm becomes better established in the market and as its leverages design innovation opportunities with customers. The NAND flash market promises huge growth opportunities. Market Research Future expects the SSD market to grow at a compounded annual growth rate (CAGR) of 15.2 percent between 2020 and 2030. This would make it one of the fastest-growing segments of the global semiconductor industry, which is forecast to expand at a strong but slower rate during the same forecast period. The SSD market growth rate is not expected to be uniform, though, with North America forecast to lead the expansion on surging demand from the data communications market.

The SSD market is also fragmented and may experience further consolidation in the years ahead. Current Players include companies like IBM, SK Hynix, Samsung, Micron, Toshiba, Kingston Technology, SanDisk, Lite-On, and Western Digital. However, these companies are not competing solely on production excellence and supply availability.

They are forming alliances, collaborating on product development, and striving to gain competitive advantages through mergers and acquisitions as in the case of SK Hynix and Intel. Design innovations and other technology initiatives have also helped the market leaders, according to industry executives and observers.

Samsung, for example, in July rolled out what it termed its second-generation Smart SSD, which can process data directly, reducing the transfers between the CPU, GPU, and RAM. The new Smart SSD is jointly developed with customers who contributed software and other IP on it in Arm cores. Collaborative development activities like this have become essential to push the technology forward as companies race to offer it as an alternative to regular HDDs.

“Commercialization of the first-generation SmartSSD, in collaboration with...”

Exclusively sponsored by Mouser Electronics
Dazed and confused about switches?

Switches are ubiquitous, so why do so few of us use the correct terminology?

Even though their underlying technologies are more than 100 years old, electromechanical switches continue to permeate today’s electronic products. For example, I just looked at the spiffy new RIGOL DS1054 oscilloscope sitting on my desk ("my precious") and counted 39 pushbutton switches on the front panel alone.

Yes, we could use touch screens to replace many switch operations, but there’s something satisfying about the tactile feedback provided by honest-to-goodness electromechanical devices, which are more rugged and reliable in hostile environments like industrial settings.

What is a switch?

In electrical engineering, the term “switch” refers to an electrical component that can disconnect or connect a conducting path in an electrical circuit, thereby interrupting the electric current or diverting it from one conductor to another.

Switches come in a wide variety of shapes and sizes, from the knife switches favored by Igor and Frankenstein (“It’s alive!”) to magnetic switches (“It’s alive! It’s Frankenstein!” favored by Igor and Coolidge, Jr. and Marshall Kincaid in 1957, which is the same year I decided to grace this planet with my presence.)

Poles and throws

The term “poles” refers to the number of electrically distinct switches that are controlled by a single actuator. The term “throws” refers to the number of separate wiring paths (other than “open”) that are associated with each pole.

In the case of toggle switches, I tend to think of the contact connected to the fixed side of the actuator as being the pole, and the contact associated with the moving side of the actuator as being the throw. In this context, the term “actuator” refers to the part of the switch to which an external force is applied to operate the switch, for example, a lever, rocker, knob, or button.

Single-pole, single throw (SPST) switches, particularly pushbutton switches, are typically “open” (not connected) by default, so their throw contacts are referred to as being normally open (NO), but normally closed (NC) versions are also available. In the case of single pole, double throw (SPDT) switches, the common terminal is usually annotated as “COM.”

Pushbutton switches are commonly of the “momentary” variety, which means they are active only while the pushbutton remains pressed. However, “latching” versions—push once to activate and push again to deactivate—are also available.

In the case of more complicated switch configurations (typically anything more than single and double poles and/or throws), such as multi-throw rotary switches, it’s common to start using numbers like 1PST (one pole, eight throws).

Make and break

Consider an SPST switch. When this switch is in its OFF state, it is said to be “open” because the effect is the same as if the switch were to be removed from the circuit leaving an “open circuit” which refers to an electrical circuit that is not complete. By comparison, when the switch is in its ON state, it is said to be “closed,” in which case the effect is the same as if the switch were to be replaced by a piece of conducting wire.

It’s also common to use the term “make” (i.e., “making the connection”) to refer to closing the switch, and “break” (i.e., “breaking the connection”) to refer to opening the switch.

In the case of a switch with more than one throw like an SPDT toggle switch, for example, then the most common type is classed as break-before-make (BBM). This means the moving contact breaks the existing connection with the current throw before making a new connection with the new throw.

Although they are less common, it’s also possible to obtain make-before-break (MBB) switches in which the moving contact makes connection with the new throw before breaking its connection with the existing throw. These are also known as “shorting switches.”

SPCO and DPCO

When we think of an SPST switch, we may also think of it as operating in an ON-OFF manner. In the case of a SPDT switch, we might describe this as operating in an ON-ON manner.

There are also toggle and rocker switches that are like SPDT switches—including using identical schematic symbols—except they have three positions for the lever (rocker). These are known as single pole, changeover (SPCO) or single pole, center off (SPCOC) devices. Similarly, there are double pole, double throw equivalents called double pole, changeover (DPCO) or double pole, center off (DPCO). We may think of these switches as operating in an ON-OFF-ON manner.

Who do you trust?

There are, of course, many purveyors of switches. One of my favorites is C&K (ckswitches.com), which recently became part of Littelfuse (littelfuse.com), not least that the company was formed by Charles A. Coolidge, Jr and Marshall Kincaid in 1957, which is the same year I decided to grace this planet with my presence.

One reason I favor C&K is that they offer 55,000+ base products and support 8,500,000+ switch configurations and combinations. Their strength is their ability to offer a full range of catalog products that can be rapidly customized into tailored solutions for their clients, of which I’m one.

The future is now

Will we always be chained to electromechanical switches? Probably not. For example, the folks at UltraSense Systems (ultrasensesys.com) have developed an ultrasonic sensor that makes a grain of rice look large by comparison.

This sensor can be mounted behind, or embedded in, a control surface of any practical thickness, because its ultrasonic signal can penetrate anything from hard plastic to stainless steel up to 5mm and 2mm thick, respectively.

In addition to the ultrasonic transceivers, four piezo strain gauges allow this little scamp to detect deformations as small as 0.1mm in the surrounding material. It also boasts a neural touch engine (NTE) that supports native machine learning (ML) that can be taught to differentiate between intended vs. accidental touches. It probably goes without saying that the one thing this little beauty doesn’t give us is any form of switch bounce.

As always, we certainly do live in exciting times.

www.biglawswitch.com
Meet the smallest DFN MOSFETs in the world

Neperia has announced the release of a new range of 20V and 30V MOSFETs in the world’s smallest DFN package, the DFN6003. Neperia already offers ESD protection devices in this package and has now succeeded in bringing it to their MOSFET portfolio, a feat as yet unmatched in the industry.

Next generation wearable andearable devices are incorporating new levels of artificial intelligence (AI) and machine learning (ML), creating several challenges for product designers—available board space is at a premium and heat dissipation becomes a problem.

The ultra-low-profile DFN6003 package, measuring only 0.63 x 0.33 x 0.25mm, uses 13% less space than MOSFETs in the next smallest package (the DFN6004). This size reduction has been achieved without compromising device performance: in fact, the RDS(on) of these devices has been reduced by 74%, helping to improve efficiency and enabling wearable equipment designers to achieve greater power density.

www.neperia.com

OGN series fuse holder is now THR compatible

Surface-mount technology (SMT) components are used with solder reflow processes to fully automate the assembly. While through-hole technology (THT) components offer a board-mounted solution, they are typically not designed for the rigors of a reflow process. In these cases, a second soldering step is necessary. This additional step is time-consuming and allows additional margin for error.

The solution is through-hole reflow (THR) components that combine the features of PCB THT mounting with a component capable of withstanding the high thermal stress of a reflow oven.

SCHURTER is known for its compact high-performance fuse holders, and the OGN series open fuse holder for 5x20 mm fuses is no exception. In addition to existing THT and SMT versions, the series now offers a version that is compatible with THR solder processes.

www.schurter.com

Increased access to MIL-PRF-55342 chip resistors

New Yorker Electronics, Co., Inc., a global franchised distributor of passive electronic components, discrete semiconductors, and supply chain services, has announced the expansion of its ready-to-skip inventory of Vishay Dale (Military M/D55342) RCWP-thick film and E/M thin film surface-mount resistor series.

These QPL MIL-PRF-55342 chips are widely specified for employment in the broadest range of mission-critical military, aerospace, weapons systems, satellites, handheld communications, and any military/non-military design in which space is limited. Vishay’s high reliability RCWP-thick film and E/M thin film resistors, together with multiple lines of Vishay resistors are now available from New Yorker Electronics.

www.newyorkerelectronics.com

Crystal oscillators deliver peak performance in non-space applications

Q-Tech Corporation has introduced the GTCC333 Series of miniature SMD crystal oscillators, which are designed to provide superior performance over MEMS devices in a wide-range of non-space military, communications, instrumentation, and avionics applications.

Their unique 3-point XO mount and miniature, ultra-low-profile (3.2 x 5 x 1.2mm) packaging provides the industry’s best combination of footprint/height/length, mechanical stability, and electrical performance. These devices also offer industry-leading mechanical and frequency vs. temperature stability, along with better vibration and shock tolerance than their MEMS counterparts.

The devices, housed in a hermetically sealed ceramic package with gold contacts, are tested for MIL-STD-202 compliance for vibration (Method 204 D) and shock (Method 213 J).

www.q-tech.com

SMT heat pipes for thermal management

Thermal management has always been an important part of design but is gaining prominence with the development of wide-bandgap semiconductors. These improved frequency and power capability of these devices are raising the average operating temperature of power conversion and amplifier circuits, thereby stressing surrounding components.

Copper-based heat pipes have great thermal conductivity but are also electrically conductive. Large ground planes and heat sinks work well but transferring heat to these devices from the source can be difficult to optimize. A novel thermal management solution is SMT heat pipes, like the Q-Bridge series from Kyocera-AVX. These are packaged in familiar EIA case sizes similar to MLCCs but are not electrically conductive and have extremely low capacitance loading. These SMT heat pipes fill a thermal management solution gap for applications needing to be smaller and lighter yet retain their performance and reliability at higher temperature operating conditions.

These SMT heat pipes are manufactured using Aluminum Nitride or Beryllium Oxide with thermal conductivities ranging from 40 to 380mW/°C and packaged in EIA case sizes from 3737 down to a miniature 3032. Capacitance values can get as low as 7 femtofarads (fF) and top out at 0.2 fF which makes them ideal for mounting directly on to transistor and IC signal pins.

Mounting follows traditional guidelines but three termination options exist for users to review different thermal conductivity and capacitance values. The varied amounts of metalization on the ceramic, cross-sectional area of the ceramic chip, and the amount of surface area contacting the heat source all contribute to these parameters. Voltage ratings are correlated to their size and range from 100 to 4000V. From reducing thermal noise in LNA’s to cooling GaN transistors, their wide range of specifications make these viable for many applications encountering thermal and size design constraints.

Multiple tests were performed to quantify the improvements afforded by SMT heat pipes. The illustration shows two series resistors in parallel with a pair of Q-Bridges. The resistors were powered up until they reached 1W or until they heated up to 85°C, whichever came first. The heat pipes were mounted on the common resistor pad and the opposing terminations were connected to heat sinks. At 0.75W the uncooled resistors had already reached 85°C, while the cooled resistors only measured roughly 62°C. The cooled resistors could achieve 1W and were well below the maximum allowed component heating. A second test held the power constant at 841mW and instead compared the cooling performance of a metal heat sink against a singular SMT heat pipe. The heat sink attached to the resistor reduced heating by 17°C, while the Q-Bridge reduced heating by 45°C.

SMT heat pipes are one example of how the passive electronics industry is keeping up with active component trends. Designing high temperature capacitors, inductors, resistors, etc. to be able to withstand harsh environments is important, but it’s also relevant to know that there are devices like the Q-Bridge that are intended to pre-empt thermal issues

Increased resistor power handling with two Q-Bridge devices

“Large ground planes and heat sinks work well but transferring heat to these devices from the source can be difficult to optimize”
Modern thermal analysis overcomes complex electronic design issues

By combining finite element analysis with computational fluid dynamics, designers can perform complete system analysis using a single tool.

Today’s modern electronic designs require ever more functionality and performance to meet consumer demand. These requirements make scaling traditional, flat, 2D-ICs very challenging. With the recent introduction of 3D-ICs into the electronic design industry, IC vendors need to optimize the performance and cost of their devices while also taking advantage of the ability to combine heterogeneous technologies and nodes into a single package. While this greatly advances IC technology, 3D-IC design brings about its own unique challenges and complexities, a major one of which is thermal management.

To overcome thermal management issues, a thermal solution that can handle the complexity of the entire design efficiently and without any simplification is necessary. However, because of the nature of 3D-ICs, the typical point tool approach that dissects the design space into subsections cannot adequately address this need. This approach also creates a longer turnaround time, which can impact critical decision-making to optimize design performance. A more effective solution is to utilize a solver that not only can import the entire package, PCB, and chiplets but also offers high performance to run the entire analysis in a timely manner.

Celsius thermal management solutions

Cadence offers the Celsius Thermal Solver, a unique technology integrated with both IC and package design tools such as the Cadence Innovus Implementation System, Allegro PCB Designer, and Voltus IC Power Integrity Solution. The Celsius Thermal Solver is the first complete electrothermal co-simulation solution for the full hierarchy of electronic systems from ICs to physical enclosures. Based on a production-proven, massively parallel architecture, the Celsius Thermal Solver also provides end-to-end capabilities for both in-design and signoff methodologies and delivers up to 10X faster performance than legacy solutions without sacrificing accuracy.

For PCB and IC packaging, engineering teams can combine electrical and thermal analysis and simulate the flow of both current and heat for a more accurate system-level thermal simulation than can be achieved using legacy tools. In addition, both static (steady-state) and dynamic (transient) electrothermal co-simulations can be performed based on the actual flow of electrical power in advanced 3D structures, providing visibility into real-world system behavior.

Designers are already co-simulating the Celsius Thermal Solver with the recently acquired Future Facilities’ 6SigmaET electronics thermal simulation software, which provides state-of-the-art intelligence, automation, and accuracy. The combined workflow that ties Celsius FEA thermal analysis with 6SigmaET CFD results in even higher-accuracy models of electronics equipment, allowing engineers to test their designs through thermal simulations and mitigate thermal design risks.

Conclusion

As systems become more densely populated with heat-dissipating electronics, the operating temperatures of those devices impact reliability (device lifetime) and performance. Thermal analysis gives designers an understanding of device operating temperatures related to power dissipation and that temperature information can be introduced into an electrothermal model to predict the impact on device performance.

The robust capabilities in modern thermal management software enable new system analyses and design insights and empower electrical design teams to detect and mitigate thermal issues early in the design process—reducing electronic system development iterations and costs and shortening time to market.
Chip design never looked more appealing

EDA

It’s a great time to be a chip designer or a verification engineer, even though these jobs are increasingly more difficult as challenges get tougher and the need to bring design, packaging, and manufacturing closer together becomes more acute. In parallel, competitive time-to-market pressures continue to demand ever shorter schedules.

Fortunately, engineers rarely run from a challenge. They’re also captivated by new applications for chips growing exponentially in various markets, including the popularity of an open-source instruction set architecture (ISA) known as RISC-V that highlights the catchphrase “Democratization of Chip Design.”

The electronic system design (ESD) market that supports chip design and verification via electronic design automation (EDA) tools and semiconductor IP is also entering an exciting period. The ESD market is hot again. Demands for automation tools and IP are rising as chip and system complexity increases. ESD is where electronics begins and is a vital component of the global electronics industry. With industry revenue at approximately $13 billion, ESD is small but mighty and serves the needs of a disparate ecosystem of chip, package, and manufacturing engineers that develop products driving the $2 trillion global market for electronic products. As a result, all EDA and Semiconductor IP product categories increased revenue in Q1 2022, according to the most up-to-date SEMI Electronic Design Market Data report.

Through supply chain shortages, semiconductor downturns, and semiconductor companies looking more like systems houses and vice versa, electronic system design suppliers globally are the much-needed problem solvers. They supply state-of-the-art design and verification tools and IP for the chips, printed circuit boards, and multi-chip modules that power leading edge electronic systems and products. Hardware-assisted verification (solutions that include hardware emulation and FPGA prototyping) can handle hardware/software co-design. Front-end design solutions enable the ability for designers to effectively implement a “shift left” methodology where more of the critical design decisions occur early in the design cycle.

Semiconductor manufacturers continue to push the envelope on new processes that deliver new levels of performance. The electronic system design community is responding, as always. ESD companies play a pivotal role in this push by providing the essential technologies, methodologies, and design automation tools to support these new processes.

New applications are especially encouraging to engineers who love a challenge. AI chips and AI techniques now giving design tools a huge boost, it was inevitable that applications for semiconductor-based solutions would ignite, and they are. Applications for cloud-based computing, automotive electronics (including autonomous driving), and 5G and 6G communications seem almost commonplace today. Up next is MedTech where funding is going into chips for drug discovery, patient monitoring, and remote access among other applications. Applications involving IoT and edge computing are a particularly attractive area as data processing moves down from the cloud and is located where the data is collected in real time.

Security and safety are other application areas that are growing rapidly and attempting to stay one step ahead of threats and breaches, while minimizing the occurrence and consequences of accidents such as roadway collisions.

The most galvanizing new application space may be the open-source silicon movement that has the potential to democratize chip design. This is expanding the community of specialized designers to an environment of creative enablement where anyone anywhere with innate skills can get their chip designs into silicon. It’s likely that this movement and subsequent innovations will empower the semiconductor and electronic system design communities to think differently.

All told, chip design never looked more appealing. Recent industry events, including SEMICON West and the Design Automation Conference, seemed to bear this out. Both were filled with young, enthusiastic engineers from many parts of the world eager to launch themselves into careers in electronics. In many ways, this could be considered the “Golden Age of Chip Design.”

www.semi.org/en/communities/esda
Heterogeneous compute heralds a new era in chip verification

Sumit Vishwakarma, Product Manager, AMS Verification for Siemens EDA explains why it is no longer sufficient to simulate analog and digital blocks separately in a “divide and conquer” approach. Siemens EDA offers comprehensive support for these advanced methodologies with the Symphony and Symphony Pro mixed-signal platforms. System verification now offers an average of 2 to 5X speed-up over traditional mixed-signal simulators while maintaining SPICE accuracy. It is fully configurable to work with all industry-standard digital solvers and provides robust debug capabilities within an easy-to-use interface. In addition, Symphony’s mixed-signal simulator offers a unique machine learning-based variation-aware mixed-signal solution with Solido Variation Designer. In summary, extending the support for digital verification methodologies for mixed-signal designs in modern EDA platforms is improving the coverage closure for heterogeneous SoCs. These techniques can speed time to market.

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MIXED-SIGNAL DESIGN

PHd’s comprised of complex mixed-signal circuitry with a significant amount of digital design interconnects with analog design. The high bandwidth memory interfaces use DDR PHYs with DLL-based clocking circuits which are very sensitive to device noise and variations in process, voltage, and temperature (PVt).

SerDes represent the basic building blocks of PHYs, and SerDes designs are always evolving, whether it is a new adaptive equalization scheme or digitally assisted analog blocks in the architecture. One of the most critical components in the SerDes is the clock generation, which is primarily performed via a phased locked loop (PLL). In a traditional PLL, the control data is represented as an analog voltage. As all sub-blocks are vulnerable to different sources of voltage noise, the performance can easily be degraded. This is especially a problem in advanced semiconductor process nodes where supply voltages are scaled down, decreasing the voltage headroom and signal to noise ratio. Additionally, in these types of processes, analog properties such as linearity or device matching grow increasingly inferior; as analog loops may be built from resistors and capacitors are not scaling down with the technology. All of this lead to the emergence of digital PLL architectures, which tend to benefit from process scaling. Despite the benefits that digital PLLs offer, there are also new challenges that arise, such as quantization errors and non-linearities in the control loop. These can degrade the performance and complicate the analysis compared to traditional PLLs. The level of communication between the analog and digital components in today’s SerDes is much more complex than it was in the past. The interplay between these two domains is so integral to the functionality of the SerDes that it is no longer sufficient to simulate analog and digital blocks separately in a “divide and conquer” approach. Designers must simulate these two domains collectively utilizing an array of advanced mixed-signal verification strategies to obtain the coverage closure required for first-pass silicon success.

Simulating the behavior of a mixed-signal design requires both digital and analog solvers to work in conjunction in a synchronized fashion. In mixed-signal simulation, analog solvers become the bottleneck in meeting the overall performance goal for verification. To achieve reasonable simulation speeds, many mixed-signal engineering teams employ analog behavioral modeling. However, models are becoming more challenging to develop and utilize effectively at smaller technology nodes (like 5/3nm) as design complexity, process variation, and physical effects add to the number of variables that need to be considered.

In mixed-signal design, errors most often occur at the interfaces between analog and digital blocks. Mixed-signal debug gets even more complex when the design employs advanced, low-power techniques. For example, data corruption in a digital block due to faulty power sequencing can pass to an analog block, resulting in inaccurate voltage conversion. Scenarios like this are difficult to debug by analog designers who are unaware of digital low-power techniques. Digital verification methodologies are mature, organized, and have mastered the art of automation. Analog and mixed-signal verification, on the other hand, traditionally relied on direct verification methods. While this might have been sufficient in the past, increasing complexity and design sizes necessitate more thorough and automated verification of mixed-signal SoCs. Analog verification teams must go beyond traditional methodologies like direct tests, sweeps, corners, and Monte Carlo analyses. Teams need to embrace digital verification techniques to facilitate regression testing of mixed-signal SoCs. These techniques include automated stimulus generation, coverage, and assertion-driven verification combined with low-power verification and automated debug for improved productivity.

As design complexity has spiked, so too has the complexity of verifying these increasingly sophisticated devices. SoC verification has become an exercise of applying many unique methodologies for each of the different classes of sub-design within a design. The advent of new technologies such as constrained-random data generation, assertion-based verification, coverage-driven verification, formal model checking, and intelligent testbench automation (to name just a few), has changed the way we view functional verification productively.

Data processing and computing power are moving into the cloud, which offers significant flexibility and scalability achieved by the deployment and use of massive infrastructure based on uniform computing platforms working in parallel. This infrastructure is comprised of powerful servers running the fastest processors. However, as the demands on cloud application processors continue to increase, so does the complexity of the underlying System-on-Chip (SoC) devices. New heterogeneous computing architectures are designed to bring together the CPU, GPU, accelerators into one SoC, often in multicore configurations to accelerate specific applications and algorithms. The complexity of heterogeneous architectures is resulting in a need for more focus on how we verify and validate the functionality of these SoCs.

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We are at a time when the computing performance benefits of Moore’s law are coming more slowly and at a higher cost, even as artificial intelligence (AI) applications are driving demand for extreme compute performance. According to non-profit research firm OpenAI, the amount of compute performance used to power the largest AI training runs has increased exponentially since 2012—doubling every 3.5 months.

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The company that fired up Arduino has recently played a crucial role in securing Arduino—and not just by using best practices in open-source software, but by adopting an entire security ecosystem from the maker go-to brand to brand to qualified industrial partner, keeping its promise to make everyone the innovator in their field. From smart cities to smart agriculture and more, platform can leverage popular programming languages and frameworks through the cloud-native workloads from the Cloud to the edge, and it contributes to a cloud-native developer experience across the brand's diverse and secure IoT ecosystem.

With Portenta X8, developers can leverage popular programming languages like Python, JavaScript, Java, Go, and Rust among others. It was designed for edge computing in industrial contexts, but also lends itself to building automation and smart agriculture applications.

On top of this, any X8-based project can be effortlessly bumped up a notch with advanced features provided by the Portenta Max Carrier. This carrier can transform Portenta modules into single-board computers (SBCs) or reference designs for Industry 4.0, further augmenting connectivity options with LoRa, NB-IoT, and more, as the carrier takes developers’ innovation capabilities to the max.

With products like the Portenta X8, Arduino Pro has made a huge leap forward in terms of performance, security, and user experience for enterprise customers, keeping its promise to make everyone the innovator in their field.
Advanced plastic enclosures for medical devices

The first thing clinicians and patients see and touch in the case of a medical device is the enclosure. Healthcare is one of the most demanding sectors for electronics. Lives are at stake. Electronics designed for hospitals, general practitioner (GP) surgeries, and other clinical environments must represent the absolute pinnacle of quality, and visibly so.

In fact, medical electronics must exude excellence in terms of their aesthetics, ergonomics, functionality, and reliability. This all starts with the very first thing that clinicians and patients see and touch—the enclosure.

Every electronics enclosure—regardless of application—must be robust to a certain degree. That is obvious. But the medical sector can be particularly demanding. Devices will have a hard life. They will be used heavily day after day because constrained hospital budgets mean there is never quite enough equipment. And the equipment will be passed between many users, some of whom may be newer and less well trained than others due to staff recruitment and retention issues.

All of these devices have to withstand every hard knock that comes their way and still look as new as possible because no patient wants to be treated with equipment that looks or feels old and tired. In the not-so-distant past, electronics designers had to specify bespoke housings for their products. Back then, standard enclosures were simply too generic to meet the specialist requirements of the healthcare sector.

“All that has changed now,” says Robert Cox, Vice-President of Marketing at OKW Enclosures, Inc. “The latest generation of standard plastic enclosures is application-specific and yet still highly versatile. It’s as if they were molded as bespoke housings. They don’t look ‘standard’ at all.”

Thanks to new technology, enclosures can be customized very quickly in the small volumes required by manufacturers of highly specialist medical equipment. As a result, they can go straight to an OEM’s production line, ready for installation of any printed circuit boards (PCBs) and other components. This applies right across the medical electronics sector—including desktop, handheld, and wearable devices—with electronics that are wired or designed to operate remotely.

Enclosures for wired medical devices

Wired remote controls seem to proliferate in hospitals. Controllers wired to beds and monitors are the most obvious examples. These must remain attached by wire to the apparatus they are controlling, not least because the idea of infrared remotes going missing or being mixed up is unthinkable in a healthcare setting.

OKW’s CARRYTEC handheld enclosures are designed for tough portable medical instruments. They don’t look ’standard’ at all.”

OKW’s CARRYTEC handheld enclosures are designed for tough portable medical instruments.

Robust handheld enclosures for medical instrumentation

Enclosures for portable diagnostics apparatus and other medical instrumentation must be particularly resilient because this sensitive equipment has to survive life in A&E departments, intensive care, or in outdoor emergency response situations.

CARRYTEC (IP 54 optional) has a tough integrated handle equipped with a soft-touch insert for added comfort. This handle doubles as a grip when the enclosure is mounted inversely on a suspension arm. Accessories also include a rail clamp, docking stations for charging and data transfer, along with zipped side bags for probes or cables. These probes and cables can remain connected to the device at all times for speed and convenience of operation.
Ergonomic wearable enclosures
Handheld enclosures must always be highly ergonomic because—not surprisingly—they spend their whole lives being handled. However, the bar is raised even higher for wearable enclosures because they will be in direct contact with users for extended periods of time—worn by a doctor or nurse for a long and grueling shift, for example, or by an elderly patient as the lifeline care alarm they never want to take off.

BODY-CASE is a wristwatch-style enclosure designed to fit a standard 18 mm strap for a range of bio-feedback applications. It can also be clipped to a belt or pocket, or suspended from a lanyard. This makes it suitable for geolocation electronics but also frees up the users’ hands for sterile clinical procedures.

Control center enclosures for desks and walls
Versatility is important for desk and wall-mount enclosures. If one type of housing can be used in both settings, then so much the better, not just for continuity of design language but also for the very real savings that can be passed on to budget-conscious hospitals.

PROTEC (IP 65 optional) is a new square enclosure for wall-mount and desktop control electronics. It is available in three variants: Version I has a deep recessed interface area at the rear; Version II conceals this recess under a snap-on cover; and Version III has a screw-fitted larger cover that doubles as a desk stand. These ASA+PC-FR enclosures feature a larger recessed top that can accommodate a touchscreen display or membrane keypad.

All of the enclosures discussed here address the goals stated at the beginning of this article by satisfying the needs of modern medical electronics products with respect to exuding excellence in terms of their aesthetics, ergonomics, functionality, and reliability.

www.okwenclosures.com

The design support you require
Since 1974, Central Semiconductor has been the go-to manufacturer for customers around the world who want innovative and reliable discrete semiconductors. Satisfying engineers’ most demanding design requirements for the latest applications and delivering exceptional quality are passions for the Central team. Your vision is our mission, just ask.

Standard products
Central manufactures standard semiconductors in surface mount, through-hole, and bare die terms. Diminishing source legacy devices are also readily available.

- Rectifiers
- Schottky Diodes
- & Rectifiers
- Switching Diodes
- Zener Diodes
- Current Limiting Diodes
- General Purpose Transistors
- RF Oscillator Transistors
- Darlington Transistors
- MOSFETs & JFETs
- Protection Devices
- Thyristors
- Silicon Carbide
- Multi Discrete Modules

Custom & semi-custom solutions
When standard devices do not meet your design requirements, Central excels at developing custom solutions. These may be new to Central or new to the world.

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