

Electronic PRODUCTS

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- Study: Only one in 10 smartphone owners willing to wear Google Glass regularly

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Music to, and for, our engineering ears!

How engineering is the next frontier in musical exploration

If you're like me, and love music, then some recent engineering innovations geared toward the music lover will surely delight you!

While we all can't be Tchaikovsky, that doesn't mean our level of enjoying – and in some cases creating – music can't be magnified.

Take the O-Bow, created by UK-based technology lecturer Dylan Menzies which translates data from an optical sensor and keyboard into violin music. Specifically, he notes, the optical flow sensor monitors the speed and angle of a (real) bow when it is moved across indented grooves on the top of it. The keyboardist turned violinist uses a keyboard to choose the notes to be played. So, in theory, any competent keyboard player can “virtually” become a violin prodigy in an instant!

Maybe classical music isn't for everyone though. Maybe some prefer hard-driving heavy metal.

Well some engineers started a real heavy metal band called Compressorhead which plays all the hits, from “Ace of Spades” by Motorhead, “Blitzkrieg Bop” by The Ramones and “Should I Stay or Should I Go” by The Clash. (What no “Mr. Roboto” by Styx?)

What separates Compressorhead is that the group is truly made of heavy metal – six tons to be exact. Stickboy, Bones and Fingers, as they are named, are robots wired to jam on the classic metal songs we love – and still have a rather modest concert hospitality rider, including assorted nuts, ample hydraulic fluid and three liters of engine oil. True.

All jokes aside, the ingenuity of Compressorhead highlights the advances in engineering we are seeing here at *Electronic Products*, such as in our new section called “Industry Innovators,” on Page 14 where we meet Marcus Ryle, who – as the co-founder of Line 6, created the first digital modeling guitar amplifier.

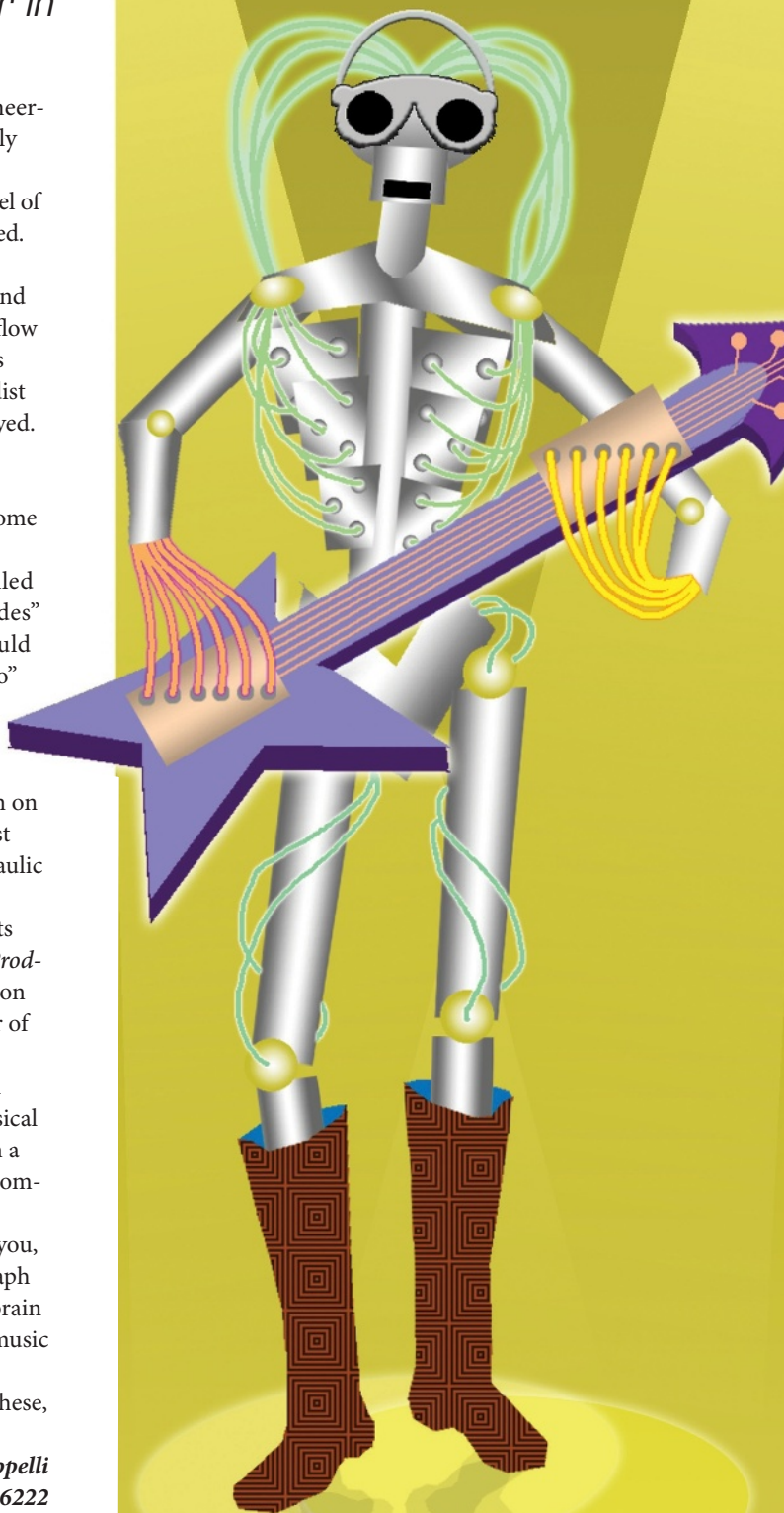
Furthermore, printed prototypes are now becoming actual products, including, yes robots – and in keeping with the musical theme – 13:30 printable headphones, which can be created on a MakerBot Replicator and combined with some off-the-shelf components for a unique look.

If all this doesn't excite the music - and robotics - lover in you, there's always headphones that feature an electroencephalograph sensor, which allows the headphones to analyze the wearer's brain patterns and determine their mood – and select appropriate music from a listing of 100 choices.

When we here at *Electronic Products* see innovations like these, it's definitely music to, and for, our ears!

John Filippelli

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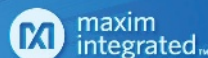
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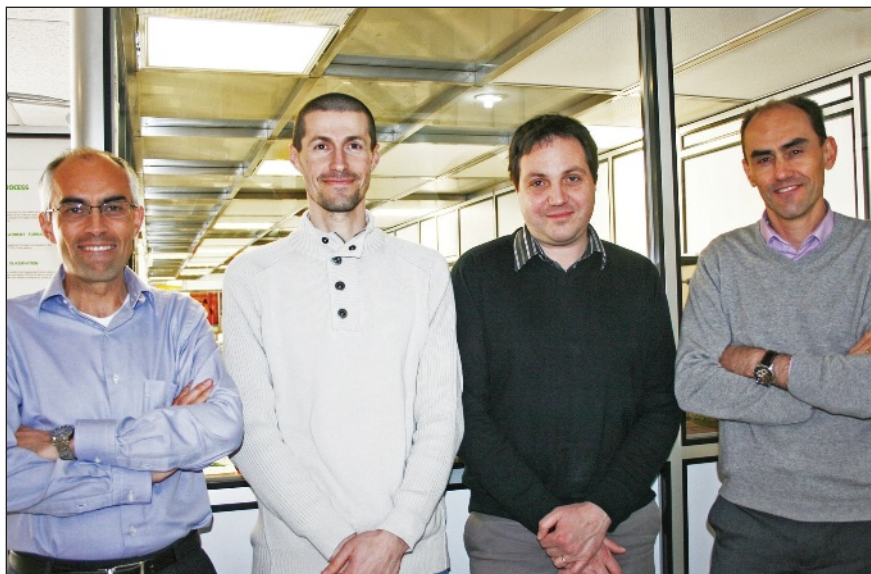
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8 Story Behind the Story

A look at the making of POY award winners



The PRAHT design team (L-R): Jean-Yves Rancurel, CAD manager, Didier Parmentier, CAD engineer, Rodolphe Cauro, R&D engineer, and Jerome Algrain, operational director.

The PRAHT resistor network from Vishay Intertechnology

Having a resistor network available that can take the heat — all the way up to a very hot 215°C — is a very good thing if you design jet engine control systems or oil down-hole extraction instrumentation or pressure sensors. For these designs and a lot more, the PRAHT four-resistor network from Vishay Intertechnology is really important.

That's why we gave the Vishay network a 2012 Product of the Year Award. It's an important device that gives engineers a TCR of 10 ppm/°C, a tolerance of $\pm 0.1\%$ or $\pm 0.5\%$, and a ratio tolerance down to 0.05% — over that wide temperature range. There are quite a few designs that just can't live without this new network.

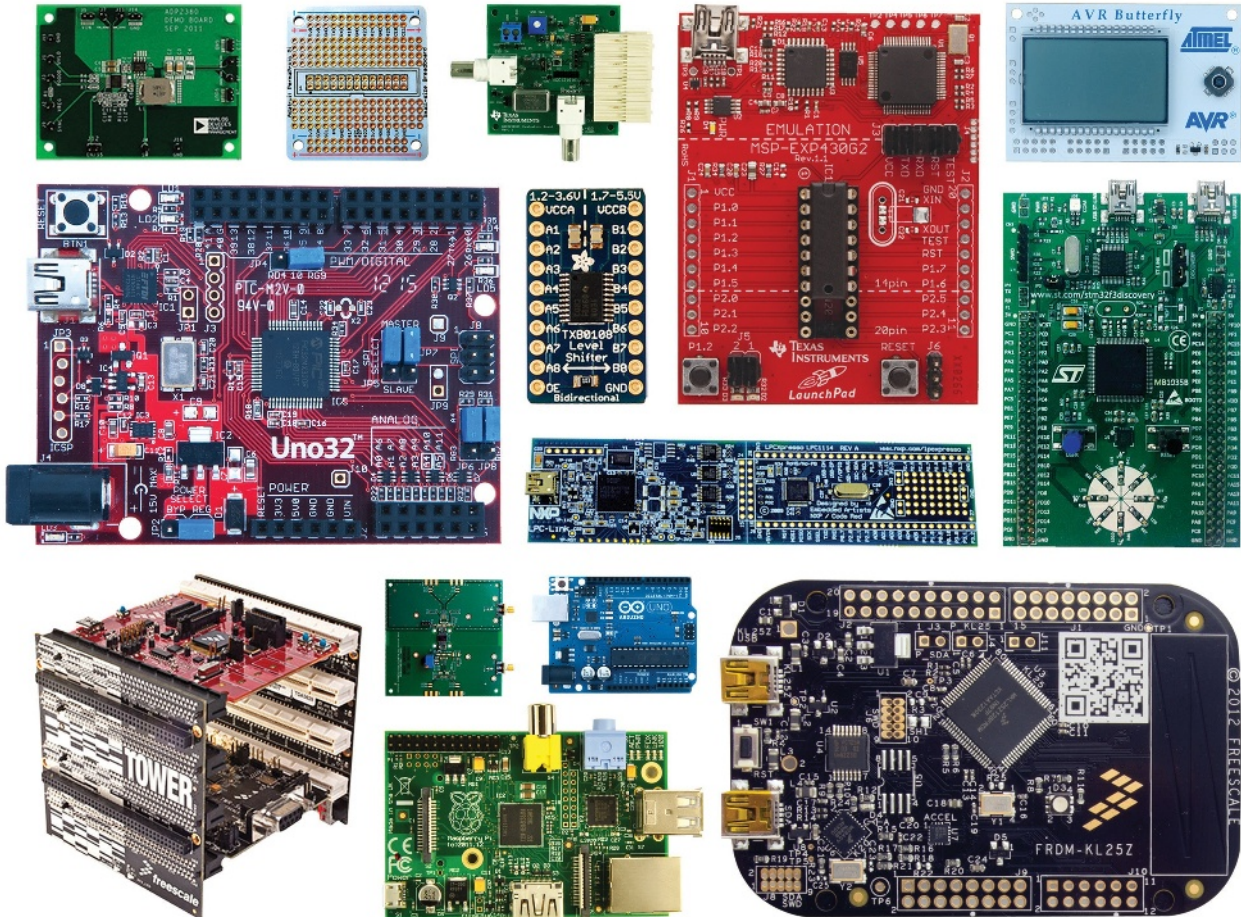
The network was designed and is produced at Vishay's facility in Nice,

France. For a customer requirement, Vishay developed the PHT and RMKHT series thin-film high-temperature chip resistors in 2009. In 2011 they decided to offer the four-resistor chip array. The tight ratio tolerance between the four elements was a big draw for precision amplifier designs.

When the team started the qualification of the new device and found tolerance matching and temperature coefficient tracking at 215°C was as good as at 140°C they were amazed and really happy. Since then the product has had excellent market success and the designers went on further and have already pushed the limits to 250°C and even ran testing at 270°C. They assured me that new versions of this product will follow soon.

Jim Harrison

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Magnetic vortex antennas may aid wireless transmission

3D magnetic vortices offer promising new applications

Three-dimensional magnetic vortices have been discovered by scientists from the Helmholtz-Zentrum Dresden-Rossendorf in Germany together with colleagues from the Paul Scherrer Institute in Switzerland. The results were published in *Physical Review Letters*. Vortex states are potential antennas for fast wireless data transmission.

“So far, magnetic vortex states have been observed only in two dimensions; in other words, within a plane,” explains Sebastian Wintz, physicist at the Helmholtz-Zentrum Dresden-Rossendorf. These magnetic vortices typically occur in nanometer-scale magnetic disks. Wintz and colleagues have now investigated three-dimensional magnetic layer systems. The researchers stacked two magnetic disks, separated by a thin nonmagnetic metal layer. Due to this special design, all magnets surrounding the intermediate layer arrange themselves in equally oriented three-dimensional vortices — an entirely new observation.

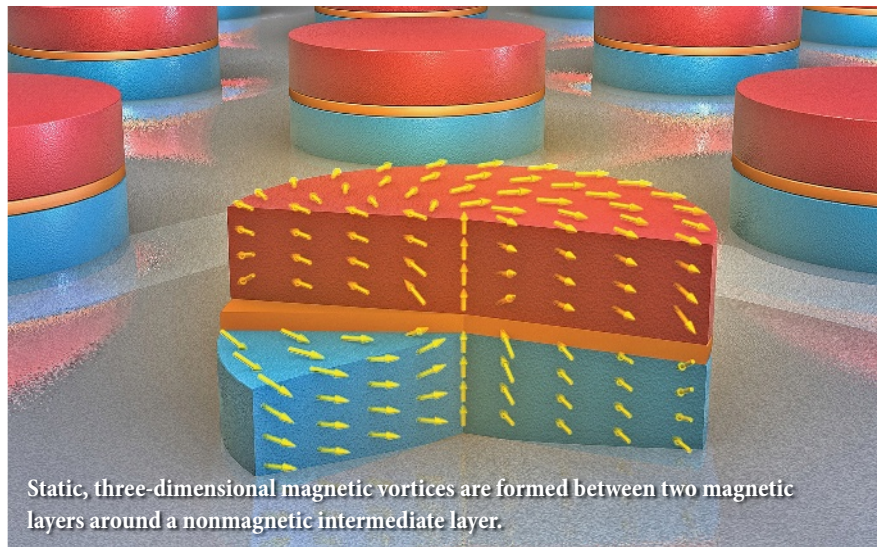
Magnetic vortices help researchers improve their fundamental understanding of magnetic materials and offer very promising applications in communication technology. “Three-dimensional magnetic vortices could permit stable high performance antennas for ultrafast, wireless transmission in, for example, mobile communications or Wi-Fi,” says Wintz. The reason is revealed by a more detailed look into a single magnetic disk, as well as the magnetic layer system.

In a magnetic disk, all magnets are arranged in a circle — just as if individual bar magnets are placed one behind another. Even though the magnets do not move, scientists refer to them as magnetic vortices. In the center of the magnetic disks, the vortex core, the magnets can no longer arrange

themselves in a circle; instead, they point out of the circle, either upward or downward. When connected to direct current, the vortex core starts moving in a circle. In doing so, it emits characteristic electromagnetic waves. If the speed is too high, though, the system will become unstable, the magnetization direction will switch, and the radio wave is interrupted. The magnets in the vortex core, now align in the opposite direction, once again start spinning and emit new waves — until the speed gets too high again. Thus, continuous data

the same direction: The magnets form a static, three dimensional vortex around the metal layer between the core and the outer edge.

In this configuration it is no longer possible for the magnets to simply switch their direction. “The three-dimensional magnetic vortices stabilize the magnetization in the vortex core,” said Wintz. The magnetic direction inside the vortex core is, thus, retained even at high rotation speeds. “It’s conceivable to obtain frequencies of more than 1 GHz,” he added.



transmission isn’t possible.

This is different if two magnetic disks, separated by a thin nonmagnetic metal layer, are stacked on top of each other. Each magnetic disk is only 10 nm thick and has a diameter of about 500 nm. The intermediate layer may cause the magnets in each magnetic disk to not align precisely along the circle and cause them to slightly incline either toward the vortex core or to the outside. The closer the magnets get to the metal layer, the more they incline in such a way that all magnets — both above and below the intermediate layer — point in

In order to produce magnetic disks with wafer-thin metallic intermediate layers, Wintz used HZDR’s electron beam lithography. “We’ve used the rare metal rhodium and we’ve finally obtained the desired properties by modifying the thickness and roughness of the layers,” he said. The magnetic vortices were revealed at the Swiss Light Source (SLS), the synchrotron light facility of the Paul Scherrer Institute. Next, the researchers will examine the behavior of such magnetic disk pairs as high-frequency vortex antennas.

Jim Harrison

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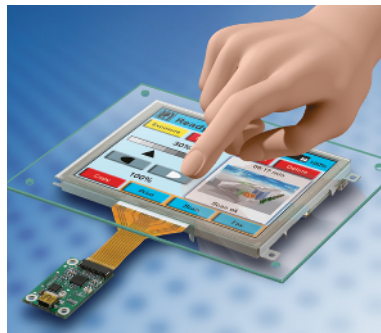
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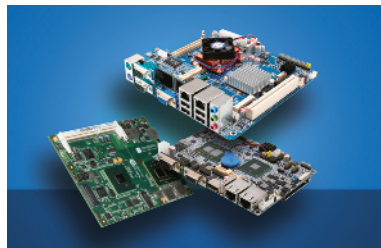
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12 Outlook

Innovations impacting product and technology

Reducing energy use by 90% in comm networks

The Internet just turned 20 years old and the amount of data traffic has increased and will continue to increase exponentially and we need a way control the energy consumption by the communications

networks. Optimizing the networks for energy consumption is what we need to do, according to researchers at the GreenTouch consortium, which is composed of information and communications technology companies, academic, and non-governmental research experts.

The GreenTouch initiative, started in 2010 and based on

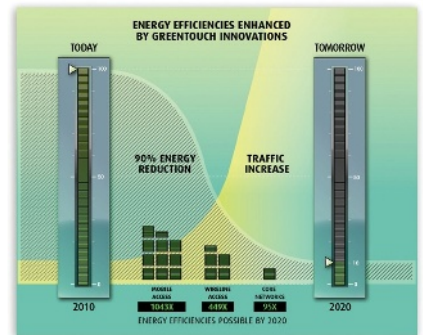
groundbreaking research conducted by Bell Labs, concluded that information and communication technology (ICT) networks had the potential to be four orders of magnitude (10,000 times) more efficient (than 2010 levels). This conclusion is based on a fundamental analysis of the underlying components of ICT networks and technologies (optical, mobile, processing, routing, and architecture) and their known physical limits.

In May 2013, GreenTouch announced a research study that shows net energy consumption in overall communications networks can be reduced up to 90% by 2020. The findings are based on network models for 2020 integrating the new architectures, technologies, and protocols developed both inside and outside of the consortium over the past three years, while taking into account the dramatic increase in traffic anticipated in communication networks.

GreenTouch provides the platform for innovative researchers, engineers and technology experts from around the world to work together and accelerate their efforts from idea creation over demonstration to standardization and policy influencing. Right now, the consortium members have 16 projects underway. These projects are being developed and delivered by working groups composed of volunteer representatives from GreenTouch member companies, directed by the GreenTouch Technical Committee.

Find more information at www.greentouch.org.

Paul O'Shea

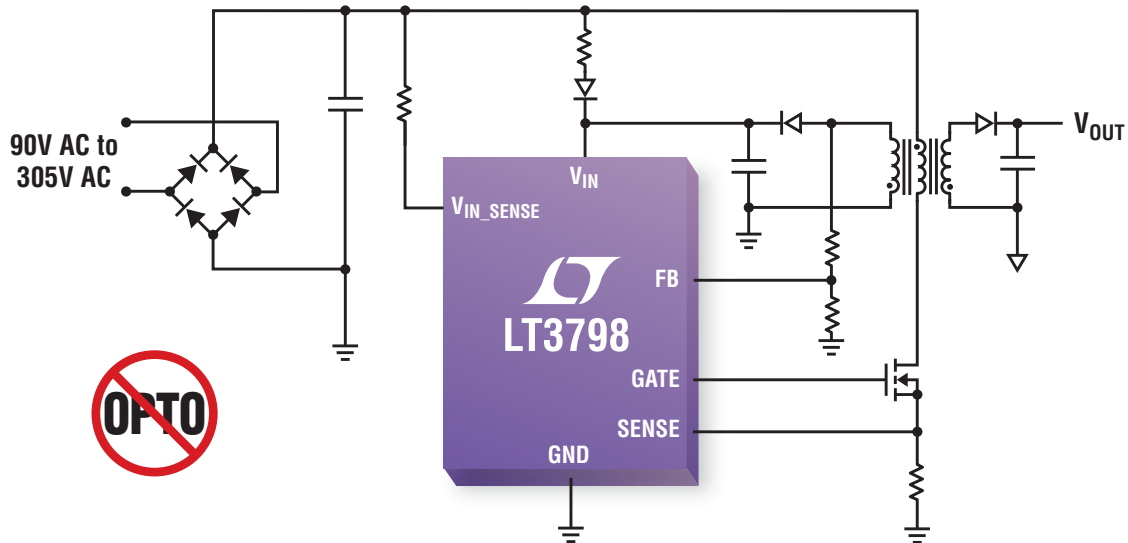


GreenTouch

GreenTouch.org

By 2015, the consortium expects to deliver demonstrations of the key components, architectures, and technologies needed to realize a fundamental re-design of comm networks that are optimized for maximum energy efficiency.

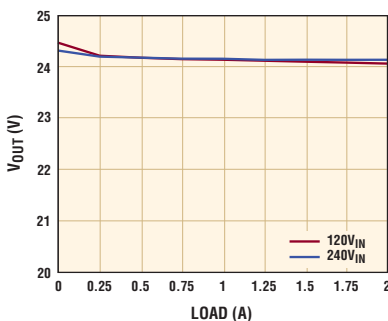
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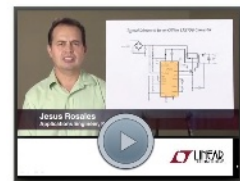


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14 Industry Innovators

Pioneers in technology

MARCUS RYLE

Co-founder of Line 6

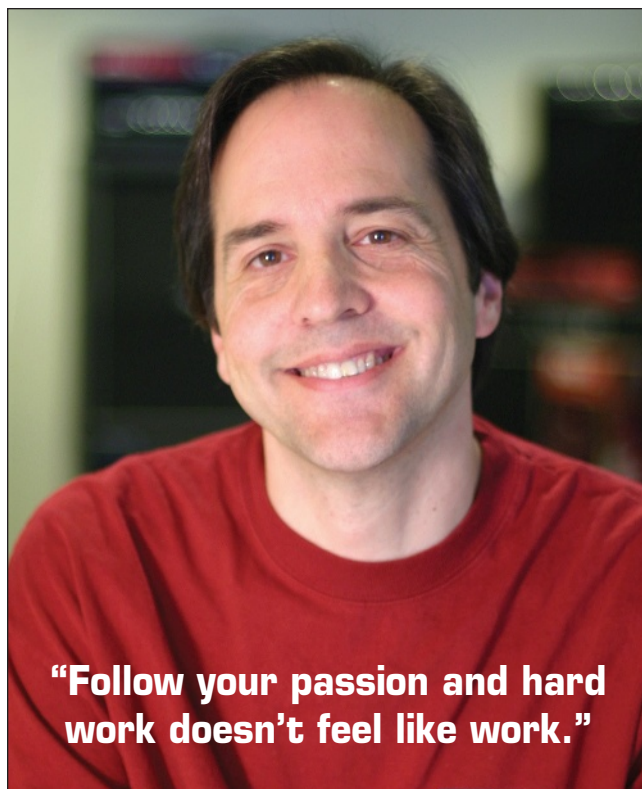
Interviewed by
JOHN FILIPPELLI

He changed engineering and music forever, having created the first digital modeling guitar amplifier — meet Marcus Ryle.

John Filippelli: What factors led to you establishing Line 6?

Marcus Ryle: For about 10 years prior to starting the Line 6 brand, we were a small engineering consulting company that developed a number of different audio products for other manufacturers, including digital audio recorders, synthesizers, drum machines, and effects processors. A theme throughout the products we developed was to use technology to create tools that inspire music creation. In 1996, it seemed that guitar players in particular were being left behind in the digital technology revolution, and Line 6 was born.

John Filippelli: From an engineering perspective, were there certain things that you needed to learn more about in order to get the product off the ground? How did you address these challenges in your product offerings?



“Follow your passion and hard work doesn’t feel like work.”



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Marcus Ryle: The foundation of Line 6 has been the digital modeling of analog audio circuitry. In order to create our first Line 6 product, which was the first digital modeling guitar amplifier, we needed to do research into creating digital models of how vacuum tubes distorted the sound of an electric guitar. This research was led by Line 6 co-founder Michel Doidic, and this work led to our first patent as well.

John Filippelli: Do you have a dream project or product that you would someday like to work on? If so, what is it?

Marcus Ryle: I've still got a soft spot for digitally controlled analog synthesizers. The last synth I worked on was a 12-voice called the Matrix-12, and maybe in retirement I can make a 24-voice version.

John Filippelli: What advice would you give to other engineers, or even hobbyists, who share multiple passions (such as in your case music and engineering)?

Marcus Ryle: I'm a firm believer in following your passion. Working hard doesn't really seem like work when it's something you like. Next, I'd suggest focusing on solving meaningful problems, and not just on the technology itself. Engineering needs to be a means to an end, so spend at least as much time understanding the end your trying to achieve as you spend on engineering. Lastly, I'd advise that the best way to learn is by doing, so do a lot of designs. Just like music, practice makes perfect! ■

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Tools to Facilitate Sensor AFE Design

BY MURRAY SLOVICK

Sensors are found in a wide variety of devices ranging from cell phones (there are as many as 14 in a smartphone—from accelerometers and gyroscopes to front- and rear-mounted image-sensing cameras) to industrial equipment to medical devices. All are complex systems that require circuitry tuning to convert the analog signals produced by the sensor itself into a signal appropriate for a microcontroller's (MCU) analog-to-digital converter (ADC). In the past, systems engineers were required to use discrete operational amplifiers, analog-to-digital converters, and passive components to design sensor systems, but this proved to be time consuming, difficult to accomplish, and expensive.

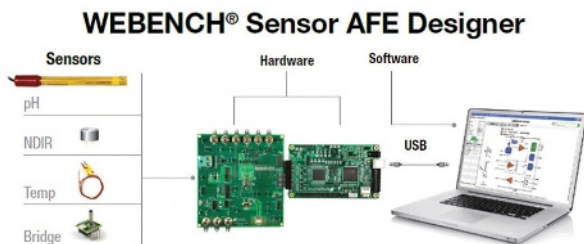


Fig. 1: WEBENCH Sensor AFE Designer software shows all configuration elements for easy online or on-bench design.

Today an analog front end (AFE), an essential system building block to a sensor circuit, conditions the analog signal received from a sensor and performs the analog-to-digital conversion. Among other things, AFE circuitry boosts the voltage provided by the sensor to levels usable by the MCU, removes high-frequency and low-frequency signal noise before the analog signal is converted to digital, and, where necessary, converts signals via a transimpedance (I/V) circuit from current to voltage in cases where the sensor outputs current.

To help system designers overcome sensor integration challenges such as signal tuning and sensor drift, not only have suppliers developed AFEs, but they have reference designs, online tools, and software that enable “on-the-fly” configuration and simulation of the AFE. The bottom line is this: You no longer need

to be an analog expert to design your AFE. Let's look at two of these design helpers.

TI's WEBENCH SensorAFE Designer (Fig. 1) lets engineers configure, evaluate, and explore the capabilities of the supplier's Sensor AFE System before implementing the design in hardware. Together with its WEBENCH Sensor Designer, these tools provide complete sensor circuit design for common sensing, transmitter, and transducer applications. The development system allows engineers to evaluate the complete signal path solution (including sensors) either online or on the bench.

The TI WEBENCH AFE Designer includes sensors such as resistance temperature detectors (RTDs), thermocouples, pressure sensors, load cells, and gas sensors. With the tool, the designer can start with an industry-standard sensor or specify his or her own sensor requirements to create a custom sensor.

To help simplify product development, reduce cost, and speed time to market, Freescale Semiconductor has introduced a Healthcare AFE reference platform that includes hardware, schematics, and software to facilitate prototyping. An integrated hardware/software development platform, the Freescale Healthcare AFE reference platform is built around the Kinetis K53 MCU, which includes an integrated AFE featuring a complete analog measurement engine for capturing biometric sensor data: a precise voltage reference, four high-performance amplifiers, and two high-resolution ADC and DAC modules.

Six different application-specific plug-in boards allow the user to choose an application and level of integration in the reference platform. The reference platform, which is based on Freescale's Tower System, includes the software and hardware needed to demonstrate or prototype portable electrocardiographs, heart rate monitors, pulse oximeters, glucose monitors, blood pressure monitors, spirometers, and Doppler ultrasound stethoscopes.

For applications that require higher performance and precision analog functionality, Freescale has partnered with Linear Technology to offer specific plug-in boards. The boards feature high-performance precision operational amplifiers for an external analog solution.

Mouser offers a wide variety of AFE solutions that provide a complete signal path solution between a sensor and an MCU.

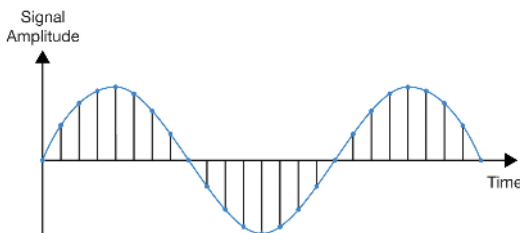
Wipe Out the Weakest Link with an AFE

By Mouser Electronics, www.mouser.com

Even though digital technology is creeping up the analog signal chain toward the source, analog signals will always be used to measure real-world analog data. An analog-to-digital converter (ADC) can be critical in moving analog data into digital processing, but you must examine the entire analog signal chain to get it right. An analog front end (AFE) can incorporate the entire analog signal chain as a kind of short cut, but let's examine the long way first.

To get real-world, streaming data into a processor, you start with a transducer that changes physical data into an electrical signal. Next, a filter is used to eliminate signal noise with a frequency either too high or too low for the anticipated operational range. The filter blocks signals with frequencies

Fig. 1: An ADC takes periodic 'snapshots' of data from the analog signal.



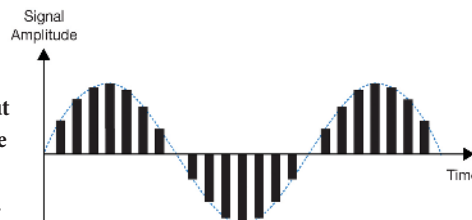
outside the expected bandwidth, eliminating extraneous noise before reaching the ADC.

The ADC then samples and digitizes the analog signal. Sampling requires taking rapid instantaneous snapshots at regular intervals. After sampling, the signal is digital, changing everything about how the signal is handled. Matching an ADC to application requirements is critical for system accuracy. Once digitized, you cannot go back. Even though signal filtering may be accomplished solely by digital means, best practices in analog design still recommend analog filtering prior to the ADC. Filtering may still occur after digitization, although it's a different type of filtering.

Another option is a programmable AFE, an integrated chip that does the design work for you, if you are lucky enough to find one that meets your analog design needs. AFEs exist for a large

variety of applications. AFEs simplify the design process, save time, space, and cost, and can eliminate tasks such as checking error budgets.

Fig. 2: The digitized data from ADC output approximates the analog signal by fitting the curve.



An ADC with better resolution takes more samples (shown here as bars.)

Texas Instruments has several AFEs, including the new AFE4490 for pulse oximeters. It includes an amplifier, filter, 22-bit ADC, buffer, and controllable timing. The device completes control feedback loops to an external processor and is repurposed for photometry applications. Analog Devices' ADAS3022 is a complete, 16-bit, 1 MSPS data acquisition system with a multiplexer, PGA, ADC, integrated reference voltage, and buffer. Analog Devices has thoughtfully designed it to accept almost any direct sensor interface.

You cannot force an application to fit an AFE; fortunately Mouser has many AFEs for a large variety of applications, such as ultrasound, powerline communication, pH sensors, copiers, energy measurement, motor control, battery management, and many more. AFEs are available for non-specific signal chains, too, such as an RF front end, inductive touch arrays, and full-duplex wideband communications. Many evaluation boards are marketed as AFEs. Come take a look at the newest AFEs at Mouser; you might find yourself saving a lot of time with your analog signal chain with one proven and tested AFE.



Ideally suited for pulse-oximeter applications, the AFE4490 is a complete AFE solution in a single, compact QFN-40 package.

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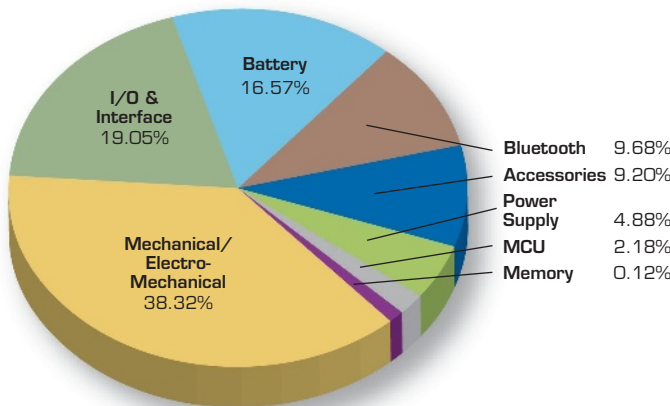
Beats by Dr. Dre Pill

A portable Bluetooth speaker that lets you play tunes and take calls

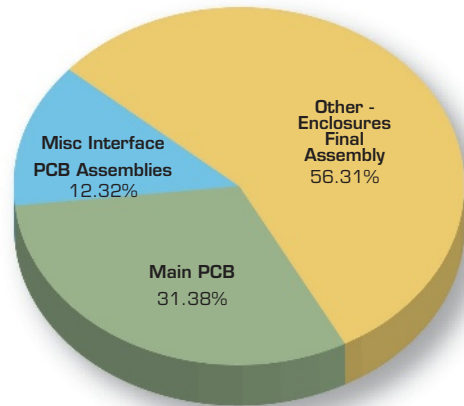
Available in five colors, the Beats by Dr. Dre Pill is a wireless, portable speaker bar that doubles as a speakerphone. It is the only unit of its kind equipped with Near Field Communication (NFC), and the only one without a passive radiator. The Pill is also higher powered than similarly sized products (6 W per channel vs. about 3 W for the other products). So it effectively makes up for the lack of enhanced low-end response that a passive radiator would provide through sheer wattage increase, and with four speakers instead of just two. This, of course, comes at the expense of battery life — the Pill is spec'd at approximately 7 hours, with other units at around 10 to 12 hours.



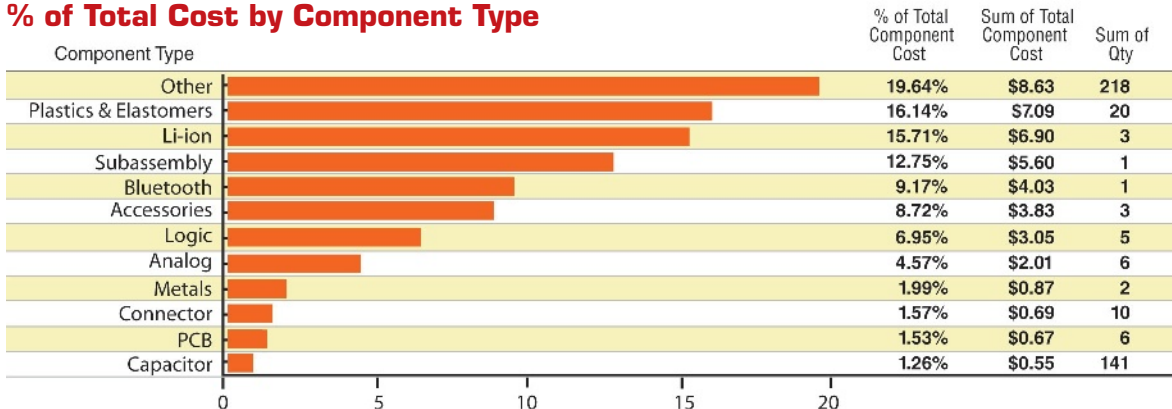
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To get the complete teardown analysis and parts list of the Beats Portable Speaker by Dr. Dre Pill, including datasheets, go to...
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The information in this feature represents a small sample of the data available from the IHS iSuppli Teardown Analysis Service. This service provides complete, detailed analyses of electronic equipment by disassembling products and studying their contents. The service has performed teardown analyses on products including wireless handsets, digital still cameras, PDAs, and laptop computers. IHS delivers complete assessments of all electronic, electro-mechanical, and mechanical components in such products, from semiconductors to passives to displays. Component data includes parts and estimated pricing and is broken down by assembly, function, component family, and type.

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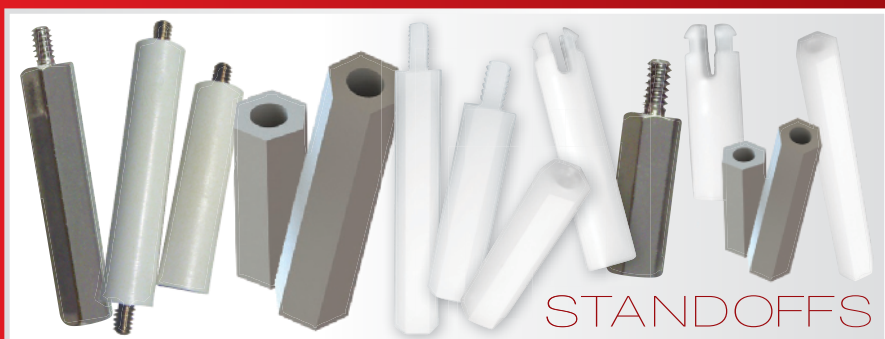
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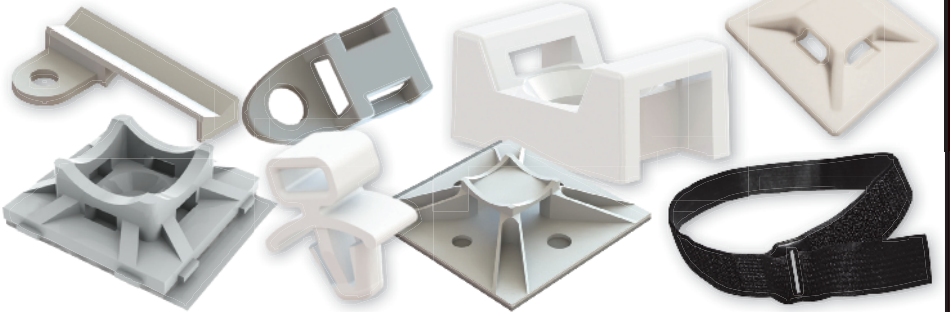
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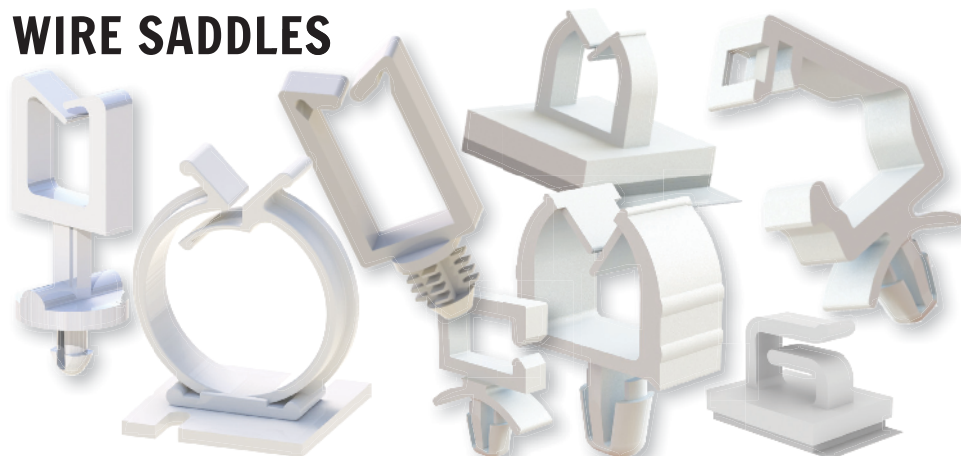


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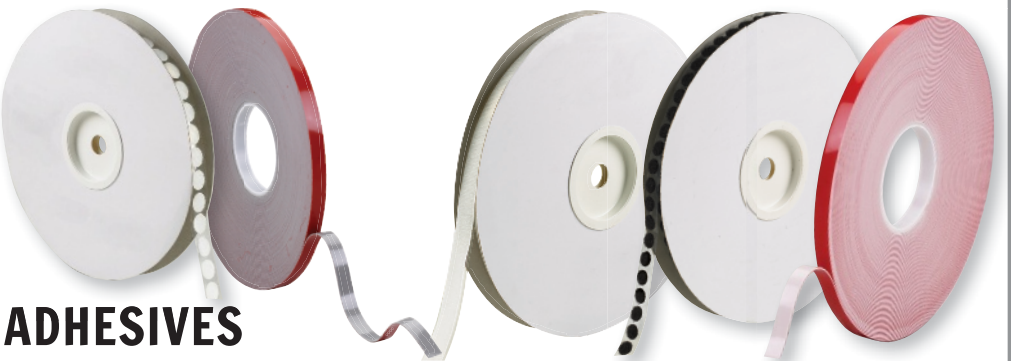
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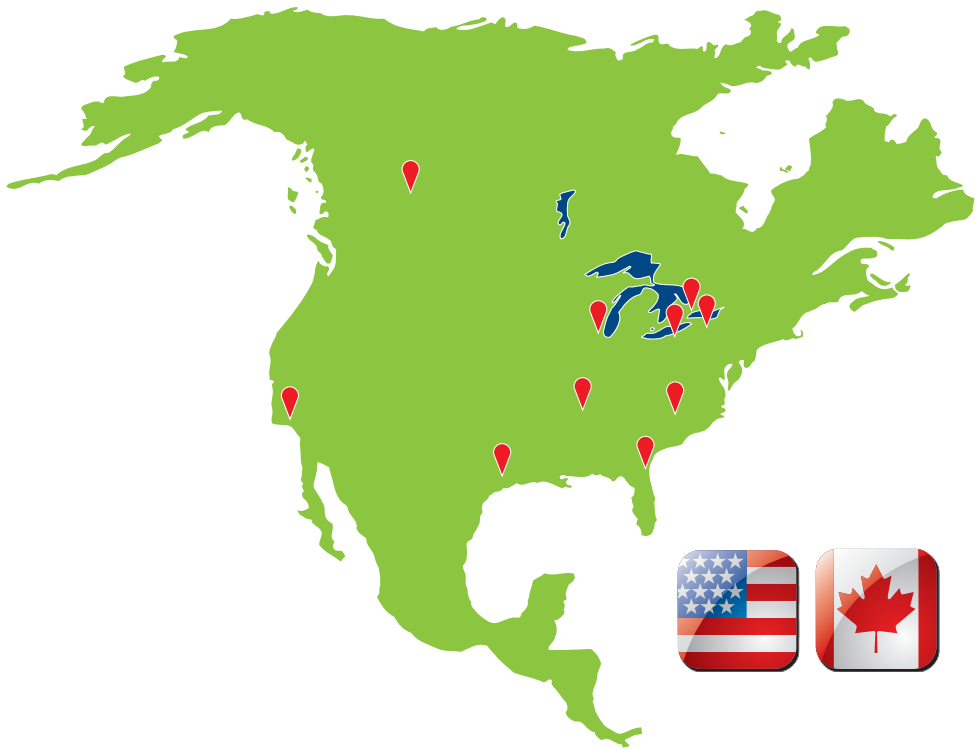
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Linux embedded systems — challenges and opportunities

A proper cross-toolchain and associated binary utilities can dramatically reduce time to market

BY CHRISTOPHER HALLINAN
Technical Marketing Engineer
Mentor Graphics
www.mentor.com

Linux has become the *de facto* standard operating system in embedded designs for consumer devices, automotive systems, military and aerospace designs, medical equipment, networking, and many others. There are likely a number of devices in the modern home that run Linux, such as digital TVs and DVRs, set-top boxes, and smart appliances. It is not uncommon for business travelers to have multiple Linux-powered devices in their laptop bag. The Android smartphone has given credence to the Linux operating system as a powerful mobile OS.

One of the most significant challenges facing embedded Linux device manufacturers is time to market. Competitive pressures and consumer demand have shrunk development cycles to mere months, in some cases. In a fast-paced development environment, early choices usually have big impact on the overall success of the project. Investing early in competent development tools helps successful companies maintain a competitive edge.

Deploying products based on Linux and open-source software presents a wide range of choices and challenges. A large collection of software must be integrated — a set of standard runtime libraries along with many core application packages and their supporting libraries. Developers need to select the correct version of the Linux kernel and then develop support for their unique design features.

Selecting a cross-toolchain

Early in the development cycle, a cross-toolchain and associated binary utilities must be selected and successfully integrated to produce a quality product (see

Fig. 1). This choice is complicated by the fact that modern processors often have specialized acceleration hardware that can be exploited by the compiler and libraries if properly configured and built within this environment.

The ARM NEON is one good example of specialized hardware acceleration that requires compiler support. The NEON architectural feature is found in some Cortex-A series cores and accelerates tasks



Fig. 1: The right development tools influence not only software and corresponding applications, but also on how effectively the hardware is used.

such as video encoding and decoding, 3D graphics, speech, and image processing. In order to take advantage of NEON acceleration, the compiler and embedded libraries must be configured to emit the specialized machine instructions for these features.

The kernel and boot loader

Once the tools and development environment are assembled and validated, the process of compiling the many software packages, including the kernel and boot loader, can start. These packages, together

with the Linux kernel, make up the base platform Linux operating system image.

When all the software for a platform is compiled, the binary and other output files must be assembled into the proper format(s) for booting the platform. Each embedded platform has its own unique image formats and requirements for booting. This often involves, at a minimum, a root file system image compatible with the root device, and boot images in the proper format and location required by the particulars of the boot loader.

Building the applications

The challenge now becomes transforming this into a product by creating application software that defines and differentiates it. This may involve developing Linux device drivers to support the unique hardware device(s). It certainly involves code that defines the product's functionality.

A typical embedded Linux device contains hundreds of software packages with multiple files including binary executable or library files, configuration and control files, initialization and startup scripts, and possibly documentation. A simple embedded Linux system without graphics may contain software from 150 packages pulled from over 100 source code repositories. A more full-featured embedded Linux system with graphics and web-centric features might contain many hundreds of software packages pulled from over 300 open-source repositories scattered around the globe (see Fig. 2).

A simple build system for all the packages could have little more than a cross-compiler and a makefile. With this a developer must have the knowledge and expertise to know what to build, how to build it, and what dependencies are involved. The build systems represent hundreds to thousands of hours of development effort and are virtually always difficult to modify and maintain.

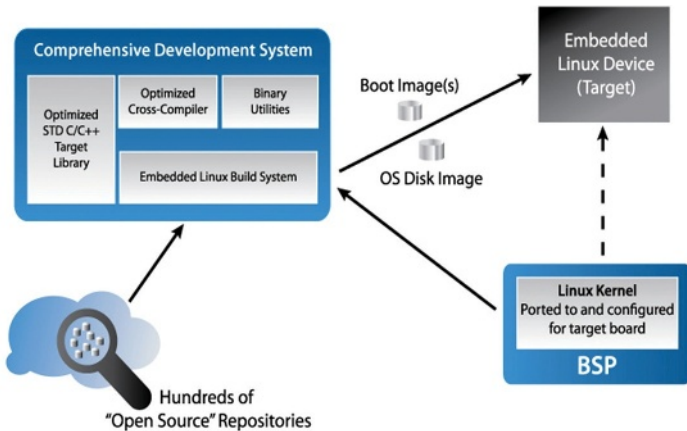


Fig. 2: Integrating hundreds of different applications requires a comprehensive development system that can pull it all together into a functioning whole.

provides by far the most powerful build system framework dedicated to embedded Linux.

The Yocto Project

The Yocto Project is a collaboration among software, semiconductor, and other hardware companies providing templates, tools, and methods for custom embedded Linux systems. It is relatively easy to build a working embedded Linux system using the Yocto Project, provided developers use the standard configurations available for a few well-known hardware platforms. Doing any kind of serious customization, however, requires substantial knowledge and expertise.

The Yocto Project framework is designed to facilitate integration of disparate software elements into a coherent set of platform images capable of booting a specific board (see Fig. 3). This framework also facilitates integration of kernel patches and configuration changes.

It is not particularly difficult for someone with good Unix/Linux skills to make the changes necessary to add a kernel patch

'No-cost' Linux images

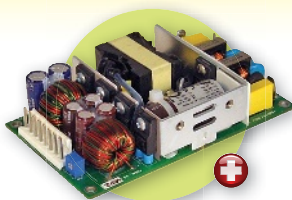
There is a dizzying array of choices for sourcing all of these components. Board vendors often have no-cost Linux operating system images that come on the board. Semiconductor manufacturers also provide no-cost Linux images for their processor chips. These are usually fixed and difficult to customize, and come with no support of any kind.

Prebuilt Linux operating system images can be found online for popular commercial off-the-shelf boards. These usually

work for the default board configurations, but suffer the same drawbacks as other free offerings — extremely difficult to customize and if modifications are made they are no longer supported. A build system capable of building embedded Linux operating system images is required to achieve any level of customization beyond the trivial.

The enormous challenge of customization has given birth to over 40 embedded Linux build systems. Most have faded into obscurity, but a few are in use today. The Yocto Project (www.yoctoproject.org)

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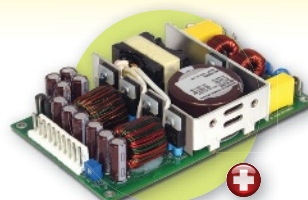
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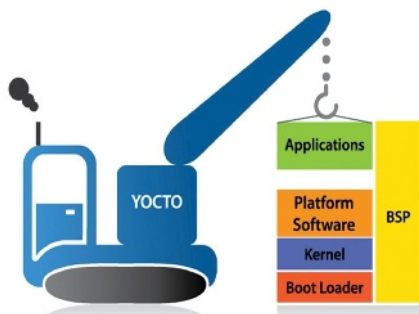


Fig. 3: The Yocto Project framework facilitates integration of software elements into a coherent set of platform images.

or modify a kernel configuration. The challenge is in determining what changes to make.

The challenge of differentiation

Product manufacturers strive to produce differentiated products with compelling features for their customers. The challenge is to limit the cost of development for the nondifferentiating elements (Linux operating system and its supporting software) while maintaining maximum investment in the core competency of the company's products – the key differentiating features. Building the customized Linux operating system image for a unique hardware design can be technically challenging and resource intensive and the company's staff may not have the in-depth Linux and hardware expertise to cost effectively develop the software.

Custom hardware usually requires specialized support from the operating system, either device drivers or custom application software, or more commonly, elements of both. Writing device drivers in any operating system is never trivial. It requires technical competency in the OS itself. Technology from the Yocto Project provides a framework for building custom embedded Linux systems, but it will not teach the developer how to write a Linux device driver. Many companies choose to work with a software vendor who has proven and deep experience in open-source software and tools.

Getting support

Knowing how and where to obtain technical support is one of the more challenging aspects of successfully employing Linux and open source. Traditional

vendors of embedded Linux bound their support around fixed templates. Once those templates are modified (which is virtually always necessary with a custom Linux product) support costs can rapidly escalate. Understanding the support policy of commercial embedded Linux vendors is critical to containing costs.

There are a number of Linux solu-

tions available including a package from Mentor Graphics that provides a complete suite of development, debug, and analysis tools and a build system based on technology from the Yocto Project. Mentor Embedded Linux addresses support challenges by expanding the support circle to include modifications made by the developer. ■



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New approach protects against ESD and high-energy surges

Protection advantages of a transient current suppressor two-stage device is superior to that of conventional TVS technologies

BY ANDY MORRISH
Chief Technology Officer,
Semiconductor Products, Bourns
www.bourns.com

As high-speed data technologies evolve to become faster and smaller, sensitivity to electrostatic discharge (ESD) and lightning surges has increased. Now more than ever, a robust and effective surge protection solution is needed that prevents damage, but does not hamper the high-frequency operation of the system. A new transient-current suppressor (TCS) technology offers a brand new approach to meet these demanding requirements.

Some estimates for the actual cost of ESD damage to the electronics industry run into the billions of dollars. According to the Insurance Information Institute, damages caused by lightning on average have increased in the United States by 5.5% over last year, driven primarily by a rise in the number and value of consumer electronics. Lightning strikes cost insurers an average of \$5,112 a claim in 2011, compared with \$4,846 the previous year. Due to these high costs and potential damage to electronic equipment, it's more important

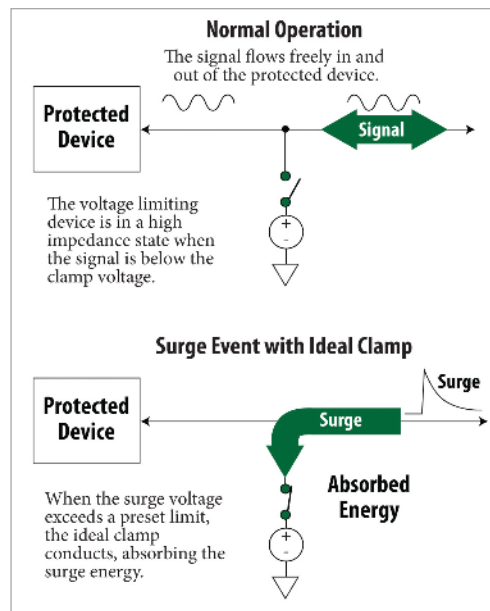


Fig. 1: Basic operation of an ideal voltage-limiting device.

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than ever to have adequate circuit protection for high-speed data applications.

This article reviews conventional single-stage protection using a voltage-limiting device such as a transient-voltage suppressor (TVS) diode and highlights the limitations of this protection method. A new approach to circuit protection will be presented that introduces new TCS technology. This new approach uses TCS devices in series with the protected signal line, in a two-stage configuration together with a voltage-limiting device. The performance and protection efficiency advantages of this new two-stage protection device turns out to be far superior to that of conventional TVS technologies.

Single-stage circuit protection

TVS diodes are electronic protection devices that absorb ESD energy at the interface of a design. The basic operation of a TVS diode is shown in *Fig. 1*.

A TVS diode typically appears as high impedance in the normal range of the signal working voltage that passes over the line. When a surge at the interface exceeds a preset limit, the TVS diode becomes conductive, quickly limiting the voltage from rising above this safe level. The ideal TVS diode creates a “brick wall” clamping electrical characteristic that causes no interference to the normal signal, yet prevents the voltage at the interface from reaching an unsafe level.

In reality, the characteristics of semiconductor TVS diodes differ from that of the vertical characteristic of the ideal clamping device. Although the real TVS diode exhibits high resistance at lower voltages, as the voltage increases a finite “leakage” current begins to flow near the breakdown voltage of the junction. This results in an actual clamping characteristic that is much softer than the abrupt vertical “brick wall” characteristic of the ideal clamp. The larger the TVS device, the more leakage can occur, which can negatively impact the operation of the circuit, particularly at higher temperatures. The clamping voltage chosen must be higher than ideal in order to make allowance for this soft transition into clamping behavior. The actual clamp voltage selected for the



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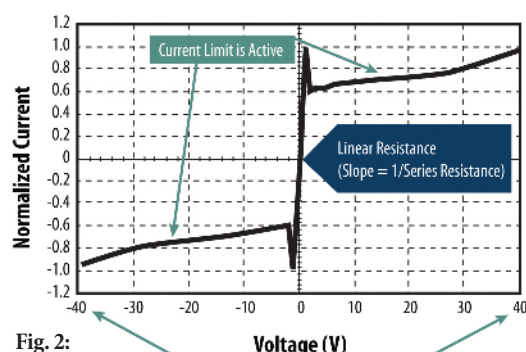


Fig. 2:
Actual I-V curve
of a TCS device.

circuit is a compromise between a high enough level that does not interfere with the signal, and a low enough voltage to maximize protection.

Simply connecting a TVS diode between an interface and ground is not always effective in protecting the low-voltage device driving that interface. For example, with a typical TVS device, the peak voltage across it may reach 20 V during a discharge of 11 A. This is far beyond the absolute maximum ratings of many low-voltage semiconductor technologies. Instead of shielding the interface device from the surge, the TVS diode simply diverts a portion of the energy away, leaving a portion of the surge energy to propagate into the protected circuit. A high level of “let-through” energy, as it is often termed, may result in equipment damage under surge conditions in harsh or exposed environments, where exposure to high-surge energies may be commonplace.

Two-stage circuit protection: A new approach

The TCS device is a new circuit protection approach that greatly improves the level of defense when used in series with the protected signal line in a two-stage design together with a voltage-limiting device. The characteristics of the TCS device is shown in Fig. 2. When normal signal current is low, the TCS device

behaves just like a low-value resistor. Under surge conditions and when the current is driven above a safe level, the TCS device transitions very quickly into a current-limiting state. Figure 3 shows the TCS device configuration and circuit symbol.

The TCS device adds a current-limiting stage in series with the protected device to complement the characteristics of the voltage-limiting device, which helps to reduce stress. The voltage at the interface increases when a surge occurs, causing current to flow through the TCS device. As the current limit is reached, the TCS device prevents further

maximum voltage clamp voltage can be much higher than a TVS by itself, as the TCS device blocks this voltage. The peak clamping voltage may rise as high as the ± 40 -V maximum voltage rating of the TCS device, allowing the use of simple low-cost, low-capacitance diode rail clamps for most application. The overall performance of the protection stage, as experienced by the driver, very closely resembles the operation of the ideal “brick wall” clamp.

As its name suggests, the TCS device is directly analogous to the TVS diode. The TVS diode limits transient voltages, and the TCS device limits transient currents. The characteristics of the TCS device, like the punch-through TVS diode, also exhibit a degree of foldback,

which causes the current to drop approximately 30% from its maximum value as the voltage increases further. This foldback further improves transient power handling in the TCS device and minimizes stress in the protected device.

The normal response time to achieve limiting operation is less than 50 ns. The speed of the current-limiting operation of the TCS device is ideal for protecting against all standard lightning surge test waveforms (1.2/50 μ s, 10/1,000 μ s, etc.), including high-frequency avionics requirements.

New TCS devices provide an effective ESD and surge protection solution. In contrast to conventional TVS

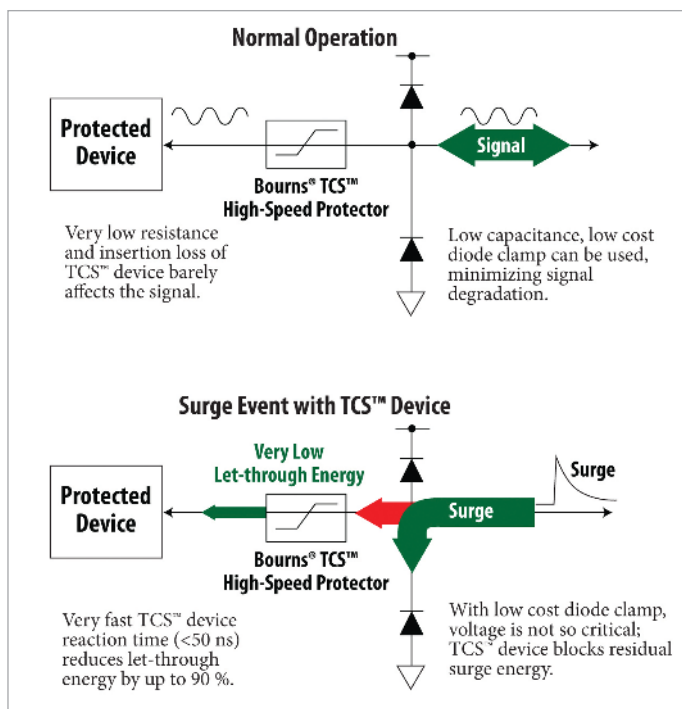


Fig. 3: Implementation of a TCS device in a circuit protection solution.

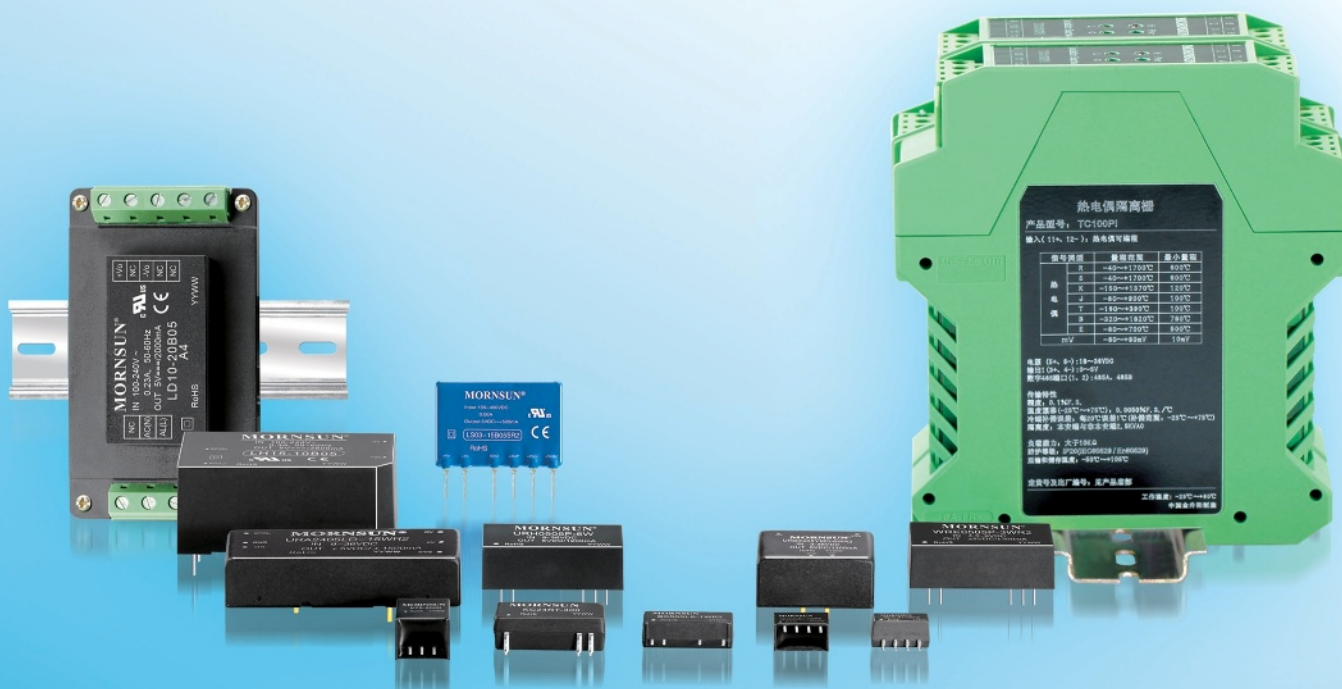
increase in current, allowing the voltage across itself to increase. This presents a very high blocking resistance, as current is limited to a near-constant level. As the current is limited, the voltage at the protected device no longer rises, and it is kept at a safe level. On the other side of the TCS device, the voltage continues to rise until the activation voltage of the voltage clamping device is reached. Both the onset of the clamping, and the

diodes, enhanced protection and functionality is not at the expense of adding capacitive devices that decrease bandwidth and reduce data rate performance. Using a two-stage protection design that combines the current limiting properties of a TCS device with the voltage-limiting properties of a TVS diode or clamp diodes offers a more-robust, low-cost circuit protection solution without compromising circuit performance. ■

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Accessing benefits of digital power in an analog system

The no-bus approach lets system architects benefit from advantages inherent in digital power without incorporating a digital bus

By BRUCE ROSE, Technical Marketing Manager, CUI, www.cui.com

As silicon fabrication technologies used to construct ICs — micro-processors, FPGAs, or special-function devices such as network or communications processors — have gone from generation to generation, the number of transistors has grown ever-larger, the individual devices have grown smaller, and the operating voltage they can tolerate has diminished. The core voltage that such a chip runs at today may be less than 1 V; 0.9 V is commonplace.

So, when you are designing the final stages of a power system that will satisfy the demands of the latest ICs on a high-density

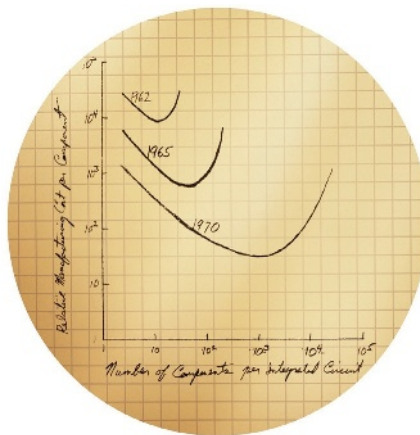


Fig. 1: Today's transistors may be significantly more efficient but the number has improved in line with Moore's Law and power consumption is increasing. (Courtesy Intel)

board, the performance of your point-of-load (POL) dc/dc converter will be critical to the performance of the entire board, and system.

And while individual transistors in today's most advanced ICs may use less power, there are millions more of them. So design engineers have struggled to keep power consumption in check.

The peak power requirement of a processor reveals a lot. It is, in effect, the maximum power you might ever need to feed such a chip, and figures of 100 W or more are not uncommon. Considering that today's core voltages are hovering around 1 V or lower, current ratings are moving to 100 A and beyond. This fact is worth dwelling on because it is in those

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Fig. 2: Digital power ICs, such as Powervation's PV3012 give real time adaptive loop compensation

figures, compounded by the energy-saving tricks built into the latest ICs, that performance of the PoL module becomes extremely critical.

To cut average power usage, the chip designer will arrange to switch off anything that's not being used at any given moment, in response to processing load. In a multicore processor, any or all of the cores might be shut down or restarted at any time, meaning tens of amps dropping to zero — or the reverse, in microseconds (or less). High dI/dt values are a design challenge in themselves; everything that they imply in terms of minimal inductance, carefully placed capacitance, and shortest track lengths is part of your basic toolkit as a power-rail designer.

Analog power

Dc/dc converters powering the load must also not only set the correct supply voltage levels but also achieve the correct transient behavior to respond to the demands of the fast-changing load. You can look at the PoL module as a control loop maintaining the set point of its fixed dc-output; or as an amplifier delivering a fixed level but with a wide frequency response. An over-damped control response will mean that when your microprocessor suddenly demands more current, voltage levels will sag, and logic values may be lost. In the other direction, the regulator will “spike” above line voltage and will ring or oscillate. Circuitry may be damaged, or conducted interference from the unwanted transients may also corrupt logic levels. In all circumstances, your regulator must be stable.

Conventionally, this has been the space where the analog power supply engineer has been at home. Their skill is to arrange

for the circuit to have high gain at dc, and apply standard control-loop techniques to place poles and zeros in the loop's response so it responds to step-changes in load rapidly, but without “ringing,” and remains stable under all load conditions. They might analyze their circuit from first principles to determine its gain/phase response profile; or they might measure it with a network analyzer; or in less demanding

cases they might reach a solution empirically. All are classic analog-design territory.

The digital alternative

Digital power offers you an alternative approach. In the digital version of the regulation loop, a fast analog-to-digital converter samples a representation of the output voltage, a DSP core runs algorithms in software that implement the chosen con-

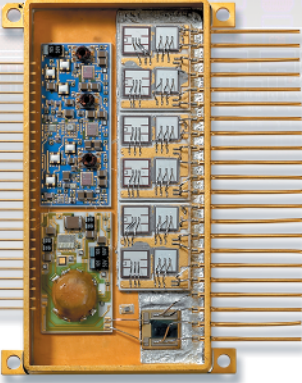
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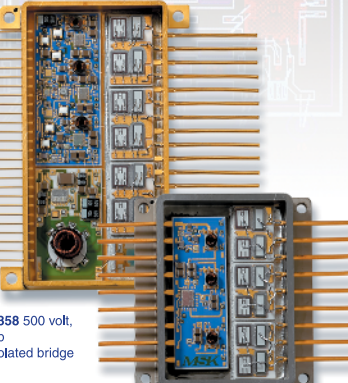
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trol loop, generating waveforms to drive pulse-width-modulated (PWM) outputs to directly control the power switches, typically MOSFETs. You can set the parameters and filter coefficients in an advanced algorithm, and you will guarantee all that is needed in terms of regulation and stability. Conversely, with the more advanced digital VR controllers the compensation is set by the VR controller itself. You need a relatively fast and powerful MCU or DSP core to carry out the processing, but that is not a large cost in today's silicon technology.

When you turn to a digital control loop you get a range of other benefits. All the "secondary" PSU functions (taking delivery of stable voltage to be the primary role), such as sequencing, ramping, margining, fault response and reporting of voltage, current and status, and external control, become exercises in software. Your system communicates with the digital power component via the power management bus (PMBus); you can get a measure of the extra flexibility by considering the spec sheet of a digital voltage regulator IC. The list of

PMBus commands (VOUT mode/command/trim — and so on) will comprise at least 10 entries; and time-related commands (delay, rise time, fall time) comprise about five commands; overall there will be well over 100 commands in the set.

Analog realities

Ask any system designer if he or she would like that degree of control and flexibility and the answer will undoubtedly be "yes." But that enthusiasm has not been reflected in the adoption of digital power technology in the broad market, and the full range of digital power functions has only been put to use in large, connected systems such as telecoms or network infrastructure racks.

An analog PoL will struggle to address the complex power needs of the latest chipsets. Both large and small OEMs run into power challenges on their board-level designs. To bridge the divide, first realize that there is a wide spectrum of reasons why the industry has only been slowly adopting digital voltage regulators.



Fig. 3: Digital PoLs, such as CUT's Novum range, give a voltage accuracy of 1% and provides leading transient response characteristics.

At one end lie smaller projects that have less of a need for system-level control; whose analog designers have the skills to configure a stable control loop with resistors, capacitors and gain settings but fear that they will need the corresponding expertise in writing software or code for DSPs. They may also wrongly believe that their microcontroller software coders will need to dust off their old text books since they haven't implemented control theory and Nyquist criteria since college.



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Stateful packet inspection	Yes	Yes	Yes
Port, protocol and address limits	15 ports, 10 protocols, 10 IP addresses & 10 MAC addresses	100 ports, 100 protocols, 100 IP addresses & 100 MAC addresses	100 ports, 100 protocols, 100 IP addresses & 100 MAC addresses
Threshold-based filtering	No	No	Yes

*The ZGATE Embedded Security Development Kit (ZGATE000100ZC0G) ships with the Premium firewall package.

Part Number	Firewall Package	Flash	SRAM	Temperature	Package
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EZ80F91GAZ0BEG	Extended	256 KB	16KB	-40°C to 105°C	144-pin LQFP
EZ80F91GAZ0CEG	Standard	256 KB	16KB	-40°C to 105°C	144-pin LQFP
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Design With Freedom

At the other end lie major OEMs, who have the capabilities to deliver fully digital systems for new designs, but perceive that the cost and complexity of adding digital power to existing systems is prohibitive.

So what can you do when you want to leverage some of the most compelling benefits of digital power but you don't want to implement a full system bus?

At CUI, we've addressed this dilemma by taking a no-bus approach – that is, to let system architects benefit from efficiency gains, transient response benefits, and auto-compensation advantages inherent in digital power without incorporating a digital bus communication into their system.

During development, users can dynamically test and manipulate the desired functions within their system, monitor the results, and set the desired fault management functions. In production, the engineering header is pulled and the specified parameters are loaded into the module by CUI based on the customer's specifics. Once downloaded to the module, any further connection to the bus is no longer needed; the upshot is that the module exceeds the performance of an analog POL module while occupying the same footprint.

But prioritizing ease of use doesn't mean sacrificing performance. The NSM2P delivers industry-leading performance intended to address the most challenging needs of today's advanced ICs. Leveraging the digital control loop, the series delivers 93% efficiency at 50% load, features voltage accuracy of 1%, and provides superior transient response characteristics. Perhaps the greatest benefit designed into the NSM2P series is automatic compensation. Auto-compensation lets the module dynamically set optimum stability in real time as conditions change. It eliminates the need for manual loop compensation, one of the most labor-intensive, time-consuming aspects of analog power design, and the need to build in margins for component aging, manufacturing variations, temperature and other factors. The realized benefits for the project manager include improved performance, faster time to market and lower overall cost.

And, just as the digital module can be selectively employed to introduce digital concepts initially where they are most needed, you can also start to use its more advanced functions as you recognize the benefits in them or switch to CUI's other Novum Advanced Power POLs, the NDM2P and NDM2Z series, and open up the entire suite of digital features.

The increasing complexity of processors means that analog techniques are rapidly becoming unsuitable for power supplies. But, for some this means rapidly learning — or buying in — the necessary skills. And for others it means adding complexity to a design when all that's needed is a small subset of features.

New devices, such as our Novum NSM2P No-Bus PoLs are simplifying digital power design, allowing small and large OEMs alike to access features such as auto-compensation in a package that is higher performing and easier to implement than an analog device.

So, what do you do when you only want the best features of digital power and don't need to implement a full system bus? Simple, get rid of the bus. ■

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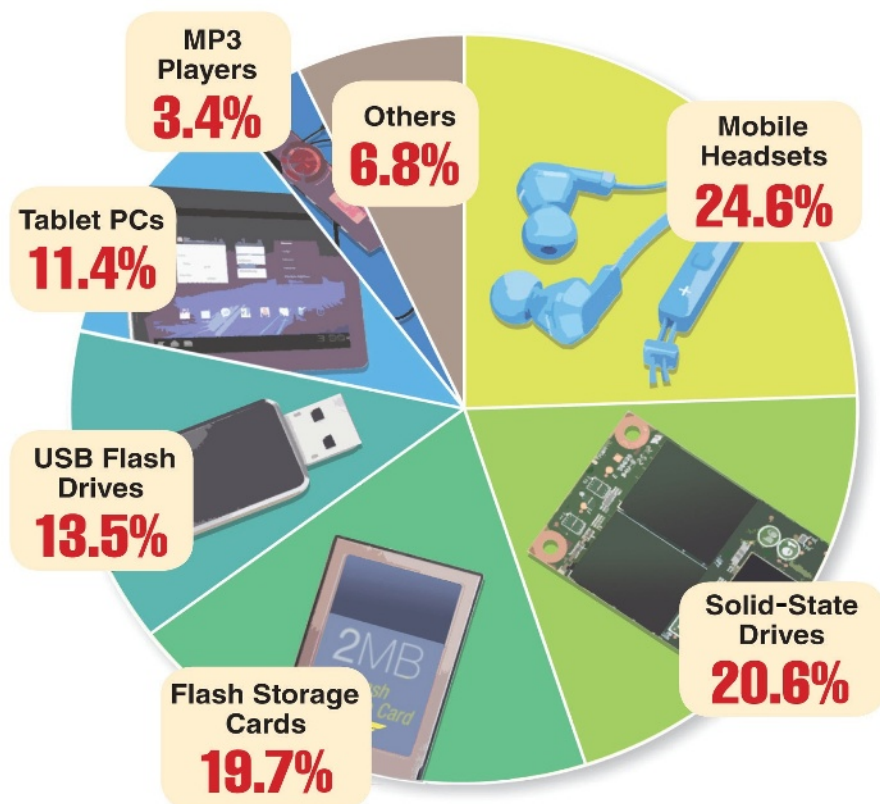
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Worldwide Forecast On Flash Market Consumption Among Devices

(Percentage Share Based on Total Bit Consumption)

Source: IHS iSuppli Research, February 2013

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Total	\$1109.3	100%	\$1343.0	100%

Source: IHS iSuppli Research, March 2013

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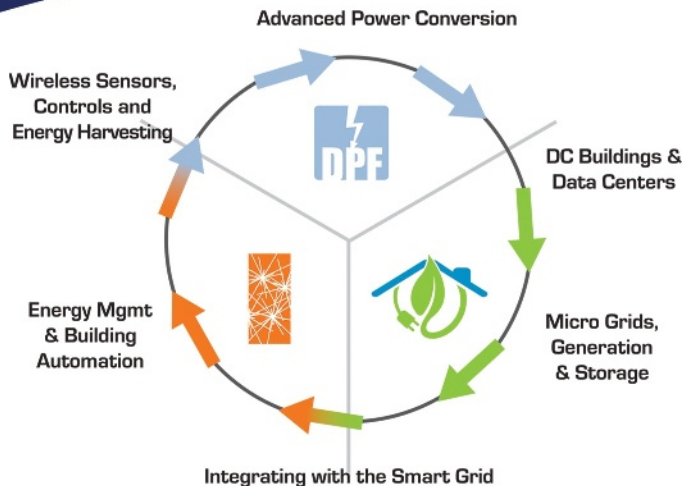


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Power electronics in renewable energy

Key power components in solar inverter systems

BY NAGARAJAN SRIDHAR, Product Marketing Manager, Texas Instruments, www.ti.com

Global demand for electricity has increased significantly over the last decade and is expected to double by 2030. In parallel, there are concerns of energy supply and distribution. Coal and natural gas are being strongly challenged due to carbon emissions, and nuclear power due to safety issues. Renewable energy, primarily solar and wind, has gained a lot of attention and has proliferated across several countries. Increased efficiency, reduced cost, and reliability are three areas where renewable-energy systems can achieve grid parity. These systems are rapidly advancing on these fronts as they become more intelligent, more loss-less, and smaller in size through increased content in digital and analog power electronics — semiconductor switches, drivers, controllers, and sense elements.

This article discusses advances in power components, particularly ICs in solar (also called photovoltaic or PV) inverter systems. The goal is to maximize system efficiency through power management control and maximum power point tracking (MPPT). Therefore, particular focus is made on digital controllers that have gained a lot of traction in recent years.

Power conversion in photovoltaic systems

The front end of the PV ecosystem are the PV panels made up of cells connected in series or parallel. These cells convert sunlight to electrical energy at typical efficiencies from 10% to 30%. The power extracted from the panels is dc and needs to be converted to ac, regardless of whether the PV system is grid tied or off-grid. Conversion from dc to ac power happens in the back

end of the PV chain in the inverter. In the case of an off-grid PV system, within the PV inverter an additional dc/dc converter is needed to charge the batteries.

The inverter function

PV inverters (see Fig. 1) generate a sinusoidal ac waveform at a fixed level from a dc source — PV panels with varying voltages. The output voltage and frequency need to be at a certain level and, if the inverter is connected to the power grid, need to be synchronized

is called a string inverter, and a high-power configuration greater than 20 kW is called a central inverter.

All inverter configurations follow the same methodology for power conversion, however, there are variations in the power conversion topology for inverter efficiency maximization. The choice of power switches (MOSFETs or IGBTs) and the number of switches and drivers employed varies by topology, which is critical for cost optimization and reliability.

Key inverter components and their role in increasing efficiency

PV inverters are built much like switch-mode power supplies. Here are the key components of an inverter:

- Controller that performs the power management, MPPT and off-line storage (batteries)
- Power semiconductor switches — IGBTs, MOSFETs

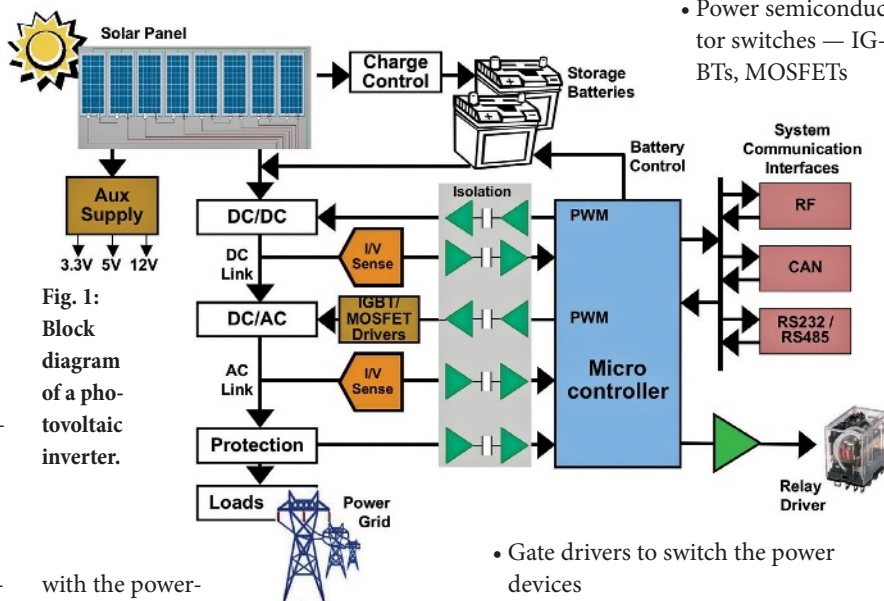


Fig. 1: Block diagram of a photovoltaic inverter.

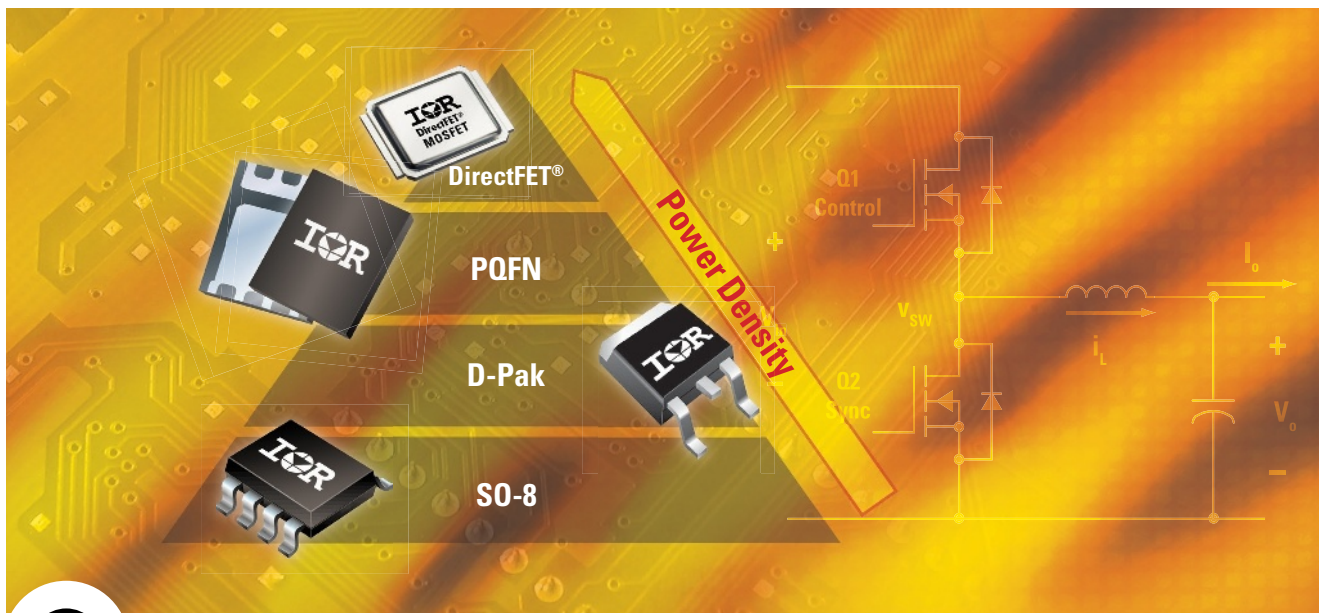
with the power-line. Single-, two-, and three-phase types are available for different applications. In addition to power management controls, the inverter performs other tasks, such as maximum power point tracking, monitoring, protection, and communication.

Inverter configuration

In general, there are three inverter configurations as shown in Fig. 2. Each depends on the power levels. A micro-inverter is a low-power configuration. A medium-power configuration between 1 and 20 kW

- Gate drivers to switch the power devices
- Feedback sensing elements — voltage and current sensing
- Auxiliary bias supplies
- Communication devices
- Passive elements
- Transformers for galvanic isolation and to adjust the voltage levels in some topologies

Power losses in semiconductor switches and gate drivers are key concerns for efficiency. Keeping the loss in capacitors and magnetic elements, such as inductors and transformers, close to zero is also critical.



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IRFHM830D	30	Sync	PQFN 3x3	4.3	13
IRFH7911	30	Control	Half-Bridge Asymmetric PQFN 5x6	8.6	8.3
		Sync		3.0	34
IRLR8729	30	Control	D-Pak	8.9	10
IRLR8726	30	Sync	D-Pak	5.8	15
IRF8714	30	Control	SO-8	8.7	8.1
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		Sync		12.7	7.6

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Inverter topology

In the inverter system, to operate a dc-to-ac converter, the input voltage usually needs to be above the output voltage. To generate a sinusoidal waveform of 230 Vac, an input voltage higher than 400 Vdc is necessary. The problem is that PV modules often deliver lower voltages than required for the dc/ac converter. There are two ways to re-

solve this issue. One is to use a boost dc/dc-converter between PV panels and the dc/ac converter. The other is to use a transformer after an H-bridge in dc/ac conversion. For the latter design, there are three fundamental topologies for inverters:

- Low-frequency transformers (50-60 Hz) (LF)
- High-frequency transformer (HF) and

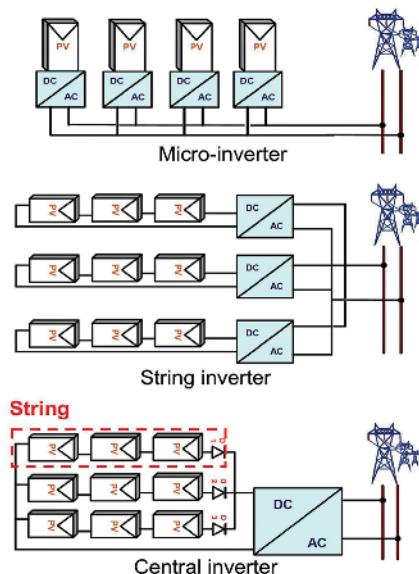


Fig. 2: Inverter configurations.

- Transformer-less inverters (TL)

The majority of U.S. market uses LF and HF (transformer-based) inverters, as mandated by standards, whereas the majority of the European market uses TL inverters. In the Japan market, there is a fairly equal split.

In LF inverters, the transformers are bulky and large, and lower efficiency by 2% to 3%. HF inverters operate greater than 60 Hz, and weigh and cost less. TL inverters weigh less as they have no transformers. They also have increased efficiency due to the absence of the transformer in the system.

The LF inverter is a single-stage system where power is directly converted from dc to ac, whereas HF and TL inverters are two-stage systems. Stage one is for dc/dc conversion — the primary-side. The second stage is for dc/ac conversion — the secondary side. Typical primary-side circuits employed are boost, buck-boost and interleaved flyback (for HF). Figure 3 shows a TL inverter design.

Dc/dc stage

The inverter's primary side performs a key function of MPPT. The MPPT algorithm ensures that maximum power is drawn accurately and quickly while there is varying irradiance. The inverter also ensures appropriate grid-compliant voltage. Finer control of MPPT is dictated by the inverter configuration. Finest control is achieved



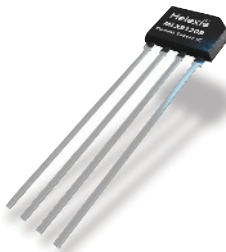
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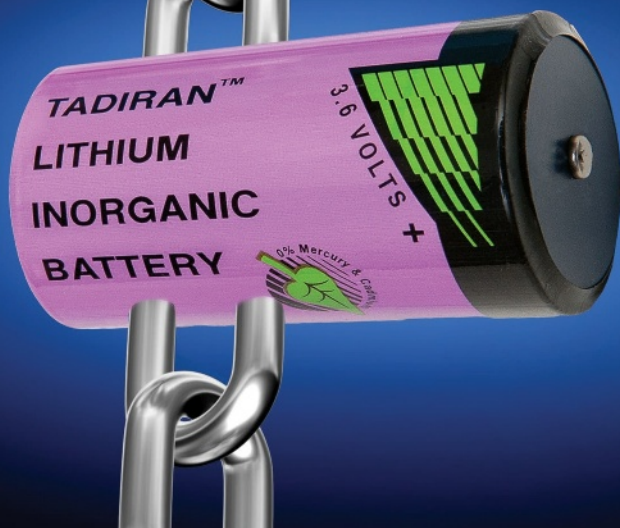


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in micro-inverters, connected at the back of each solar panel. This enables MPPT at a module level, followed by a string

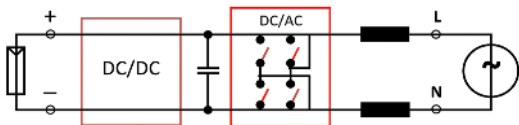


Fig. 3: TL inverter design

inverter connected to a series of modules with lesser control. Both configurations are usually employed in residential and commercial installations. The central inverter connected to a large set of modules at a utility scale gives the lowest control.

The same digital controller is responsible for pulse-width modulation (PWM) in the primary side. PWM takes place using gate drivers, which do not require isolation. Given that the bus voltage is less than 600 V and high switching frequencies are used in the primary side, power MOSFETs are ideal for DC/DC conversion. Depending on the topology, single, dual, or half-bridge MOSFET drivers are used with fast

propagation delays and high drive currents. Today's commercial inverters use silicon MOSFETs. Next-generation inverters are evaluating GaN (gallium-nitride) and SiC (silicon-carbide) FET solutions that offer lower conducting and switching loss solutions.

Dc/ac stage

The dc/ac stage, or the secondary side, uses the H-bridge circuit. This involves four power switches for a single-phase solution, and 12 for a three-phase system. Here, the switching frequency is usually a few kilohertz. However, the rail voltages are in the order of 600 to 1,200 V, particularly in string and central inverters, making IGBTs the preferred choice for switching.

With the goal of reducing the conducting loss in the secondary side for efficiency improvement and the high blocking voltage requirement, SiC MOSFETs have gained attention in the development of next-generation invert-

ers. Gate drivers needed to switch IGBTs used today require advanced features such as desaturation, short-circuit current protection, Miller clamping, and negative voltage handling.

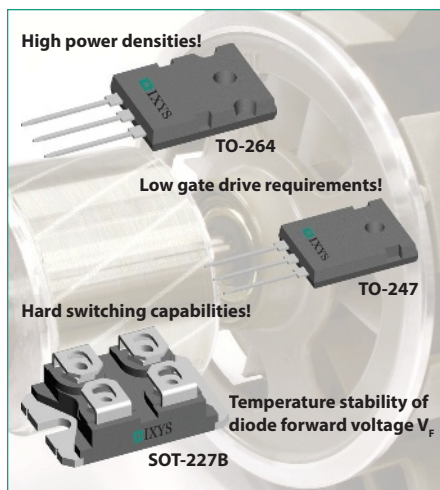
Furthermore, several isolation technologies, currently being developed and commercialized, are getting integrated into these gate drivers. These requirements are driven by safety standards for signal isolation. Moreover, several ICs have been developed for output-stage drive solutions that provide extra drive capability that discrete solutions used to provide, along with level-shifting and protection features.

Components

Gate drivers such as Texas Instruments' UCC27531 and UCC27210 are key elements to efficient and reliable solar power conversion. Digital and analog controllers such as TI's UCD3138 and C2000 real-time control Piccolo microcontrollers are available for efficient PWM and MPPT control. ■

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IXXH30N65B4	650	65	30	2	100	0.6	0.65	Single	TO-247
IXXH110N65C4	650	234	110	2.35	43	0.77	0.17	Single	TO-247
IXXN110N65B4H1	650	240	110	2.1	105	1.4	0.17	Copacked (Sonic-FRD™)	SOT-227B
IXXK160N65C4	650	290	160	2.1	57	1.3	0.16	Single	TO-264
IXXK160N65B4	650	310	160	1.8	160	2.36	0.16	Single	PLUS247
IXXK200N65B4	650	370	200	1.7	110	2.54	0.13	Single	TO-264

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Muscular micromotors

Multiple-axis joint makes robotic arm lighter; brushless motors make it reliable

BY SHERYL YENGERA, Marketing Manager, MICROMO, www.micromo.com

We have all seen industrial robot arms — solid constructions for heavy tools — and they are pretty hefty themselves. In fact, these designs are simply too heavy for many applications. Engineers at igus in Cologne (www.igus.com) wanted to develop a multiple-axis joint that would allow small loads to be swiveled or turned around a jib. They needed high levels of flexibility and low weight, with

rotation and swivel — to be incorporated in a single joint, thereby providing high levels of precision for the moving parts. The tribo-plastic joint is also maintenance-free and does not corrode or conduct electricity. The “bones” of



Fig. 1: An articulated robot using the igus Robolink, a free-range robotic joint.

simple upgrade options for additional axes. These requirements have now been elegantly translated into a new concept with a multiple-axis joint made from plastic and cable controls.

The cables themselves are moved from the arm's “shoulder joint” using compact, high-performance, brushless dc-servomotors. This prevents inertia in the arm, allows dynamic movements and means the drive block can be compact in design.

Bionic methods

To avoid having to reinvent the wheel, the team of engineers looked at further refining the trusted human elbow joint. This allowed two degrees of freedom —

the arm to which the joints are attached are also pared down to a lightweight construction. Aluminum, carbon fiber, and fiberglass-reinforced plastic provide excellent rigidity and good vibration insulation.

As in the human arm, the weakest components of this kind of robot arm are not the bones (i.e., the body tube) or the muscles (i.e. the drive motor) but rather the “tendons” which transfer the power. The high-tension “tendons” or control cables are therefore made of a highly wear resistant and tensile load resistant fiber made from highly crystalline, UHMW-PE (ultra-high molecular weight polyethylene). With tensile strength of 3,000 to 4,000 N/mm², it

only breaks under its intrinsic weight at a length of 400 km. This design allows a load/intrinsic weight ratio of 1:1 to be achieved, or even less if the structure is optimized. As well as the traditional robot arm functions, the joint can be used for new functions such as special fittings for cameras, sensors, or tools where lightweight construction is key. In the future, it may even be used on prosthetics. It is the separation of the tool, the moving parts, the control module and the actual drive that make it ideal for mobile use.

As the components that have been removed from the moving parts represent a sort of counterweight to the mass of the arm, the overall structure is very light. A magnetic angle position sensor is built into every joint to improve precision. Combined with the highly dynamic drives, this produces a precision-controlled robot module.

Powerful and compact drives

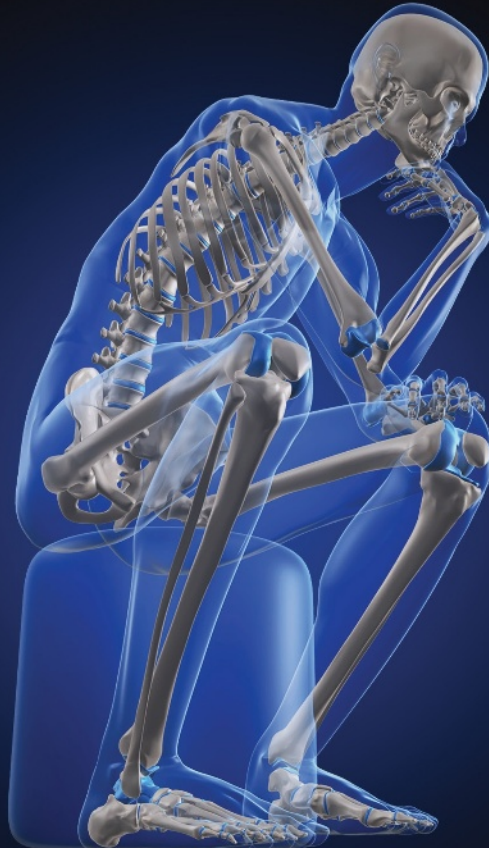
Compact drive solutions are required in order to operate the largest possible number of cable controls within a confined space. Where high levels of dynamism, real power yield, and



Fig. 2: Robolink joints have a transmitted torque (rotation) of from 5 to 7 Nm in continuous operation.

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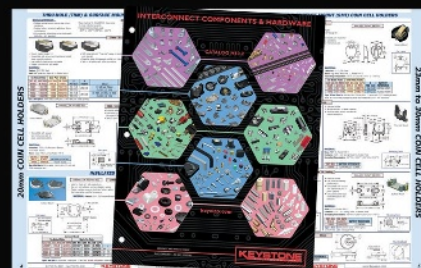


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precise, controllable use are required, electronically commuted servomotors are the best option. The small compact drives have a low moving mass and an outstanding performance to volume ratio, making them ideal for dynamic use. The excellent heat deflection allows considerable overload when operated for short periods, which is a big advantage

when it comes to fast swivel movements.

The motor operating voltage of 24 Vdc is perfectly tailored to battery power; crucial for mobile applications. The 32-mm-diameter motor gives a high output and can yield 80% efficiency



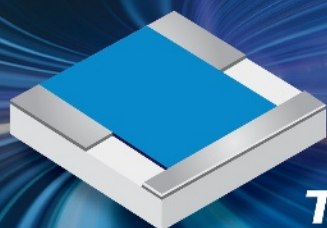
Fig. 3: The 3268 brushless motor with planetary gearhead provides 38.5 W.

in four-quadrant mode. The 97-mNm torque of the four-pole motor is increased by the diameter-compliant planetary gearheads to the values required to operate the arm. Depending on the area of application for the swivel movement, the planetary gearheads allow ratios of 1:4 to 1,600 or 6 to 20 Nm continuous torque at up to 96% efficiency. The stainless steel casing is as weatherproof as the plastic joints and cable controls.

The fact that brushless drives have no wearing components, apart from the rotor bearing, guarantees a long service life over many tens of thousands of hours. The precision gearheads also boast a long no maintenance service life. The motor can be operated in temperatures from -40° to $+100^{\circ}\text{C}$, the gearheads from -25° to $+90^{\circ}\text{C}$. This means they can both cope with environmental conditions from the Arctic to the tropics, and thus a wide range of industrial operating conditions.

Modern servomotors are the tool of choice for various applications where movement is required in the construction process. High precision levels and a long service life combined with easy integration into the control system mean they can be used both for mobile application.

An example of a motor that perfectly fits this application would be the 3268 BX4 motor from MICROMO. This motor has a 32-mm diameter and, at a length of 68 mm, provides the required 97-mNm torque. It features an ironless stator coil, high reliability and long operational lifetime, no sparking or cogging, and a dynamically balanced rotor. This motor can have optional digital or analog hall sensors. ■



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Power devices for industrial ac servo drives: A closer look

The power device for the inverter in today's robotic applications is the Trench IGBT

BY SATYAVRAT LAUD, Senior Product Marketing Manager, Renesas Electronics America, www.renesas.com

Industrial motor drives used in robotic applications such as CNC machines, x-y tables, factory automation robots, and actuators often require high performance and robust power devices. The motor of choice today in such applications is the three-phase ac-brushless motor (an ac-servo motor) and the power device of choice today for the inverter is the Trench IGBT. This article reviews some of the key characteristics of Trench IGBTs that are most relevant to the motor drive circuit designer from a high performance and robustness perspective.

The IGBT

So what are the desired qualities of the IGBT to be selected given the nature of this application? At a high level, two key requirements are “robustness” and “high performance.” Often, these requirements place contradicting demands on the power device in terms of its design and characteristics. The challenge is thus to select a device that enables a robust drive solution, and yet achieves the highest possible level of drive performance. These requirements are best satisfied by high-conductivity Trench gate IGBTs as discussed in the following sections.

1. Robustness: As the very nature of the word implies, “robustness” means an inherent capability of the device to meet demanding operating conditions, including severe transient events. While there are different aspects to device robustness, in the context of IGBTs, two key datasheet aspects are considered here:

a. Safe operation areas: In servo motor drive applications, the motor has to be able to accelerate and decelerate quickly.

This results in high current demands and sudden changes in this current demand, on the inverter. From a device perspective, this implies that the device needs to be able to handle high-pulsed currents (at instants of turn on and turn off). On

peak voltages resulting due to turn off of inductive load current (such as in case of a motor drive).

b. Short-circuit capability: In the event of a short circuit from one of the motor terminals to the frame (earth ground) or to another terminal, the IGBT affected sees the entire dc-bus voltage and has to withstand the full short-circuit current

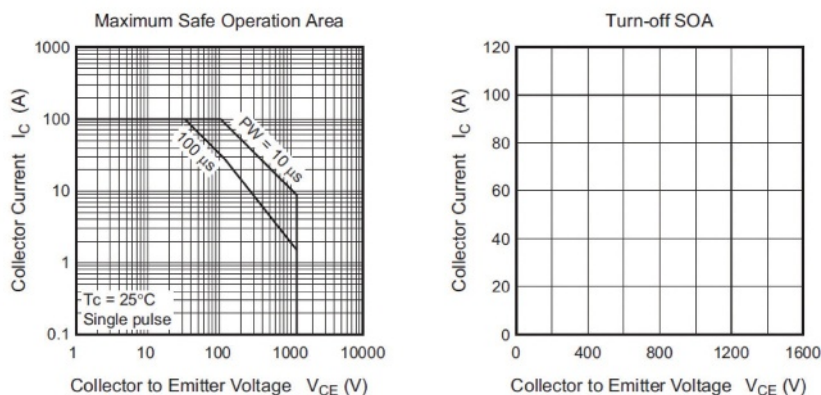


Fig. 1: Forward bias (on left) and reverse bias (on right) SOAs

IGBT datasheets, a useful characteristic that provides guidance in this regard are the safe operating areas (SOAs). As a reference, the SOAs in Fig. 1 are reproduced from a 1,200-V rated Renesas IGBT, RJH1CM7DPQ-E0 datasheet.

(limited only by the device transconductance and the circuit impedances). This is an extremely severe condition for the device. Typically, when this happens, the short circuit is sensed by means of current shunt resistors or desaturation detection

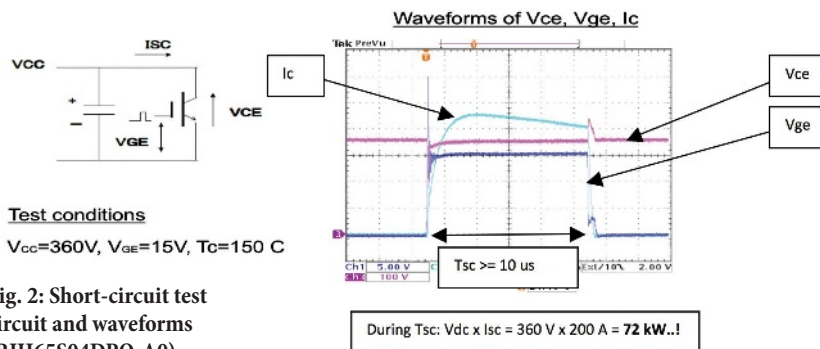


Fig. 2: Short-circuit test circuit and waveforms (RJH6S04DPQ-A0).

In essence, the wider (or “squarer”) the SOAs, the more robust is the device’s capability to withstand high peak currents at turn on and turn off. Also, a square turn-off SOA indicates a high level of robustness to withstand high

circuits (that sense the V_{CE} across the device) and the controller commands the gate drive to the affected IGBT to be disabled (typically at a controlled rate of turn off). In this short time, the device has to be able to withstand several kilowatts

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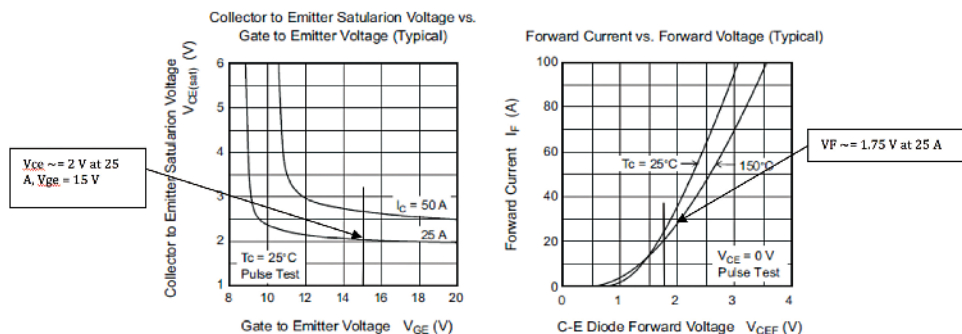


Fig. 3: The $V_{CE(sat)}$ vs. V_{GE} and V_F vs. I_F characteristics (RJH1CM7DPQ-E0)

of power dissipation until it is turned off. While certain devices have a 5- μ s short-circuit time-withstand capability, a device having a ≥ 10 - μ s withstand capability to such an event is considered a robust device. This allows that much more time for the controller to respond and shut down the gate drive in case of such an event. For example, Fig. 2 shows the test circuit and actual V_{CE} , V_{GE} , and I_C waveforms during a short-circuit test conducted on a 650-V-rated Renesas IGBT, RJH65S04DPQ-A0.

2. Performance: A high-performance device would need to have performance characteristics that help make the drive more efficient (reduced

“The challenge in choosing an IGBT is to select a device that enables a robust drive solution, and yet achieves the highest possible level of drive performance.”

losses and operating temperatures, minimized thermal impact), and enable the best possible dynamic performance (response of the drive to sudden load changes for example). Key aspects of the device in relation to achieving a high performance are now reviewed.

a. Reduced losses: For any power device, there are two main loss components, conduction loss and switching loss. A low conduction loss is achieved by means of as low a forward saturation voltage ($V_{CE(sat)}$) as possible for the IGBT, and as low a forward drop (V_F) (see Fig. 3) for the reverse connected diode, as possible. A low switching loss

is achieved by as low a turn-on and turn-off loss (E_{ON} and E_{OFF}) as possible for the IGBT, and as low a reverse-recovery loss as possible for the diode (as this loss has to be included in the turn-on loss of the IGBT). So not only are the IGBT's characteristics very important, but also those of the reverse connected diode. For example, the graphs in Fig. 3 are reproduced from the datasheet of a 1,200-V-rated Renesas IGBT, RJH1C-

high-side IGBT has turned off and the complementary low-side IGBT is commanded to turn on) must be as short as possible. This helps to minimize nonlinearity in the control loop and helps the current achieve as close to a sinusoidal shape as possible (this is highly desired). To enable a shorter dead time, what is critically important

is that the IGBT not exhibit a long turn-off time particularly in terms of its “tail current.” This is the effect of the recombination time of the minority carriers in the IGBT at turn off. This behavior can be better understood by referring to Fig. 4.

Test conditions; $V_{CC} = 300$ V, $V_{GE} = 15$ V, $I_C = 50$ A, $R_G = 10$ Ω

High performance and robustness are both highly desired characteristics in the

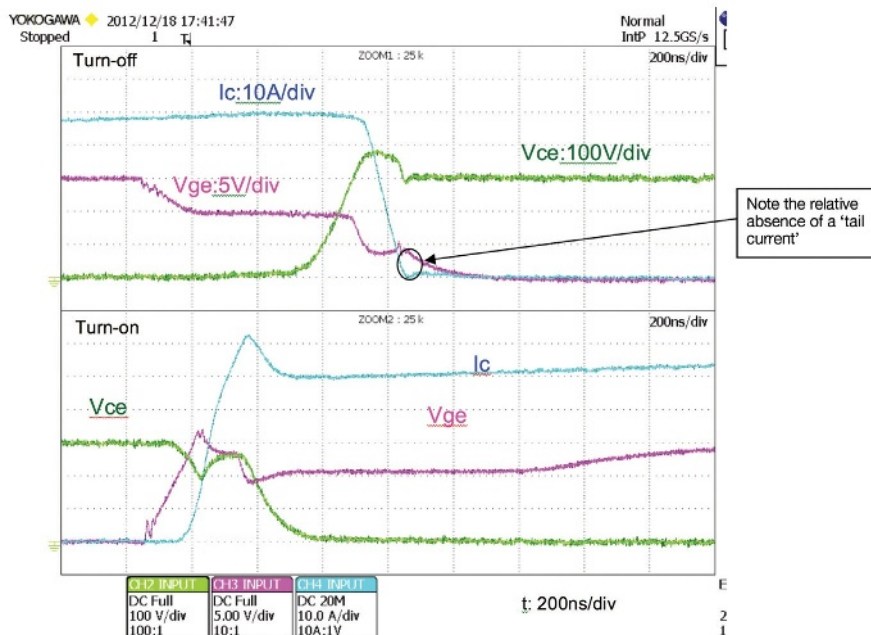


Fig. 4: Turn on and turn off waveforms under specified test conditions (RJH60CM7DPQ-E0)

M7DPQ-E0 that highlight the relatively low $V_{CE(sat)}$ and V_F specifications of the IGBT and reverse connected diode, respectively:

b. Dynamic performance: In high-performance ac-servo drives, the dead time (time interval between when the

power device used in industrial ac-motor drives. The device of choice today is the trench-gate IGBT. This article highlights some of the key characteristics of trench-gate IGBTs in the context of high performance and robustness as needed in this application. ■

Smaller and smarter autonomous robotics

Computers-on-modules facilitate mobile autonomous robotics designs

BY ANDREW SIMPSON
Content Developer and
DR. W. GORDON KRUBERG
President & CEO
Gumstix, www.gumstix.com

Autonomous and semi-autonomous robotic systems — those systems capable of performing complex tasks without continuous human intervention — are smaller, more capable, and more prevalent than ever. These systems are almost universally mobile, whether aerial, terrestrial, or marine, and require not only a small, light form factor, but one with low power consumption and communications capability. In an effort to balance costs and requirements, roboticists often turn to

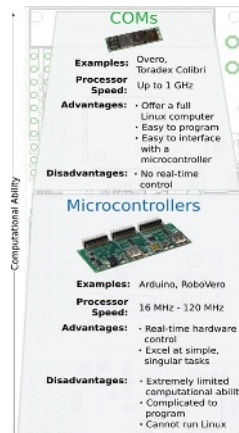
single-board micro-controllers, such as the popular Arduino. Selecting such a microcontroller, with its requirement for “bare-metal programming,” may make sense in some subsystems, but complex behavior is not a realistic possibility without a modern operating system like Linux.

Computers-on-module (COMs) are the answer to providing high-level software functionality in a tiny pack-

age. Available as compact, powerful, standardized platforms, COMs provide strong features in both hardware and software. They represent an excellent balance of physical and computational requirements. Whereas microcontrollers offer hardware-control at a low

level with limited software capabilities, COMs using powerful application processors offer a familiar high-level

Fig. 1:
Computer-on-module vs a microcontroller.



Linux environment and modular, expandable hardware. Using COMs, engineers move much of the autonomous systems’ artificial intelligence onto the robots themselves, advancing innovation within the field in diverse, unique, and interesting ways.

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vehicles (UAVs), including quadrotors, are the most discussed, imagination-capturing and, perhaps, have the most potential for practical application in the near future. The physical requirements of the vehicles demand small, light and low-power components. In the

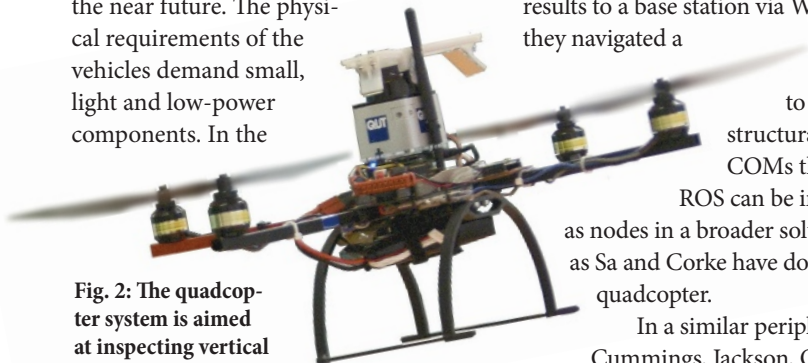


Fig. 2: The quadcopter system is aimed at inspecting vertical infrastructure.

past year alone, thousands of articles have been published on research with UAVs in some form or another. The use of COMs varies immensely, from functioning as a visual subsystem for a remote operator to the complex task of autonomously piloting a UAV, communicating with others flying in cluster, all made possible by the versatility of the computers-on-module.

Inkyu Sa and Peter Corke, both of the Queensland University of Technology in Brisbane, Australia, developed a quadcopter system aimed at inspecting vertical infrastructure, as noted in their 2012 publication “Vertical Infrastruc-

Sa and Corke employed a laser range finder on their quadcopter with a COM to run the standard Robot Operating System (ROS) laser scanner node, publishing scan results to a base station via Wi-Fi, while they navigated a

utility pole to check its structural integrity. COMs that support ROS can be implemented as nodes in a broader solution, just as Sa and Corke have done with the quadcopter.

In a similar peripheral usage, Cummings, Jackson, Quimby, and Pitman deployed a COM and a Summit expansion board as an inexpensive and effective video-streaming subsystem in a smartphone-based quadrotor control system for novice users. The quadrotor implemented a semi-autonomous flight system not unlike what was used by Sa and Corke, where the user has the ability to input waypoints and issue teleoperation commands, but cannot directly control the quadrotor. The COM’s features were crucial in the subsystem providing a novice user with critical visual flight information. The COM’s low power allowed it and an attached webcam to be powered with just four AAA batteries. The result-

ing weight of the entire system was only 215 g.

Finally in the field of UAVs, Martin Selecky and Tomas Meiser at Czech Technical University used COMs in a swarm of UAVs controlled by a modified version of the university’s AgentFly system.

AgentFly is a multi-agent system for the simulation of air traffic written mostly in Java. A critical consideration for the COM was the ability to run a Java virtual machine. AgentFly’s

“plane agent” controller conducts hardware control of the UAV and provides the “pilot agent” with an interface for high-level control. The pilot agent is responsible for

the UAV’s reasoning — it calls the trajectory planner and handles the communication with other UAVs for the purposes of collision prevention and thus requires the processing power and communications capabilities offered by a COM.

Terrestrial autonomous robotics

Again at Czech Technical University, Microslav Kulich and his colleagues have developed SyRoTek, a system that is “an e-learning platform for [the distance teaching of] mobile robotics, artificial



Fig. 4: SyRoTek is an e-learning platform developed at Czech Technical University.

intelligence, control engineering, and related domains.” SyRoTek features an enclosed arena with 13 terrestrial robots called S1Rs. Each S1R is controlled via Wi-Fi by a main control computer, is monitored and visualized by a camera and video server subsystem and is user-accessible via a web-based task programming and management system. Users, who are mostly students, program their task over the web in either Player/Stage or ROS.

Upon the completion of a task or depletion of battery, the S1R robots autonomously navigate to their docking stations for charging until their next task is initiated by the system. The researchers intend to expand the visual capabilities of the system by adding an onboard camera to the next revision of S1Rs, an expansion made easy through the use of a supported Caspa camera. The high-level communications and processing power — not to mention expandability — make SyRoTek one of the most capable and effective platforms for teaching robotics.

As Vincke, Elouardi, and Lambert note, “autonomous robots must be able to localize themselves” and that simultaneous localization and mapping (SLAM) is an ideal method of achiev-

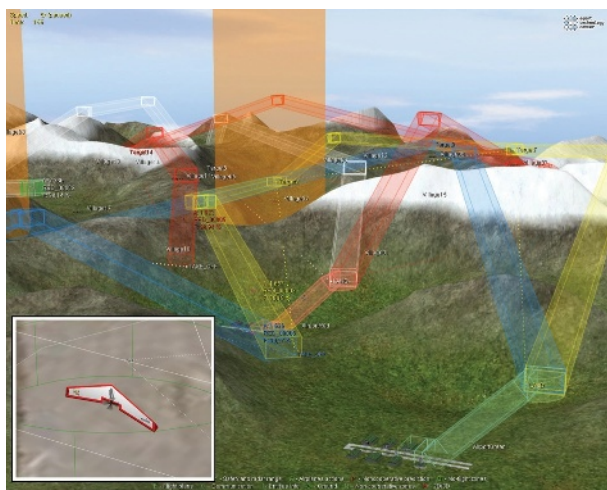


Fig. 3: The AgentFly networked remote controlled craft for simulation of air traffic.

ture Inspection Using a Quadcopter and Shared Autonomy Control.” Central to the design was partial autonomy, allowing an unskilled operator to conduct inspections.

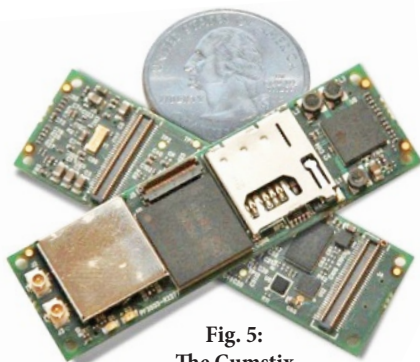


Fig. 5:

The Gumstix

Overo series is an example of a powerful computer-on-module.

ing this. Vincke *et al.*, however, recognize that “classical SLAM algorithms are too computationally intensive to run on an embedded computing unit” and “require at least laptop-level performances.” Building on research by Gifford *et al* in “Low-cost multi-robot exploration and mapping,” Vincke *et al* employ a COM as part of a terrestrial SLAM system, taking full advantage of the performance offered by the OMAP3530 processor. Data control and acquisition are managed by an Atmega168 microcontroller running at 16 MHz that communicates with the 500 MHz COM, responsible for all other functions. The researchers also plan to implement the COM’s on-board GPU coprocessor as part of a forthcoming map-joining system, an expansion made simple by the platform’s design.

Autonomous underwater vehicles

Finally, in marine robotics, Alexandra Gottschall, of the Florida Institute of Technology’s Department of Marine and Environmental Science, designed and built an autonomous underwater glider for her undergraduate thesis. Gottschall noted that, while many commercial gliders exist, none were available for student research at FIT. Using a COM with an expansion board to control all functions of the vehicle, Gottschall was able to design a sophisticated, autonomous vehicle named Bumblebee. with Gottschall noting that “the strength of the system is the ability to be upgraded and expanded without in depth knowledge of the hardware layers or system specific programming techniques.”

COMs

The Gumstix Overo series is an example of the many COMs available today. Based on TI’s OMAP 3, Gumstix Overo COMs have been used around the world in autonomous robotics, as well as in research and development.

These COMs offer Wi-Fi and Bluetooth communications, graphics

processing, camera connectivity, low-power consumption, an ARM processor, and various Linux flavors — including Ubuntu with ROS — all in a package only 58 x 17 mm. Overo COMs are also accompanied by a library of 16 useful, open-source expansion boards, including the robotics-oriented RoboVero. ■



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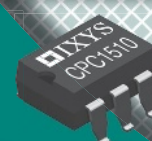
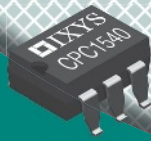
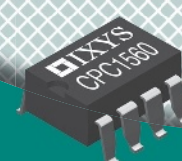
Part Number	Blocking Voltage (V)	Load Current (mA)	On Resistance (Ω)	Over-Voltage Threshold (V)	Speed t_{on}/t_{off} (ms)	Current Limit (mA)	Isolation Voltage (V_{rms})
CPC1510	250	200	15	-	2 / 2	450	3750
CPC1540	350	120	25	100*	2 / 2	285	3750
CPC1560	60	300	5.6	-	0.1 / 0.4	900	3750
CPC1563	600	120	35	100*	2 / 2	285	3750
CPC1593	600	120	35	21*	2 / 2	285	3750

* Over-Voltage protection active only when device is in current limit.

- Industrial Controls
- Electronic Switching
- Telecom Switching
- Instrumentation
- Telephony Hook Switch
- Security







IXYS Integrated Circuits Division
(Formerly Clare, Inc.)
78 Cherry Hill Drive
Beverly, MA 01915
978-524-6768
www.ixysic.com

For more information:
<http://www.ixysic.com/Products/SSRILTM.htm>

48 Product Update

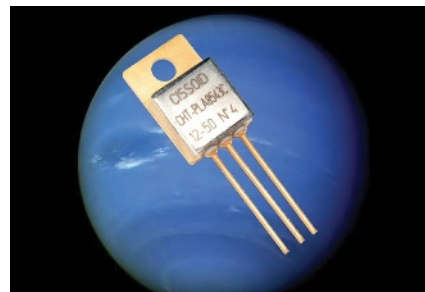
Discrete semiconductors

High-temp SiC MOSFET suits power converter applications

The CHT-NEPTUNE is a high-temperature, high-voltage SiC MOSFET specifically built for power converter applications in high-temperature and harsh environments.

It is available in a hermetically sealed TO-257 metal package. The case is isolated from the switch terminals and features junction-to-case thermal resistance of 1.1°C/W.

The SiC MOSFET is guaranteed for operation over the full range from -55° to +225°C. It has a breakdown voltage in excess of 1,200 V and is capable of switch-



ing currents up to 10 A at the maximum temperature ($T_j = 225^\circ\text{C}$). The device features a body diode that can be used as free-wheeling diode. The switch can be controlled with a typical gate voltage (V_{GS}) of -2 V / +20 V. The transistor's $R_{DS(on)}$ exhibits 90 m Ω at 25°C and 150 m Ω at 225°C with $V_{GS} = 20$ V. The device features low and temperature-independent switching energy <400 μJ at 600 V/10 A.

Cisoid: www.cisoid.com



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Industry's smallest MOSFETs suit power management

The NTNS3193NZ and NTNS3A91PZ ultrasmall, ultrathin small-signal MOSFETs are optimized for space-constrained



portable consumer electronics such as tablet computers, smartphones, GPS systems, digital media players, and portable

games consoles. The industry's most compact small-signal MOSFETs are housed in a tiny 0.62 x 0.62 x 0.4-mm XLLGA3 package. The MOSFETs have a total surface-mount area of 0.38 mm², replacing packages such as SOT-883 (surface-mount area of 0.6 mm² or the SOT-723 (with mount area of 1.44 mm²).

The NTNS3193NZ is a 20-V single n-channel 0.75- Ω MOSFET with typical on-resistance at ± 4.5 -V gate to source. This is complemented by the NTNS3A91PZ -20-V, single p-channel device, which has 1.3- Ω typical on-resistance at ± 4.5 V.

ON Semiconductor: www.onsemi.com

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CMSH1-200HE	1.0	200	0.9	50	SMA
CMSH3-200MHV	3.0	200	0.9	50	SMB
CMSH5-200HV	5.0	200	0.9	50	SMC
CSHD8-200	8.0	200	0.9	50	DPAK
CSHDD16-200C	16	200	0.9*	50	D ² PAK

* V_F @ 8A per rectifier

200V Schottky Bridge Rectifier

CBRHDSH1-200	1.0	200	0.9	50	HD DIP
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Schottky Rectifier Packages

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16.6 x 10.4 x 4.8mm	10.73 x 6.81 x 2.75mm	8.13 x 6.22 x 2.62mm	5.59 x 3.81 x 2.44mm	5.59 x 2.92 x 2.62mm	4.9 x 7.0 x 2.7mm

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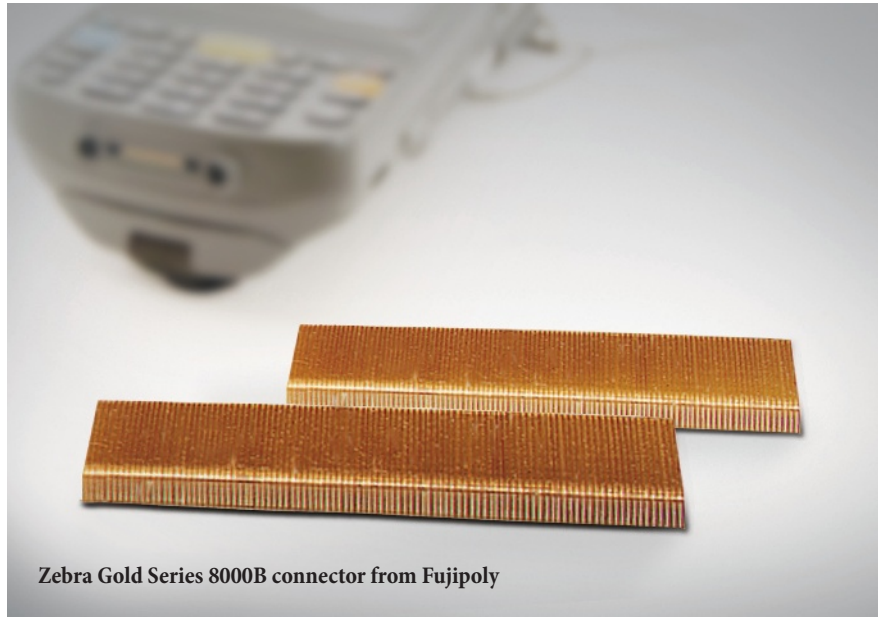
50 Product Roundup

Connectors and sockets

When it comes to today's connectors and sockets, performance is definitely key. For engineers seeking the highest performance from their selected connectors and sockets, they should look no further than the following products below.

Such is the case with some of the recent interconnection introductions that showcase the technological capabilities of recent socket and connection introductions. On the following pages *Electronic Products* highlights some recent offerings that best reflect these current trends.

Connectors



Zebra Gold Series 8000B connector from Fujipoly

Low-Ω connector handles tight spacing

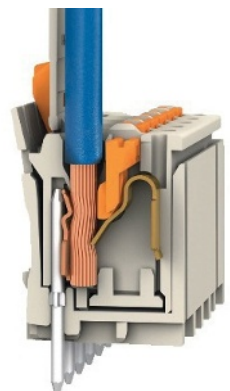
The Zebra Gold Series 8000B connector from Fujipoly America is a high performance, low resistance device capable of transferring both data and power between parallel components or circuit boards. It is constructed from a low durometer silicone core covered with 133 parallel rows of flat, gold-plated wires per inch. This unique construction allows the connector to accommodate PCBs with pad center spacing down to 0.19 mm.

In addition, each 0.05 x 0.10-mm gold-plated element delivers a current carrying capacity of 500 mA while exhibiting a typical electrical resistance of less than 25 mΩ on a 0.635-mm wide contact pad.

Compact connector keeps signal integrity, strong grip

The compact picoMAX pluggable connection system from WAGO offers a shortened current path, minimal voltage drop, and vibration-resistance up to 20 g. The connector provides up to 30% space reduction for wire-to-board applications, with operating temperatures to 125°C. The patented male header / female connector design uses a dual-function spring: the dynamic contact force from a Cr-Ni stainless steel spring clamps conductors and also connects them to the header pin. A truncated contact bridge separates the termination unit from header pin, minimizing contact resistance. Applications include industrial

**picoMAX pluggable
connection system
from Wago**



electronics (such as panel meters, controllers, and data loggers) and consumer electronics (for instance, garage door openers).

The connector is available in 2 to 12-pole configurations with 3.5-, 5-, or 7.5-mm pin spacing for wire-to-wire, wire-to-board, board-to-wire, and panel feed-through variants. It accommodates 24 to 12 AWG conductors and carries ratings to 15 A/300 V. To terminate cables, solid or ferruled conductors are directly inserted; for stranded conductors, integrated push-buttons provide terminations. Some versions provide gripping plates with a sliding connector release.

RJ45 connectors press-fit to PCBs

The JPB 2x6 1000BASE-T PoE and JT5 2xN 10GBASE-T I RJ45 integrated connector modules (ICMs) families with integrated magnetics from Pulse Electronics use a press-fit pin (also called compliant or interference pin) to provide



RJ45 from Pulse Electronics

a pressure contact with a printed circuit board (PCB), thereby eliminating the need for wave soldering.

Not only does this assembly method save time, increase throughput, and reduce costs, but it also allows rework of the ICM without damaging the PCB. Detailed process specifications for the ICMs, which meet IEEE 802.3 specifications, are available. The ICMs are packaged in trays and prices start at approximately \$5.00/port.

Sockets

BGA socket for DDR4 ICs minimizes performance loss, footprint

For 253-pin, 0.5-mm-pitch BGA DDR4 ICs, the CG-BGA-5019 socket from Ironwood Electronics is designed to operate with less than 1 dB insertion loss for 8 x 13.5-mm packaged devices oper-

ating at bandwidths up to 10 GHz. It is said to have the smallest footprint in the industry and all socket pins can handle 10-GHz signals with typical contact resistance of 20 mΩ per pin.

The socket has an easy-open, double-latch lid with integrated compression mechanism and high performance/low-



The CG-BGA-5019 socket from Ironwood Electronics



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52 Product Roundup

Connectors and sockets

inductance elastomer contactor, and can be mounted on a PCB with no soldering. The small footprint allows inductors, resistors, and decoupling capacitors to be placed very close to the device for impedance tuning. Priced at \$851 in single quantities, the socket has a -35°C to 100°C range, 0.11-nH pin self-inductance, 0.028-nH mutual inductance, 0.028 pF capacitance to ground, and 2-A-per-pin current capacity.

Internal mechanism secures power electrical connections

The IEC Auto-Lock from Quail Electronics is an internal retention mechanism that hooks to the pins of power supply inlets and resists any axial force unless the mechanism is released. A wide selection of configurations is available, with either the IEC-60320-C13 Auto-Lock or the IEC-60320-C19 Auto-Lock, in either black or clear.



Universal fit with any C14 or C20 inlet (snap-in or screw-on) and available in black or clear, the mechanism requires no tools or hardware

to implement. It meets UL, C-UL, and TUV domestic and international approvals, and is rated for 30 lbs.



Caton Connector: Custom Solutions for Custom Needs

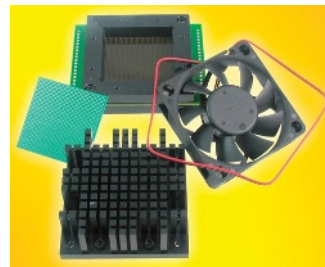
- Manufactures high voltage connectors and cable assemblies for use in the Military, Semiconductor, Utility, Medical and Avionics industries
- Creates products that operate at voltages exceeding 100kVdc, altitudes over 50,000 ft, and have partial discharge levels of 5 to 15 picocoulombs at voltages up to 40kV RMS
- Designs assembly configurations that have up to 13 conductors, multi-shields and use single, double and triple extruded silicone cables built to lengths over 300 feet
- Award-winning supplier with 39 years of high-voltage interconnect experience

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Socket takes 1-mm pitch BGAs to 10 GHz

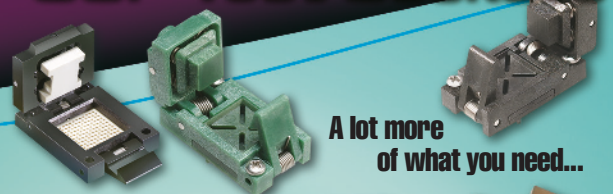
For use in test as well as field-upgradeable system designs, the SG-BGA-803 socket from Ironwood Electronics is designed to handle 1-mm pitch, 1,521-ball BGAs (39 x 39 ball array, 40 x 40-mm footprint) that operate at bandwidths to 10 GHz. The socket has the smallest footprint in the industry, supports 10 GHz on all connections, and provides less than 1 dB insertion loss.



SG-BGA-803 from Ironwood

With an integrated heat sink and a fan to dissipate 60 W, the socket mounts on the target PCB with no soldering, using supplied hardware. An integrated compression mechanism lets users simply drop IC into the socket, and apply down force using heat-sink compression socket lid. The socket is constructed with high-performance, low-inductance, gold-plated embedded-wire-on-elastomer as the interconnect material between device and PCB. The socket's contact resistance is typically 20 mΩ per I/O, capacitance to ground is 0.01 pF, pin self-inductance is 0.15 nH, mutual inductance of 0.025 nH, and current capacity is 2 A per pin. Operating range is -35°C to +100°C. ■

CSP Test Sockets



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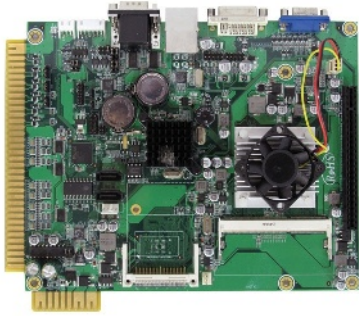
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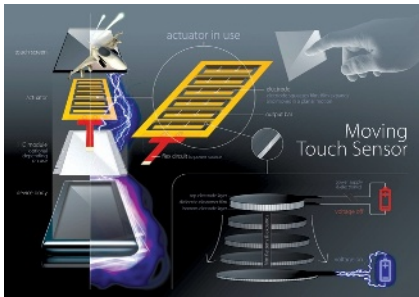
The Evolution of
Interconnect Innovation

Applications in Gaming Technology



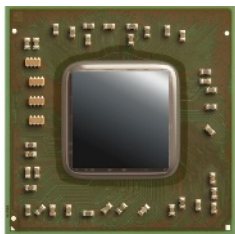
WIN Enterprises, Inc. offers the MB-63020 and AMD G-Series processor-powered gaming board. According to the company this single board computer (SBC) offers onboard 3D graphics performance with support for DirectX 11 and Open GL 4, independent dual display by VGA + DVI-D and full bit stream decoding of H.264/MPEG4 AVC, VC-1, DivX, Xvid, MPEG2 and Blu-ray 3D.

WIN Enterprises: www.win-ent.com



The Vivitouch HD Feel technology from Vivitouch enables the user to feel physical sensations through a Moving Touch Sensor. Among its key features are an actuator with a flex circuit to the power source, an optional HIC module and an output bar.

Vivitouch: www.vivitouch.com/company.html



The AMD Embedded G-Series SOC is the world's first embedded quad-core x86 SOC and first available

SOC based on AMD's "Jaguar" microprocessor design. It combines a low-power CPU, advanced AMD Radeon™ 8000 Series GPU and I/O on a single die, ideal for small form factor, energy efficient solutions.

AMD: www.amd.com/us/products/embedded/Pages/embedded.asp

In many ways, gaming technology represents the future of many other aspects of technology, including the desire for realistic 3D graphics, HD-quality resolution and reliability for discerning consumers. *Electronic Products* interviewed some of the leaders in gaming technology to discuss what types of trends in gaming products and applications they are seeing.

Keys to gamers' hearts

According to John Hill, director of marketing for North Andover, MA-based WIN Enterprises, adaptability is the buzzword in gaming technology today.

"We need to create rich content faster and graphics hardware must work with modern, established software environments such as Windows, Linux; and OpenGL- or DirectX-based APIs," he says.

For instance, he suggests using mature software environment ts to speed up development, adding that newer board-level digital circuits are more flexible, while integrators now have the ability to increase performance and upgrade by replacing relatively few components.

The reason this is so important, he adds, is because "it lengthens the life of their hardware platforms and this enables the development of games that provide a hybrid experience with classic lever/button/switch interfaces with today's high-resolution, 3D graphics and HD sound."

Dirk Schapeler, CEO of Artificial Muscle in Sunnyvale, CA, agrees: "We think gaming is moving to become a much more immersive medium than it is today. Through controllers that move hundreds of different sounds to how the next generation of headphones will pull you further in the gaming world. Making the player feel more a part of the game will be critical."

Kevin Tanguay, Embedded Gaming Manager, AMD Embedded Solutions

adds: "There is definitely a fight for eyes. The games are becoming more sophisticated and this is done in part by using machines with more advanced processor and graphics technology that can run a number of different games and multiple screens to enhance the overall effect."

Reliability strategies

Hill also notes that reliability remains a key issue as well.

"The hardware people like is the traditional golden fingers connectors because it helps ensure system reliability. This reliable connector accommodates the fact that games are often and regularly moved on the game floor in order to present a continuous fresh look to casino gamers."

He continues: "Exciting graphics performance isn't typically found on the single-user, single-screen systems. A developer can leverage the increased graphic capability of boards by increasing display size or number of screens for multiple players."

Hill adds: "People expect superior graphics support plus response and performance at reasonable cost. In addition, the ability to support more than a single display hints at the demands to come, which will be increasingly immersive to meet the expectations of increasingly savvy users."

Shapeler adds: "While major advances have been seen in both graphics and audio quality in gaming, touch sensations in game control have had the same one-buzz-fits all vibration for over a decade. The days of one-rumble-fits-all are numbered!"

Tanguay concludes: "First and foremost is graphics performance. The second is the number of screens a solution will drive. In addition, like most other embedded uses the industry is also interested in greater energy efficiency and reduced size."

John Filippelli



Wide range of fully isolated DC/DC converters in compact SIP package.

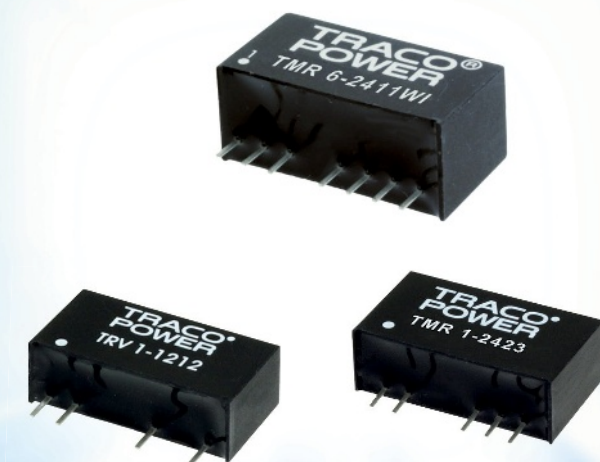
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www.tracopower.com

Rechargeable Li-ion cells target wireless use

The TLI series of batteries are long-life rechargeable lithium-ion cells designed specifically for use in harsh environments. They deliver 25+ year service life and feature an operating temperature from -40° to 85°C, with storage up to 90°C.

The Li-ion batteries deliver current pulses up to 5 A, have an annual self-discharge rate of <5%, provide 5,000 life cycles, and have an operating life of 10 years. The devices have a glass-to-metal seal compared to crimped seals used by competitive products. The battery cells can be recharged using dc-power or can be used in conjunction with photovoltaic solar systems or energy harvesting devices. They are available in AA-size (1550), 1530, and 1520, as well as custom battery packs.

Tadiran: www.tadiranbat.com



Many new options added to 1U supplies

The 1.7-in. high 1U format 720-W single-output and 750-W wide-adjust output ac/dc dc/dc models are now optionally available with a thermostatically controlled fan. Additional options include three-phase 208-Vac or 170 to 240-Vac (60 to 400 Hz) input voltage, in addition to 15-Vdc/100-mA auxiliary voltage. Provisions for n+1 redundancy and paralleling for higher current are also available.



The low-profile family of ac/dc and dc/dc power supplies are UL recognized, CE certified in a 1U format. They are supplied standard with universal input and active PFC and support either constant voltage or a constant current. Those with wide output voltage ranges can be adjusted down to 0 V. Both voltage and current are programmable with 0 to 10-V control voltage inputs. Pricing for outputs from 3.3 to 135 V is \$775 and \$800 for wide-adjust versions, with options ranging from \$15 to \$30 each.

Acopian Power Supplies: www.acopian.com

Waterproof ac/dc modules target field use

The waterproof ac/dc power modules in the PM-IP67A series target use in harsh environments for the field. They operate from 90 to 264 Vac and 100 to 353 Vdc inputs. The power modules provide output voltages of 5, 12, 15, 24, 36, 48, ± 12 , ± 24 , ± 48 and 12/24 Vdc. They are designed for worldwide use under extreme environmental conditions including dust and humidity.

The vacuum encapsulated power supply modules suit decentralized systems that don't have switching cabinets. The modules are offered in 50-, 75-, 100- or 200-W output power; are short circuit protected, and need no ground load. They operate from -25° to +70°C. The modules are VDE and UL/cUL approved. (Contact company for price and availability.)

MTM Power: www.mtm-power.com



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Smart Battery Chargers Offer Three-Phase Operation

Available in versions delivering 4.2V, 8.4V, or 12.6V at 1 A to address single- or multiple-battery configurations, the



GTM91128 families of smart Li-Ion battery chargers from GlobTek offer three charging methods: conditioning, constant current, and constant voltage. The universal-input devices have a minimum current charge termination technique with timer as back up, with LED indication of charging and fully charged states. An additional

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Medically- Approved Open-Frame Switchers Deliver Up to 240W

Suitable for use in a variety of medical, ITE, and PoE applications, the GTM91110P240 Family of open-frame AC/DC switchmode power supplies from GlobTek deliver up to 240W in a 3 x 5-inch footprint. The devices are provided in factory-configured outputs from 12 to 55 V (in 0.1-V increments). Available in Class I or II versions, the 1.75-high power supplies are 85% efficient at full load and include features such as active PFC, a built-in EMI filter, and a 12-V fan output as well as DC input

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Rechargeable Battery Pack Provides Fuel Gauge Data

Providing smart rechargeable power capability to advanced portable and remote devices, the BL3100C1865004S1PSQA Li-Ion Battery Pack from GlobTek incorporates fuel-gauge functionality to provide important power status information. The 14.4V pack has a 3.1Ah capacity and includes a built-in protection circuit as well. "You can no longer put a battery in one of today's products without providing a means to check on the power

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56 New Products

Power Sources

Isolated CAN/RS-485/RS-232 transceiver feature smaller size and lower consumption

MORNSUN's new integrated isolated CAN/RS-485/RS-232 transceiver module, the combination of transceiver chip, isolation chip, optocoupler, and isolation power supply, is widely used in motor driver, railway system, control system, smart meter applications, etc. It is an ideal solution to replace the traditional optocoupler to simplify a customer's design. Compared to optocouplers, these modules feature a smaller size, lower consumption, and higher port protection, as well as higher port protective capability and long-term durability, the company notes.

Mornsun America: www.mornsunamerica.com

Portable solar charger provides 8 W

The SLPD-01 Solar Pad is a high-efficiency Li-polymer solar charger suitable for charging smart phones, tablets, and multimedia players via a USB connection. It produces 5.2 V at 1.5 A, which is about 8 W. It measures 120 x 76 x 18 mm and weighs 300 g — about the size of a smart phone. The portable charger is equipped with two USB ports, one micro-USB port,

and four white LEDs.

The solar charger (\$69 ea) uses a 1-W solar cell and achieves 22% efficiency. The 600-mAh Li-polymer battery can also be charged through a USB input at the rate of 1.2 A at 5 V. A smart charging feature that uses an MCU protects the device from being over-charged or discharged.

IXYS: www.ixys.com



Next-Gen converters offer 89% efficiency

The PDS and PES series of second generation, board mount dc/dc converters feature offer 89% efficiency in the 2 W models and better thermal performance compared to existing products. The unregulated dc/dc modules are available in 1 W and 2 W configurations, providing 1.5-kVdc isolation and anti-static protection up to 8 kVdc. Both dc/dc converter series are designed with an operating temperature range from -40 to 105°C, offering a solution for converting and/or isolating dc rails within a range of industrial, telecom, security, and machine control applications.

The dc/dc converter families are housed in industry standard SIP, DIP, and SMT packages with pricing that starts at \$3.81 each for 500. They provide nominal inputs of 3.3, 5, 12, 15, and 24 Vdc and a range of single and dual output voltage configurations. To further



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www.megaelectronics.com
sales@megaelectroncis.com

enhance the series' performance across the entire load curve, the modules have been designed to greatly reduce power draw under light and no load conditions. The new family of dc/dc converters also comes standard with continuous short circuit protection, providing an additional layer of protection for sensitive loads.

CUI: www.cui.com/

6-W converters target medical applications

The MA600MHI series is a family of compact, 6-W dc/dc converters approved to both EN 60950 and EN 60601. They are specifically designed to meet the isolation, reinforced insulation and low leakage requirements of medical grade equipment.

The dc/dc converter series offers twelve models that operate from 2:1 inputs of 9 to 18, 18 to 36, and 36 to 75 Vdc, providing single and dual outputs of 5, 12, ± 12 , or ± 15 Vdc. Standard features include an I/O isolation of 4,000 Vac rms, efficiency to 80%, 2 μ A maximum leakage current, and input filtering that meets EN 55022 class A. Other features include continuous short circuit protection, input under voltage shutdown and overload protection.

MicroPower Direct: www.micropowerelectronics.com



Vehicle mounted dc/dc converter provides 5-Vdc out

The GTD21088L-1505-T2 vehicle/automotive mounted dc/dc converter power supply provides 5-Vdc regulated output with a maximum of 15-W continuous output for systems and applications and features a 1:3 input from 10 to 32 Vdc. Common applications include powering industrial PC systems, instruments, medical equipment, and automotive applications. The converter is compatible with marine, industrial, private aircraft, forklift, law enforcement, police, fire, ambulance, lift truck, and military 24-Vdc output systems.



The dc/dc switching power supply is available in a high-impact and high-temperature plastic housing with wire harnesses for input and output. The positive lead of the input includes a field serviceable 5-A automotive fuse. Input and output wires may be terminated with customer specified terminations or stripped and tinned. Ferrite beads may be added to either the primary wire, secondary wire, or both for EMI suppression.

GlobTek: www.globtek.com

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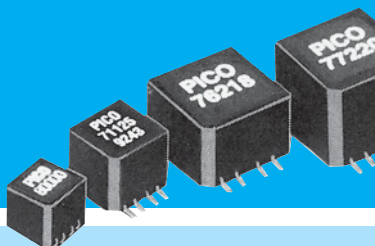
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58 New Products

Components & Subassemblies

Highlight of the Month

Tiny MEMS mic is built for hearing aids

The ADMP801 MEMS omnidirectional microphone from *Analog Devices* was developed specifically for hearing aid applications, providing high performance and low power consumption in a very small package. With a volume of only 7.3 mm³, the unit is not only much smaller than commonly used electret condenser microphones, but also offers greater performance stability over time, temperature, and environmental changes.

The mic has a very low equivalent input noise (EIN) figure of 27 dBA SPL, and consumes only 17 µA from a 1-V supply. The bottom-port MEMS device's noise performance, package size, and phase and gain stability, as well as its \$10.78 / 1,000 price, enable multiple units to be used for beam-forming to facilitate sound localization in advanced hearing aids. Production quantities of the microphone are currently available in 3.35 x 2.50 x 0.98-mm reflow-solderable surface-mount packages, and a \$95 evaluation kit (EVAL-ADMP801Z-FLEX) is also offered.

Analog Devices: www.analog.com



0402 SMT resistors are high precision

RN73H line of ultra-precision chip resistors is now available in a 0402 size. The thin film metal chip resistors feature a temperature range of -55° to 155°C and a tolerance of ±0.1%. Versions are also available with 0.25, 0.5, and 1.0% tolerances.

The 0.063 W (de-rated after 85°C) devices have a 50 V maximum working voltage and enhanced moisture resistance. They come with TCRs of ±10, ±25, or ±50 ppm/°C in a resistance range of 10 Ω to 300 kΩ and are AEC-Q200 qualified.

KOA Speer Electronics: www.koaspeer.com

Buy Now



650-V trench IGBTs feature 30 to 200-A ratings

The 650-V XPT trench IGBTs feature current ratings from 30 to 200 A at 110°C. On-stage voltages are as low as 1.7 V and the devices minimize conduction and switching losses, especially in hard-switching applications. The IGBTs are optimized for switching speed ranges up to 60 kHz. These IGBTs are available in TO-247, TO-264, SOT-227B, PLUS247, ISOPLUS247 international standard packages. Some part numbers are the IXXH30N65B4, IXXN110N65C4H1, IXXK160N65C4, and IXXX200N65B4, with collector current ratings of 65, 234, 290, and 370 A, respectively.

The IGBTs are developed using thin wafer technology and fourth generation vertical IGBT process. They are suited for power conversion applications, lighting control, motor drives, power inverters, power factor correction circuits, switch-mode power supplies, and uninterruptible power supplies. The IGBTs have square reverse bias safe operating areas (RBSOA) up to the breakdown voltage of 650 V, making them suitable for snubberless hard-switching applications. Other qualities include a positive collector-to-emitter voltage temperature coefficient which enables designers to use multiple devices in parallel to meet high current requirements and low gate charges.

IXYS: www.ixys.com



Buy Now



Audio processor features rate converters

The HD-compatible TAS5548 audio processor features an 8-channel PWM and dual asynchronous sample-rate converters. It allows designers to seamlessly mix two audio sources by accepting sample rates from 8 to 192 kHz and converting them to a fixed rate of 96 or 192 kHz. It provides 4-channel native audio processing at 192 kHz.

The IC's 40-kHz audio bandwidth is compatible with Dolby True HD and DTS-HD. Extra micro-

phone and I²S input combines with the ASRC's ability to mix two different

sample rate sources and yields the flexibility to mix a microphone with up to eight karaoke tracks. The 56-pin TSSOP-packaged chip is available now for \$3.68 ea/1,000.

Texas Instruments:
www.ti.com

Buy Now



Dual-core MCU targets automotive safety

The SPC56EL70 32-bit dual-core microcontroller is aimed at safety applications for car electronics and complies with ISO 26262. The 120 MHz Power Archi-

itecture MCU has 2 Mbytes of flash and 192 Kbytes of SRAM — both with ECC. The chip's dual cores provide lock-step mode and fail-safe protection.

The device has boot-time built-in self-test for memory and Logic (LBIST) triggered by hardware and boot-time self-test for the A/D and flash memory triggered by software. It also has a replicated safety-enhanced watchdog. It has two 12-bit A/D converters, three CAN and two LIN interfaces, and PWM peripherals for two BLDC motors. It costs \$16.50 ea/500.

STMicroelectronics:
www.st.com

Buy Now



G-series embedded processors up performance

The latest G-Series system-on-chip platform targets embedded control systems and is based on the AMD next-generation "Jaguar" CPU architecture. The ICs are standalone processors that do not need a chipset. The devices feature high-performance Radeon HD graphics and an average power of only 9 to 25 W. They operate over -40° to 85°C, have 7-year availability, and are said to have 113% higher performance than previous

AKM

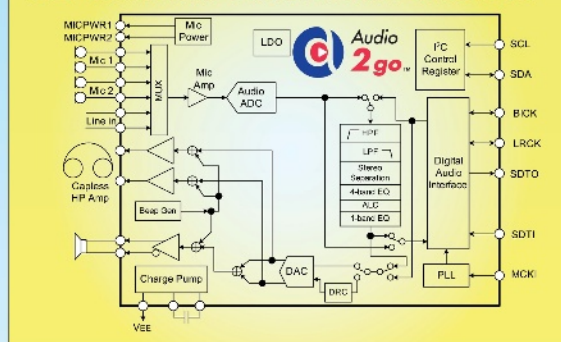
AKM Semiconductor, Inc.

New 32-bit Stereo Audio CODEC Delivers 100dB Performance (playback and record)

Consumes just 6.2mW!

The AK4954 is a low power 32-bit stereo CODEC with microphone, headphone and speaker amplifiers. The input circuits include a microphone amplifier and an ALC (Automatic Level Control) circuit, and the output circuits include a cap-less headphone amplifier, a mono speaker amplifier, and stereo line output. An excellent performance ratio is achieved, with 100dB dynamic range for both playback and recording.

32-bit Ultra-Low Power CODEC



AK4954 Features

- 32-bit stereo audio CODEC
 - 32-bits, 8kHz to 96kHz, 100dB dynamic range
 - 5-band EQ, wind noise filter, ALC
- 20mW cap-less ground-referenced headphone amp
- 400mW BTL mono speaker amp into 8Ω (SV_{DD} = 4.2V)
- Integrated PLL for master clock-free operation
- Low power operation: 6.2mW (playback), 10.4mW (record)
 - 2.5 to 3.5V core, 1.6 to 2V digital
 - 1.6 to 3.5V digital I/O, 0.9V to 5.5V speaker amp
- Small 32-pin QFN package (4mm², 0.4mm pitch)

For more information visit our website at:
<http://www.akm.com>
Contact our technical support staff at:
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E-mail: icinfo@akm.com



60 New Products

Integrated Circuits

units, with a 33% smaller footprint.

The 1 to 2 GHz GX-420CA, GX-415GA quad-core and GX-217GA, GX-210HA dual-core devices have graphics processors running at 300 to 600 MHz and enterprise-class ECC memory support. The quad-core 1.6 GHz GX-416RA does not have a GPU. The devices support virtualization and trusted platform. Pricing ranges from \$49 to \$72 each.

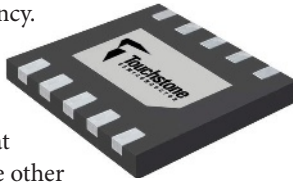
Advanced Micro Devices (AMD): www.amd.com

Low-power timer gives 0.0043 Hz to 300 kHz

The TS3004 NanoWatt analog timer IC operates over a wide supply voltage range of 1.55 to 5.25 V and can provide 0.0043 Hz to 300 kHz. The chip only needs 1.9 μ A at 25 kHz and uses a single resistor to set the base output frequency. Output period is adjustable from 3.3 μ s to 233 s.

Available in a 10-pin TDFN-EP package, the TS3004 has pricing that starts at \$0.95 in 1k quantities; three other versions are available: the TS3003, TS3005, and TS3006. The chip's output period accuracy is 3% with a temperature stability of 0.02 %/°C. Specifications are over -40° to 85°C.

Touchstone Semiconductor: www.touchstonesemi.com



8-port PoE PSE controllers eliminate optos

The LTC4290/LTC4271 isolated eight-port power source equipment (PSE) controller chipset suits IEEE 802.3at (PoE+) Type 1- and Type 2-compliant PoE systems. The LTC4271



provides a digital interface to the PSE host, and the LTC4290 provides the high voltage Ethernet interface. The two ICs are bridged by an Ethernet transformer. The transformer-isolated

communication protocol replaces up to six optocouplers and an isolated 3.3-V supply.

The PSE controller uses a proprietary dual-mode, four-point detection mechanism that ensures optimum immunity from false PD detection. The controller uses power management technique that includes prioritized fast shutdown, a 12-bit/port voltage and current readback, an 8-bit programmable current limits and 7-bit programmable overload current limits, and field-upgradeable firmware. An I²C interface allows a host controller to digitally configure the IC or query port readings. The LTC4290 is offered in three power grades to support power needs from 13 to 90 W. The chipset prices start at \$10 each/1,000.

Linear Technology: www.linear.com

Buy Now



Battery charger offers safe charging for portables

The MAX77301 Li+ battery charger integrates the intelligence to enumerate with the host device, automatically identify the adapter type, and then determine the fastest rate to charge a battery.



With advanced temperature monitoring, the MAX77301 modulates the charge current and battery regulation voltage automatically to

maximize safety in any temperature environment. It performs all of these functions without an external CPU or system hardware. The MAX77301 suits mobile equipment, such as cameras, Bluetooth headsets, MP3 players, and portable medical devices.

The battery charger automatically sets charge parameters at a safe level. The device also provides full programmability via the I²C interface, increasing flexibility. It integrates an enumeration and adapter detection engine to maximize charge current and to ensure safe and fast charging. Pricing starts at \$2.22 ea/1,000 in a 25-bump 2.44 x 2.44-mm wafer-level package.

Maxim Integrated Products:

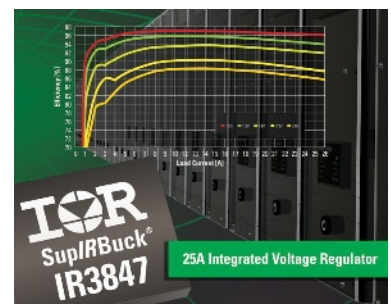
www.maxim-ic.com

High-current regulator reduces PCB size 70%

The IR3847 high-current PoL integrated voltage regulator is a third-generation design that extends the current rating to 25 A in a 5 x 6-mm package. A thermally enhanced package uses a copper clip and several proprietary innovations that enable the device to operate at 25 A without a heatsink, and reduces PCB size by 20% compared to alternative integrated solutions and 70% compared to discrete solutions. A complete 25-A power supply solution can be implemented in 168 mm².

The PoL regulator integrates power MOSFETs with a controller (starting at \$2.23 each/100,000) that includes post-package precision dead-time trimming, and an internal LDO to optimize efficiency across the entire load range, 0.5% reference voltage accuracy from 25° to 105°C, and output voltage accuracy <3% over line, load, and temperature. Other features include external synchronization, sequencing, VTT tracking, and output voltage margining. The pinout is optimized for easy placement of bypass capacitors.

International Rectifier: www.irf.com



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	Part Number	Resolution)	Maximum Sample Rate	# of Channels	Power Dissipation	SNR (dBFS)	SFDR (dBc)	EasySuite™ Evaluation Kit P/N
	HMCAD1520	12-Bit	160 / 320 / 640 MSPS	4 / 2 / 1	490 mW	70	78 ^[1]	EKIT01-HMCAD1520
	HMCAD1520	14-Bit	80 / 105 MSPS	4	530 / 603 mW	75 / 74	85 / 83	EKIT01-HMCAD1520
NEW!	HMCAD1513	8-Bit	250 / 500 MSPS	4 / 2	710 mW	50 / 49.8	59 / 56	EKIT01-HMCAD1513
	HMCAD1512	8-Bit	450 / 900 MSPS	2 / 1	650 mW	49.8	63 / 64 ^[1]	EKIT01-HMCAD1512
	HMCAD1511	8-Bit	250 / 500 / 1000 MSPS	4 / 2 / 1	710 mW	49.8	70 / 63 / 64 ^[1]	EKIT01-HMCAD1511
	HMCAD1510	8-Bit	125 / 250 / 500 MSPS	4 / 2 / 1	295 mW	49.7 / 49.8	69 / 65 ^[1]	EKIT01-HMCAD1510
	HMCAD1104	10-Bit	20 / 40 / 50 / 65 MSPS	8	12 / 20 / 25 / 30 mW / Channel	61.6	81	EKIT01-HMCAD1104
	HMCAD1102	13 / 12-Bit	80 MSPS	8	59 mW / Channel	70.1	77	EKIT01-HMCAD1102
	HMCAD1101	13 / 12-Bit	65 MSPS	8	51 mW / Channel	72.2	82	EKIT01-HMCAD1101
	HMCAD1100	13 / 12-Bit	20 / 40 / 50 MSPS	8	23 / 35 / 41 mW / Channel	72.2	82	EKIT01-HMCAD1100
	HMCAD1050-80	13 / 12-Bit	65 / 80 MSPS	2	85 / 102 mW	72.6 / 72	81 / 77	EKIT01-HMCAD1050
	HMCAD1050-40	13 / 12-Bit	20 / 40 MSPS	2	30 / 55 mW	72.2 / 72.7	85 / 81	EKIT01-HMCAD1050
	HMCAD1051-80	13 / 12-Bit	65 / 80 MSPS	1	50 / 60 mW	72.6 / 72	81 / 77	EKIT01-HMCAD1051
	HMCAD1051-40	13 / 12-Bit	20 / 40 MSPS	1	19 / 33 mW	72.2 / 72.7	85 / 81	EKIT01-HMCAD1051
	HMCAD1040-80	10-Bit	65 / 80 MSPS	2	65 / 78 mW	61.6	77 / 75	EKIT01-HMCAD1040
	HMCAD1040-40	10-Bit	20 / 40 MSPS	2	24 / 43 mW	61.6	81	EKIT01-HMCAD1040
	HMCAD1041-80	10-Bit	65 / 80 MSPS	1	38 / 46 mW	61.6	77 / 75	EKIT01-HMCAD1041
	HMCAD1041-40	10-Bit	20 / 40 MSPS	1	15 / 25 mW	61.6	81	EKIT01-HMCAD1041
NEW!	HMCAD1052	12-Bit	160 MSPS	4	490 mW	69	78 ^[2]	EKIT01-HMCAD1052
NEW!	HMCAD1054	12-Bit	320 MSPS	2	490 mW	69	78 ^[2]	EKIT01-HMCAD1054
NEW!	HMCAD1056	12-Bit	640 MSPS	1	490 mW	69	78 ^[2]	EKIT01-HMCAD1056
NEW!	HMCAD1062	14-Bit	80 / 105 / 125 MSPS	4	490 / 605 / 765 mW / Channel	74	85	EKIT01-HMCAD1062
NEW!	HMCAD1062B	14-Bit	80 / 105 / 125 MSPS	2	300 / 380 / 460 mW	74	85	EKIT01-HMCAD1062B
NEW!	HMCAD1063	14-Bit	400 MSPS	2	750 mW / Channel	72	85	EKIT01-HMCAD1063
NEW!	HMCAD1073	16-Bit	400 MSPS	2	1100 mW / Channel	76	90	EKIT01-HMCAD1073

[1] Excluding interlacing spurs.

[2] For BW <40 MHz. See HMCAD1052/1054/1056 datasheets.

Dc input LED downlight suits solar panels

The expanded LED downlight Capella series features four new dc-input LED lights that range from 8 to 18-W output, including the GL-DL04LD, GL-DL06LD, GL-DL08LD, and the



GL-DL06LD-IP.

These downlights come with bundled GlacialPower drivers that enable the lights to be connected to 12- and 24-V solar panel

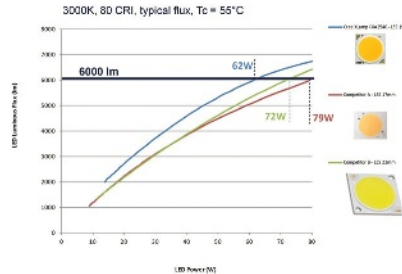
batteries without the need of an additional PV inverter. The four lights accept an input voltage of 11 to 15 Vdc and 22 to 30 Vdc. The LED lights suit boat, bus or train interiors.

The LED downlights all have a 120° beam angle and come in three different color options: 3,000 K, 4,000 K, and 5,700 K. The GL-DL04LD measures 114 x 13 mm and consumes 8 W. The 12-W GL-DL06LD measures 180 x 13 mm and has an IP50-rated casing. The GL-DL08LD measures 240 x 13 mm, features a different constant-current driver than the three other lights, and consumes 18 W. The GL-DL06LD-IP LED light consumes 12 W, measures 161 x 20 mm, and has an IP54-rated casing that prevents dust and water damage.

GlacialLight: www.GlacialLight.com

LED array breaks 10,000-lm barrier

The extended XLamp CXA family of integrated LED arrays now offers the CXA2540 and CXA3050 LEDs. The new CXA LEDs deliver 5,000 to 10,000 lm, enabling new applications



such as high output track lights, downlights, outdoor area lighting, and high bay lighting.

The CXA3050 LED is the brightest member of the CXA family and

can enable LED replacements for up to 100-W ceramic metal halide in spot lighting or up to 175-W pulse-start metal halide in high-bay and outdoor area lighting. The new CX2540 LED delivers up to 20% higher efficacy at 5,000 lm and 3,000K than competing LED arrays of similar size.

Cree: www.cree.com/modules

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330,000-lm light tower features pneumatic mast

The PLM-18-3X1000W pneumatic light tower takes the work out of producing large scale site illumination withstands the demanding conditions found on industrial and commercial work sites. The tower system provides 330,000 lumens and covers 3+ acres with light in a wide flood pattern.

The three metal halide lamps on the light tower are suitable for work sites where seeing details and performing close work is critical. Each lamp features a 16-in. aluminum housing and reflector assembly with heat-treated glass lens. Each lamp is independently adjustable to eliminate shadowing and excessive beam overlapping.

Larson Electronics: www.larsonelectronics.com



Downlight uses heat pipe technology for cooling

The Prescolite MegaLum is offered as the industry's highest-output LED downlight, providing 12,000 lumens by integrating heat pipe technology into the fixture. It features the Multi-Source modular fixture platform that incorporates plug and play connectors to accept a variety of illumination technologies.

The high-output LED fixture uses heat pipe technology used in computers, HVAC systems and solar products to transfer heat away from the LEDs more than 10 times faster than conduction systems. The recessed downlight is available in multiple configurations. The downlight's driver and light engine are accessible from above or below the ceiling plane for servicing.

Hubbell Lighting/Spaulding Lighting brand:
www.spauldinglighting.com

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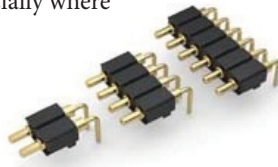
310.534.3016

Right-angle spring-loaded connectors have long-stroke option

The 829 series single-row, right-angle, spring-loaded connectors from Mill-Max have added a version, 829-22-0XX-20-002101, with an increased mid-stroke distance of 0.045 in. (0.090 in. full stroke) – close to double most standard series products and providing more flexibility and tolerance for your assembly. The 829 series suit applications calling for a spring-loaded connection that lies parallel to the PC board. They fit small packaging requirements of handheld devices, especially where vertical space is limited.

With tails bent at right-angles and locating pegs on the insulator, the 829 series connectors are installed as through-hole components providing a secure connection to the PC board. These SLC's are suitable for hand, intrusive reflow or wave soldering. Gold-plated brass components and beryllium copper springs ensure the highest conductivity, corrosion resistance and durability. The 829 series connectors feature spring-loaded pins rated at 2 A continuous (3 A max), use high-temperature Nylon 46 insulators, and are offered in up to 20 positions in a strip.

Mill-Max: www.mill-max.com

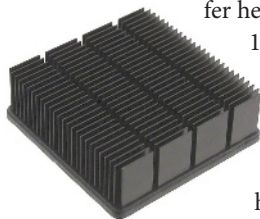


Heat sinks feature low thermal resistance

The AER, APF, APR, and BDN series of heat sinks suit BGA, PGA, PLCC, QFP and other IC packages. The AER, APF, and APR forged, low-profile thin-fin heat sinks offer height ranges from 6.3 to 32.6-mm with thermal resistance of 1.9°C/W with 200 lfm convection. These heat sinks require no special tools to assemble on the IC packages or additional holes on the PCB. They suit large ICs with heat dissipation needs.

The BDN extruded heat sinks have a pre-applied adhesive tape that peels off and sticks onto the component. The adhesive shear strength at 100°C is 36 psi so, a one-inch square heat sink would require a 36-lb force to remove heat sink. Thermal resistance for this product is as low as 2.6°C/W at 400-lfm forced convection flow conditions.

CTS: www.ctscorp.com



Buy Now



Reliable compression connector handles 3 A

The 9155-100 (part #9155002100 or 9155003100) ultra-low-profile board-to-board compression power connectors are rated for 5,000 mating cycles. Featuring a 1.3-mm minimum operating height, they have 0.4- μ m selective gold-plated BeCu contacts that are insert-molded within the insulator for location and mechanical stability.

The connectors have a sweeping contact design that provides a 0.7-mm Z-axis deflection range, a long contact wipe, and greater than 40 grams of contact force at minimum operating deflection. They are rated for 3 A per contact, 125 Vac, and a -40° to 105°C operating temperature range. They will be available in one-, two-, and three-position configurations in June.

AVX: www.avx.com

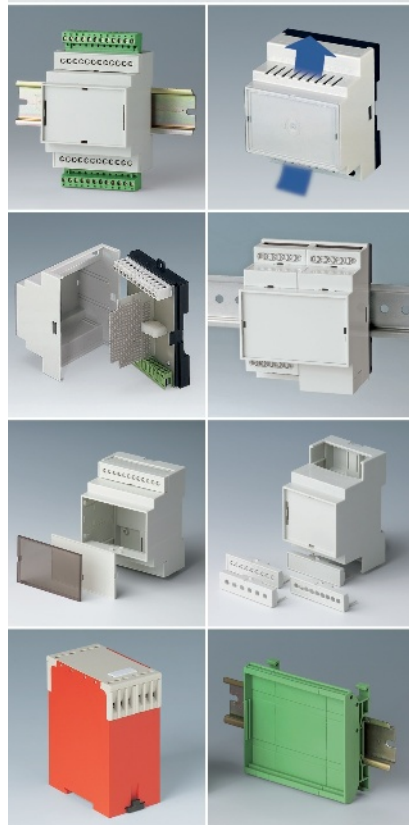


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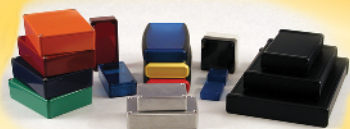
okwenclosures.com

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Phone: 800-965-9872



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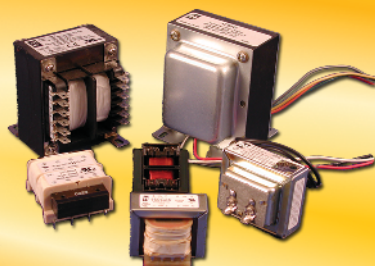
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www.hammondmfg.com

Tel: (716) 630-7030

64 New Products

Packaging & Interconnections

Power strip outlets rotates to accept bulky plugs, converters

The 2500.PS8-R Rotating Power Strip by *Quail Electronics* provides six outlets that rotate 180° to allow room for oversize plugs and ac/dc converters. Priced at \$30 in single quantities, the power strip also has two fixed outlets, for a total of eight sockets, and is rated cumulatively for 1,800 W.

The strip's 360° rotating 0.5-in. power plug lets users swing the strip from one side to the other, and lays flush with floor molding and chair rails. A cable management system for clamping wires and X3MOV surge protection system are included.

Quail Electronics: www.quail.com



Connectors feature thermocouple material

The M12-FM series connectors from *Omega Engineering* feature male pins and female sockets made of thermocouple material.

Priced from \$55 each, the male and female connectors, with straight or right-angled connection styles, provide a wide selection of connection options. They are suitable for ovens for heat treating, engines, and automation machines in manufacturing and the oil and gas industries.

Omega Engineering: www.omega.com



Racks, internal accessories feature distinct style

The TN Series enclosures and racks, available from *AMCO Enclosures*, are fully welded, offered in three distinct styles, and now available through the company's new 24-hour shipping program. These racks have a 12,250-lb load rating, feature a heavy-duty skirted caster base with two ground studs, four 1,000-lb levelers, two pair of 10-32 tapped mounting channels, and a durable black powder coat finish.

The PTN Series 24-in.-wide rack features open sides for easy access to electronic equipment. The BTN Series 22-in.-wide rack features open sides for easy access to electronic equipment. The ETN Series 22-in.-wide rack that includes two non-removable, vented side panels. According to the company, the PTN is available to ship in 24



hours in two heights, 37RU and 44RU, and depths of 27.5 and 32.5 in. The BTN is available to ship in 24 hours in two heights; 37RU and 44RU and depths of 26.5 and 31.5 in. and the ETN is available to ship in 24 hours in three heights — 35RU, 40RU, and 44RU — and in smaller frame depths of 20 and 25 in.

AMCO Enclosures: www.amcoenclosures.com

Packaging & Interconnections

Dual-band Ethernet port adapter has external antenna

The RWE251s Ethernet port adapter from connectBlue features Wireless LAN (WLAN) dual-band functionality and an omnidirectional external stub antenna. These features give the RWE251s a versatile use for both the 2.4- and 5-GHz ISM bands as well as the possibility to freely select where to position the Ethernet Port Adapter. Based on WLAN IEEE 802.11 a, b, g, n (Wi-Fi), the device suits industrial and medical applications where the Ethernet cable needs to be replaced with a robust wireless connection. The ready-to-use RWE251s optimizes the installation process as well as lowers the installation costs in demanding applications.

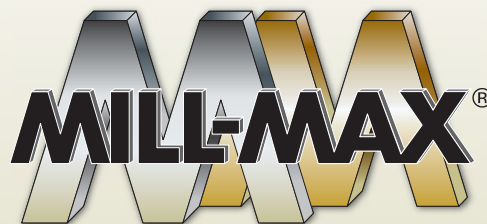
Configuration of the device is simple and intuitive thanks to the SMART configuration mode and the availability of a web browser configuration tool. The RWE251s supports WEP64, WEP128, WPA-PSK, WPA2-PSK, TKIP, CCMP (AES), LEAP, PEAP and is radio type approved for US (FCC), Europe (ETSI R&TTE) and Canada (IC RSS). Further, the RWE251s is configurable to optimize for Profinet.

connectBlue: www.connectblue.com

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LISN measures disturbances at 150 A

For measuring conducted emissions disturbances on dc-power ports of photovoltaic (PV) inverters, the DC-LISN-M2-100 line impedance stabilization network (LISN) from Teseq can run



at a maximum operating current of 150 A for 30 min, or continuously at 100 A. The tester conforms to the latest requirements of the international standard working group MT

GCPC (grid connected power conditioners), offering a maximum operating voltage of 1,500 V and measuring disturbances over a frequency range of 150 kHz to 30 MHz.

Testing with impedance levels of 150 Ω in common mode and 100 Ω in differential mode, the \$6,990 instrument can serve where a typical artificial mains V-network (as described in CISPR 16-1-2) cannot: for assessment of unsymmetrical disturbances of a photovoltaic inverter's DC port. CDNs based on IEC/EN 61000-4-6 are typically not specified for high common-mode currents or differential-mode disturbances. Depending on the switch position, the new LISN works as V, Y, or Delta shape as well as offering a defined termination impedance from 1 kHz to 30 MHz.

Teseq: www.teseq.us

Color analyzer tests popular displays

With a measurement range of 0.05 to 100,000 cd/m² that is better able to handle low-luminance measurements, the CA-2500 2D color analyzer from Konica Minolta Sensing Americas is well suited for the evaluation and inspection of a variety of display technologies used in products such as high-end displays (avionics/broadcast/medical), smartphones, and tablets. The instrument uses XYZ filters that provide high correlation with



the spectral response of the human eye, and closely match the CIE 1931 color-matching function to provide luminance and chromaticity measurements.

The included CA-S25w data management software provides advanced functionality to ease the entire measurement process,

from measurement preparations such as focusing and positioning, to the evaluation of measurement results. The software provides improvements over the previous CA-S20w software, but can also read data that was measured and saved using the CA-S20w.

Konica Minolta Sensing Americas, Inc.: sensing.konicaminolta.us/

Low-cost counter-timer offers 6-GHz range

The TF960 counter-timer is a 6-GHz bench/portable frequency counter. It features a high-quality temperature-compensated internal frequency reference (TCXO) that is stable to within ± 1 ppm over the full temperature range. An external reference input is provided, and changeover from the internal time-base is automatic when an external reference standard is connected. The counter-timer can measure and count from 0.001 Hz to 6,000 MHz, and incorporates a USB control interface, which facilitates control and data transfer. The unit operates from internal rechargeable NiMH batteries that typically give 24 hours operating life. The universal ac-charger supplied recharges the batteries in <4-h and can also provide continuous ac operation. The instrument can also be powered from a standard USB port.



The TF960 counter-timer can measure frequency, period, pulse width, duty cycle, and frequency ratio, as well as event counting/totalizing. For frequency, period, and ratio functions, the TF960 uses a reciprocal counting technique to provide high resolution at all frequencies with up to 10-digit accuracy. For frequencies up to 125 MHz, the device input is configurable as 1-M Ω or 50- Ω impedance, ac or dc coupling, and 1:1 or 5:1 attenuation. The threshold is fully variable, and the active edge can be a positive or negative transition. Two high-frequency inputs cover a range of 80 MHz to >3 GHz and 2 GHz to >6 GHz, the latter input being via an N connector.

Saelig: www.saelig.com

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Detailed specs at:

<http://krohn-hite.com/html/calibrators/Calibrators.htm>



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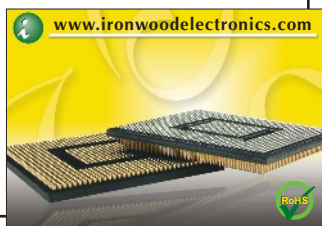
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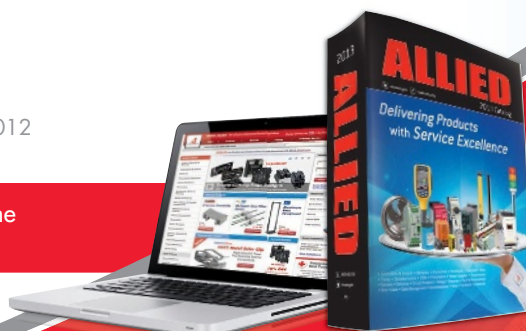
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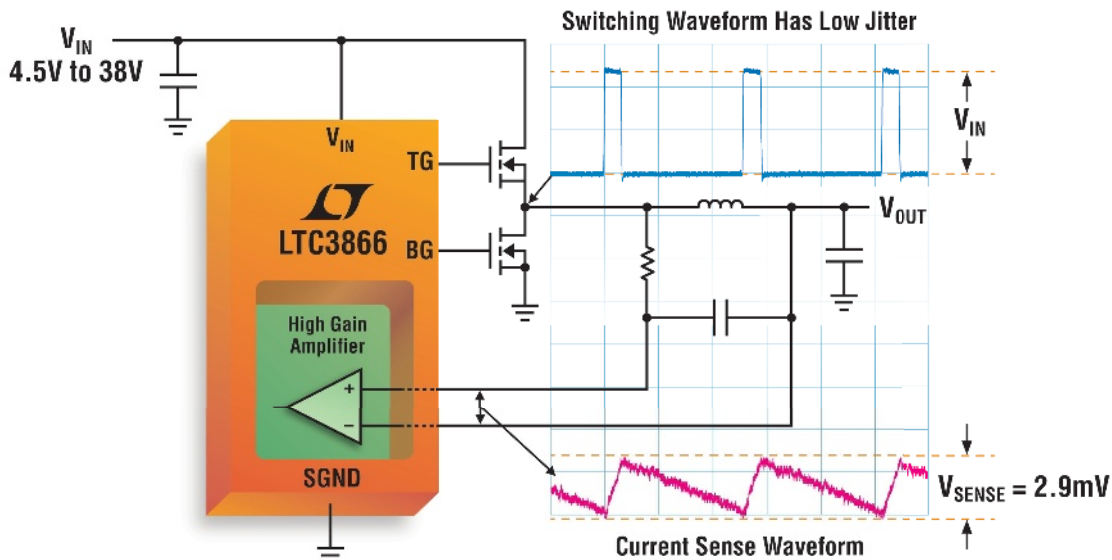


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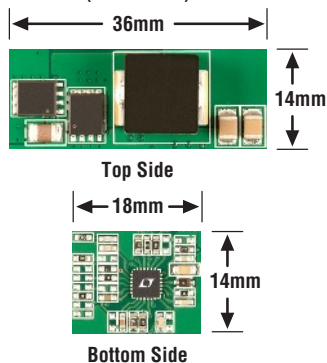
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- Synchronizable and Easily Paralleled for Multiphase Outputs
- Integrated Thermal Shutdown

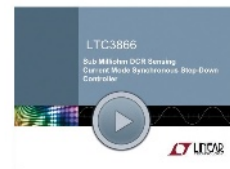
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