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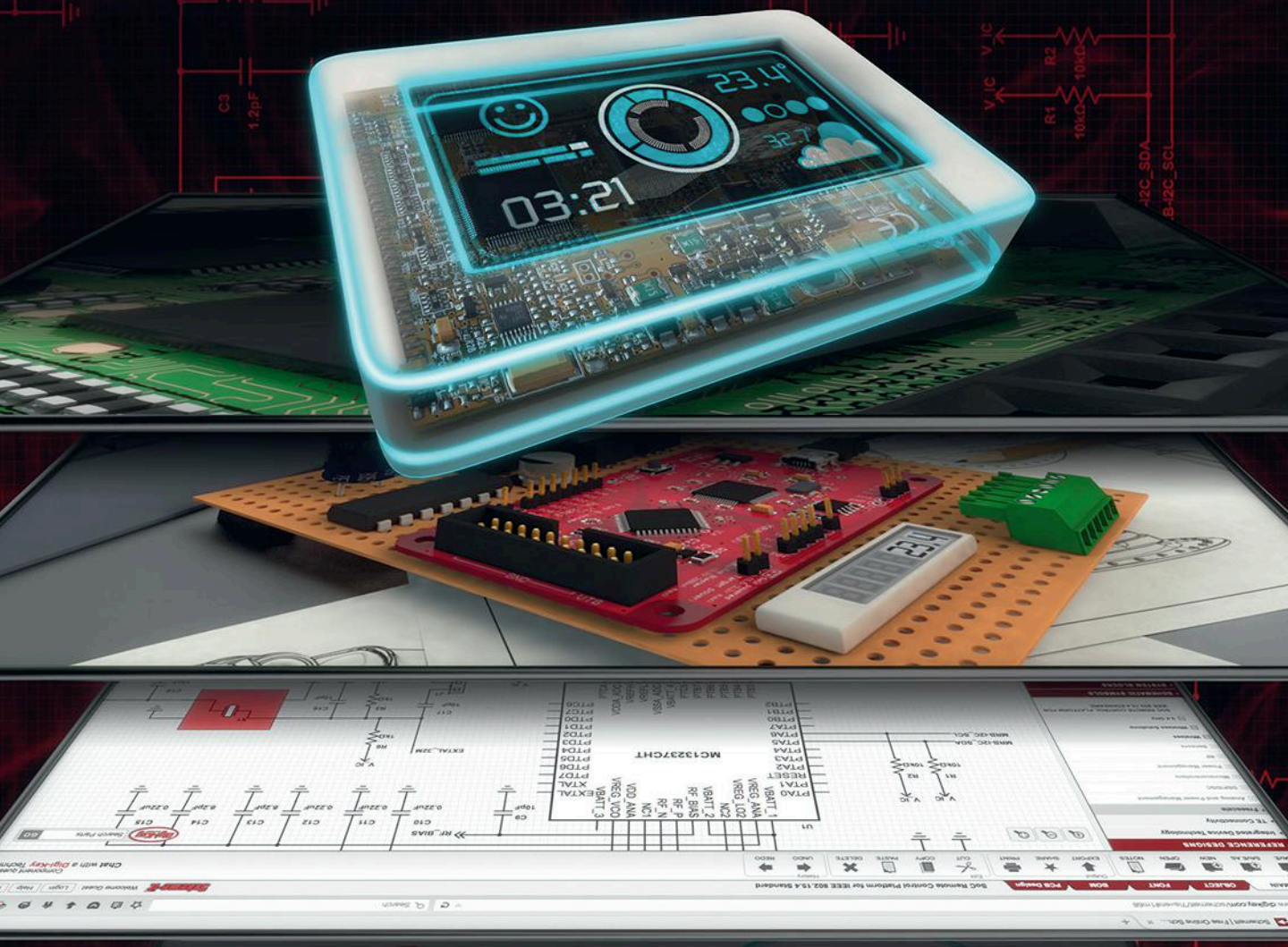

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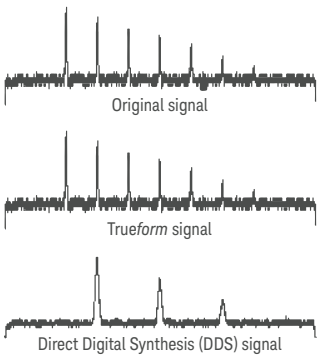

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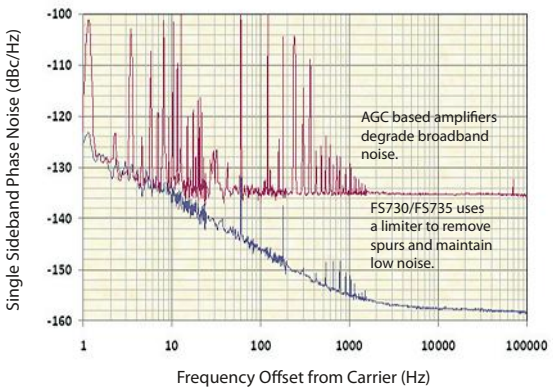

Additive phase noise in 10 MHz Distribution Amplifiers: Limiter vs. AGC Designs

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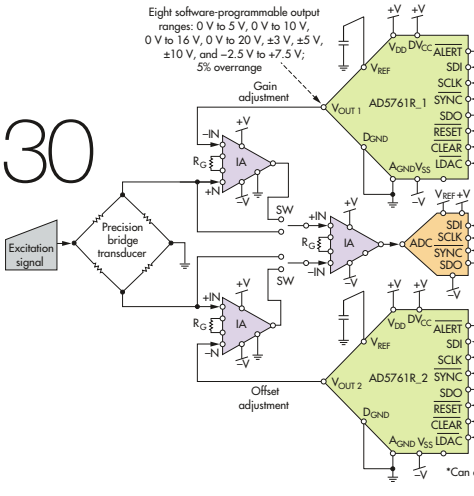

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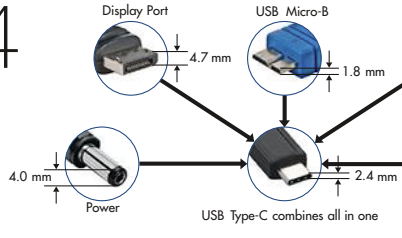

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RESEARCH LOOKS TO BOLSTER QUANTUM COMPUTING

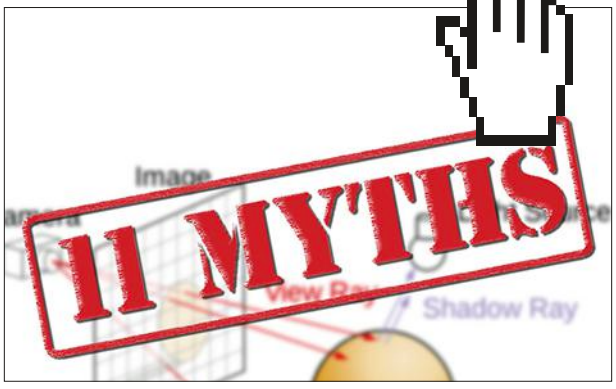
http://electronicdesign.com/microprocessors/new-research-injects-optimism-question-quantum-computers

Researchers at the Technical University of Munich (TUM) have taken the latest step toward incorporating quantum devices into computer technology, inventing semiconductor nanostructures that process information using quantum bits.

CURBING THE COST OF WIRELESS PRODUCTION TEST

http://electronicdesign.com/test-measurement/curb-rising-cost-wireless-production-test

Tomorrow's wireless test challenges will require a combination of lightning-fast instrumentation, a new approach to wireless test, and the engineering expertise required to put it all together.



11 MYTHS ABOUT THE INTERNET OF THINGS

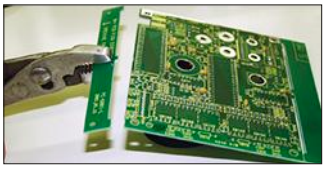
http://electronicdesign.com/iot/11-myths-about-internet-things

In the first installment of our new online feature, "11 Myths," Technology Editor Bill Wong takes a look at many of the things we've all been hearing about the Internet of Things—and just how true they are.

PANELIZATION GUIDELINES FOR PCB DESIGNERS

http://electronicdesign.com/boards/pcb-designers-need-know-these-panelization-guidelines

Unplanned delays and redesigns can be avoided by following common-sense PCB processing edge and array guidelines, as well as understanding the basics of the assembly methods.



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MARIA GUERRA | Analog/Power Editor
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Meet Our New Analog/Power Editor

Hello! My name is Maria Guerra and I am the new Technology Editor on *Electronic Design* covering Analog/Power. I hold a bachelor's degree in Electrical Engineering from Universidad Metropolitana in Caracas, Venezuela. Upon graduation, life circumstances brought me to the United States, where I earned a master's degree in Electrical Engineering with a certificate in Wireless Communications at NYU Tandon School of Engineering.

Over the course of my career, I have been involved in the oil and gas industry. In my hometown, I worked at Pequiven S.A., where I was responsible for estimating electric-circuit variables pertaining to the bottom of oil wells. Variables pertaining to the surface of oil wells were normalized and fed into a neural network for the estimation. In the UK, I worked for Kellogg, Brown, and Root Ltd. (KBR). While working there, one of the responsibilities that I enjoyed the most was giving technical support to the Electrical Engineering Group.

At KBR, I performed power systems studies (e.g., load-flow calculations, short-circuit analysis, motor-starting studies, harmonic studies, etc.) for different projects for both offshore and onshore designs. I communicated the results of those studies by writing technical reports, which I always found quite rewarding and challenging. Now I find myself in a similar situation: researching and reporting.

In my new role, I am going to have the chance to report on the latest information related to emerging technologies in the analog and power electronics world. I am also looking forward to sharing with our readers various learning resources that will help to refresh and reinforce engineering concepts.

I am particularly looking forward to talking about power-semiconductor technology trends. I would like our readers to be aware of what the industry leaders in the power electronics world have to offer in the areas of power management, charging, energy harvesting, power generation, and more. Among the hot topics that I plan to cover are electric/hybrid cars, renewable energy sources, and wireless charging technologies.

I'm based in *Electronic Design*'s New York City office and can be reached at maria.guerra@penton.com. ed

News

SILICON LABS BUZZING
for ZigBee Modules with Telegesis Buyout

With the wireless industry's growing emphasis on low-power, short-range data transmission, Silicon Labs recently moved to acquire Telegesis, a supplier of mesh networking modules based on ZigBee technology, a communications protocol for generating personal area networks (PANs) with low-power radios. The transaction was settled near the end of last month for approximately $20 million.

By acquiring Telegesis, the company has positioned itself to extend its mesh networking products into modules backed by IEEE 802.15.4 software stacks and development tools.

This strategy of expanding into modules was underlined in February when Silicon Labs introduced its Blue Gecko Bluetooth Smart modules developed by Bluegiga Technologies, the Finnish company that Silicon Labs had purchased earlier that month for approximately $61 million. According to Tyson Tuttle, chief executive of Silicon Labs, the addition of Bluegiga's modules helped to balance the company›s wireless hardware and software stacks for the Internet of Things (IoT).

Telegesis has developed ZigBee modules primarily for smart meters, USB adapters, and gateways for smart energy networks. The modules, which are based on the IEEE 802.15.4 standard, can also be used in home automation, connected lighting, security and industrial automation. Telegesis modules are built around Silicon Labs' EM35X and EM358X mesh networking SoCs and the EmberZNet PRO ZigBee protocol stack.

The market for ZigBee modules is growing rapidly, with 20% of all ZigBee PRO integrated circuits shipping in modules this year, according to a report from IHS Technology. ZigBee module shipments, on the other hand, are expected to grow at an

Both the ZigBee Alliance and Silicon Labs have begun to work closely with the Thread networking protocol for smart homes. In recent years, Silicon has acquired several suppliers of ZigBee modules, which are also used in consumer devices for the smart home.
(Image courtesy of Silicon Labs).

NASA LOANS HUMANOID ROBOT Prototypes to Universities

THE NATIONAL AERONAUTICS and Space Administration (NASA) is making two prototypes of its humanoid Valkyrie robot available to American universities "for active research of high-level humanoid behaviors." The agency recently announced that it would give one prototype to a research laboratory at the Massachusetts Institute of Technology (MIT), and the other to researchers at Northeastern University.

Officially designated as the R5—but known more colloquially as the "superhero robot"—the Valkyrie was built in 2013 to compete in the DARPA Robotics Challenge, an annual competition that tests humanoid robots in a series of disaster-relief scenarios. The robot was originally designed by a research team from NASA's Johnson Space Center in Houston, in partnership with the

(continued on next page)

annual rate of 24.6% between 2015 and 2019, according to the report.

James Stansberry, senior vice president of Silicon Labs and general manager of the IoT division, says that the combination of Telegesis modules and Silicon Labs' mesh networking chips will open a cost-efficient "migration path" from modules to SoCs based on both ZigBee and Thread—a relatively new protocol for low-power wireless personal area networks (LWPAN) that also supports mesh networking.

Earlier this year, the Thread Group announced that it would begin working with the ZigBee Alliance to make its protocol compatible with the ZigBee Cluster Library application layer. Thread, which is headed by Google's NEST smart-home subsidiary, was founded last year with support from Samsung Electronics and ARM Holdings. Thread places a significant emphasis on mesh networking as its core feature.

As a rival protocol to low-energy Bluetooth Smart, which will add mesh networking capabilities in its 2016 version, Thread and ZigBee are both designed for consumer and industrial equipment that requires short-range low-rate wireless data transfer. ZigBee transfers data over the 2.4 GHz ISM band at a defined rate of 250 kbit/s, making it well-suited for intermittent data transmissions from sensors or other devices. The transmission range is typically limited to between 10 and 100 m. ■

University of Texas and Texas A&M.

The administration will lend one Valkyrie prototype to each university, providing technical support from NASA engineers and up to $250,000 in funding for each of the next two years. Both projects are focused on developing new software programs that can make the Valkyrie robots more autonomous and resilient when carrying out tasks during space missions.

NASA is hoping that humanoid robotics will eventually be able to assist or take the place of astronauts working in extreme environments. For instance, the administration has expressed interest in sending robots to Mars before humans so that they can prepare for human astronauts arriving on the planet. The robots could also assist the astronauts with routine maintenance and other repairs during the mission.

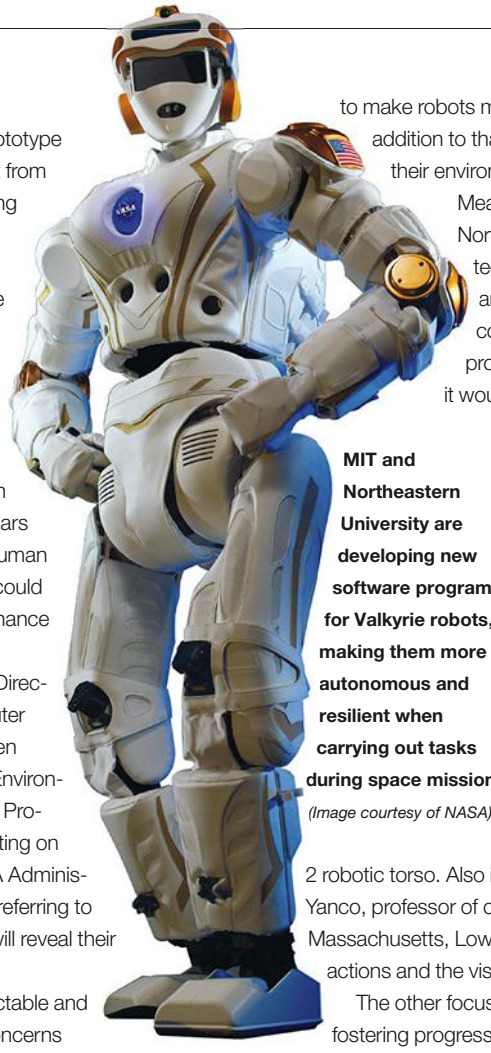
The MIT project, led by Russ Tedrake, the Director of the Center for Robotics at MIT's Computer Science and Artificial Intelligence Lab, has been titled "Robust Autonomy for Extreme Space Environments." The Northeastern project, headed by Professor Tashkin Padir, is called "Accessible Testing on Humanoid-Robot-R5 and Evaluation of NASA Administered (ATHENA) Space Robotics Challenge," referring to the competition where both research teams will reveal their upgrades to NASA.

The problem of interacting with an unpredictable and complex environment is one of the primary concerns with the MIT project, said Tedrake in a statement to IEEE Spectrum. His personal goal over the next two years is enabling the Valkyrie robot to more efficiently interact with the environment without a safety harness or belay. This problem, he notes, will require careful revisions to the entire sensor system and control stack.

Realistic interactions with the environment were one of the rarest sights at the DARPA Robotics Challenge earlier this year, an event that serves as barometer for the state of humanoid robotics. Unintentional contact with the environment usually caused the robot to fall, especially if it could not turn a valve, cut into a wall, or toggle a switch with extreme precision.

The ability of humanoid robots to roll with the punches of an unstructured environment has been at the heart of recent research. Earlier this year, Boston Dynamics released video footage of its experiments with the Atlas humanoid robot. It showed the robot walking across rocky terrain and recovering its balance after being hit with a weight.

On the cognitive side of the spectrum, DARPA is funding research to forge more intuitive interactions between humans and computers. For instance, Colorado State University researchers are developing new technologies for making computers recognize not only verbal instructions but also non-verbal ones. The research has the potential to make robots more collaborative with humans but, in addition to that, also more intuitive when reacting to their environment.



MIT and Northeastern University are developing new software programs for Valkyrie robots, making them more autonomous and resilient when carrying out tasks during space missions. *(Image courtesy of NASA)*

Meanwhile, the research team from Northeastern has revealed little about the technological aims of their project. Padir, an associate professor of electrical and computer engineering, discussed the project on his personal blog, saying that it would concentrate on "novel perception-based grasping and human-robot interaction techniques."

Padir, who led the robotics program at Worcester Polytechnic Institute before transferring to Northeastern, also wrote that the research team would combine a wide range of expertise. Joining him on the research project is Robert Platt, an assistant professor of computer and information science, who worked on the grasping and manipulation technology used in NASA's Robonaut 2 robotic torso. Also involved with the research is Holly Yanco, professor of computer science at the University of Massachusetts, Lowell, who studies human-computer interactions and the visualization of sensor data.

The other focus that Padir has for the research is fostering progress in the field of autonomous robotics. He also wants to make the Valkyrie software developed in the research project available to the entire humanoid robotics community.

"Successful completion of this project will not only progress the technological readiness of humanoid robots for practical applications," he writes, "but also nurture a community of competitors and collaborators." ■

LOW-POWER WIDE-AREA NETWORKS Gain IoT Footholds

UNTIL RECENTLY, most technologies within the Internet of Things (IoT) have been forced to transmit data over satellite and cellular networks. But even though the infrastructure is well-established, these networks are often considered too expensive for IoT technologies, which incorporate thousands of low-power, low data-rate devices.

To meet these new requirements, low-power wide-area networks (LPWAN) have emerged to replace satellite and cellular networks in the industrial and commercial IoT. A recent report from SNS Telecom estimates that LPWANs will record service

revenues of $27 billion by 2020.

As LPWAN technology reaches maturity, the SNS Telecom report suggests that LPWAN modules will become less expensive and more accessible. The report estimates that today the cost of a typical module ranges from about $5 to $20, depending on the specific technology. However, the cost per module will eventually fall below $1 to $2 in volume quantities.

In separate reports, analysts have suggested that lowering the cost of modules could be accelerated by moving toward a few core API standards. This would be a stark contrast to the recent explosion of LPWANs spurred by chipmakers, industrial manufacturers, and wireless companies.

The Wireless IoT Forum was recently established to stop the IoT from being "held back by fragmentation and the absence of standards." The organization will attempt to drive consensus between competing standards and promote

Smart meters, such as this one from Pacific Gas & Electric, have been one of the earliest applications for low-power wide-area networks. *(Image courtesy of Ellin Beltz, via Wikimedia Commons)*

requirements for ideal LPWANs.

The SNS Telecom also anticipates that government bodies will get involved to regulate these networks, many of which operate in the license-exempt or unlicensed spectrum bands. "There are a number of ongoing initiatives that call for regulators to dedicate spectrum bands exclusively for LPWANs," the report says, noting that the widespread usage of unlicensed spectrum can result in significant interference. At present, most LPWANs occupy the industrial, scientific, and medical (ISM) bands.

With all of these LPWANs entering the market, the report says that wireless operators have begun to invest in carrier-grade LPWA networks to support low bandwidth IoT systems. In October, for instance, Verizon introduced ThingSpace, a platform for application development, device management, and other tasks required for IoT systems.

The largest potential for IoT technologies exists in the industrial and commercial markets, but consumer network protocols such as Bluetooth and ZigBee are making a bid to compete on both sides of the plate.

Silicon Labs, on the one hand, supports the SigFox standard, while at the same time continuing to increase its investment in the ZigBee standard: The company recently acquired Telegesis, a manufacturer of ZigBee modules. ■

BILL WONG | Embedded/Systems/Software Editor
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Performance, Power, and Security Top Digital Hardware Trends

We take a look at the hardware trends for 2016—and, no surprise, the Internet of Things is making its presence known.

SMALLER, FASTER, AND LOWER POWER remain the mantras for digital technology this year, but security has been added to the list, primarily due to the phenomenal growth of the Internet of Things (IoT). At least the increased connectivity that's been driven by IoT designs and the never-ending reports of security breaches, buggy code, and cyber attacks has pushed the design and development community to bring security to the forefront.

Expect the usual churn in 8-, 16-, 32-, and 64-bit microcontrollers and microprocessors with interesting multicore combinations and ties to GPUs as well as specialized controllers for handling real-time and communication chores.

Storage is about DDR4 and the plethora of flash-memory systems that will effectively push hard-disk storage to the sidelines for the majority of applications.

Now for a few specifics:

HARDWARE SECURITY FOR THE IoT

Hardware-based security support is not new, but the number of chips that have it is rapidly increasing. In 2015, ARM announced its ARMv8-M architecture. The low-overhead, ARMv8-M specification adds TrustZone support to the 32-bit Cortex-M microcontroller series (*see "New ARM v8 Architecture for Microcontrollers" on electronicdesign.com*). The Cortex-M architecture enjoys the widest 32-bit support in the microcontroller space.

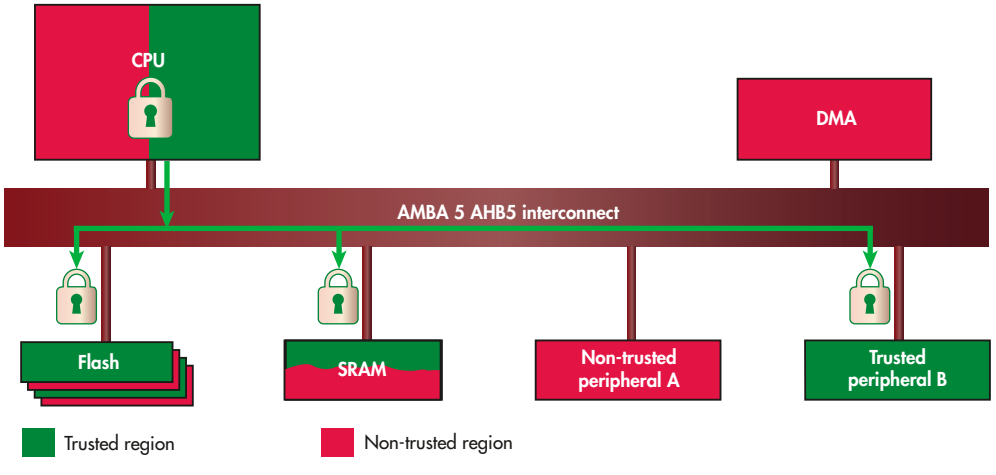
TrustZone support was already available for the Cortex-A family. The two implementations are not identical as the ARMv8-M definition had to address the real-time needs of the Cortex-M microcontrollers. The ARMv8-M provides an untrusted user and trusted system mode of isolation that also partitions memory and peripheral access (*Fig. 1*).

Other ARMv8-M features include architectural enhancements such as hardware divide, compare and branch instructions, and long branching for cross-unit tail-call support. It is also designed to handle multiprocessor system support with the addition of C11 atomic data-type instructions.

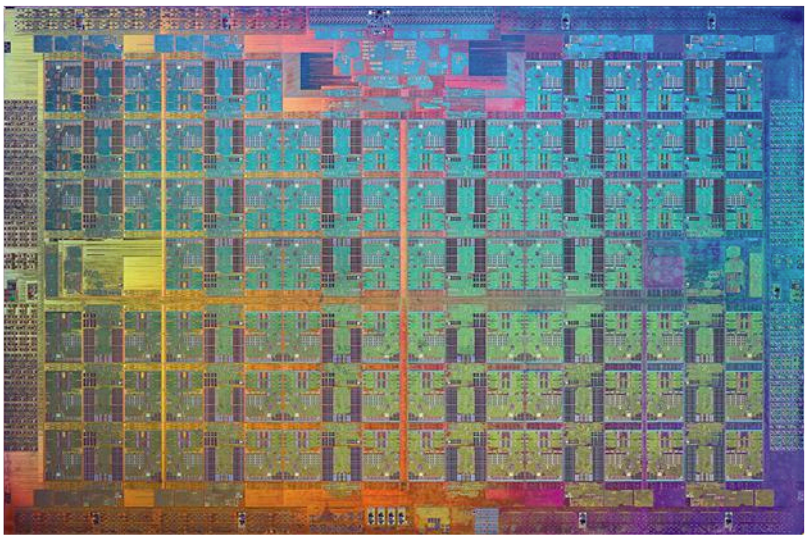
Other security-related support that is becoming more prevalent is anti-tamper support. This is needed for protecting user data as well as protecting intellectual property (IP) in the form of applications and algorithms. Again, this is not a new idea, but one that is becoming more standard and less expensive.

HIGH-PERFORMANCE COMPUTING

Dozens of 64-bit CPU cores and even more GPU cores on a single chip will be the norm as densities increase and chip-process resolution decreases. ARM's 64-bit cores are becoming more popular in the enterprise, complementing the increased



1. The ARMv8-M architecture provides a trusted system mode and an untrusted user mode. The latter can be restricted to select memory and peripherals.



2. The current Xeon Phi die highlights the numerous regular cores. The new architecture will employ a mesh communication system instead of a ring-based link.

performance already used in the mobile space. The ARM Cortex-A72 provides more performance than the current crop of Cortex-A5x chips, but at this point Intel remains the leader in processor architectures. Intel is expected to deliver Broadwell-based Xeons with up to 24 cores.

The Intel Xeon Phi (*Fig. 2*) will be getting a major refresh. The ring architecture will be replaced with a mesh used in many competing core devices. The Knights Landing implementation will be built around two Silvermont cores. The 16 GB of in-package, multichannel DRAM (MCDRAM) will challenge AMD's high-bandwidth memory (HBM) implementation found in its current crop of GPU boards (*see "High-Density Storage" on electronicdesign.com*).

The new Xeon Phis also use Intel's Omni-Path Architecture. A four-lane connection operates at 25 Gb/s. It is designed for low latency. Copper and optical connections can be utilized between chips and boards.

AMD and NVIDIA's GPUs will remain an important HPC component in addition to providing graphics support. NVIDIA's Maxwell architecture is in the latest GTX 970 boards. The NVIDIA Tegra X1 on the Jetson TX1 module has four, 64-bit ARM Cortex-A57 cores plus a 1024-GFLOPS Maxwell GPU with 256 cores (*Fig. 3*).

PUSHING COMMUNICATION LIMITS

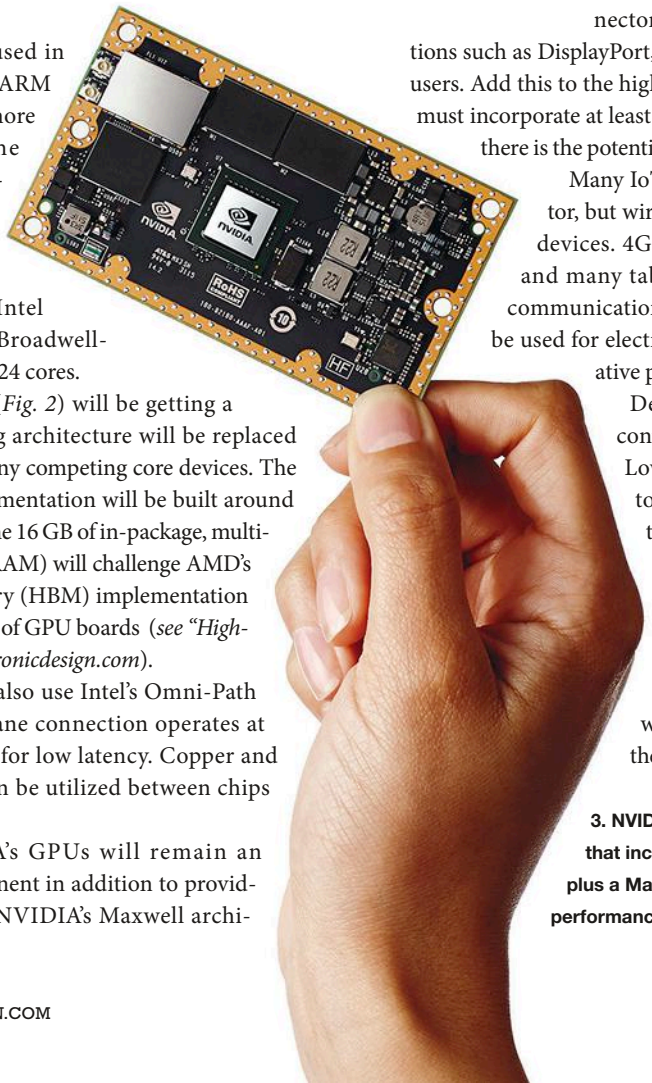
The USB 3.1 Type-C connection will be the communications darling this year. It has the bandwidth and is reversible, making it more convenient and easier to use (*see "USB 3.1 Type C Connector Is Reversible" on electronicdesign.com*). It also supports a more advanced power-management system that can deliver significantly more power than the prior USB standards.

The Type-C cabling also supports different protocols, not just USB. This is an advantage and can allow a system to have a single connector to handle different types of connections such as DisplayPort, but this feature could be confusing to users. Add this to the higher cost of Type-C cables because they must incorporate at least some electronics for handshaking and there is the potential for user confusion.

Many IoT devices will sport a Type-C connector, but wireless tends to be the choice for mobile devices. 4G is obviously part of the smartphone and many tablets are likely to include near-field communication (NFC) support. NFC will primarily be used for electronic payment systems, but more creative pairings are possible as well.

Developers and consumers will have to contend with Bluetooth Smart/Bluetooth Low Energy (BLE) as well as legacy Bluetooth. BLE delivers significant advantages, ranging from much lower latency and power requirements to better device handling.

ZigBee and Z-Wave continue to improve, but IoT software standards like Thread from The Thread Group, which uses 6LoWPAN, will be making the 802.15.4 space more interesting.



3. NVIDIA's Jetson TX1 module has a Tegra X1 that includes four, 64-bit ARM Cortex-A57 cores plus a Maxwell GPU that delivers 1024 GFLOPS of performance.

> "Heading into 2016, we're seeing a significant increase in customer interest and activity in the area of 5G research."
>
> —Ken Karnofsky, The Mathworks

4. The Samsung 950 Pro m.2 uses stacked 3D V-NAND MLC flash memory to pack in up to 512 Gbytes of storage, accessible using a 4x PCI Express interface.

Another IoT interface to keep an eye on comes from the LoRa Alliance. LoRaWAN is a Low-Power Wide-Area Network (LPWAN) specification designed for wireless battery-operated devices. It operates at low bit rates (under 100 kb/s) in the ISM bands, but the radios can operate at distances over 100 km.

The current 4G environment will provide IoT support from a cellular standpoint, but it will be worth watching the emerging 5G standard. Ken Karnofsky, senior strategist at The Mathworks, says, "Heading into 2016, we're seeing a significant increase in customer interest and activity in the area of 5G research." (*See "5G Trends in 2016: Shifting the Design Workflow Paradigm" on electronicdesign.com.*)

Designers will be able to take advantage of more multiprotocol solutions, such as chips that support WiFi, Bluetooth, and 802.15.4.

STORAGE WARS

Flash-memory technology is a confusing hierarchy of chip technologies and packaging ranging from eMMC chips to NVMe-based drives. The DRAM landscape tends to be less confusing with DDR3 and DDR4 dominating and new motherboards pushing the DDR4 bandwidth.

The non-volatile RAM (NV-RAM) space is heating up. Diablo Technologies Memory1 puts 1 TB of flash into a single DIMM socket on the processor's memory channel.

Flash memory is available in m.2 (*Fig. 4*) and conventional-drive form factors using SATA, SAS, and PCI Express (PCIe) interfaces, with PCIe having the edge on throughput. The m.2 is also finding a home in motherboards, enabling very compact system designs.

Samsung started the 3D race with its V-NAND (*see "Flash in the 3D Pan" on electronicdesign.com*). This is just one of many stack storage systems that will be readily available this year. AMD's HBM chip architecture is another. It brings stacked DRAM into the same package as AMD's GPU.

This year will also see more flash-memory alternatives turning into real products. Texas Instruments is already using FRAM in a range of its MSP430 microcontrollers. According to Jim Handy, an analyst at Objective Analysis, Intel's new 3D XPoint memory technology fills a gap between DRAM and flash storage (*see "3D XPoint: A New Revolution in Memory?" on electronicdesign.com*). Intel is still keeping quiet about the technology's details, but it will eventually show up in areas where flash is currently used (including on memory channels like Memory1).

Server and enterprise systems may have a steep memory hierarchy with various nonvolatile memory technologies delivering different levels of performance and cost. The hierarchy starts at the memory channel, where DRAM and flash can reside.

SWaP+C DRIVES MILITARY TECHNOLOGY

Mergers and acquisitions in this space have made 2015 interesting, but military technology continues to push the envelope. ARM-based systems are becoming more prevalent with Intel platforms dominating in many areas.

John Cowles, general manager, RF and Microwave Group at Analog Devices, notes, "Advanced defense systems are pushing the boundaries of performance even as they continue to reduce size, weight, and power (SWaP). In addition, the demand for multifunction systems and the need to reduce system development costs (SWaP+C) is driving system designs to be more modular and platform-centric, further pushing semiconductor integration levels and device configurability. Advanced SiGe, CMOS, and GaN technologies are well aligned with these goals, providing higher levels of integration, the inclusion of digital signal processing, and improved efficiency." (*See "SWaP+C Will Drive Military System Designs in 2016" on electronicdesign.com.*)

High-end FPGAs with very fast SERDES will provide more performance typically through the use of advanced chip packaging, which will allow multiple chip technologies to be combined into a single package (*see "Hyper-Registers Boost Throughput in Monolithic FPGA Chip" on electronicdesign.com*). High-speed, rugged systems communications will continue to use 10 G and 40 G Ethernet.

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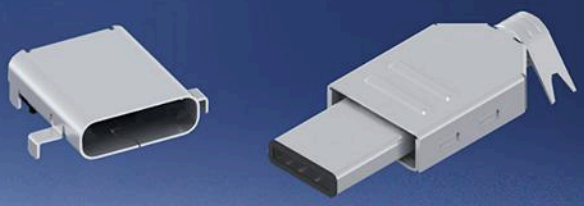

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IoT Frameworks/Development to Dominate Software Trends in 2016

Is this the year that the Internet of Things really takes hold? Advances in cloud technology and resolving security and quality issues in software could at long last tip the scales.

IT'S TIME TO STOP KICKING THE TIRES and take the plunge into the Internet of Things (IoT). Most IoT frameworks finally have some meat on the bone, and the plethora of options has become mind-boggling.

One major trend is the move to cloud-based development as tools become more complex, which increases setup and integration costs. Having someone else set up, support, and maintain the tools can offload these chores from a company, but developers need to be wary of issues like long-term support.

Also taking center stage are the matters of security and software quality. Though these areas have always been important, they're often neglected in the general embedded space due to cost and effort. Of course, no one wants insecure and buggy code, but where is the boundary between total security and bug-free code? Moreover, what actually gets delivered by most software projects? For unconnected devices, security has become less of an issue.

SOFTWARE FOR THE INTERNET OF THINGS

The challenge with IoT has always been the large number of interfaces, connections, and entities involved in even the most basic designs *(see the figure below)*. IoT offers many benefits and provides a potentially flexible environment, yet one must factor in its greater complexity with more potential points of failure, attack, and maintenance. The entire system needs to work together properly, otherwise problems become inevitable. And with possibly millions of end nodes and gateways involved, the ramifications could be catastrophic.

Organizations and vendors have been taking the wraps off IoT frameworks and environments, often expanding the func-

An IoT environment typically includes end devices, gateways, cloud services, and control applications found on devices like smartphones and tablets.

tionality, coverage, and partnerships. Many IoT standards organizations were closed societies made up of vendors looking to guide the design of the frameworks. This year they will be delivering their incarnation of these frameworks to developers, so that they can examine and utilize them to build IoT solutions.

The ability to create IoT solutions is not new, as many are being developed and deployed already. However, these cutting-edge implementations tend to be limited to larger companies or those willing to deal with emerging standards. It will now be easier for developers to deliver IoT solutions thanks to more-established standards and tools.

Nonetheless, one big issue continues to cast a shadow: The large number of choices in the IoT development space will limit interoperability.

WILL IOT BE SAFE AND SECURE?

Software quality and security are related because security breaches are often caused by bugs in the code. Both issues arise when it comes to IoT development because connectivity between devices opens the door to remote attacks.

Most IoT frameworks incorporate multiple security measures, from the use of Transport Layer Security (TLS) on communication links to secure boot. Encryption is a vital ingredient and more hardware with built-in hardware acceleration is being made available. Secure key storage and even anti-tamper support is becoming more common.

The challenge for developers continues to be how security measures can be incorporated into a design and subsequently contending with them, let alone developing the other functional features of an application. Framework and policy-based security support can help, but it doesn't eliminate security issues for application design. Beware of claims that a framework or system will handle all security needs. This is rarely the case, but it does make the job of securing a system significantly easier.

Lots of IoT development is being done in C, which has the reputation of allowing developers to shoot themselves in the proverbial foot. Adding security to the mix compounds the issue, as many problems often result from misunderstandings of how things work, or just due to carelessness. Many available tools, such as static analysis, often support standards like MISRA C++ and the new MISRA C:2012 standard.

Formal methods are moving out of areas such as military and avionics systems and into industrial applications. For example, companies in the transportation and automotive space are looking at programming languages, namely Ada and SPARK, to provide better development environments for embedded, real-time applications *(see "Best of 2015: CodePeer SPARKS Ada" on electronicdesign.com)*. Functional programming languages that are also more amenable to formal proofs can be found in the cloud. In this space, they're being used in everything ranging from system control to financial calculations and analytics.

DEVELOPING IN THE CLOUD

Not everyone will jump to the cloud for development. Even so, vendors continue to push the technology, and developers are finding advantages in this approach.

There are literally dozens of cloud integrated-development-environment (IDE) systems/sites to choose from, and many IoT solutions providers now partner with some of these sites to augment their offerings. This follows from the success of collaboration and code-management sites like Github and Pastebin. Moreover, sites such as Cloud9, mbed, and even Arrow Cloud Connect provide embedded IoT support for the ARM Cortex-M0+.

Some, like Codevny, support online as well as workstation-based tools (e.g., Eclipse), taking advantage of cloud-based servers for compilation and build services. Wind River's Helix environment includes the Helix Lab Cloud, which allows developers to test their applications on hardware that resides in the cloud.

The advantages remain significant by offloading installation, management, and support. Developers can have access to the latest software. However, developers must be cognizant of issues such as maintaining toolsets and runtime support for specific versions of their own application.

Online development, which does give more control to the vendor, is not for everyone. This is especially the case when control over the code and tools is critical or required. The quality and performance of the Internet connection is also important. Cloud operation obviously works best with reliable, high-speed connections.

Cloud-based solutions tend to excel in collaboration support; such capability is often crucial for IoT applications spanning multiple hardware nodes. This type of collaboration tends to be a bit more difficult to integrate when the tools operate independently of each other.

MORE TOOL INTEGRATION FOR DEVELOPERS

Tool integration and support is essential to cloud-based environments, but vendors will not ignore conventional development toolchains. These are being enhanced well past providing IDEs and compilers by including operating systems and stacks. Though available in the past, the level of integration and support is now becoming much better. It's one way for vendors to lock in their customers by providing a better alternative than the competition.

Sometimes this integration is more focused. Take, for instance, Renesas' Synergy, which specifically targets its Synergy line of Cortex-M microcontrollers *(see "Dev Kits: Getting Synergy" on electronicdesign.com)*. It's built around Express Logic's Thread-X RTOS. Microchip's Harmony is a more inclusive framework that features multiple third-party components (*see "Interview: Rich Hoefle Presents Microchip's Harmony" on electronicdesign.com)*.

There are advantages to vendors and developers for both approaches. Tighter integration allows for better support but fewer choices. Developers will have to consider the indirect costs of using these frameworks and tools, because there's really no such thing as a free lunch or IDE. It's just that the costs may be hidden elsewhere, e.g., higher hardware costs.

OPEN-SOURCE SOFTWARE AND IoT

The interplay continues on between open-source software (OSS) and proprietary software. OSS is playing a critical part in IoT because it generally induces more collaboration among participants negotiating standards.

Vendors can get a better handle on where OSS fits within their offerings, ranging from support for Linux to providing some or all of their software with an open-source license. It's still not an easy choice, though, and vendors need to determine where they can best gain their advantage and income. Luckily, a multitude of developers are willing to pay for support and integration.

Like security, though, developers and companies might be forced to contend with OSS licensing as more standards are built around OSS. Developers may need to utilize tools like Black Duck Software Suite to track compliance, security, and governance issues related to an application *(see "Is it GPL if it Quacks Like a Duck?" on electronicdesign.com)*.

Making the choice to go with proprietary licenses is often a preferred alternative. However, choices might be more limited, especially when addressing IoT that incorporates many more components within an overarching IoT application environment.

DON'T FORGET POWER-MANAGEMENT SOFTWARE

The need for efficient power-management hardware and software ranks high on the list of issues surrounding mobile IoT devices. It's cropping up in more sophisticated hardware with more granularity in terms of power control and the types of peripherals available. Just managing the large number of power modes and peripherals is pushing chip vendors to provide power-management frameworks that work with applications and operating systems.

Battery-operated IoT devices usually operate in cycles where most time is spent in a low-power mode. Developers will need to examine all of the options when trying to minimize power requirements, from using non-volatile storage like FRAM, to choosing chips with ultra-low power peripherals, to taking advantage of intelligent, configurable peripheral interconnects that allow on-chip devices to operate independently of the CPU.

Keep an eye out for multicore, asymmetric microcontroller solutions that provide even more granularity for controlling power and performance. Although the downside will be a programming environment with heightened complexity, it should provide important advantages in both system isolation and security.

NOT EVERYTHING IS IoT

IoT continues to be a major theme for developers and vendors, but it's really just a part of the embedded software landscape. It just happens to be growing quickly and becoming more important to the long-term plans of many companies. It also makes companies think about where and how solutions will be monetized.

Still, IoT isn't everything or everywhere, and developers should not be espousing IoT solutions just because it's popular. On the other hand, many of the tools and support targeting IoT can be employed for more conventional types of embedded applications.

Cloud development tools work with the same efficacy for non-IoT development, too. Security hardware and software can play roles that are just as important for unconnected devices and networked devices that may not be part of a large cloud-based IoT solution.

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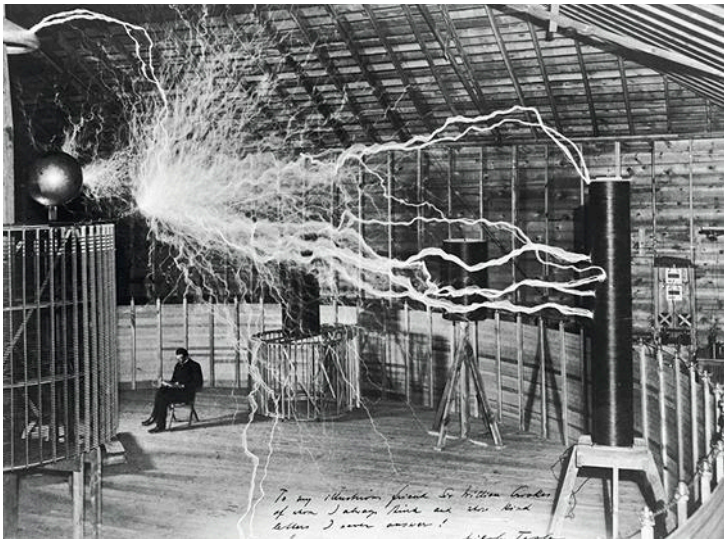
Wireless-Charging Technologies: Transforming the Mobile World

The fast-growing wireless-charging market has manufacturers and developers scrambling to find a global wireless-charging standard for interoperability between devices.

THE RACE TO CREATE a universal wireless-charging technology is on. New and exciting wireless-charging technological advances and products continue to emerge, with some companies committed to one technology and others working with several. But a lack of interoperability between technologies still remains a major issue, due to the non-existence of a unified wireless-power standard.

The idea of wireless-power transfer has been around for years. In the early 1900s, Nikola Tesla was very involved in creating a way to supply power without wires across the world, but never achieved total success. He came close, though, with his revolutionary invention called the Tesla coil. This system, which transmitted electricity without wires, changed the way electricity was used *(Fig. 1)*.



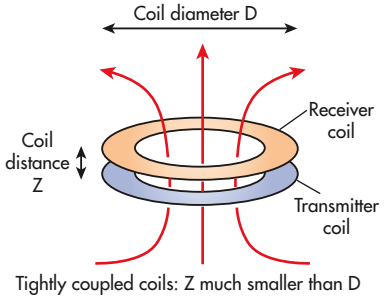
1. The Tesla coil was invented by Nikola Tesla in the 1900s. *(Courtesy of Wikipedia)*

Transmission of power without interconnected wires via short distances can be accomplished through different technologies or methods—electromagnetic induction, magnetic resonance, capacitive coupling, magnetodynamic coupling, etc. The first two in that group are probably the most commonly used in today's market.

ELECTROMAGNETIC INDUCTION (INDUCTIVE COUPLING)

This near-field method transmits power wirelessly using a magnetic field created between coils of wire. When current circulates through a transmitter coil, it generates a magnetic field that induces a voltage in the receiver coil.

The better the coils are coupled, the better the power transmission. Couple factor k indicates the grade of coupling. The value k depends on several elements, such as the shape of the coils, the angle between them, and the distance between inductors.



2. Shown are tightly coupled systems with coils that have the same diameter. *(Courtesy of WPC)*

Depending on the distance between the transmitter coil and the receiver coil, the system can operate as a loosely or tightly coupled system.

In a tightly coupled system, the transmitter and receiver coils are the same diameter size. They're aligned with each other with a minimal Z distance between them. The distance Z is much less than the coil diameter. This system tends to produce less heat and higher efficiency *(Fig. 2)*.

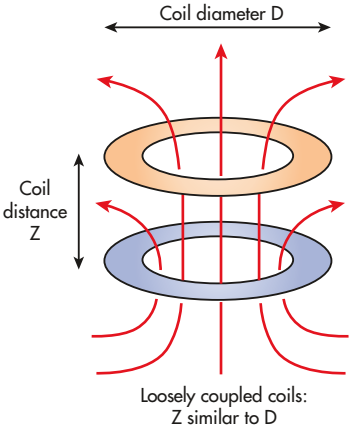
A loosely coupled system, on the other hand, trades off a larger distance between coils for lower power-transfer efficiency and higher electromagnetic emissions *(Fig. 3)*.

Electromagnetic induction has several advantages, such as the simplicity of its circuit scheme and its cost-effectiveness. Major disadvantages include the limited charging distance and the necessity for precise alignment between the transmitter and receivers.

MAGNETIC RESONANCE (RESONANT INDUCTIVE COUPLING)

This near-field method transmits power wirelessly over a space utilizing a resonance phenomenon based on the same principle as electromagnetic induction. The transmitter and receiver coils oscillate (or resonate) at the same frequency, which is determined by the material and shape of the coil *(Fig. 4)*.

The main advantage of magnetic resonance is its ability to transmit electrical energy over a relatively long distance without precise alignment between transmitters. However, production costs are higher due to complex circuit control.



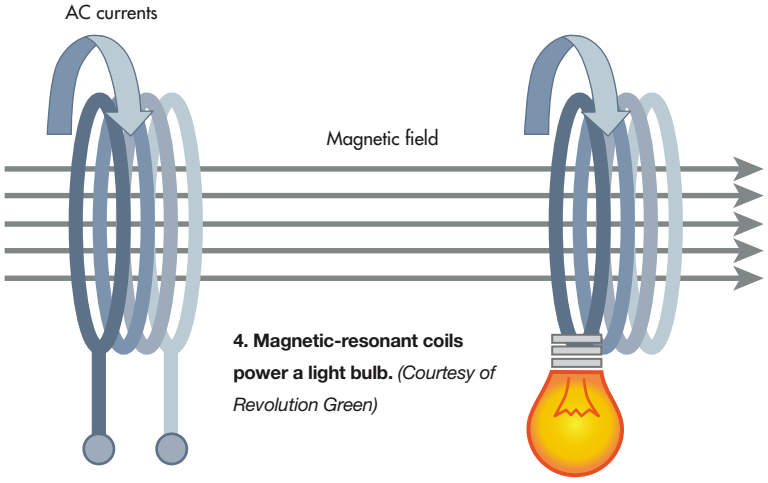
3. In a loosely coupled system, a larger distance exists between coils. *(Courtesy of WPC)*

TRENDING PRODUCTS

Most of the products populating the market right now rely on magnetic-induction and magnetic-resonance wireless-charging technologies. These include:

- *Qi:* Created by the Wireless Power Consortium (WPC), Qi charges or powers an array of devices from smartphones to cordless kitchen appliances. It combines induction and resonance technologies. *Figure 5* shows one of the many products that support the Qi standard.
- *PowerbyProxi:* This member of the WPC delivers resonant wireless solutions in a number of battery-powered applications, but design constraints limit their effectiveness. They offer several product solutions for the industrial field. For example, the Proxi-Point wireless connector provides power to sensors in hard-to-reach locations and recharges batteries *(Fig. 6)*.
- *WiPower:* Qualcomm is a member of both the WPC and Airfuel Alliance. Its WiPower technology is based on the principles of magnetic resonance. WiPower recently announced that it can deliver wireless charging to devices with metal exteriors.
- *WiTricity:* This magnetic-resonator-based technology is designed for distances anywhere from a centimeter to several meters. It was created for original equipment manufacturers (OEMs) to embed directly in their products and systems *(Fig. 7)*. WiTricity is an active member of Airfuel Alliance.
- *Powermat:* This technology, based on electromagnetic induction, consists of a pad that charges electronic devices. It was certified by the Power Matters Alliance (PMA). Devices with built-in wireless charging can power up instantly on charging spots. If the device isn't enabled, a plug-in Powermat Ring is used to wirelessly enable it *(Fig. 8)*.

One theme becomes rather apparent when looking at these trending products: Magnetic resonance and electromagnetic induction rule the roost from a technology standpoint. The choice of one technology over the other depends on the application.



4. Magnetic-resonant coils power a light bulb. *(Courtesy of Revolution Green)*

Wireless charging is a new and still-growing market. As more technologies and products arrive, consumers can expect the market to be replete with interoperable products.

MAJOR PLAYERS

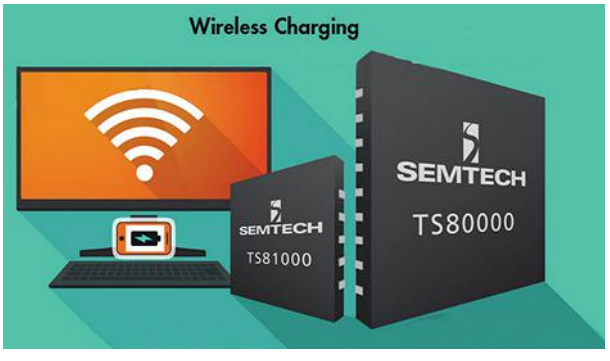
Two key organizations in this space that work with both magnetic resonance and electromagnetic induction are the Wireless Power Consortium (WPC) and Airfuel Alliance. The WPC, founded in 2008, is the creator of the Qi standard.

5. This wireless Qi charger stand was developed by Samsung. *(Courtesy of Samsung)*

6. The Proxi-Point wireless connector provides power to hard-to-reach sensors. *(Courtesy of PowerbyProxi)*

7.Witricity's Prodigy is able to deliver wireless power to two devices from a single source. *(Courtesy of onlinetes.com)*

8. This Samsung device is being charged via Powermat, using a Powermat Ring. *(Courtesy of Powermat)*



9. Semtech's Tri-Mode wireless-charging platform includes the TS80K transmitter and the TS81K receiver. *(Courtesy of Semtech).*

Members of the WPC are working toward a global standardization of wireless-charging technology. More than 200 companies offer more than 800 products that support the Qi standard. Members of the board of management include LG, Qualcomm, Samsung, Texas Instruments, Toshiba, and Verizon.

Airfuel Alliance is a global ecosystem that's the result of a recent merger (June 2015) between the Power Matters Alliance (PMA) and Alliance for Wireless Power (A4WP). Some of the companies that form its board of directors are AT&T, Intel, On Semiconductor, Powermat, Samsung, and WiTricity.

It's worth mentioning that the Power Matters Alliance (PMA) is a global, not-for-profit, industry organization that's working to create a paradigm for wireless-power technology. Its founding member is Powermat. Similarly, the Alliance for Wireless Power (A4WP) is an independently operated, not-for-profit organization dedicated to building a global wireless-charging ecosystem based on Rezence technology.

Unfortunately, this battle for standards doesn't create any functionality, interoperability, or flexibility between the WPC and Airfuel Alliance. Some big names in the manufacturing industry, such as Microsoft, Qualcomm, and Samsung, have hedged their bets by becoming members of both the WPC and Airfuel Alliance. Therefore, their products support both wireless-charging standards.

Semtech Corp. is another company with dual membership. Last October, Semtech launched a new wireless-charging platform capable of supporting all major standards (Qi, PMA, and A4WP Rezence). The TS80K platform, which includes the TS800000 transmitter and TS81000 receiver, supports multiple system configurations for wearable, mobile, and embedded-systems applications *(Fig. 9)*.

The TS80K offers greater flexibility because the platform supports all major wireless-charging standards in multimode (for both transmitter and receiver applications). In addition, it can quickly be adapted to support evolving wireless-charging standards. The TS80K platform handles a wide range of power solutions, from 100-mW wearable solutions to 100-W solutions for industrial tools, medical equipment, and "connected" furniture applications.

The TS80K's multimode transmitter solutions work with power levels ranging from 100 mW to more than 40 W. As a result, it enables embedded charging capability in furniture, vehicles, and public venues that can support all major wireless standards based on a single, easy-to-use, cost effective platform.

Lack of agreement on standards between the Wireless Power Consortium and Airfuel Alliance has suppliers taking a slow approach toward incorporating these technologies in their products. Once a clear winner is declared in this wireless-standard battle, the market should quickly turn into a multi-billion-dollar business for universal wireless chargers. In the end, customers will be able to pick and choose from an abundance of options.

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"More" and "Faster" Are the Watchwords

Key wireless technologies continue to evolve to meet changing communications needs and opportunities.

YOU CAN NEVER HAVE ENOUGH DATA SPEED. And you can never have enough memory, network connections, bandwidth, or longer range. More is always better. Technologies that offer more of anything continue to drive communications development. You probably already know that these technologies are incorporating 5G wireless, the Internet of Things, LTE, and Wi-Fi enhancements. Here's a summary of what's happening now and what's coming in the years ahead.

5G WIRELESS

Fifth-generation (5G) wireless technology research and development projects are now well under way. This worldwide effort will eventually lead to new standards for cellular and broadband wireless. With 4G LTE still not fully deployed, you have to wonder just why there is a need for a new standard.

As usual, the desire is simply to increase the subscriber capacity and offer higher data speeds. Faster mobile broadband is required to support the ever-increasing need to stream video and transmit photographs. There's also a need to be prepared to handle the glut of messages that will eventually come from the emerging Internet of Things (IoT) and machine-to-machine (M2M) markets. Billions of new connections are projected. Then there's an eventual need for a highly reliable low-latency service to handle applications such as vehicle-to-infrastructure (V2I) communications in the forthcoming intelligent transportation system (ITS).

The features and specifications of 5G will eventually form a new standard that most worldwide carriers will adopt. This R&D is being done in universities, company research labs, and international organizations such as the Third-Generation Partnership Project (3GPP). The standard will in due course be adopted by the International Telecommunications Union (ITU) as IMT2020.

While the details are still in flux, we do know some of the general characteristics of the 5G system. Here is a brief summary:

Data rate. The targets are a rate of at least 1 Gb/s and as much as 10 Gb/s peak with an average user rate of about 100 Mb/s.

Spectrum. The millimeter-wave (mmwave) bands in the 6- to 100-GHz range will be used. Governments are just now allocating spectrum for 5G. In the U.S., the Federal Communications Commission recently proposed the following band assignments for 5G: 27.5-28.35, 37-38.6, 38.6-40, and 64-71 GHz.

Modulation and access. Multiple formats are being explored, including standard OFDM, filtered OFDM, and a non-orthogonal method called generalized frequency division multiplexing (GFDM). Other variants include universal filtered multicarrier (UFMC), filter bank multicarrier (FBMC), and others.

Network configuration. Short-range small cells overlay existing LTE networks with self-organizing networking (SON) software for automating provisioning and deployment.

Virtualization and a cloud-based architecture. Software-defined networking (SDN) and network function virtualization (NFV) techniques are expected to be used to establish and manage the network.

Massive MIMO. Configurations of 4×4 and 8×8 will be common to help achieve the desired data rates and reliable links in the mmwave bands.

Many technical issues are yet to be resolved. Dealing with mmwaves is a major problem because of the high channel propagation loss. These signals experience diffraction, scattering, and reflections. Penetration loss of buildings, trees, and other obstructions is also extremely high. These problems will be dealt with through the use of higher power and MIMO. The higher power will come from agile beamforming directional gain antennas. Phased arrays, which are widely used in radar, tend to be very small at mmwave frequencies and offer an excellent solution.

Another looming challenge is putting all of this mmwave hardware inside an already fully packed smartphone. Space for MIMO chips, filters, PAs, and antennas, and the resulting higher-power consumption, are problems that have yet to be solved.

5G is a work in progress. Research, prototyping, and trials are ongoing. Research is focused on things such as modulation methods and mmwave channel models that are critical to the success of this advanced wireless technology. Initial deployments are not expected until 2020 and beyond. Cellular infrastructure provider Ericsson predicts that 5G will be adopted faster than 4G with as many as 150 million subscribers by 2021. In the meantime, we have a very successful 4G LTE system in place that is doing a fine job and it, too, is a work in progress.

Image courtesy of Thinkstock

4G LTE

Most cellular operators are still rolling out their LTE networks while still maintaining their 2G and 3G connections. Sprint is finally shutting down its 4G WiMAX network in favor of LTE service. A few carriers are beginning to deploy LTE Advanced. LTE-A uses carrier aggregation (CA) to provide wider bandwidths (up to 100 MHz) to deliver higher speeds approaching a peak of 1 Gb/s. Again, Sprint's latest network expansion uses some carrier aggregation and other LTE-A features to boost speeds. It will take a while for full LTE-A rollout. This will provide much higher speeds until 5G comes along.

Another enhancement now showing up in existing LTE networks is voice-over LTE. VoLTE is the compressed voice service that's expected to replace the 2G and 3G voice service still used by most carriers. VoLTE is far more efficient in terms of spectrum and should significantly improve voice capacity and performance while lowering costs. AT&T and T-Mobile have begun implementation, but Verizon, Sprint, and others lag in this deployment. Juniper Research anticipates 2 billion VoLTE connections by 2020, up from 123 million connections in 2015.

Another LTE development is LTE-U for unlicensed. Another name for LTE-U is Licensed-Assisted Access or LAA. LAA is a method of using the 5-GHz unlicensed Wi-Fi spectrum for LTE cellular data. The big question is will LAA interfere with Wi-Fi access points (APs) and hot spots, disturbing millions of Internet connections. So far, there is an ongoing battle between the cellular carriers and the Wi-Fi interests over the potential deployment of LTE in the unlicensed spectrum. However, it's an interim solution for the lack of new spectrum for high-speed LTE.

The 3GPP, the organization that develops the next cellular standards, is working on LAA right now to be incorporated into the forthcoming LTE Release 13. Companies like Ericsson and Qualcomm already have products under development. The FCC seems to be staying out of this fight as long as current regulations are met. Some carriers say they will try to implement LAA in 2016 as part of their LTE-A small-cell system using carrier aggregation. If it works, it is just an LTE stopgap.

LTE will be with us for many years to come. Its enhancements will keep it useful and competitive until 5G arrives.

Wi-Fi

There's always something happening with Wi-Fi. This wireless technology has become like an expected utility service to us all. We use Wi-Fi at home, at work, and on the road to connect our smartphones, tablets, and laptops. It's everywhere and mostly free as the FCC is fining hotels and convention centers for charging a fee. Because of its ubiquity, Wi-Fi is expected not only to be there, but also to become faster and more reliable. New versions and enhancements are always in the works with the IEEE standard body and the Wi-Fi Alliance.

Right now, most networking organizations are still upgrading their networks from 802.11n to the faster 802.11ac standard. The 11ac version operates only in the 5-GHz unlicensed band, but is faster. The Wave 1 version can achieve up to 1.3 Gb/s peak under ideal conditions. Most new smartphones, tablets, and laptops already incorporate Wave 1 chips. Wave 2 versions are showing up in routers and some advanced APs. Wave 2 802.11ac uses 80 and 160 MHz wide channels to achieve peak rates of over 6 Gb/s. Wave 2 also uses multi-user MIMO to allow up to four users to transmit data at the same time.

As both Wave 1 and Wave 2 versions are rolling out in the months and years to come, network operators are considering whether to upgrade their wired Ethernet connections from 1 Gb/s to 10 Gb/s to keep up with the wireless speeds. Though 10-Gbit Ethernet is available, it's still expensive. Some are using multiple 1-Gb/s connections as an interim solution. There are 2.5- and 5-Gb/s Ethernet versions being developed. Called NBASE-T, this new version of Ethernet is expected to be ratified later in the year, but companies like Cisco already have routers and APs available.

The next generation of Wi-Fi is 802.11ax. It's under development in the IEEE's 11ax task group. The 11ax version will use advanced MIMO and orthogonal frequency division access (OFDA) to offer greater capacity and higher speeds. OFDA-like OFDMA in LTE divides the OFDM spectrum into smaller clusters of subcarriers so that multiple users can be accommodated simultaneously. Peak data rates could top 10 Gb/s, but a typical user can expect rates of hundreds of Mb/s up to 1 Gb/s. The 802.11ax standard is not expected to be ratified until 2018.

Other Wi-Fi versions of interest are 802.11af and 802.11ah—802.11af is a version of Wi-Fi that uses the unused television white-space (TVWS) channels in the 54- to 698-MHz range. These VHF/UHF channels promise much longer-range communication than the traditional 2.4- and 5-GHz bands. Typical range with 100 mW is 1 km or more, depending upon frequency and antenna height. Using 6-MHz wide channels with higher-level QAM data rates to 24 Mb/s is possible. The use of the TVWS requires cognitive radio techniques in order to avoid interference to TV stations and wireless microphones. The 11af standard is available now, but has not been widely adopted.

The 802.11ah standard is another <1-GHz wireless technology that uses the 902- to 928-MHz unlicensed band. Using 1-, 2-, 4-, 8-, or 16-MHz wide channels, 11ah can provide data rates of 100 kb/s to as much as 40 Mb/s, depending upon modulation method and coding. A range of many kilometers is possible. This makes 11ah flexible to accommodate a wide range of applications. The 11ah standard is expected to be finally ratified this year. Its intended use will be in IoT activities and could replace M2M in some situations.

The Systech SL1500 gateway can hold up to five plug-in wireless modules for a mix of Wi-Fi, Bluetooth, ZigBee, Z-Wave, and 3G/4G cellular applications. Ethernet provides the Internet connection.

THE INTERNET OF THINGS

Probably the most hyped technology in 2015 was the Internet of Things (IoT). It seems as if every electronics-related company is gearing up to enter this business that appears to offer something for everyone. But does it really? Maybe companies are basing their IoT plans on some of the early overly optimistic predictions of 10 to 50 billion connected devices by 2020 and trillions of dollars in new revenue by 2025. Similar projections seem to be way off base.

UK market study firm Beecham Research recently indicated that "…these numbers to be unrealistic and potentially damaging to the industry, if they are believed, and companies are building their business plans and funding expectations on such false promises." Furthermore, Beecham indicates that currently there are less than 1 billion connected devices, not including smartphones and tablets. While several predictions indicate that many of the new connections will come from home automation, Beecham indicates that there is no evidence regarding the connected home market ready to take off in a big way. If not the home market, what will be the largest initial segment of the IoT movement?

Taking in all of the latest articles, research reports, white papers, product brochures, and other sources, here is a summary of current and expected outcomes:

- The industrial IoT (IIoT) may be the largest beneficiary of initial IoT efforts, with plenty of real needs and buyers for remote monitoring and control applications as sensor and actuator networks in factories, process control plants, the smart grid, etc.
- No one wireless technology will emerge as the clear winner in IoT applications as Wi-Fi, Bluetooth, ZigBee, 802.15.4, Z-Wave, and a few others will all find their niche. In fact, one company, Systech Corp., has a line of gateways that are full routers for Internet connections that can accommodate a mix of modules for any of the above-mentioned wireless technologies, including cellular (*see photo below*).
- Longer-range low-power wide-area (LPWA) networks using newer wireless technologies such as LoRa, Sigfox, Weightless, 802.11f/h, and others will greatly expand the usefulness of IoT.
- LPWA networks will also probably impact the M2M segment of this movement. M2M typically uses 2G or 3G cellular technologies for remote monitoring and control and some Internet access. LPWA technology will capture some of the M2M business. However, M2M will continue to be competitive as a new version of LTE comes on line in the coming months. Called LTE-M, it is a modified version of LTE in Releases 12 and 13 of the 3GPP standards that reduces power consumption, bandwidth, data rates, and electronics costs to accommodate large numbers of devices over the cellular networks. This could lead to more rapid phase-out of the older 2G systems.
- No one software platform appears to dominate the IoT landscape. Many are available, including AllJoyn, Thread, Brillo, MQTT, IPSO, JSON, IoTivity, HomeKit, and multiple others. As with wireless technologies, these multiple platforms will find their markets and niches.
- Security is still a key factor in all segments of IoT. All hardware devices incorporate encryption, but service providers will also face the need to provide additional authentication and security features to meet the demand.
- IoT and M2M produce massive amounts of data. Some studies indicate that as much as 60% to 90% of that data is never used. To make IoT worthwhile, there is a huge need for data analytics to make useful sense of all that big data. This is a complex, but potentially rewarding, opportunity for some software companies.
- Node costs can be an issue for some applications. Many simple sensor nodes just do not need a 32-bit processor with an operating system to be effective. Simpler focused software on a dirt-cheap 8-bit processor is what's needed.
- What's really needed is a good business case for many application areas.


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ESTIBALIZ SANZ OBALDIA, JUNIFER FRENILA | Analog Devices

New DAC Architectures Address Diverse System Design Challenges

The latest bipolar digital-to-analog converter topologies take on difficult control and measurement tasks across a variety of industrial applications.

WITH CURRENT MARKET DYNAMICS constantly driving toward shorter design cycles, enhanced system functionality, and more portable end systems, the need for a new methodology to simplify these challenges without adding design complexity is a must. This article will address some key system challenges for control and measurement that impact many applications, including data-acquisition systems, industrial automation, programmable-logic controllers, and motor control.

The article also explores the latest advances in bipolar digital-to-analog converter (DAC) architectures and how these topologies can address end-system challenges, which include adding even more functionality and intelligence within the same or reduced space. On top of that, it will discuss discrete and more functionally complete solutions, as well as outline a number of alternatives to traditional design topology that support higher flexibility in design reuse and system modularity.

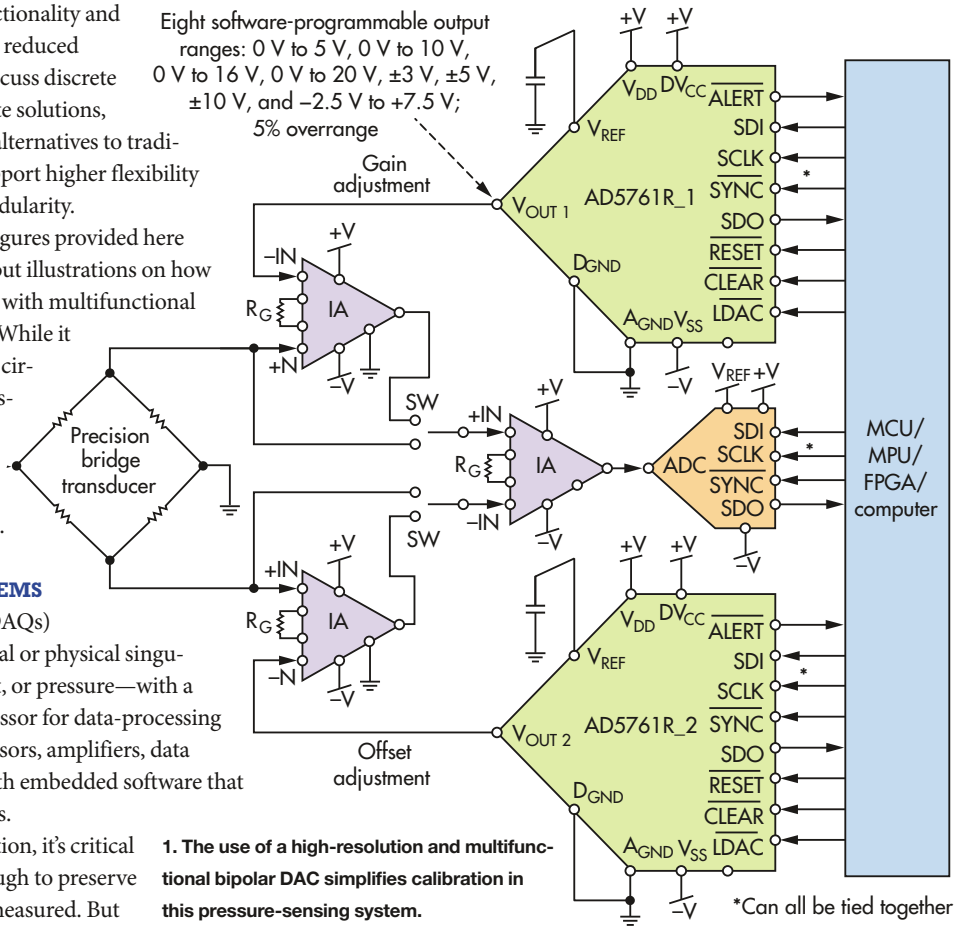
It should be noted that the figures provided here are not the actual schematics, but illustrations on how applications could be achieved with multifunctional DACs and other components. While it doesn't include aspects such as circuits for power supplies, bypassing, and other passive components, these diagrams illustrate how applications can be implemented in general.

DATA-ACQUISITION SYSTEMS

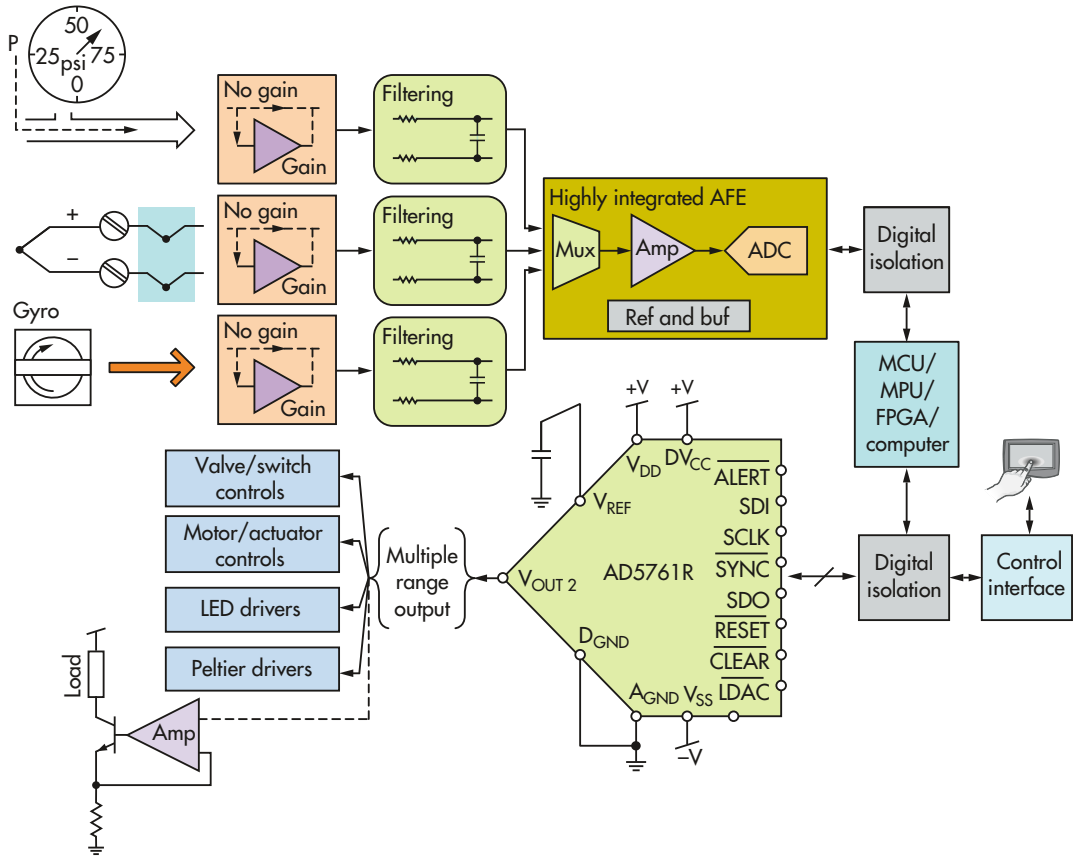
Data-acquisition systems (DAQs) are used to measure an electrical or physical singularity—such as voltage, current, or pressure—with a microcontroller or microprocessor for data-processing capability. DAQs consist of sensors, amplifiers, data converters, and a controller with embedded software that controls the acquisition process.

In a process-control application, it's critical that the sensor is sensitive enough to preserve the quality of the signal to be measured. But even if the sensor is sensitive enough, the signal-chain errors such as gain and offset could still interfere with the signal quality. High-performance applications employ DACs in automatic calibration of the conditioning circuits in data-acquisition systems. *Figure 1* shows the block diagram of a pressure-sensing system. It illustrates how bipolar DACs can be used in an automated gain and offset calibration scheme.

The precision bridge transducer receives an excitation signal from a pressure sensor and produces an output voltage. Due to the low amplitude of the transducer's signal, an instrumentation



1. The use of a high-resolution and multifunctional bipolar DAC simplifies calibration in this pressure-sensing system.



2. Performance of the signal-acquisition and control units defines the operational efficiency of an industrial automated system.

amplifier is typically used as a signal multiplier. This low-amplitude signal is susceptible to errors. Such errors are usually caused by drift due to changes in temperature, parasitic errors across circuit boards, and tolerances of passive components.

With the use of a bipolar DAC, gain and offset calibrations can be implemented into the system to dynamically correct the errors as the system operates over time. Depending on the level of adjustment and the polarity required, a complete, high-resolution and multifunctional bipolar DAC can greatly simplify the calibration process. The DAC can be programmed through a high-speed, four-wire SPI interface with a serial data output (SDO) line available to facilitate daisy-chain and read-back operation.

INDUSTRIAL AUTOMATION

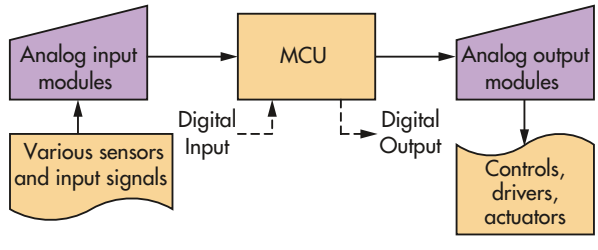
There's a broad array of applications within the industrial-automation space. Regardless of the application though, the functionality and performance of such automated systems lies in their signal-acquisition and control units. On the acquisition side, the sensitivity of the sensors, adaptability of the conditioning circuits, and the speed of acquiring correct information from low-level signals is very important. On the control side, the flexibility to adapt to the requirement of various actuators and drivers is vital.

Figure 2 shows an example of an industrial automated system. A thermocouple with cold-junction compensation is used to measure the temperature of industrial equipment, such as a laser machine or heavy-duty motor. The voltage is gained up, filtered, and sent to an integrated analog-front-end (AFE) IC for conversion and the digital data is passed into the processor for analysis.

Based on the processed data, the processor sends a signal to a control DAC, which is also fully isolated, to drive an industrial fan, activate cooling apparatus such as a Peltier, or open the valve of a water-cooling system. In addition, the user can input an override command via a control-interface device.

The same system can be adopted for pressure and vibration measurement and control. A pressure-sensor system can typically be used for oil and chemical tank monitoring, while a gyroscope system could be used for vibration monitoring of fast-moving machine heads. These applications share the same AFE, which is fully isolated from the external environment.

A high-voltage, high-resolution, bipolar DAC with a low-drift internal reference and software-selectable output range is a practical replacement for multiple DACs or a single-multiplexed DAC. It provides unipolar and bipolar voltages while maintaining the same accuracy with an option of over-range



3. A basic PLC process control block consists of an input, MCU, and output module.

output. The bipolar DAC supports the actuator's different needs, including the adjustment of the control unit through software, thus avoiding hardware modifications. This new industrial-control approach also helps to minimize board space and reduce cost.

PROGRAMMABLE-LOGIC CONTROLLERS

Programmable-logic controllers (PLCs) incorporate power supplies, central processing units, and several analog and digital I/O modules to control, actuate, and monitor complex machine variables. PLCs are widely used across industries, offering extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact.

In a fundamental process-control system building block *(Fig. 3)*, an input signal reporting on the status of a process variable is monitored via the input module and transferred to the MCU to be analyzed. Based on the results of this analysis, a response containing the necessary arrangements is managed by the output module to control the devices in the system.

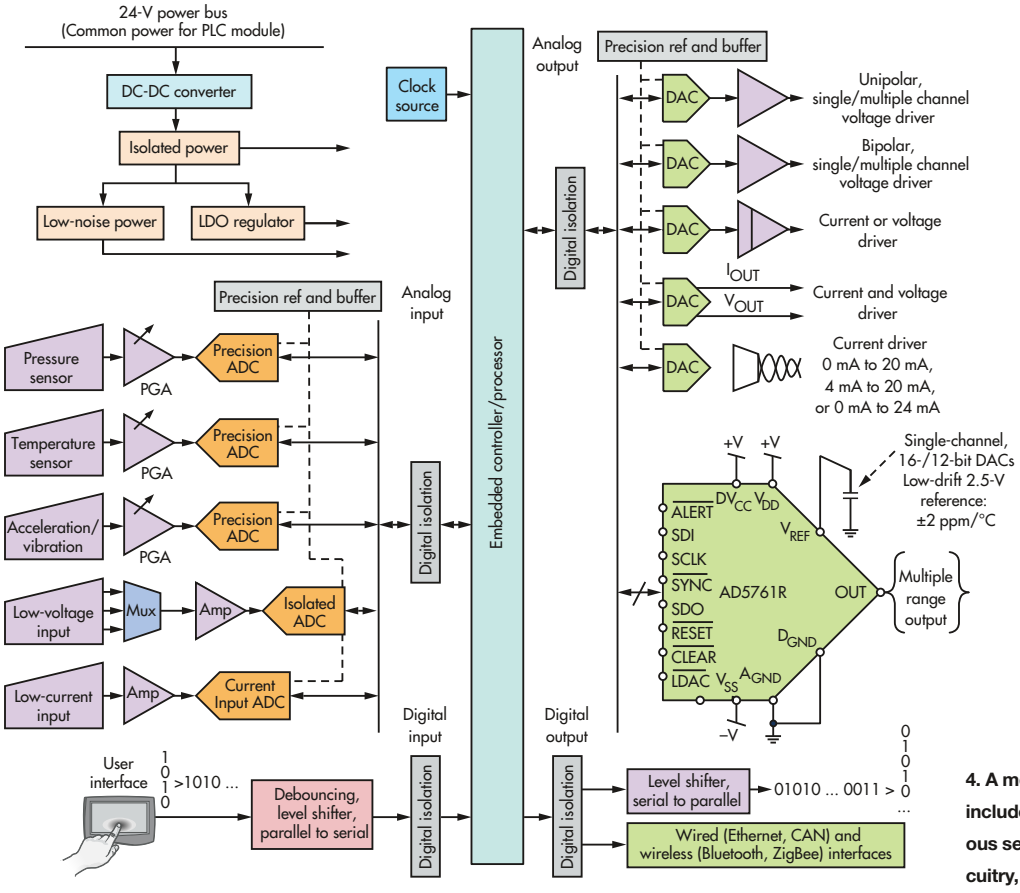
Figure 4 shows a more complete industrial PLC system, including an embedded controller/processor as the main system controller interfacing to the fully isolated input and output modules. Excluding the power-supply module, the system is divided into four subsystems that differentiate the analog input, analog output, digital input, and analog output modules.

Several types of sensors are deployed to acquire analog signals of different amplitudes and frequencies. It's necessary that these signals be pre-processed and converted into digital form for further analyses.

Programmable-gain amplifiers condition the small input signals so that they can be accurately measured and converted into their digital representation by analog-to-digital converters (ADCs). Isolation is required to protect the controller or processor from possible unexpected overvoltage coming from the field, for which optical or integrated isolators are placed among the processor and the input and output modules.

The accuracy and resolution requirements for the input and output modules are considerably distinct. While the input modules monitor highly precise and accurate data acquisitions from the process, the output modules essentially adjust the output with a 16-bit resolution and accuracy in high-end applications. As a result of these conditions, sigma-delta ADCs are commonly used for input modules in PLC systems from which a wide range of isolated, single- and multichannel and simultaneous sampling ADCs are available in the market.

Output modules may offer precision voltage DACs, precision current DACs, or a combination of both. Several methods allow current and voltage levels to be generated for the PLC's analog output. The evolution of precision bipolar DACs, providing extra functionality and a high level of integration, significantly benefit PLC systems from reduction of system complexity, board size, and cost.



4. A more-complex PLC control block includes an embedded controller, various sensors, signal-conditioning circuitry, and signal isolation.

MOTOR CONTROLS

DACs perform an integral function in motor-control loops, for example, in infusion pump systems *(Fig. 5)*. Infusion pumps are widely used in human healthcare to provide medical treatment to patients of all ages. The role of an infusion pump is to deliver fluids,

DESIGN NOTES

Ultrathin Dual 2.5A or Single 5A µModule Regulator Fits on the Backside of PCBs, Allowing Space on the Topside for Digital ICs

Design Note 546

Sam Young, Afshin Odabaee

Introduction

The top side of a typical system board, such as a PCIe card, is densely populated with FPGAs/ASICs/microprocessors, transceivers, connectors, memory ICs and DC/DC regulators, while the backside is often unused. This is a common side effect of the significant difference in top vs back side height restrictions, where board specifications may allow topside devices to reach a few centimeters, but restrict backside packages to less than 2.3mm. What if functions usually found on the topside, such as DC/DC regulator circuits could be thinner and moved to the bottom? Real estate on top would be available for expanding memory or enhancing the board/given the additional top side space.

The LTM®4622 is a dual 2.5A, or single two-phase 5A, output step-down µModule® (power module) regulator in a 6.25mm × 6.25mm × 1.82mm ultrathin LGA package. At nearly the height of a soldered down 1206 case size capacitor, its ultralow height allows mounting on the backside of a PCB, freeing space on the topside of the board. The thin profile allows it to meet demanding height restrictions such as those required by PCIe and advanced mezzanine cards in embedded computing systems.

Flexible Dual Supply in a Simple <0.5cm² Footprint

The LTM4622 has a wide input voltage range of 3.6V to 20V, and it can be configured to operate down to 3.1V for operation from a 3.3V input supply. It regulates two voltages for a compact multi-rail solution, where each output can supply up to 2.5A (3A peak) and is capable of precisely regulating 0.6V to 5.5V within ±1.5% maximum total DC output voltage error over line, load and temperature. For higher output current up to 5A, simply tie the outputs for current sharing.

The LTM4622 requires only three ceramic capacitors and two resistors to complete a solution occupying less than 1cm² single-sided or 0.5cm² on a double-sided PCB.

Figure 1 shows the LTM4622 circuit in a typical dual output application, illustrating the compact solution size. Efficiency and power loss for the circuit operating at 12V input are shown in Figure 2.

Reliable High Performance Regulation

The LTM4622 features a controlled on-time current mode architecture for a fast transient response and

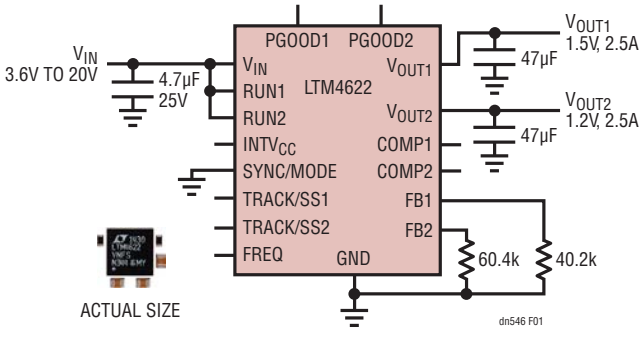


Figure 1. Typical Application: 1.5V/2.5A, 1.2V/2.5A Dual

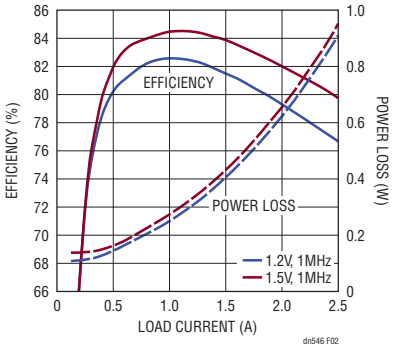


Figure 2. Efficiency, Power Loss at 12V Input (Figure 1 Design)

loop stability over a wide voltage range. It provides short-circuit, overvoltage and overtemperature protection and ensures monotonic output voltage ramping with tracking, soft-start and the ability to start into a prebiased output. It places no limitation on input supply slew rate.

Figures 3 and 4 demonstrate the fast transient and prebias start-up performance for the 1.5V output rail of the Figure 1 circuit.

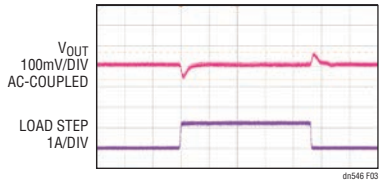


Figure 3. Load Step Response (Figure 1 Design) [12V Input, 1.5V Output, 1.25A to 2.5A]

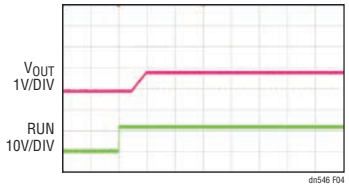


Figure 4. 12V_{IN}, 1.8V_{OUT} Start-Up into Prebiased Output

Parallel Operation for Higher Current Applications

The LTM4622's current mode architecture yields reliable cycle-by-cycle current monitoring, allowing its two outputs to be combined in parallel for load currents up to 5A.

Figures 5 and 6 demonstrate the thermal and current sharing performance of the LTM4622 when configured for two-phase current sharing, generating a 3.3V output at 5A (16.5W) from a 5V input.

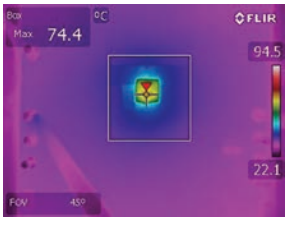


Figure 5. V_{IN} = 5V, V_{OUT} = 3.3V/5A, T_A = 25°C Thermals

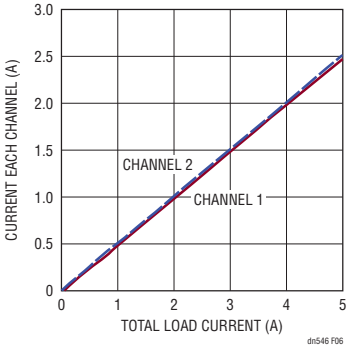


Figure 6. Accurate Current Sharing Over the Entire Load Range [V_{IN} = 5V, V_{OUT} = 3.3V at 5A]

Mirrored Layout for Smaller PCB but Higher Power

The LTM4622's pin configuration is organized symmetrically. So for higher current applications where two LTM4622s can be paralleled for up to 10A_{OUT}, one device can be on the topside of PCB and the other mirrored on the bottom side, minimizing PCB area while increasing output power and power density.

Conclusion

The ultrathin LTM4622 makes it possible to put a high performance regulator for single and multi-rail applications on the backside of a PCB, or into tight spaces on the topside. Its wide operating range, features and compact solution size make it a highly flexible and robust solution.

Data Sheet Download

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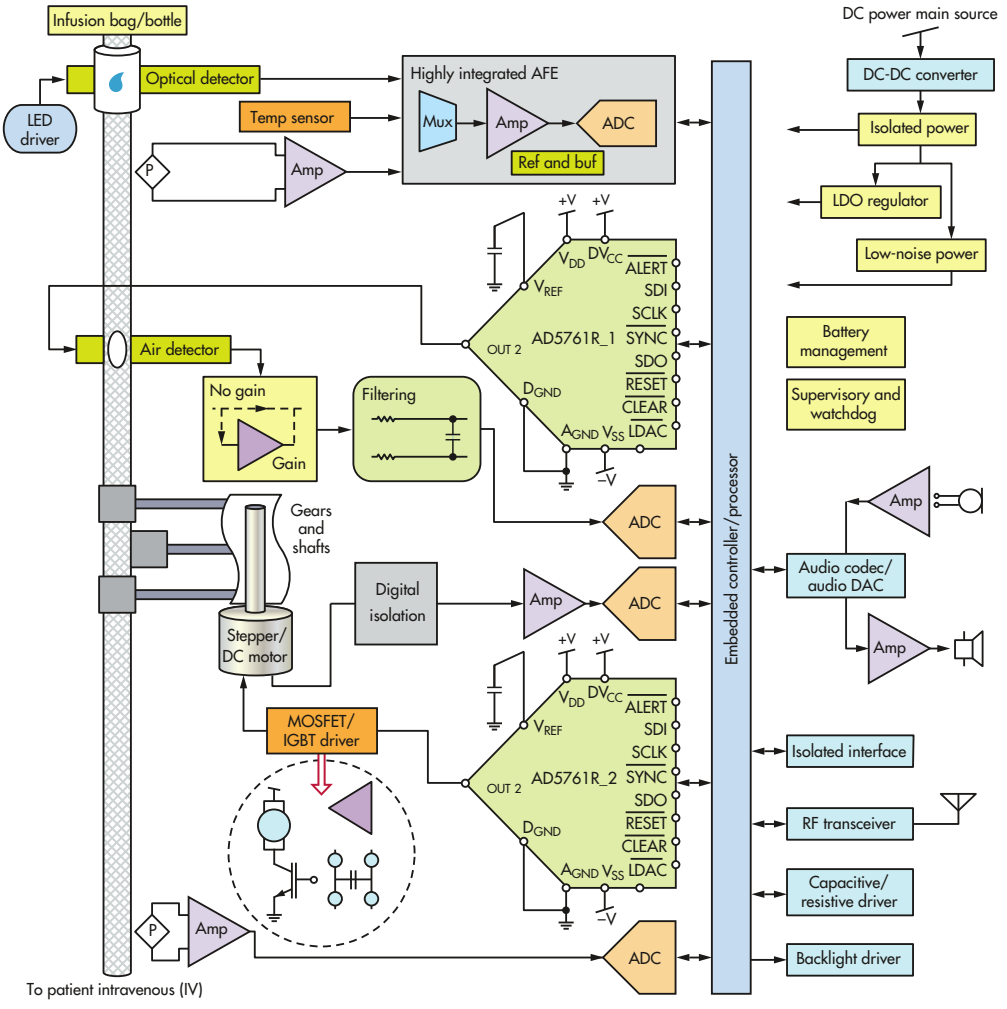

5. DACs provide an integral function in motor-control loops, such as this large-volume infusion-pump system.

medication, or supplements to the patients' cardiovascular system in an intermittent or continuous procedure.

Although infusion pumps require a qualified user to program the specific parameters for the treatment, the implicated advantages over manual administration influence greater user confidence. The ability of these instruments to accurately deliver tiny dosages at scheduled intervals in a self-operated mode negates the need for a nurse or doctor to manually control the flow of fluid to the patient.

Doctors and medical administrators can depend on the safety of infusion pump systems to display real-time system information on dosage limitations for titration safety, or to prevent overdose. It also creates more confidence that the physical delivery mechanism itself will be reliable and accurate.

During operation, the microcontroller receives the monitored speed and direction signals from the dc motor, which are analyzed and adjusted (if required) to meet the set point. The DAC in the feed-forward path makes system adjustments, while the ADC in the feedback path monitors the effect of each adjustment. The desired set-point voltage set by the DAC is amplified through the driver network to provide the required drive current to the dc motor.

Analog Devices (ADI) offers analog and mixed-signal processing solutions for detecting, measuring, and controlling sensors and actuators used in chemistry analyzers, flow cytometers, infusion pumps, dialysis equipment, ventilators, catheters, and many more medical instruments. In particular, ADI's AD5761R, a high-resolution, bipolar DAC with eight available software-selectable output ranges that maintains a common accuracy, is designed for motor-control applications. It supports the different voltage swings demanded by motors.

CONCLUSION

DACs play a key role in determining the performance and accuracy of many control systems and simple conversion circuits, as well as other complex applications. The 16-bit AD5761R bipolar DAC offers configurable ranges (0 V to 5 V, 0 V to 10 V, 0 V to 16 V, 0 V to 20 V, ±3 V, ±5 V, ±10 V, and –2.5 V to +7.5 V; 5% over-range) and integrates an output buffer and a buffered 2-ppm/°C internal reference. ed

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USB Type-C Is Revolutionizing the Market

USB Implementers (USB-IF) has developed the USB type-C with a small, reversible connector that is expected to grow fast in the mobile, consumer electronics, and computer markets.

When USB 1.0 was released in 1996, it delivered 1.5 Mbps. Through the years, it has increased transfer rates up to 10 Gbps. The latest USB 3.1 can support a wide range of USB peripherals. The new Type-C will support multiple standards (e.g., USB 2.0, 3.0, 3.1, Thunderbolt, etc.) and it will bring consolidation to a market tangled with so many different cables. Consumers will be able to eventually buy one cable that will serve as a universal connector (*see figure below*).

In 2012, USB-IF created a specification called USB Power Delivery. Power Delivery protocols have been updated to facilitate USB Type-C to provide power delivery along with data over a single cable. USB Power Delivery offers multiple features such as: increased power levels from existing USB standards up to 100 W; power direction that is no longer fixed; and optimized power management across multiple peripherals.

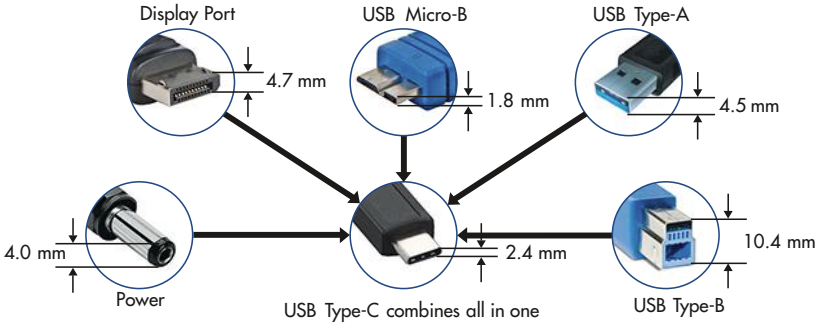
USB TYPE-C DESIGN CHALLENGES

With increased simplicity for end users comes increased complexity from a design and engineering perspective. Keysight Technologies' Marketing Manager Brig Asay pointed out some of the design challenges that this new technology will create. For starters, the PHY layer presents a challenge because now the connector is reversible and supporting higher rates and power. A Cable Detect (CD) function is implemented and CC1 and CC2 help determine if they are connected to the Downstream Facing Port (DFP) or Upstream Facing Port (UFP) as well as the orientation of the cable. There are now two high-speed data paths to handle data rates up to 10 Gbits/s.

Implementing USB type-C and USB 3.1 also creates a signal challenge, due to the signal complexity required across the 24-pin connector. Channel response is affected by loss, reflection, cross-talk, and mode conversions. Consequently, signals are severely degraded in the channel and many tests need to be implemented. They include BERT error detection and performing high-speed interconnect analysis including impedance, S-parameters, etc. At the same time, EMI and RFI levels from the cable assembly need to be controlled.

USB Type-C and USB 3.1 are backward-compatible with USB 3.0 and USB 2.0. Adapters will allow you to plug your legacy devices into a Type-C port. Because USB Type-C is a new technology, be aware that there are non-compliant Type-C new adapters and cables in the market that are using a 10-kΩ resistor instead of the 56 kΩ that should be standard for Type-C cables. In other words, a connected device may attempt to draw 3 A, when the power source (the USB port on your computer, a third-party wall charger, etc.) is only rated to supply 2A, potentially damaging your power source.

It will take time for USB Type-C to become as popular as the current USB Type-A. But with the expanding presence of smartphones and wearables in our modern lives, consumers will finally have one cable for any device, for data, and for video and power connections.



This USB Type-C connector can be used as universal connector. *(Courtesy of Cypress)*

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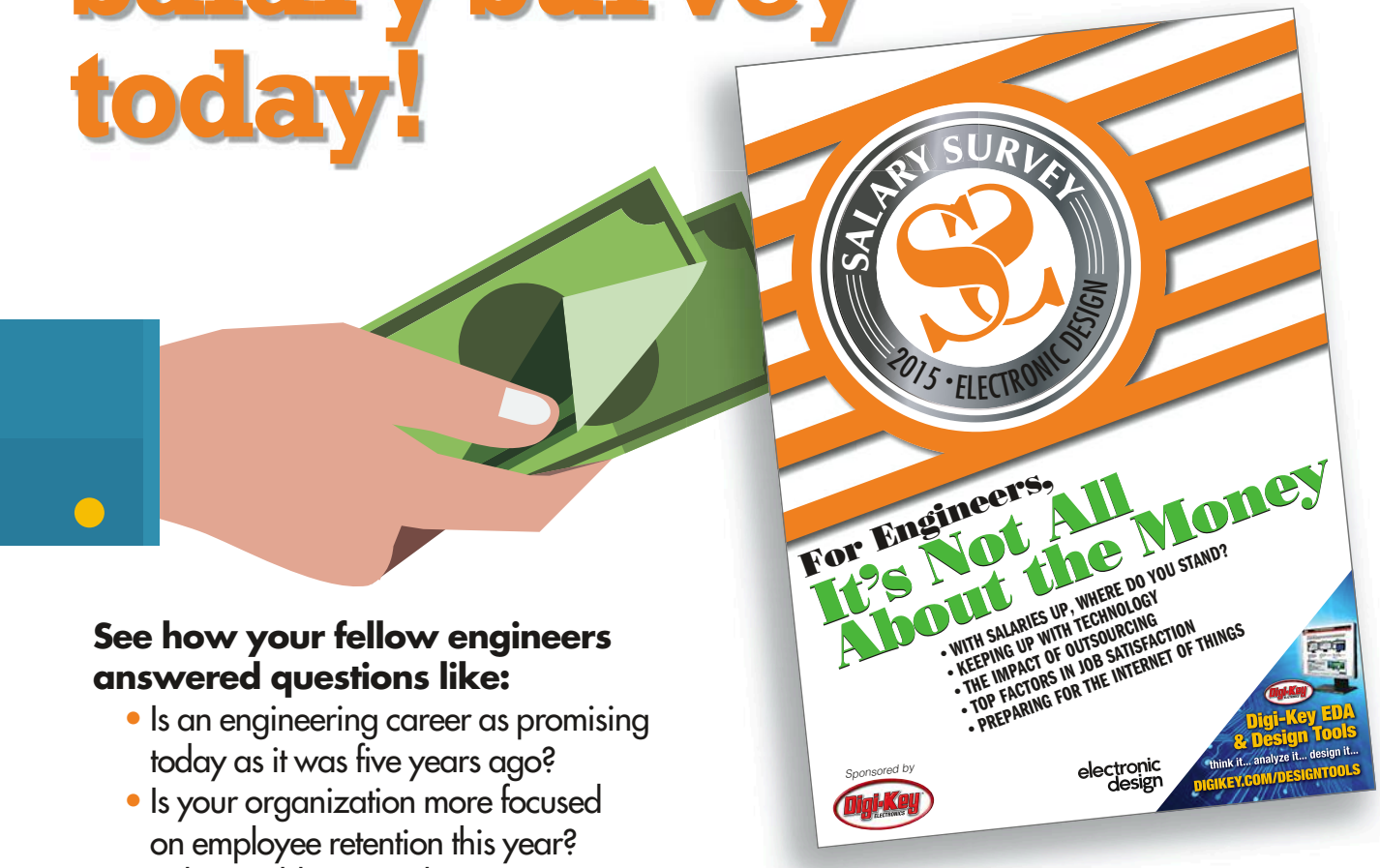

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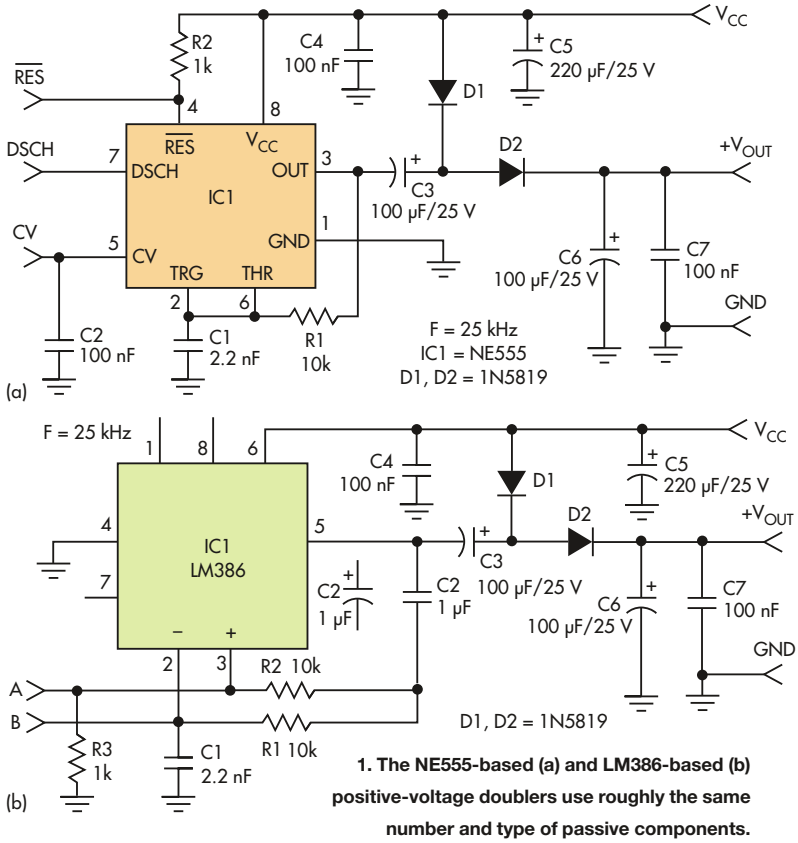
Comparing the NE555 Timer and LM386 Amplifier as Inductorless DC-DC Converters

PETRE TZVETANOV PETROV | SOFIA, BULGARIA ptzvp1@yahoo.fr.

THE BIPOLAR NE555 TIMER IC is widely used in inductorless dc-dc converters, most frequently in doubling and inverting converters. However, another very popular IC, the LM386 audio amplifier, may be a better solution in this application. Note that the results also depend on the specific manufacturer of these multisourced ICs and on the quality of the related components. (We will use only Schottky diodes, to reduce the voltage losses to the minimum.)

BASIC COMPARISON OF NE555 AND LM386

The full power-supply range of NE555 extends from 4.5 to 16 V, but its use near the maximum supply value with the maximum specified current of 200 mA, and at high frequency, can be a problem. The full power-supply range of LM386N1 is from 4 to 15 V (with a working range of 4 to 12 V) and the full supply range of LM386N4 is 4 to 22 V (working range of 5 to 18 V). Thus, the LM386N4 has an advantage over the NE555 because it can work with higher supply voltage. The quiescent current of NE555 is typically 3 mA (6 mA maximum) and that of the LM386 is typically 4 mA (8 mA maximum); here, the NE555 has a small advantage.



1. The NE555-based (a) and LM386-based (b) positive-voltage doublers use roughly the same number and type of passive components.

The maximum output current of the NE555 is specified at 200 mA, but the voltage drops over the output transistors are around 2 V at ±100 mA, which makes use of the IC at higher currents questionable. In comparison, the maximum output current of LM386 isn't specified, but it's much higher compared to NE555 because the LM386N1 typically provides 0.7 W output with a V_{CC} of 9 V and load RL of 8 Ω, while the LM386N4 provides 1 W (typical) with V_{CC} at 16 V and RL of 32 Ω. (These results are based on the classic formulas for Class AB amplifiers using the maximum peak-to-peak output voltage and peak output current.)

The maximum power dissipation of NE555 in a DIP8 package is only 600 mW, while the comparable specification for the LM386 is 1.25 W; here, the audio amplifier has considerable advantage compared to the timer. The maximum junction temperature of NE555 isn't explicitly specified in the datasheet; for the LM386, that parameter is 150°C. The junction-case thermal resistance TJC of LM386 is 37ºC/W, but for NE555 that parameter isn't specified.

For our tests, the power-supply V_{CC} is 10 V. Since the analysis of these ICs as dc-dc converters will

TABLE 1: CONVERTER OUTPUT-VOLTAGE COMPARISON

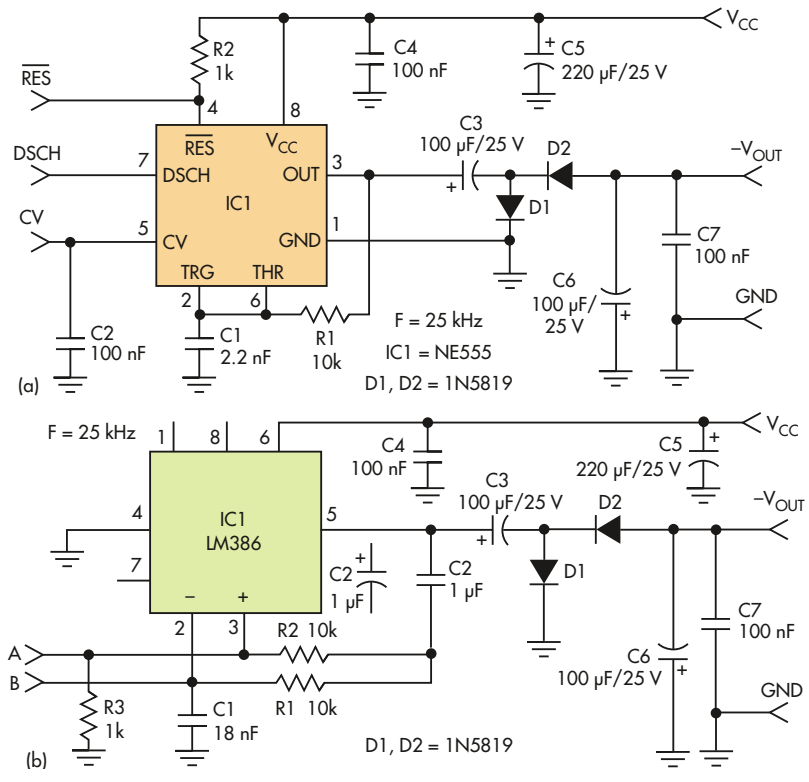
NE555 timer			LM386 audio amplifier		
$+V_{OUT}$	R_{LOAD}	I_{LOAD}	$+V_{OUT}$	R_{LOAD}	I_{LOAD}
+18.6 V	No load	0 mA	+18.6 V	No load	0 mA
+17.7 V	1 kΩ	17.7 mA	+17.9 V	1 kΩ	17.9 mA
+16.7 V	470 Ω	35.5 mA	+17.7 V	470 Ω	37.7 mA
+15.6 V*	235 Ω*	66 mA*	+17.4 V	235 Ω	74 mA
+15.3 V*	156 Ω*	98 mA*	+17.1 V	156 Ω	110 mA

*The NE555 timer begins to overheat and temperature is not measured, while the LM386 does not overheat.

TABLE 2: COMPARING THE CONVERTERS INVERTING THE POSITIVE POWER SUPPLY

NE555 timer			LM386 audio amplifier		
$+V_{OUT}$	R_{LOAD}	I_{LOAD}	$+V_{OUT}$	R_{LOAD}	I_{LOAD}
–8.1 V	No load	0 mA	–8.7 V	No load	0 mA
–7.9 V	1 kΩ	–7.9 mA	–8.0 V	1 kΩ	–8 mA
–7.7 V	500 Ω	–15.4 mA	–7.9 V	500 Ω	–15.8 mA
–5.8 V	100 Ω	–58 mA	–7.35 V	100 Ω	–73.5 mA
–4.8 V*	40 Ω*	–120 mA*	–6.4 V	40 Ω	–160 mA
–3.5 V*	20 Ω*	–175 mA*	–4.24 V	20 Ω	–212 mA

*The NE555 timer begins to overheat and temperature is not measured, while the LM386 does not overheat.



2. With a modest reconfiguration, the NE555 (a) and LM386 (b) can be used to invert a positive supply rail.

be performed at around 25 kHz (T = 40 µs), which is much lower than their maximum possible operating frequencies, there's no need to compare switching speeds, slew rates, and related factors. In general, it's a good idea to use them at below approximately 50 kHz (T = 20 µs).

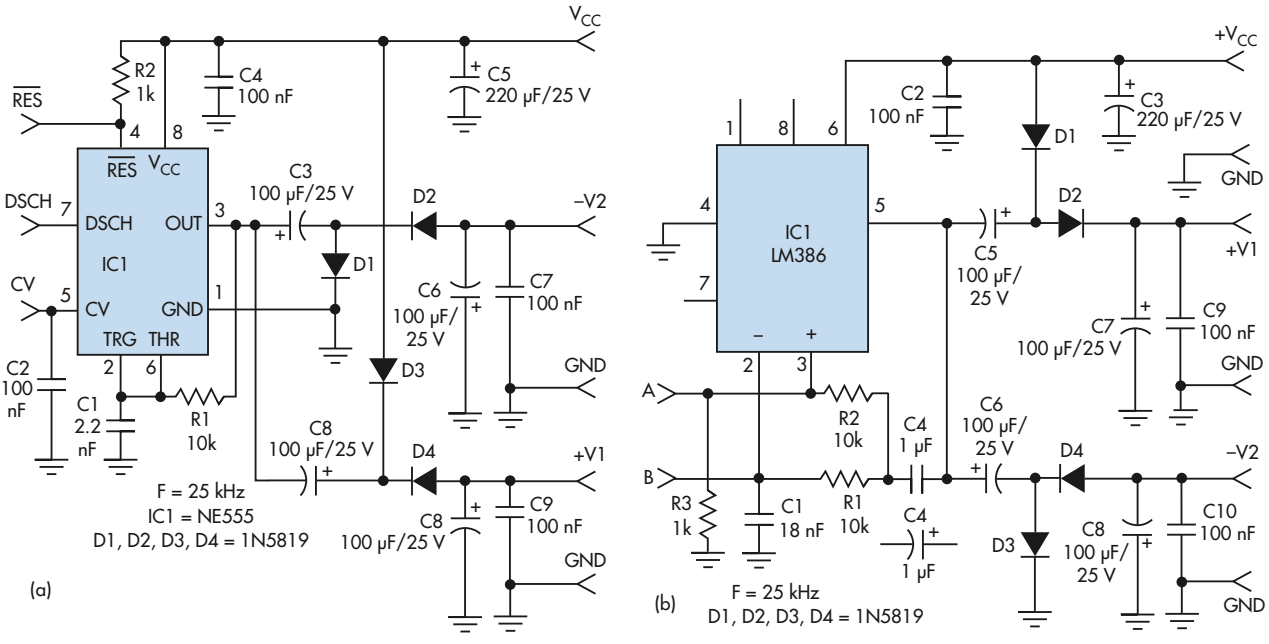
The points A and B on the circuits with LM386 can be used to stop the oscillators with elements having open collectors or open drains; for the NE555, the reset input serves the same function. To measure the output currents, a 1-Ω resistor should be inserted in series with the the ICs' outputs. Therefore, the signals on an oscilloscope are viewable. In the schematics, all resistors are 0.25 W, ±5%, and all non-electrolytic capacitors are 30-V, ±10%, ceramic units.

COMPARING CONVERTERS IN VARIOUS TOPOLOGIES

• Doubling the positive power supply

In *Figure 1a*, a doubling converter uses the NE555 as a simple oscillator with a Schmitt trigger. The frequency is set primar-

ily by R1 and C1, with a slight dependence on the load. It's important to have nearly equal high and low times for the signal produced by the timer. (Other oscillator circuits use the NE555, but that will not significantly change the results about the output voltages produced by the converter.) The converter in *Figure 1b* is based on the LM386.



3. The doubling and inverting circuits can be merged to produce circuits that do both, while using only a single NE555 (a) or LM386 (b).

Table 1 compares the output voltages of the converters at several load resistances. The LM386-based converter provides higher voltages at larger load currents. This is expected because the output stage of LM386 provides greater maximum output current and has lower voltage drop.

• Inverting the positive power supply

Table 2 compares the output voltages at several load resistances for inverting a positive power supply with the NE555 (*Fig. 2a*) and LM386 (*Fig. 2b*). Again, the converter with the LM386 audio amplifier can provide more power to the load, which is a result of its higher output-current rating.

DOUBLING AND INVERTING THE POSITIVE POWER SUPPLY

We can combine the previous converter circuits and develop converter designs that produce two output voltages, with one as a positive rail higher than the power-supply V_{CC} and the other a negative output voltage. *Figure 3a* shows a NE555-based dc-dc converter, while *Figure 3b* uses the LM386. The circuit with the NE555 provides less total output current and power compared to the circuit using the LM386.

In conclusion, the popular 8-pin, bipolar NE555 timer and the low-power LM386 audio amplifier can both be used as the core of inductorless dc-dc converters. The LM386 has some advantages compared to NE555, but the final choice may also depend on factors beyond those examined here..

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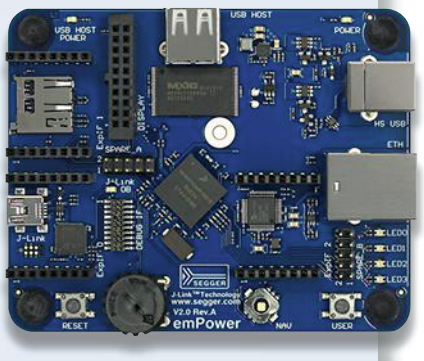

The emPower board is based on a Freescale Kinetis K66 MCU with 256 KB SRAM and 2 MB flash memory. The MCU is built on the ARM Cortex-M4F core and is optimized for applications requiring large memory densities and low-power processing efficiency. Non-volatile storage capability of the emPower evaluation board is provided by means of a 1 Gb SLC NAND Flash from Macronix with built-in ECC controller.

SEGGER

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7-In. TFT Delivers Full HD, IPS, and Accurate Color Reproduction

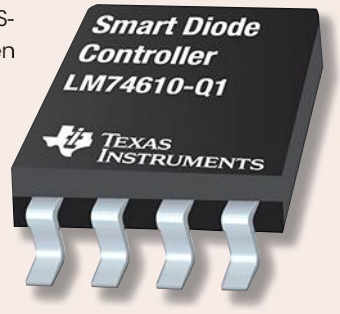
THE 7.0-IN. TFT DISPLAY MODULE from KOE features full 1920 x 1080 HD resolution, IPS, LVDS data interface, LED backlight, and a 20°C to +70°C extended operating temperature range. The display module has a thickness of 4.0 mm and mechanical outline dimensions of 169 x 103 mm. A pixel density of 314 ppi is achieved with a pixel pitch of .081 x .081 mm in an active display area of 155.52 x 87.48 mm. Implementing the latest IPS technology, the full HD display experiences color image consistency over 170 deg. vertical and horizontal viewing angles. A contrast ratio of 800:1 and a brightness specification of 600 cd/m² ensure optical performance and concise display images. The white LED backlight is specified at 40 K hours to half brightness lifetime. Other features include a 20-pin LVDS interface which supports 8-bit RGB enabling a color palette of up to 16.7 M colors. Typical applications for the 7.0-in. display include multimedia monitors, medical imaging systems, security monitors, and portable test and measurement equipment.

KOE

https://www.koe-europe.com

Smart Diode Controller Realizes Zero Quiescent Current

THE LM74610-Q1 SMART DIODE CONTROLLER with zero quiescent current from Texas Instruments provides lower power consumption and heat in a compact solution size, suiting it for reverse polarity protection in high-current industrial power tool and automotive applications. The controller features a unique floating ground architecture that models a diode behavior with zero ground current. Paired with TI's CSD17313Q2Q1 NexFET n-channel MOSFET, the duo emulates a diode rectifier when connected in series with a power source, discharging the MOSFET gate in the event of reverse polarity. The controller can also be used to combine two alternate power sources in an O-ring configuration to provide redundancy.



AEC-Q100 qualified, the smart diode controller comes with 4 kV ESD protection for automotive applications, and a 45 V reverse voltage capability that protects against automotive transients. For automotive alternator and industrial power ac rectification, TI also offers the LM74670-Q1 smart diode controller, which has higher gate drive current (70 µA) than the LM74610-Q1, allowing it to handle ac signals up to 300 Hz.

TEXAS INSTRUMENTS

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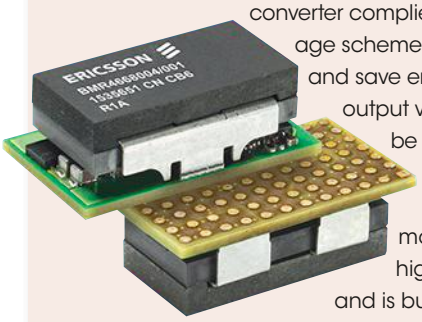
60 A Digital POL DC/DC Converter Boosts Power Density

THE BMR466 DIGITAL POL dc/dc converter designed by Ericsson to power microprocessors, FPGAs, ASICs and other digital ICs on complex boards. Up to eight of the fully regulated 60 A 3E converters can be connected in parallel to deliver up to 480 A in multi-module and multi-phase systems. Operating from a 4.5 V to 14 V input, the converter complies with the Dynamic Bus Voltage scheme to reduce power dissipation and save energy. The factory default output voltage is set to 1.2 V, but can be adjusted from 0.6 V to 1.8 V either via a pin-strap resistor or PMBus commands. The module powertrain guarantees high efficiency and reliability and is built from the latest generation of power transistor semiconductors, enabling the module to deliver up to 94.9% with a 5 V input and a 1.8 V output, at half load. In multi-module systems, two or more of the single-phase POL converters can be synchronized with an external clock to enable phase spreading.



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Family of Breakout Boards Support X-Chip USB Platform

ADDING TO THE SUPPORT for its X-Chip series, FTDI Chip's array of new X-Chip Breakout Boards facilitate the bridging of USB 2.0 signals to serial or parallel interfaces. The UMFT200XD is a USB-to-I2C module with four control bus lines, which is based on the FT200XD device. The UMFT201XB incorporates an FT201XQ IC and is also designed for USB-to-I2C conversion. The UMFT220XB, featuring a FT220XQ, enables conversion of USB to a user-chosen, parallel bit interface where the data bus may be set to a bit width of 1, 2, 4, or 8. The UMFT230XB module relies on a FT230XQ USB-to-UART IC. It has four control bus lines and can be utilized for UART bridging with a UART rate of 3 Mbit/s available. Powered via USB, the modules do not have a built-in USB connector, allowing direct insertion into the USB Host connector instead.

In addition to the standard -01 products, the breakout boards will also be offered in an -NC variant to be supplied without the connector on the I/O side, and a -WE variant to come with 15 cm "flying leads" attached.

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Low-Power Industrial Gateway Provides Mission-Critical LTE

THE AIRLINK RAVEN RV50 INDUSTRIAL GATEWAY is Sierra Wireless' LTE successor to the AirLink Raven X cellular gateway solution for energy and industrial applications. The rugged solution boasts the lowest power consumption of any LTE industrial gateway. The AirLink Management Service (ALMS) is a cloud management solution providing remote device management for the RV50, as well as alerting and monitoring of key variables such as signal strength, location, temperature and voltage. Offering intelligence at the edge, the gateway includes the ALEOS Application Framework (AAF), an embedded programming environment for on-board data gathering, real-time data processing and alert generation. The application framework also enables delivery of critical real-time data and information, reliably and securely over LTE networks, to the Sierra Wireless IoT Acceleration Platform or to other software applications and operational systems.

The AirLink Raven RV50 LTE industrial gateway offers SIM-based network operator switching and ships as a single product variant that works on all major North American networks and expands network coverage in remote areas without increasing complexity.

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Connection System Integrates Power and Signal Contacts

THE AMPHE-RXS CONNECTION SYSTEM from Amphenol Industrial incorporates both power and signal contacts in one connector, using Amphenol's RADSOK terminals as power contacts and either standard or high-vibration (AHVB) signal terminals to produce an all-inclusive connector. Its unique design particularly suits the mixed connector for devices and systems where space is at a premium.

The connector incorporates Amphenol's RADSOK technology for higher amperage, lower t-rise, less resistance, and lower mating forces. The power terminals can range in size from 2.4 to 5.7 mm, while its signal terminals can use the high-vibration AHVB technology and range from size 22 to size 16. The all-in-one connection system can accommodate a variety of locking solutions ranging from plastic lock tabs to small screws. The Amphe-RXS connectors can be overmolded with leads, and offer custom options.

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Production Test Socket for BGA30

Ironwood Electronics recently introduced a new Stamped spring pin socket addressing high performance requirements for testing BGA30 - CBT-BGA-7027. The contactor is a stamped spring pin with 31 gram actuation force per ball and cycle life of 500,000 insertions. The self inductance of the contactor is 0.88 nH, insertion loss < 1 dB at 15.7 GHz and capacitance 0.097pF. The current capacity of each contactor is 4 amps at 40C temperature rise.

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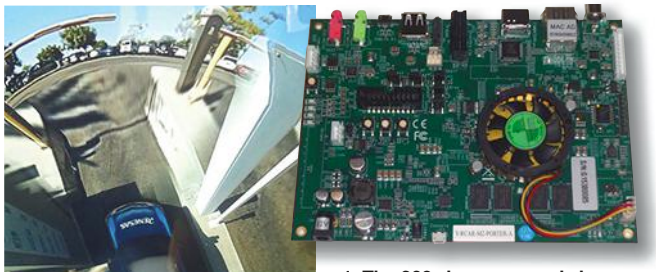
High-End Dev Kits Deliver Advanced Features

Development kits are getting more sophisticated to support the latest hardware from networked FPGAs to 360-deg. automotive views.

Electronic systems continue to get more complex, but new development kits and software can help. At one end of the spectrum is the tiny, $5 Raspberry Pi Zero while at the other end are platforms like Renesas' R-Car (*Fig. 1*) and Digilent's NetFPGA SUME (*Fig. 2*). These two highlight why the price and size of a development platform are not always small.

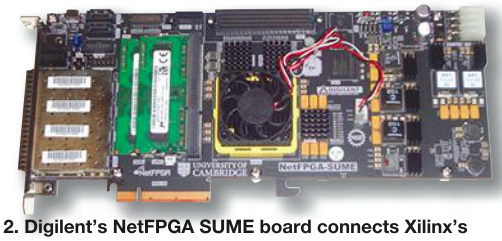


1. The 360-deg. surround view (left) can be experienced using the Renesas R-Car evaluation board (above).

The R-Car series system-on-chip (SoC) incorporates the IMP image recognition hardware core designed to offload the multiple Cortex-A15 cores. The R-Car can address a range of automotive applications from Advanced Driver Assistance Systems (ADASs) to knitting together streams from four cameras to provide the user with a 360-deg. view of the surrounding area.

The R-Car platform obviously targets automotive and transportation solutions where OEMs have a substantial software and manpower investment. There are other application areas such as robotics that can take advantage of the hardware as well. This is where the latest dev kits from Renesas come into play, allowing other developers to get their hands on the hardware and software. Renesas is providing open-source image manipulation and recognition software that take advantage of the hardware.

Digilent's NetFPGA SUME is the top-end board in the NetFPGA family that is an open-source hardware and software platform that is supported by a number of vendors and educational institutions like Stanford Univerisity and the University of Cambridge. The SUME is built around Xilinx's Virtex 7 FPGA. It also has four SFP+ interfaces that can handle 10 Gbit/s transceivers along with a VITA-57 HPC FMC connector with 10 RocketIO transceivers and a QTH connector. The board can plug into a PCI Express Gen 3 x8 connector or be used in a standalone configuration using external power. There are 8 Gbytes of DDR 3 memory on a pair of SODIMMs.



2. Digilent's NetFPGA SUME board connects Xilinx's latest Virtex 7 FPGA to 10 Gbit/s serial connections.

The NetFPGA SUME is supported by a large collection of free IP blocks on the NetFPGA.org site. The one catch is the 10 Gbit/s IP that comes from Xilinx. Xilinx's Vivado FPGA design suite is the underlying development tool. The 100 Gbit/s platform can be used to experiment with new interconnect and high-bandwidth switching applications. For example, three boards could be connected together to provide a 300 Gbit/s non-blocking switch with three 100 Gbit/s bidirectional links.

The Renesas R-Car platform starts at $350 while the educational version of NetFPGA SUME is $4,995. These are not inexpensive, but they are actually a bargain considering the support they deliver.

Of course, developers on the cutting edge will turn to chip vendors and their partners to gain access to the latest technology like Xilinx's 16-nm UltraScale+ FPGAs that incorporate features like UltraRAM that bring large amounts of storage onto the chip. ed

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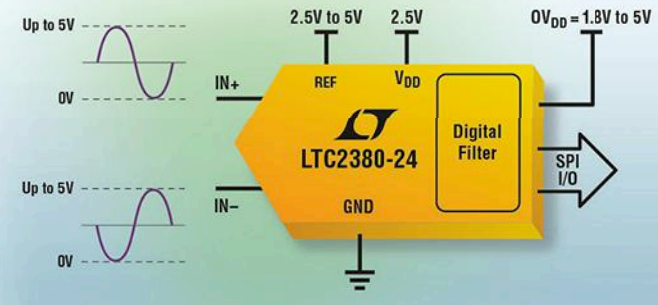

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