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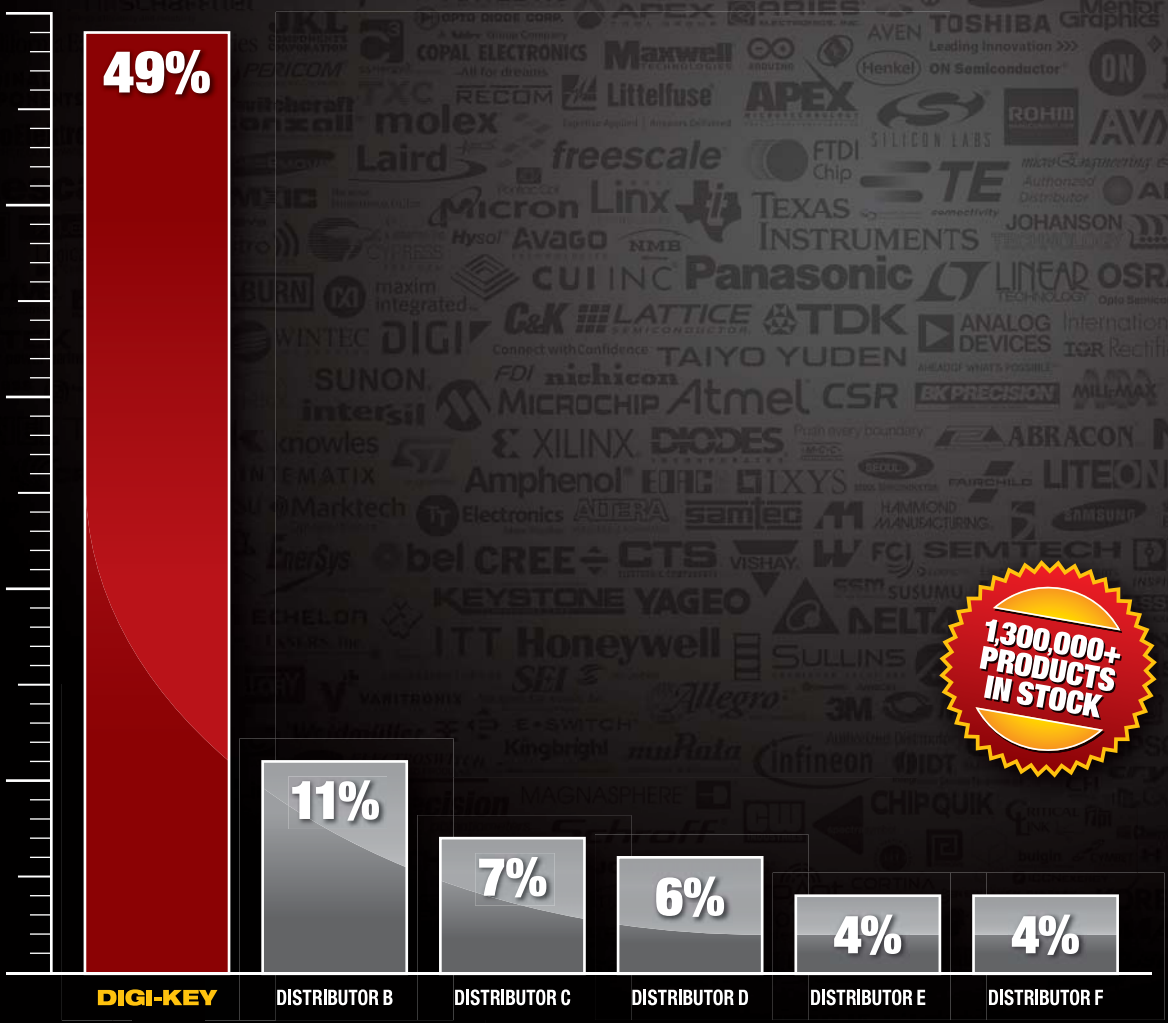

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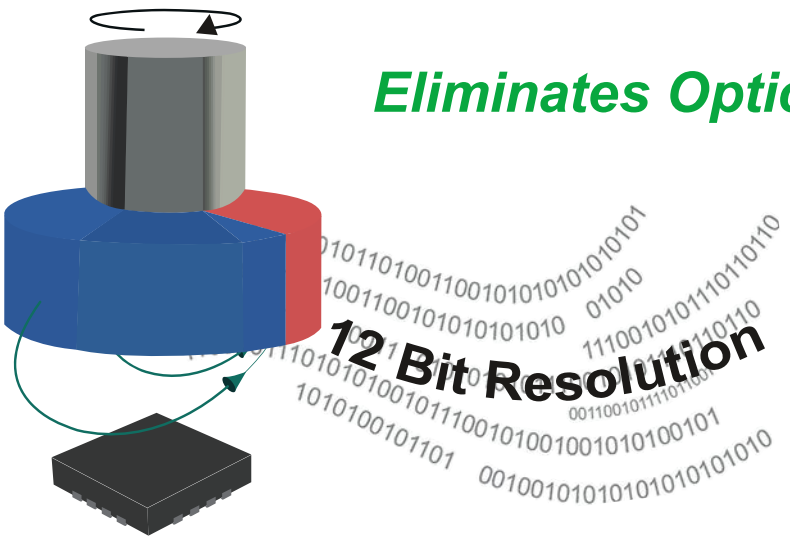

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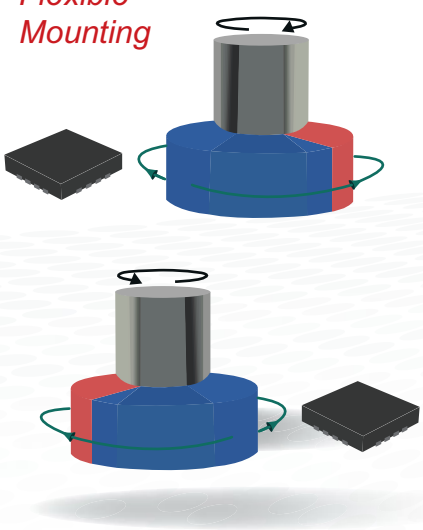

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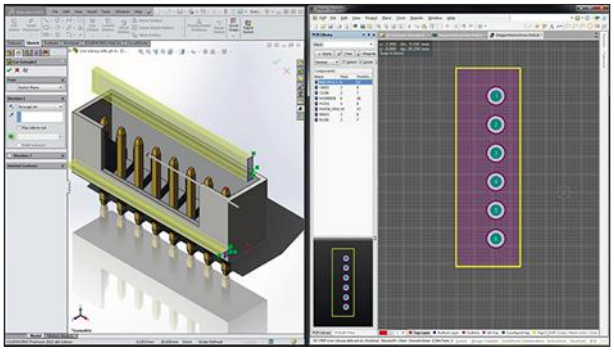

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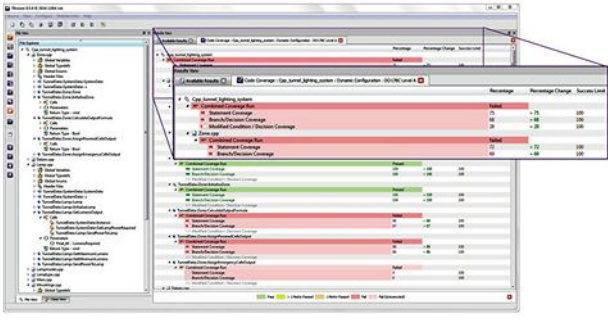

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What's the difference between augmented reality (AR) and virtual reality (VR) technologies? AR lets you see the outside world while adding to what you see while VR masks the outside world presenting its own version exclusively. Find out more about the latest innovations in both of these growing segments. *(Photo of Hololens courtesy of Microsoft)*

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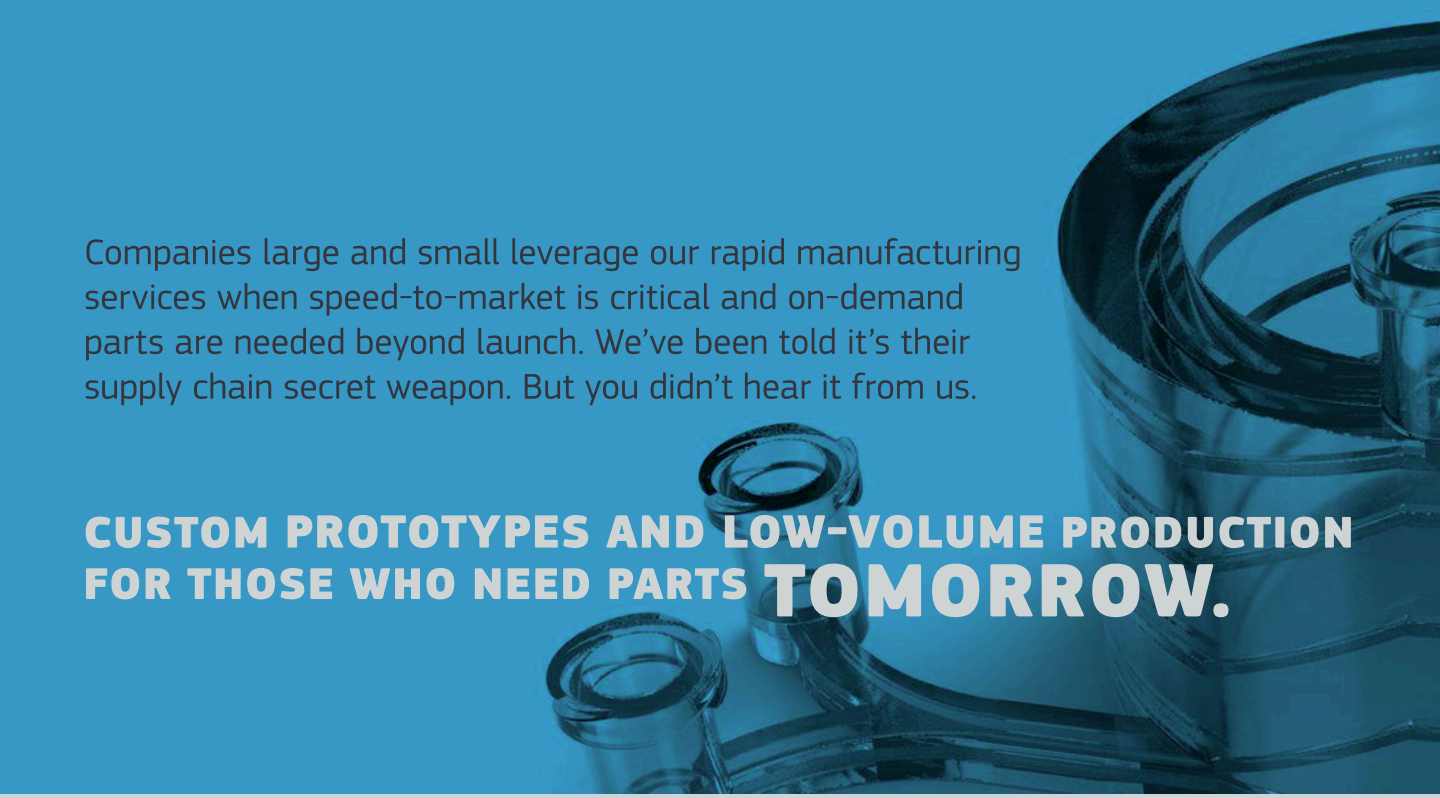

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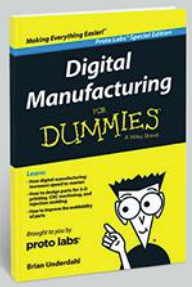

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MARIA GUERRA | Analog/Power Editor
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Networking and Learning at APEC 2016

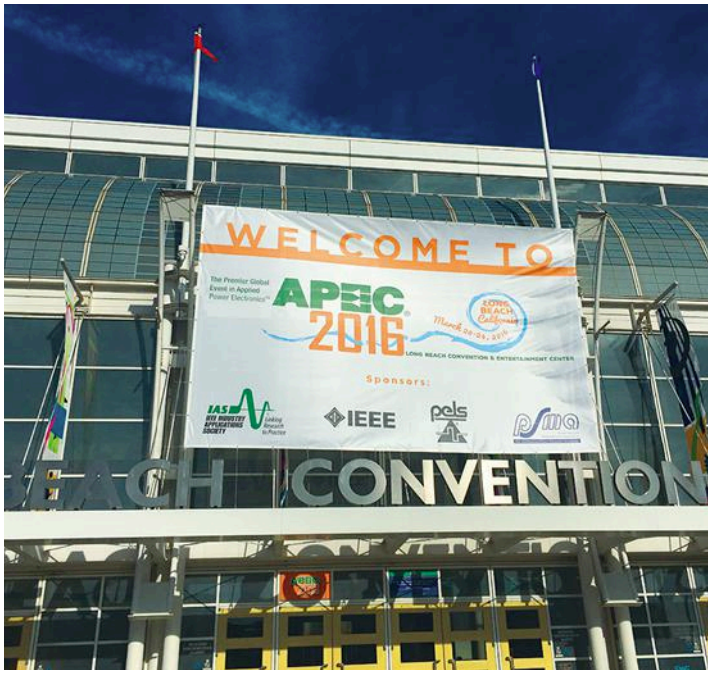
Having just joined *Electronic Design* last fall, I just attended my first annual Applied Power Electronic Conference (APEC). The opportunity was immensely valuable, as I had the chance to meet a number of very experienced, bright people. All of them were keen to share their knowledge, explain and demonstrate different technologies at their booths, and proudly talk about the latest product introductions.

The most common phrases I kept hearing on the show floor were: better performance, higher power density, higher efficiency, higher switching frequency, lower switching losses, and smaller footprint. To me, those words reflect the hard work and effort that companies put into creating, adjusting, and delivering their best solutions for their customers.

I got to know about the latest developments from well-known companies in the power electronic industry (e.g., Linear Technology, Power Integrations, Infineon, Texas Instruments, Vishay, Renesas, and others), which I plan to share with you all through future articles and photo galleries. Also, I was able to meet with several new companies, with one in particular that got my attention: GLF Integrated Power. Its product (IQSmart load switch) is unique because it promises to draw zero current when an application is in standby mode, which I find quite valuable since it will highly improve power efficiency in wearables, mobile medical applications, and other battery-powered devices.

The presence of wide-band-gap materials like silicon carbide (SiC) and gallium nitride (GaN) was noticeable, too. Efficient Power Conversion was there with a wide display of GaN applications and a relative new company, Navitas Semiconductor, was there, too, announcing its new AllGaN Power IC. Wolfspeed was also on hand ratifying the power of SiC with its 900V SiC MOSFET evaluation products.

After my visit to APEC I can only say that the future of



power electronics looks more promising than ever; power electronic companies are highly engaged in a broad range of applications that will keep them developing better solutions as the needs change. APEC proved to be the best place to learn about the latest developments in power electronics and the perfect opportunity to meet or reconnect with the best professionals in the industry today. ed

News

SMARTPHONES
Creep into Wallet Territory

Photo courtesy of Thinkstock

Samsung Electronics recently announced that its mobile payment app, Samsung Pay, would soon become available in China. It will join a crowded field of similar services, which let people make payments in stores using their smartphones. Apple Pay, for instance, absorbed more than 300 million credit card registrations during its first three days in China, while services developed by natives Alibaba and WeChat have long been entrenched in the country.

Samsung executives have said that the service has been an unexpected success for the South Korean conglomerate, which has recently taken steps toward selling more software products. But that success has also underscored a fierce competition to get people using their smartphones like digital wallets. Technology companies, credit card issuers, and banks are all building contactless payment apps that not only send money but also collect data on customer trends.

Mobile payments have been slow to spread, but most analysts agree that they will steadily become more widespread in the next five years. Broad campaigns to educate people about the convenience and security of mobile payments are helping to increase the overall number of users, while placing pressure on retailers to accept contactless payments.

Payments made with smartphones are expected to reach $240 billion globally by 2021, up from under $50 billion in 2016, according to reports from research firm Strategy Analytics. Other research conducted by the eMarketer has said that 37.5 million people in the United States will use mobile payments in 2016, up from around 23.2 million in 2015.

That is partly related to the growing availability of the technology. Samsung Pay and rivals from Apple and Android can be linked to an increasing number of credit cards from American Express and Mastercard, among others. Most services have also added support for local banks and debit cards. Samsung, for instance, recently began to support the Blackhawk Community Credit Union, a small chain in southern Wisconsin. Large banks, including JP Morgan Chase and Barclays, are also developing mobile payment apps.

"We're now reaching more of a tipping point," said Nitesh Patel, director of mobile payments at Strategy Analytics. "We aren't going to see the death of the wallet anytime soon, but we will see more contactless payments in the next five years."

With all the available options, retailers are installing new payment terminals using near-field communication (NFC) technology, which allows smartphones to exchange wireless data with other devices and terminals. In some cases, these terminals are also equipped with readers for smart cards, which contain tiny microprocessors that protect data better than magnetic card stripes.

Even though the infrastructure is slowly falling into place, the potential for mobile payments has been obscured by its relatively limited impact thus far. Around 52% of North Americans are "extremely aware" of mobile payments, according to an Accenture survey that ended late last year. The survey found that only 18% use contactless payments at least once a week, though 23% of millennials and 38% of higher-income households used them.

To help ease the transition for average consumers, one mobile payment service works with the same terminals that credit card shoppers have used for years. In addition to near-field communication, Samsung Pay also uses so-called "magnetic secure transmission" that lets smartphones emulate an actual physical card swipe. That means it can work at virtual payment terminals that accepts card swipes.

Persistent concerns about security are a major barrier to widespread growth. Most surveys cite security as the main rea-

(continued on p. 12)

TELEDYNE LeCROY Buys Test Equipment for Digital Video and HDMI

FOLLOWING THE SHIFT toward higher-definition video in television and streaming services,Teledyne LeCroy has agreed to buy Quantum Data, a test-equipment company that develops signal generators, protocol analyzers, and other tools for testing digital video.

With the acquisition, Teledyne LeCroy acquired protocol analysis tools for two of the most widespread digital video standards: HDMI and SDI. HDMI is installed in a wide range of televisions and other consumer products, while SDI transmits unencrypted data from professional broadcast equipment used in television stations.

"These standards are key to emerging capabilities in consumer electronics, professional video, and studio [and] video broadcast applications," Tom Reslewic, CEO of Teledyne LeCroy, said in a statement. "We anticipate a growing need for protocol test tools among designers in these markets."

These tools will complement Teledyne LeCroy's existing line of oscilloscopes and protocol analyzers, according to Allen Jorgensen, CEO of Quantum Data. The terms of the deal were not disclosed.

Over the last decade, HDMI has grown alongside high-definition television and video streaming. The standard sends uncompressed video data and compressed audio data to and from digital cameras, mobile devices, personal computers, digital televisions, and Blu-ray players. New versions can stream video with higher frame rates and greater color range and contrast than earlier forms of digital video, and especially analog ,technology.

UltraHD televisions from Samsung Electronics on display earlier this year at the Consumer Electronics Show. (*Image courtesy of Samsung)*

Teledyne LeCroy said that the transaction would build on its buyout of Frontline Test Equipment in April. In addition to analysis and emulation tools, Frontline develops test tools and packet sniffers for analyzing Bluetooth and Wi-Fi signals. The terms of that deal were also not revealed.

The Frontline buyout enabled Teledyne LeCroy to "further penetrate the automotive market for emerging serial data requirements" and positioned it "to support Internet of Things emergence including health and fitness sensor integration," the company said in a statement. ■

son why people are reluctant to experiment with the technology. The fact that credit cards are faster and not dependent on batteries are also discouraging factors.

The challenge for companies with mobile payment apps is explaining that security measures on smartphones are superior to physical cards. These include pass codes to lock smartphones in the event they are stolen and the option to use thumbprint identification in Apple Pay.

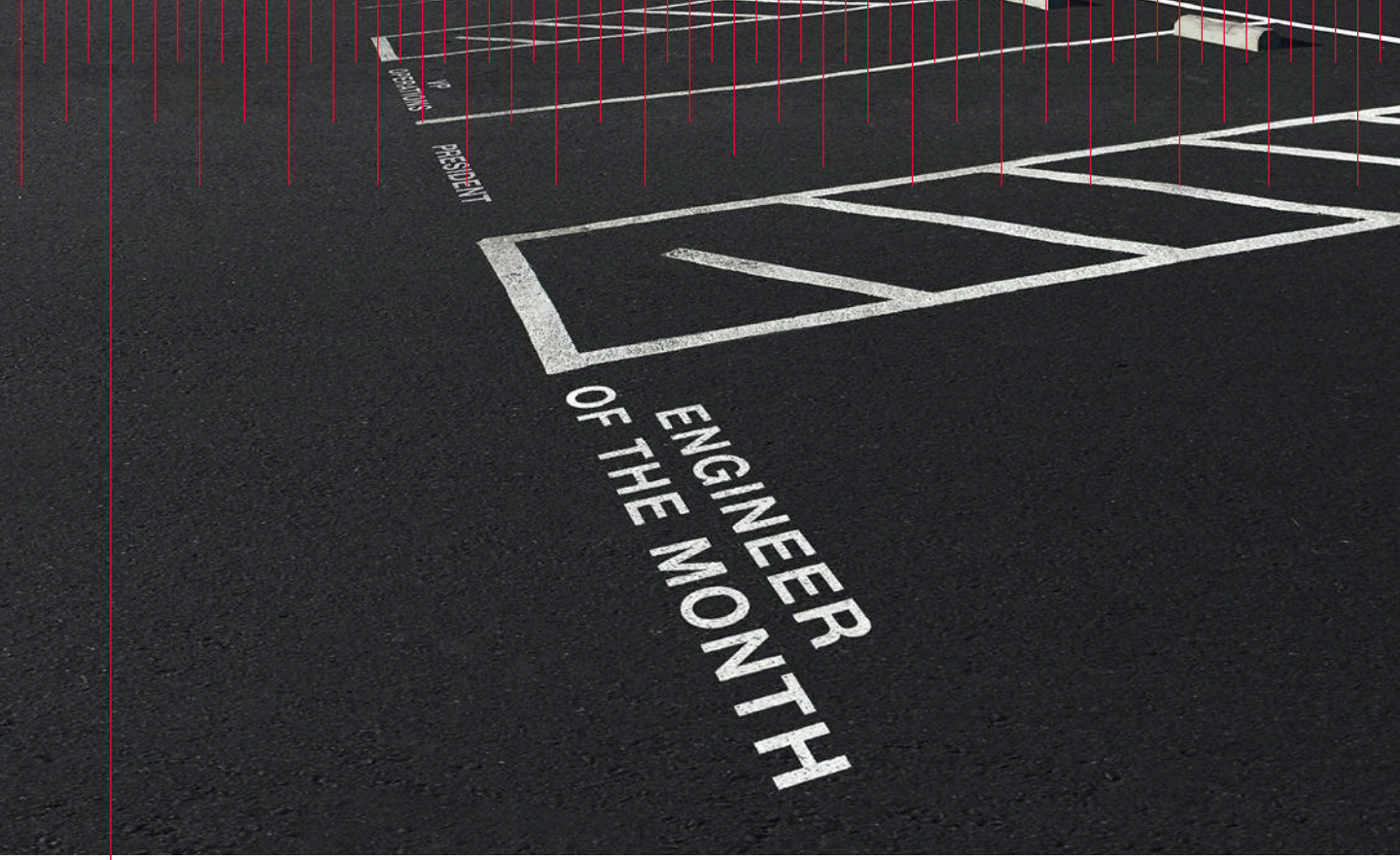
Technology companies have also designed a security feature called tokenization, which replaces your credit card number with secret codes that share transactions with your payment network. When your smartphone makes a payment, the code is decrypted and the transaction authorized, while the credit card number remains with card providers. Neither the smartphone nor retailer gets access to the credit card number directly.

In some cases, the wide range of available apps has discouraged stores from accepting mobile payments, but credit card companies are giving them incentives to upgrade. Last year, several card providers in the United States enacted a fraud "liability shift" to encourage stores to accept more secure forms of payment, like mobile apps and cards with embedded chips. The shift makes stores responsible for counterfeit fraud if they refuse to accept these options.

Retailers are also giving customers incentives to choose contactless mobile payments over physical cards. Starbucks had one of the first major successes in that respect, and others have followed suit. Apple Pay began to support store loyalty cards with the rollout of iOS 9. Walgreens was the first to add loyalty cards to Apple Pay last year. On the other hand, Android Pay has partnered with Coca-Cola to track reward points when someone uses their smartphone to buy a Coke at vending machine.

Despite a relatively tepid reception, mobile payments are not a huge leap of faith over other digital payments. "People already do things on their phones related to shopping, like price comparison...the only thing they aren't doing is making payments [in stores]," Patel said. Also, people have also long been familiar with digital payments, like using an iTunes or Google Pay balance to purchase music or apps.

Patel draws a parallel between contactless payments and credit cards. It was nearly a decade before credit cards started making progress with the general public. In the same way, not everyone is rushing to the technology, but the outlines of a future where we reach for our smartphones instead of our wallets are starting to take shape. ■



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VICTORIA FRAZA KICKHAM | Distribution Editor

TOP 2016 DISTRIBUTORS

Another SLOW-GROWTH YEAR, Say Top Distributors

Technology, lackluster growth shape leading electronic components distributors' business strategies in 2016.

THE ELECTRONIC COMPONENTS INDUSTRY'S largest players expect another slow-growth year, though they say the outlook calls for an improvement over 2015. Customer demand for the newest technology—in products, services, and in their online business experience—is driving the need for more technical expertise and a solutions-based selling approach that has authorized and independent distributors alike focused on delivering better service levels across the board. These are just some of the insights unveiled in *Global Purchasing's 2016 Top Electronic Components Distributors* report.

Avnet Inc., which takes the No. 1 spot again this year with $27.35 billion in sales, is "upping its game" in software, technology, and embedded offerings in response to greater demand for product and technology integration across its customer base, says Gerry Fay, global president of Avnet Electronics Marketing, the company's global business unit focused on electronic component solutions. The technology trend crosses over into business process and digital platform issues, as well—another area on which Avnet is focused. "Digital business is becoming even more important. Customers want to create relationships with distributors online as well as offline," says Fay, emphasizing an "omni-channel" experience that is increasingly in demand among buyers of electronic components.

Avnet's efforts to address the converging technology issues are evident in the executive-level changes the company has made in the last six months alone. In December, the distributor announced the newly created role of chief information security officer (CISO), naming

Sean Valcamp to the post. Valcamp is responsible for Avnet's global IT security as well as enterprise architecture and strategic planning for IT. The company followed up with a January announcement that Ed Smith, president of Avnet Electronics Marketing Americas, will lead the company's embedded solutions business worldwide as senior vice president, global embedded business, effective this July. Also in January, Avnet created its first executive-level Internet of Things position, hiring Eric Williams as vice president of IoT. Williams will work across Avnet's technology, embedded, and electronic components businesses to develop a global IoT strategy.

Commenting on the latter position in particular, Fay emphasized the importance of a company-wide, global approach to technology issues.

Rapidly changing technology continues to drive change in the distribution channel, says Avnet's Gerry Fay (right).

"For the first time in history, we've hired an executive to drive a business strategy across the business," explains Fay. "And we will continue to grow that."

Other top distributors are focused on similar demands, especially as they relate to services.

"The overall makeup of our operations group is different today than it was 10 years ago in terms of the skills and talents we're looking for," says Mark Bollinger, president of Houston-based independent distributor N.F. Smith and Associates, which ranks 13th in this year's report, with sales of $516.2 million. He explains that N.F. Smith has hired more technically proficient employees in recent years and has dedicated more space in its Houston headquarters facility for component testing and services—all in response to changing customer demands.

"[Independent distributors], because we don't make a product and because we don't have franchised lines, a lot of our business is driven by what specific customers need," he says. "We're effectively service organizations—and like any service organization, you have to be meeting the needs of the customer."

TOP DISTRIBUTORS, BY THE NUMBERS

This year's *Top Electronic Components Distributors* report highlights 27 companies serving customers in North America

TOP DISTRIBUTORS OF ELECTRONIC COMPONENTS
(WITH GLOBAL ANNUAL SALES OF AT LEAST $75 MILLION)

Company	2015 Global Revenue
1. Avnet Inc. [1]	$27.35 billion
2. Arrow Electronics[2]	$23.3 billion
3. WPG Holdings Ltd.	$16.24 billion
4. Future Electronics[3]	$5 billion (EST)
5. Macnica Inc.	$3.25 billion
6. TTI Inc.	$1.95 billion
7. Electrocomponents plc/Allied Electronics[4]	$1.94 billion
8. Digi-Key Corp.	$1.7 billion
9. Newark/element14[5]	$1.5 billion
10. Mouser Electronics	$936.6 million
11. Rutronik Elektronische Bauelemente GmbH	$900 million
12. DAC/Heilind	$761.6 million
13. N.F. Smith & Associates	$516.2 million
14. Fusion Worldwide	$340 million
15. America II Electronics	$260 million
16. Sager Electronics	$242.9 million
17. PEI-Genesis	$194.2 million
18. Master Electronics	$183.1 million
19. Rebound Technology Group Holdings Ltd.	$148.4 million
20. Advanced MP Technology	$145 million
21. Bisco Industries Inc.	$141 million
22. Powell Electronics	$135 million
23. Classic Components Corp.	$104 million
24. Flame Enterprises	$94.8 million
25. Electro Enterprises Inc.	$89.6 million
26. Steven Engineering Inc.	$85 million
27. RFMW Ltd.	$77 million

[1] Sales figure reflects sales of computer/peripheral products.
[2] Sales figure reflects sales of computer/peripheral products.
[3] Future Electronics does not disclose yearly sales; rank is based on Global Purchasing estimates.
[4] Company-provided estimate for fiscal year 2015 ended March 31, 2016; sales expected to exceed $1.94 billion.
[5] Sales figure reflects worldwide sales for Premier Farnell, Newark, element14 for the financial year ended Jan. 31, 2016.

NOTEWORTHY DISTRIBUTORS
(WITH GLOBAL ANNUAL SALES OF LESS THAN $75 MILLION)

Company	2015 Global Revenue
Hughes Peters	$70.7 million
Edge Electronics	$47.4 million
Marsh Electronics	$44.2 million
NRC Electronics	$39 million
IBS Electronics Inc.	$37.8 million
Crestwood Technology Group	$37.3 million
SMD	$30.6 million
Arco Inc.	$27 million
Air Electro Inc.	$25.7 million
March Electronics	$22.7 million
PUI (Projections Unlimited)	$19.1 million
Gopher Electronics	$18.3 million
Area 51 ESG	$18 million
Cumberland Electronics Strategic Supply Solutions	$17.7 million

and around the world, with sales of more than $75 million. It also recognizes a handful of noteworthy U.S.-based firms with sales of less than $75 million, which also serve customers across North America and around the world. Twenty of the companies in this year's report cited a sales increase in 2015 compared to figures they provided last year—an average 6% increase. Three companies reported flat sales, and 15 reported a decline in year-over-year sales—an average 7% drop. (Year-over-year figures were not available for three of the companies in our list). Looking ahead, most distributors in the electronic components channel are predicting another modest year in 2016.

"We're building a little better momentum coming off 2015," says Michael Knight, senior vice president, Americas, for distributor TTI Inc., No. 6 on this year's list with $1.95 billion in sales. "Last year ended on a disappointing note. It started hot and finshed cold. I wouldn't say this year is starting hot, but medium-warm—which is a lot better than cold."

Despite a modest outlook for 2016, TTI's Michael Knight (right) points to a bright long-term outlook for the electronic components supply channel.

North America continues to be soft, with better conditions reported in Europe and Asia, distributors agree.

"In North America, it will be another one of those years—not good enough to throw a party, but not bad enough for a wake. Something in between," says Knight. "We continue to see good things happening in Europe…the weaker euro is helping everyone."

He says he expects to see slower growth in Asia due to the slower global economy and slowing conditions in China, especially.

According to Digi-Key, its core strength is the number of components it has in stock and available for immediate shipment.

Minnesota-based global distributor Digi-Key Electronics, No. 8 on this year's list with $1.7 billion in sales, reported strong growth in China in 2015, pointing to recent investments the company has made in the region, including infrastructure, an expanded product offering, ongoing development of design tools, and localized customer service and currency options. The distributor opened its first location in China in late 2013 and began doing business in local currency there at around the same time. Company leaders say they will continue to expand their product breadth to meet customer demand.

"Our core strength is the number of components we have in stock and available for immediate shipment, with access to over [4 million components] via our website," said Dave Doherty, Digi-Key's president and COO, in a statement earlier this year citing the firm's growth in China.

For independent distributors such as N.F. Smith, 2016 is shaping up to be an improvement over 2015 as well. Smith saw a 30% drop in annual sales in 2015, which Bollinger attributes to the nature of the firm's business serving open-market needs.

"We don't look at 2015 as a bad year, just as a year with a very different mix of components that were in demand," Bollinger explains. "For independent distributors, that's generally the case. It's difficult for our revenue numbers to match up year to year, because we're dealing with the open market—with whatever is in demand.

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Minnesota-based global distributor Digi-Key Electronics is No. 8 on this year's list with $1.7 billion in sales. The company reported strong growth in China in 2015, pointing to recent investments it made in the region.

"When I look at 2015, it was not a banner year from a revenue perspective, but we still experienced growth in our global footprint," Bollinger adds, pointing to the opening of the company's Bangalore, India, office.

"So far this year we're seeing a not terribly exciting market; it's not bad, but it's pretty flat. There are certainly some bright spots. Automotive is very active for us; there is a lot of excitement in that market. Obviously, anything cloud-based is pretty robust right now."

Knight says he sees the automotive market as a continued bright spot as well, driven by demand for new features and electronic enhancements on both the commercial and passenger sides of the equation. Medical markets and commercial

(continued on p. 22)

TOP DISTRIBUTORS REPORT: METHODOLOGY

***GLOBAL PURCHASING* IS** proud to publish its sixth annual *Top Electronics Distributors* report, compiled from nomination forms submitted during February and March of this year. Each company in our list is ranked according to its total global sales volume, and all figures are reported in U.S. dollars. We used self-reported data from each company and verified the information against annual reports and earnings statements, where possible, as well as in follow-up interviews with some of the companies at the top of the list.

Figures for Avnet Inc., ranked first, and Arrow Electronics, ranked second, include the sale of computer products, which comprise large segments of each company's business. The ranking for privately held Future Electronics, fourth, is based on a *Global Purchasing* estimate.

Figures for Allied Electronics, seventh, reflect its worldwide sales as part of UK-based Electrocomponents plc, which also operates RS Components in Europe. The figure here is a company-provided estimate for global sales for the year ended March 31, 2016. Likewise, sales for ninth-ranked Newark element14 reflect worldwide sales as part of its parent company, Britain-based Premier Farnell, for the year ended Jan. 31, 2016.

For this year's report, we have highlighted 41 of the largest authorized and independent distributors serving customers in North America and around the world. We broke our list into two segments, those with $75 million or more in annual sales, and those with less than $75 million in sales. The top portion represents the largest companies doing business in the market today, while the bottom portion represents noteworthy U.S.-based companies serving customers primarily in North America.

Our goal is to provide a look at the largest electronic components distributors serving manufacturing customers around the world. We will compile information for next year's report early in 2017 and we welcome your input. Send your comments to sourceESBeditor@penton.com.

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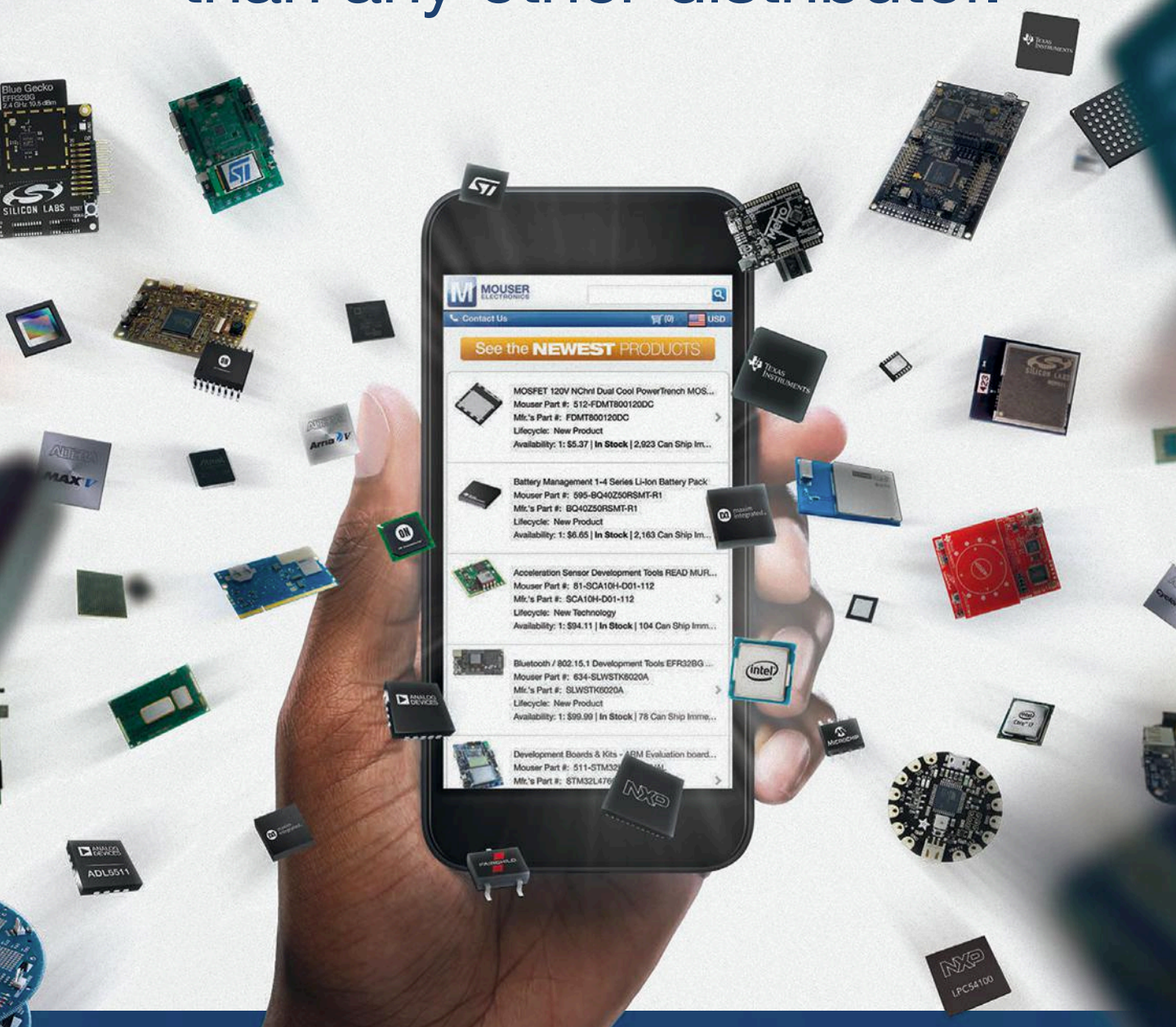

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JOE NOWLAN | Contributing Editor

From LEDs to Smart Lighting

As LEDs become commoditized, suppliers revamp their strategies toward smart lighting solutions that help customers create more advanced, efficient products and systems.

THESE DAYS, THE RATE OF ADOPTION for LEDs has never been higher. Shelves in the big box home improvement stores devote more space to LED bulbs than "old fashioned" incandescent bulbs, as just one example.

The effect and use of LEDs is growing far beyond the lights in your hallway or bedroom, though, as buyers, designers, and suppliers throughout the electronics supply chain can affirm. In fact, as prices decline, many working in the lighting industries view LEDs as close to being a commodity these days.

"The downward trend in price is accelerating. To me, it is almost a fully commoditized product," says Robbie Paul, director of lighting sales at global distributor Digi-Key Electronics. "There is an oversupply right now. It's a similar situation to what we're seeing in oil. It is not a demand issue. Demand is always there and people are always making newer LED light fixtures. But the supply is a glut. We have too many players and so many LEDs to choose from and the price points have come down."

Yet this is hardly the death knell for LEDs. Quite the contrary, as many companies are focused on so-called smart lighting. As LED usage itself has become widespread, its ongoing popularity will continue due to various apps and value-added features such as dimmers and controls.

"Control capabilities set LED apart, especially with what is on the horizon with the Internet of Things, the IoT. We have yet to witness what the IoT will mean to the lighting industry. It's going to shake things up all over again, just like the introduction of LED," explains Lara Cordell, director of technology at Wiedenbach Brown, a smart lighting and electrical solutions specialist. "[LED] gives you the flexibility to do what you need to do. There are more color temperature and color rendering options. There are more optical configurations. There are more dimming and control options."

Digi-Key's Paul anticipates that smart lighting will affect all areas of lighting and related industries.

"That is one of the things [Digi-Key is] focusing on. It is one of my goals to try to figure out how we can best play in the smart lighting market," he says. "That is what you are going to hear about a lot."

MORE THAN JUST LIGHTING

Some smart lighting controls may do far more than simply turn lights on or off as needed. Chenell York is a new product development engineer for one of Digi-Key's manufacturer partners, Eaton Corp., in Peachtree City, GA. As an example, she refers to a large floor space or large room and the potential for energy savings.

"For the indoor space, wouldn't it be great if your lighting could sense not just when somebody walks into a room but what part of the room are they in? How many people are inside that room? What is the temperature in that room?" she explains. "All of those things can lead to savings."

The remote controls—and how best to connect all this lighting—is now an increasingly important issue.

"What we're seeing is that we can't just sell smart lighting in isolation. It has to be connected to the rest of the house or the main building and on and on into the Internet of Things," Paul explains. "The whole connectivity thing is not an easy thing to solve because if you want to get your garage door, your thermostat, and your lights to work together—those are three different industries with different players and different incentives. To get some kind of a common standard is a big challenge."

The push to innovate and get customers to invest in controls will become increasingly important in the next couple of years—primarily because some observers believe that LED adoption could peak as early as 2018.

"The old traditional model was that you used to replace your bulbs at least once a year. Well, LED bulbs are going to last 20 years," explains Paul. "So the replacement cycle has completely disappeared. Right now it is all about [LED] adoption by 2018. They say that once 50% to 60% of the market adopts a product, then it just slows down. So the peak is 2018 for LED bulbs in terms of sales."

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It means companies such as Digi-Key need to come up with new strategies and gameplans.

"We are changing our strategy quite a bit—moving away from these discrete LEDs to more value-added products [such as] modules, smart lighting, and other things," Paul explains.

York and her colleagues at Eaton work with municipalities on their highway and street lighting, she says, where controls have also become more in demand.

"Working with Georgia Power, they tend to be one of the leading utilities. They do a lot of controls with dollies and that kind of thing. It is not only dimming, it is daylight sensing. If you have a streetlight on the highway, there is no need for it to burn during the middle of the day," she says. "So we want a sensor that is smart and can sense that it is noon and the light doesn't have to be on. That is a power savings and an energy savings."

> "Demand is always there and people are always making newer LED light fixtures."
>
> ***Robbie Paul, Digi-Key Electronics***

Controls and the overall quality of lighting are big selling points right now in some offices and large work spaces. When lighting designers visit customers' offices, they often find that everyone wants to share their thoughts about their own lighting.

"People all have an opinion. It's almost like the temperature in the room," Cordell explains. "Some want it colder, some want it hotter…[For example] some people who are working on computers, especially in the IT world, want the ambient lighting much darker than typical and you have to balance that against other lighting preferences in the same office space."

Paul admits there may be a tendency to offer some customers too much of a good thing as far as modules and apps are concerned.

"You can talk about the residential environment. Everything is controlled by your phone, by apps," says Paul. "It is great to have lights that you can control but…[some say] 'I don't want a separate app for my light. I have one for my garage door. I have one for my camera, one for my thermostat. Now you're going to give me another app for my lights?'"

With an eye toward minimizing a potential app overload, heavyweights such as Apple and Google have become involved in the connectivity end of things. Apple has its HomeKit, which enables users to connect to their homes from their iPhones. Likewise, the Thread Group—which is backed by Google—allows homeowners to connect to their homes. It describes itself as a "nonprofit group…focused on making Thread the foundation for the Internet of Things in the home…"

And Apple and Google are far from alone in this. As York explains, Eaton is also working a similar set of features.

"We are in the process of creating our own interface to go with our lights," she says. "This is an interface that is going to be based off of existing platforms so that you may have a house that has an app for your garage door, another app for this and that. Our interface will actually be on the same platform as them so that you can have one app that does it all. So you won't be saying, 'I have to close this app and open this other one to do this one little thing that I want to do.' It will be all in one."

This involvement by the likes of Apple and Google reaffirms to many that the controls and connectivity market is the next phase in LEDs.

"And [Apple and Google] are big enough or they can create their own de facto standards…So these big guys are coming in now to try to change the game as well," adds Paul. "Plus you have Lutron and GE who are already in the home automation area that are also trying to step it up and get more app-based controls. It is going to be very interesting."

(continued from p. 18)

aerospace continue to perform well, too, he says, adding that the proliferation of electronics across all aspects of life continues to bode well for the electronic components supply channel.

"Conditions have been flat for, [say], 10 years, so it's easy to start to thinking that it's going to be this way always," says Knight. "I don't believe that. There is so much going on in technology that, once it's realized, it will spur growth."

Sensors embedded in everything from health and wellness devices to smart-city applications are likely to produce widespread demand for new products and the replacement of outdated ones, for example.

"There is going to be a wave of products that have really interesting and new features that will add value in our businesses, our lives, and we will start buying them," Knight explains. "I think before I'm done in this business we will see at least one, maybe two more surges, when it feels like things are on fire. It won't be this year or next year…but it could be in the early 2020s that we'll see something. There is just too much really interesting stuff going on in technology [to not expect that]."

Services are a growing opportunity across the board as well, and one Bollinger says independents are beginning to home in on. "An interesting thing for independents right now is that there is an increasing amount of supply chain service business," he explains. "We're seeing more supply chain service opportunities—managing inventory, logistics, supporting warranty, and repair-type work. We're working on cost-savings opportunities and using the market to bring down the average cost of inventory."

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NOLAN JOHNSON | Product Marketing, Sunstone Circuits

7 Engineering Essentials

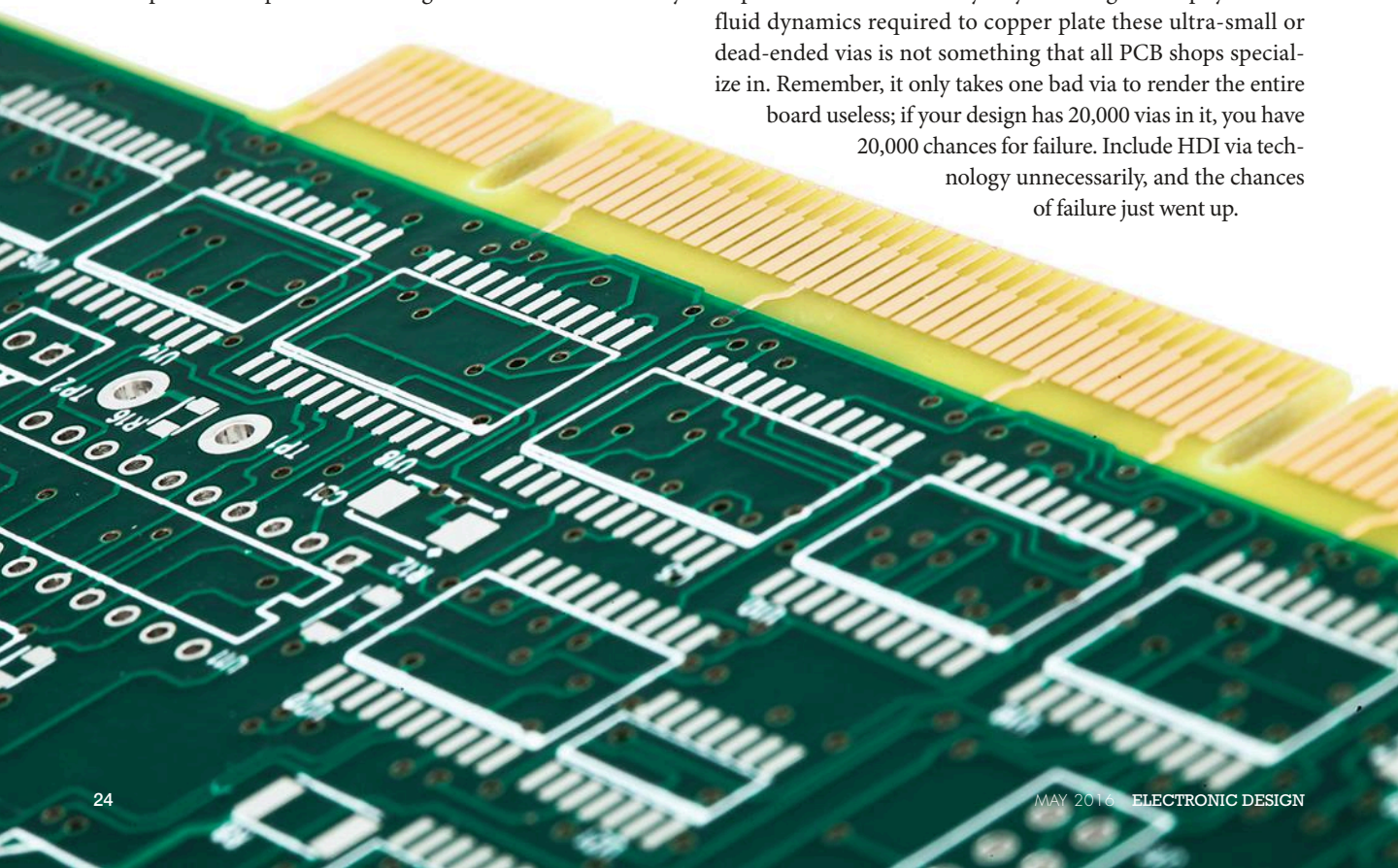
Here are seven critical design strategies and tips, for beginners and gurus alike, to help ensure successful PCBs.

In this article, we'll discuss seven basic (but critical) tips and strategies for beginners and masters alike. Pay attention to these tips during your design process, and you'll reduce spins, design times, and overall diagnostic hair-pulling for you and your team. So let's get started.

1. BONE UP ON FABRICATION METHODS AND FAB CHEMISTRY

In this era of fabless IC companies, it isn't all that surprising how many engineers don't actually know the steps and chemistry involved in creating PCBs from their design files. This lack of practical knowledge can often lead a newer designer to make design choices that are more complicated than necessary. For example, a common novice mistake is to lay the board out in extremely precise geometries, using orthogonal trace bends on tight grids, only to find out that not every board shop has the capabilities to produce the design with sufficient reliability to sustain a lifetime in the field. The shops that do have these capabilities may not provide the most economical pricing for the PCB. Did the design really need to be that complex? Could the board have been laid out on a larger grid, reducing the cost of the boards and improving the reliability? Other pitfalls for novice designers are unnecessarily small via sizes, and blind and buried vias. These advanced via structures are great tools in the PCB designer's toolbox, but highly situational in their effectiveness. Just because they are in the toolbox doesn't mean they should be used.

Bert Simonovich's "Design Notes" blog has this to say about via aspect ratios: "A via aspect ratio of 6:1 pretty much ensures your board can be fabricated anywhere" (*http://blog.lamsimenterprises.com/2011/02/15/pcb-vias-an-overview/*). For most designs, with a little thought and planning, these HDI characteristics can likely be avoided, which again will save cost and improve manufacturability of your design. The physics and fluid dynamics required to copper plate these ultra-small or dead-ended vias is not something that all PCB shops specialize in. Remember, it only takes one bad via to render the entire board useless; if your design has 20,000 vias in it, you have 20,000 chances for failure. Include HDI via technology unnecessarily, and the chances of failure just went up.



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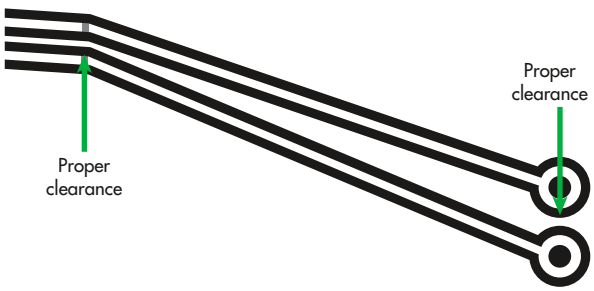


1. In this example, the narrow shielding between traces is properly secured to the board substrate.

2. TRUST THE RAT'S NEST

Sometimes it just seems like the schematic is a waste of time for a simple board, especially if you've done a design or two in the past. For first-time designers, though, the schematic can be a daunting prospect as well. Skipping the schematic is a tactic often taken by novices and intermediates alike. Resist the urge, though. Developing your layout from a complete schematic that you can use as a reference helps ensure your layout connections will all be complete. Here's how.

First, the schematic is a visual representation of the circuit. It communicates information on a number of levels. Subsections of your circuit can be detailed on multiple pages, and components can be arranged close to their functional counterparts, independent of their eventual physical placement. Second, a schematic helps you ensure that your circuit is complete. With each pin on each component represented in the schematic symbols, an unconnected pin is easy to spot. In other words, either the formal rules for describing a circuit have been followed, or they haven't. Schematics help you determine this fact quickly, and visually.

In a discussion thread on stackoverflow.com, one poster comments, "If a schematic is likely to mislead a human observer, it is a bad schematic whether you can eventually show that ... it was in fact correct. The point is clarity. A technically correct but obfuscated schematic is still a bad schematic." While this is certainly easy to agree with, in a CAD program, an impossible-to-read schematic can still convey connection information that describes that circuit and will be helpful during layout.

The takeaway is this: When laying out a PCB, having a schematic to use as a golden reference makes the job easier. Work through the connections with the symbols; work through the tracing challenges without having to think through the connections at the same time. Ultimately, you save a spin just in catching the trace connections you forgot to make in the first revision.

3. USE THE AUTOROUTER, BUT DON'T "TRUST" THE AUTOROUTER

Most professional-grade PCB CAD tools have autorouters. But unless you design PCBs professionally, using the autorouter is best used as a preliminary pass; it is *not* a one-click-and-done solution for PCB connectivity. You should still know how to route traces by hand.

Autorouters are highly configurable tools. To use them best, careful and thoughtful setup of the router parameters can change from job to job, and even from module to module inside a single PCB design. There simply aren't any good basic general-purpose default settings.

Often, when you ask a veteran designer, "what's the best autorouter?" they'll say, "the one between your ears" and they're mostly serious. Routing as a process is as much art as algorithm; routing is heuristic by nature, and lends itself best to traditional backtracking algorithms. Backtracking algorithms are good for finding solutions and great for constrained path choices like mazes and puzzles, but backtracking algorithms are not strong at finding optimal solutions in open, unconstrained fields like a printed circuit board with components pre-placed. Unless autorouter constraints have been highly tuned by the designer, autorouter results will still require a human to spot the weak spots in the backtracking algorithm results.

Trace sizes are another trouble spot. The autorouter cannot reliably determine how much current you plan to pass down a trace, so it can't determine what trace width to use for you. The result is that most autorouter traces will be at widths that aren't within specification. Many autorouters have mechanisms by which they reference trace constraints that you specify. In a forum post on stackexchange.com, Martin Thompson writes,

"I've used an autorouter (admittedly, a high-end one…) on every board I've done (10+ years). If you have constraints like: only on this layer; these two signals form a differential pair; must match lengths on these nets, then you must tell it about them." Just ask yourself this as you contemplate using the autorouter: "By the time I get the autorouter constraints set up for my board, perhaps even going trace-by-trace setting constraints in my schematic, how much could I have manually hand-routed?"

2. A very narrow, sliver-shaped region, such as this example in the original design file, can peel off uncontrolled during manufacture, creating shorts and yield issues.

Veteran designers put a great deal of emphasis on the initial component placement, spending as much as half the design time getting the component placement optimized for the following:

Routing simplicity—minimize rat's-nest crossovers, etc.

Part proximity—shorter routes mean better routes.

On the Sunstone Circuits user forum, one poster writes, "Take more care of component placement. Place them in a way where they are easier to route. Component placement is 70% of the job. Place [all components] *before* starting to route a single trace ... use the rat's nest (the lines which indicate connections which are not routed yet) as a rough guide [for tracing complexities.]"

Old timers often use a hybrid approach to routing—hand-routing the critical routes, then locking them down. Non-critical traces can then be handled by the autorouter, autorouting regions of the design to help manage "runaway conditions" in the routing algorithms. This can sometimes be a good compromise between the control of hand-routing and the speed of auto-routing.

4. BOARD GEOMETRIES AND CURRENT FLOW

Most anyone working in electronics design recognizes that, just like a river in its course, electrons can encounter choke points and bottlenecks. This factor is put to direct use by the automotive fuses. By manipulating trace thickness and shape (U-bent, V-bend, S-shape, etc.), the fuse can be calibrated to melt at a choke point upon overload. Trouble is, PCB designers occasionally create similar electrical choke points in their PCB designs. Examples are: using 90-deg. bends when two quick 45s will make the corner just as well; bends larger than 90 deg., creating a switchback shape. At best, these traces slow down signal propagation; at worst, they act just like the auto fuse and melt at the point of resistance.

3. In this example, the chemical etch changes the shape/dimension of the narrow sliver fill. Unexpected flakes and flaps can occur if the sliver peels away.

5. UH-OH, SLIVER!

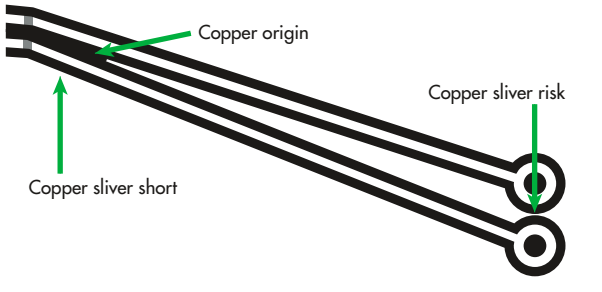
Slivers are a manufacturing failure that are best managed through proper board design (*Fig. 1*). To understand slivers, first we need to review the chemical etch process. The intent of the chemical etch process is to dissolve away the unwanted copper. But if there are extremely long, thin, sliver-like features to be etched away, these features can sometimes detach as chunks before they fully dissolve. The sliver chunks then float around in the chemical bath, where they might potentially land on another board randomly.

Equally risky is when the sliver is intended to stay attached to the board. If the sliver is narrow enough, the acid baths may etch away just enough copper underneath to partially detach the sliver. Now the sliver is flopping around, attached to the board like a flag. Invariably, it flips over onto your own board, and shorts out other traces.

So where do you look for potential slivers and how do you avoid them? When laying out your PCB, it is best to avoid leaving very narrow areas of copper (*Fig. 2*). Such areas are usually caused by filled planes where trace and pad clearances intersect (*Fig. 3*). Keep the minimum width of copper areas above your manufacturer's minimum and your design should be fine. A pretty standard minimum width for etching is 0.006 in.

6. PAY ATTENTION TO THE DRCs

Whereas setting up the autorouter is often very specific to the design function, the Design Rule Checker is typically organized to capture a fabricator's design constraints. While still tedious, it's generally not quite as bad as the autorouter. Most design teams eventually create a set of design rules that aim to: standardize the bare board build costs and maximize yields; and make assembly, inspection, and test as consistent as possible. Beyond the design benefits, these design rules—by keeping designs within pre-defined fabrication limits—



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can also help create more consistency in the purchasing department as well. Pricing for the manufacture of the board is consistent, and purchasing can often reduce the number of specialized PCB manufacturing agreements that need maintaining.

To help with all this, many PCB design tools have a built-in DRC checker (some tools call them "constraint managers") that will flag design rule violations for you interactively as you're editing. Once you've set up the DRC rules for your fabricator of choice, get ready to take the errors seriously. DRC tools are, by design, conservative. They'll err toward reporting a possible error, and let you decide. It can be tedious to sift through several hundred "possible" problems. Do it anyway. Somewhere deep in that list just might be the reason your first spin is destined to fail. Besides, if your design is triggering a lot of possible errors, you might want to take that as a hint that your trace placement needs some improvement.

Dave Baker, Sunstone Circuits, a PCB designer with over 20 years of design experience offers this advice. "Take time to understand and correctly set up the constraint system of your layout tool. Take the time to review all levels of your constraints. Constraint tools can be powerful and flexible, but also confusing and dangerous. Incorrect constraints can easily lead to defective or unbuildable boards. Errors in constraint setup can effectively limit or disable DRC checks. This can create a situation in which every DRC passes and yet the board is still unbuildable or non-functional. I've seen this happen before. The team is all happy because the board passes DRC and yet the first articles literally go up in smoke on the test bench. Tracing the failure took the team back to the CAD tool's constraint manager. The constraint manager does not have a design conscience; it will let you do anything, no matter how bad."

At Sunstone Circuits, for example, it's an almost daily occurrence to receive a quote request for a board design that we could easily build, except for a critical area in which design tolerances and clearances were compressed dramatically. This situation puts the PCB fabs, such as Sunstone, in the position of delivering the bad news: either we can't build the board at all because of the tolerances that are beyond our capabilities, or we *can* build the boards but at an increased price and at a riskier yield. These customers would have benefited from designing with a specific manufacturer in mind.

Baker adds, "If your layout software allows you to waive the DRC violations, then use that feature with caution. It is so easy to temporarily waive DRCs, meaning to get back to them later, and then forget them. Remember to review all waived DRC errors prior to sending your design for fabrication."

Bob Tise, veteran PCB designer currently on staff with Sunstone Circuits, offers a counterpoint. "You could also just resist

the temptation to waive DRCs altogether and just follow the rules you set up in the first place."

7. KNOW THE FAB YOU'RE USING

After discussing DRC setup, this tip is almost—but not quite—redundant. Besides helping you set up the DRCs correctly, knowing which fab you'll be sending your board also allows you some additional pre-fab help. A good fab will give you pre-order help and suggestions on how to approach your design to reduce design spins, reduce the number of issues you end up debugging on the bench, and increase your board yields overall.

On the blog onmyphd, Hugo, a PhD student at Carnegie-Mellon University, has this to say about knowing your manufacturer:

"Each manufacturer has its own specifications, such as minimum trace width, spacing, number of layers, etc. Before starting design, you should consider what you need and find a manufacturer that meets your requirements. Your requirements also include the grade of materials of the PCB. There are grades ranging from FR-1 (paper-phenolic mixture) up to FR-5 (glass cloth and epoxy). Most PCB prototyping manufacturers use the FR-4, but FR-2 is used in high-volume consumer applications. The type of material affects the circuit board's strength, durability, moisture absorption, and flame resistance (FR)."

Understanding the processes that go into the manufacture of a printed circuit board will help you make better design decisions, as will knowing which processes and methods will be employed by your manufacturer. Set up a visit to your preferred supplier and walk through the processes; you might be amazed. And make use of DFM tools prior to submitting your design for fabrication.

WRAPPING IT UP

When you stay mindful of these essential skills and techniques, you're well on your way to quick, reliable, professional-quality PCBs for your project. Understand the manufacturing processes; use DRCs and DFM to help you catch inadvertent design features that could increase your fab costs and/or decrease your yields. Then plan your component placement carefully to help eliminate the need for expensive design features.

Make judicious use of all the design tools offered by your CAD tool, including autoplace and autoroute, but be patient and thorough about autorouter setup if you're serious about autorouting successfully. Don't trust the autorouter to do anything more than place routes; adjust trace sizes by hand if necessary to ensure appropriate current flow for your design. And by all means, *do* trust the rat's-nest lines. Until those are 100% gone, you have at least one open in your circuit.

BILL WONG | Technical Editor

These Software Trends Will Influence IoT Strategies

IoT is all the rage, but building a system from scratch is impractical. So where is IoT software headed, and where can you get it?

Has the Internet of Things (IoT) driven you to distraction yet? Fortunately or unfortunately, IoT is not going away. The challenge for most developers and companies is determining where they fit within the IoT spectrum and how they will address it.

In general, IoT is not that complicated. Typically, a cloud component is built around a database with information coming from IoT endpoints, possibly through IoT gateways. Then there's the other side—a user interface, usually an app, that runs on a smartphone, tablet, or PC. The problem, though, is trying to whittle down the plethora of choices available without selling off the farm. It's usually impractical to build your own end-to-end solution, and any part that you don't build yourself will incur a fixed and, possibly, ongoing subscription cost.

IoT ENDPOINTS

Wireless IoT endpoints are becoming the norm, with many options to choose from when connecting these devices from cellular and Wi-Fi to ZigBee, ANT+, and Thread. Some can provide direct links to the cloud, while others typically need a local gateway to provide connectivity to the cloud. Sometimes the gateway simply provides routing support, but more often than not, it includes other services such as data consolidation, endpoint management, and additional security support.

The discussion can get a little muddled because IoT frameworks like mbed are typically part of the discussion, and network transport options may or may not be dictated by the framework. Though IPv6 is the trend, Ethernet and Wi-Fi connections still regularly run IPv4.

This simplest case is where IoT devices communicate with a limited number of entities. It's occasionally only the cloud, but some applications call for more a federated approach that possibly requires cooperation directly between IoT devices. Collaboration protocols like AllJoyn and Google's Nest Cloud API are just a couple options.

Dell will build to order IoT gateways like this Embedded Box PC 3000, which has wireless support.

IoT GATEWAYS

IoT gateways can range from tiny wireless nodes to Dell's Embedded Box PC 3000 *(see figure)* or ADLINK's Modular Industrial Cloud Architecture (MICA) that runs software like the Wind River Intelligent Device Platform XT. Some applications can incorporate many different types of gateways. However, all IoT gateways typically have common functionality, such as a common communication, security, and management system.

Many board vendors have moved into the gateway arena with hardware and software to match. For example, Eurotech's Everyware is based on the open-source Eclipse Kura project and runs on Eurotech's ReliaGATE15-10.

IoT AND THE CLOUD

Developers actually have a wider selection of options when it comes to the cloud component, but selecting one typically locks in the design to the vendor.

Getting into the IoT cloud can be as easy as utilizing Buglabs' dweet or freeboard. Cayenne has a download that links a Raspberry Pi to the cloud in minutes using its myDevices platform. Ayla Networks provides a similar Design Kit and Microsoft's Azure IoT Suite is another framework that links devices to Azure cloud services. Azure IoT Suite supports ARM-based platforms in addition to Microsoft Windows.

To sum up, compare solutions before committing to a design, as major differences in cost and effort over the long run may become apparent. Start your search from the client, the gateway, and then the cloud to see the different outcomes.

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LINEAR TECHNOLOGY

DESIGN NOTES

60V, 4A Synchronous Monolithic Step-Down Regulator Has Rail-to Rail Operation

Design Note 550

Victor Khasiev

Introduction

The LTC3649 is a high efficiency synchronous monolithic step-down regulator, which integrates top and bottom N-channel MOSFETs on the die. This regulator features a wide input voltage range, 3.1V to 60V, and a wide output voltage range from 0V to (V_{IN} – 0.5V). This extremely wide range of operating voltages makes the LTC3649 especially attractive for industrial, medical and transportation applications, where the rail voltage can be less than 5V or above 40V during voltage transient events. The input voltage range of the LTC3649 also covers mass produced and widely accepted 12V and 24V solar panels, where it is used as a downstream converter in alternative energy systems.

In contrast to the majority of DC/DC controllers and regulators, the output voltage of LTC3649 can be programmed by either a single resistor or the reference of its internal error amplifier. It also features a current monitoring output, I_{MON}. The LTC3649's unique combination of features opens up interesting applications in power adapters and portable computer systems.

Circuit Description and Functionality

A 5V output power supply is shown in Figure 1. This circuit is centered on the extremely small footprint high voltage step-down DC/DC LTC3649. The input voltage extends up to 60V and the output is set to 5V at 4A. Only a few additional components are required for the complete solution, including inductor L1 and a few passive components.

The feedback loop can be closed by external components off the ITH pin or by internal compensation. The ITH pin should be connected to $INTV_{CC}$ through optional resistor R_{ITH} if its internal loop compensation is used. The output voltage is set by resistor RST. Despite the small size of the converter and integrated switching MOSFETs, efficiency reaches 95%, as shown in Figure 2.

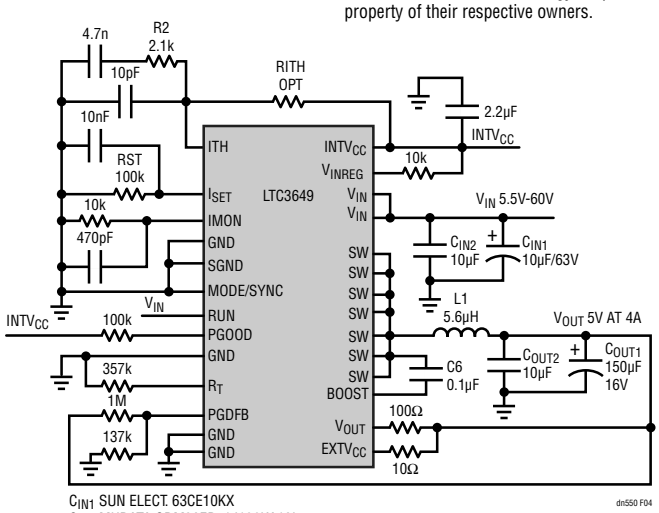

Figure 1. LTC3649 Step-Down Converter Delivers 5V at 4A from Inputs Up to 60V

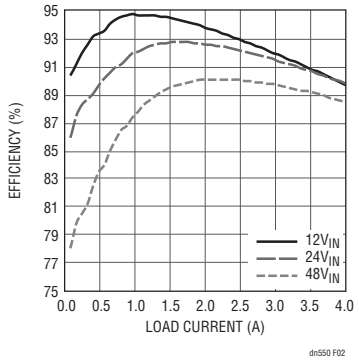

Figure 2. Efficiency vs Load and Input Voltage for Circuit in Figure 1

Figure 3 shows the LTC3649 in an application with cable drop due to a remote load. This approach can be used in systems which do not have additional remote sense wires in long power cables. The circuit takes advantage of the current monitoring terminal IMON and the ability set the output voltage with an external resistor.

In this example, two 0.1Ω resistors simulate the impedance of the power wires in a long cable. Resistors R_{C1} and R_{C2} set the voltage reference and are fed by two current sources: from pin I_{SET}, a constant 50µA, and from pin IMON, a current proportional to the output current. Increases in the load current proportionally change the voltage on the V_TERM output, but the load voltage at the end of the cable remains unchanged, as shown in Figure 4. A similar approach can be used for remote sensing. See the LTC3649 data sheet for details.

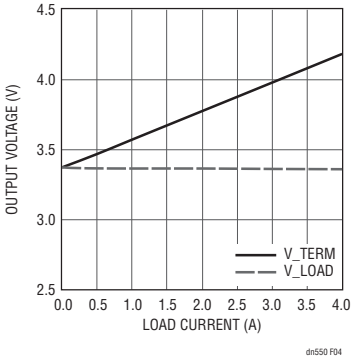

Figure 4. Cable Drop Operation Load Curves

Conclusion

LTC3649 is a highly integrated, high performance step-down regulator, with the input and output ranges that enable it to satisfy the requirements of industrial test and measurement, and transportation applications, as well as regulating solar panels and portable devices.

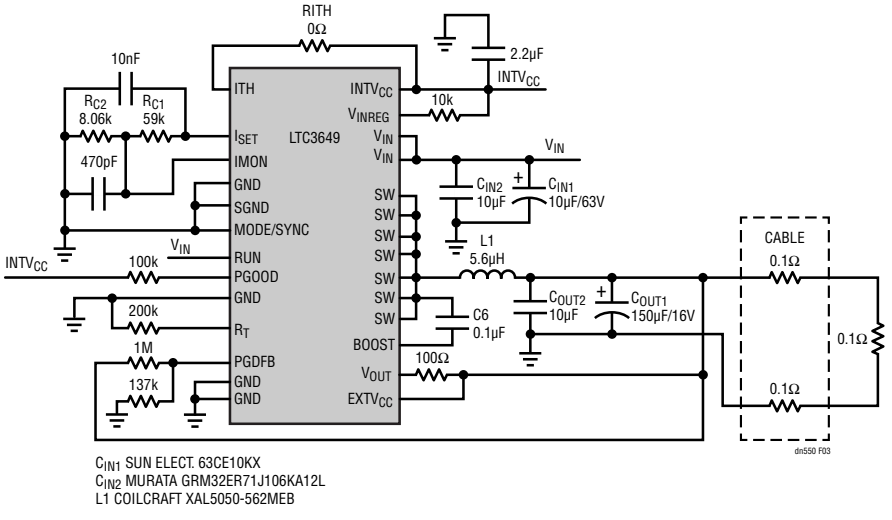

Figure 3. The LTC3649 Can Provide Cable Drop Compensation for Long PCB Traces

Data Sheet Download

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MARIA GUERRA | Technical Editor

What Trends Emerged at APEC 2016?

Here's a closer look at some of the many power semiconductor devices and power solutions that debuted at this year's Applied Power Electronics Conference.

The Applied Power Electronics Conference (APEC) offers networking opportunities to meet or reconnect with the industry's best and brightest people. It's also the place to become familiar with the latest products in the power electronics industry. This year, it was interesting to see how gallium-nitride semiconductor technology has started to outperform silicon technology. GaN devices are steadily emerging across several markets, such as automotive (e.g., LIDAR sensors and wireless chargers).

MOSFETs AND IGBTs

MOSFETs and IGBTs once again had a big presence at APEC. They are commonly found in applications such as motor drives, uninterruptible power supplies (UPS), and solar inverters. Some innovations particularly made an impression:

Power Integrations announced its new power device for high-voltage applications, the 900-V InnoSwitch-EP IC *(Fig. 1)*. This device meets all international energy-efficiency standards, targeting power supplies operating from high-voltage dc and three-phase power sources. Applications include industrial, motor-drive, metering, and renewable energy.

The InnoSwitch-EP IC features an uprated, integrated 900-V power MOSFET that provides an operating margin for 450-V ac industrial systems, increasing reliability and operational life. The device works continuously with an input voltage of up to 450 V ac. An optional layer of undervoltage/overvoltage protection prevents the IC from switching and protects the circuit up to 650 V ac. The device boasts typical efficiency of 85%, which eliminates the need for heatsinks.

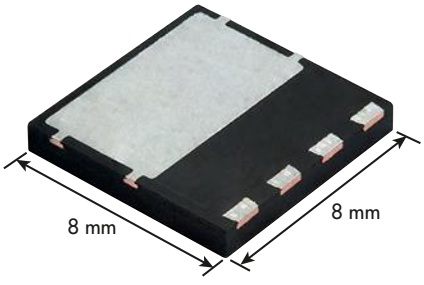
1. The 900-V InnoSwitch-EP works continuously with an input voltage of up to 450 V ac. *(Courtesy of Power Integrations)*

Vishay unveiled the 600-V E Series SiHH26N60E in a compact PowerPAK *(Fig. 2)*. It's 57% smaller than the TO-263 (D2PAK) at one-fifth the height. The device features a Kelvin source connection to increase efficiency by improving the gate-drive signal. Low on-resistance down to 0.135 Ω at 10 V minimizes conduction and switching losses.

Fairchild presented its newest generation of 100-V N-channel power MOSFETs, the FDMS86181 100-V Shielded Gate Power Trench. It reduces voltage ringing due to its 40% reduction in $R_{DS(ON)}$, which lowers conduction losses. Meanwhile, its minimized gate charge (Q_g) reduces switching losses.

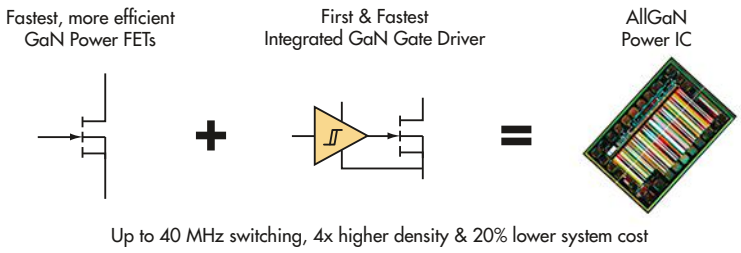
Renesas presented its 8th-generation G8H Series *(Fig. 3)* in the company's IGBT lineup (RBN50H65T1GPQ-A0). These transistors promise to minimize conversion losses in power conditioners for solar-power generation systems and reduce inverter applications in UPS systems by adopting an exclusive trench-gate configuration. The configuration involves the formation of deep, narrow grooves (trenches) in the chip surface, followed by the formation of MOSFET gates on the sides of the trenches. This

600 V E Series MOSFETs with
Kelvin Source Connection in Power PAK 8x8



2. The 600-V E Series SiHH26N60E can be used in wide range of applications, such as server and telecom power supplies, switch-mode power supplies, PFC power supplies, motor drives, PV inverters, etc. *(Courtesy of Vishay)*

3. Six new 650- V and 1250-V IGBTs for UPS or industrial inverters represent the first group of 8th-generation IGBTs from Renesas. Also in the works are 1800-V devices for wind-power generation or solar inverters, and 650-V (supporting over 50 kHz) products for air conditioning or induction heating.



4. The AllGaN monolithically integrated 650-V platform features 20X lower drive loss than silicon. *(Courtesy of Navitas)*

permits a higher cell density and contributes to lower on-resistance.

The 8th-generation IGBTs generate substantially less gate noise during switching due to small displacement current. This lets system manufacturers eliminate gate resistors to reduce noise.

GaN

The presence of gallium nitride was noticeable throughout the APEC event, particularly with regard to applications that exploited the multiple advantages of GaN semiconductors.

Efficient Power Conversion displayed a strong range of GaN applications from its customers. All of these applications leverage EPC's GaN products, which range from wireless power systems to dc-dc converters:

- *Envelope tracking:* A 4-phase buck converter using eGaN FETs enabled fast switching frequencies. The demo delivered 60 W and 20-MHz bandwidth that

5. Implementing a modular, configurable circuit design using standard components, Wolfspeed's evaluation unit can rapidly optimize three-phase SiC power module designs for performance, efficiency, thermal management, and circuit protection. *(Courtesy of Wolfspeed)*

was LTE-compatible. On the oscilloscope, it was possible to see how the envelope was successfully tracking the power demand.

- *DC-DC converters:* There was a 48-to-12-V dc-dc regulator converter on a brick format. Using eGaN FETs, it can reach 700 W. Also on display was a 48-to-1-V dc-dc—it used an 80-V, monolithic half-bridge IC, enabling use of lower-voltage devices.
- *LiDAR:* Thanks to eGaN FETs, a 3D real-time LiDAR imaging camera was able to switch faster-generating smaller and accurate pulses.

Navitas Semiconductor announced GaN power ICs that use its proprietary AllGaN monolithically integrated 650-V platform *(Fig. 4)*. According to the company, combining GaN power FETs with GaN logic and drive circuits enable higher switching frequency than existing silicon circuits. It comes in a 5- × 6-mm QFN package with a Kelvin source connection for gate-drive return.

Housed in a TO-247 package that reduces system volume up to 50% without sacrificing efficiency, Transphorm's 650-V TPH3207WS GaN FET features an on-resistance of 41 mΩ. By implementing continuous-conduction-mode (CCM) bridgeless totem-pole power-factor-correction (PFC) designs, the company claims designers can reduce overall power-supply losses by as much as 40% while achieving up to 99% efficiency.

GaN Systems showcased its customers' systems that are enabled by GaN transistors. It also displayed the Google's Little Box Challenge winning device (designed by CE+T Power using GaN Systems' GS66508P transistor). CE+T Power won by not only exceeding the required goal of 50 W/in.[3] by almost 3X, but also passing the rigorous system testing performed by NREL.

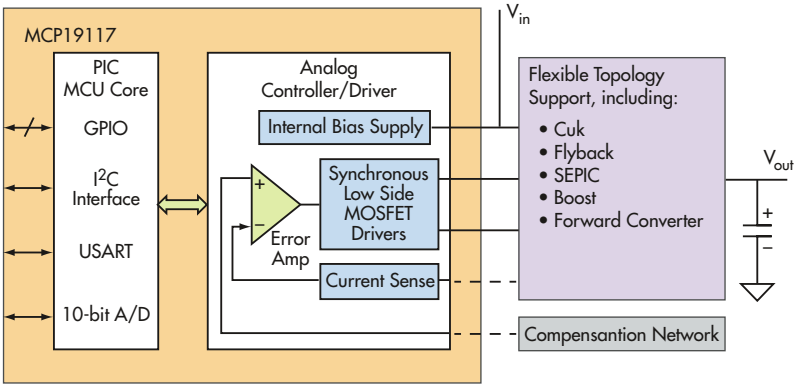
SiC

Wolfspeed demonstrated a board that enables power electronics designers to quickly evaluate the performance of

900-V C3M MOSFET technology in a surface-mount 7L-D2PAK package. The company also displayed a three-phase power evaluation unit that reduces the development time required to implement SiC power modules in a three-phase inverter *(Fig. 5)*.

A 1200-V silicon-carbide (SiC) diode, the FFSH40120ADN, is the first arrival in Fairchild's series of SiC solutions. The FFSH40120ADN diode has stable temperature characteristics that allow for high-temperature operation without increasing switching losses. Its minimized reverse-recovery charge (Q_{RR}) reduces switching losses and enables high-speed switching.

Monolith Semiconductor demonstrated its fast-switching SiC MOSFET by operating a 5-kW buck converter with 675-V nominal input and 350-V nominal output at high frequencies (~200 kHz). The converter's high efficiency (>98%) can't be achieved with silicon IGBTs, according to the company.



6. Microchip's MCP19117 is functionally equivalent to the MCP19116; however, the MCP19117 offers more GPIO and a debugging interface. *(Courtesy of Microchip)*

POWER SOLUTIONS

Texas Instruments introduced a 2.2-MHz, dual-channel synchronous buck converter with a unique set of features. The LM5140-Q1 supports up to 10-A dual-channel loads for high-end infotainment systems. Its adjustable gate-drive slew-rate control reduces EMI emissions and saves space in automotive supply systems. The device comes in wettable flank packaging that helps speed manufacturing. The LM5140-Q1's 8-pin VQFN housing measures 6 × 6 × 0.9 mm. The converter is designed to significantly reduce high-frequency noise in high-voltage dc-dc step-down applications such as automotive-infotainment and high-end cluster power-supply systems.

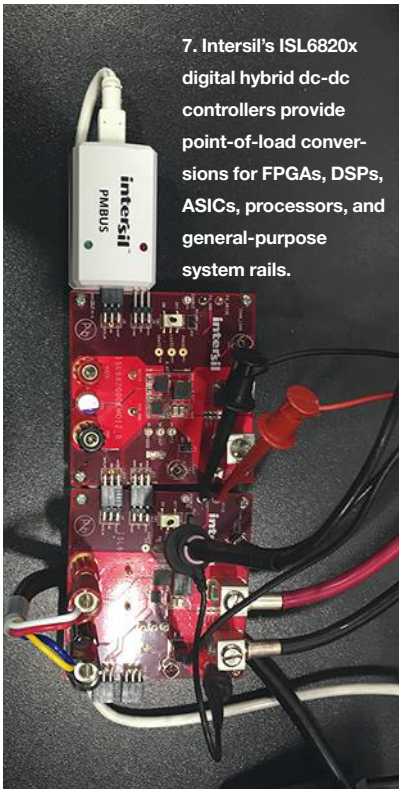
Microchip Technology announced a new digitally powered analog control-

ler. The MCP19117 is a mid-voltage (4.5 to 42 V) analog-based PWM controller designed for LED lighting *(Fig. 6)*. It has a fully integrated 8-bit PIC MCU core.

Infineon's Integrated Power Stages family, unveiled at APEC, comes in 50-A through 70-A current ratings (IR35412 and TDA21470). With power-efficiency ratings reaching 96%, the power-stage devices can be combined with the company's latest digital PWM power-management controllers to provide a full multiphase voltage-regulation system solution.

CUI and VPS demo'd their software-defined power that intelligently controls power performance across data centers, maximizing capacity use. It gives visibility to data centers and makes it possible to allocate utility budget cap per rack.

Two new PMBus-compatible, single-phase, digital hybrid dc-dc controllers were unveiled by Intersil *(Fig. 7)*—the ISL68200 with integrated MOSFET drivers and ISL68201 with PWM output. They help simplify power-supply designs for data-center routers, servers, etc.



7. Intersil's ISL6820x digital hybrid dc-dc controllers provide point-of-load conversions for FPGAs, DSPs, ASICs, processors, and general-purpose system rails.

Monolithic Power Systems' unveiled its new MPQ2314 at APEC. The high-frequency, synchronous-rectified, step-down switch-mode converter features internal power MOSFETs. The MPQ2314 maintains synchronous-mode operation for higher efficiency over output-current load range.

As we can see from this product rundown, MOSFETs and IGBTs still have a strong presence, while GaN technology has crept into more products within multiple markets. SiC research and development continues to mature, and its integration into more products in the future is all but certain. ed

WILLIAM WONG | Technical Editor

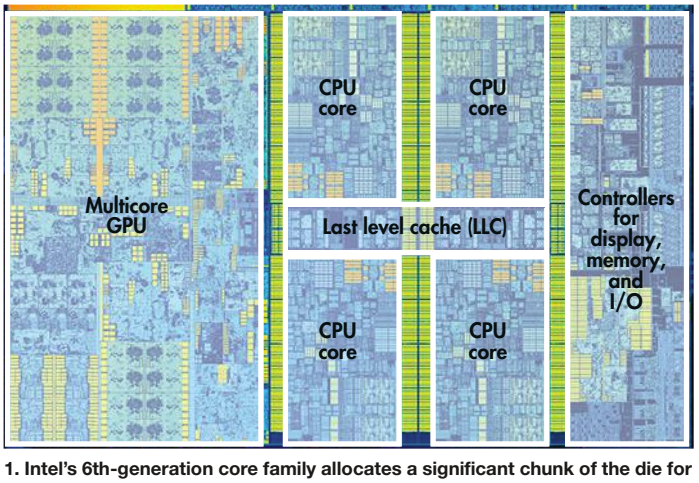
Processor Technology Puts Faith in Core Value

Vendors continue to grace us with new processors, but do they add any new technology or is it just repackaging? Find out about these latest enhancements and why they matter.

New processors continually emerge from the fabs, but the nagging questions surrounding these recent arrivals are whether they're actually faster, better, and/or more power-efficient. Generally speaking, the answer to all of them is yes. The degree of each depends on what design aspects are important to your application as well as the path taken from older to newer architectures.

The low end of the spectrum has enormous growth potential—these processors tend to be on the trailing edge of transistor technology and can exploit the work done to develop high-performance systems. It may be a while before an 8-bit microcontroller has 3D FinFET transistors *(see "16nm/14nm FinFETs: Enabling The New Electronics Frontier" on electronicdesign.com)*; however, they're already used with 32-bit designs.

Intel's 6th-generation platform, formally known as Skylake, is the current king in the desktop and mobile PC space. The 14-nm chip incorporates a Gen9 GPU that takes up a significant amount of die space *(Fig. 1)*. This reflects the importance of GPUs in interactive platforms: GPUs provide increased power since they're not limited to just displaying graphics.



1. Intel's 6th-generation core family allocates a significant chunk of the die for the GPU.

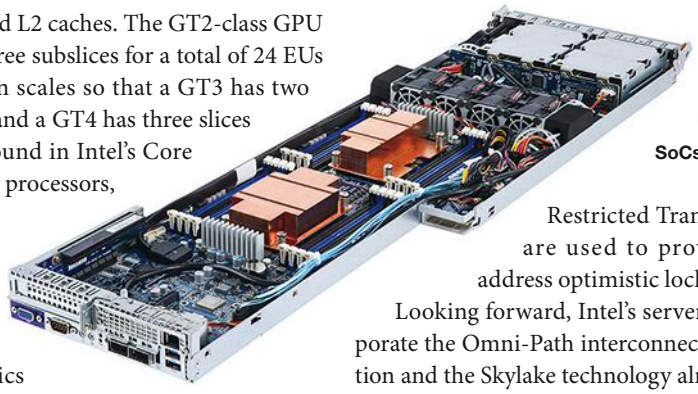
MULTICORE MOVEMENT

For practical purposes, heat and power have limited the top speed of a single core. Thus, designers use multiple cores to get more performance as transistors continue to shrink. The different system architectures affect the kinds of cores used and how many cores can be found on a single chip.

For example, Intel's Gen9 GPU is based on a subslice that contains eight execution

units (EUs) along with L1 and L2 caches. The GT2-class GPU has a slice that consists of three subslices for a total of 24 EUs and an L3 cache. The design scales so that a GT3 has two slices with a total of 48 EUs and a GT4 has three slices with 72 EUs. The latter is found in Intel's Core i7-6700K and Core i5-6600K processors, along with an L4 cache.

High-end graphics cards integrate GPUs with even more processing power, but these newer processor chips with integrated graphics are able to match the performance of dedicated, low-end GPU cards. AMD's APUs take a similar approach by incorporating high-performance GPU support with the CPUs.



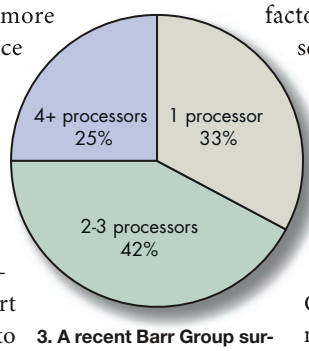
2. Gigabyte's H270-T70 motherboard integrates two Cavium ThunderX CN8890 SoCs, each with 48 cores.

ARM Cortex-A5x and Cortex-A7x platforms are making inroads into the conventional PC space for a variety of reasons, including low-power requirements. Microsoft Windows and the x86 platforms remain a dominant force. However, Linux-based tablets, smartphones, and compact PCs are being fueled by the ARM Cortex-A family. Some platforms, like the Cortex-A72, target these mobile devices.

Though quad to octal core is the norm for consumer and many embedded platforms, the server side has been taking on cores with a vengeance. The AMD Opteron 6300 series includes up to 16 cores, while the latest Intel Xeon E5-2600 v4 family will feature up to 24 cores running 48 threads.

Initially, the top-end EP series will have 22 cores. The Broadwell-EP architecture is implemented on the latest 14-nm technology. Base clock rates were reduced, but each core raises performance by about 5%. Therefore, more cores continue to deliver the major performance boost for the system.

Server platforms have differed significantly from their personal-computer counterparts. In particular, multichip solutions starting at 2P and 4P configurations employ a non-uniform memory access (NUMA) shared-memory configuration. In addition, each processor chip typically features four memory channels that support more dual-inline memory modules (DIMMs) to provide massive amounts of DRAM to the processor complex. Very large caches on the order of 50 MB help smooth out memory accesses.



3. A recent Barr Group survey indicates the majority of new projects will employ more than one core.

Server platforms often have instructions or support to accelerate applications that are less common on the PC side, such as database servers. One example is Intel's Transactional Synchronization Extensions (TSX). TSX can usually improve the number of database transactions per second by a factor of four and boost typical application execution by 40%. Instructions for Hardware Lock Elision (HLE) and Restricted Transactional Memory (RTM) are used to provide this support. They address optimistic locking and memory access.

Looking forward, Intel's server processor line will incorporate the Omni-Path interconnect fabric in the next generation and the Skylake technology already found in the PC side. Omni-Path is a switch-based fabric like InfiniBand, which has been popular in high-performance computing (HPC). Inclusion in the processor simplifies scaling and interconnects in large systems common in public and private clouds.

Intel's Xeon Phi *(see "ARMv8, GPUs and Knights Landing at ISC 2014" on electronicdesign.com)* will get a refresh this year. Its current incarnation already supports more than 60 CPU cores.

The other elephant in the server room is AMD's 64-bit ARM-v8 platforms from companies like AMD, AppliedMicro, and Cavium *(see "64-bit ARM Platforms Target the IoT Cloud" on electronicdesign.com)*. Though they have yet to challenge the top-end Xeon platforms in performance, they're making a difference in the low- to mid-range server market as well as in specialized areas like storage and network processing. These applications are actually more common than the high-end systems.

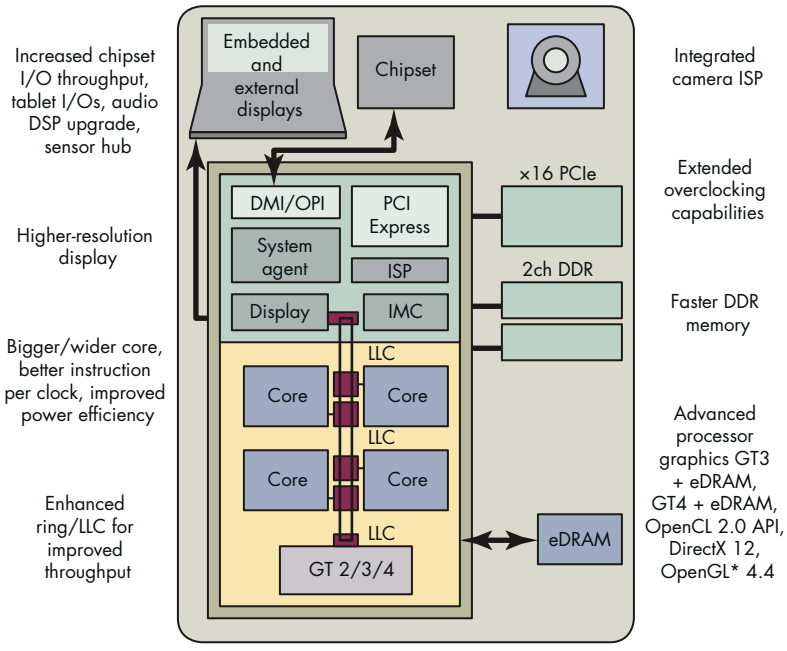
AMD's Hierofalcon features up to eight 64-bit Cortex-A57 cores using 28-nm technology, while AppliedMicro's Helix also has up to eight 64-bit cores. Typically, 10 Gigabit Ethernet is available on-chip along with PCI Gen 3, which is the de facto standard on all platforms from PCs through servers.

Cavium's ThunderX delivers up to 48 cores and 100 Gigabit Ethernet. Like AppliedMicro, Cavium has SoCs with multiple SATA interfaces to address network storage applications. Gigabyte's H270-T70 *(Fig. 2)* motherboard includes two Cavium 2.5-GHz, ThunderX CN8890 SoCs with 48 cores each. The Cavium Coherent Processor Interconnect (CCPI) connects the two SoCs together for a total of 96 cores that have access to 1 TB of 2400-MHz DDR4 DRAM. Four boards fit into a 2U server slot to provide 384 cores and 4 TB of memory. On top of that, each node maintains four hot-swappable SATA drives.

GPUs have come into their own as major compute platforms. Servers with multiple GPU boards are common for many HPC and specialized applications. It's possible to have a blended CPU/GPU like those on the PC side. However, for servers, it usually makes more sense to dedicate silicon and

board area to CPU or GPU support, enabling more power systems to be optimized for the application area. PCI Express is the usual interconnect mechanism.

Barr Group's latest survey *(see "What Does Your Company Do About Safety and Security?" on electronicdesign.com)* indicates that embedded developers are using multicore solutions in two-thirds of the new projects *(Fig. 3)*. It did not break out how these cores are connected and used, because scaling symmetrical multiprocessing (SMP) found in Intel and AMD CPUs differs from asymmetrical processing (AMP) in which cores are dedicated to different chores within the system. The cores could be the same, but are tailored to different jobs, such as a DSP core for a motor-control application or a packet processor to work on network traffic.



4. Improvements to Skylake included the addition of eDRAM.

PROCESSOR ENHANCEMENTS

Intel's Skylake delivers 2.5 times the productivity compared to a five-year-old mobile PC, let alone three times better battery life, 30 times better 3D graphics, and instant-on capabilities due to flash-memory support.

It's all very good, but one thing is missing—faster processor cores. The latest arrivals tend to be faster, but not by factors as significant as those just mentioned. Nonetheless, a lot has changed under the hood.

Of course, the GPU is one of the major changes with Skylake, but other key upgrades include eDRAM *(Fig. 4)*. The eDRAM is on-chip memory that comes in 64- or 128-MB versions. The approach is similar to AMD's high bandwidth memory (HBM) used on its latest Radeon R9 GPU *(see "High-Density Storage" on electronicdesign.com)*. It brings more, faster memory closer to the cores. Other platforms, such as IBM's POWER7, have incorporated eDRAM, too. Skylake uses an enhanced ring architecture to link eDRAM, the last level cache (LLC), and the CPU and GPU cores together.

AMD's A-series application processing units (APUs) targeted at PC applications now incorporate a security module based on an ARM Cortex-A5. The Platform Security Processor (PSP) implements ARM's TrustZone security technology that manages the host, x86 core, and GPU in an APU *(see "Platform Security Processor Protects Low Power APUs" on electronicdesign.com)*. Most processors intended for the PC market, and all for the server market, feature improved security technology.

On the server side, more cores is a given. However, the Xeon E5-2600 v4 also increases key encryption-algorithm performance by 70%. New instructions include ADCX/ADOX (large integer adds) and PCLMULQDQ (carryless multiplication quadword) help with algorithms like RSA, ECC, and Secure Hash Algorithm (SHA). There's also a hardware random number generator on-chip.

Another major difference on the server side is resource management, which is normally automatic on the PC side as well as for many embedded platforms. An example is Intel's Cache Monitoring Technology (CMT). CMT tracks cache usage so that a system administrator could track per-VM (virtual machine) resource usage, making it possible to adjust scheduling policies and address contention issues if needed. It can also be used to deliver tiered service classes. Moreover, CMT could be beneficial in embedded applications with remote-management capabilities, or to guarantee cache support for high-priority applications.

Intel's Memory Bandwidth Monitoring (MBM) focuses on the L3/memory interface and provides similar tracking to CMT. NUMA optimizations can be addressed with information from MBM.

Common instruction sets allow many applications to run equally well on PC and server-class processors. As noted, though, major differences exist between the two. Newer processors are all reaping the rewards of lower power technologies and better security, but the method of implementation, scale of the support, and level of control differ significantly.

Server-class platforms benefit from additional CPU cores, and by separating the GPU, they can be added and scaled independent of the CPU cluster. There are advantages to the CPU/GPU combination, with the GPU improvements providing the biggest performance boost on the PC side. And don't forget that the move to 4K displays will also drive higher-performance GPUs. ed

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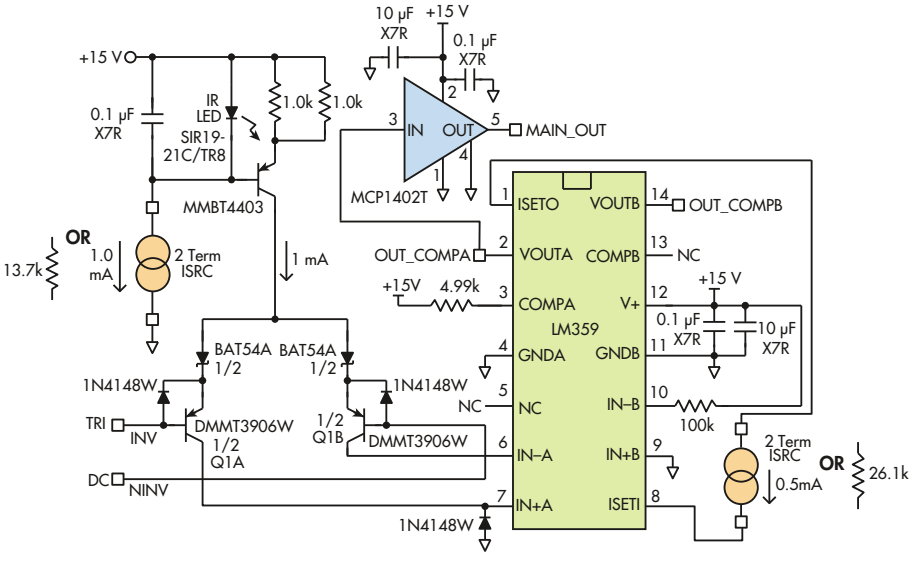
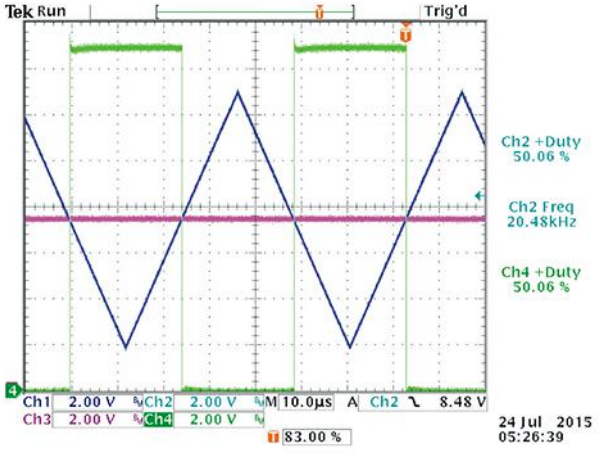


1. The schematic and text include several circuit options (current source, transistor bias).



2. CH1 (dark blue) is the triangle to the input stage's inverting terminal; CH2 (light blue) and CH4 (green) (on top of each other) are the square-wave outputs of the MCP1402Ts; and CH3 (pink) is the half-supply dc-voltage level to the input stage's non-inverting terminal.

DUAL PRECISION COMPARATORS are needed in many designs, such as for industrial and instrumentation applications, to generate accurate pulse-width-modulated (PWM) waveforms with very high (>99%) and very low (<1%) duty-cycle percentages. This design idea (*Fig. 1*) improves on designs based on the common LM311 and LT1011 devices, both of which require resistor pull-ups and have asymmetric timing paths. The features of this new design include matched, short propagation delays (T_{pd}); accurate duty-cycle generation; push-pull, rail-to-rail output; and operation from a supply above 15 V.

The circuit is based on the LM359 high-speed video op amp with an additional bipolar PNP input stage, and an MCP1402T output driver powered with a single +15-V supply. The LM359 is used to get a high-speed "IC Process" device to meet a comparator's specifications. This IC also permits design changes at a low level because it has both input and output programming-current pins, and the compensation node is available as well. Input and output programming currents are driven by a 0.5-mA source.

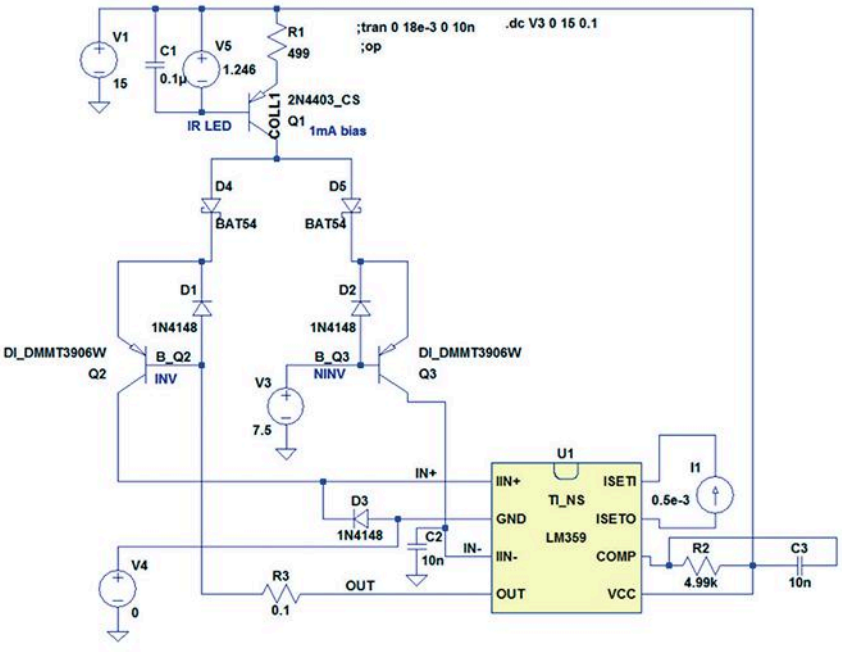
Since this op amp is a dual device, one half is connected as a comparator and the other half remains as a spare. A spare is shown to define its connections. A transconductance stage is placed ahead of the LM359's current-mode input to enable a voltage-mode input. The gain is reduced at the cascade stage's high-impedance node (COMP pin) by the 4.99-kΩ resistor. A capacitor in parallel with the resistor also controls the bandwidth of the LM359. The IN- terminal of the LM359 is an additional high-impedance node and it, too, can be locally compensated to GND. (Figure 43 of the LM359 datasheet, "Adding a JFET Input Stage," helped spark ideas for the input stage.)

The output of the LM359 is connected to the input of the MCP1402T, a device that can drive rail-to-rail and drive capacitive loads very well. The LM359's supply voltage can even be set to a lower voltage level and the MCP1402T can still be set to drive to a 15-V output level. The maximum supply voltage of the comparator is limited by the MCP1402T to 20 V dc, which means that it can be used for 18-V designs.

Using a higher supply voltage improves signal-to-noise ratio (SNR), as there is a larger signal for a given amount of noise. In addition, large input signals dominate any voltage-offset terms, which is an advantage of using the higher voltage supply. (Note that the output polarity can also be easily changed on a fabricated printed-circuit board by using a MCP1401T in place of the MCP1402T.)

The circuit uses both 1-mA and 0.5-mA (two-terminal) current sources. In the original design, custom sources were used, but resistors can be used in their place (although with a reduction in supply rejection performance). An LM334 is also an option, as well as a JFET with a source resistor to control V_{GS}. The 1-mA current biases the SIR19-21C/TR8 IR LED; a 1.2-V shunt voltage reference can be used in place of the IR LED. The 1N4148W diodes at the transconductance input stage protect against reverse-biasing at the emitter-base junctions, while the BAT54A prevents current from one side or the other of the differential pair adding to the tail current.

Table 1 shows the measured results of this circuit, and *Fig. 2* shows measurements of key nodes in the comparator and the matching of both comparators. The measured propagation-delay mismatch causes the 0.06% offset from 50% duty cycle. Several simulations were also done for this circuit, using the Spice circuit of *Fig. 3* to simulate systematic V_{OS} and I_{IN} over the input-voltage range.



3. This simulation schematic was used for Spice modeling for systematic V_{OS} and I_{IN} over the input-voltage range.

MEASURED RESULTS		
Spec	**Measured Number**	**Notes**
V_{OUT} T_r	5.6 ns	Main output driving 10x scope probe
V_{OUT} T_f	3.3 ns	Main output driving 10x scope probe
I_{SUPPLY} at 15 V	12.4 mA	With half of LM359 as comparator and the other half as spare
I_{SUPPLY} at 15 V	21.8 mA	With both sections of the LM359 used as comparators
Input V_{OS}	<=0.5 mV	One-half supply to Q1B base non-inverting terminal (see note)
T_{pd1}, out rise	100 ns	Square wave to Q1A base inverting terminal, half supply to Q1B base non-inverting terminal
T_{pd2}, out fall	133 ns	Square wave to Q1A base inverting terminal, half supply to Q1B base non-inverting terminal
I_{VR}	0.4 V ≤ I_{VR} ≤ 13.4 V	15-V supply; simulation gives 0.4 V ≤ I_{VR} ≤ 13.4 V; calculation estimate was 0.5 V to 13 V (see note)
I_{IN} over I_{VR}	2.6 µA ≤ I_{IN} ≤ 4.5 µA	15-V supply; I_{IN} is out of PNP's base (see note)
V_{OS} over I_{VR}	1.81 mV ≥ V_{OS} ≥ –0.70 mV	Input swept from 0.4 V to 13.4 V (see note)
+Peak duty cycle	99.2%	Matched duty cycle, triangle and sine-wave inputs used
–Peak duty cycle	0.85%	Matched duty cycle, triangle and sine-wave inputs used
Timing jitter	≤200 ps	Measured result from Yokogawa TA320, due to its timing-resolution and rms-jitter floor; 1-MHz low-jitter square wave at input.

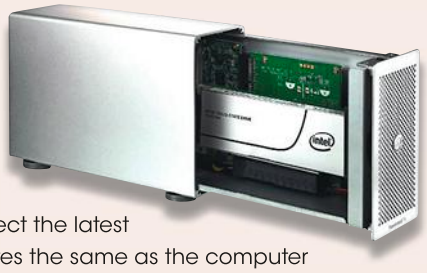
Note: LM359 in unity gain. MC1402T not included as it has hysteresis. Per compensation: 10-nF NP0 in parallel with 4.99k on LM359 COMP pin, 10-nF NP0 from LM359 IN- to GND.

TIM DAVIS graduated with a BSEE from Iowa State University in Ames, Iowa. He has more than 28 years of experience in analog circuit design, power electronics, and IC design, including several patents for electronics in the medical industry. He can be reached at tdavismn@gmail.com.

New Products

Storage Device Combines 750 NVMe SSD with 40 Gb/s Port

THE THUNDER3 PCIE SSD external storage device, manufactured by AKITIO for high-speed transfer of large files, is the first to combine the full PCIe Gen3 x4 bandwidth of Intel's 750 NVMe SSD with Thunderbolt 3's 40 Gb/s port, resulting in 2.5 GB/s of performance with a storage capacity of 1.2 TB. About 8x faster than USB 3.1 Gen 1, the PCIe SSD features two Thunderbolt 3 Ports as well as a DisplayPort video output to connect the latest 4K displays. The second port operates the same as the computer port by supporting USB 3.1 (up to 10 Gb/s), DisplayPort monitor or up to five daisy-chained Thunderbolt 3 devices.



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NATIONAL INSTRUMENTS IS NOW OFFERING an enhanced version of their InsightCM Enterprise online fleet-wide monitoring software that helps companies gain insight into the health of capital equipment for machine maintenance and operations. The new version is an end-to-end software solution that addresses some of the growing challenges in the asset monitoring industry. NI IIoT technology platforms, such as InsightCM, DIAdem and CompactRIO, include distributed sensor measurement, edge processing, analytics and open communication and data management. These features help solve Big Analog Data problems by delivering timely information rather than large volumes of unfiltered data.

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360-Deg. Continuous-Travel Rotary Stages Boast High-Precision

GRIFFIN MOTION'S HIGH-PRECISION, 360-deg. continuous-travel RTS-DD Series rotary motion platform now features the RTS-DD-100-M-D-A-P-0-00 with a compact, low profile design and a brushless direct-drive servo motor that eliminates backlash and improves reliability by eliminating sliding friction throughout the stage. Exhibiting 30 arcsec angular accuracy, 3 arcsec repeatability, and 0.324 arcsec resolution, in addition to 480 deg/s angular velocity, 5 µm axial and radial run-out, and 10 arcsec wobble, the rotary stage is suited for use in a variety of laboratory, factory automation, and semiconductor processing applications, including inspection, laser marking and machining, and rate table, pan-and-tilt, and beam-steering operations.

GRIFFIN MOTION

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FPGA SoM Features Low Power and Secure DSP

THE SXOM-SF2 FROM SOLECTRIX is a high-performance, low-power, secure and ultra-compact DSP SOM based on Microsemi's SmartFusion2 SoC FPGA devices. The DSP SOM with a SmartFusion2 SoC FPGA and DDR3 memory, enables numerous higher performance applications to be readily built. The device functions as a modular system core for high performance DSP applications and uses a carrier board with a PCIe interface to enable high-speed streaming of processed data to the host (PCIe streaming server). The SmartFusion2 SoC FPGA combines a flash-based FPGA fabric featuring 56K LEs with an ARM-based hard processor system running at 166 MHz.

MICROSEMI

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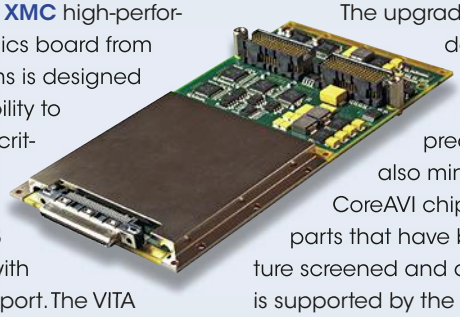
High-Performance Graphics Board Targets Safety-Critical



THE XMCGA8 XMC high-performance graphics board from Abaco Systems is designed to offer the ability to deliver safety-critical applications certified to DO-178 and DO-254 with long term support. The VITA 42-compliant board is available with the AMD/CoreAVI Radeon E8860 'Adelaar' GPU, enabling it to deliver twice the graphics throughput of its predecessor, the XMCGA7. The upgrade can also deliver twice the performance/slot of its predecessor, while also minimizing TDP. The CoreAVI chip set features parts that have been temperature screened and qualified, and is supported by the necessary low level OS graphics drivers (OpenGL) for VxWorks 6.9 and VxWorks 653 safety-critical applications.

ABACO SYSTEMS

https://www.abaco.com

MCUs Utilize Latest 65 nm Flash-Embedded Logic

A NEW GROUP OF 30 MCUs from Toshiba America based on the ARM Cortex-M3 core for embedded 32-bit microprocessors are the first product group in the TXZ Family of products, and are Toshiba's first MCUs to be fabricated with an embedded flash-memory process based on the 65 nm logic process. The MCUs incorporate high-performance analog circuits and a range of basic functions required to support comprehensive motor control and consumer and industrial device applications. The devices operate at up to 40 Mhz, and the lineup includes low-pin-count packages (32 to 100 pins) and small flash-memory sizes (32 to 128 KB).

TOSHIBA AMERICA

http://toshiba.semicon-storage.com/us/top.html

ED 7/16 ISSUE PREVIEW

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TECHNOLOGY:
Top 101 Components
Communication

INDUSTRY TRENDS
Computer Interconnects

PRODUCT TRENDS
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ENGINEERING ESSENTIALS
Power

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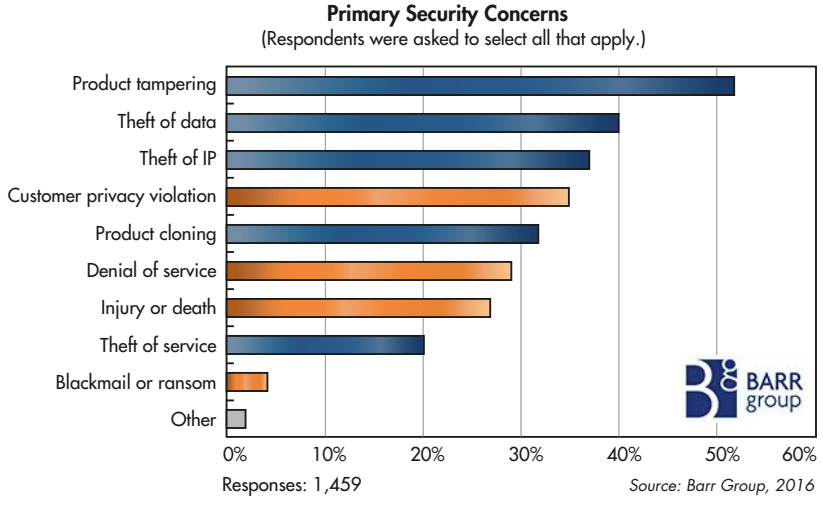
What Does Your Company Do About Safety and Security?

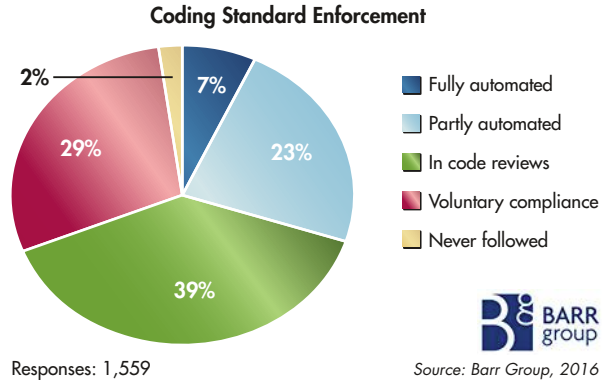
The Barr Group's latest survey of embedded programmers reveals some interesting statistics about safety and security in current development.

The Barr Group's latest survey results (*see http://www.barrgroup.com/Embedded-Systems/Webinars/Survey-Results-2016*) from embedded programmers reveals some interesting statistics about safety and security in current development. I have taken a closer look at the results (*see "Barr Group Survey Results Reveals Embedded Safety and Security Trends" on electronicdesign.com*) and a couple stand out. The average years of experience of the responders was 15.9 years.

The results from the question about primary security concerns (*Fig. 1*) indicate that product tampering, cloning, and theft of IP are high on the corporate priority list. These are important issues, but they do seem to play second fiddle to customer-related concerns highlighted in orange, such as injury and death.



1. These are the primary security concerns from the Barr Group's latest embedded developer survey.



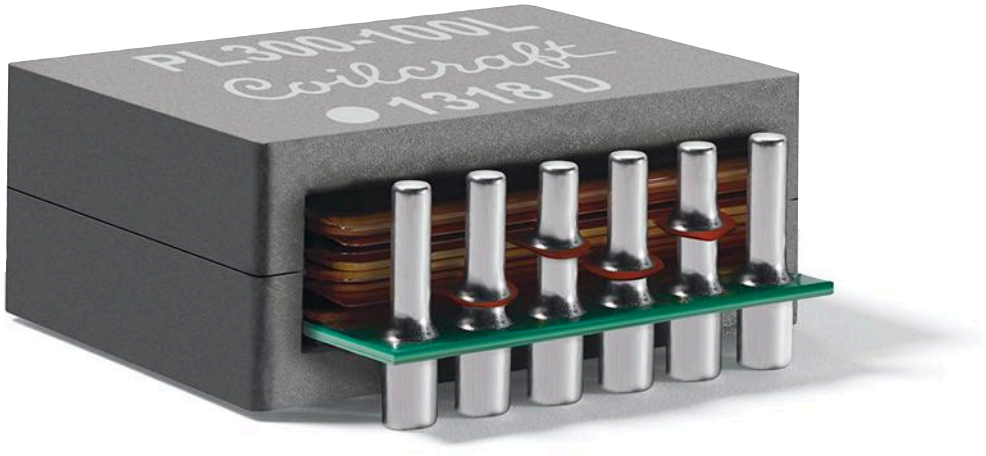
2. Most developers are using manual techniques to check their code.

The problem is that developers have a finite amount of resources and protections against cloning and IP theft, but do not always help improve a product's overall safety and security. The bigger question is whether companies limit their security support to only addressing these types of issues.

The other aspect that jumped out at me was code-standard enforcement (*Fig. 2*). Only a small fraction utilize fully or partly automated compliance. Code reviews and voluntary compliance made up the bulk of the responses. I do find code reviews useful, but they are better used to finding architectural bugs. Software tends to do a better job at finding compliance issues. The usual reason for coding standards is to reduce errors due to improper usage of tools. Unfortunately, C remains the dominant embedded tool and C allows a programmer to easily make mistakes that automated tools can catch.

No survey can capture all the nuances of engineers, but it is definitely worth looking at the details of what the Barr Group has come up with. ED

300 Watts. Zero Wait.



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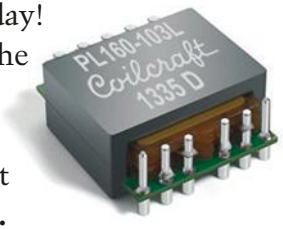

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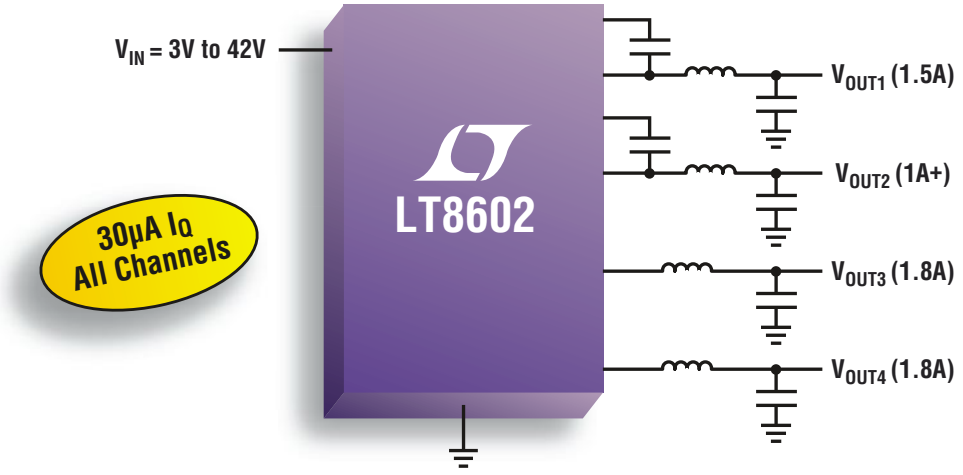
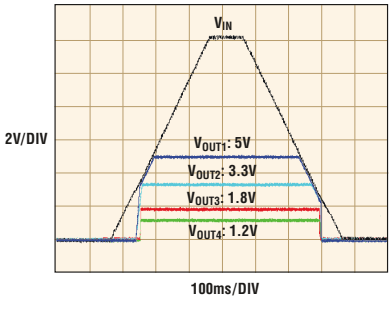


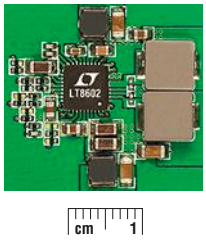
93% Efficient, High Step-Down Ratios & Small Solution Size

The LT®8602 brings a new level of integration to 42V input monolithic multiple output synchronous buck converters. Channel 1 delivers up to 1.5A of continuous output current, channel 2 can deliver over 1A depending on the configuration, and channels 3 and 4 can deliver up to 1.8A each. Channels 1 and 3 operate 180° out of phase from channels 2 and 4, further reducing input ripple. In Burst Mode® operation, the LT8602 requires only 30µA of quiescent current with all channels on, thereby extending battery life. For high step-down ratio applications, the LT8602 can operate from 16V down to 0.8V at a switching frequency of 2MHz. And each channel's dropout voltage is only 200mV at 1A outputs.

LT8602 Dropout Performance



LT8602 Demo Circuit
(Actual Size)



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