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THE AUTHORITY ON EMERGING TECHNOLOGIES FOR DESIGN SOLUTIONS

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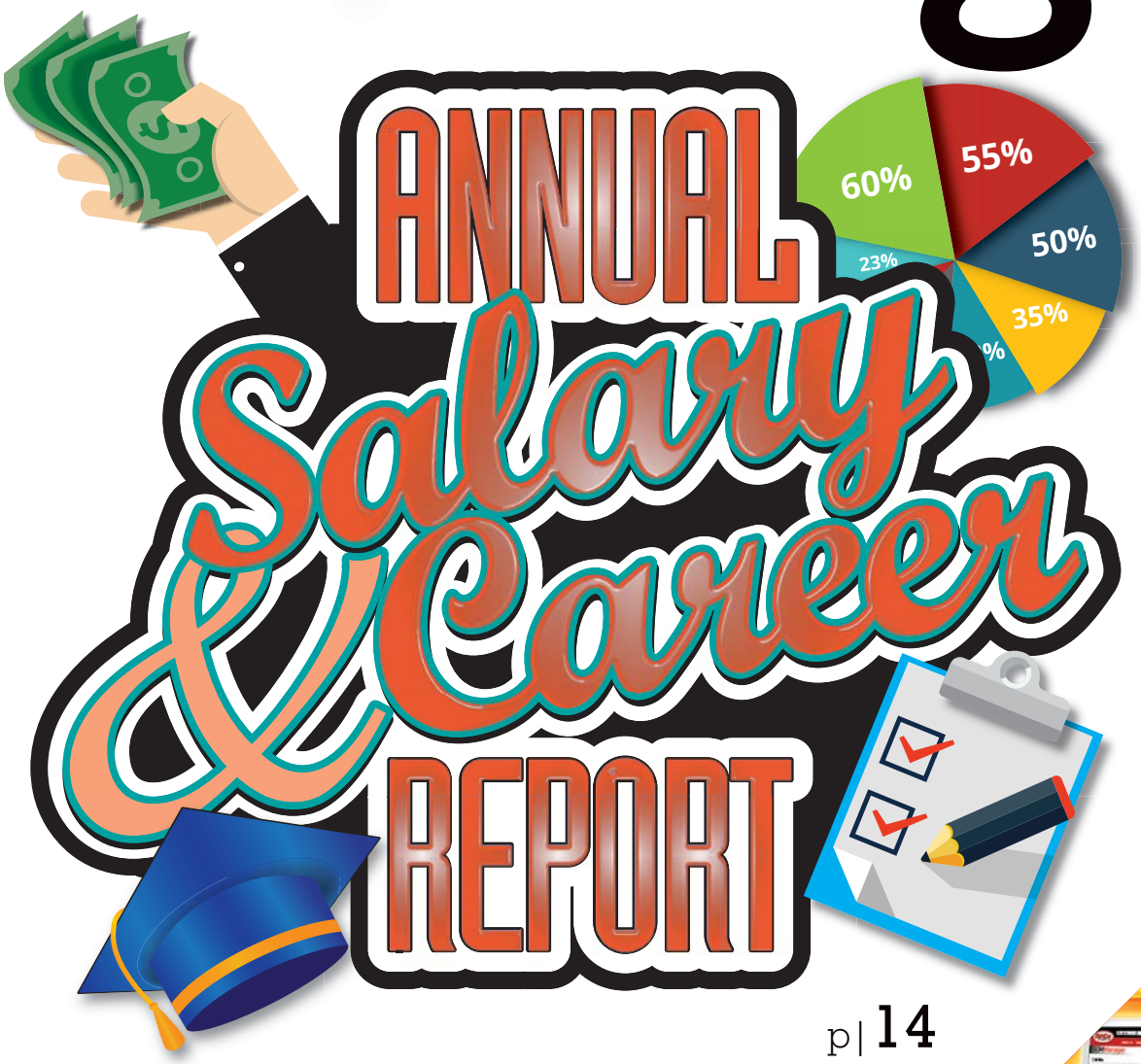

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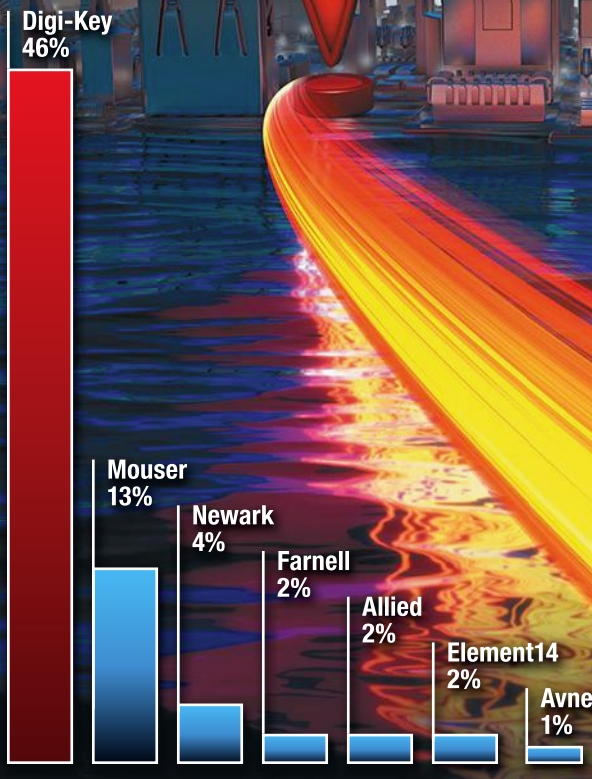

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*AspenCore's 11th Design Engineer and Supplier Interface Study gathered information from engineers regarding their need for product information and other services, as well as how and when they interface with suppliers and how they see the quality and value of that interface. 1,750 U.S. engineers participated in this year's web-based survey. The results represent those surveys completed by April 2016.

When asked "Easy to navigate website?" The chart above shows the results among the industry's electronic component distributors.

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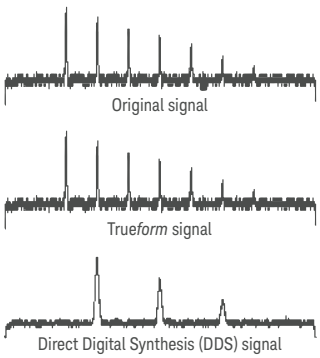

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While engineers in our survey report higher salaries, competition for jobs intensified, outsourcing continued unabated, and continuing education remains a difficult chore.

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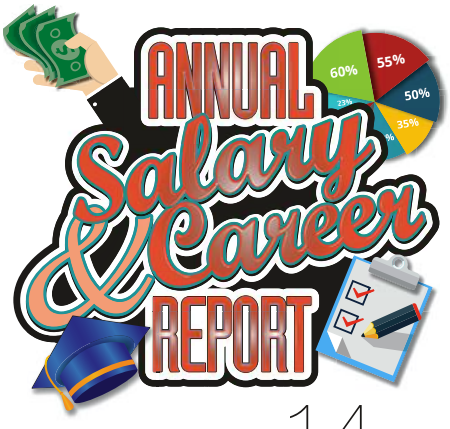

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EDITORIAL MISSION:
To provide the most current, accurate, and in-depth technical coverage of the key emerging technologies that engineers need to design tomorrow's products today.

ELECTRONIC DESIGN (ISSN 0013-4872) is published monthly by Penton Media Inc., 9800 Metcalf Ave., Overland Park, KS 66212-2216. Paid rates for a one-year subscription are as follows: $120 U.S., $180 Canada, $240 International. Periodicals postage paid at Kansas City, MO, and additional mailing offices. Editorial and advertising addresses: ELECTRONIC DESIGN, 1166 Avenue of the Americas, New York, NY 10036. Telephone (212) 204-4200. Printed in U.S.A. Title registered in U.S. Patent Office.

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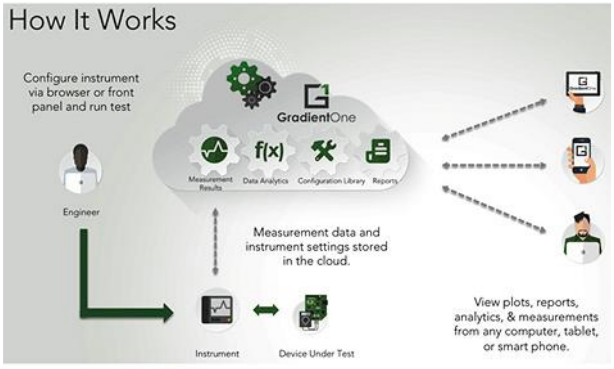
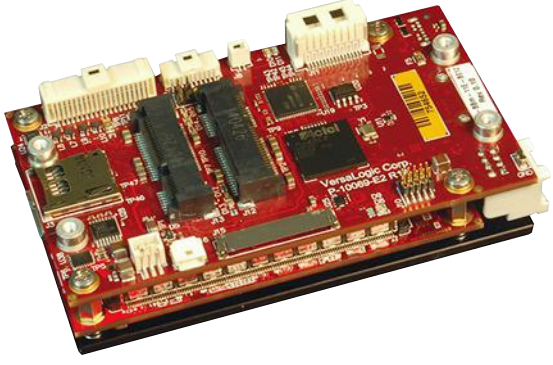


5 TIPS TO AUTOMATE YOUR LAB USING THE CLOUD

http://electronicdesign.com/test-measurement/instruments-and-cloud-5-tips-automate-your-lab

Cloud computing coupled with modern-day web browser capabilities represents a tool in the engineer's arsenal to automate lab instruments, accelerate time to market, and build better products. Here are five tips using Gradient Inc. software to help you start taking advantage of cloud capabilities.



PLATFORM CHOICES FOR EMBEDDED DESIGNERS

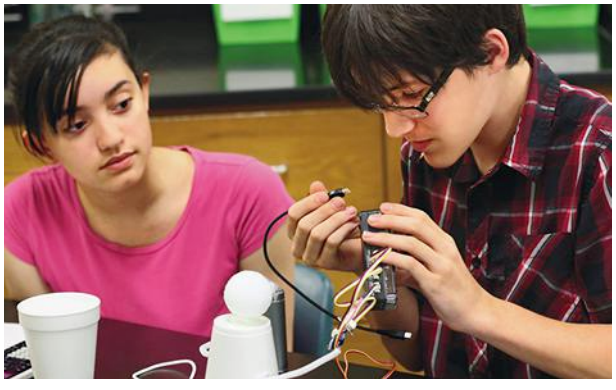
http://electronicdesign.com/boards/plenty-platform-choices-embedded-designers

Developers have a wide range of choices when it comes to industrial single-board computers. In last month's cover story, we examined many of the options available. If you missed it, check out the article online now.

THERE'S NO STOPPING SELF DRIVING CARS

http://electronicdesign.com/blog/self-driving-cars-are-coming-whether-you-it-or-not

Despite the naysayers, Tech Editor Bill Wong writes in his latest blog, "We are not going to be able to forget this 'self-driving car nonsense.' It is coming whether we like it or not. We can only hope that it winds up being safe enough to live with."



TAKING OVER WHERE HEATHKIT LEFT OFF?

http://electronicdesign.com/microcontrollers/have-chip-vendors-taken-over-where-heathkit-left

Texas Instruments' TI-Innovator Hub targets the classroom and STEM education with its new LaunchPad Board—perhaps filling a need left by the departure of Heathkit and its educational platforms.

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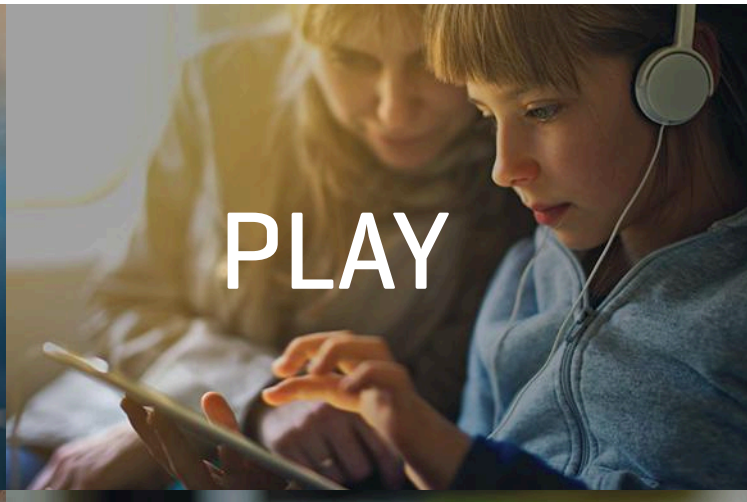

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WILLIAM WONG | Embedded/Systems/Software Editor
bill.wong@penton.com

Stacked Memory

Because it provides a significant boost in capacity, 3D memory is now the norm for flash and DRAM.

3D chip technology is pushing the envelope in the memory industry. The latest multilayer non-volatile solutions include 64-layer NAND flash memory from Toshiba, Western Digital, and Micron. Toshiba is sampling its 64-layer, BiCS Flash that uses its triple-level cell (TLC) technology. A single chip packs 32 Gbytes of storage. Chips with twice that capacity are on the roadmap using the same 64-layer architecture.

Stacking DRAM has been part of the high-bandwidth memory (HBM) systems found in high-end GPUs like AMD's R9 Radeon (*see "Best of 2015: High Bandwidth Memory Helps GPU Deliver on Performance" on electronicdesign.com*) and NVidia's latest Tesla P100 (*see "GPU Targets Deep Learning Applications"* on *electronicdesign.com*). HBM takes advantage of both 3D stacking and a wider, on-chip memory bus, greatly increasing bandwidth and capacity.

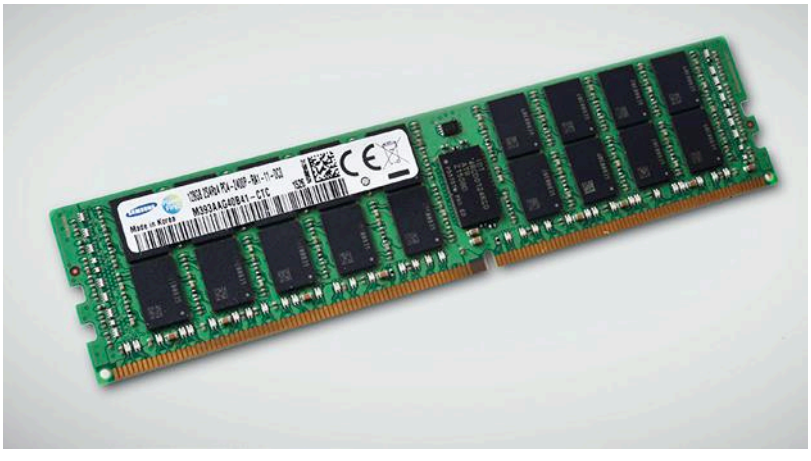
SAMSUNG STACKS UP

DRAM is not to be outdone, but it is trailing in stack size. Samsung's latest 128-Gbyte DDR4 memory *(see photo)* uses a four-level stack. Many multilayer memory devices employ a bonded stack where each chip is wired to the base in the same fashion that a single die is wired. This requires that connectivity be done at the edge of the chips. Newer devices, including Samsung's DRAM, employ through-silicon vias (TSVs). This is comparable to through-holes in a printed circuit board (PCB). It has multiple advantages, including the ability to place holes almost anywhere on the die. Samsung's roadmap has eight- and 16-layer devices on it.

The number of layers varies with each type of device because there are other issues than just 3D stack connectivity involved in the design process. For example, DRAM operates at faster speeds than flash memory.

Still, there are more advantages driving the migration to higher stacks, including power savings and increased bandwidth. The trend toward massive in-memory databases is pushing capacities on the server side, while more compact platforms are pushing the technology in the embedded space.

There may be a limit to the number of layers that are practical, but for now we have not reached that limit.



Samsung's 128 Gbyte DDR4 DIMM internally uses a four-level silicon stack linked via through-silicon vias (TSVs).

News

Renesas Clinches $3.2 Billion Deal FOR INTERSIL

The battle over chips used inside electric vehicles and self-driving cars is growing more competitive. Last month, Japanese chipmaker Renesas said that it was paying $3.2 billion to acquire Intersil, in the latest example of the industry's retooling for automotive and industrial electronics.

The deal unites two companies tackling automotive electronics from different angles. Renesas is one of the biggest makers of microcontrollers, or chips that are embedded in vehicles to control things like power steering and dashboard displays. The California-based Intersil makes chips that limit the amount of power consumed by microprocessors, as well as the analog chips that translate physical things like light and sound into digital signals.

Bunsei Kure, Renesas' chief executive, said that both companies produced complementary products. In a conference call following the deal's announcement, Intersil executives said that chips from both companies could be combined into complete systems: microcontrollers to carry out tasks, analog chips to handle sensor data and displays, and special circuitry to lower the system's power consumption.

The acquisition is the latest sign of Renesas' turnaround, following a devastating earthquake in 2011 that shut down many factories in Japan and forced auto plants around the world to throttle production. The fallout from the quake brought Renesas—which was formed in 2010 from the semiconductor units of Mitsubishi Electric, NEC, and Hitachi—to the brink of collapse. It consolidated chip factories, cut jobs, and sold businesses to stay afloat.

In 2012, a government investment fund and several major customers, including Toyota and Nissan, bailed out Renesas. With the investment, the chip maker refocused its business on power and analog chips that could be paired with its microcontrollers inside cars and industrial equipment.

Intersil, too, has placed bets on the automotive industry in an attempt to counteract the slowing growth of smartphones and computers. It has shifted more of its business into technology that handles dashboard displays and manages battery life in electric cars.

Intersil is the latest chipmaker to vanish in the semiconductor industry's recent wave of consolidation. Big chipmakers are buying up competitors in slightly different fields to expand scale, reduce costs, and sidestep the costly process of designing analog chips. A recent example was Analog Devices' unprecedented acquisition of Linear Technology for $14.8 billion in July.

The acquisition came on the heels of other major deals by Renesas' competition: NXP's acquisition of Freescale last year and Infineon's absorption for International Rectifier in 2014. Both moves pushed Renesas down the list of the world's biggest auto chip suppliers.

The deal ends a month of speculation about Intersil's fate, when in August a Japanese newspaper reported that the two companies were in talks. Other reports came out that Maxim Integrated was placing a competing bid for Intersil.

One of the stumbling blocks to the deal is Intersil's military and aerospace business. Transferring that part of the company outside of the United States would be subject to regulatory approval. The companies expect the deal to close in early 2017. ■

INTRODUCING A DATABASE FOR
Power-Supply Safety Standards

AN ENGINEERING TRADE association is building a database of safety standards for power supplies. It is the latest attempt to keep engineers updated on such regulations, a task that has been relegated to individual companies and safety agencies for years.

The group, the Power Source Manufacturers Association *(http://www.psma.com/)*, announced the general availability of the new Safety and Compliance Database, which can be accessed for free on its website. The group said that it would update the database to reflect the latest power supply standards, including ones for current leakage, wire insulation, and material toxicity.

The purpose of the database is to help professionals and engineers to sort through the growing number of safety regulations that exist for power supplies. And failing to meet these standards can have negative consequences. If products are not certified to the standards of many different countries, they can be disqualified from being sold internationally.

"As companies design their new products for global markets, they have to grapple with current, new—and sometimes conflicting—safety standards and regulations," said Kevin Parmenter and James Spangler, the chairs of the PSMA Safety and Compliance Committee, in a statement.

And complying with these standards is not for nothing: The standards ensure that power supplies will not burst into flames or electrocute the people handling them. That is extremely important in certain applications, like medical devices, which are used in close proximity to doctors and patients.

The International Electrotechnical Commission and the International Organization for Standardization are responsible for defining electrical safety standards. But there are still regional variations between standards—for medical power supplies, for example—meaning that power supplies sold within the United States might have to follow additional safety regulations to be sold in Europe.

To deal with that, the PSMA said that it would regularly update the database and organize it based on application. The group also plans to include links to news releases and industry meetings related to different standards. The list will also contain links to safety agencies, like Underwriters Laboratories, that certify products.

At *psma.com*, anyone can register for free access to the database. Users can subscribe to receive emails alerts when standards change. Users can also request to add emerging standards to the database, so that it can continue evolving.

The safety database is not the first list of regulations compiled by the PSMA. In 2009, it established the Energy Efficiency Database, which follows changes to power supply efficiency standards, as well as the industry groups and government agencies that draft regulations. ■

Z-WAVE SPECIFICATIONS GO Open-Source

THE COMPANY RESPONSIBLE for drafting the Z-Wave home networking standard has made certain parts of the technology publicly available.

In an attempt to lure hardware and software developers to the standard, Sigma Designs released a public version of Z-Wave's interoperability layer, which ensures that devices ranging from door locks to security cameras can share information.

Sigma Designs released a public version of Z-Wave's interoperability layer, which ensures that devices ranging from door locks to security cameras can share information.

The company has added the software to Z-Wave's open-source library. The code represents the "language" that defines how devices from different manufacturers talk to each other, said Raoul Wijgergangs, vice president of Sigma Design's Z-Wave business. That makes it easier for home owners to connect devices with an internet gateway and control them remotely using a phone, computer, or tablet.

Z-Wave is also a wireless technology for creating mesh networks. In these networks, every device acts like a repeater that bounces wireless signals around a house or building. That method of skipping wireless signals between devices results in low power consumption, allowing devices to work for years without needing to replace batteries.

Sigma Designs also released a pair of APIs for making internet gateways, so that devices can send information—whether you left your garage door open, for example—with the cloud. The full specification behind Z-Wave's security software is also available to the public, the company said.

With the code's publication, software developers and hobbyists can teach devices the Z-Wave language with fewer restrictions. They are no longer forced to sign nondisclosure

agreements with the Z-Wave Alliance, the industry group that maintains the standard, or buy a Z-Wave development kit.

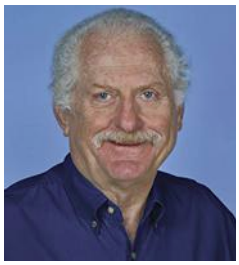
Sigma Designs is the latest company to release public software in an effort to lure developers to its particular brand of home automation. Z-Wave contends with a wide range of other technologies for connecting devices to each other and the internet. But if the public version hits the mark, it could increase the number of devices using Z-Wave.

Z-Wave has a healthy start. Over 1,500 devices have been certified by the Z-Wave Alliance, which counts 350 companies, including Honeywell and Bosch, among its members.

But other wireless technologies are not sitting on the sidelines. Bluetooth and Wi-Fi are evolving to consume less power and create mesh networks, while other standards unique to home automation like Thread and Zigbee are also gaining acceptance.

There has been much talk in the consumer electronics industry about how closed standards are stunting the growth of smart appliances and other household devices. And attempts have been made to remedy that fragmentation: The Allseen Alliance and Open Connectivity Foundation have both released software for linking smart home devices. In May, the smart home division of Google parent Alphabet, Nest Labs, turned out a public version of the Thread mesh networking protocol. ■

TRUCHARD STEPPING DOWN AS Chief Executive of National Instruments



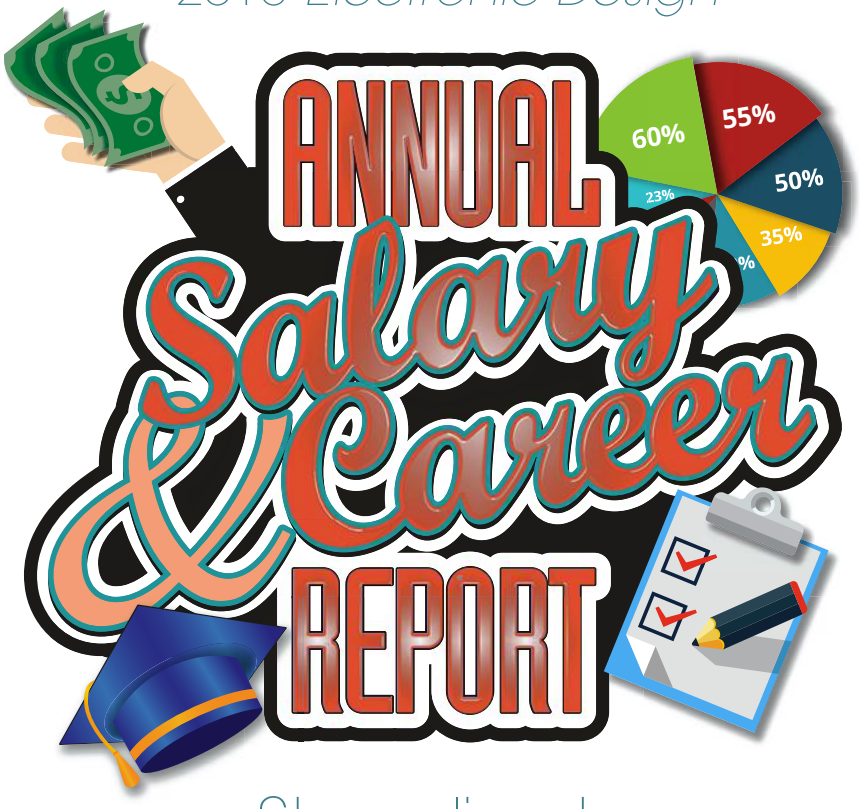
DR. JAMES TRUCHARD, the chief executive and one of the founders of National Instruments, started out in a garage in Austin. Today, NI is one of the biggest makers of software and test equipment for helping engineers design everything from industrial control systems to wireless transmitters.

Now Dr. Truchard—affectionately known as Dr. T within the industry—is stepping down as chief executive after 40 years, announcing that he would retire at the end of the year, though he would keep his position as the chairman of the board of directors.

The change will take effect in January, the company said in a statement. Alex Davern, NI's chief operations officer and chief financial officer, will replace Dr. Truchard. It will be the first time that anyone other than Dr. Truchard has served as chief executive of the company, which was founded in 1976.

Under Dr. Truchard's leadership, NI focused on developing platforms, like its PXI modular test equipment and CompactRIO embedded industrial controllers, which could be built upon over the years. Arguably, the company's biggest platform success is the LabVIEW programming environment, which is used by millions of engineers to plot out test and control systems. ■

2016 *Electronic Design*



Struggling to STAND OUT

Electrical engineers this year reaped the highest salaries in the last decade. But at the same time, the competition for jobs intensified, outsourcing continued unabated, and continuing education remained a difficult chore for many engineers.

The average electrical engineer's salary in 2016 was $106,250, up almost 6% from last year, according to data gathered from 2,200 engineers surveyed by *Electronic Design*. The data also showed that most engineers are satisfied in their current position and feel intellectually challenged by their design projects.

The salary growth is evidence that compensation for electrical engineers is recovering after years of stagnation. In 2007, survey respondents were earning an average of $104,320 adjusting for inflation, but that number declined with the economic recession. The gains also mirror the overall economy: the United States Census Bureau said in a recent report that median household incomes grew 5.2% last year.

While employers are paying more for engineering expertise, they are also having trouble finding qualified job candidates. Around 41% of respondents said that they had difficulty hiring analog engineers, up 4.8% from five years ago. Nearly 33% are striking out with embedded designers, a 4.1% increase from five years ago.

Higher salaries have done little to alleviate work concerns, such as long working hours—most engineers spend 14 hours each week working outside the office—and tight deadlines for delivering products. These concerns have remained extremely consistent over the years.

The survey was conducted as the job market for electrical engineers slowed. In the United States alone, the number of electrical engineering jobs in 2015 was 315,900, according to data from the Bureau of Labor Statistics. That number will likely remain the same for the next eight years, the agency said.

In the written responses to the survey, many engineers shared their views about the job market. Many respondents pointed to companies employing people with specialized knowledge, while outsourcing general tasks like manufacturing and testing. Others pointed out that there were tons of opportunities for young people—but the number of engineers entering the industry is dwindling.

"Engineering jobs continue to change. As long as you are willing to keep up with it, the opportunities continue to exist," said one of the engineers that answered the survey. Others said that those opportunities are difficult to turn into jobs: "It seems like employers are much pickier and less willing to take chances on people," said another respondent.

Many electrical engineers, however, are optimistic. Around 62% of the survey's respondents believe that their prospects for salary advancement are higher than they were in the previous year, up from 47% in 2006. The data also found that two-thirds of engineers think that their company pays them adequately.

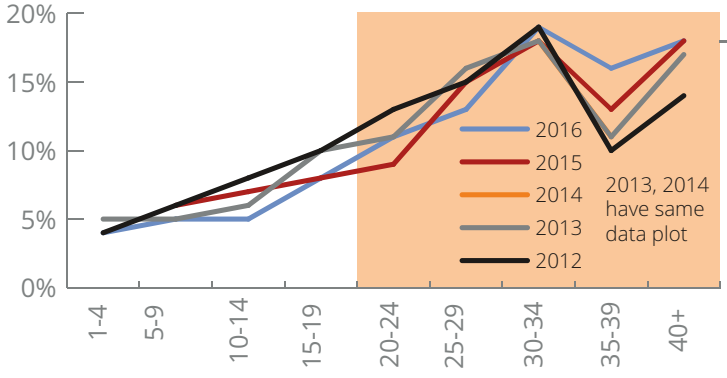
There are also new opportunities for engineers working in high-growth industries, like renewable energy, biomedical engineering, and the Internet of Things. With venture capital firms raising record amounts of funding, there are also opportunities for engineers to work for start-ups.

What has not changed over the last few years is that respondents want to see more young people in engineering. Nine out of 10 survey respondents said that they would recommend engineering as a career path to young people. While engineering jobs have their shortcomings, there is always room for young engineers to grow, they said.

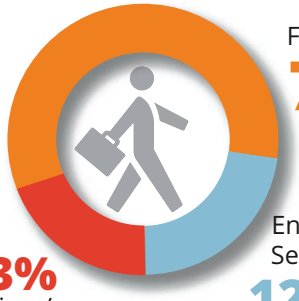
THE TYPICAL ENGINEER

In 2016
77%
of engineers have
20+ years of experience

Years in the Profession



Employment

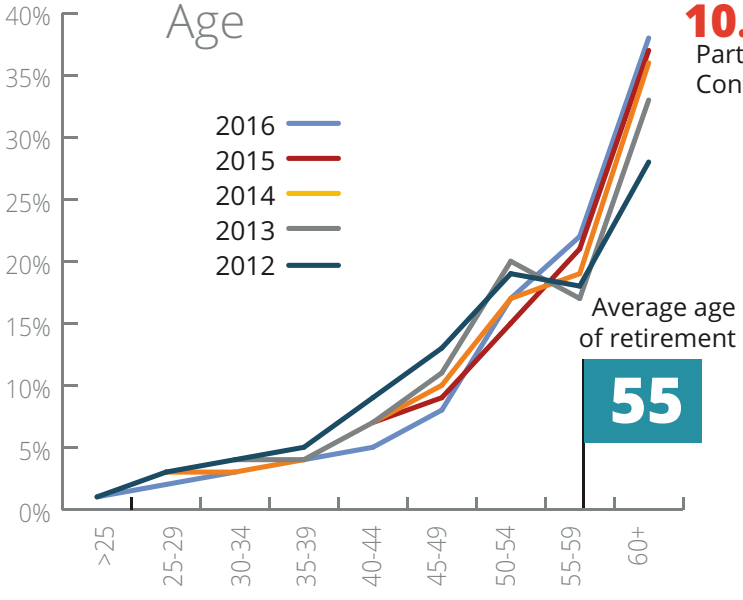


Full time
77.5%

Entrepreneur/
Self-employed
12.2%

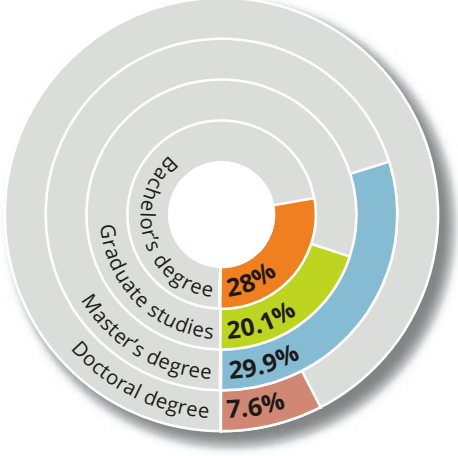
10.3%
Part-time/
Contract worker/other

Age

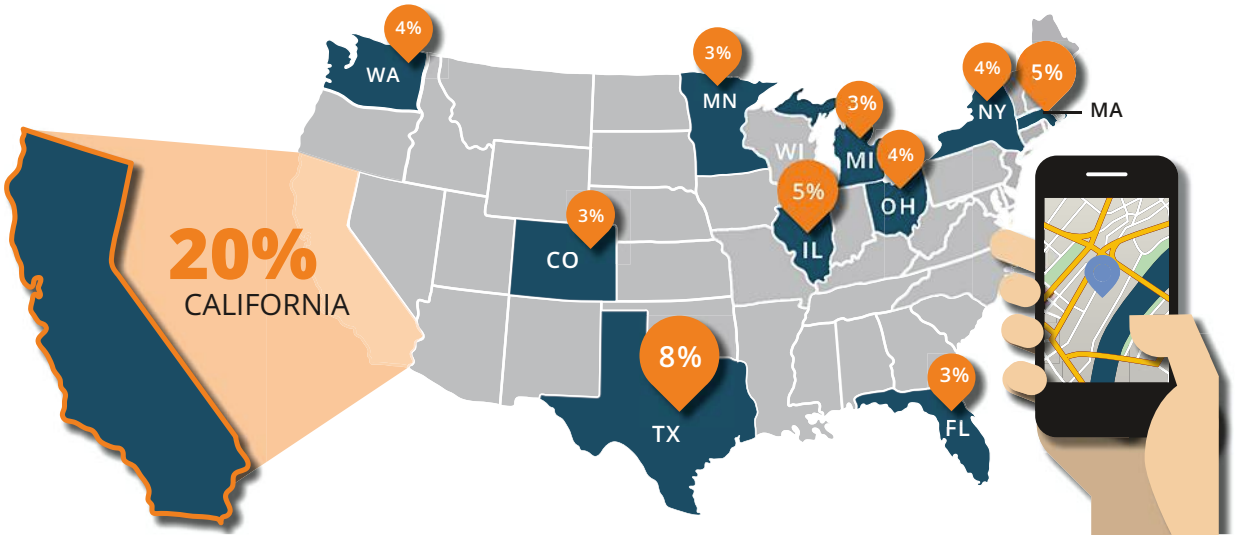


Average age
of retirement
55

Education



Where Engineers are Working

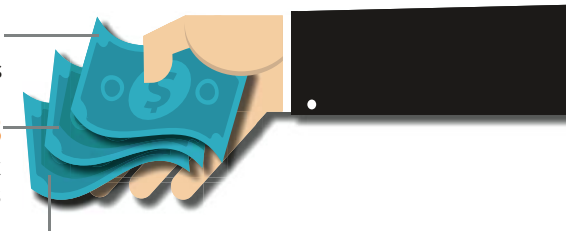


ANNUAL Salary & Career REPORT

COMPENSATION

Average Salary in 2016

$106,250



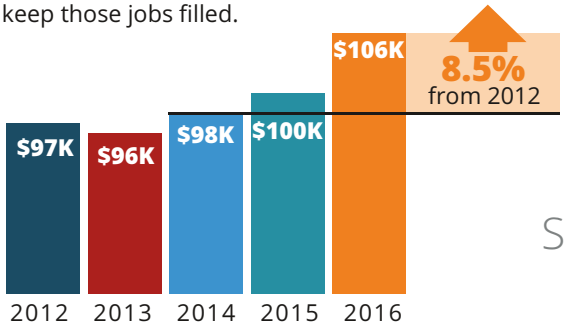
$4,241
Average bonus

$2,938
Average stock options

$2,422
Average other options

YoY - Average Salaries

According to the Bureau of Labor Statistics, the number of electrical engineering jobs in the United States will not change over the next decade. The recent spike in salaries indicates that employers are paying more to keep those jobs filled.

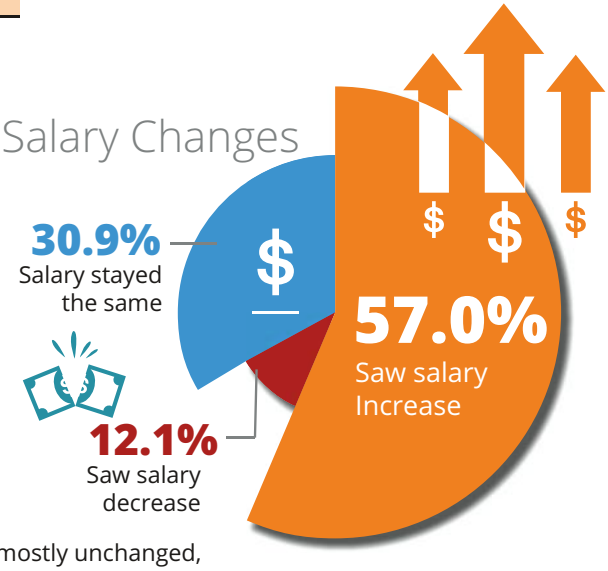


Adjusted for inflation, the average salary in 2012 was

$101,894

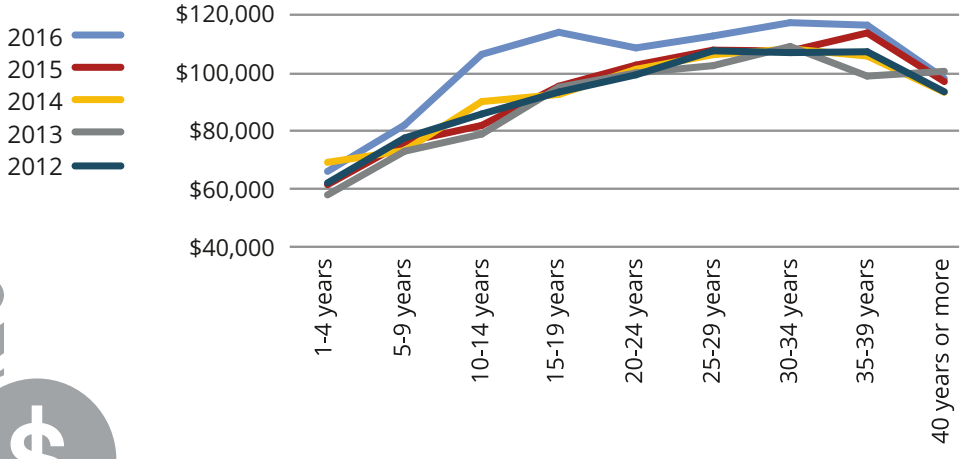
In 2016, engineers are earning **4.5% more** than five years ago, accounting for inflation

Salary Changes



YoY - Salary by Experience

For years, the average engineering salaries were mostly unchanged, rising until engineers reached around 30 years of experience.



REFUSE TO LET DESIGN FALL FLAT

Proto Labs is the world's fastest manufacturer of prototypes and low-volume parts. To help illustrate the design challenges encountered with injection molding, we created the Design Cube. See thin and thick sections, good and bad bosses, knit lines, sink and other elements that impact the moldability of parts.

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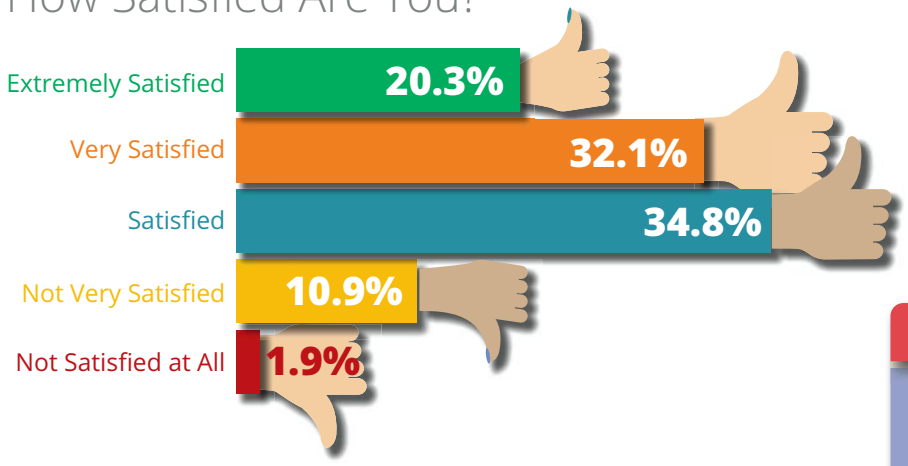
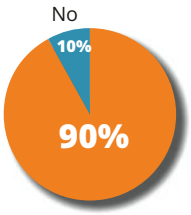
ANNUAL Salary & Career REPORT

JOB SATISFACTION

How Satisfied Are You?



Recommend Engineering



Average Hours per Week

39.2

Down 1.4 hours from 2012

Reasons Engineers Would Leave the Profession

37% Try something different

35% Pursue other opportunities

29% Do something more fulfilling

20% Make more money

Most Important Factors in Job Satisfaction

Challenges
The challenges that accompany the design of new products

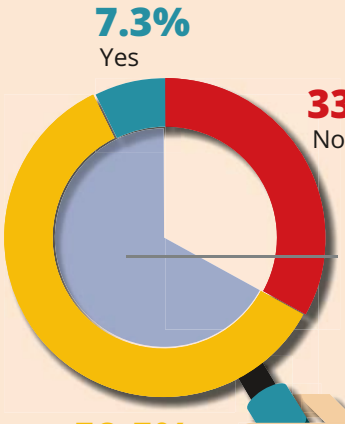
Research
Researching potential design solutions

Compensation
Compensation for the work that you do

Benefits Society
Opportunity to design products that can benefit society

EMPLOYMENT OUTLOOK

Actively Seeking a New Position



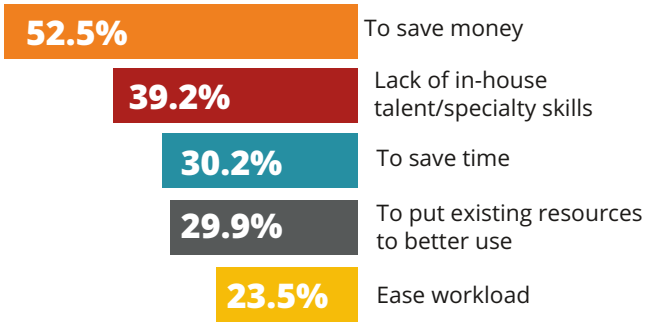
CONCERNS

Top Concerns at Work

Resources **Time** **Funding**

1. Insufficient human resources to get the job done
2. Finding resources for my designs
3. Time-to-market pressures
4. Having to compromise my design approaches
5. Inability to adequately test product designs
6. Insufficient funding for my design projects
7. Competitive market pressures
8. Shrinking product life cycles
9. Lack of design management direction
10. Politics at work
11. Second sourcing for the components specified
12. Management is taking company in wrong direction
13. Seniority issues

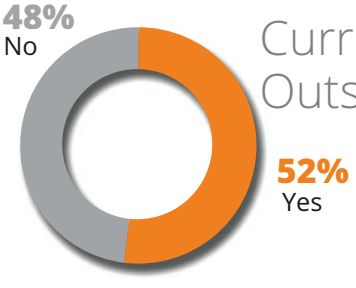
Reasons for Outsourcing



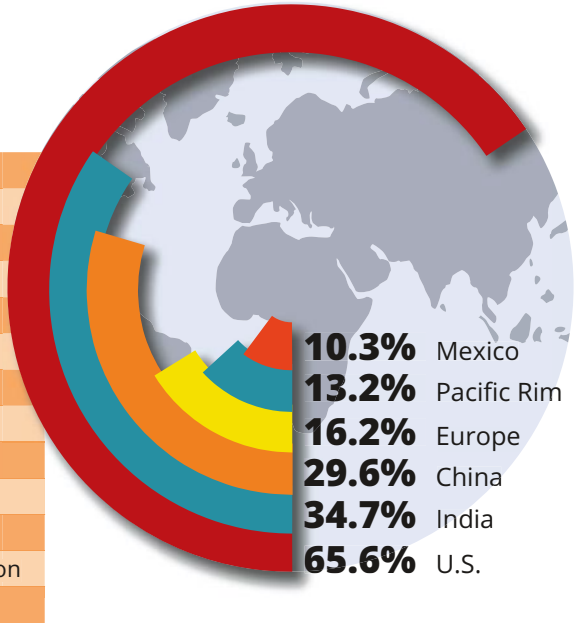
Work Being Outsourced

Software engineering/development	52.1
Manufacturing/assembly	48.8
Design	40.7
PCB layout	37.6
CAD/CAE	23.5
Software verification/test	23.4
R&D	19.6
Final test	18.6
Design verification	17.1
Drafting	12.9

Currently Outsourcing?



Where is Work Being Outsourced?



ANNUAL Salary & Career REPORT

2016

WHAT'S KEEPING ENGINEERS UP AT NIGHT?

Staying Current
with new and emerging technologies

Looming Project Deadlines

Product Reliability Issues

Product Quality Issues

Concerns about the general health of the economy

37%

30%

29%

25%

24%

20%

20%

19%

19%

19%

16%

14%

13%

13%

6%

4%

Concerns about financial health of suppliers

Documenting ROI on engineering expenditures

Component availability issues

Specifying the right products/ vendors for my designs

Price/ performance issues

Age discrimination

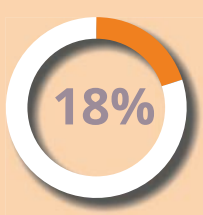
Dealing with reductions in staff

Concerns about job security

Outsourcing issues

Concerns about financial health of your company

Product interoperability issues



Nothing keeps me up at night

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- ***200 kHz system bandwidth***
- ***24-bit / 192 kHz digital audio***
- ***<600 ps residual jitter***
- ***Cross-domain analysis***

SR1 ... $9400 *(U.S. list)*

Introducing *SR1* Dual-Domain Audio Analyzer
— AP 2700 class performance at $9400.

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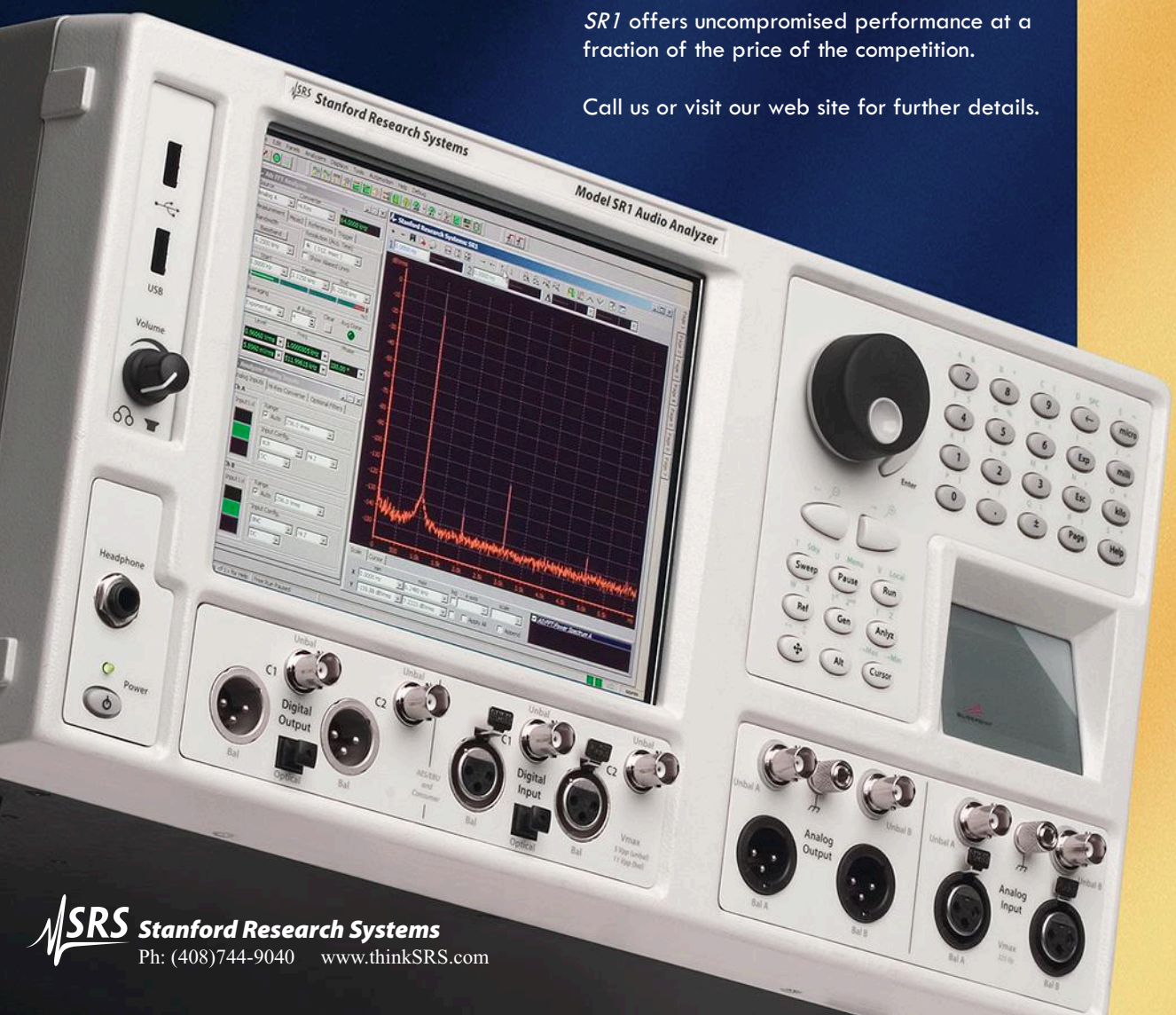

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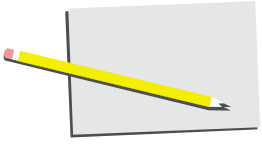
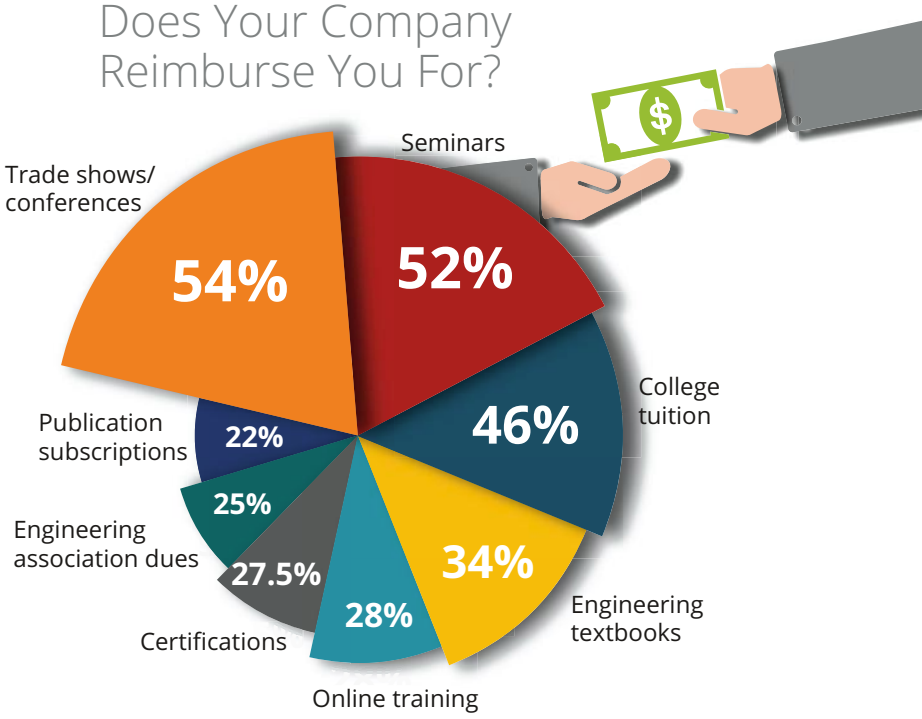
How Engineers are Keeping Up

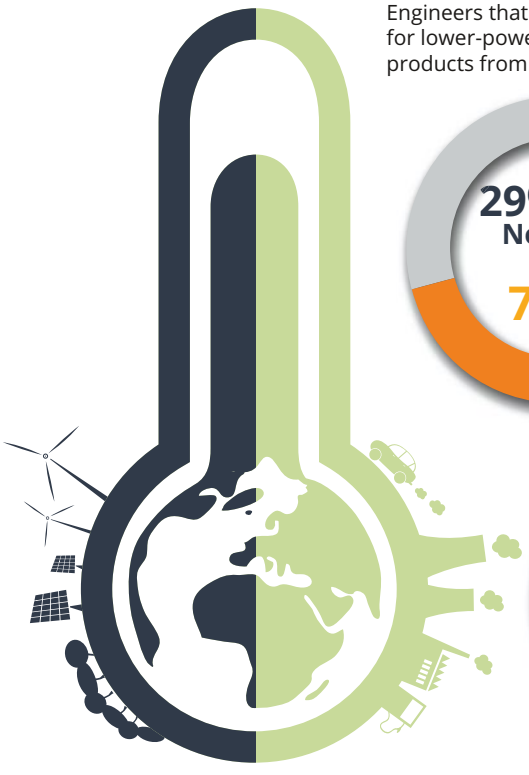


An engineer's thoughts:
"My company is relatively good about encouraging continuing education. The problem is that with constantly-changing deadlines it is extremely difficult to take the time."

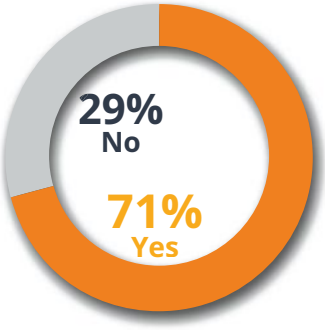
Which Forms of Education Does Your Company Reimburse You For?



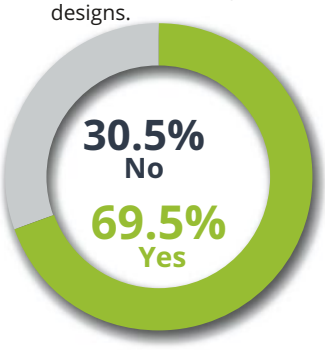
Efficient Engineering

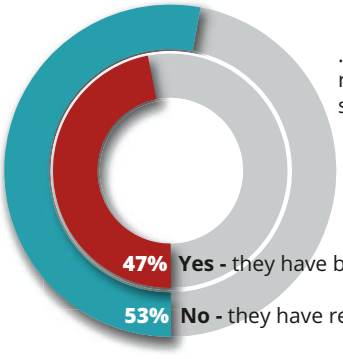


Engineers that have seen growing demand for lower-power, more energy-efficient products from customers.



Engineers that have seen growing demand for miniaturization in product designs.



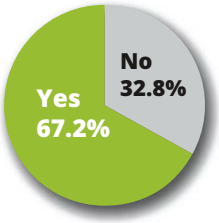


. . . . have seen these requirements become stricter over the last year.

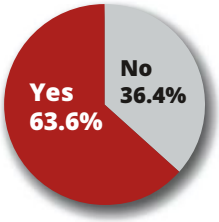
47% Yes - they have become stricter

53% No - they have remained as strict as always

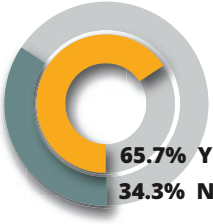
Test & Measurement



Do you feel that your company invests sufficiently in test and measurement equipment to support your design needs?



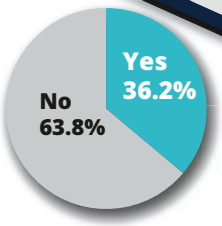
Is there sufficient training and documentation for your test requirements?



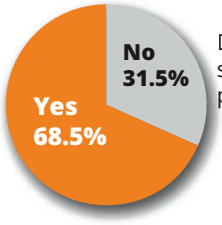
Is testing still a challenge for your design process in terms of time consumption—or has the efficiency of recent test and measurement products made this a non-issue?

65.7% Yes— it's still a challenge

34.3% No— it's not an issue

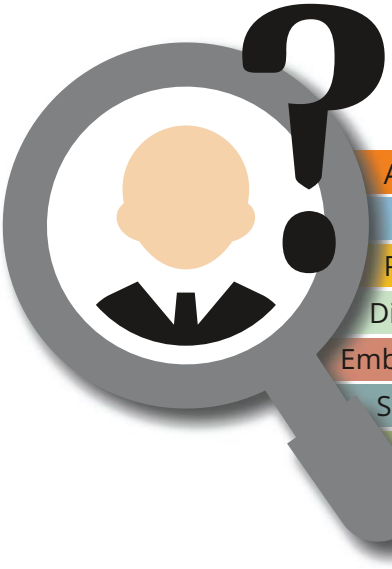


Do you expect the Internet of Things to affect test methodologies at your company?



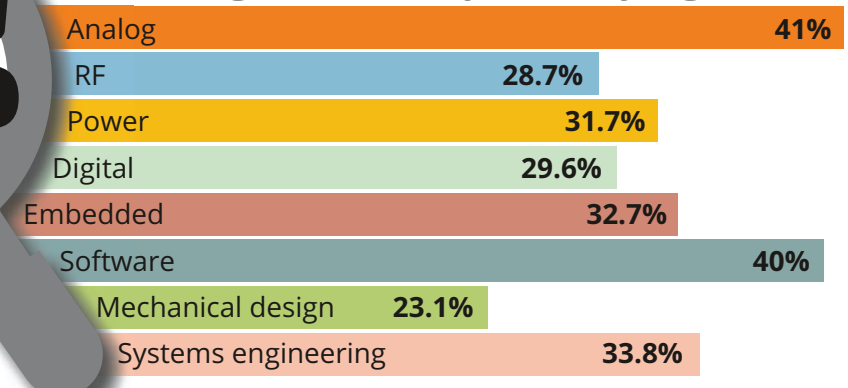
Do you use design simulation software in your product design process?

The Internet of Things (IoT)

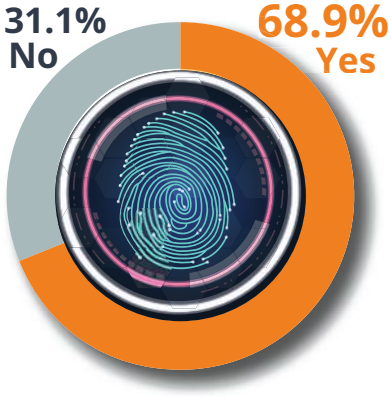


51% of companies are having trouble finding qualified candidates for open engineering positions

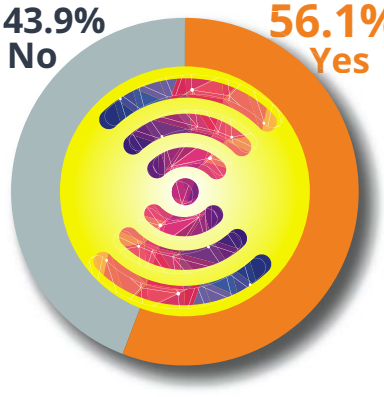
The Engineers They Are Trying To Find...



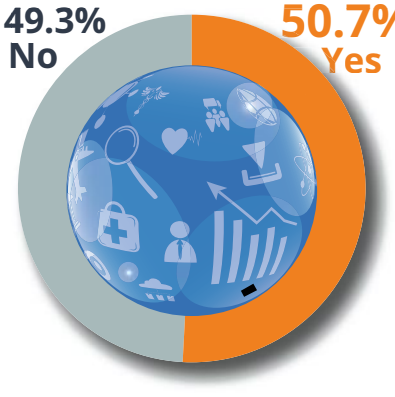
Engineers incorporating sensor technology in their products



Engineers incorporating wireless technology in their products

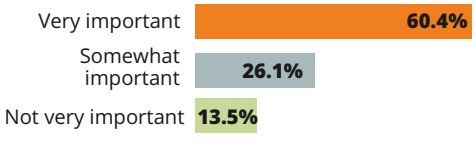


Engineers whose designs are being influenced by the Internet of Things

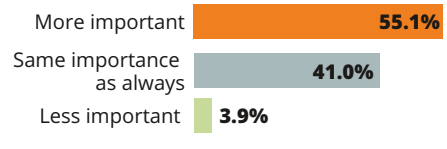


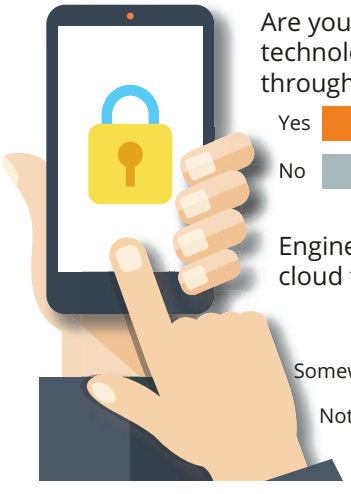
Security

How important is the issue of security in your products?



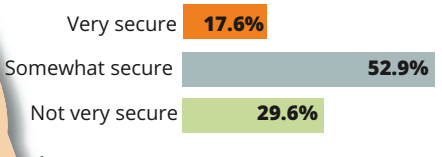
Engineers think that security in their products will become...





Are you working on technologies that route information through the cloud?

Engineers think those cloud technologies are...



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MURRAY SLOVICK | Contributing Editor

What Can You Expect at electronica 2016?

Over 2,700 exhibitors from 50-plus countries around the world will participate in the massive electronics-technology spectacle this November in Munich.

Arguing is easy—just look at the constant bickering between our two major political parties. Agreeing on the best parts and systems for a design project is hard, though.

In this regard, finding a locale where you're able to share ideas and ask technical questions of fellow engineers can be an invaluable asset as you weigh possible solutions. And there's no better venue to do so than electronica, which started in Munich back in 1964 and has been held on a bi-annual basis ever since.

The show presents an unrivaled opportunity for electronics engineers, designers, purchasers, and researchers to catch up on the latest electronics technology. An estimated 75,000 will pass through the gates of Messe Munchen from November 8 through 11, making electronica the world's largest business-to-business electronics trade fair.

BIGGER THAN EVER

Electronics manufacturers usually view electronica as a barometer of industry trends. Thus, the fact that the show is growing from 12 to 13 halls (Hall C4 will now be occupied) with exhibition space increasing from 133,000 to 143,000 square meters can be viewed as a solid affirmation of the health of the industry.

This expansion has resulted in some hall assignment changes. The sectors for printed circuit boards (PCBs) and other circuit carriers, and electronic manufacturing services (EMS), will occupy two entire halls, i.e., B4 and C4. Power supplies now are the focus of exhibits in Halls A2 and A3 and electromechanics/system periphery is moving into Halls B2 and B3.

While statistics may be pliable, as Mark Twain noted, there is no getting around the fact that electronica is huge. Visitors will find more than 2,700 exhibitors from at least 50 countries around the world. Plus there's a show guide resembling the Yellow Pages of a couple of decades ago (remember them?).

Is it worth attending, though? Admittedly, electronica is a grind and no one ever gets to see every bit of the technology on display at the show. You may get blisters on your feet walking from a booth in one hall to another quite a distance away, and you're also likely to be really tired at the end. But it's worth the effort, particularly if you do business in Europe.

What's more, in addition to ICs, PCBs, and systems, electronica exhibitors include manufacturers of power supplies, passives, connectors, and displays. Since there's no equivalent single show in the U.S., you would have to attend several events in different locations here to view the breadth of electronics on display in Munich.

IN THE SPOTLIGHT: AUTOMOTIVE AND EMBEDDED SYSTEMS

The conferences on tap at electronica 2016 feature an array of prominent speakers, giving visitors a chance to get in-depth knowledge about Automotive, Embedded, Wireless, and Industry 4.0 topics.

When not at the show, check out the Hofbräuhaus, with its main-floor beer hall being the main attraction.

Choosing not to wait for the ribbon-cutting, the Automotive Conference commences one day before the opening of the fair on November 7. It focuses on such future-oriented subjects as security, autonomous driving, and interior electronics. Steve Nadig, chief engineer of mechatronics at Daimler Trucks North America (DTNA), kicks off the program with a keynote talk on autonomous driving, and it concludes with a panel discussion entitled "The secure connected (self driving) car."

Embedded Systems is one of electronica's most important focal points. This year the Embedded Platforms Conference will be held at the Press Center East on November 9 and 10. On November 9, "IoT and Security" and "Microcontrollers and Peripherals" take center stage. Then, on Nov. 10, speakers will discuss "Power and Sensors" and "Embedded Communications."

Besides the conferences, several forums invite visitors to exchange ideas and dialog. The range of topics of the Automotive Forum, the Exhibitor Forum, the PCB & Components Marketplace, and the Electronica Forum is broad. One highlight of the Electronica Forum will be the CEO Roundtable. Participants include leading executives from the semiconductor industry, OEMs, and user industries, this year discussing "Connected Worlds—Safe and Secure."

Startups provide important impetus for economic and employment growth. But they often face major challenges when it comes to finding the right partner for their own ideas or to secure financing. Organized in conjunction with *Elektor* magazine, electronica Fast Forward gives founders and developers a chance to submit their projects in the "Idea," "Prototype," and "Startup" categories for a chance to win an award, as well as to make contacts with companies from around the world.

Here's a useful tip to prepare you for your visit: An electronica App features new functions that will be of great assistance when you attend the fair. The latest version has interactive hall diagrams with a new routing function; it can navigate you from location A to stand B. Another nice app feature involves location-related alerts, such as the beginning of a lecture in a forum, which can be received via iBeacons.

THINGS TO SEE AND DO IN MUNICH

Munich, Bavaria's capital, is a cultural metropolis and home to centuries-old buildings, numerous museums, and nightlife that should not be missed. The city is perhaps best known for its annual Oktoberfest celebration and its beer halls. Although you'll miss Oktoberfest 2016—it started in September (by moving the festivities up years ago, it allowed for better weather conditions)—biergartens are a big part of Munich life and you should partake at least a little bit.

To that end, the Hofbräuhaus is admittedly a tourist trap, but also where many of your colleagues—especially those visiting electronica from outside of Munich—will invariably end up in the evening, hosted by personnel from the major electronics companies at the show. In the Altstadt (Old Town), central Marienplatz square contains landmarks such as the Neues Rathaus (town hall), with a popular glockenspiel show that chimes and reenacts stories from the 16th century. You can also make your way to BMW Welt, a space dedicated to the "Ultimate Driving Machines." The BMW Group is celebrating its centenary this year, and its celebrating with an exhibition showcasing past products and its view of automotive technology in the next 100 years.

The BMW Group, celebrating its centenary this year, has a special exhibition on past and possible vehicles of the future at its BMW Welt museum.

MARIA GUERRA | Technology Editor

5 Different Ways to Use LED Drivers

Appropriate light-emitting diode drivers give more flexibility in designing better energy-efficient systems.

Light-emitting diodes (LEDs) are semiconductor devices that emit light when an electrical current passes through semiconductor materials. But for LEDs to perform at their best they need the assistance of LED drivers to provide better efficiency, reliability, and longevity.

LED drivers are electrical devices that prevent damage to LEDs by regulating the forward voltage (V_F) of the LED that changes with temperature, avoiding thermal runaway while delivering a constant current to the LED. LED drivers also aid efforts to meet new energy requirements (e.g., Energy Star).

The steady growth of LED lighting technology has generated a wide range of LED-driver IC options in the semiconductor market. An appropriate driver generates a successful application. Some of the major developments in LED applications that have occurred and continue to evolve are as follows: dimming LED lamps, automotive lighting, LED signage, smartphone backlighting, and TV backlighting.

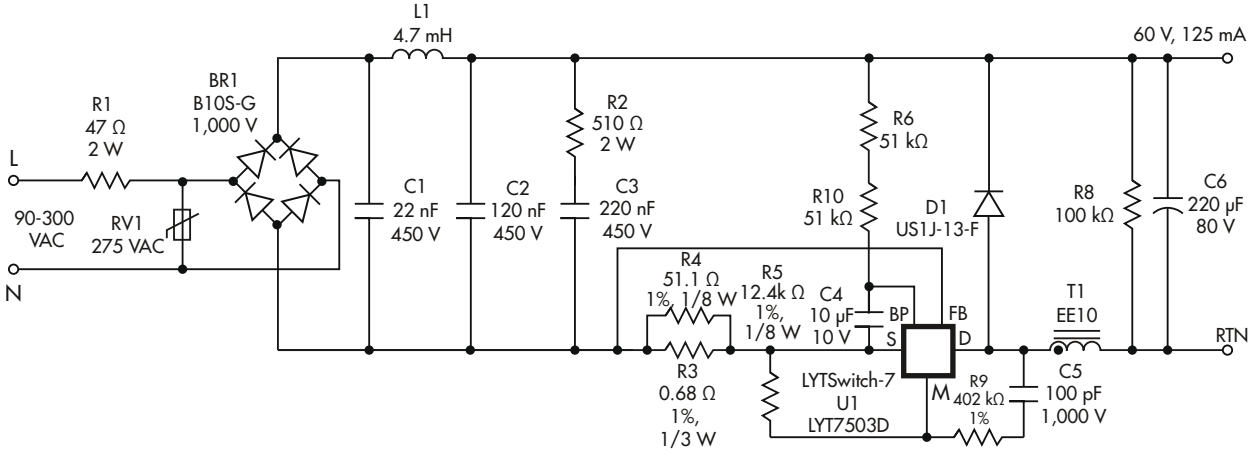
Here we present five different LED driver products for the major developments in LED applications mentioned earlier:

1. DIMMING OF SMALL-FORM-FACTOR LAMPS.

Few LED applications use the ON and OFF setting, as dimming helps to reduce energy consumption. There are two popular methods for dimming LEDs in switch-mode driver circuits: analog and Pulse-Width Modulation (PWM) dimming.

Analog Dimming refers to the adjustment of the nominal LED current. The analog voltage is adjusted and the LED current is changed to achieve dimming. This approach is not acceptable in many applications because there is a color shift with current variation. In contrast, pulse width modulation (PWM) dimming is accomplished by adjusting the nominal LED current by switching ON and OFF at a sufficiently high frequency to avoid a flickering effect.

One of the challenges of dimming is pairing LED lights with TRIAC or phase-cut dimmers that were never designed for



1. This is a schematic of LED driver configured as a low-side buck utilizing the LYT7503D from the LYTSwitch-7 family of ICs. This dimmable LED driver is designed to power a 60 V LED voltage string at 125 mA output current from an input voltage of 90 V ac to 300 V ac. *(Figure courtesy of Power Electronics)*

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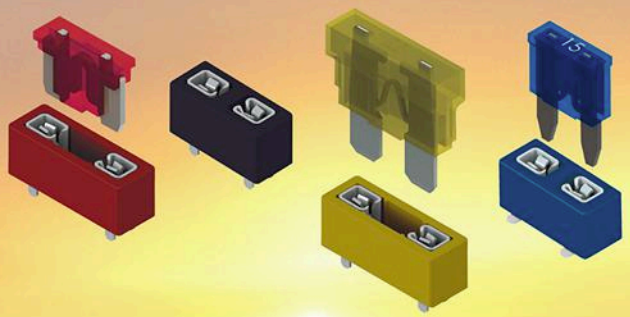

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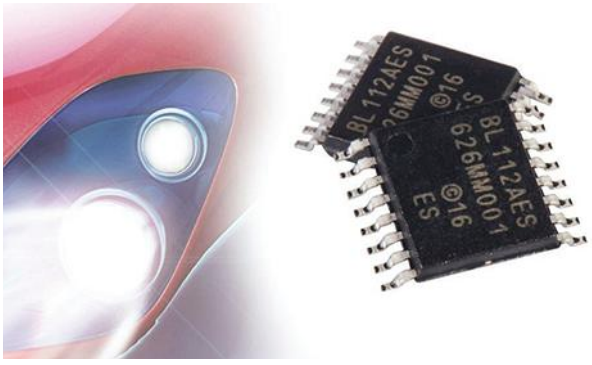


2. Its synchronous operation eliminates unstable dimming that can occur when the input voltage is low. *(Figure courtesy of Cypress Semiconductor)*

LEDs. However, an array of products exist that can be used in this application. For example, Power Integrations offers the LYTSwitch-7 *(Fig. 1)*. This buck LED driver IC has a buck topology with a power factor higher than 0.9. It is compatible with TRIAC dimmers capable of delivering up to 22 watts. The 735V integrated MOSFET ensures sufficient overvoltage protection during line surge occurrence. Its design offers a wide input (90 VAC – 308 VAC) and output voltage range operation. An EMI pi filter blocks differential and common mode noise. Bleeders are not included in the design; passive damping and a single winding inductor are used for TRIAC management.

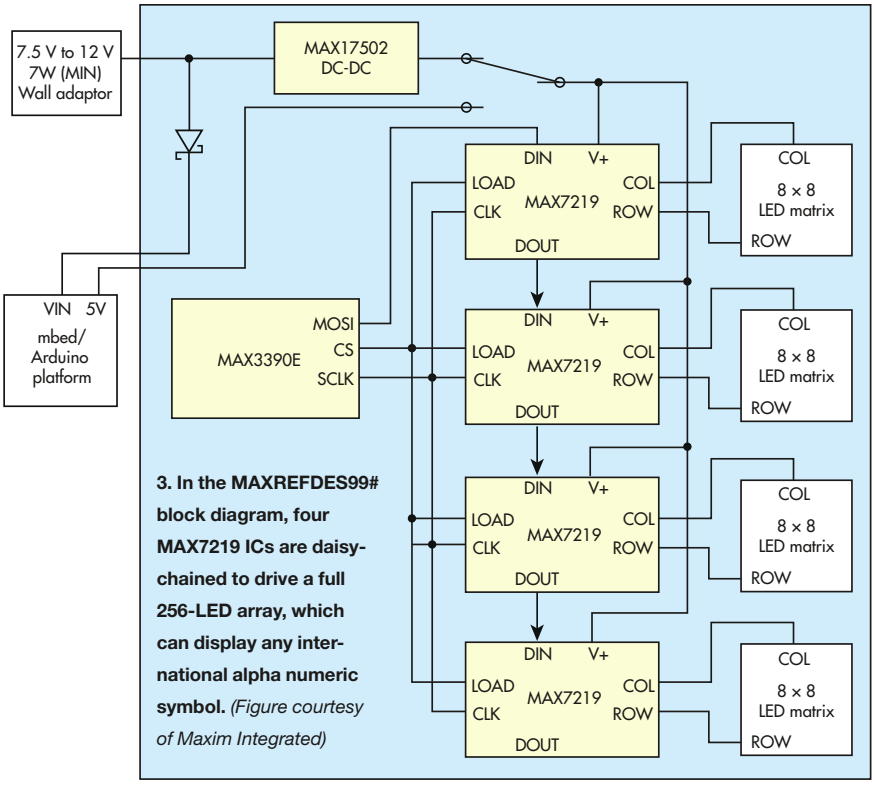
2. AUTOMOTIVE LIGHTING.

The LED automotive lighting market is actively growing. Every automotive lighting solution includes a distinctive LED driver; they are used for energy saving solutions, visibility, etc. Depending on the application, sometimes it's better to use linear drivers instead of switching drivers. This also applies to automotive lighting if the LED lights are outdoors or indoors or on the back or on the front of the car. They will dissipate heat at different levels, depending on the environment and placement.

LED lighting can improve the safety of drivers and pedestrians by enhancing the range of visibility when the headlights are turned ON, OFF, or dimmed to efficiently perform at any stage of the journey. LED headlights present several challenges because the input voltage can vary depending on the condition. Therefore, step down (buck) and step up (boost) topologies are demanded for better performance.

The S6BL112A *(Fig. 2)* single-output synchronous Buck LED driver from Cypress, for example, supports both analog and PWM dimming functions. It includes a frequency adjust pin that allows the user to adjust the frequency from 205 kHz to 2.1 MHz. The switching frequency (FOSC) is programmed by using an external resistor (RRT) connected between RT and GND.

Cypress' S6BL112A Automotive LED driver features an input voltage range of 4.5-42 V that allows it to handle extreme operating conditions such as cold-cranking. Cold cranking occurs when the automobile engine starter draws an excessive amount of current due to starting the engine in cold temperatures. It also can function during load dump, which is a power surge that occurs when an automobile battery is disconnected while the alternator is supplying current during engine operation.

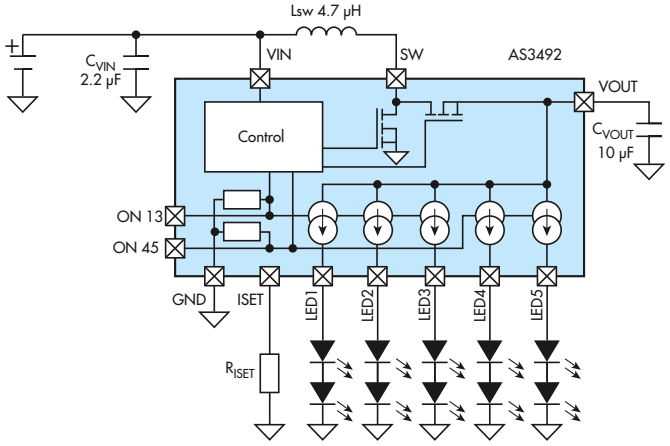


3. In the MAXREFDES99# block diagram, four MAX7219 ICs are daisy-chained to drive a full 256-LED array, which can display any international alpha numeric symbol. *(Figure courtesy of Maxim Integrated)*

3. 16 × 16 LED DISPLAYS.

16 × 16 displays are becoming more common, as they are great for outdoor use like storage signs, billboards, public transport signs, etc. Most LED displays today are 8 × 8 and cannot communicate many international alpha-numeric characters. With a 16 × 16 display, however, it is possible to create signs in multiple languages that require more LEDs.

Recently, Maxim released a reference design (MAXREFDES99#) *(Fig. 3)* that integrates four of its MAX7219 LED drivers to create a 16 × 16 display with 256 LEDs. The MAXREFDES99# can be powered from a wall-wart which provides a minimum of 7W of power and an output voltage in the range of 7.5 V dc to 12 V dc. The reference design works with both Arduino and ARM mbed platforms.



4. AS3492 Typical Operating circuit. The ON13 and ON45 can be used as PWM inputs to accurately control the LED brightness. *(Figure courtesy of AMS)*

The MAX7219 is a compact, serial input/output common-cathode display driver that interfaces microprocessors (µPs) to seven-segment numeric LED displays of up to eight digits, bar-graph displays, or 64 individual LEDs.

4. SMARTPHONE BACKLIGHTING.

LEDs enable thinner backlight designs and support advanced backlight architectures that reduce PCB area and lower cost. The amount of LEDs changes depending on the size of the smartphone display. Bigger displays require more LEDs for backlighting applications.

Inductive drivers (inductive DC-DC converters) are very efficient when driving applications with multiple strings of LEDs. Because they operate more efficiently than single strings of LEDS at lower output voltages, they result in longer battery run-time.

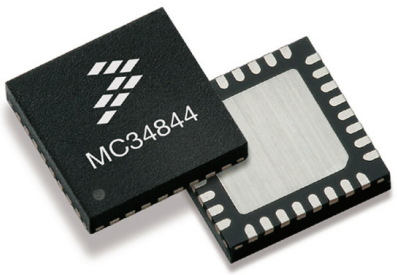
AMS' AS3492 *(Fig. 4)* is an inductive DC-DC converter that can drive up to five strings with two LEDs each in series with a system efficiency of 86% (DC-DC and current sources combined). The DC-DC converter operates at a fixed frequency of 2 MHz and includes soft startup to allow easy integration into noise-sensitive RF systems.

The output of the DC-DC converter is used for five current sources connected to up to 10 LEDs. The AS3496 has the following built-in protection mechanisms: Short LED protection (SLP), Open LED Protection (OLP) and Over Voltage Protection (OVP). This display backlight driver has been designed specifically for mobile phones, digital cameras, PND and PMPs.

5. TV BACKLIGHTING.

LEDs have been replacing cold cathode fluorescent lamps (CCFLs) and Liquid Crystal Displays (LCDs) for backlight technology in many sizes of TVs, monitors, laptops, etc.

The backlight unit (BLU) in a TV or monitor is a major source of power consumption. LED drivers can offer significant power



5. The MC34844 is a solution for backlighting small and medium size LCD panels, on low power portable and high definition devices. *(Figure courtesy of NXP Semiconductors)*

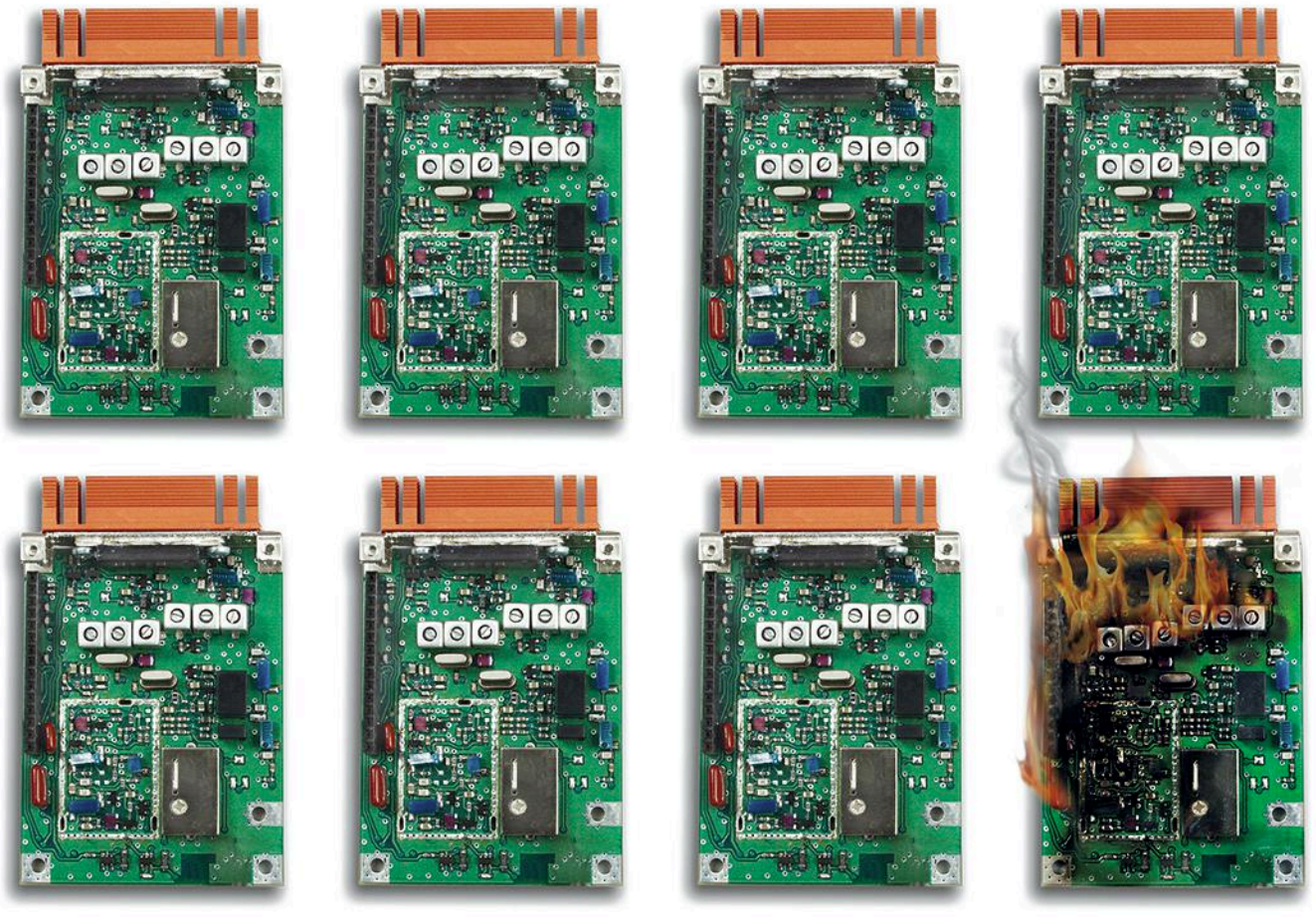
reduction through different backlight architectures: direct and edge backlight. In the edge backlight architecture, the LEDs surround the edge of the display. This approach offers the advantage of cost reduction by using fewer LEDs. For its part, direct backlight architecture puts the LEDs directly behind the display. In doing so, it provides better contrast but at a higher cost.

Two major dimming modes are used for LED backlight applications: global dimming (all LED strings are dimmed together) and local dimming (LED strings are dimmed independently).

Among the products targeting this market is NXP Semiconductor's MC34844 *(Fig. 5)*, an LED driver for backlighting small- and medium-size LCD panels. It specifically serves low-power portable and high-definition devices. Operating from supplies of 7 to 28 V, the MC34844 is capable of driving up to 160 LEDs in 10 parallel strings. The integrated boost converter generates the minimum output voltage required to keep all LEDs illuminated with the selected current, providing 90% efficiency (dc-dc). The MC34844 also includes a Pulse Width Modulation (PWM) generator for LED dimming. The LEDs can be dimmed to one of 256 levels, programmed through the I2C/SM-bus interface. Therefore dimming ratios up to 65,000:1 (256:1 PWM, 256:1 Current DAC) can be supported. External PWM inputs may also be used.

The MC34844 features LED over temperature protection, LED short protection, and LED open-circuit protection. The IC includes overvoltage protection, overcurrent protection, and undervoltage lockout. To achieve enough voltage to drive a number of LEDs in series, a boost converter is implemented to produce a higher voltage from a smaller one, which is typically used by the logical blocks to do their function.

There are many approaches for controlling LED lighting; every application is different, and LED drivers can provide efficiency and reliability by selecting the appropriate parameters. As technology advances we will see better LED driver applications capable of minimizing power consumption without trading off in terms of efficiency, switching frequency, component counts, and so forth. ed



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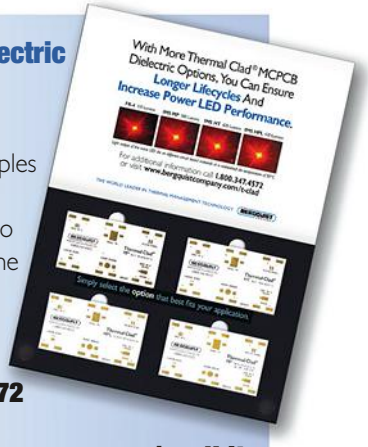

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WILLIAM WONG | Technical Editor

Module Targets Rapid IoT Development

Compact embedded systems can be implemented using a range of modules and boards designed for low-power and mobile applications.

As development platforms shrink to match end-product portability, the challenge intensifies to create a compact hardware platform for a proof of concept and then turn it into a final product. One of the latest platforms in this arena is Hexiwear *(Fig. 1)*, which comes from a collaborative effort between NXP and MikroElektronika.

The Hexiwear module is an IoT platform that can be used as a mobile sensor or even a smartwatch-type device, although it's not designed to take on the likes of an Apple Watch or an Android Wear watch. It does have Bluetooth Low Energy and 802.15.4 connectivity, as well as its own battery that's charged by the Micro USB connection.

The platform is an open-source hardware and software design based on a 120-MHz, 32-bit Kinetis K64 chip with an ARM Cortex-M4. It has 256 kB of SRAM and 1 MB of flash storage. Wireless support is via a dedicated Kinetis KW4x based on a Cortex-M0+.

The peripheral sensor suite is impressive, including an NXP FXOS8700CQ 3D accelerometer and 3D magnetometer, an NXP FXAS21002 3-axis digital gyroscope, and an NXP MPL3115A2R1 absolute digital pressure sensor. It also features

1. The Hexiwear module can fit into a wristband. The heart-rate sensor is on the back of the module.

2. The Hexiwear module plugs into the breakout board, providing access to an SD card slot and three expansion sockets.

a light, humidity, and temperature sensor plus a heart-rate monitor. The latter is designed for use when the module is installed in the wristband, which comes in a number of colors.

The 1.1-in. OLED display is surrounded by capacitive touch sensors; hence, the wide bezel. There's a haptic feedback mechanism as well. A header on the rear of the module provides expansion options.

It's also designed to mate with the breakout board *(Fig. 2)*, which adds an SD card slot and three MikroElektronika Click Board sockets. These can accept a range of modules from additional wireless interface to relays and motor-control boards. The module is compact and easily removed from its case, allowing it to be incorporated into other devices.

The module comes with a built-in application that links to the Hexiwear app running on Apple and Android platforms. This, in turn, can be linked to the WolkAbout WolkSense cloud support. The WolkAbout Smart IoT Cloud includes data-analytics support for big data plus data visualization and reporting tools. Of course, it's integrated with smartphone and tablet apps in addition to app-development tools.

The system software can be replaced by applications developed on the Kinetis Design Studio, an Eclipse-based IDE that supports the Kinetis Software Development Kit (SDK). A range of third-party development platforms are available, too, from companies such as Keil, IAR, Somnium, and Green Hills Software. The platform is also supported by ARM's mbed *(see "ARM Continues to Enhance mbed" on electronicdesign.com)*. The design of custom enclosures can be done using Autodesk's Fusion 360.

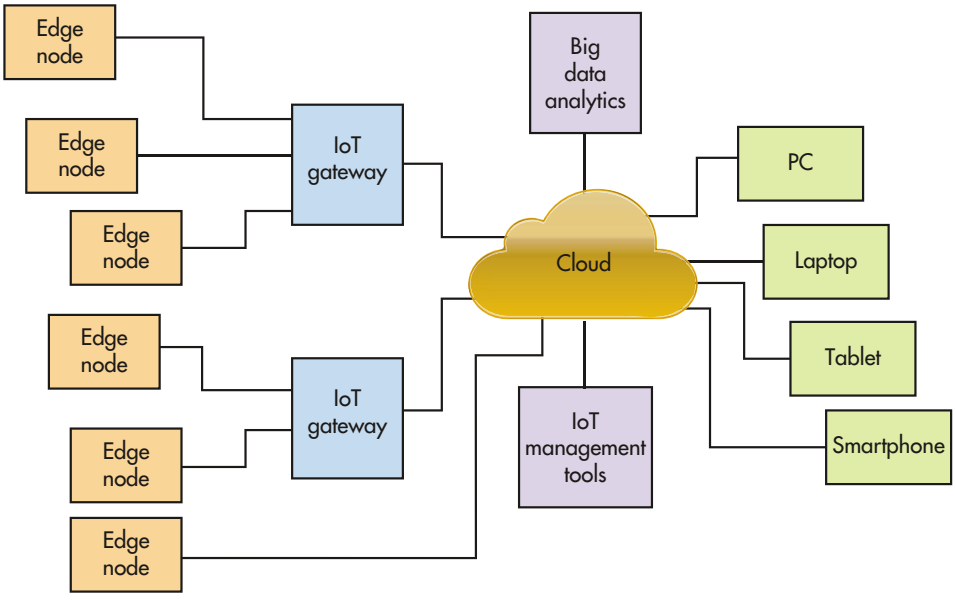
Platforms like Hexiwear don't address every mobile or IoT application, but they do engage with enough to be very interesting to developers. Most, like Hexiwear, employ components that are readily available, even in small quantities, versus other platforms like Raspberry Pi. This can become a critical factor when turning a prototype into a product.

WILLIAM WONG | Technical Editor

What's the Difference Between Consumer and Industrial IoT?

The Internet of Things is invading everything from consumer to industrial products, but all platforms are not created equal.

The Internet of Things (IoT) is the latest product-development buzzword, akin to other terms like "the cloud" or "smart cities." These terms are typically very nebulous, but generally apply to an important set of identifiable products or technologies. They can be more focused, such as "cloud storage" and "cloud computing," and many companies often identify themselves as providing products and services that fall over these names. The more-focused terminology helps narrow the collection of vendors, products, and services to a more manageable or understandable level. Hopefully, this will be the case with consumer, commercial, and industrial IoT (IIoT).



1. An Internet of Things (IoT) environment contains a mix of devices connected via the Internet/cloud. It's also possible for edge nodes to connect directly to the cloud without connecting to a gateway.

To start, we need at least a basic description for IoT. Generally speaking, IoT is a distributed network system that typically employs the internet/cloud for some aspect of its communication and usually includes sensors/control systems, a storage component, a compute component, a user-interface component, and possibly gateways *(Fig. 1)*.

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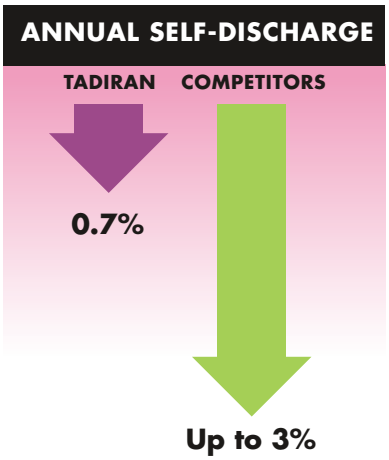

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Some devices might incorporate multiple components. For example, a smartphone could provide information from its sensors while also running a user-interface application that displayed information moved up to the cloud. It might also act as a gateway to other devices like a smartwatch or a Bluetooth-based sensor.

Granted, the description is very general and a lot of details come into play in an actual system from a plethora of protocols like MQTT and TCP/IP to security and management systems. In theory, an IoT system should be expandable, allowing dynamic changes to its operation and include devices not provided by a single vendor.

Consumer, commercial, and industrial IoT share attributes and are typically built on the same hardware and software platforms. That's why IoT discussions tend to get murky, especially when delving into the details. For instance, smartphone and tablet apps tend to provide one way of querying and controlling devices. Windows and iOS PCs, on the other hand, generally run the heavier user interfaces, often providing management tools that would be cumbersome on the smaller, portable devices.

The IoT devices and software basically differ in areas such as ruggedness and expected lifetimes, as well as who has access to data and how that data is made available to various parties.

CONSUMER IoT

Consumer IoT devices and services are oriented toward individual users or families. This includes products like Amazon's Echo *(Fig. 2)* or Google's Nest Thermostat *(see "An Elegant Thermostat Designed For The Internet" on electronicdesign.com)*. Hardware tends to be designed for low cost and limited lifetime and maintenance. A device is likely to have a shelf life measured in months or years, with new versions quickly replacing older products on store shelves. The device lifetime may be many years, but replacement rather than maintenance or upgrade is the norm.

2. An example of a consumer IoT device would be Amazon's Echo voice-control system, which doubles as a wireless music player.

Numerous devices will be unique per consumer, although some may require more than one—e.g., multiple thermostats for a larger house or smart lighting where each bulb is a device. This limited number of devices tends to simplify the user's management interface software for various reasons, including security. Products are often isolated to a couple of users that may have limited, if any, access controls other than access to the devices using matching applications. From a user's point of view, the collection of devices and their management is isolated to that user or his or her family.

Typically, a vendor's device and data-management infrastructure isn't seen or controlled directly by the consumer, although the user's management support is provided through it and isolated from other users. This may be related to a vendor's monetization of consumer information or a mechanism for providing additional services, such as Amazon Echo's ability to place orders for products or services.

The vendor's infrastructure is a much different animal than that of the consumer. It will need to manage hundreds, if not millions or billions, of devices, and it needs to take the user partitions into account. The infrastructure may also be built on a third party's tools or services. The latter is often based in the cloud, and provides connectivity through the cloud/internet. This adds another level of complexity, though, since the third party will have its own management infrastructure to provide its services to the vendor that is, in turn, providing services to its own consumers.

COMMERCIAL IoT

Commercial IoT sits between consumer and industrial IoT and shares aspects of both. Some may actually group commercial and industrial IoT together. The scope of commercial IoT typically resides at the company or organization level. Applications like smart power and lighting would fall under the commercial IoT umbrella.

One example of a commercial IoT platform is Verdigris' Einstein system *(Fig. 3)*. It hooks into existing building power infrastructure to provide smart metering and monitoring to minimize power consumption in large commercial buildings that may have a mix of occupants.

New hardware also supports 4G-LTE connectivity. The cloud-based support employs artificial intelligence (AI) to analyze electrical "fingerprints" and subsequently optimize building controls, sending users critical notifications of energy use. It can also help predict future breakdowns based on system use and operation.

Verdigris' system highlights some major differences between consumer and commercial IoT systems. The first is scale, followed up by management and analysis. Commercial systems rarely involve single devices—there may be dozens

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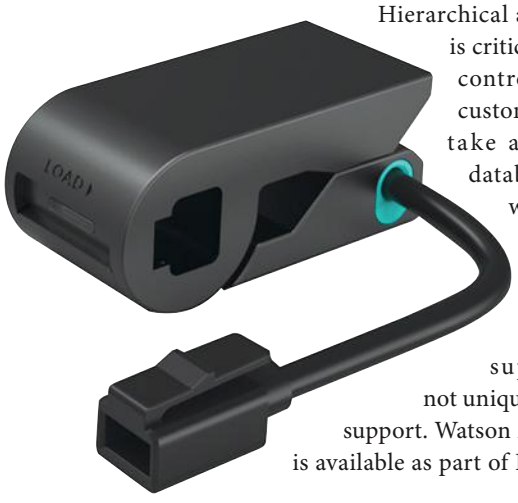
or thousands depending on the application. A number of sites may also be involved in one system, adding to the management challenge.

Moreover, customer management and analysis is substantially more sophisticated versus that of consumer IoT. Hierarchical access control is critical to data and control features. A customer will likely take advantage of database access as well as service APIs and data analytics such as Verdigris' AI support. AI is not unique in IoT cloud support. Watson AI technology is available as part of IBM's IoT services, which are accessible from IoT platforms like mbed *(see "mbed IoT Starter Kit Links to IBM's Cloud" on electronicdesign.com)*.



3. Verdigris' Einstein smart sensor can be added to existing installations to provide information to the company's artificial-intelligence platform.

INDUSTRIAL IoT

Industrial IoT might be viewed as rugged, long-term commercial IoT, but that overlooks the differences in IIoT's design and infrastructure. Like many commercial solutions, IIoT solutions often target existing automated industrial systems. The difference is that these systems may be older, so the level of sensors is often based on what was available. They provide sufficient information to control the industrial process, but additional information would be useful if it's possible to incorporate more sensors. Such sensors might track the status of components such as plumbing. Sometimes, it can provide supplemental information about system wear and tear to anticipate maintenance requirements.

Integrating information from existing systems with new IoT support is often more complicated than with commercial IoT. Likewise, integration will need to be maintained over the long term as well as support updates on both sides of the equation. The potential for bidirectional integration also leads to a more-complex security integration process. This is

one reason why full IIoT integration generally requires more time than a commercial IoT application.

Like commercial systems, industrial IoT is more amenable to gateway use. Incorporating many gateways requires planning, but they ultimately provide the ability to do more processing on the floor. They also enable more independent operation, with the possibility of distributing information locally.

IIoT gateways will often have more user customization, or even the ability to run user applications. These systems may require significantly more customization than a commercial system in order to tailor them for a particular industrial process.

The customization involved with IIoT systems is one reason why deployment will take longer than many commercial IoT systems. IIoT developers will usually require more support and create more integration solutions, whereas most commercial IoT integration is likely to be done in the cloud. Security, latency, and application issues surrounding IIoT often make cloud type of integration impractical.

IIoT equipment also tends to have more demanding requirements than commercial alternatives. Very long-term support and rugged specifications such as extended temperature support are common requirements for many applications.

IoT systems and platforms are not created equal. The types of communication and operations used by consumer, commercial, and industrial IoT are very similar if not identical.

So where do IoT applications like smart cars and smart cities fit? Smart cars would fall into the consumer IoT realm, while smart cities might be a mix of commercial and industrial IoT.

IoT systems and platforms are not created equal. The types of communication and operations used by consumer, commercial, and industrial IoT are very similar if not identical. The differences concern those who procure, and are allowed to procure, information or control within the system.

Oftentimes, multiple players are involved in support and management of the software, because building an IoT system from scratch isn't an easy task. On top of that, supporting it in the long term becomes a full-time job that's usually very distracting for commercial or industrial companies, and a bit ridiculous for consumers. ed

VICTORIA FRAZA KICKHAM | Contributing Editor

Final DFARS Rule Improves Anti-Counterfeit Efforts

The Final Defense Federal Acquisition Regulation Supplement further clarifies procedures for sourcing electronic parts and emphasizes authorized sources.

Electronics industry representatives were praising new efforts to clarify certain government anti-counterfeiting provisions over the summer, as a final Defense Federal Acquisition Regulation Supplement (DFARS) was released. The U.S. Department of Defense published its final DFARS addressing required sources of electronic parts for defense contractors and subcontractors in August, addressing issues surrounding terminology, traceability, and flow-down requirements, among others.

The final rule emphasizes a preference for purchasing parts from original manufacturers or their authorized sources, and leaves the onus on contractors when it comes to identifying and buying from trusted suppliers.

The rule clarifies provisions outlined in the National Defense Authorization Acts of 2012 and 2015, which issued new guidelines for government contractors that procure electronic parts—essentially telling them what they need to do to detect and keep counterfeit parts out of the defense supply chain. The newest update addresses key issues identified by the authorized electronic components industry: it clarifies definitions of the term "supplier," establishes traceability requirements for contractors, and notes that flow-down requirements do not apply to the original component manufacturer.

The Electronic Components Industry Association (ECIA) was among the authorized channel sources weighing in on the final rule. ECIA participated in the industry comment process regarding the rules, suggesting changes in key areas: use and definition of the terms "authorized dealer" and "trusted supplier"; procurement policy; traceability; and flow-down requirements. ECIA's COO and general counsel Robin Gray said he was satisfied with the final rule, and the association pointed to the following changes specifically in a statement issued in early August:

The term "authorized dealer" was deleted and replaced with the term "authorized supplier." Authorized supplier means a supplier, distributor, or an aftermarket manufacturer with a contractual arrangement with, or express written authority of, the original manufacturer or current design activity to buy, stock, repackage, sell, or distribute the part.

The term "trusted supplier" was deleted and replaced with the term "contractor-approved supplier." Contractor-approved supplier means a supplier that does not have a contractual agreement with the original component manufacturer for a transaction, but has been identified as trustworthy by a contractor or subcontractor.

The rule establishes a strict, three-tiered approach to the procurement of electronics parts; it provides that the contractor is responsible for inspection, testing, and authentication if the contractor cannot establish traceability from the original manufacturer for a specific part; and it clarifies that the flow-down requirements do not apply to the original component manufacturer.

A CONTINUING PROBLEM

The counterfeit component problem continues to be a key issue across the electronics supply channel, especially among buyers at manufacturing organizations. In a recent *Global Purchasing* survey of more than 700 purchasing professionals, 34% listed counterfeit components as one of the major issues that "keep them up at night," and 47% said that keeping up with government regulations surrounding anti-counterfeit efforts is one of their major workforce challenges.

The questions about quality and counterfeit parts were part of *Global Purchasing*'s annual Salary & Career Survey; results will be published online in October at *www.globalpurchasing.com.* ED

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Optimize High-Voltage Measurements with Self-Adjusting Attenuator

By STEVEN GALECKI, Checkpoint Surgical Inc.

IT'S A COMMON challenge to measure voltages that exceed the operating voltage of the ADC used as part of the measurement circuit. One commonly employed method is to use a resistor string as a voltage divider, setting the resistor ratio such that the highest voltage of interest is scaled below the ADC's reference voltage. It provides a fixed ratio, but small input voltages can't take advantage of the dynamic range of the ADC. Also, unanticipated oversized signals may damage the input of the ADC circuit, as well as distort the signal due to changes in the circuit's impedance.

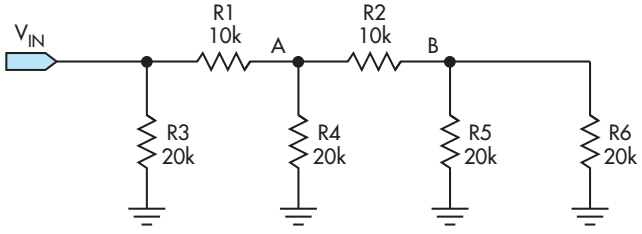
The alternative circuit approach discussed here scales the input voltage using multiple voltage dividers to maximize measurement accuracy. It takes advantage of the fact that the signal source for this circuit is a current sink that feeds a defined range of load impedances (resistances).

The voltage divider used is based on an R-2R circuit *(Fig. 1)*. Each leg of the divider (or top of a 20-kΩ resistor) will have one-half the voltage of the previous leg. The voltage at A is half the voltage at V_{IN}, and the voltage at B is half the voltage at A. Each leg also carries one-half the current of the previous leg. The current through R5 is half the current through R4, which is half the current through R3, and the current through R3 is half the total current coming into the R-2R circuit. In addition, the input impedance of the circuit will be 10 kΩ.

The voltage at the different nodes of the resistor-divider network (V_{IN}, A, B) may be higher than the reference voltage of the data converter. Rather than measuring the voltages on the nodes, this circuit measures the current through each leg. Three op amps are used to create virtual grounds for the resistor network; these op amps mirror the current flowing through resistors R3, R4, and R6 *(Fig. 2)*.

U1 changes the voltage on Out_1 (and the current through resistor R3 and feedback resistor (R9) so that U1's negative input is at the same voltage as U1's positive input. The output voltage of U1 is $V_{IN} \times R9/R3$. To limit the voltage drop across the feedback resistor to approximately 2 V, two diodes in series (a blue LED and a Schottky diode) are placed in parallel with R9.

Leakage current reduces the accuracy of the voltage across the feedback resistor, but the blue LED has very low leakage current. The low capacitance of the Schottky diode (≈2 pF at 0 V)



1. The design's principle is based on an R-2R circuit used to create multiple attenuation points.

reduces the capacitive loading of the LED on the feedback loop. Similar circuits are used on the other legs of the R-2R circuit.

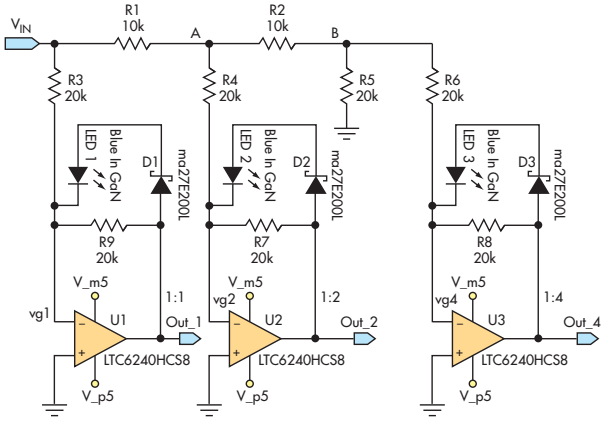
The output voltage from the op amp then feeds two circuits *(Fig. 3)*. The first circuit is a comparator with a threshold at V_{REF}. The comparator changes state when the op-amp output voltage exceeds V_{REF}, and its output provides information to the controller regarding the gain of the analog signal. The output of the op amps also goes to an input of U5, an analog multiplexer, whose output is determined by the comparator with the largest input signal that hasn't exceeded V_{REF} *(see table)*.

If U1's signal is the appropriate signal to feed into an ADC, then the voltage is not scaled (1:1) and the MSB of the ADC represents ½ V_{REF}. If U1 saturates, then the signal from U2 is used. The signal to the ADC is reduced by 2:1 and the MSB of the ADC represents V_{REF}, which is accomplished by performing a left shift on the ADC data. If U2 also saturates, then the signal from the U3 is used. The signal to the ADC reduces by 4:1 and the MSB of the ADC represents $2 \times V_{REF}$, in which case the ADC data shifts two bits to the left.

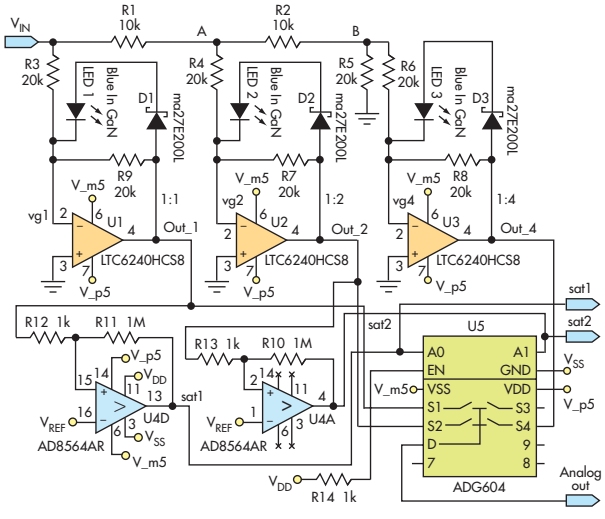
OUTPUT OF ANALOG MULTIPLEXER DRIVEN BY COMPARATORS

sat1 (A0 of ADG604)	sat2 (A1 of ADG604)	output of ADG640
0	0	Out_1
1	0	Out_2
0	1	Can't get here
1	1	Out_4

This circuit allows the signal to be measured with the full accuracy of the ADC within each range. A 1.0-V signal could be measured with 10-bit accuracy using a V_{REF} of 1.25 V (approximately 1.25 mV/bit), while a 4.0-V signal could also be measured with 10-bit accuracy (approximately 5 mV/bit) using the same ADC converter. The circuit also self-selects the appropriate gain of the signal while not overdriving the measurement circuitry during large signals. ed



2. Op amps are employed to create the virtual grounds needed to make the R-2R circuit work in the configuration. A pair of diodes is used with each op amp's feedback path to limit the voltage drop across the feedback resistor.



3. Shown is the complete design of the R-2R circuit with op-amps feeding comparators and an analog multiplexer.

STEVEN GALECKI is Manager of Engineering at Checkpoint Surgical Inc., a portfolio company of NDI Medical LLC, Cleveland, Ohio. He received a BSEE from Purdue University and is a Sr. Member of the IEEE. He can be reached at *sgalecki@yahoo.com*.

Text Encoding Simplifies Microcontroller Command Parsing

By DAVID HUNTER, First Consulting Inc.

WHEN WORKING ON a Microchip PIC project, I created a set of SCPI-style commands (Standard Commands for Programmable Instruments) to control the PIC. These SCPI commands use the first four characters of text words separated by a colon ':' character. In previous projects, I found that parsing text consumes significant computing time and code space; typically, text parsing is handled by string comparisons or developing a parsing tree. Neither of these techniques is simple to design and implement on a microcontroller.

I knew that it would be faster to parse commands if I could convert the text into 16-bit numbers, so I developed this method that converts the first four characters of each command to upper case, and then encodes them as a 16-bit number. Each character is translated into a four-bit representation, and then packed into a 16-bit number.

The obvious question is, *"Don't you need 5 bits to represent 26 letters?"* Yes, if each letter is treated uniquely. To reduce the letters to four bits, I did some analysis of two-letter pairs and grouped the letters based on how often they are used. This encoding worked out well for the 25 or so commands I needed. (More-extensive commands sets may need to be checked for duplication and the encoding changed accordingly.)

The encoding gives <space>, A,E,I,O,U,Y and S single codes, since they are very common. The consonants are subsequently grouped together in sets, as shown in the encoding chart here:

ENCODING CHART

4-bit code	Character
0000	<space>
0001	A
0010	E
0011	I
0100	O
0101	U
0110	Y
0111	S

This is a lookup table in C for the letters A-Z; note that the space character is handled separately.

```
const unsigned char LookUpTable[] =
{0x1,0xA,0xB,0xA,0x2,0xD,0xB,0xD,
0x3,0xF,0xC,0x8,0xE,0x9,0x4,0xC,0xF,
0x9,0x7,0x8,0x5,0xE,0xE,0xF,0x6,0xF};
```

These two examples show the encoding of SCPI commands:

Command :CLS<space>
translates to 0xB870

Command
:CALCulate:AVERage:COUNt
translates to 0xB18B,0x1E29,0xB459

After encoding the incoming text, parsing is now just a matter of checking 16-bit numbers rather than text strings. This can be done as a CASE statement or series of IF statements, either of which is much simpler (and usually faster) than handling text strings in a microcontroller. Using this approach greatly reduced the amount of code needed.

DAVID HUNTER is an Electrical Engineer with First Consulting Inc. in Rochester, N.Y. He has a BSEE and an MSEE from the Rochester Institute of Technology, and has worked for over 25 years as a design engineer in the areas of embedded-systems software, digital, analog, and RF circuit hardware design.

4-bit code	Character
1000	L, T
1001	N, R
1010	B, D
1011	C, G
1100	K, P
1101	F, H
1110	M, V, W
1111	J, Q, X, Z

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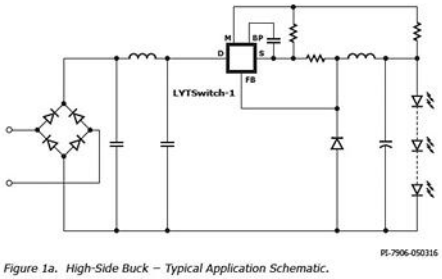

Figure 1a. High-Side Buck – Typical Application Schematic.

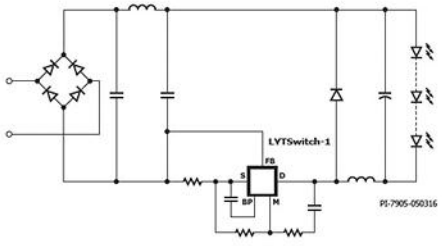

Figure 1b. Low-Side Buck – Typical Application Schematic.

Compact LED ICs Provide 0.9 PF, 93% Efficiency

BY UTILIZING Power Integrations' new LYTSwitch-1 single-stage non-isolated LED driver ICs, LED bulbs and tubes can be designed with high constant-current accuracy using a minimum number of components. Housed in a compact SO-8 package, the LED driver ICs use a novel driver algorithm that results in high power factor (PF < 0.9) and low total harmonic distortion (THD down to 15%), while achieving 93% efficiency.

The ICs, delivering up to 22 W without a heatsink, are universal input and incorporate a 725 V MOSFET for high reliability. Devices can be used in a low-side buck topology for reduced EMI or in a high-side buck topology for design simplicity. Small, off-the-shelf inductors can be used due to the unique peak current control algorithm. The LYTSwitch-1 LED driver ICs comply with international efficiency programs and standards such as: CEC Titles 20 and 24, ENERGY STAR Luminaires Version 2.0, EN61000-3-2 (C) plus China and India standards.

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MICROSEMI CORP.'S unique PDS-EM-8100 Power-over-Ethernet 2.5 Gbps Multiplexer enables installations of new 802.11ac access points with 2.5 Gbps rates without the need to replace the Ethernet switch with a 2.5G NBASE-T interface. The PoE multiplexer converts two ports of 1G into a single port with a 2.5G NBASE-T interface and 30 watt IEEE802.3at PoE. The compact, pre-configured device seeks to enable faster adoption of 802.11ac 2.5G for 2.5 Gbps product installations such as WLAN access points, small cells and other IP terminal installations.

As an alternative to using high-end PoE switches, the new device focuses on the specific needs of the communications market and more specifically, for Wi-Fi 802.11ac technology. It is suitable for fast-growing applications such as enterprise IT, with plug and play/zero configuration needed, and the ability to perform remote software upgrades. The PDS-EM-8100PoE 2.5 Gbps Multiplexer is available now for $399

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Basic Scope Exhibits Long Record Length

TEKTRONIX' NEW TBS2000 Series oscilloscopes utilize a 9-in. WVGA display, 20-million point record length, and 1 GS/s sample rate for capturing and displaying significantly more signal. The scopes feature new on-waveform cursor readouts and 32 automated measurements. The TekVPI probe interface works with traditional BNC connections, but also enables wide application coverage with the latest active voltage probes and current probes.

With features focused on learning engineering fundamentals, students can take a hands-on approach. TekSmartLab network-based software aids instructors in setting up and monitoring multiple instruments from one PC, and the Courseware ecosystem facilitates the loading of information into the TBS2000 and presents lab exercise guidance on the display.

The oscilloscopes give you 10 vertical divisions and 15 horizontal divisions, so more of a signal can be seen. Record length is selectable, from 2,000 samples up to 20 million samples for capturing long time periods. The exceptionally long record length will help find signal anomalies and verify digital communications. To help navigate long acquisitions, the Zoom function allows you to pan through the record and zoom in to see signal details. TBS2000 Series oscilloscopes are priced starting at $1,200.

TEKTRONIX

www.tek.com

LINEAR TECHNOLOGY

DESIGN NOTES

Uncompromised Clocking Solution for 16-Bit 2.5Gsps High Performance DAC

Design Note 555

Clarence Mayott

Introduction

The LTC®2000 16-bit 2.5Gsps DAC offers excellent AC performance. For many DAC applications, phase noise, noise spectral density (NSD), and spurious free dynamic range (SFDR) are critical to maximize the number of possible channels in a band without eroding the signal to noise ratio (SNR) in the band of interest. High speed DACs require a clean sample clock to achieve the best possible noise and spurious performance. Using the ultralow noise and spurious LTC6946 PLL synthesizer as a clock source for the LTC2000 maximizes system performance (Figure 1).

16-Bit High Speed DAC

The high spectral purity and low noise of the LTC2000 make it an excellent signal generator. Figure 2 highlights the excellent additive phase noise performance of the LTC2000 of –165dBc/Hz at 1MHz offset and –147dBc/Hz at 10kHz offset with a 65MHz output. For output frequencies up to 100MHz, the LTC2000 has NSD better than –166dBm/Hz and SFDR better than 76dB. For higher output frequencies up to 1GHz, the SFDR is more than 68dB and the NSD remains below –155dBm/Hz. Producing these results requires a clock with good noise, high spectral purity and excellent jitter performance.

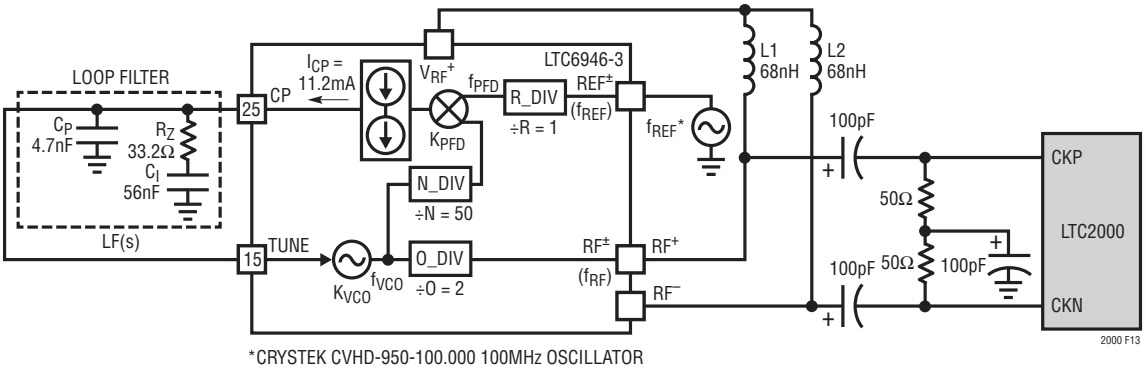

Figure 1. LTC6946 Driving the LTC2000

Frequency Synthesizer as a Clock Source

The LTC6946 is an integer-N frequency synthesizer with integrated VCO that can produce signals from 370MHz up to 6.39GHz. It features excellent phase noise performance and very low spurious content, making it ideal to clock the LTC2000 at 2.5GHz. It can drive the LTC2000 directly without filtering to produce a spectrally pure low noise output.

The LTC2000 divides the clock frequency (f_{CLK}) down to an output frequency (f_{OUT}). This frequency division causes the phase noise of the clock to appear at the DAC output, attenuated by a factor of 20 • log(f_{CLK}/f_{OUT}). The total phase noise at the DAC output will be a combination of the additive phase noise of the LTC2000 (Figure 2) and the attenuated phase noise of the LTC6946.

Wideband phase noise or jitter on the sample clock must be minimized to avoid degrading the NSD of the DAC output, and the low spurious content of the LTC6946 output is critical to maintain high SFDR at the output of the LTC2000.

The lower the phase noise, the closer signals generated by the LTC2000 can be spaced. This allows more information to be transmitted in a given bandwidth. With a lower phase noise floor, the total SNR of the system increases, which improves the integrity of the signal produced by the LTC2000.

Results

The single-sideband phase noise of the LTC2000 clocked by the LTC6946 is shown in Figure 3. The LTC6946 works well with the LTC2000, producing a clean clock that maximizes the DAC's performance. The combination of the LTC2000 and the LTC6946 offer phase noise and spurious performance comparable to the best signal generators. For more information visit www.linear.com.

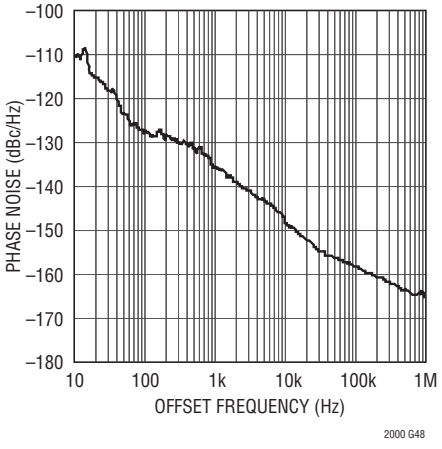

Figure 2. Additive Phase Noise of the LTC2000, f_{OUT} = 65MHz, f_{DAC} = 2.5GHz

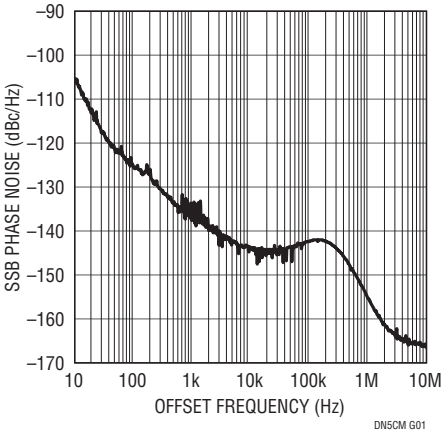

Figure 3. Phase Noise of the LTC2000 Output at 80MHz Clocked by the LTC6946-3

Data Sheet Download

www.linear.com/LTC2000

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H-Bridge Module Enables Full Current Bidirectional Operation

VINCOTECH HAS a new fastPACK 0 HC H-bridge module that improves UPS, SMPS, solar and welding applications in speed, efficiency and full-current capability for bidirectional usage. The module is available in the low-inductive flow 0 housing and features high-frequency 650 V IGBT H5 technology, which in combination with a fast diode, boosts efficiency and reliability. Suitable for soft switching to reduce switching losses, the device delivers 30+ kHz fsw.

The H-bridge module enables bidirectional operation for charger and SMPS applications with full current FWD. It is also equipped with integrated capacitors reducing electromagnetic interference.

VINCOTECH

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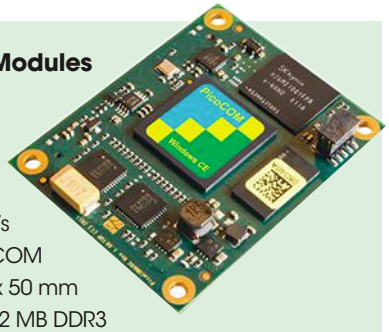
40 x 50 mm COM Modules Integrate ARM Cortex-A9, –M4



PICOCOMA9X IS the latest member of the F&S Elektronik Systeme's small-form factor PicoCOM module family. The 40 x 50 mm module offers up to 512 MB DDR3 RAM, 1 GB SLC NAND Flash and 32 GB eMMC, as well as an SD-Card slot interface. Other interfaces include 2x IEEE 1588 Ethernet, 1x USB host/1x device, 2x CAN, I2C, SPI, 3x UART, audio (line I/O), and digital I/O. A 16/18-bit RGB interface and a resistive touch-panel interface are also offered. The power supply is 3.3 V and power consumption is 2 W typ.

The processor is an NXP i.MX 6SoloX (ARM Cortex-A9 and –M4), which supports asymmetric multiprocessing. Both ARM Cortex cores are connected to the internal bus fabric and have the possibility to access all peripherals. The advantages of the M4 core are real-time processing and the interfaces are available immediately after power on.

All members of the PicoCOM product family are pin-compatible and have a robust 80-pole plug connector. Ported by the company's software department, Windows Embedded Compact 2013, Compact 7 and Linux OSs are available for the module.

F&S ELEKTRONIK SYSTEME

https://www.fs-net.de/en/

LPWAN SDK Provides Connectivity Out of the Box

WEIGHTLESS SIG'S new Weightless-P hardware, dubbed the Weightless Ignition Pack, enables a Weightless-P IoT network to be deployed out of the box' The pack includes a Weightless-P base station, end-device modules, antennas from Antenova, a full Weightless-P protocol stack for the base station, end device, host, and all necessary cabling.

Flexible channel assignment enhances network capacity by enabling frequency reuse in large scale deployments, while adaptive data rates from 200 bps to 100 kbps permit optimal radio resource usage. Time synchronized base stations allow for radio resource scheduling and utilization. The hardware uses GMSK and offset-QPSK modulation schemes which deliver optimum power amplifier efficiency. A low transmit power of 17 dBm allows the terminals to operate from coin cell batteries. Adaptive data rate also permits minimal transmit power for nodes with a cleaner signal path to the base station.

Operating across the entire range of license exempt sub-GHz ISM/SRD bands, Weightless-P is an Open Standard for high-capacity LPWAN. The Weightless Ignition Pack will be made available at a list price of $1,500, as part of a pre-launch offer on the Weightless website with a limited number offered to Weightless Developers free of charge. The pre-launch of a Weightless-P Software Development Kit is also under way.

WEIGHTLESS SIG

www.weightless.org

Rugged Embedded Computers Boost Storage Density

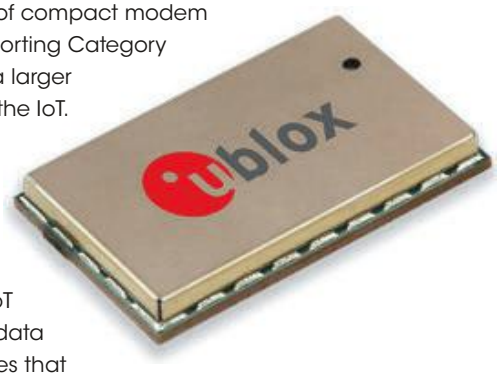
THE MXC-6400 Series of high-performance expandable fanless embedded computers from ADLINK Technology integrate 6th generation Intel Core i7/i5/i3 processors and the QM170 chipset. With its high storage density and rugged fanless construction withstanding operating shock up to 50 G and vibration to 5 Grms, the series meets the needs of ITS for rolling stock, maritime operations, in-vehicle infotainment, and high-speed data processing and mission-critical industrial automation. A front-mounted I/O array includes support for up to three independent displays via two DisplayPorts and one DVI-I port enabling up to 4 K UHD resolution, two software-programmable RS-232/422/485 + two RS-232 ports, three Intel GbE ports with teaming function, six USB 3.0 ports, and 16 CH DI and 16 CH DO.

ADLINK TECHNOLOGY

www.adlinktech.com

LTE Cat M1 Modules Targeted for IoT Apps

U-BLOX PLANS to launch a series of compact modem modules, the SARA-R4 series, supporting Category M1 LTE networks, which will allow a larger number of devices to connect to the IoT. Along with the recently released NB-IoT, LTE Cat M1 modules are part of the new 3GPP Release 13 standard supporting LPWA technologies in the licensed spectrum, and are designed for IoT applications with low to medium data throughput rates, as well as devices that require long battery lifetimes. Additionally, M1's vehicular handover capability delivers the technology necessary to support vehicle, asset and people tracking. Support for lower latency applications and a data rate of 375 kbps in half duplex mode and 1 mbps in full duplex mode are also included.



Market focus for LTE Cat M1 technology includes applications in areas such as the smart home, security systems, industrial monitoring and control, asset tracking, telematics, connected health, smart metering, smart cities and wearables.

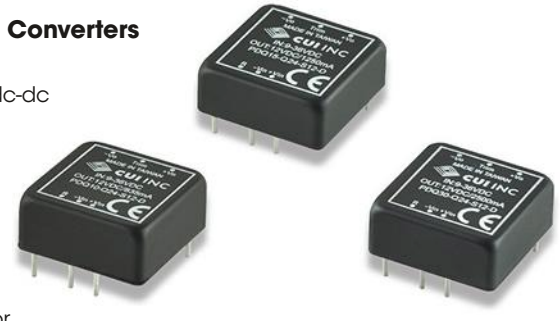
The first module out of the SARA-R4 series will be available in Q4 2016 targeting mobile network operators in the US market. The modules will follow u-blox' "nested design" philosophy to maintain form factor and software continuity.

U-BLOX

https://www.u-blox.com

Rugged, Isolated DC-DC Converters Increase Efficiency

CUI IS adding to its isolated dc-dc converters lineup with three new encapsulated models ranging from 10 W to 30 W, the PDQ10-D (10 W), PDQ15-D (15 W), and PDQ30-D (30 W). The models feature a 4:1 input voltage range of 9~36 or 18~75 Vdc with typical efficiencies up to 90%. All models offer an input to output isolation of 1,500 Vdc and feature remote on/off control, while single output models also offer output voltage trimming that allows for a ±10% adjustment of the nominal output. Protections for overvoltage, input under voltage lockout, and continuous short circuit are also included.



Housed in compact, low-profile DIP packages with five-sided, shielded metal case, the rugged, encapsulated modules measure 25.4 x 25.4 x 10.16 mm and come available with single regulated output voltages of 3.3, 5, 12 and 15 Vdc or dual regulated output voltages of ±5, ±12 and ±15 Vdc. With their -40°C to +105°C operating temperature range and encapsulated design, the modules are suited for convection-cooled equipment and harsh environments with target applications that include telecom, industrial, remote sensing and portable electronics. The PDQ10-D, PDQ-15-D and PDQ30-D are available immediately with prices starting at $21.84 each/100.

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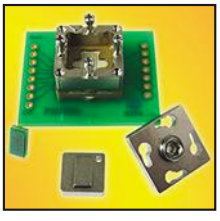
BGA Socket for IDT's wireless power receiver



Ironwood Electronics introduced BGA socket for IDT's wireless power receiver chip (BGA, 4x7.5mm, 0.5mm pitch, 98 position, 7x14 ball array) to wirelessly charge Galaxy S7. BGA socket uses a stamped spring pin with 31 gram actuation force per ball, cycle life of 125,000 insertions and operate -55C to +180C. The self inductance of the contactor is 0.88 nH, insertion loss < 1 dB at 15.7 GHz and capacitance 0.097pF.

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Web Site: www.ironwoodelectronics.com

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Integrated Fabric Is Key to Many Core Platforms

Intel's Knights Landing Xeon Phi is now shipping with built-in support for Intel's OmniPath fabric.

Intel's 14-nm, Knights Landing (KNL) Xeon Phi chip (*photo below*) now supports the OmniPath fabric. The chip has more cores (up to 72), memory, and the ability to be a host processor, but the addition of the fabric support will probably be the most important aspect of the system; it changes how large clusters are constructed for high-performance computing (HPC) environments.

OmniPath is Intel's answer to InfiniBand and other fabrics used in HPC applications. It is part of Intel's Scalable System Framework. OmniPath switches and adapters have previously been available, but adapters typically link to a host processor via PCI Express. This adds small but noticeable overhead and latency. It is designed to handle clusters with more than 10,000 nodes. OmniPath incorporates features like adaptive routing, dispersive routing, dynamic lane scaling, and packet integrity protection. It also employs traffic flow optimization algorithms. Links run at 100 Gbits/s.

The KNL Xeon Phi can run 288 threads with its 72 1.5-GHz cores. The cores are based on the Atom Silvermont, with enhancements including support for 4 cores/thread, deep out-of-order execution, scatter/gather support, and improved branch prediction. The system has a high bandwidth cache. The cores support AVX-512, the 512-bit version of Intel's Advanced Vector Extensions. This allows support of wider arrays. The cores are connected via a 2D mesh. The cores do not support virtual machines.

The chips have up to 16 Gbytes of Multi-Channel DRAM (MCDRAM) high-bandwidth memory (HBM) from Micron. It also has six memory channels that can access up to 384 Gbytes of DDR4 memory. The HBM bandwidth is 490 Gbytes/s. There are two integrated OmniPath providing 50 Gbyte/s bi-directional connections. The chip plugs into the LGA 3647 "Socket P." Internally the OmniPath support is linked to the many core matrices via dual x16 PCI Express links.

The Xeon Phi will be taking on various high-end GPGPUs like NVidia's Tesla P100 *(see "GPU Targets Deep Learning Applications" on electronicdesign.com)* using techniques such as deep learning. NVidia's Tesla P100 has 160 Gbyte/s NVLink connections to tie multiple chips together.

The Xeon Phi is supported by Intel's HP Orchestrator that is based on OpenHPC. It integrates provisioning tools, resource management applications, and development tools. It provides advanced testing support and validation for tools like Intel's Parallel Studio XE Cluster Edition 2016 Suite.

This latest fabric-based platform will definitely make things more interesting in the HPC space, and will likely find its way into high-performance embedded computing (HPEC) applications. ed

The 72-core, Knights Landing, Xeon Phi chip is available with built-in OmniPath fabric interfaces. The Groveport platform supports the Xeon Phi as a host processor.

Superior Performance

HIGH VOLTAGE DIODES - STANDARD AND CUSTOM

Dean Technology offers an exceptional range of high voltage diodes for all applications including power supplies, medical equipment, instrumentation, control systems, voltage multipliers and military. If our standard range of products aren't exactly right, we are able to customize every detail, generally with little to no increase in lead times or price.

Contact DTI today to find out about the exact diode for your high voltage or high power design.

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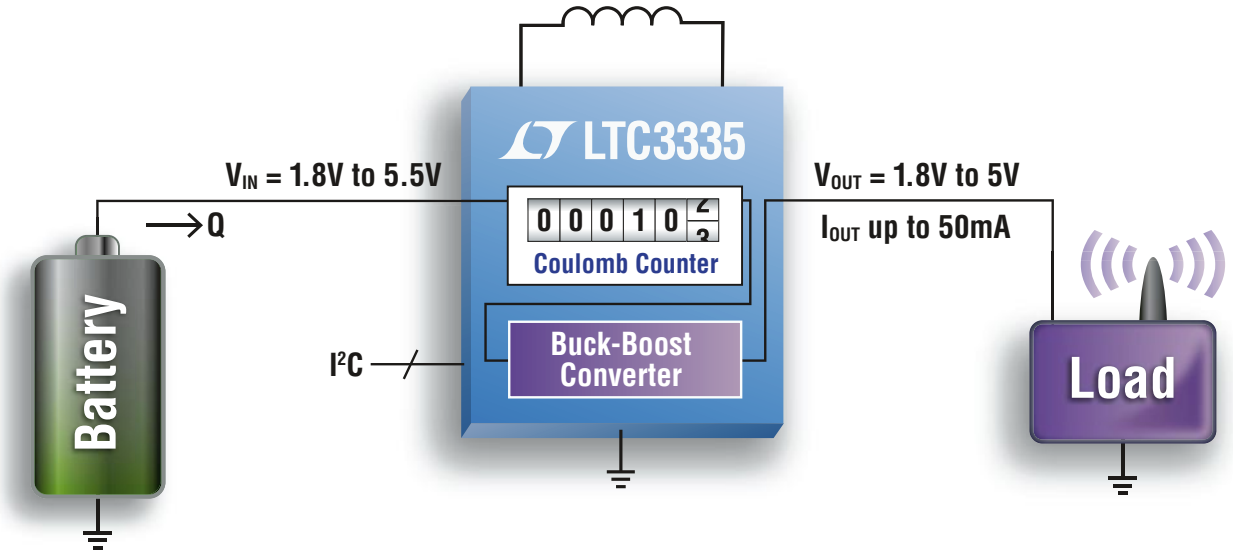
HVCA CKE HVPSI

PRODUCTS BY: DEAN TECHNOLOGY

680nA I_Q Buck-Boost Converter Counts Coulombs



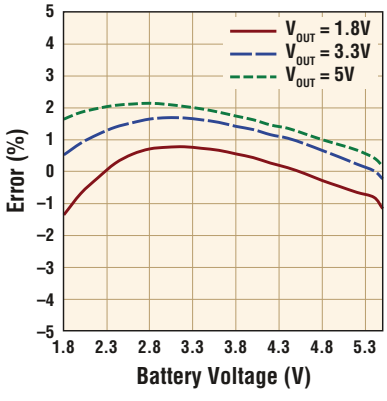
Accurate Coulomb Measurement of Battery Usage

The LTC®3335 provides a simple and accurate means to monitor battery state of charge while producing a regulated output. This buck-boost converter contains an integrated precision coulomb counter which is easily accessible via an I²C interface. The converter draws only 680nA quiescent current from the battery and offers a number of common fixed output voltage settings to eliminate the need for external resistors. It also features a programmable input current limit and delivers output currents up to 50mA at up to 90% efficiency.

Features

- 680nA Input Quiescent Current
- Input Voltage Range: 1.8V to 5.5V
- ±5% Accurate Coulomb Counter Measures Accumulated Battery Discharge
- Selectable Outputs: 1.8V, 2.5V, 2.8V, 3V, 3.3V, 3.6V, 4.5V & 5V
- Programmable Peak Input Current
- Up to 50mA of Output Current at 90% Efficiency

Total Unadjusted Coulomb Counter Error



Info & Free Samples

www.linear.com/product/LTC3335

1-800-4-LINEAR