electronic design

THE AUTHORITY ON EMERGING TECHNOLOGIES FOR DESIGN SOLUTIONS

January 2017 electronicdesign.com

Wireless in 2017:

HIGHER FASTER BETTER

p| 12

$10.00 Powered by Penton

Simplifying Your Life!

*Which Website Offers the Easiest Checkout Process?**

*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 "When purchasing electronic components online, which website offers the easiest checkout process?" The chart above shows the results among the industry's electronic component distributors.

AspenCore

Digi-Key is an authorized distributor for all supplier partners. New products added daily.

ecia MEMBER ecsn member CEDA

Digi-Key® ELECTRONICS

1.800.344.4539

DIGIKEY.COM

INJECTION MOLDING THAT CRUSHES CONVENTIONAL MANUFACTURING WISDOM.

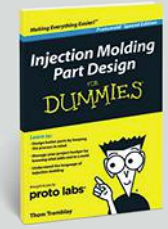
At Proto Labs, we have the automation and capacity to deliver low-volume production runs in just 15 days or less. We call this a game-changer.

DIGITAL MANUFACTURING FOR THOSE WHO NEED PARTS TOMORROW.

proto labs®

Real Parts. Really Fast.®

3D PRINTING | CNC MACHINING | INJECTION MOLDING



FREE BOOK

Request your Injection Molding for Dummies book at **go.protolabs.com/ED7ED.**

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.

www.deantechnology.com

HVCA CKE HVPSI

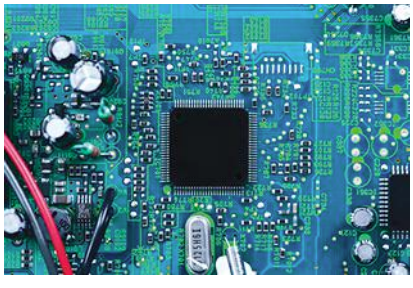
PRODUCTS BY: DEAN TECHNOLOGY

In This Issue

FEATURES

12

18



26

IDEAS FOR DESIGN

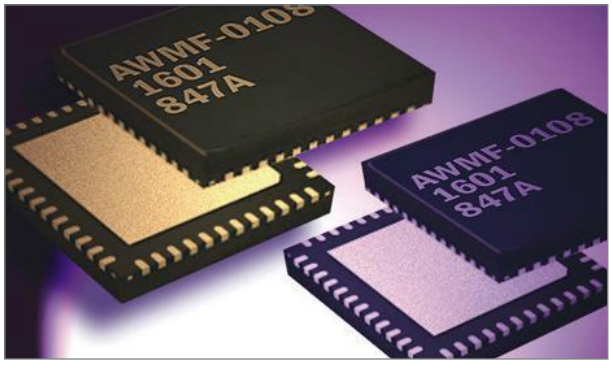
COLUMNS & DEPARTMENTS

42

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.

on electronicdesign.com



ARE IC TRANSCEIVERS READY TO SUPPORT 5G WIRELESS NETWORKS?

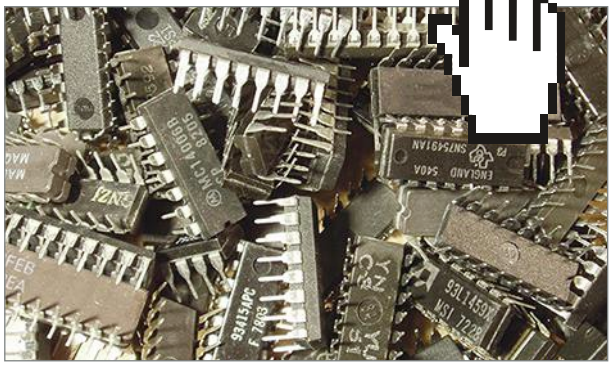
http://electronicdesign.com/communications/are-ic-transceivers-ready-support-5g-wireless-networks

The evolution of transceiver technology permitted the integration of multiple wideband transmitters and receivers on a single chip. The resulting solutions provide a reduction in SWaP (Size, Weight, and Power) without decreasing performance. Such an approach has allowed some transceiver ICs to promise early 5G support.

SIZE, SPEED, AND EFFICIENCY DRIVE COMPONENTS TRENDS

http://electronicdesign.com/iot/size-speed-and-efficiency-drive-components-trends

As electronic-component suppliers race to meet design engineers' requirements, their eyes and ears are tuned into a handful of trends dominating the industry—especially the Internet of Things (IoT).



RETRO ICS THAT WILL NEVER DIE

http://electronicdesign.com/blog/retro-ics-will-never-die

While ordering parts for some projects recently, Technology Editor Lou Frenzel discovered that many older ICs and transistors—some introduced as far back as the 1970s—remain in stock. Even more incredibly, distributors continue to sell millions of these throwback parts each year. So what's the deal?

6 THINGS TO KNOW ABOUT AUGMENTED REALITY

http://electronicdesign.com/embedded/6-things-know-about-augmented-reality

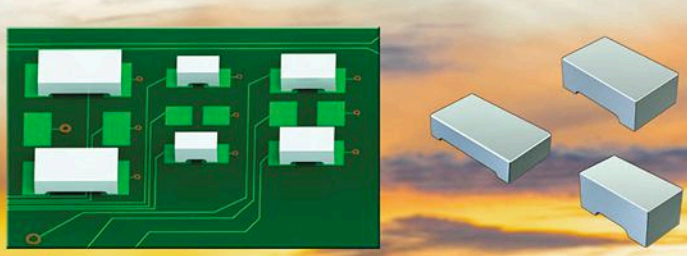
Augmented reality (AR) enhances and expands your view of the real world with computer-generated outputs, including sound, video, graphics, or GPS data. Many people first became aware of it when Google Glass arrived a few years ago, and augmented really hit the mainstream this last summer when Pokémon Go took off. AR has exciting implications for everything from education, defense, healthcare, and advertising, to construction, automotive, games, and much more.

join us online

Follow us on Facebook: http://tinyurl.com/odzo6hc and Twitter: http://tinyurl.com/k5pum39

THINK™

ZERO OHM SMT JUMPERS



• True Zero ohm jumper • Designed to replace 0603, 0805 and 1206 "Zero" ohm resistor chip sets without changing board designs or layouts • For high current applications • Low Impedence • Low profile • Manufactured from Copper with Silver plate • Supplied on tape and reel • Compatible with vacuum pick & place assembly systems • Other chip set sizes available upon request • Request Catalog M65

IT'S WHAT'S ON THE INSIDE THAT COUNTS

KEYSTONE®
ELECTRONICS CORP.

www.keyelco.com • (718) 956-8900 • (800) 221-5510

electronic design
Powered by Penton
JANUARY 2017

PENTON

1166 AVENUE OF THE AMERICAS, 10TH FLOOR
NEW YORK, NY 10036 **T** | 212.204.4200

Penton

Electronic Design | Machine Design | Microwaves & RF | Source ESB | Hydraulics & Pneumatics | Global Purchasing | Distribution Resource | Power Electronics | Defense Electronics

PENTON IS AN INFORMA BUSINESS

MARIA GUERRA | Technical Editor
maria.guerra@penton.com

BATTERY SAFETY: Do We Need New Regulations?

If Samsung's aggressive design is found to be behind the explosions of the Galaxy Note 7, will the safety regulations for lithium batteries change?

At the time of this writing, we are still waiting for an official announcement from Samsung concerning what caused Galaxy Note 7 batteries to catch fire and explode. However, a manufacturing technology company called Instrumental (www.instrumental.ai) is suggesting new reasons for this dangerous flaw—among them, that there was no space to allow for swelling of the battery. This insight has led me to think about whether safer regulation and standards for cell-phone battery designs should (and could) be implemented.

Instrumental decided to tear down a Galaxy Note 7, owing to a suspicion that the flaw was more than a battery part issue. The firm concluded that the smartphone's aggressive design was responsible for the battery explosions. "What we found was surprising: The design can compress the battery even during normal operation," said Anna Shedletsky, Instrumental's CEO and founder, in a blog entry *(https://www.instrumental.ai/blog/2016/12/1/aggressive-design-caused-samsung-galaxy-note-7-battery-explosions)*.

"Any battery engineer will tell you that it's necessary to leave some percentage of ceiling above the battery [10% is a rough rule-of-thumb]," Shedletsky noted. "Over time, the battery will expand into that space. Our two-month-old unit *(see photo)* had no ceiling: The battery and adhesive was 5.2 mm thick, resting in a 5.2-mm deep pocket. There should have been a 0.5-mm ceiling. This is what mechanical engineers call line-to-line. And since it breaks such a basic rule, it must have been intentional. It is even possible that our unit was under pressure when we opened it."

If Samsung—in an effort to innovate—pushed boundaries and consciously built a dangerous product, it begs the question: Should standards be changed to better reinforce the safety of consumers from product fails like this? It is confusing to understand which U.S. entities and international organizations take part in lithium-battery safety standards and regulations, and the roles those involved play. Equally unclear is how device manufacturers deal with battery certification. Some of the organizations that are actively addressing these issues include the Nationally Recognized Testing Laboratory (NRTL), the American National Standards Institute (ANSI), Underwriters Laboratories (UL), the Institute of Electrical and Electronics Engineers (IEEE), and the U.S. Consumer Product Safety Commission (CPSC).

This look inside a Galaxy Note shows the tight XY clearances to the battery. *(Courtesy of Instrumental)*

UL, for example, provides safety-related certification, validation, testing, inspection, auditing, advising, and training services to a wide range of clients, including manufacturers, retailers, policymakers, regulators, service companies, and consumers. The key standards are UL 1642, UL 1973, and UL 2580.

Given the crossover between them and the different missions of these organizations, it's hard to tell which group should step in and at what point. Maybe the Jurisdiction of Consumer Product Safety Commission should change the way it protects consumers by putting in steps to eliminate such product fails. Or should we better reinforce lithium-battery safety standards? Should test and certification procedures for designs change, too?

As an engineer, I admire and respect how design engineers are always seeking to innovate in order to increase battery operating times while reducing size and weight. But as a consumer of electronic products, I think safety should go first. I believe that stronger standards should be implemented to avoid another major fail design and protect consumers. Yet, such steps must be taken without over-limiting innovation.

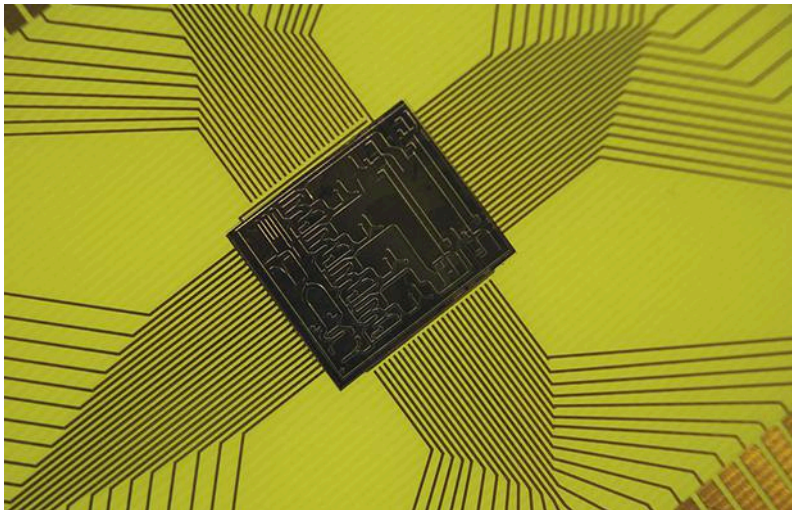
How about you? What do you think should be done?

News

GE SPINS OUT COMPANY
to Reimagine the Electronic Switch

For years, General Electric has used an electronic switch of its own design to control the circuits inside thousands of imaging machines it sells to hospitals. Now it's ready to stop getting high on its own supply and bring the switches to a wider audience.

Last month, the industrial conglomerate said that it had spun out a company to sell the parts in new markets, ranging from electric vehicle chargers to cellular equipment. The startup, Menlo Micro, based in Irvine, Calif., also said that it raised $18.7 million in funding from GE Ventures and others.



A typical microelectromechanical systems (MEMS) chip, the building block of Menlo Micro's new electronic switches.

Menlo Micro is the latest of several companies that claim to have reinvented the electronic switch, a primordial part of electronics that controls the flow of electricity in a circuit. Their switch is both an ancestor of the mechanical light switch invented over a century ago and a relative of the tiny switchboards inside Intel chips.

The startup's switches are made of micro-electromechanical systems, or MEMS, which are like microscopic cotton gins with interlocking parts. They handle kilowatts of power like mechanical switches, while having the speed and reliability of semiconductor devices, said Russ Garcia, Menlo's chief executive, in an interview. They also fabricated with a low-cost semiconductor process.

The switch operates with low resistance and low losses, making it better than electromechanical devices at reducing heat and enduring billions of switch cycles. Menlo's switches can be programmed digitally and could be used in relays that automatically control smart household devices, light bulbs, and heating systems in buildings.

"It is very close to an ideal switch," Garcia says.

The timing of Menlo Micro's launch is also advantageous. GE and rivals like Rockwell Automation are increasingly using layers of software and sensors to give factory equipment and medical devices more autonomy. The new switches can be used to remotely control a circuit breaker in electric vehicle chargers, manufacturing systems, or factory robots—all of which need hundreds of volts to be turned on. The company said in a briefing last week that Tesla, Nest, and Honeywell are target customers.

Menlo Micro's technology centers on a metal alloy that the company is keeping under wraps. Many of the patents were devised by Chris Keimel, the co-founder of Menlo Micro and its chief technology officer, while he worked on circuit breakers in GE's research and development division.

The work sprouted from not being able to find an extremely reliable MEMS switch, which Garcia said were the only devices that could handle the large power demands in industrial devices. GE engineers tested parts from multiple suppliers but kept on finding failure points.

"That brought about this thought—if we can't buy it we're going to make it," Garcia says.

What the engineers learned about switch failures paid off. Menlo Micro's devices have longer lifetimes than mechanical switches, which are prone to fail because the mechanism wears down either over time or after operating outside normal conditions. Though

semiconductor devices have longer life spans, the new switches last for billions of switch cycles without degrading, Garcia says.

The switches can also handle hundreds of volts while being small and efficient, running on a billionth of an amp, the company said. To handle these higher voltages, Menlo was forced to make some slight sacrifices. Their switch flips circuits in the microsecond range, as opposed to the nanosecond switching of semiconductors.

The tradeoffs have not deterred investors. Paladin Capital Group, Corning, and Microsemi chipped into the $18.7 million funding round with GE Ventures. The startup is using Corning's glass materials to improve the heat tolerance of its switch.

Menlo Micro is starting out with one product, the MM3300, a MEMS switch for radio frequency applications like military radio and wireless equipment. It might also be used in tunable filters that block out signals straying into smartphones or power amplifiers that beam signals directly into devices. The company said that it would license any mobile technologies.

The company is bound to have some competition. Cavendish Kinetics, a startup that makes MEMS switches for radio frequency applications, has raised over $68 million in funding and claims to have built devices that last for 100 billion switch cycles. Paul Del Santo, the company's chief executive, expects to sell over 10 million parts this year. Analog Devices and Memtronics also sell MEMS switches.

Garcia, a former vice president at Microsemi, said that the company has already proved its reliability of its switches in harsh industrial environments. "We already have proof of this," he says. "We have tens of thousands of pieces already out in the market because GE has been using them in its M.R.I. platform. And that has some of the more rigorous specs in the industry." ■

AMAZON PLUGS XILINX FPGA Into Its Cloud

AMAZON HAS BUILT a cloud computing business that has swelled to many times the size of its competitors. Now it is taking some time to test new ideas, like transferring trillions of bytes of data in a shipping container and plugging off-beat computer chips into its data centers.

Amazon Web Services, the company's cloud computing unit, said that it planned to offer a new service powered by field-programmable gate arrays, or FPGAs, in the latest sign that cloud companies are increasingly lured to the flexibility of configurable chips.

At an event in Las Vegas in December, the company said that it was using chips from Xilinx, one of the biggest makers of FPGAs. The chips can be quickly reprogrammed for various specialized jobs, ranging from searching through financial data to analyzing encryption algorithms. The Xilinx chips are built with circuits measuring just 16 nanometers long.

The FPGA's promise is that it's a jack and a master of all trades. Engineers can program them to handle tricky computing jobs like speech and image recognition better than general-purpose computers sold by Intel and the graphics chips devised by Nvidia. They also contrast with application-specific chips—like the machine-learning chips that Google devised for its data centers—which put all their energy into a single task.

"We are giving you the ability to design your own logic, simulate, and verify it using cloud-based tools," wrote Jeff Barr, the chief evangelist for Amazon Web Services, in a blog post. It is "a business model that is more akin to that used for every other type of software," he added.

Programming an FPGA is still extremely tricky, though. It can take months to plot the routes that electrical signals take over the chip—a fact that has slowed the FPGA's shift into the mainstream market. But over the last year, the technology's future has brightened and some big cloud companies are diving into it.

For instance, FPGAs are the keystone in Microsoft's Project Catapult, an initiative to improve how fast its cloud computing servers finish complicated tasks like machine learning. In October, China's search engine company Baidu said that it was using Xilinx chips to power artificial intelligence services. Nimbix, a supercomputing cloud company, recently said it would offer more powerful services based on Xilinx chips.

Meanwhile, Xilinx has worked to distinguish its technology from competitors like Intel, which bought Altera last year for $16.7 billion. Last month, the chipmaker announced its Reconfigurable Acceleration Stack, which includes libraries, frameworks, and developer boards for working with FGPAs. The chipmaker says that the tools will vastly improve an FPGA's computer efficiency, making them better at handling machine learning programs. ■

INFINEON JOINS SMART Appliance Security Lab in China

INFINEON HAS MADE chips that lock away encryption keys and other sensitive information inside things like smartphones into a pillar of its business. Now it is sharing its expertise in hardware and software security with companies in China eager to sell household appliances linked to the internet.

Infineon has jointly opened a research center in Beijing, called the Open Laboratory for Smart Home Interconnection Security, to develop stronger security technology for household devices. It is perhaps a sign that China's fear of cyberattacks outweighs its wariness toward foreign chipmakers and internet companies.

China has been trying to break its habit of binging on foreign semiconductors. In 2013, the country spent $232 billion on importing foreign chips, more than it spent on petroleum. The effort has included erecting obstacles for chipmakers like Qualcomm to do business in the country. Last year, Qualcomm fought antitrust allegations in China, which forced the company to lower its licensing fees for cellular chips used in smartphones.

The Chinese government also remains skittish about the potential for foreign chips to be used in foreign surveillance. In 2015, Chinese officials announced plans to test domestic versions of chips embedded in passports and identity cards, like the security chips built by foreign companies like Infineon and Dutch chipmaker NXP Semiconductors.

Infineon, based in Neubiberg, Germany, is the only member of the research initiative not from China. But it has spent years selling tiny security chips for credit cards and public transportation tickets in cities like Shenzhen, Guangdong Province. Infineon's China division has its headquarters in Shanghai and a manufacturng plant in Wuxi.

The other members include messaging and gaming giant Tencent, as well as the home appliance maker Midea and Huawei. Also involved is the China Electronics Standardization Institute, or CESI, which ratifies technology standards under the supervision of the Ministry of Industry and Information Technology.

"Together, we want to develop standards to better protect connected smart home appliances that are increasingly part of the Internet of Things," said Helmut Gassel, a member of the management board of Infineon, in a statement. "The joint lab is a major step forward in increasing consumers' privacy."

China is the fastest-growing market for smart appliances, which range from tiny sensors inside refrigerators to smart-home gateways with a full operating system and user interface. These devices can be connected to the internet using an IP address, making them potentially vulnerable to attacks. Consumers in China are expected to buy 223 million smart-home devices in 2020, up from 15 million in 2016, according to research firm IHS Markit. ■

TOYOTA EAVESDROPS ON Battery Chemistry in Search of Breakthroughs

TOYOTA STUMBLED THROUGH the gate with electric vehicles, shuttering several pure electric models because of poor sales and instead pouring money into hybrids and vehicles powered by hydrogen fuel cells. But the company has not stopped studying the fundamental battery tech used inside electric cars.

The Japanese automaker reported in December a new way of viewing the movement of particles that generate current inside batteries. That insight is critical to understanding the chemistry of lithium-ion batteries and could guide scientists to advances in storage capacity and durability.

Toyota's new tool allows scientists to follow the path of lithium ions flowing within battery electrodes. Those movements are extremely hard to detect, but understanding them could prove useful in testing new battery materials and structures that extend the driving range of hybrids and electric cars.

Toyota developed the new technology with Japan's Synchrotron Radiation Research Institute and the Institute of Physical and Chemical Research, or Riken. It used Riken's X-Ray facility to test the procedure.

Toyota also said that the observation method will give scientists a window into "the behavior of Li-ions in the electrolyte under the same environment and conditions as when it is being used." There is also potential to better grasp how the batteries deteriorate after multiple charging cycles.

Toyota's new observation method for lithiumion batteries.

Toyota has largely stayed out of the market for electric vehicles, shutting down production of its last pure electric model in 2015, outpaced and outgunned by Japanese rival Nissan, which has sold around half of all electric vehicles on the road. Toyota has instead promoted fuel cell vehicles that consume hydrogen fuel.

The company plans to share its observation method with other electric vehicle makers, but it will not share its findings, according to a report from the Associated Press. It is also building a new electric vehicle that will enter the market in "several years," the company told the Associated Press. ■

INTEL TO INCREASE Focus on Automated Driving Technology

INTEL HAS RESTRUCTURED its business to emphasize its ambitions in the growing market for automotive chips. It has also hired an executive from rival chip architect ARM to improve the odds that its chips will power devices like thermostats and factory equipment.

The company has formed a new division called the Automated Driving Group, which will devise technology to let cars sense their surroundings, connect to the internet, and avoid collisions. It will split from another division selling chips for the Internet of Things, which includes devices like connected sensors and industrial robots.

Doug Davis, a senior vice president who has been running the Internet of Things group, will serve as the general manager of the automotive unit. Intel said he postponed his retirement to take the job, which involves carving out part of an automotive chip market worth around $30 billion last year.

Kathy Winter, a former executive at auto component supplier Delphi, will serve as general manager of a division of the group focused on automated driving solutions. She defected to Intel in August after heading Delphi's automated driving software and services efforts.

Intel's automotive plans have broadened since its sudden exit from mobile chips last year, which turned its focus to blue-collar computing jobs in factories and car dashboards. In October, it announced a new Atom chip for digital gauges and dashboard displays in cars. It will be available in the first half of 2017, said Ken Caviasca, a vice president of Intel's Internet of Things unit, in an interview.

Intel has also planned to pour money into autonomous driving technology. Early last year, it entered a partnership with machine vision chipmaker Mobileye and BMW to build cars that drive themselves on city streets. In addition, it has pledged to invest $250 million in autonomous car technology over the next two years. ■

Not To Be Left Out, MEDIATEK PLOTS STRATEGY FOR AUTOMOTIVE CHIPS

THE MARKET FOR automotive chips is an increasingly crowded field. Most major chip manufacturers, including Intel and Qualcomm, are trying to translate their success in personal computers and smartphones into car electronics. Others entrenched in the market, like Renesas and STMicroelectronics, are trying to hold onto their lead.

Mediatek, the biggest supplier of chips to China's mobile phone industry, does not want to be left out. The chipmaker outlined its initial strategy for automotive chips, saying that its products will help cars visualize the road and share their location over the internet. The first samples will be available in the first quarter of 2017, the company said.

The Taiwanese chipmaker is known for selling processors and cellular chips in low-end phones in China and India, as well as products for televisions and tablets. But it has always strived for the international clout of adversaries like Qualcomm and Samsung. The company has gone so far as to make overly powerful smartphone chips with eight computing cores to grab some of the spotlight.

Now the chipmaker is looking to bring its experience to the automotive market. It is aiming to provide chips for car entertainment, connectivity, and millimeter-wave radar to enhance vehicle safety. It also tipped a vision processing unit that will carry out tasks like tracking highway lanes and that will presumably compete with machine vision chips from most major chip firms.

If those parts seem complementary, that is what Mediatek intended. "MediaTek will bring one integrated package of semiconductors to the market," said J.C. Hsu, general manager of the new business unit, in a statement. It is "a holistic solution that is now lacking in the auto industry," he said.

To fill that technology gap, major chipmakers are increasingly willing to spend billions on new technology. Qualcomm has taken the most drastic shift, buying NXP Semiconductors, the world's biggest automotive chip seller, for around $47 billion including debt. The deal has the potential to fundamentally alter the mobile chip maker, giving it access to factories and storerooms of automotive chips.

Others have responded. While Samsung bought automotive audio supplier Harman for $14 billion, Intel recently vowed to invest $250 million in autonomous driving over the next two years. The world's largest chipmaker has also created a new business unit for self-driving cars and staffed it with former industry executives.

Mediatek has not been the subject of similar headlines, but its new strategy builds on Mediatek chairman Tsai Ming-Kai's pledge to invest more than $6 billion over the next five years into self-driving cars and artificial intelligence. The company has also provisioned around 100 engineers to work on 5G technologies, some of which could be used to connect cars. ■

LOU FRENZEL | Contributing Editor

Major Wireless Developments Driving 2017 Agendas

IoT and 5G top the list of dominant communications trends this year.

The overall trend affecting wireless communications (along with other sectors of electronics) is the perpetual quest for higher computing speeds and faster data rates. Edholm's law indicates that bandwidth and data rates have doubled every 18 months over the past three decades. That trend continues. Driving that movement is the greater use of video, the forthcoming VR glut, and the adoption of the new ways that society generates and consumes information and entertainment. Those processes increasingly stress most communications channels. As user capacity also increases, the only natural solution is faster data rates.

With that overall trend in mind, this article outlines progress in some major wireless communications movements, including the Internet of Things (IoT) and the Fifth-Generation (5G) cellular system. Other trends to be covered include progress in the Advanced Driver Assistance Systems (ADAS) automotive program and forthcoming developments with the ubiquitous Wi-Fi.

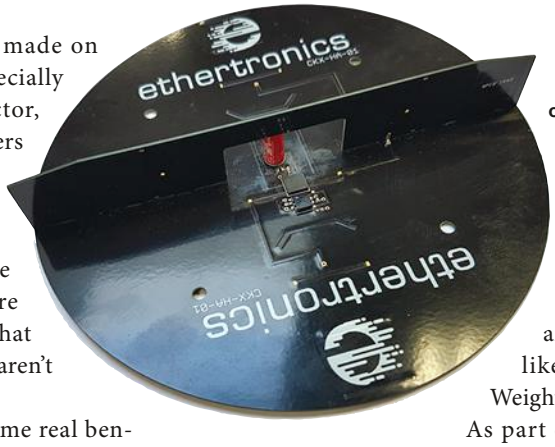
1. The Anritsu MS2840A is a spectrum and signal analyzer that offers models with an upper frequency limit of 26.5 or 44.5 GHz. It is the base instrument for 5G testing.

IoT COMING INTO ITS OWN

IoT has been with us for years, but it is finally beginning to blossom into the network of billions of connected devices predicted by many. Two major growth areas are consumer and industrial. For example, in the consumer space there is an ever-increasing number of wearable products launching. Fitness watches are popular—as are shoe insoles and other devices—for monitoring physical attributes such as pulse and actions like number of steps taken. Medical wearables are also growing in number, making critical monitoring easier.

Home automation is another growing consumer IoT sector. Security and HVAC systems are increasingly made IoT-compatible. Lighting systems using IoT wireless light bulbs are now available, and more and more major appliances are incorporating some wireless connectivity. Wireless door locks and video monitoring systems are becoming more common. Pet and other animal monitoring is a growing application. Wi-Fi and Bluetooth are the dominant wireless technologies used, but others are also involved—for example, 802.15.4 and its ZigBee and Thread derivatives, as well as Z-Wave.

While progress has been made on the consumer IoT front, especially in the home automation sector, the bad news is that consumers are still not buying into the concept (much less know of its existence). Those who are cognizant of IoT believe devices incorporating IoT are just gadgets and gimmicks that may be nice to have, but just aren't necessary.



2. Ethertronics' V2X is a smart active antenna for DSRC and the European equivalent. It offers a peak 5 dBi gain and either vertical or horizontal polarization.

Successful devices offer some real benefit and convenience or some addictive behavior. Some such products include thermostats, smartphone video monitors, door locks, and lighting. Many consumers have trouble seeing any real convenience or monetary advantage in products like Wi-Fi refrigerators or other appliances. Some say that the most successful IoT products will be those accompanied by some related service. One example is Netflix, Hulu, and YouTube video over Wi-Fi via a Roku over the top (OTT) video box. Nevertheless, the consumer IoT segment will continue to grow, and the marketplace will begin to sort out what is useful and what is not.

The other IoT growth segment is industrial IoT (IIoT). The good news is that IIoT is seeing most of the action and growth because applications are more easily recognized and benefits more clearly identified. As the incoming U.S. administration pushes for more manufacturing on shore, manufacturing will become more automated, featuring AI-controlled robots and other machines. This movement is what is being called Industry 4.0.

New equipment and systems will deploy hundreds of sensors to collect data about the machines and the processes. Older manufacturing plants will begin to retrofit existing equipment with more sensors and wireless interconnections. In both new and retrofitted facilities, sensors will collect tons of data that will be sent to the cloud for analysis and decision-making—all in order to improve overall productivity, boost reliability, and lower costs. Industrial IoT just makes sense, and that is why it has seen greater adoption than consumer IoT.

Some other key trends to follow are:

The importance of security. This issue continues to hold back the adoption of IoT in all segments. Multiple efforts are underway to develop true secure methods to protect IoT wireless nodes. Otherwise, what we will face is billions of new nodes ripe for hacking.

The emergence of a long-range category. Most current IoT wireless products use short-range technologies like Wi-Fi, Bluetooth, ZigBee, and others. Range extends from a few meters to about 100 meters. A need has been identified for longer-range connections of devices. This need is beginning to be met by chip, module, and system vendors with technologies like LoRa, Sigfox, Nwave, Ingenu, and Weightless.

As part of this movement, cellular IoT (*née* M2M) is rapidly developing. This is the use of existing LTE cellular systems called LTE-M to carry data for remote monitoring and control operations. For example, the NB-IoT version offers up to 250 kb/s in a 180 kHz OFDM narrowband channel that fits nicely into existing LTE bands. Other LTE-M versions use 1.4, 10, or 20 MHz channels for higher data rates. This is clearly a fast-growing long range sector.

No standards solution. The multiple standards problem, if it is actually a problem, won't go away. On one hand, multiple standards and product choices are good for developers, as one size does not fit all and the opportunity exists to choose the standard that best fits the application. The downside of this is lack of interoperability between devices and systems. For many applications, however, this is not an issue. In any case, the market will eventually dictate which standards survive.

A lack of qualified personnel. That is business as usual for any new technology. No one has multiple years of IoT experience, yet. Development of IoT is slowed as companies seek people with the right background. Wireless engineers are definitely helpful, but the real need is for programmers and systems designers. IoT is more of a software challenge than a hardware issue.

5G WIRELESS

The Fifth-Generation cellular system is a work in progress; the Third-Generation Partnership Project (3GPP) is grinding away at the standards details. A final standard is scheduled for the 2019-2020 timeframe, although one carrier (AT&T) is pushing for earlier standard definition in 2017. That may not happen, but it shows the need and interest for faster systems with increased user capacity.

Here is an overview of 5G today:

- Small cells. The 5G system will be a network of small cells mounted on walls, lamp posts, and small masts, as well as indoors. Typical range will be 100 to 200 meters.
- Data rate. The goal is 10 Gb/s under the best conditions. Real data rates will approach 1 Gb/s, but with a common average of 100 to 500 Mb/s.

One clear trend is the advanced work done by the test equipment manufacturers. These companies have really stepped up and contributed to the 5G standards work, as well as providing the incredibly complex test instruments and software needed to evaluate and develop 5G products.

- Carrier aggregation. Increased bandwidth via combining channels will permit even-higher data rates. This includes the use of unlicensed spectrum such as the 5 GHz ISM/UNII band.
- Latency. Less than 1 ms.
- Modulation. Some variation of OFDM for downstream and a single-carrier variant for uplink.
- Duplexing. TDD.
- Spectrum. Millimeter wave (30 to 300 GHz range) spectrum. 27.5 to 30 GHz, plus 37 and 39 GHz in the U.S.
- Massive multiple-input multiple-output (MIMO). Multi-user MIMO. Antenna arrays from 16 to 1,024 elements.
- Antennas. Active beam steering phased-array antennas for high gain and directivity.

The real key to the success of 5G is the adoption of massive MIMO technology with phased-array beam steering. Beam steering points the antenna in the right direction and focuses the beam to produce boosted transmitter power and higher receiver gain and sensitivity. This increases link reliability and minimizes interference with nearby cells.

There is no clear indication as to how 5G will fit into a smartphone. Apple, Samsung, and the others are just beginning to figure out how to package all that millimeter-wave circuitry with its MU-MIMO and adaptive beamforming phased array, along with the LTE "legacy" hardware.

Because of that challenge and the need for carriers to profit from 5G investments early on, one prediction is that initial 5G service will be fixed wireless broadband. This, of course, is internet connectivity for companies and consumers in competition with existing cable TV, DSL, and fiber broadband providers. That is a promising scenario. Carriers will be busy for years enabling 5G while maintaining and upgrading their 4G LTE networks.

Keep in mind that 4G LTE systems will still remain active for years to come. As it stands, many carriers have yet to upgrade sites to LTE-Advanced Pro (4.5G) that uses carrier aggregation to boost bandwidth and data rate. LTE-Advanced Pro includes key features such as Licensed Assisted Access (LAA) that uses the 5 GHz Wi-Fi band in conjunction with licensed spectrum to provide more bandwidth and higher speeds. Other features are 3D/FD-MIMO (Full Dimension) and latency reduction, among other enhancements. It will boost speed to the 1 Gb/s range, keeping LTE vital until full 5G arrives.

Also, because of 5G's short range in the millimeter spectrum, it will take up to 10 times the number of small cell sites to provide the same coverage as 4G today. That investment will be spread out over a long time. Look for a long life for LTE-A even after 5G shows up.

A question some are asking is how IoT and 5G will intersect, if at all. One possibility is that 5G will provide the capacity to handle the billions of IoT nodes predicted to emerge in the years to come. While high data rates won't be an issue, the availability of adequate coverage will be. 3GPP added the LTE-M and NB-IoT specifications into the LTE standards, so perhaps we can expect to see some IoT provisions in the 5G specifications.

One clear trend is the advanced work done by the test equipment manufacturers. These companies have really stepped up and contributed to the 5G standards work as well as providing the incredibly complex test instruments and software needed to evaluate and develop 5G products. Congratulations and thanks go to Anritsu, Keysight, National Instruments, Rohde & Schwarz, Tektronix, and others involved in this effort. An example is shown in *Fig. 1*. This is Anritsu's MS2840A spectrum/signal analyzer that is the base for 5G testing.

THE CONNECTED CAR

The adoption of electronic systems in automobiles continues to increase. Vehicles already use dozens if not hundreds of sensors and microcontrollers to monitor and control multiple subsystems. Infotainment, hands-free, and GPS navigation systems are commonplace. Newer vehicles are embracing advanced driver assistance systems (ADAS) that include backup cameras, lane departure detection, adaptive cruise control, and automatic braking. Many vehicles already have built in Wi-Fi hotspots using an LTE cellular link. Now cars are set to become even more connected thanks to programs set forth by the National Highway Transportation Safety Administration (NHTSA).

The new systems enable vehicles to talk to one another (V2V), to nearby infrastructure (V2I), or to other external resources (V2X). Such communications will take place automatically without driver assistance or intervention, although a driver interface will provide notifications and interaction. This communications is expected to be implemented with the Dedicated Short Range Communications (DSRC) system that uses 75 MHz in the 5 GHz band (5.85-5.925 GHz). Vendors are already showing products for DSRC like Ethertronics' Vehicle to Everything (V2X) antenna *(Fig. 2)*.

The radio technology of DSRC is 802.11p a variant of Wi-Fi. It is similar to 802.11a in that it uses 52 OFDM subcarriers. Instead of the usual 20 MHz channels, 11p specifies seven 10 MHz channels with modulation options that implement data rates from 3 Mb/s to 27 Mb/s. Vehicles will exchange data in the form of a Basic Safety Message (BSM) 10 times per second. The BSM contains information on GPS location, speed, direction, and related conditions. The goal is to have vehicles aware of one another so as to avoid collisions. The NHTSA projects huge decreases in the number of accidents and injuries and an increase in the number of lives saved.

V2I communications involves connections between vehicles and roadside units that will transmit safety and traffic information such as weather, road conditions, traffic light status, nearby accidents and other hazards, parking availability, and tolls. The safety goals of the NHTSA and related benefits will not occur until a critical mass of vehicles are deployed with V2V capability and V2I networks. That will be years in coming. While NHTSA has mandated the incorporation of V2V, it has not announced a requirement date. Automobile manufacturers are beginning to plan for this. As of now, only the 2017 Cadillac CTS has DSRC.

Two issues are apparently slowing adoption. First, the FCC announced that it was considering the use of the DSRC 5 GHz spectrum for expanding Wi-Fi. New Wi-Fi channels would be shared with DSRC spectrum. Many worry that interference between the two services would make DSRC or 802.11ac less reliable. The auto industry prefers 802.11p without Wi-Fi interference. That issue still needs to be resolved.

Second, some say that cellular LTE or cellular 5G (C-5G) should replace DSRC. With new technologies like LTE-M and NB-IoT (and eventually C-5G), vehicles could take advantage of existing communications networks and eliminate the need for a new V2I network. A hybrid system may be possible by using DSRC for V2V and V2I and using cellular connections for V2X. Deliberation continues.

Of course, the self-driving car will be connected with the same technologies. Yet autonomous vehicles are still years away. The delay is no longer a technological problem. The hold-ups are mainly legislative- and insurance-related.

3. Quantenna Communications' QSR10G-AX chip is designed to implement 11ax access points.

A WORD ABOUT WI-FI

Wi-Fi continues to be not only relevant, but essential to our communications infrastructures. One estimate says that at least 50% of all internet connections occur through Wi-Fi. It has become ubiquitous and addictive. Thankfully, that standard continues to grow and evolve with the times. Devices using the 802.11ac standard have come online quickly, greatly boosting data rates. We can look forward to the 802.11ax standard that is an upgrade over 11ac.

The goal of 11ax is to improve the average throughput per user by a factor of 4 in dense user environments. It achieves this by using OFDMA and multi-user MIMO with beamforming, plus a boost in data rate. The standard supports 8 streams of data in the 5 GHz band and 4 streams in the 2.4 GHz band. It can support a shared data rate up to 7 Gb/s using a 160 MHz channel and 1024QAM. Multiple users can get fast service simultaneously. The 802.11ax is still in draft status, with ratification expected shortly. Already, Quantenna Communications is offering an 11ax chip for access point implementation designated the QSR10G-AX *(Fig. 3)*. Rapid adoption of 11ax is expected.

Also look for increased adoption of the 802.11ad standard called WiGig. It uses the 60 GHz ISM band to achieve data rates of up to 3 Gb/s to a range of 10 meters. Now that the Wi-Fi Alliance has implemented a testing and certification program to ensure interoperability, 11ad should be more widely deployed. Wireless links to replace HDMI, Thunderbolt, and USB-C wired connections are possibilities for video transport. An even faster successor called 11ay is being developed by the IEEE 802 working group.

WIRELESS HOPE

As the relentless push for higher wireless data rates increases and as spectrum space becomes more limited, new technologies are thankfully offering hope for the future. One obvious path forward is to continue to move more products and services into the higher frequencies where the bandwidth exists to support the higher data rates. This is an

Within the coming years the mmwave bands will fill up, and then what? Relax: There is still some room above the mm-wave bands to be tapped.

ongoing process, and we are witnessing it right now as the cellular service is pushing into the millimeter (mm) wave region (30-300 GHz).

Within the coming years the mmwave bands will fill up, and then what? Relax: There is still some room above the mm-wave bands to be tapped. Specifically, there is the region from 300 GHz to infrared (IR) known as the Terahertz (THz) portion of the spectrum. (A THz is 1000 GHz, or 10^{12} Hz.) The upper limit of the THz region is sometimes called far infrared (FIR), that segment where radio waves morph into light waves.

This fertile wireless space is essentially untapped, mainly because there are few devices capable of operating at these exalted frequencies. But that is changing. Research and development in semiconductors is now making transistors and integrated circuits for THz use. HEMT and HBT transistors made from InP can produce gain and switching to well above 200 GHz. Even SiGe, GaAs, and Si CMOS have been demonstrated to work at frequencies to 850 GHz.

The downside of THz waves is that, like light, they do not penetrate obstacles. And there is considerable oxygen absorption of the waves, making attention high for long-range operation. There are nevertheless workarounds, and new applications will be discovered as the technology becomes available. While millimeter-wave band technologies will probably peak out at a data rate of 10 Gb/s, look for 100 Gb/s rates and potentially 1 Tb/s with the THz technologies. There is hope in our lifetime. ed

VOICE COMMUNICATIONS BECOMING MORE COMMON

HUMANS COMMUNICATE BY VOICE. Now voice-to-devices communications is becoming a popular technology. For example, I have used the Dragon (Nuance) voice-to-text translation software in my writing for years; in fact, I've dictated several books with it. While error-prone in its early years, Dragon has improved dramatically over the years thanks to major improvement in artificial intelligence voice recognition software and hardware. And those improvements are now being incorporated into more and more products.

Voice technology is now common in many cars to facilitate more hands-free operation of phone and entertainment devices. And what smartphone does not have AI voice technology? To wit: Apple's iPhones has Siri, Samsung's Galaxy has S Voice, and Google's Pixel has Google Assistant.

Amazon's Echo personal digital assistant Alexa answers questions and provides access to music, and can even control some home electronic products like lights and thermostats.

Now we have a whole new class of voice-activated devices, including home automation and control systems like Amazon's Echo and Google's Home. Known as voice assistants, both serve as Bluetooth speakers and answer questions like Siri. They can also provide control of home IoT devices such as lighting, security, and thermostats. These two devices work by way of the companies' music subscription, plus Spotify and Pandora. And you can even order products from Amazon using Echo.

More home assistants are on the way. To help with that, Qorvo's new GP712 radio chip supports multiple communications protocols suited to connected home applications. This chip should bring ZigBee and Thread IoT devices for more voice-activated personal home assistants. Voice-activation used to be iffy. But today, thanks to AI and readily available wireless, it has become far more accurate and reliable. A definite growth trend. ■


WISHING YOU ALL A HAPPY AND PROSPEROUS 2017
MPD
HELPING YOUR IDEAS COME TO LIGHT THIS 2017
* MEMORY PROTECTION DEVICES *
THE INDUSTRY STANDARD SINCE THE 80'S
MPD
MEMORY PROTECTION DEVICES
BATTERYHOLDERS.COM

WILLIAM WONG | Embedded/Systems/Software Editor

These Trends Will Shape Embedded Tech in 2017

Despite its ups and downs, IoT still headlines the embedded arena, with AI and augmented/virtual reality making greater inroads in this rather turbulent market.

It looks like 2017 is shaping up to be an interesting year in the embedded-technology space—for a variety of reasons. We're coming off a year that saw a number of large mergers, and the change in the U.S. political climate is significant.

Tom Starnes, analyst with Objective Analysis, notes, "One country's loss is another's gain as corporations try to hold on to as much of their revenues as they can in very complex and competitive markets for sophisticated technology. Meantime, the very-global chip industry has been consolidating at a rate and with a mass not seen before, with all but a few companies struggling for profitability."

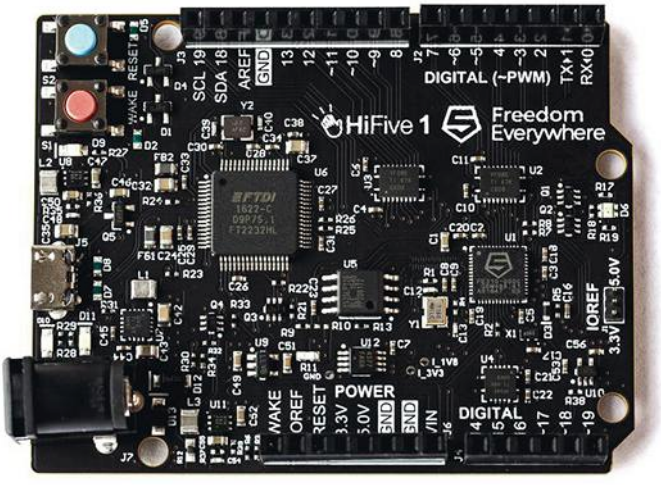
Jim Handy says, "Objective Analysis expects the memory business to be highly profitable in 2017, followed by a collapse beginning in mid-2018."

Not only will the chip industry be chaotic, but most of the related technologies will experience new and disruptive advances. I'll highlight five hot topic areas at this point just to keep things manageable:

- The Internet of Things (IoT)
- Processor technology
- Artificial intelligence
- Storage
- Virtual reality and augmented reality

THE IoT AND EMBEDDED SOFTWARE

The Internet of Things (IoT) will continue to be a market that involves everyone, but confusion reigns supreme. Developers get a break if they determine whether they're targeting IoT for consumer, commercial, or industrial applications, as these have much different characteristics when it comes to networking, management, and security (see "*What's the Difference Between Consumer and Industrial IoT*?" *on electronic design.com*).



1. SiFive's Freedom 32-bit RISC-V E310 powers the Arduino-compatible HiFive1 board.

IoT-specific hardware will benefit many applications, but software remains the key to successful IoT solutions. "Software continues to take on a proportionally larger role in functionality, safety, and security for IoT devices, relative to hardware," says Andrew Girson, CEO of Barr Group. "The enforcement of discipline and quality in the coding process through coding standards such as MISRA is growing. However, as indicated by Barr Group's *2016 Embedded Safety & Security Survey*, as a profession, we still have a long way to go when it comes to using industry best practices for the development of safer and more secure embedded systems."

Developers that deliver quality code, not just for safety- and security-related applications, will have an edge in the IoT space because over-the-air updates only help to address problems after the fact. Though wireless connectivity significantly

reduces corrections in the field, the cost of bugs still grows exponentially as code moves from the developer through testing to deployment.

"The reality is, safety and security are clearly coupled. We believe that systems are not safe without security," says Jim McElroy, Vice president of marketing for LDRA. "Industry concern is accelerating pertaining to security, and in 2017, we expect to see our customers needing to comply with the developing security standards, as they have done in the functional safety area."

MISRA is one of the best options for C and C++ developers, although programming languages like Java and even Ada offer improvements that should not be overlooked. Good tools such as static analysis will return huge benefits to IoT developers.

Developers will also need to contend with more security-related hardware features. This is good if they can take advantage of the hardware, but it means incorporating security into the application's design.

PROCESSOR TECHNOLOGY

Advances in processor technology will continue to push IoT applications, though all embedded applications will benefit from higher performance, lower power requirements, and increased connectivity. In particular, ARM and its partners have made a significant investment in IoT solutions. This year will see the delivery of the latest Cortex-M23 and -M33 platforms that incorporate advanced security support as a standard component (see "*Cortex-M23 and M33 Incorporate Latest TrustZone Features" on electronicdesign.com*).

However, developers should not overlook ARM alternatives. MIPS and x86 solutions often make more sense depending on the application. In addition, a new player has arrived, especially in terms of the custom system-on-chip (SoC) arena: RISC-V (see "*First Open Source RISC-V Chip Arrives" on electronicdesign.com*).

RISC-V is actually an instruction set architecture (ISA) that provides the same type of application and tool portability exhibited by ARM, MIPS, and x86 platforms. RISC-V is finally available as a standard chip in the form of SiFive's 32-bit Freedom E310, available on the HiFive1 Arduino-compatible board (*Fig. 1*). Microsemi is also including RISC-V soft-core support in its line of FPGAs. These two platforms will prove handy by allowing developers to kick the tires. However, the big impact will be felt with custom SoCs. RISC-V is also defined for 64- and 128-bit architectures, but the 64-bit space will be a much more difficult nut to crack.

ARM's 64-bit solutions dominate a number of application areas, such as smartphones, but its push into the enterprise continues to gain steam and supporters. Lots of cores per chip will be the driving force. Of course, Intel will not be outdone—its Skylake-X family is expected in mid-2017. Intel's Xeon family will remain the mark to hit.

General-purpose GPUs (GPGPUs) have garnered a place in high-performance computing, where deep neural nets (DNNs) and deep-learning applications continue to gain in importance. Intel's Knights Mill Xeon Phi platform, which is expected to debut in 2017, is a purpose-built platform for DNN processing. The existing many-core Xeon Phi already occupies this space, and the latest release provides a bootable platform with more than 60 cores and on-chip support for Omnipath connectivity (*Fig. 2*).

2. Intel's Xeon Phi is bootable and has Omnipath connectivity support.

ARTIFICIAL INTELLIGENCE

DNN and deep learning are just one aspect of artificial intelligence (AI), yet it's the hot topic right now. AI is moving quickly from research to production because it can address such a wide range of applications, including object identification—a critical aspect for applications like automotive advanced driver assistance systems (ADAS). DNN is also being used to improve handwriting recognition, noise cancellation, and much more.

The thing to keep in mind, though, is that DNN works well for many applications, but it is not a definitive solution for all applications. In fact, it will not replace most procedural application controls.

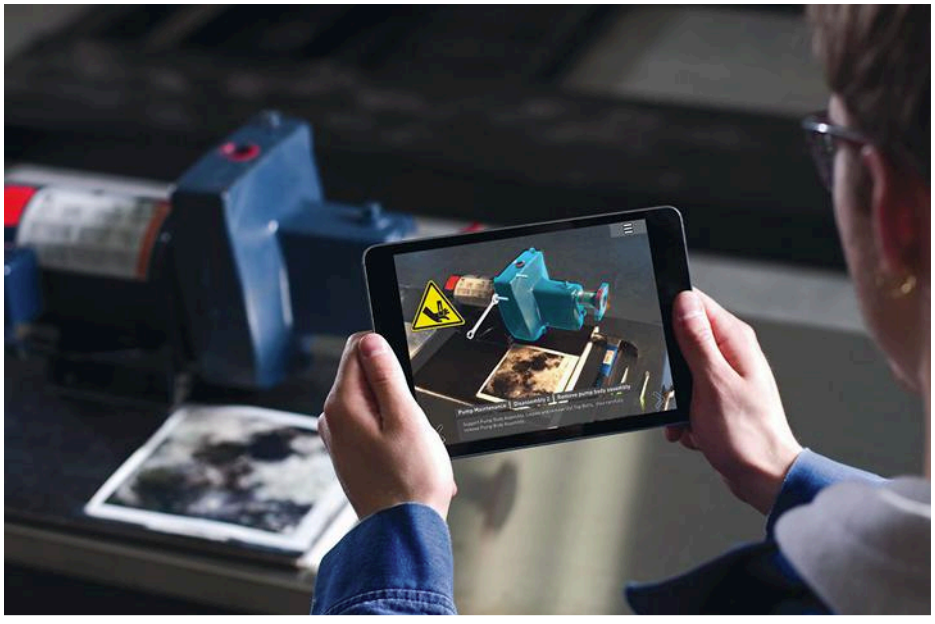
DNN solutions can often be set up as a black box, making them easier to incorporate into an application that might need something like object recognition. On the other hand, coming up with new networks for new applications tend to be very challenging.

Don't overlook other AI technology, as quite a bit is already in use (ranging from expert systems to behavior-based robotics). These are often complementary to DNN technology. The interest in DNN is likely to push more interest in other types of AI technology.

STORAGE

Storage is another key component to IoT and AI that's expected to undergo significant change in 2017. DRAM and flash storage will remain dominant, but new technologies like Intel's long-awaited 3D XPoint will challenge the status quo.

Today, 3D chip technology has become commonplace. Even high capacity and performance is heading toward 3D DIMM



3. Scope AR's WorkLink brings augmented reality to tablet and smartphone users.

DRAM. High bandwidth memory (HBM) offers significantly more storage on-chip with a wider bus than is possible with off-chip memory.

One major change revolves around more pervasive software support for non-volatile DIMMs (NVDIMMs). JEDEC now has three definitions for this technology:

- NVDIMM-N is a DRAM/flash memory hybrid that will save the DRAM contents to flash upon power failure.
- NVDIMM-F is an all-flash DIMM. It operates more slowly than DRAM, but provides much higher capacity.
- NVDIMM-P is a flash DIMM treated as persistent memory (block-addressable).

Support for platforms such as database servers and memory-caching systems make it possible to incorporate this technology immediately. Even more benefits will be available as operating systems and applications take advantage of the underlying hardware.

NVM Express (NVMe) is showing up on more motherboards that support M.2 and U.2. SATA and SAS offer many benefits, but performance is driving adoption of NVMe. These platforms offer interesting alternatives in the embedded space, where small-form-factor boards can take advantage of larger amounts of flash memory in compact packages.

VIRTUAL AND AUGMENTED REALITY

Virtual-, augmented-, and merged-reality solutions will move from the novelty stage to becoming useful tools in many areas. Applications like Scope AR's WorkLink (*Fig. 3*) catapulted AR into the commercial and industrial space *(see "Putting Augmented Reality to Work" on electronicdesign.com)*.

"To date, augmented reality has consisted of a relatively unsophisticated first-generation set of hardware, with apps developers focused on creating game-like experiences that don't really demonstrate AR's value," says David Oh, head of developer relations at Meta. "However, in 2017, there will emerge more sophisticated hardware technologies like our Meta 2 (*Fig. 4*)."

Different companies will have different focuses in what they bring to market. Many will zero in on entertainment because that's the low-hanging fruit. Others will be concerned with bringing to market solutions that build on existing operating systems.

Virtual-reality systems with higher resolution will challenge available display and processor technology. Wireless or mobile solutions will be taxed by weight and power concerns. Gaming will remain a major thrust for VR, but more applications will emerge in 2017.

Complementary technologies like 3D imaging and Ultrahaptics' ultrasonic haptic response system (see "*Ultrasonics Brings Haptics to Augmented and Virtual Reality" on electronicdesign.com*) will make these reality systems much more usable. Like IoT, developers need to understand the differences and advantages of these technologies to better pinpoint their applications. ed

4. The Meta 2 glasses address advanced augmented-reality applications.

10 MHz Distribution Amplifiers

- **Sine wave outputs (+13dbm)**
- **Amplitude leveling**
- **Low additive phase noise**
- **High channel-to-channel isolation**
- **High return loss**

***FS730 and FS735 series ... starting at $1250** (U.S. list)*

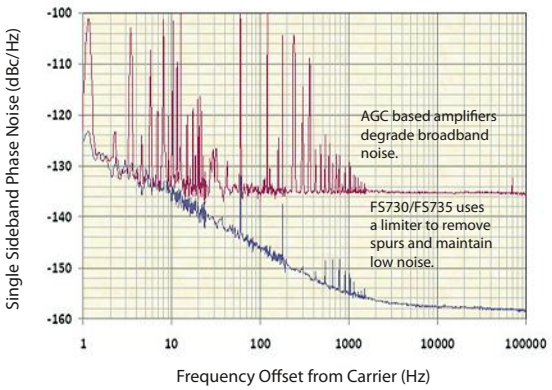
The FS730 and FS735 10 MHz distribution amplifiers from SRS provide state-of-the-art solutions to challenging signal distribution tasks.

These distribution amplifiers use an input limiter design, which removes amplitude modulation from the signal, provides fixed amplitude outputs and blocks input noise. Virtually any 10 MHz waveform with a duty cycle near 50% may be used as an input.

The FS735 model provides fourteen 10 MHz output BNC connectors on the rear panel, with status indicators on the front panel. The half-rack sized FS730 model gives seven 10 MHz outputs and is available in both bench-top and rack-mount forms.

With mix and match capability, the FS735 can also be configured with 10 MHz, 5 MHz, Broadband, and CMOS Logic distribution amplifiers side-by-side for other applications. Multiple units can be daisy-chained for easy expansion.

Please visit www.thinkSRS.com for details.



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

SRS Stanford Research Systems

(408)744-9040
www.thinkSRS.com

MARIA GUERRA | Technical Editor

Power & Analog 2017 Forecast: What Experts Are Saying

Representatives from major players in the semiconductor industry share their predictions for 2017 regarding power modules, wireless power, data converters, wireless sensing, and more.

The increasing number of electronic applications integrating power electronics makes one thing very clear: The power semiconductor market will continue to grow and gain more presence across a variety of markets. In this article, experts offer their forecast for one specific area of interest.

POWER MODULES AND REFERENCE DESIGNS

Designers rely on power modules to speed up designs and optimize space using smaller, easy-to-use power modules. We asked Steve Goacher, marketing director of power modules at Texas Instruments, what trends will likely impact the power-module industry in 2017:

"The semiconductor and packaging technologies used in power modules have advanced considerably, and the industry is developing modules today that are denser, less expensive, and easier to use. Packaging technology has evolved to be considerably smaller and perform better thermally versus discrete designs.

> "As modules continue to get smaller and easier to use, engineers will increasingly choose a module over a discrete design." —Steve Goacher, Marketing Director of Power Modules, Texas Instruments

"For example, the former large open-frame, leaded packaging has migrated to small surface-mount, and often over-molded, solutions. An example is TI's TPS82130 3-A 17-V step-down converter module with integrated inductor. The module supports input voltages up to 17 V and output currents up to 3 A—all in a 3- × 2.8- × 1.5-mm package size. It is a fraction of the size and cost of Power Trends' original PT78HT305 that measured a stout 25 × 25 × 10 mm. As well, the TPS82130 is 40% smaller than the discrete equivalent.

"Modules must be designed to work for a wide range of applications and are typically tested to meet EMI requirements, operating over extended temperatures and environmental conditions. Engineers may 'just plug a module in,' but the expectation is that it will work over the lifetime of the product. As modules continue to get smaller and easier to use, engineers will increasingly choose a module over a discrete design.

"It's not outlandish to expect that power modules will make up a significant percentage of the overall dc-dc power market within just a few years. Advances in packaging and semiconductor tech will continue, and the industry will see even further dramatic improvements in module density and cost."

WIRELESS-POWER APPS AND DC-DC CONVERSION

During 2016, wireless-power applications started to pick up across many fields in the semiconductor industry, and it will continue to do so. Also, advances in deep-learning technologies and the use of higher voltage distribution inside data centers led to new alternatives for handling power efficiency, according to Alex Lidow, CEO of Efficient Power Conversion:

"Wireless power will continue to gain traction with increased consumer demand. Hewlett Packard, Dell, jjPlus, and Witricity have already announced products based on Airfuel standards. And, products based upon the Qi standard will continue to grow at a rapid pace.

"Wireless power will continue to gain traction with increased consumer demand. Hewlett Packard, Dell, jjPlus, and Witricity have already announced products based on Airfuel standards." —Alex Lidow, CEO, Efficient Power Conversion

"Qualcomm has included the Airfuel format into Snapdragon chipsets, reducing the cost to enable wireless charging in hundreds of millions of cell phones, tablets, and Chromebooks. Automotive companies including Toyota and GM have wireless charging in vehicles. Furniture makers such as IKEA are embedding wireless chargers into desks, tables, lamps, and chair armrests.

"Servers will be limited by their power density. Servers have shifted toward cloud computing, artificial intelligence, and deep learning, resulting in exponential growth in the inter-server communications requirement. Extremely fast computations need to be made inside the server farm in order to keep pace with the growing use of massive parallel computations.

"A new limitation is the density of the server itself. More servers need to be packed closer together, and have the functional elements inside packed more tightly to speed computation and communication. Getting the heat out and making the servers more energy-efficient has been elevated from a cost savings to a bottleneck to performance.

"OpenRack and OpenCompute projects are increasing the distribution voltage inside the server itself. This approach, plus transitioning to new materials such as gallium nitride in the power-conversion systems, can reduce overall power consumption by 20% and increase server densities by 30-40%."

RF AND WIRELESS

The communications industry continues to march onward in its relentless search for wider bandwidth spectrum at higher frequencies. Greg Henderson, vice president, RF and Wireless

> "To make effective use of the wireless channel, system operators are moving toward massive-MIMO, multi-antenna systems that transmit multiple wide-bandwidth data streams—geometrically adding to system complexity and power consumption." —Greg Henderson, Vice President, RF and Wireless Business Unit, Analog Devices

business unit for Analog Devices, gives his take on what to expect for RF and wireless in 2017:

"There are two megatrends driving RF, microwave, and millimeter-wave technology: the insatiable demand for broadband connectivity, and the emergence of wireless sensing.

"The exponential growth of broadband data is driving wireless (and wired) communications systems to more effectively use existing bandwidth, even as the industry searches for wider bandwidth spectrum at higher frequencies. To make effective use of the wireless channel, system operators are moving toward massive-MIMO, multi-antenna systems that transmit multiple wide-bandwidth data streams—geometrically adding to system complexity and power consumption.

"This trend can be seen in markets such as cellular access, point-to-point radio, and satellite and military communications, where peak data rates have been increasing by about 58% each year for last six years and total mobile data traffic is expected to grow at 45% CAGR to 2020. For system operators, higher-frequency systems provide the promise of greatly increased data rates, but with significant added complexity due to propagation challenges and inherently lower power efficiency.

"The other rapidly emerging market is wireless sensing. Originally serviced by discrete solutions for military systems, the technology has evolved to a point where there are a broad array of wireless-sensing applications such as automotive radar for driver assistance, industrial radar for

applications such as drone collision avoidance and smart traffic systems, and millimeter-wave scanners for airport security.

"In wireless sensing, higher bandwidth means higher resolution, and this is driving systems to higher frequencies. As with the communications sector, wireless sensing is moving to multi-antenna (phased-array) systems that allow for sophisticated beam-steering and multi-beam sensing configurations.

"Analog Devices has a broad commitment to the communications infrastructure and sensing markets, and is investing in the above technologies to bring system-level innovation in performance, efficiency, size, and complexity up through 100 GHz."

David Andeen, Applications Director and David Loftus, Vice President, Worldwide Sales and Marketing, Maxim Integrated

INTERFACES, AUTOMOTIVE

Two experts from Maxim Integrated reveal what they observe as emerging trends in these two key industry sectors. In terms of interfaces, David Andeen, applications director, contends that:

"Interface ICs will continue to help simplify high-bandwidth designs while making them more robust and reliable. Maxim offers an array of interface ICs for interconnection, signal translation, voltage protection, current protection, and electrical isolation. Application areas that will benefit include automotive, communications, and industrial. Part of this portfolio is wired interface solutions, which also shouldn't be overlooked as there are plenty of applications—mobile and automotive, for example—where the impact on overall cost and performance would prohibit wireless communications."

On the automotive front, David Loftus, vice president, worldwide sales and marketing, predicts that:

(Continued on page 41)

MATHEW STEVENSON | Director of Marketing, Sunstone Circuits, *www.sunstone.com*

11 Myths About PCB Layout

PCB layout is not as straightforward as one might think—there is an art form to being effective.

Printed circuit boards (PCBs) have been an integral part of electronics for many years. Through the years, electronic devices are getting smaller and more complex and so are the PCBs needed to connect the components in an efficient manner. As robotics and electronic design begin to be taught as early as grade school, the art of PCB layout becomes more meaningful. What follows are 11 common myths about PCB layout:

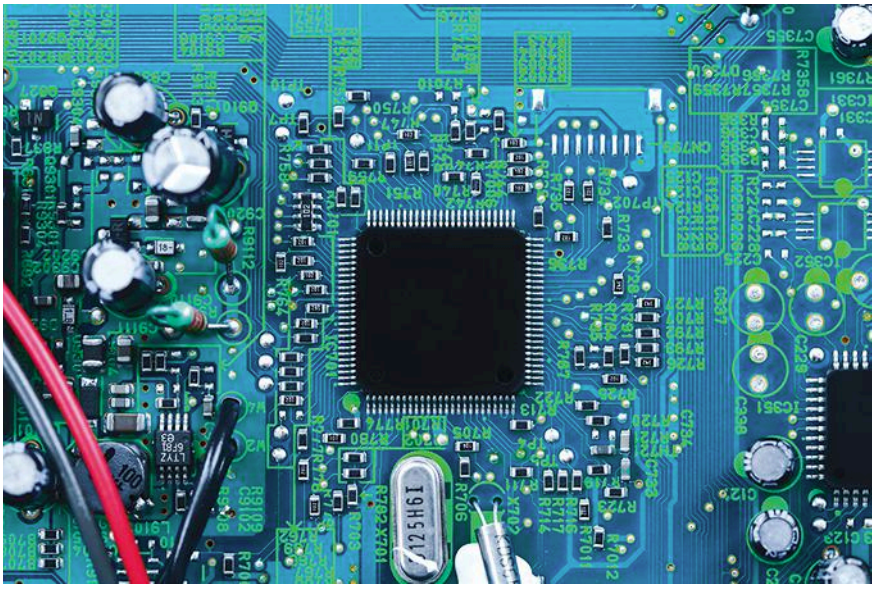
1. Once an electrical schematic is complete, the hard work is over.

The layout of a PCB from an electrical schematic seems like a simple two-step process: Place the required components and connect the wires/traces to the appropriate point on the components. However, many factors still must be considered when getting from the schematic to a finished PCB design suitable for prototype or production. Some of these include physical design constraints (size and placement of the parts, orientation of parts on opposite side of PCB), electrical interaction between signals, heat dissipation, and signal loss through the wires/traces. All of these and more still require an engineering mind to accomplish a working design.

2. PCB layout for prototyping and production are similar.

Depending on the intent of your design, you may make vastly different choices in the types of components to be used. For a prototype or proof-of-concept design, you may opt for through-hole parts for as many parts as you can. They're relatively inexpensive and easy to solder to your PCB.

However, in a production design, you want to shy away from use of through-hole parts in favor of surface-mount parts. Through-hole parts are costly to assemble in volume and can dramatically increase production cost due to increased board size, layer count, component availability delays, etc. Also, reducing the number of unique parts on the bill of materials (BOM) is another way to minimize production cost.



3. Components can be placed almost anywhere on the board, and it will result in an effective PCB.

Planning your PCB layout in terms of modules, similar to your schematic, is a much more effective way to layout your design. Components close in proximity in the schematic should also be in close proximity in the layout. Most designers like to think of the design in terms of modules. One common error in layout is to ignore the physical height of a component and its location with respect to case or neighboring boards.

4. Power distribution is not a critical element in layout.

Power delivery is critical in the performance of any circuit. Some parts require much more power, and better conditioned power, than others. This has to be taken into account early in the design or circuit performance will suffer.

Supplying power to all of the various components on a PCB can be done in several ways. But, regardless of the method, it needs to be planned so as to deliver the correct current to each component without creating voltage drops by unnecessarily running power in series, creating longer paths, or choking down the current with trace size or a chopped-up power plane (a plane with poorly placed through vias that will limit the current flow).

5. Standard DRC settings are applicable for all designs.

The best strategy to getting the PCB when you want and how you want, at a cost that doesn't kill your project, is to know your PCB manufacturer and tailor your "in tool" design-rule-check (DRC) settings to their manufacturing "sweetspot, whenever possible." Working with a trusted manufacturing partner (and to their strengths) maximizes the success rate of the PCB design. Just because you can design it, doesn't mean every PCB manufacturer can build it.

Another tool that saves time and unnecessary cost to a project is a design-for-manufacturability (DFM) analysis on your completed design by the manufacturer, prior to manufacturing. If your PCB fabricator makes a suggestion for improvement, it may be worth the effort to alter your design slightly in order to produce a more reliable and cost-effective product. You might even want to stop your current production cycle and rework your design before continuing. While this sounds painful, receiving boards that fail in the field due to manufacturing defects caused by design flaws is even worse.

6. Any part published in a library is ready to place on a layout.

Not all parts libraries are created equal. Discrepancies often exist between the component footprints and the technical datasheet. Sometimes it's a matter of the size, or pin assignments, or even the orientation. Everything may look okay at the layout stage, but when the physical part will not fit into the footprint, delays and spin revisions can ensue. Take the extra time to verify that the part matches the datasheet. Remember, it only takes one bad part to destroy a project.

7. Grouping of similar parts in a design is a good use of space.

It might seem like grouping similar parts of a PCB into a common area is the best use of space, but as we have discussed above, the parts should be located in relative proximity to its space in the schematic, limiting the distance that the signal must travel and eliminating unnecessary routing on the board. This is especially true for microcontrollers and their caps.

Minimizing the trace lengths from the controller to the cap decouples noise from the power supply to ground, creating a better result. Sometimes a schematic will have all of the decoupling capacitors grouped on one page, away from the component pins that they service. You will need to make that association and place those parts logically in order to ensure proper circuit function.

8. Auto-routing a layout, once components are placed, saves time and money.

While the intent of an auto-router is to do just that, the execution of the algorithm is not 100% foolproof. Oftentimes, the results of an entirely auto-routed board may connect all of the necessary points, but it can result in a poor design from electrical and manufacturability standpoints. Route the clocks, route the power/ground, route any critical nets; then, if you must, run the auto-router. Once the auto-route is complete, go back and see if you can clean up any poorly routed nets.

9. Minimum trace widths are adequate for all traces in a design.

High-speed lines sometimes have impedance requirements that will govern trace widths of these traces. Make sure that these requirements are taken into account when routing them. Also, the current load of a power net should be considered before routing. Traces with a high current load need to be sized large enough to carry that current without overheating. Use of a trace width calculator, readily available on the internet, can simplify this calculation significantly.

10. My design passed all of the DRC checks in my tool; therefore, it should work as I expect.

Even powerful DRC tools have limitations as to the extent of the design rules. They simply cannot replace good engineering practices. An example is the return paths to ground. The DRC can verify that they exist, but not necessarily determine the size, path length, and trace geometry to get the best electrical results.

11. Now that my design is finished, all I have left to do is export my Gerber files and order my PCBs.

Unfortunately, there are pitfalls in the Gerber extraction process of most tools, potentially resulting in the PCB manufacturer seeing one thing and you seeing another in the design tool. Verify your output (Gerber) files before submitting them to be built.

As the need increases for engineers, inventors and hobbyists to include a PCB in their projects, so does the need for knowledge transfer for PCB layout. Awareness of the myths of layout and adjusting accordingly can improve the time to market and cost of the project simply by reducing design spins and additional troubleshooting and engineering evaluations. ed

MATTHEW STEVENSON, a 20-year PCB manufacturing veteran, has held roles from the manufacturing floor, process engineering, quality manager, and now director of marketing at Sunstone.

BRUCE RAYNER | Distribution Editor

Putting the Pieces Together for Avnet's Next Chapter

Gerry Fay, president of Avnet's Electronics Marketing.

An interview with Gerry Fay, president of Avnet's Electronics Marketing business line, reveals the rationale behind the recent flurry of strategic business decisions the global company has made in the last four months. Here's a hint: "We want to be known as the company that gets makers to market."

Phoenix, Ariz.-based Avnet Inc. has been busy recently assembling the pieces that will define its strategic direction for years to come.

In September, the world's largest electronics distributor announced it was selling its Technology Solutions business for $2.6 billion to Tech Data Corp. A month later, Avnet completed the acquisition of Premier Farnell PLC, a UK-based global distributor, for £691 million. And in November, the company acquired a majority interest in Hackster Inc., which serves the engineering, maker, and hobbyist community through its website hackster.io.

Premier Farnell brings Avnet a registered community of more than 430,000 engineers and "innovators" across 36 countries. The company's U.S.-based Newark element14—and UK-based Farnell element14—has produced Raspberry Pi single-board computers in the UK since 2012. The company manufactures Beaglebone Black, and is the exclusive manufacturer of educational programming boards such as the BBC micro:bit and Codebug.

Hackster adds about 200,000 additional registered users to the mix.

These moves have occurred on the watch of William Amelio, Avnet's chief executive since September, following a two-month stint as interim CEO. He is taking the long view on building the company's position with design engineers—including future engineers—that are expected to feed Avnet's pipeline of component sales for years to come.

"As technology reaches deeper into more products and innovation proliferates through the Internet of Things, the ability to reach a wider base of engineers earlier in the design process will be critical to our future growth and success," he said in October.

Avnet is not alone. Every distributor worth its salt is targeting design engineers, with a focus on the amorphous social

Premier Farnell brings Avnet a registered community of more than 430,000 engineers and "innovators" across 36 countries.

phenomenon known as the maker market. Defined loosely as electronics DIY enthusiasts, one source estimates there are over 100 million adult makers in the U.S., or about 25% of the population. There were an estimated 190 Maker Faires in over 35 countries in 2016. President Barack Obama declared the week of June 17, 2016, as National Week of Making.

For insight into Avnet's rationale for these decisions, Global Purchasing talked with the man charged with executing Avnet's new strategy, Gerry Fay, senior vice president, Avnet Inc., and president, Avnet Electronics Marketing, Global.

TARGETING THE LONG TAIL OF CUSTOMERS

"One of the things all broad-line distributors are struggling with is how to grow the long tail of customers in order to get new business," says Fay.

The long tail refers to the millions of potential customers around the world—from established companies to startups to kids and independent designers in the maker market—that need parts for a prototype of their product design. The theory goes that a percent of these customers will one day drive volume purchase orders when their new product becomes the Next Big Thing.

"We cannot get to every 200-square-foot apartment around the world to find out who is drawing something on the back of a napkin that is going to become the next Fitbit," says Fay. "So today, the challenge is how to find the next customer of tomorrow because the customer acquisition model is going to be different."

Fay admits that Avnet was behind the curve in targeting the design front-end of the value chain business. "We were not positioned to seed our suppliers' products to the designers and small customers," he says.

"Avnet was attracted to Premier Farnell because it has the largest engineering user community in the world and rich technical content that engineers use," says Fay. "By putting together what Premier Farnell is good at and what Avnet is good at, we now are the only distributor globally that can take the customer from product ideation all the way to end of life."

Of course, that's easier said than done. The new value chain is complex and multigenerational. It runs the spectrum from seasoned EE designers to kids who are just learning about technology.

"Those kids may someday go to engineering school and become engineers. They will remember Avnet because back in the seventh grade we sold them a Raspberry Pi board that helped them learn how to program and build a prototype," says Fay.

There are other pieces of the customer-acquisition puzzle that Avnet has added to complement Premier Farnell.

In June, the company launched MakerSource, an online directory to help makers find services to get their new products to market. "Say you're a maker and you have a prototype and you want to productize it, you need design engineering help. There are design engineering companies listed on the MakerSource directory. Do you need a prototype? There are prototype manufacturers on the directory," Fay says.

> "The challenge is how to find the next customer of tomorrow because the customer acquisition model is going to be different."

Looking further upstream, Avnet is targeting the engineering and design education space through Hackster.io. "Approximately 60% of Hackster's users are design engineers in their day jobs. Hackster helps them get to the resources they need," said Fay.

"When they are ready to move to limited prototyping, we send them to Premier Farnell. Then when they are ready for production, we can move them to Avnet. It's a way to take a customer all the way from a kernel of an idea to becoming a company," he says.

NURTURING THE COMPONENT PIPELINE

Knowing when a customer is preparing its product for production is critical information for broad-line distributors like Avnet. That means having good visibility into the prototyping phase of customers.

"I can't afford to send sales people to everyone who buys one or two of something, but I can analyze those leads to determine if they are production customers or not. If so, I can then turn them over to the Avnet sales team to go after and help with their time to market," says Fay.

That means getting in early enough to discuss bill-of-materials issues—such as component lead times—during the design phase to ensure parts arrive on the production floor when production begins. Some companies new to electronics manufacturing don't even know what a lead team is, according to Fay.

"If we can get to the customer early enough we can have those conversations, start to build a pipeline, and speed time to production. We can start planning so they get first-mover advantage," says Fay.

There are a variety of metrics Avnet will use to measure the performance of its investments. But at the end of the day, there's only one that matters: "Are we growing our revenue and are we growing our profits?" says Fay.

"All the digital investments we are making are focused on improving our ability to service our customers and our suppliers, which will generate more revenue and better profits for us if we are doing it better than anyone else," he says.

APEC®

2017

THE PREMIER GLOBAL EVENT IN APPLIED POWER ELECTRONICS™

Visit the APEC 2017 website
for the latest information:
www.apec-conf.org

IAS IEEE INDUSTRY APPLICATIONS SOCIETY Linking Research to Practice

IEEE Advancing Technology for Humanity

pels IEEE POWER ELECTRONICS SOCIETY Powering a Sustainable Future

psma Power Sources Manufacturers Association The Multinational Power Electronics Association

MARCH 26-30, 2017 | TAMPA, FLORIDA

JOHNNIE HANCOCK | Oscilloscope Applications Program Manager
Keysight Technologies, *www.keysight.com*

What's the Difference Between a DSO and DPO?

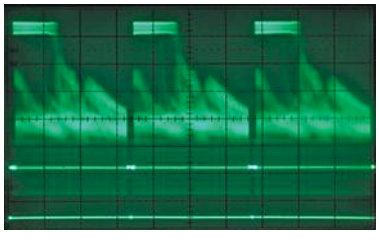
A digital phosphor oscilloscope is also a digital storage oscilloscope, and the same can be true in reverse. So what exactly separates the two?

DSO stands for digital storage oscilloscope. DPO stands for digital phosphor oscilloscope. A DPO is also a DSO. And a DSO can also be a DPO. So what exactly is a DSO and what is a DPO?

A DSO is typically a real-time sampling oscilloscope. Real-time sampling simply means that the scope is able to capture signals in a single acquisition utilizing a high-sample-rate analog-to-digital converter (ADC). In other words, a DSO doesn't utilize repetitive acquisitions to "build-up" sufficient samples to represent the signal under test (equivalent-time sampling), although this isn't a hard-and-fast rule.

As mentioned before, a DPO is also DSO. But a DPO adds one additional element that allows it to better represent the signal's third dimension. The first two obvious dimensions are voltage and time. The third and less obvious dimension is frequency-of-occurrence, which is represented by trace intensity on a scope's display.

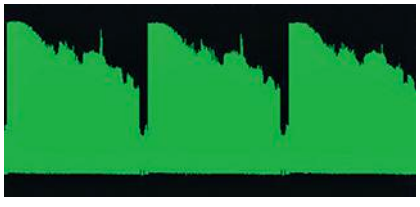
If you can remember back to the old analog scope days, you may recall that these oscilloscopes were able to display a range of trace intensities. This can provide valuable insight into the true analog characteristics of a signal under test. This is especially true for complex-modulated analog signals *(Fig. 1)*, as well as for digital signals that contain varying degrees of noise and/or jitter.



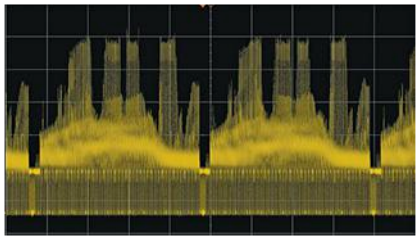
1. Analog oscilloscopes could display a range of trace intensities, especially for complex-modulated analog signals.

With older analog scope technology, trace-intensity variation was a natural phenomenon based on how much time the electron beam remained within a XY region on the inside face of the cathode ray tube (CRT). The inside face of CRTs of analog oscilloscopes are coated with a material called phosphor. When electrons strike the phosphor, the phosphor begins to glow. The more electrons that strike the phosphor in a given region of the CRT for a given amount of time, the brighter the phosphor glows.

When DSOs were birthed in the early 1980s, this third dimension of trace intensity was initially lost *(Fig. 2)*. As technology progressed, oscilloscope vendors developed a technique that could closely emulate the display quality of analog oscilloscopes utilizing digital signal processing to bring the third dimension back *(Fig. 3)*.



2. The original DSOs were not able to display trace intensity.



3. Modern oscilloscopes use digital signal processing to show trace intensity.

Basically, by counting the number of hits (digital samples) in particular XY regions of a bitmap—sometimes called buckets—pixel intensity could be digitally modified to represent trace-intensity modulation of phosphor. This is the genesis of the term digital phosphor oscilloscope (DPO).

So why don't companies like Keysight have DPOs listed in their product repetoire? Actually, they do. But they don't call them DPOs. Nearly all of Keysight's DSOs employ trace-intensity modulation. In fact, the company's oscilloscope display technology is claimed to offer the highest-quality trace-intensity modulation, thanks to fast waveform update rates with deep memory acquisitions. This provides more hits in XY regions (buckets) in a shorter amount of time to provide a higher level of statistical information upon which to base pixel intensity.

MIKE LYNCH | Chief Strategy Officer, InAuth
www.inauth.com

Changing the Mindset in IoT Manufacturing

Mark Zuckerberg's guiding mantra of "move fast and break things" may have encouraged a reckless mindset.

In creating Facebook, Mark Zuckerberg popularized the motto: "Move fast and break things." And it wasn't long before this mindset was adopted at many other Silicon Valley companies.

In a way, this guiding mantra was liberating for product developers. The saying acknowledged the inevitability of mistakes when making new products and, instead of punishing people for them, encouraged learning from them and moving on.

Unfortunately, it also encouraged a mindset that was potentially reckless. "Move fast and break things" works when making an inconsequential app like Farmville, but is catastrophic when producing a jet turbine, or when it comes to bringing an

DESIGN NOTES

Bidirectional DC/DC Regulator and Supercapacitor Charger

Design Note 558

Victor Khasiev

Introduction

The LTC®3110 bidirectional buck-boost DC/DC regulator charges and balances a supercapacitor when a bus voltage is present (for example 3.3V) and discharges the supercapacitor into the load when the bus fails. The LTC3110 maintains the bus's nominal level (3.3V in the example in Figure 1) even if the supercapacitor voltage is above or below the nominal bus voltage. Supporting the load this way allows data backup and retention during a power interruption—important in a wide variety of industrial and automotive applications.

Low Profile Data Backup Power Supply

Industrial and automotive applications are distinguished by their lack of stable, high quality voltage sources. In automotive environments, a 12V nominal voltage rail can change from 4V to above 40V during cold starts and load dumps. The 24V equipment bus used in factories and plants suffers voltage spikes and brownouts just from cycling electric motors and solenoids.

Industrial applications, however, share something in common with consumer electronics: the trend toward increased portability and mobility. Space is increasingly limited for electronics inside modern industrial equipment. The volume, in particular the thickness, of a data storage unit is at a premium in industrial assemblies and modules. With that in mind, the solution herein aims to minimize the profiles of the selected components. Table 1 shows two passive component group options, arranged by thickness: 1mm and 2.5mm. The required semiconductor parts are not listed because the controllers, MOSFETs and resistors do not exceed 1mm thickness.

Figure 2 shows a low profile energy storage solution for data backup or wireless data transmission in situations where the input voltage changes in an extremely wide range from 4V to 40V, with possible input voltage interruption.

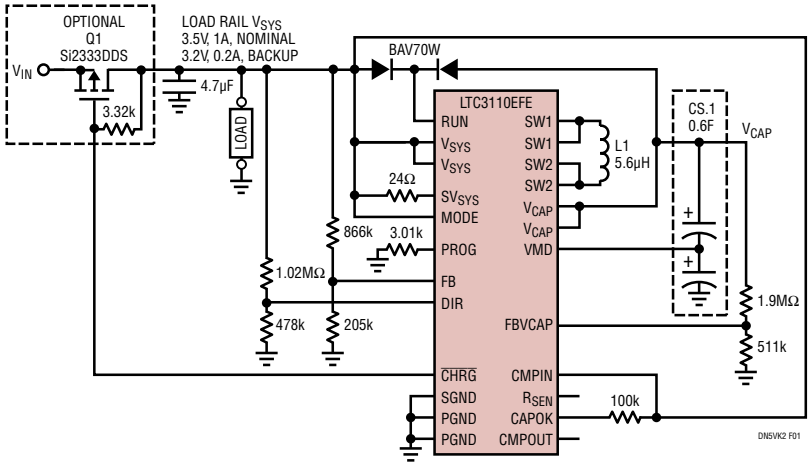


Figure 1. LTC3110 Application, V_{SYS} = 3.3V, V_{CAP} = 5.0V

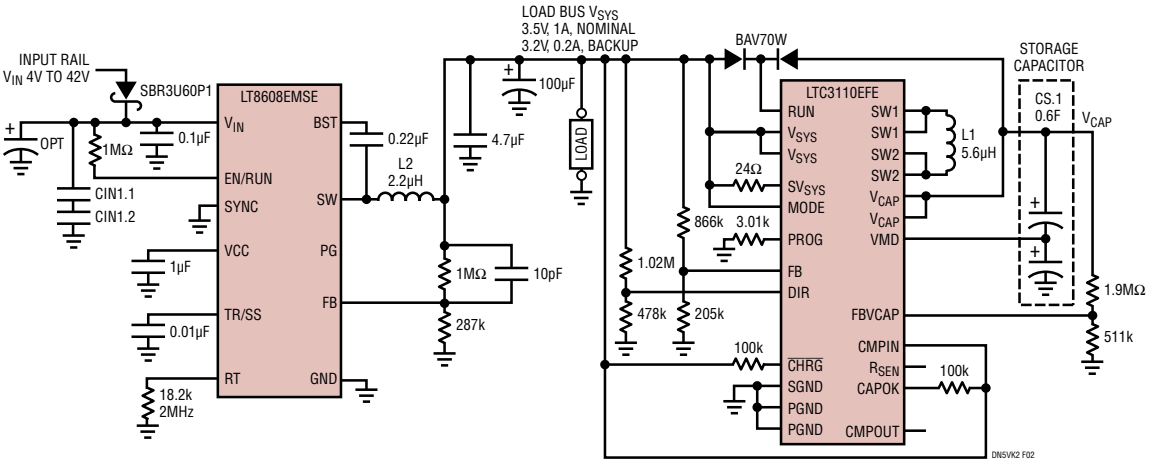


Figure 2. LTC3110, High Voltage Application, V_{IN} = 4V to 40V, V_{SYS} = 3.3V, V_{CAP} = 5.0V

This solution uses two converters to produce a complete industrial/automotive application. The converter, based on the LTC3110 supercapacitor charger (SCCH), charges the storage capacitor when the input voltage is present and provides a regulated system output during power interruption. Under normal operating conditions, when a 4V to 40V input supply is present, sensitive electronic loads and the LTC3110 are supported by a step-down converter (SDC) based on the LT8608.

The LT8608 is a low quiescent current, high efficiency, highly integrated synchronous buck converter featuring a wide input voltage range extending from 3V to 42V. Its 42V upper limit minimizes the volume required for system protection circuitry, practically eliminating the need for traditional transient voltage suppressor diodes (TVS). The SDC maintains the system voltage within 3.3V bus rail limits.

If the input voltage is disconnected, the SCCH takes over, powering the regulated 3.3V rail. The LT8608 supplies 3.5V to the system bus under normal circumstances; the LTC3110 supplies 3.2V when it registers a power failure and supports the load. These supply voltages are well within the recommended limits for 3.3V logic power supplies. The $\overline{CHRG}$ flag can be used to alert digital systems to disconnect non-essential loads and begin data backup or wireless transmission.

Figure 3 shows the beginning of the switchover process; with the input voltage disconnected, the SDC turns off while the SCCH is turning on.

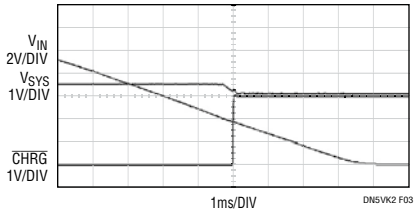


Figure 3. Switchover [V_{SYS} Load Voltage, V_{IN} Input Voltage, $\overline{CHRG}$ Flag Status]

Conclusion

LTC3110 is a highly integrated, high performance supercapacitor charger and balancer, which can be implemented in low profile solutions for data retention and backup in automotive and industrial applications.

Table 1. Converter Components for 1mm and 2.5mm Thickness Solutions

Height	L1	L2	CS1	CIN1
Vendor	Wurth Elektronik	Wurth Elektronik	CAP-XX	TDK
1mm	74437321022	74437321056	2 x HS103F	2 x C3216JB1H475K085AB
2.5mm	74437334022	74437334056	HS206F	C3225X7R2A225K230AB

Data Sheet Download

www.linear.com/LTC3110

For applications help,
call (408) 432-1900, Ext. 3161

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408) 432-1900 • FAX: (408) 434-0507 • www.linear.com

dn558f LT/AP 0117 71K • PRINTED IN THE USA

internet-connected device to market without securing it first.

According to Gartner, approximately 5.5 million new IoT devices are connected each day in 2016, an increase of 30% from 2015, bringing the worldwide total to 6.4 billion connected things for the year. If current growth rates hold, the number of connected devices is expected to reach 20.8 billion by 2020. That's almost three devices for every person on Earth.

We're now seeing the consequences of this growth in IoT devices and their rush-to-market mindset in the wave of cyberattacks that occurred across America on Oct. 21, 2016. These enormous attacks on web infrastructure providers Dyn and Amazon Web Services, which temporarily brought down internet giants like Twitter, PayPal, and Netflix, were made possible by millions of new Internet of Things (IoT) devices like cameras, baby monitors, kids' toys, and home routers, secured with incredibly obvious passwords, or worse, reusing the device's default password.

Despite continual prompting about the importance of strengthening passwords on all one's devices, people continue to disregard these warnings as was proven in this recent hack.

WHAT'S NEXT?

The size and scale of these attacks have a lot of security professionals on edge asking, "What's next?" A cyberattack in a world filled with billions of connected devices might be used for more than bringing down Twitter. All of these connected devices could be a conduit for bringing down the power grid of a large city, shutting down medical devices throughout a hospital system, or terrorists hacking into a self-driving car carrying a foreign dignitary in an attempted assassination.

If there's a silver lining to these DDoS attacks, it's that it has called attention to these gaps and lapses of security present in these devices and the change of mindset required to correct it.

As the IoT grows, traditional manufacturing organizations will need a top-down, C-level emphasis on IT security. To do so requires sophisticated technology and an investment in people that fully understand the risks inherent in pushing these devices to market. "Move fast and break things" will inevitably need to become "move cautiously and make sure we aren't blowing things up" (or perhaps, helping others blow things up). In today's always-connected world, we need to have the mindset that we're all involved in security.

For the full version of this article, visit *http://electronicdesign.com/iot/changing-mindset-iot-manufacturing.* ed

MICHAEL LYNCH is Chief Strategy Officer for InAuth, responsible for leading the company's new products strategy, along with developing key domestic and international partnerships.

JAKE HARNACK | Product Manager, Modular Instrumentation, National Instruments

Highly Parallel Wafer-Level-Reliability Systems with Modular SMUs

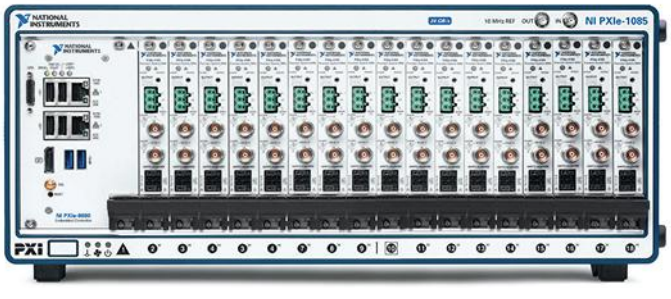
To overcome the reliability data bottleneck, many companies are turning to modular platforms like PXI to build highly parallel WLR systems with high uptime.

Reliability testing has long served as a method of ensuring that semiconductor devices maintain their desired performance over a given lifetime. As IC manufacturers continue to introduce new and innovative processes with decreasing device geometries, they need to ensure that the additional complexity from these changes doesn't affect the long-term reliability of their ICs. In addition, major technology trends in autonomous driving, cloud-based data storage, and life sciences are forcing IC suppliers to provide higher assurances of product reliability to their customers who work on mission-critical applications.

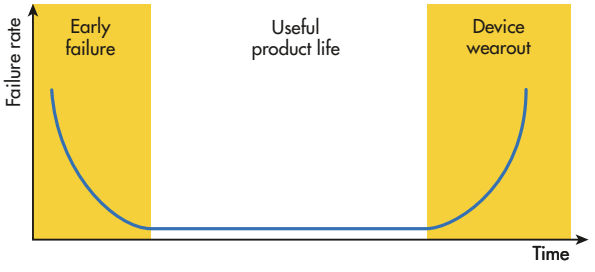
These two trends are driving semiconductor manufacturers to vastly increase the amount of reliability data they collect and analyze while decreasing the cost of test. When faced with this problem of more data at a lower cost, many reliability engineers find they cannot solve it using traditional reliability solutions. As a result, they're turning toward modular, flexible solutions that can scale to fit their needs (*Fig. 1*).

RELIABILITY TESTING

Device reliability is typically modeled as failure rate over time, with the highest failure rates occurring immediately after manufacturing and again after the product has exceeded its useful lifetime (*Fig. 2*).



1. The modular PXI platform provides scalable, high-density solutions for test applications.



2. As shown in this typical model, device reliability is usually modeled as failure over time.

The left side of the graph shows early failures often caused by defects in the manufacturing process. These types of failures can be screened during production to minimize the number of defective parts sent to customers. However, the functional tests performed during production can neither identify defects that cause the device to prematurely wear out, nor offer insight into the product's usable lifetime. But reliability testing identifies these types of failure mechanisms and estimates the product's usable lifetime.

Reliability testing involves stressing a device at the extreme ends of the device's specifications—usually voltage and temperature—to accelerate device wearout and model the usable lifetime against known failure mechanisms. These tests can be performed on a wafer or packaged part. Wafer-level reliability (WLR) provides more data earlier in the manufacturing process without the cost and potential damage associated with cutting and packaging the IC.

WAFER-LEVEL RELIABILITY

WLR is a type of parametric test that extracts information about the device's usable lifetime and long-term reliability. These tests typically aren't performed on the actual IC being

developed, but rather a set of test structures or purpose-built dies that are built into the wafer specifically for gathering parametric data. These test structures consist of fundamental wafer elements such as transistors, capacitors, and resistors, which provide insight into the manufacturing process. Most WLR tests involve applying a stress, such as voltage or current, and measuring the response of the device to monitor for any signs of degradation. Common failure mechanisms include:

- Bias or negative bias temperature instability (BTI or NBTI)
- Hot-carrier injection (HCI)
- Time-dependent dielectric breakdown (TDDB)
- Electromigration (EM)

TRADITIONAL APPROACH TO BUILDING WLR SYSTEMS

WLR systems, which have been around for decades, vary in both measurement capability and architecture. Specialized WLR systems may involve high-frequency ac or pulsed stimulus. However, most CMOS devices are tested with dc instruments such as source measure units (SMUs), which supply the necessary stress and measurement capability for collecting parametric data. Historically, the two main approaches for building WLR systems involve either building a rack-and-stack system from traditional box instruments or buying a purpose-built turnkey system.

RACK-AND-STACK SYSTEMS

SMUs are traditionally expensive, high-precision dc instruments that tend to limit the number of channels you can place in a standard test rack due to instrument size. Because of these constraints, SMUs are often combined with a low-leakage switching matrix to route signals from the SMU to dozens of test points while minimizing the noise, leakage current, and thermal EMF associated with relays. This approach works well when the serial testing of a small number of test structures generates statistically significant reliability data.

In addition, switching is a practical extension of a box instrument that historically has cost $5,000 to $10,000 per channel and been limited to 20 or 40 channels in a full 19-in. test rack. But, given the performance expectations for the relays, the switching subsystem is often a large and expensive piece of the WLR system.

TURNKEY SYSTEMS

The alternative approach is to purchase a purpose-built turnkey system that's prepackaged with all components, such as the oven, test rack, instrumentation, and software. Aligning your test requirements with the functionality of the equipment saves development and integration time, but requires a large capital budget.

These systems are often built with a fixed number of channels, hardware specifications, and software, and are serviced by the vendor. System vendors may sell separate systems for wafer and packaged reliability systems, or they may sell the same system for both applications regardless of the differences in test requirements.

CHALLENGES OF TRADITIONAL WLR SYSTEMS

The traditional WLR approaches of either buying purpose-built systems or building rack-and-stack systems from box instrumentation served their purpose for decades. However, many engineers are finding these architectures don't scale well to meet their new channel-density and cost requirements.

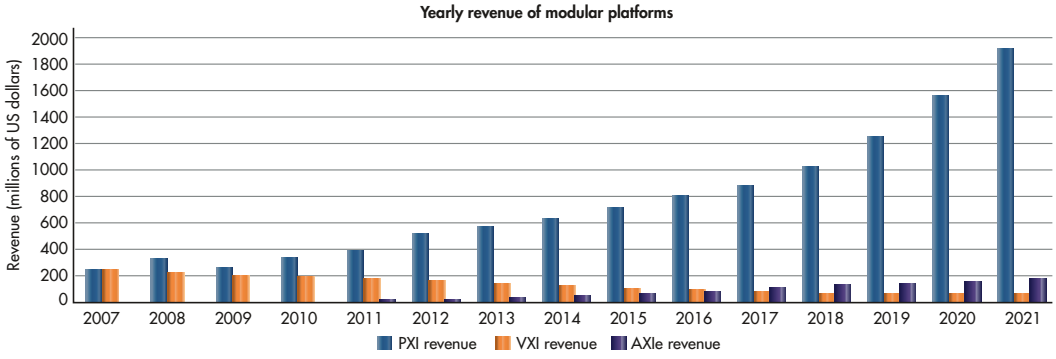
Turnkey systems don't provide the flexibility needed to modify the test software or hardware as device requirements change, or the modifications are prohibitively expensive.

Rack-and-stack systems are limited by the low-channel density of traditional box SMUs. This low density creates challenges for building high-channel-count systems with a small footprint, and often forces engineers to use a switched topology to multiplex the SMU to multiple pins. However, this switched topology quickly becomes a bottleneck because the pins are tested serially instead of in parallel. Therefore, implementing advanced stress algorithms that require constant stress and monitoring is impossible.

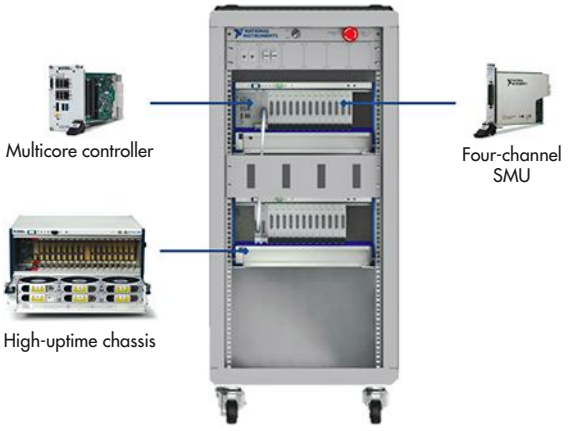
Because of these challenges, many companies have opted to build parallel test systems using modular instrumentation.

A NEW APPROACH FOR BUILDING WLR SYSTEMS

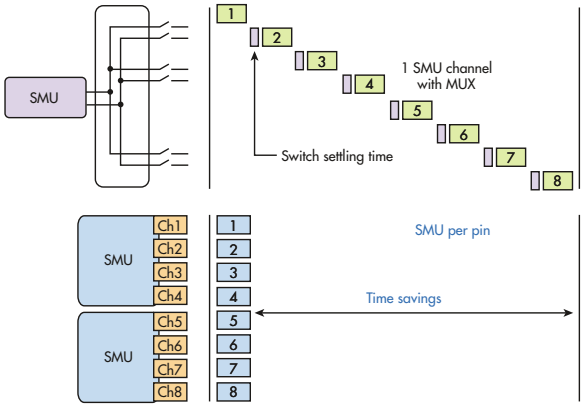
The market for test instrumentation has changed dramatically over the past decade with the rise of modular platforms such as PXI (*Fig. 3*). Modular platforms have grown increasingly desirable for building automated test systems because of



3. Industry analysts predict PXI will continue to be the leading modular platform.



4. This highly parallel reliability system uses the modular PXI platform (100 SMU channels).



5. A parallel, SMU-per-pin architecture reduces test time compared with a multiplexed architecture.

their extensive I/O capability, compact form factor, and flexible software.

Using a modular approach, you can dramatically reduce the footprint of WLR systems without sacrificing measurement quality (*Fig. 4*). The open software architecture allows you to define the functionality of your system, modify tests, and add hardware as your requirements change. This includes integrating the latest multicore processors, maximizing system uptime through health and monitoring tools, and adding I/O.

HIGH-DENSITY SOURCE MEASURE UNITS

Modular platforms, such as PXI, allow you to build systems with hundreds of SMU channels while maintaining a reasonable footprint and cost per channel. With the high-channel density of these instruments, you can avoid routing your signals through a switching subsystem and instead connect each test pad directly to a high-precision SMU.

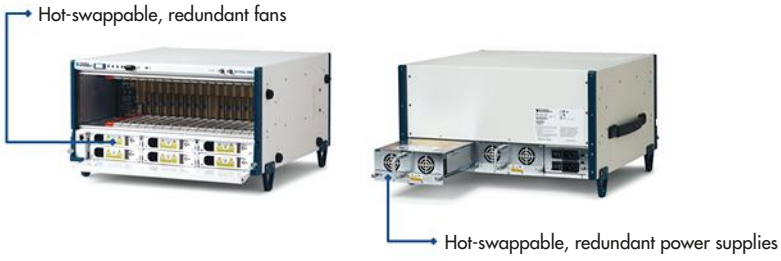
This "SMU-per-pin" architecture prevents the negative impact that switches have on signal integrity and test time (*Fig. 5*). It also provides the flexibility to implement advanced stress-measure algorithms.

HIGH UPTIME AND SERVICEABILITY

Ensuring system uptime is critical for both inline and offline reliability systems. If an inline system fails, wafer production can come to a halt. Offline reliability tests don't directly influence wafer production, but they do involve experiments that can run for several months. Ensuring a tester stays active and continues to acquire data is essential for the experiment's success, because a failed tester can lead to a failed experiment.

High-uptime applications often require systems with built-in redundancy for high-risk parts such as fans and power supplies. Building a test system with redundant, hot-swappable fans and power supplies allows you to mitigate the failure risk associated with these parts and ensures that the test system continues running after a component failure (*Fig. 6*).

If the component is also hot-swappable, you can service the system without powering down the chassis and aborting the experiment. Furthermore, you can remotely monitor the health of your system for fan speed, temperature, power consumption, and other key parameters that may indicate an upcoming failure. By implementing these tools, you can dramatically reduce the risk of a test system failure.



6. To mitigate failure risk, this high-uptime PXI chassis is built with redundant fans and power supplies.

PARALLELISM AS A COMPETITIVE ADVANTAGE

Traditional reliability systems have served their purpose for decades; however, the inability of these systems to provide and analyze massive amounts of reliability data is becoming a bottleneck. To address these needs, many companies are turning to modular platforms, such as PXI, to build highly parallel WLR systems with high uptime and the latest commercial processors.

Using the software-defined architecture of these systems, companies can maintain control of their intellectual property and scale their systems as requirements change. This approach satisfies their need for more reliability data at a lower cost and positions them well to address the ever-changing test requirements of the future.

ideas for design

"Bolt-On" Circuit, Transistors Create Zero-Drift Current Source

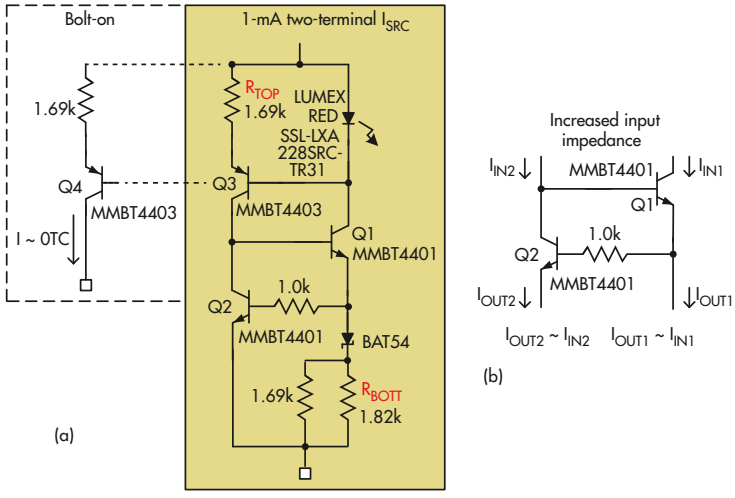
By TIM DAVIS | Engineer

A TWO-TERMINAL CURRENT SOURCE using the basic circuit of *Figure 1a* can be enhanced by adding on an independent subcircuit that uses degeneration of a PNP transistor to achieve zero temperature coefficient (tempco or TC). This low-cost design is the result of collecting data on many semiconductor devices over a 15+ year period and frequent reviews of the data. ("Degeneration" is the insertion of a resistor in series with the emitter, which decreases the gain of the amplifier but improves attributes such as linearity and input impedance.)

The key semiconductors in the bill of materials (BOM) of *Table 1* are critical to this circuit, so design and test only with these parts. The choice of parts and their vendor makes this design viable, and the circuit has been built over various lots of material with parts purchased from different distributors. Both the MMBT4401 and the MMBT4403 transistors should each come from their own, single tape reel of parts.

Audio-design engineers have known for years that ON Semiconductor's MMBT4401 and MMBT4403 feature very low base resistance (R_b) and thermal noise, and are very good for current-source and mirror circuits. The MMBT4401 and MMBT4403 are complementary devices related to dc biasing and tempco *(see Figures 10 and 11 in the article's Appendix on www.electronicdesign.com)*. Complementary devices make it easier to understand the zero tempco design, as a "glue" circuit needs to pass the current from the PNP device Q3 of its mirror to Q2. The base-to-emitter voltages V_{BE} will be approximately equal in those two transistors.

The design is fault-tolerant and can be reverse-biased. For industrial designs at higher supply voltages, the majority of the forward voltage drop is across the collector/base of Q1 and Q3, the top MMBT4401 and MMBT4403 devices, with a 40-V BV_{CBO} (the collector-to-base breakdown voltage with open-circuit emitter). A series resistor can be used for surge protection, with a penalty in voltage headroom.



1. In the circuit for the 1-mA two-terminal current source, the leftmost PNP transistor (Q4) is a "bolt-on" to harvest the approximately 0 temperature-coefficient current in the left leg (a). The "glue" circuit allows the top current source to be mated to bottom current source (b).

TABLE 1: BOM OF KEY PARTS

OEM part #	Vendor	Description	Notes	Single piece cost in QTY=10, $
SSL-LXA228SRC-TR31	Lumex	RED LED	LED lens designed to be facing down in through-hole on PCB	0.42
MMBT4403LT3G	On Semi	PNP BJT	SOT-23	0.094
MMBT4401LT1G	On Semi	NPN BJT	SOT-23	0.094
BAT54T1G	On Semi	Schottky diode	SOD-123	0.227
CRCW0603____	Vishay	1% thick film resistors	0603 SMT	0.044

A compact printed-circuit-board (PCB) layout is needed to prevent thermal gradients. The LED "photoelectric effect" has been found to not be an issue here, as the LED is the type where the LED lens is pointing down when mounted in the PCB. Light-tolerance testing has also been performed. Viewing the LED from the die-mount side of its package shows a red glow and can be used as a visual indicator that the current source is functional.

Figure 1b is the "glue" circuit, using two each of MMBT4401 NPN devices and 1.0-kΩ resistor. It connects a top current mirror and a bottom current mirror. The two key design equations for the add-on circuit are:

IE(Q2) ~ IIN2, therefore:

$$IE(Q2)/IIN2 = IE(Q2)/[IC(Q2) + IB(Q1)] = (1 + 1/\beta)/[1 + IB(Q1)/IC(Q2)] = (1 + 1/\beta)/(1 + 1/\beta) = 1$$

IOUT1 ~ IC(Q1), therefore:

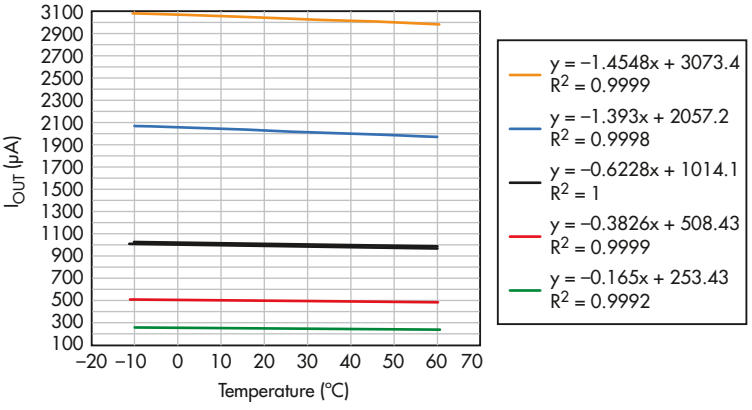
$$IOUT1/IC(Q1) = [IC(Q1) \times (1 + 1/\beta) - IC(Q2)/\beta]/IC(Q1) = 1 + 1/\beta - [1/\beta \times [IC(Q2)/IC(Q1)]] = 1$$

Figure 2 shows the current-source values and their change with temperature, while the steady-state performance over input voltage and the minimum operating conditions are shown in *Fig. 3*. The tempco of the bolt-on circuit *(Fig. 4)* compares favorably with the REF200, a commercially available, precision, dual-current source/current sink. That device has a temperature coefficient of ±25 ppm/°C on its fixed 100-µA current source.

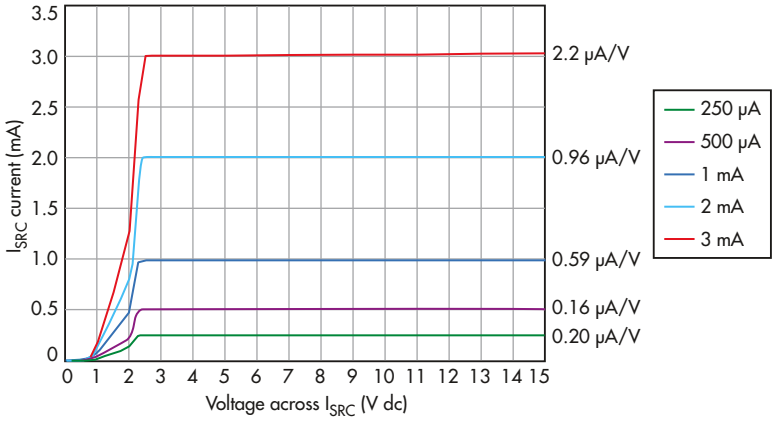
However, this current source can be set to any desired current and costs significantly less than the REF200. Also, the typical capacitance of the REF200 is 10 pF, while the value for this current source is less than 10 pF, and the typical output impedance of a REF200 is 100 MΩ from 2.5 V to 40 V. The two-terminal current source is a very repeatable, low-cost circuit and is a viable choice for replacing certain commercial ICs providing the same function.

In the online version of the article, an Appendix is included that provides a thorough summary of the data and a technical description.

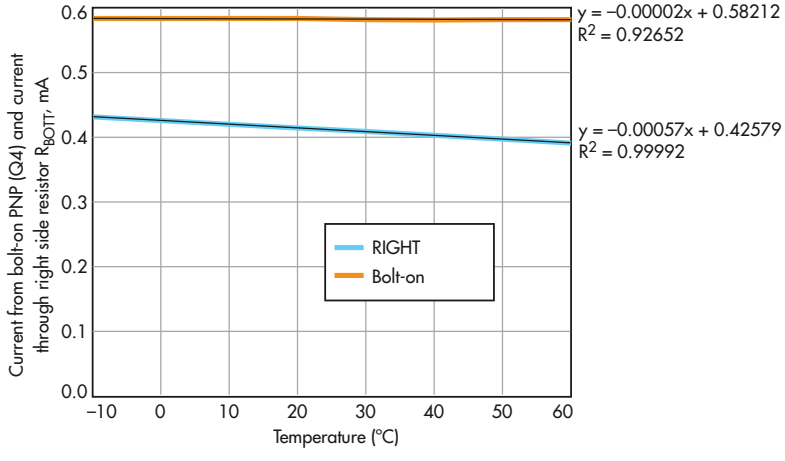
TIM DAVIS graduated with a BSEE from Iowa State University in Ames, Iowa. He has more than 28 years of experience in analog circuit design, power electronics, and IC design, including several patents for electronics in the medical industry. He can be reached at tdavismn@gmail.com.



2. Current (and thus tempco) versus temperature for the basic two-terminal current sources are: at I = 250 µA, TC = -660 ppm/°C ; at I = 500 µA, TC = -765 ppm/°C; at I = 1 mA, TC = -623 ppm/°C, at I = 2 mA, TC = -697 ppm/°C, and at I = 3 mA, TC = -485 ppm/°C.



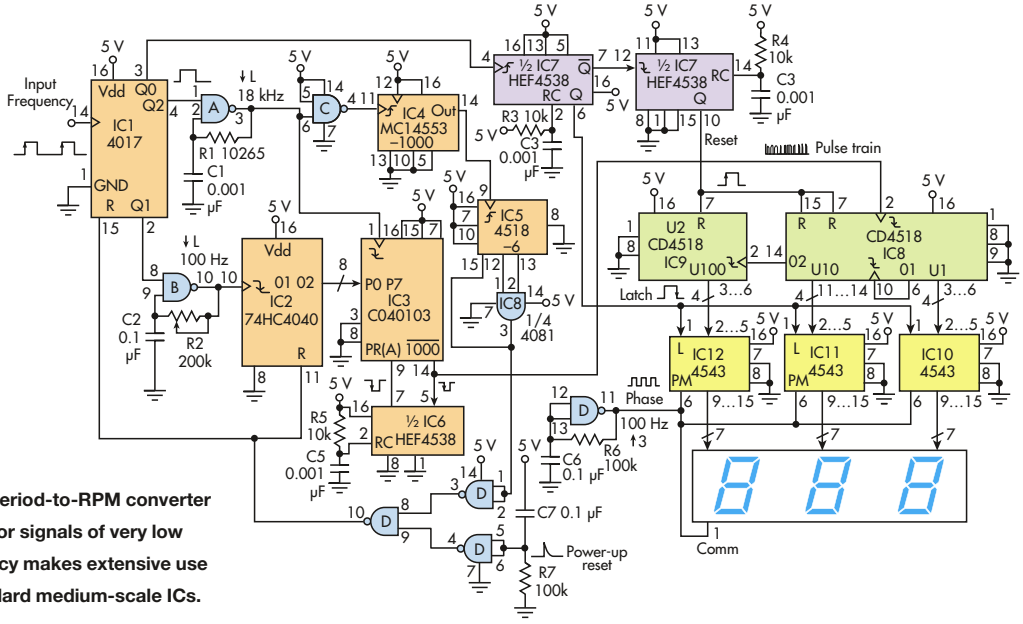
3. This plot of output impedance Z_{OUT} (with independent *current* source I_{SRC}) for the designed current-source values shows both the steady-state performance over both input voltage and the minimum operating conditions.



4. The plot indicates ~0 tempco in the bolt-on MMT4403 (Q4) PNP transistor to the 1-mA I_{SOURCE}. The red plot line for the bolt-on shows a TC of –35 ppm/°C.

Period-to-RPM Converter Measures Very Low Frequencies

RICARDO JIMÉNEZ, FERNANDO D. PACHECO, AND BLANCA L. RODRÍGUEZ | Instituto Tecnologico de Mexicali (ITM)



1. The period-to-RPM converter circuit for signals of very low frequency makes extensive use of standard medium-scale ICs.

MEASURING THE LOW FREQUENCIES that are common in many real-world situations, such as biomedical or speedometer applications, is a challenge due to the long periods of the cycles. A medium-scale-integration (MSI) CMOS circuit *(Fig. 1)* can measure frequencies in the range of 0.33 to 3.00 Hz (equal to 20 to 180 RPM).

The algorithm was designed to solve the equation RPM = 60/T, where T is the input-signal period and the "60" represents one minute. The circuit first measures the period with a 100-Hz time-base frequency, which holds the binary reading in a 74HC4040 counter, and then loops are made to determine how many times that period fits into the constant 6000.

The comparison technique is performed by a CD40103 8-bit synchronous countdown counter, which generates the first output pulse when the first clock arrives from NAND Gate A. This triggers the monostable IC6 (HEF4538) that loads the down counter with the period T.

The 18-kHz frequency continues, and each time the counter reaches zero, the output pulses trigger monostable IC6 at the falling edge of that signal *(Figs. 2 and 3)*. This signal is a feedback pulse that asynchronously presets IC2 (CD40103) for a new counting cycle. This process is repeated with a pulse train of 6000 pulses.

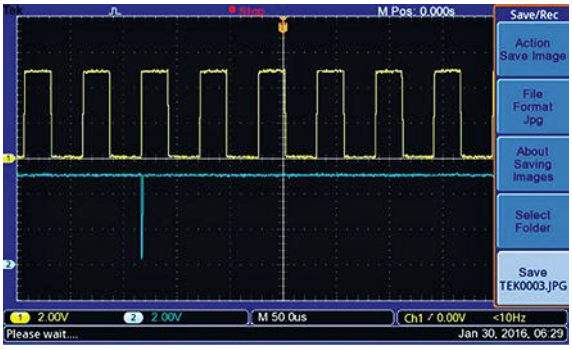
The pulse train is controlled by an 18-kHz logic oscillator and a frequency divider with a modulo equal to 6000. The frequency division is achieved with a MC14553 (IC4), CD4518 (IC5), and AND gate IC8 (CD4081).

A master chip, the Johnson counter CD4017 (IC1), controls the entire process. In this counter, Q0 is the starting point. In *Figure 4*, when the first pulse arrives, Q1 goes to a logic-1 level to enable the 100-Hz logic oscillator. The input signal's period is then registered in IC2 (74HC4040).

When the second pulse arrives, Q1 goes to a logic low and Q2 goes to a logic 1 *(Fig. 5)* to start the comparison process. An 18-kHz logic oscillator is used in this process. Once finished, the total number of pulses accumulated in BCD counters IC8 and IC9 (both CD4518s) will represent the period in pulses per minute (RPM.)

In addition, when the comparison process is done, a pulse is sent by AND gate IC8 in the frequency divider. This resets both IC2, clearing the binary period reading, and IC1, making its output Q0 equal to 1. When Q0's output goes from low to high logic level, it drives two monostable circuits based on the HEF4538 (IC7) to control the Latch and Reset functions of the BCD counters, as well as decoders that drive the LCD display *(Fig. 6)*. The LCD phase signal is controlled by another 100-Hz logic oscillator, NAND gate D, made of one Schmitt-trigger NAND gate (CD4093).

If you need a higher range, augment the number of bits in the period counter CD4040, and add a second counter CD40103 in cascade. Due to the fact that the oscillator in NAND gate B has a startup time delay, adjust it to 120 Hz to compensate this



2. A frequency of 18 kHz is received by the down counter (CD40103), and the ZERO pulse is detected when the counter reaches zero.

3. The zero-detect pulse indication is provided by the down counter.

delay and get true readings. A power-up reset-RC network (R7 and C7) assures that IC1 starts with Q0 = 1, and IC2 starts with a binary reading equal to zero.

The frequency equation for all of the logic oscillators used is:

$$F = 1/RC\ln[(V_P/V_N) \times (V_{DD} - V_N/V_{DD} - V_P)]$$

and the startup time delay for each oscillator is given by:

$$T = RC\ln(V_{DD}/V_N)$$

where V_P is the positive threshold voltage, V_N is the negative threshold voltage, and V_{DD} is the 5-V power supply.

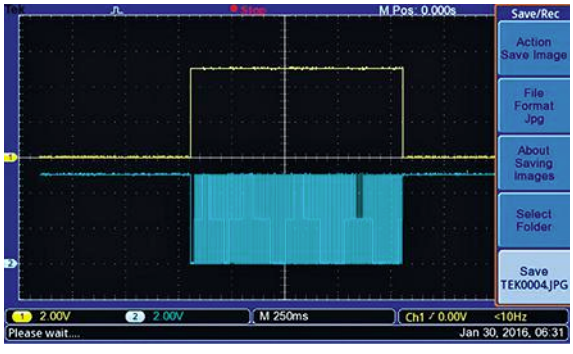
The equation for all monostables using the HEF4538 is:

$$T = RC$$

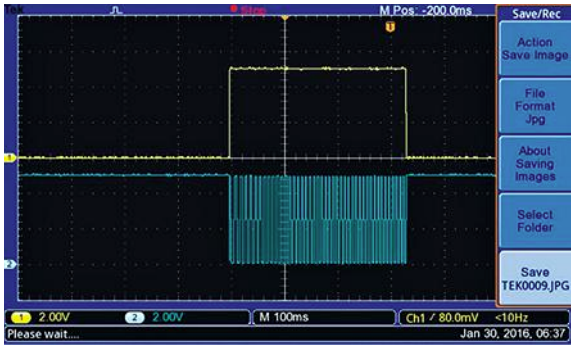
The power-up reset pulse is equal to:

$$T = R7 \times C7\ln(V_{DD}/V_N)$$

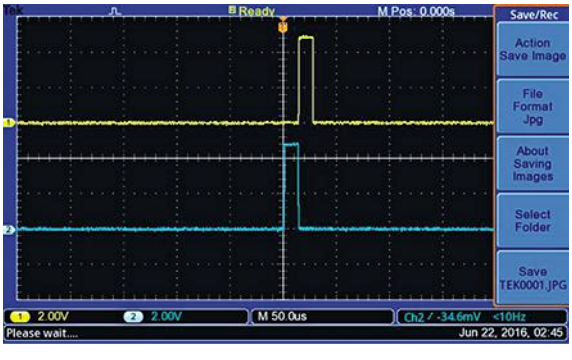
All of the NAND gates used in this project are Schmitt triggers (CD4093BE) from Texas Instruments.



4. Q1 and the 100-Hz time-base pulse train are used to measure the period.



5. Q2 going to logic 1 starts the 18-kHz signal generated by the second logic oscillator.



6. These Latch and Reset pulses were generated by the two half-monostables (IC7).

REFERENCES
Karen Hunsberger, "Rate Multiplier Eases Measurement of Ultra-Low Frequencies," *Electronic Design*, June 4, 2015
David Conrad, "Frequency Quadrupler Enables Low-Frequency Measurements, Spans Up To Four Decades," *Electronic Design*, March 6, 2014

RICARDO JIMENEZ is an adjunct faculty professor at Imperial Valley College, Imperial, Calif. He is the author of the book *Designing with Speech Processing Chips,* published by Elsevier Science Direct. **FERNANDO D. PACHECO** and **BLANCA L. RODRIGUEZ** are in their 4th college year at ITM, pursuing their degree in Electronics Engineering.

(Continued from page 25)

"We will see driver-assistance features being added to cars that will improve safety. An example of this is an increased number of optical cameras being added to cars to enable a vision system for accident avoidance. Such new systems will require high-speed video distribution throughout the car. With this, we will see dramatic increases in computational capability required to process vision-system data, which in turn requires more efficient power management. These trends play to Maxim's strengths in video distribution and power management."

IGBT AND SiC-MOSFET GATE DRIVERS

We asked Michael Hornkamp, senior product marketing manager at Power Integrations Inc., what challenges will confront IGBT and SiC-MOSFET gate drivers this year:

"The power electronics market is moving faster than ever before. Besides traditional industrial, renewable, and traction sectors, new applications such as energy-storage systems, micro-grids, and dc chargers are emerging, which place new demands on power semiconductors, specifically in terms of packaging, gate-driver functionality, and compactness.

"Also, as the automotive world moves to electric vehicles, this creates challenges for IGBT and SiC-MOSFET ICs, and their associated gate drivers. New packages for high-voltage IGBTs (1.7 kV, 3.3 kV, and up to 6.5 kV) and high-voltage SiC-MOSFETs (1700 V to 3.3 kV) are being introduced, so gate drivers need to be reconsidered to deliver the required isolation and gate-drive functionality within the reduced space available on top of the new modules. Finally, gate drivers must be able to manage the paralleling of these new package technologies.

"Because of these developments, discrete gate drivers are no longer suitable. Furthermore, a wide range of SiC-MOSFET gate voltages by must be available as the gate driver is paired with higher switching frequencies; faster short-circuit detection (below 2 µs) is also necessary.

"A clear trend for the EV automotive market is the use of on-chip current and temperature sense. Besides traditional dc-link measurement, there is a need for sophisticated fault reporting and management. The emerging technologies benefit from advanced controls and the gate driver must be able to provide galvanically isolated on-chip current- and temperature-sensing data. Power Integrations' investment in new technologies and products supports the current and future needs of power electronics design."

> **"A clear trend for the EV automotive market is the use of on-chip current and temperature sense"—Michael Hornkamp, Senior Product Marketing Manager, Power Integrations**

SENSORS

Pierre Laboisse, executive vice president, Global Sales & Marketing at ams, offers his perspective on where the sensor market will focus in 2017:

Pierre Laboisse, Executive Vice President, Global Sales & Marketing, ams

"Data is everywhere, and sensors are at the very heart of that. Sensors are helping expand networks to endpoints that were not dreamed of 20 years ago. As a sensors company, ams is focusing its efforts on four key areas we believe will be the most important in the coming years: optical, imaging, environmental, and audio sensing. We're working very hard to identify and address all of the market opportunities in each of these areas.

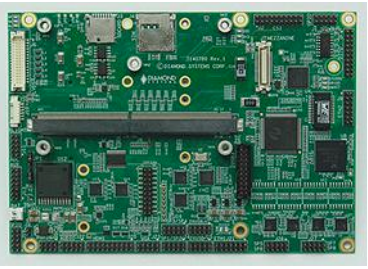
"While no one really knows what technology's next "killer application" will be, we are confident that any killer app will rely on sensors. These tiny, powerful solutions are creating the interface between the analog and the digital world to mimic human senses.

"The medical space provides a good example of what's to come. With the high costs of healthcare, medical equipment is becoming increasingly mobile. An at-risk diabetic patient might wear a smart watch that automatically tests blood-glucose levels, and sends that data directly to a caregiver for monitoring without disrupting the patient's life unless there is a problem.

"Along the same lines, heart rate, blood pressure, and even other forms of blood analysis all can be possible from the patient's home. It's like bringing the doctor and lab right to the patient. Fewer office visits, lowered costs, and more patient independence are just some of the benefits.

In the future, as these solutions all become even more accurate, physicians and practitioners will use the vital signs measured by sensors and other tools—likely with video backup—to make their diagnoses remotely. For patients, and in particularly the elderly, the result is better quality of life, improved health safety, and independence." ed

New Products



I/O SBCs and Carrier Boards Provide OTS Complete ARM

DIAMOND SYSTEMS' Eagle family of compact, rugged I/O baseboards, designed to support the Toradex Apalis family of ARM COMs, is composed of two models: the full-size, full-featured Eagle and its smaller-sized Eaglet. The I/O baseboards combined with the pin-compatible Toradex Apalis family of ARM modules provides a scalable platform for embedded computing applications with interchangeable processors similar to the COM Express concept. Eagle enables upgrading to a new Apalis module and installing new driver software.

Eaglet provides the core functionality of the installed Apalis COM. Eagle adds extra functionality for applications requiring more I/O, and includes a novel I/O expansion socket that can be used to attach compact I/O expansion modules such as analog and digital I/O. The first expansion module for the baseboard family is a dual CAN isolated transceiver module measuring 29 × 35 mm providing access to the two CAN ports native on each Apalis COM.

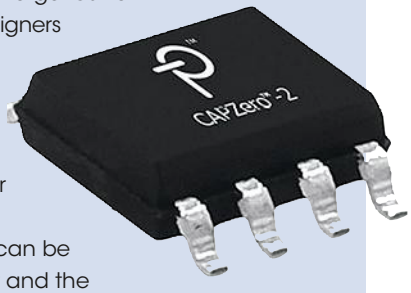
Development kits are available, along with a fully configured off-the-shelf solution including a select ARM module, installed heat sink, and integrated Linux OS. The 183 × 165 × 81 mm enclosure supports table-top, bulkhead, and DIN rail mounting options.

DIAMOND SYSTEMS

www.diamondsystems.com

Discharge IC Saves Energy, Delivers Zero-Crossing

A NEW FAMILY of CapZero-2 capacitor discharge ICs from Power Integrations allows power-supply designers to only have one part number qualified for all of their X capacitor discharge IC applications. The devices are safety-certified to CB and NEMKO requirements, so a separate safety test on the X capacitor discharge circuit is not needed.



A 45-W flyback power supply (DER-581) can be implemented based on the LinkSwitch-HP and the CapZero-2 device to perform the lossless generation of a zero-crossing signal, while still reducing the standby input power. Commonly used to synchronize the turning on and off of TRIACs and other similar switches, the zero-crossing signal minimizes EMI and component stress.

Targeted for systems designed to meet EuP Lot 6 requirements, the rugged two-terminal CAP200DG IC blocks current flow in the X capacitor safety discharge resistors when ac voltage is applied, reducing the power loss to less than 5 mW (zero at 230 V ac). When ac voltage is disconnected, the device automatically discharges the X capacitor by connecting the series discharge resistors. This operation allows for total flexibility in the choice of the X capacitor to optimize differential-mode EMI filtering with no change in power consumption.

POWER INTEGRATIONS

www.power.com

Switching Architecture Extends Service-Provider Reach

THE BCM88470, BCM88476, and BCM88270 families, the latest from Broadcom's StrataDNX line of switch SoC devices, extend the silicon platform for service providers networking to new high-volume markets and closer to the edge of the carrier network. The product families, devices ranging from 30 to 300 Gb/s, complement the StrataDNX switching product line. Offering consistent capabilities and a similar programming model to the flagship devices, the new products enable customer investment leverage and end-to-end product coverage from carrier edge to carrier core.

Each device provides high-performance carrier-grade packet processing, an integrated hierarchical traffic manager, external packet buffers with enhanced buffer management, and advanced packet processing with expandable tables. Select members of the family also offer paths for expansion capabilities with the StrataDNX switch-fabric interface and external table lookup expansion for Broadcom KBP.

The new switch families include the BCM88476 300-Gb/s packet processor, incorporating StrataDNX fabric interfaces compatible with BCM88750 and BCM88770 elements; the BCM88470 single-chip packet processor, delivering 160 to 300 Gb/s of Ethernet capacity; and the BCM88270 small-footprint single-chip packet processor, delivering 30 to 120 Gb/s of Ethernet capacity. The StrataDNX BCM88470 ("Qumran-AX"), BCM88476 ("Kalia"), and BCM88270 ("Qumran-uX") devices are currently sampling.

BROADCOM

www.broadcom.com

Modular PXIe Digitizers Capture Signals for Wideband

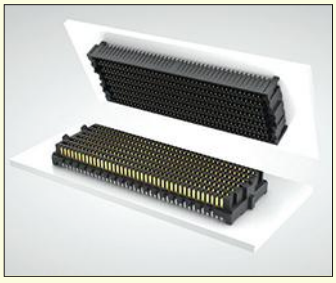
SPECTRUM INSTRUMENTATION HAS expanded its line of PXIe-based high-speed digitizers with the new nine-card M4x.22xx series, including modules that offer one, two, or four fully synchronous channels. Each channel is equipped with its own 1.25- to 5-GS/s ADC and scope-like signal-conditioning circuitry that allows programming of parameters such as input gain, signal offset, and coupling. Flexible front-end circuitry is complemented by a powerful trigger system and an on-board acquisition memory of 4 Gsamples, and with bandwidth up to 1.5 GHz, the digitizers are suited for automated testing applications where wideband electronic signals from dc to the GHz range need to be acquired and analyzed.

All units in the series are packaged in a dual-width 3U module, incorporating a four-lane PCI-e Generation 2 interface, allowing data-transfer speeds over 1.7 GB/s. The digitizers are shipped with software tools for creating control programs with most programming languages. SBench6 Pro software controls all of the digitizer's operating modes and hardware settings from one GUI. The M4x.22xx digitizers are available with immediate delivery, and include a base version of SBench 6 software and support drivers for most programming languages.

SPECTRUM INSTRUMENTATION

spectrum-instrumentation-usa.com

FMC+ Connectors Compliant to ANSI/VITA 57.4-2016



SAMTEC'S NEW family of high-speed board-to-board connectors, Searay, is designed to support the expanded interface and faster speeds of the latest FMC+ applications. The FMC+ connectors are compliant to the new ANSI/VITA 57.4-2016 standard, which extends the capabilities of ANSI/VITA 57.1-2010 in support of the increased number and data rates of multi-gigabit interfaces found in advanced FPGA architectures. Features of the new standard include increased multi-gigabit interfaces from 10 to 32, increased multi-gigabit interface data rates from 10 to 28 Gb/s, and backwards compatibility with VITA 57.1 FMC modules. The standard defines two mated connected pairs that embody the new FMC+ electromechanical interface.

A new HSPC connector contains 560 pins arranged in a 14 × 40 array and supports up to 24 multi-gigabit interfaces. A second, optional HSPCe connector contains 80 pins in a 4 × 20 array and supports up to eight additional multi-gigabit interfaces. The combination of HSPC and HSPCe connectors enable support of up to 32 multi-gigabit interfaces. With each multi-gigabit interface running up to 28 Gb/s, the ANSI/VITA 57.4-2016 specifications provide maximum system level throughput of 896 Gb/s via the 32 channels. The HSPC connector utilizes customized polarization to enable proper mating with FMC HPC and LPC connectors, and provides additional columns compared to legacy FMC connectors.

SAMTEC

www.samtec.com

New PXIe Chassis Models Enable Range of PXI Application Requirements

KEYSIGHT TECHNOLOGIES has three new PXIe chassis with different sizes and performance characteristics: the M9010A 10-slot Gen 3 chassis designed for high-performance, benchtop, and R&D applications; the M9005A five-slot Gen 1 chassis; and a redesigned 18-slot Gen 2 chassis (M9018B) with improved power-supply and system-integration features. Optimized for module cooling and high-performance, the 10-slot chassis delivers advanced sound power levels combined with exceptional per-slot cooling to meet the demands of high-performance PXIe modules. The 10-slot chassis provides a suitable platform for small channel-count R&D applications, while the 18-slot chassis enables test of multi-channel, high-performance manufacturing applications, such as MIMO and PA/FEM.

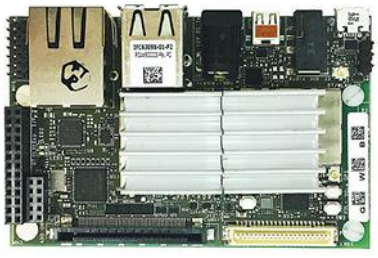
The five-slot chassis, targeted for smaller applications such as low-channel count VNA systems, provides an integrated system module with a x1 cable interface to an external PC, three hybrid slots, and two PXIe slots. The 18-slot chassis is a platform to build large systems when Gen 3 performance is not required. The M9018B is an updated version of the M9018A with a new power supply to provide more power. Available now, prices start at $4,500 for the M9010A, $1,600 for the M9005A, and $8,900 for the M9018B.

KEYSIGHT TECHNOLOGIES

www.keysight.com

High-Performance, Low-Power SBC Based on Snapdragon 410/410E

THE THIRD in Inforce Computing's Snapdragon family of processor-based embedded computing platforms, the Inforce 6309 Micro SBC is powered by the Qualcomm Snapdragon 410/410E application processor (APQ8016/APQ8016E) with quad-core ARMv8 Cortex-A53 CPUs. Features include support for Wi-Fi/BLE, GPS, HDMI displays, dual-MIPI-CSI cameras, GbE ports, LVDS, and optional PoE and RS-485 interfaces.



With robust support for an upstream Linux kernel (Linaro) and Android (Lollipop), coupled with an extended operating-temperature range and long lifecycle, the 54 × 85 mm SBC—complete with heat sink, EMI shielding, and RTC—suits industrial applications such as industrial automation, IoE, digital signage, smart infrastructure, and retail.

The plug-and-play development kit provides industrial IoE system designers instant access to the compute power, comprehensive I/O, and connectivity of the Snapdragon SoC. Priced at $136, the full Inforce 6309 Micro SBC development kit includes the micro SBC, power adapter, microUSB cable, and acrylic base. Commercial production SKUs are available with different combination of features for OEMs, with prices starting at $85 each/small quantities.

INFORCE COMPUTING

www.inforcecomputing.com

FPGA Accelerator Card Increases PCIe Bandwidth Capability

THE ADM-PCIE-9V3 FPGA accelerator card from Alpha Data, designed for HPC applications, is a half-length, low-profile, PCIe add-in card supporting the Xilinx Virtex UltraScale+ VU3P-2 in the FFVC1517 package. A 16-lane PCIe Gen3 or 8-lane PCIe Gen4 interface allows for maximum data throughput. The board is equipped with front I/O via 2x QSFP28 sockets, each supporting one 100-GbE interface with RS-FEC or four 25-GbE interfaces. Full-profile card slots can also support two additional 100-GbE interfaces via Samtec FireFly modules. The card also includes two x72 DDR4-2400 ECC memory banks, each providing 8 GB of on-board DDR4-2400 memory. System monitoring of temperature, voltage, and current offers feedback of power utilization. Software-based development flows will be supported by the hardware using OpenPOWER CAPI and the Xilinx SDAccel Development Environment.

An optional BSP with example FPGA designs, application software, mature API, and driver support for MS Windows and Linux is available, thus enabling cloud-scale deployments in Hyperscale data centers. The ADM-PCIE-9V3 accelerator card comes with low-profile (standard) and full-height front brackets and an optional blower for low air-flow systems.

ALPHA DATA

www.alpha-data.com

SDK Supports Development of HomeKit-Enabled Accessories

SILICON LABS' new Bluetooth Solution for Apple HomeKit is designed to create HomeKit-enabled accessories. Available as a library with clean APIs, the software has passed certification tests for the HomeKit specification and is pre-tested and certified by Apple to provide a low-risk development solution. Support for Apple HomeKit development projects includes a portfolio of Wireless Gecko SoCs and modules, Simplicity Studio development tools, plug-ins for Bluetooth Developer Studio, example accessory applications and source code, an iOS app with source code, documentation, and support. The protocol stack supports LE secure connections for secure Bluetooth pairing, LE packet extensions for higher throughput, and LE dual topology for flexible network configurations and OTA firmware updates. Simplicity Studio streamlines IoT design with one-click access to an Eclipse-based IDE, energy profiling, network analysis tools, demos, examples, and documentation. Support for the third-party tool, Bluetooth Developer Studio, enables auto-generation of code for Apple HomeKit accessories.

The core of the hardware offering for HomeKit development is the Wireless Gecko SoC portfolio, including Blue Gecko SoCs and Bluetooth module families highlighted by the new ultra-small BGM12x SiP. The Bluetooth software for Apple HomeKit is available free of charge to Apple Made for iPod/iPhone/iPad (MFi) program licensees.

SILICON LABS

www.silabs.com

SMT TVS Diodes Safeguard Automotive Electronics

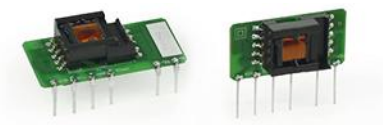
A NEW line of AEC-Q101 qualified transient-voltage-suppression (TVS) diodes from Littelfuse, the SLD8S Series, is designed specifically to protect sensitive electronics from voltage transients induced by events like alternator load dump and inductive load switching. The TVS diodes offer a choice of 7,000 W (10/1,000 µs) or 2,200 W (load dump) peak-pulse power-dissipation ratings in a surface-mount package. Operating junction temperature is extended up to 175°C, and high peak dissipation ratings allow power systems to pass the ISO 7637-2 5a, 5b surge tests and meet the ISO 16750-2 load-dump waveform standard. The diodes, available in surface-mount SMTO-263s packages with leaded modification, are designed to provide precision overvoltage protection for sensitive electronics, such as automatic pick-and-place assembly and reflow processes.

The series is targeted for long pulse applications that require high reliability, such as load dump and ESD protection in automotive electronics like TCUs, ECUs, BCMs, BMSs, sensors, and entertainment systems. The SLD8S Series automotive TVS diodes come in tape-and-reel packaging in quantities of 500.

LITTELFUSE

www.littelfuse.com

3-W/5-W AC-DC Supplies Packaged in Ultra-Compact SIPs



THE PBO family of ultra-compact ac-dc power supplies in open-frame SIP packages from CUI include 3- and 5-W configurations. The PBO-3 and PBO-5 series measure 35 × 11 × 18 mm; the low-profile, right-angle versions of the 3-W configuration, the PBO-3-B series, measure 35 × 18 × 11 mm. Available with typical efficiencies up to 80%, the high-density devices offer an 85- to 264-V ac or 70- to 400-V dc input voltage range for high-voltage dc-dc systems. For more challenging environments, the 3-W models offer an operating temperature range of –40 to +85°C, while the 5-W models provide a range from –25 to +85°C. All models are designed to provide 3,000-V ac input-to-output isolation.

The power supplies include overcurrent and short-circuit protections, and are suited for applications in ranging from industrial systems and automation equipment, to security, telecommunications, and smart-home devices. The PBO-3, PBO-3-B, and PBO-5 series are available immediately, with prices starting at $5.85 each/500.

CUI

www.cui.com

Low-Profile Flip-Locking FPC Connector Handles 4 A

AVX CORP. is now supplying the low-profile 6808 Series of 4-A right-angle flexible-printed-circuit (FPC) connectors from Kyocera Connector Products. Suitable for both FPC connections and battery connections in applications including batteries, power supplies, robotics, and small electronic motors, the zero-insertion-force flip-locking FPC connector features dual-sided, top and bottom contacts that mitigate FPC insertion and PCB layout restrictions. Six power pins are able to transfer up to 4 A, and one signal pin is capable of transferring 0.5 A. The ultraminiature 0.5-mm-pitch devices can also be employed as seven-pin signal connectors, and come combined with a notched FPC to prevent contact misalignment and enhance resistance against shock and vibration.

Measuring 7.3 × 5.3 × 1.5 mm, the 4-A connectors exhibit a minimum FPC retention force of 15 Newtons and come with right-angle cable connections, copper-alloy contacts, and heat-resistant plastic insulators. Rated for 50 V dc with 10 mating cycles and operating temperatures spanning –40 to +85°C, the 6808 Series FPC connectors are supplied in reels of 5,000 parts per reel. Current lead time is 12 weeks.

AVX CORP.

www.avx.com

For more information on products or services visit our website www.electronicdesign.com, menu item Reader Service. The advertisers index is prepared as an extra service. *Electronic Design* does not assume any liability for omissions or errors.

New to Penton Ad Portal?
https://penton.sendmyad.com
Your new account will give you access to begin sending ads to Penton.

Lab Bench

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

Learning from an Ada Neophyte

Technology Editor Bill Wong recently judged the "Make with Ada" competition and found some interesting feedback that will intrigue embedded developers.

Delivering an application that does what it was designed to do is the goal of most developers. One way to accomplish that is to use tools that enhance the development process. Using MISRA coding standards is one approach to improving C/C++ development. Another method is to use SPARK, a subset of Ada designed for safe and secure applications *(see "What's the Difference Between SPARK 2014 and Apache Spark?" on electronicdesign.com)*.

Of course, taking on a new programming tool is not something to do lightly. I recently served as one of the judges for Adacore's "Make with Ada" competition. Stephane Carrez of Issy Les Moulineaux, France took first place with a network-traffic monitoring tool called EtherScope. In second place was German Rivera of Austin, who developed an Autonomous Car Framework for the NXP cup race car. But what I want to highlight is the feedback from the third-place winner, Shawn Nock from London, Ontario, who developed a Bluetooth Beacons "iBeacon" using Ada.

The reason is that Shawn is a C programmer who had not used Ada before competing. "Developing the beacon in Ada (a language I don't know well) took roughly the same time as the similar functionality in C," he wrote in his blog, "and I have more confidence in the Ada code." As to why:

"I find Ada's syntax to be intuitive. I've done a fair amount of work in Python, so I found the block notation and indentation to be comfortable immediately. Unlike Python, Ada retains semicolons as statement delimiters [making] me all warm and fuzzy.

"I found it natural to draft my interfaces in spec files. In C, I've acquired the bad habit of writing code and interface at the same time in .c files and back-filling header files when my compiler complains. I could have always done this better in C, but the context switch to Ada allowed me to see the advantage clearly.

"More opinionated compiler—I've run external linters and static analysis tools in my VCS commit hooks for ages, but there are 90 ways to write C and a thousand tools...having the compiler express strong opinions and enforce them at compile time saved me time. From syntax checking to style checking; I didn't find myself needing to spend time searching out good tooling to start writing decent code. I imagine that when working on a team, it's easier to agree on (and enforce) a list of compiler flags than a whole ecosystem of tools.

> "I find Ada's syntax to be intuitive. I've done a fair amount of work in Python, so I found the block notation and indentation to be comfortable immediately. Unlike Python, Ada retains semicolons as statement delimiters, [making] me all warm and fuzzy."
> —Shawn Nock, "Make with Ada" third-place winner

"GNAT—It's a part of the GCC. This is perhaps a downside for some embedded engineers...but I enjoy working with GCC. It's consistent, available on nearly every platform, well maintained, and free. With GNAT, I only needed to add a single tool to my development ecosystem to get started on Ada.

"I didn't spend any time in the debugger. Once I convinced GNAT of my intentions on with some pretty intense compiler flags (-gnatg -gnatp -gnatn2 -gnatwa -gnatQ -gnatw.X); my software tended to Just Work."

Most of the projects targeted microcontrollers like STMicroelectronics' 32-bit STM32 family, which includes Cortex-M4 and Cortex-M7 solutions.

This type of feedback is not limited to individuals in a competition. I recently hosted Adacore's webinar, "Building High-Assurance Software without Breaking the Bank," where Protean Codes' Rod Chapman talked about a number of projects that utilized SPARK (*available on electronicdesign.com*). The bottom line was that the safety-critical projects presented were completed on time with fewer errors, thereby reducing the amount of testing required. This reduced project costs.

Static- and dynamic-analysis tools are being used for C, C++, and Java applications to improve code quality. Unfortunately, they fall short compared to SPARK. C and C++ will remain the primary tools for embedded applications for a number of reasons, but if you're searching for that edge, SPARK may be worth a look. ED

When it comes to power inductors, we're spreading things a little thin

(actual height)

In fact, with hundreds of options under 1.2 mm high, selecting the perfect low-profile power inductor is no tall order!

Let's face it, thin is in. From smart phones and wearables to all types of portable devices, there is constant pressure to pack more performance into the thinnest package possible.

To help, we continue to expand our line of mini, low-profile power inductors with footprints as small as 1.14 x 0.635 mm and maximum heights as low as 0.50 mm!

Select inductance values from 0.018 to 3300 µH and current ratings up to 20 Amps.

Get the skinny on all our low-profile power inductors, including the new ultra-low loss XEL4012 Series with low inductance values that have been fully optimized for high frequency applications over 5 MHz.

Visit **coilcraft.com/lowprofile** today!

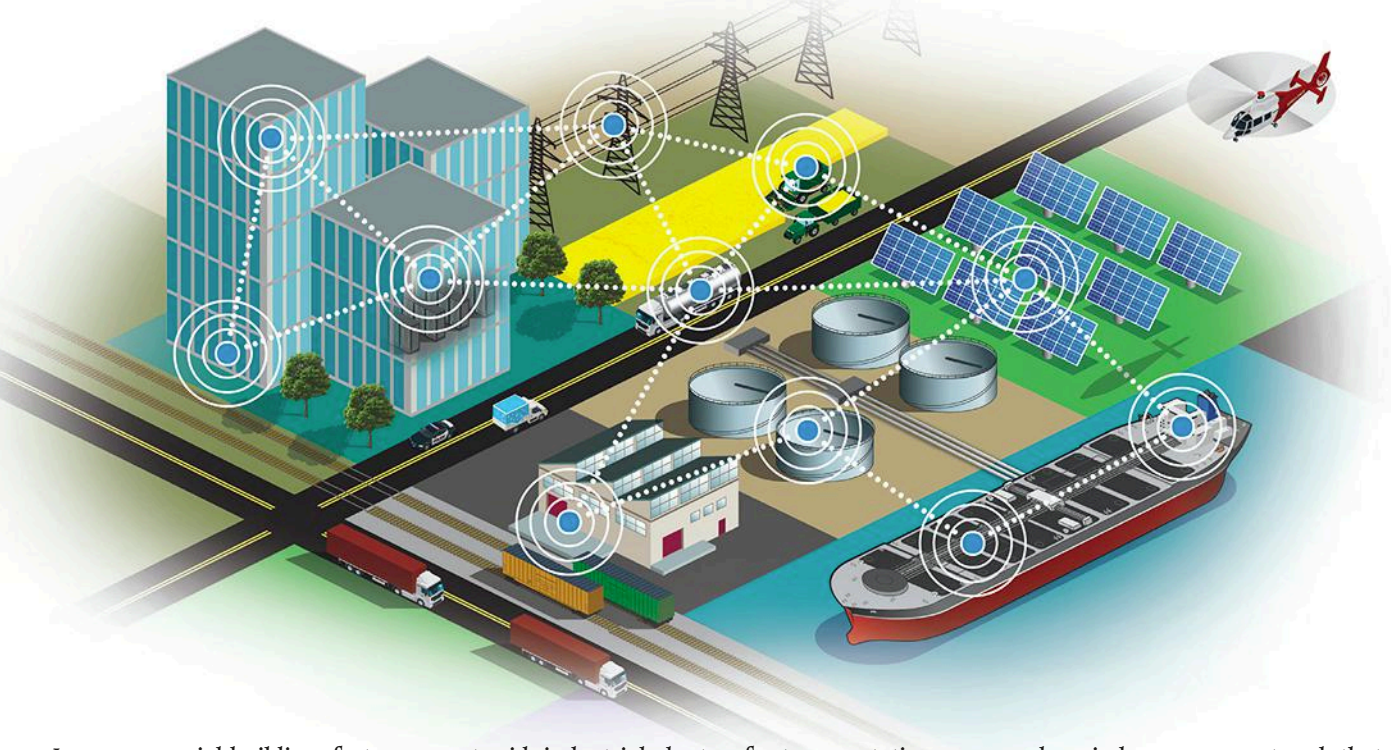
coilcraftdirect.com
No min order. Next day delivery.

Coilcraft®

WWW.COILCRAFT.COM

Industrial Wireless Sensor Networking

SmartMesh®



In a commercial building, factory, smart grid, industrial plant or for transportation, you need a wireless sensor network that performs in tough RF environments, in extreme environmental conditions, and operates reliably for many years. With over 50,000 customer networks in over 120 countries, SmartMesh is field-proven to deliver >99.999% data reliability and >10 year battery life. Customers trust SmartMesh to deliver their business-critical data and enable their Industrial IoT businesses.

Features

- The Only Network Built for Industrial IoT
- Complete Networking Software Speeds Development
- Engineered for Years of Trouble-Free Operation

Reliable Wireless Sensor Network Streamlines Manufacturing Operations

video.linear.com/7254

Learn More

www.linear.com/SmartMesh

1-800-4-LINEAR