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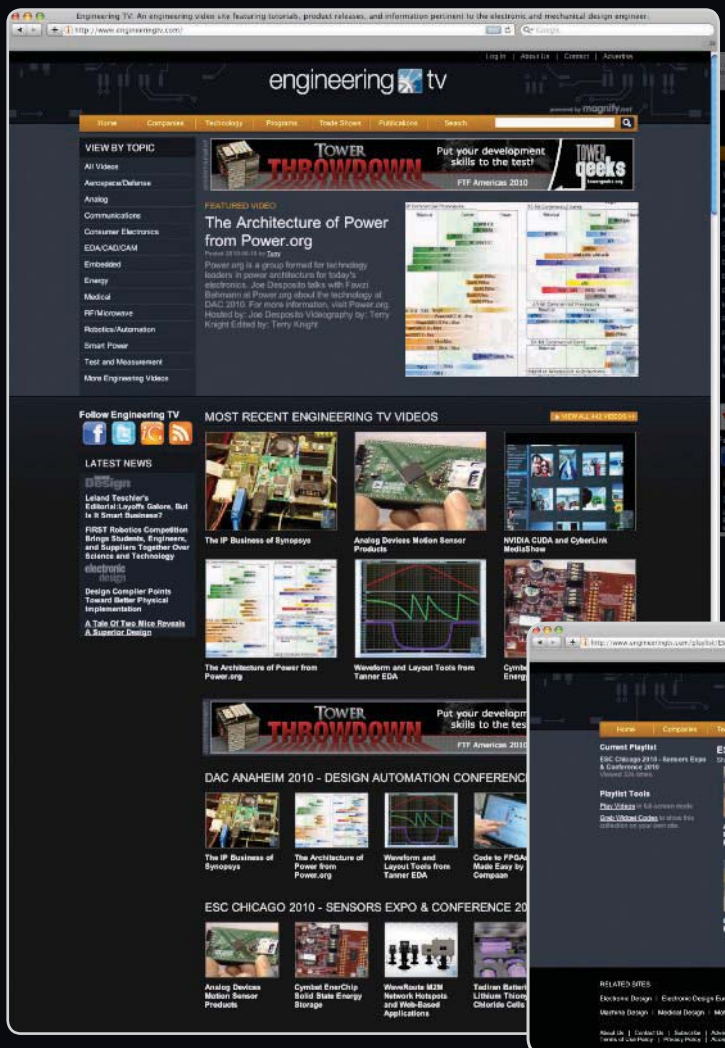

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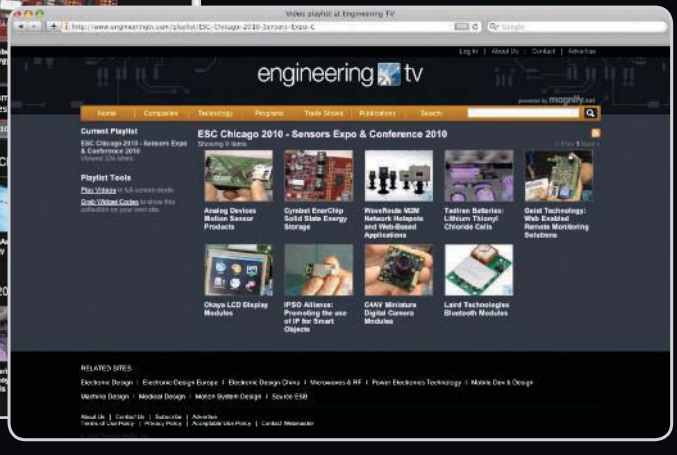

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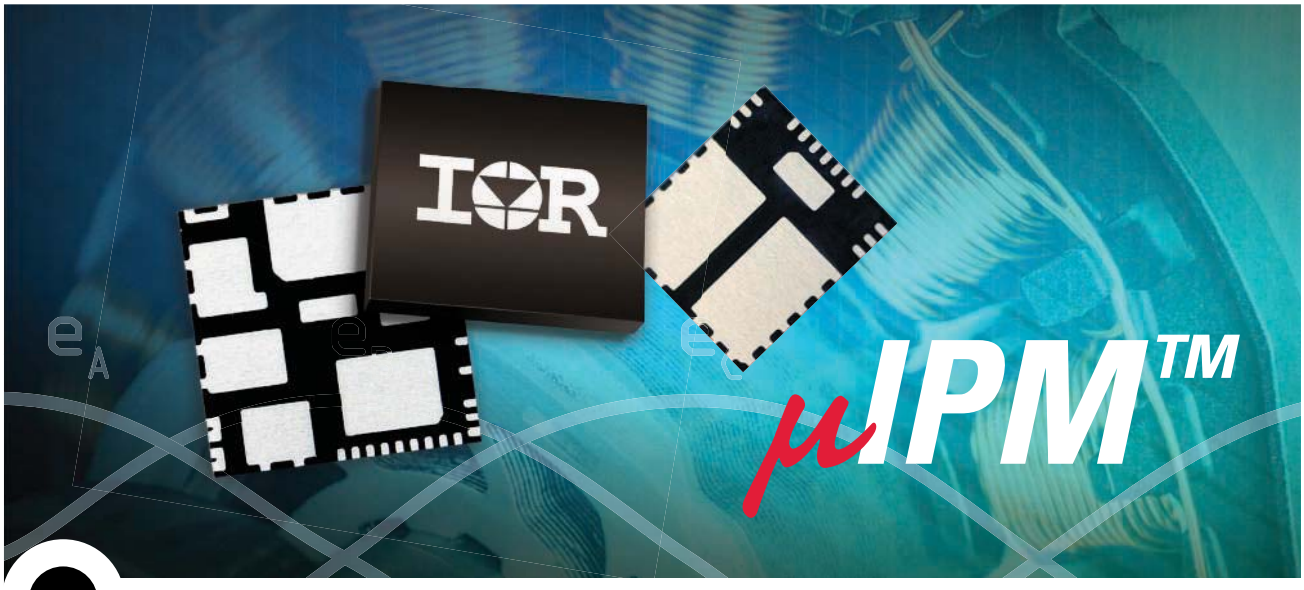

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IRSM836-035MB	12x12	500V	3A	420mA	510mA	108W/135W	3P Common Source
IRSM836-035MA	12x12	500V	3A	420mA	510mA	100W/130W	3P Open Source
IRSM836-045MA	12x12	500V	4A	550mA	750mA	145W/195W	3P Open Source
IRSM808-105MH	8x9	500V	10A	1.1A	1.3A	285W/390W	Half-Bridge
IRSM807-105MH	8x9	500V	10A	1.1A	1.3A	285W/390W	Half-Bridge

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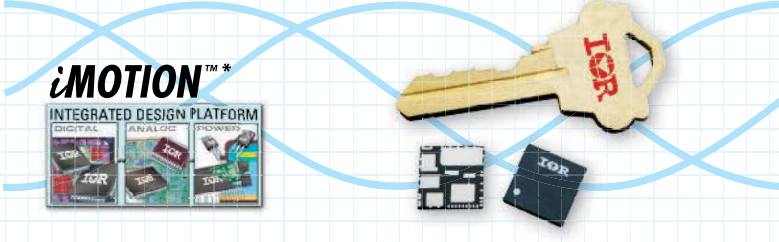

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EDITORIAL MISSION:
To provide the most current, accurate, and in-depth technical coverage of the key emerging technologies that engineers need to design tomorrow's products today.

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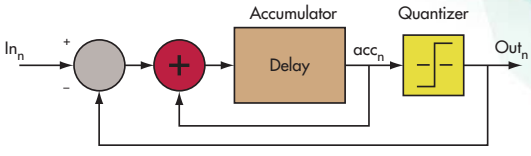

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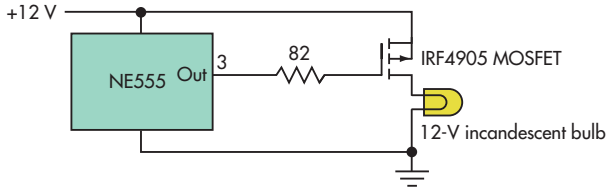

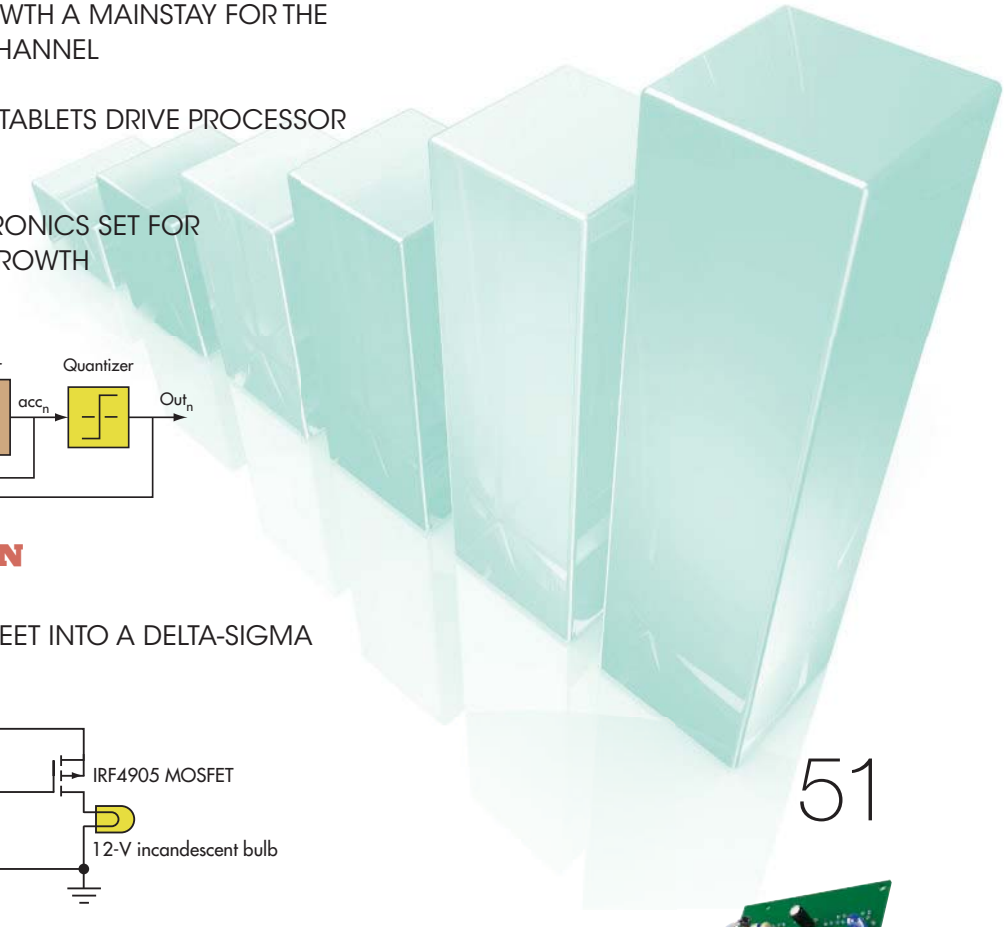

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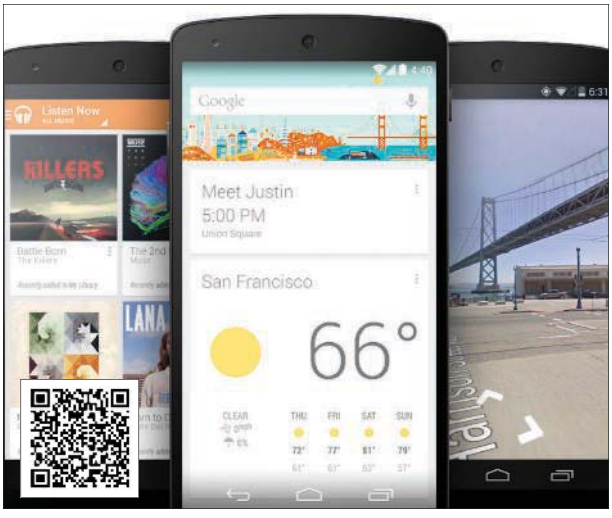

SNAPDRAGON PROCESSORS BOOST CAPABILITIES OF NEXUS 5 SMART PHONES

The Nexus 5 will be the first smart phone released with global LTE support and Android 4.4.

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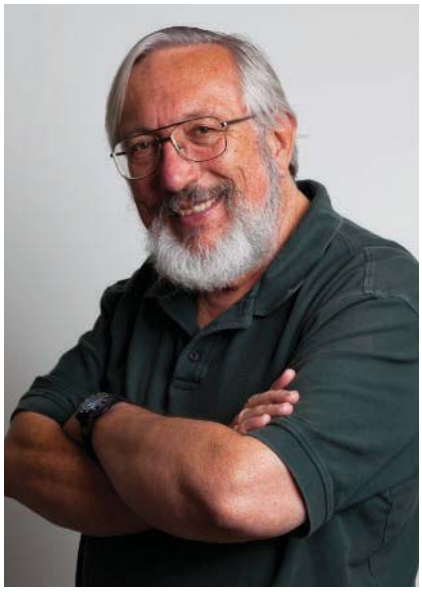

Expect Collaboration And Innovation In 2014

A new year should mean new ideas, new horizons, and new ways of doing things. But there also are older tasks carried forward—all the ideas there almost was time for in the year gone by that are still fresh and worthy of pursuit. Here are a few projects I have in my hip pocket that should make for interesting and provocative stories in 2014.

The first looks at universities and entrepreneurial incubation programs. These collaborations provide facilities, professorial expertise, and grad-student labor in return for new visions of technologies and a piece of the action when the technologies break into the mainstream.

Last summer, I dropped by the New Jersey Institute of Technology for a morning's worth of interviews with the directors of one such program there and entrepreneurs who were taking advantage of it. I have transcripts of those conversations, and you will find out more about them in the months ahead.

I also want to pursue more grassroots collaborations that could develop new skills among participants and foster innovation. My wife Vicky has taken part in several hackathons this fall. Meanwhile, my future son-in-law Adam helped found Hacker Dojo, which is something more than the usual incubator.

Hacker Dojo is a 16,600-square-foot community center and hackerspace in Mountain View, Calif. Besides providing working space for software projects, it hosts events that range from technology classes to biology, computer hardware, and manufacturing. There's a huge library, fast Wi-Fi, and access to friendly geniuses. What's especially cool is that there's no stratification in terms of age or gender. There are scary-smart youngsters collaborating with working engineers and coders and grad students in a resource-rich, friendly collaborative environment.

Along those lines, I need to revisit TechShop and see why it works so well in Silicon Valley and struggles so hard elsewhere. TechShop is where you go when you need the machine tools to develop hardware prototypes. Membership isn't cheap, but look at the machines you get access to once you've been trained to use them. There are manual and CNC mills; metal lathes and routers; MIG, TIG, gas, arc, and spot welders; sheet metal brakes and shears; plasma cutters; and even industrial sewing machines.

Finally, I've been husbanding a bunch of contributed technical articles that will see publication in 2014. Topics range from applications for ultracapacitors to autonomous vehicles, with some good advice about troubleshooting power supply noise both acoustical and at radio frequencies.

I have 12 months to get all that and much more neat and into print and online. It should be an interesting year

BOB ZOLLO | Contributing Technical Expert
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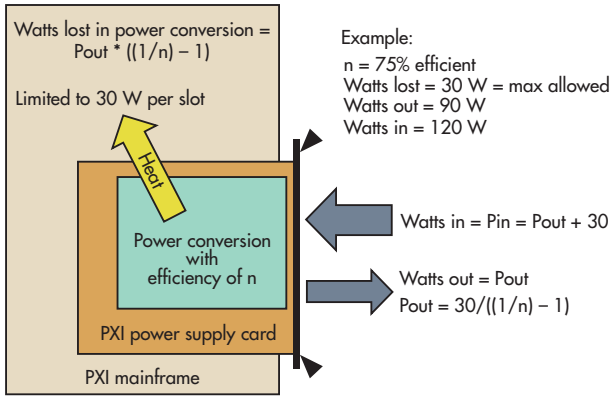
Expect More Power In PXI, But Watch Out

MANY TEST SYSTEMS TODAY are based on PXI, which offers a whole test system in one frame. PXI gives you high speed, small size, vendor interoperability, and a wide variety of available cards. But for dc power supplies, being squeezed into a PXI slot can pose a real challenge.

At low output power, perhaps up to 20 W, it makes a lot of sense to put the dc power supply inside the PXI mainframe to take advantage of the compact mechanical environment and common communications. But when the output power gets larger, it becomes harder to host a dc power supply within a PXI mainframe.

Even an efficient dc power supply card will only be able to source a fraction of the up to 30 W of limited power per slot from the PXI backplane. That difference in power between input power from the backplane and dc output power is lost as heat on the PXI card. Since the PXI mainframe can only support 30 W of cooling per slot, the dc power supply card is also constrained by cooling.

The trend, though, is to get more dc output power out of a PXI power supply card. Manufacturers are trying several approaches to overcome the limited power and cooling per slot.



1. Output power could be determined based on efficiency with losses limited to 30 W per slot.

NEW SOLUTIONS

One approach is to build a more potent PXI mainframe that has beefier supplies and extra cooling per slot so more power-hungry and heat-producing dc power supply PXI cards can be used. However, this approach defeats PXI interoperability, as these more power-hungry, heat-generating power supply cards will only work in these special PXI frames.

The next approach is to relieve the burden on the PXI mainframe's backplane supply by powering the dc power supply card directly with ac or dc power via the card's front plane. Cards that use an ac input are less common because the ac power conversion circuitry tends to take lot of space. Since the ac components don't tend to fit nicely on a thin PXI card, these vendors sell multi-slot cards. While this solves the problem, it mitigates the small size benefit.

Driving the dc power supply card with dc power from the front plane is a more common solution. These PXI cards are effectively programmable dc-dc converters. Putting 24 V dc or 48 V dc into the front plane does create a bit of a configuration hassle, as it means you must have some kind of auxiliary dc source outside of the PXI mainframe but still in the ATE system.

Often, this auxiliary dc source is an ac-dc power brick like those that power and charge laptops. While the cost is low, this brick-charger needs to be mounted somewhere within the test system with a wire run to it. This is not a terribly difficult mechanical configuration to manage, but it does defeat the benefit of a whole test system in a frame.

Providing ac or dc into the PXI dc power supply card does overcome the limited power available from the PXI mainframe's backplane power supply, but this approach has its

2. The Agilent N6700 modular power system offers one to four outputs in 1U of rack space. There are 34 power supply modules to choose from at up to 500 W per output.

limits based on the efficiency of the dc power supply card. All of the heat generated by the inefficiencies of the PXI power supply card must be dissipated and therefore limited to 30 W per slot *(Fig. 1)*.

If the PXI power supply card is a linear power supply, the typical efficiency is less than 50%, limiting the total output power to 60 W or less. If a switching power supply or some other efficient design is used, you can get more power output, but even efficient designs will be limited to 100 W to 200 W of output power. By having the power supply take up more than one slot, you can accumulate the available power per slot and the available cooling per slot.

However, while this solves the power and cooling, it does increase the size and raise the cost of the solution, as there is a per slot mainframe overhead cost that needs to be considered. You may also have to consider how the heat generated on the power supply cards could cause thermal drift problems on nearby cards. Additionally, there could be issues with magnetic or radiated interference from noisy high-power conversion circuits packed in a frame close to sensitive RF cards.

So while vendors can offer you solutions for higher output power, you need to watch out for compromises in size, cost per slot, interoperability, mechanical complexity, and nearby card performance.

There is another way to configure a system that can provide more dc power. For higher power and higher point count, a complementary solution like the Agilent N6700 modular power system makes sense *(Fig. 2)*. While a complementary solution is not a pure PXI system, by moving the power supplies out of the PXI frame, you are no longer limited in size, power, and cooling.

Dedicated power supply solutions such as the Agilent N6700 can offer very small sizes (up to four dc outputs in 1U of rack space) and lots of power (up to 500 W per output) in a mainframe that is optimized for power and cost, leaving the PXI frame for instruments that can be efficiently packed onto a small PXI card and take advantage of the fast backplane communications of PXI. ed

BOB ZOLLO is a product planner with the Power and Energy Division, Electronic Measurements Group, at Agilent Technologies. He is responsible for creating Agilent's power products roadmap by researching customer and industry trends and developing product plans to meet emerging customer needs. He holds a degree in electrical engineering from Stevens Institute of Technology in Hoboken, N.J. He can be reached at bob_zollo@agilent.com.

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Looking Forwards And Backwards At The IoT

1. Companies like Pražská Teplárenská a.s. are using cellular routers like the Spectre 3G from B&B Electronics to add Internet of Things capabilities to older infrastructure.

THE ALLIES BUILT ENORMOUS NUMBERS of Douglas C-47s for the Second World War. Thousands of them are still in service seven decades later. They're used for everything from firefighting and rescue work to crop dusting and freight services, and their pilots like to say the only replacement for a C-47 is another C-47.

The C-47 is easy to fly. It's easy to maintain. It can take off and land on dirt or grass runways. It can be equipped with skis, floats, or wheels. After three quarters of a century, it's still an excellent airplane.

Modern aircraft typically fly higher and faster than the C-47. Their onboard avionics will normally be far more advanced. But C-47s still do what they were designed to do, and they do it very well. There's no reason to doubt that they'll keep on flying for decades. That's worth thinking about when we discuss the evolution of the Internet of Things (IoT).

2. Dual-band wireless serial servers give RS232/422/485 equipment such as the Airborne M2M from B&B Electronics Wi-Fi connections and the ability to choose between 2.4 GHz and 5 GHz, depending upon which frequency provides the more reliable connection under local conditions

NEW NETWORKING FRONTIERS

To be sure, we'll be connecting new, cutting-edge devices with unprecedented capabilities. We'll be extending the network edge to include locations that were once unimaginable. We will be able to collect and manage increasingly large and complex data sets and use them in increasingly powerful applications. We're about to experience an exciting new wave of innovation and invention.

But many of the data networking tools of the present and the past will still be perfectly able to do their jobs. And as a result, we'll quickly discover that the Internet of Things is going to include more than just the devices of the future. Like a pilot who has installed a new GPS receiver in his trusty old C-47, we'll find ourselves working backwards to connect equipment that already exists and give it new capabilities.

You can already see the principle at work. In Prague, the capitol and largest city in the Czech Republic, Pražská Teplárenská a.s. operates a district heating system with 265,000 customer connections, 49 heating plants, and 696 km of pipeline. District heating systems like this are hardly new technology. Many are more than a century old. But when heat distribution networks are large enough, they're surprisingly cost-effective. Rather than seeking to replace them, many operators are actively expanding them.

Pražská Teplárenská a.s. is no exception. It has added heating plants that burn waste rather than fossil fuels. It has installed gamma ash meters that analyze coal in real time, letting operators apply efficient process control measures like coal homogenization. But the company also wanted to add remote monitoring and metering all across the system, and it needed to connect devices that used protocols ranging from Modbus to Ethernet. Inconveniently, Prague is more than 1000 years old. There are winding streets, irregular property lines, and even some canals. Installing cable connections would have been a nightmare. So Pražská Teplárenská a.s. chose one of the

newer communications technologies and deployed cellular routers *(Fig. 1)*.

The cellular routers communicate with the central control using TCP/IP over the cellular telephone network, but they also connect to remote networks and devices using hardware interfaces that are built directly into the routers. They'll support Wi-Fi, Ethernet, RS232/422/485, and even Modbus. Rather than abandoning its legacy infrastructure, Pražská Teplárenská a.s. used new technology to make it better.

WHAT'S NEXT?

Pražská Teplárenská a.s isn't alone. The world's installed base of legacy systems and equipment is far too large, far too complex, and far too valuable to be casually cast aside. So each time new data networking options have appeared, manufacturers have responded by developing devices that let older equipment remain relevant.

Dual-band wireless serial servers give RS232/422/485 equipment Wi-Fi connections and the ability to choose between 2.4 GHz and 5 GHz, depending upon which frequency provides the more reliable connection under local conditions *(Fig. 2)*. Similar devices give serial devices their own Wi-Fi hotspots, allowing technicians to communicate via laptops, tablets, and smart phones. As Ethernet has moved off the desktop and into the real world, manufacturers have met the challenge, producing Ethernet equipment with industrial specifications and the ability to stand up to harsh, real-world environments. That trend will continue.

New devices will continue to become smaller and smarter, of course. More and more intelligence will be distributed around the network, calling for less and less direct human intervention. Power requirements will continue to drop, just as power harvesting techniques continue to improve. It's an exciting prospect, and we're only beginning to grasp the possibilities.

But the Internet of Things will be more than a network of small, smart new devices. It will include older equipment as well. Like an old C-47 waiting its turn in the landing circle above a modern airport, your valuable legacy device will be welcome to keep on doing its job. It will be just one more node among many on the Internet of Things. ed

MIKE FAHRION, director of product management at B&B Electronics, has more than 20 years of design and application experience overseeing M2M connectivity solutions for wireless and wired networks. He also is author of the eConnections newsletter.

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Analog Chip Companies Provide Higher Levels Of Design Support

Designers no longer are on their own when it comes to new ideas. Several leading companies now offer libraries, communities, and other tools to help help you start or refine your next project.

THE DAYS OF CONTINUOUS IMPROVEMENT in analog/mixed-signal performance baselines for analog components are not over. In fact, remarkable strides are still being made in speed, precision, power consumption, and noise performance *(see "ADC Makers Challenge Conventional Wisdom About SAR Speed And Resolution" at electronicdesign.com)*.

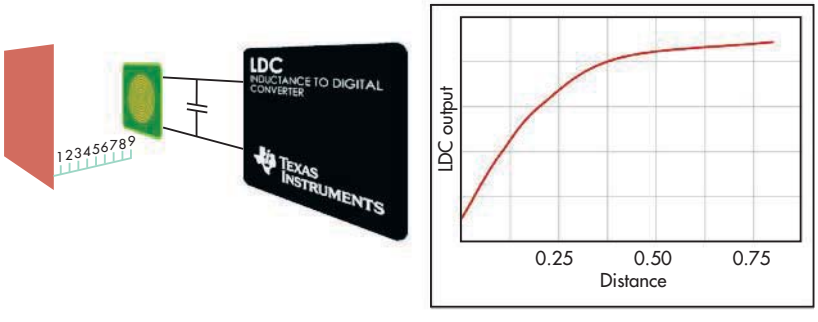
Yet the trend is toward embodying advanced electronics in complete solutions, rather than leaving system designers to create circuits from basic components. This works to the chipmaker's advantage, since it accommodates a broader spectrum of circuit design skills. A junior engineer can be assigned to a project and still come up with an acceptable design in a reasonable amount of time and with less need for interaction with a senior engineer.

Indeed, in many cases, the approach taken by the semiconductor designer may require some special knowledge to realize performance that matches a part's data sheet. Bundling a part with more support information than an application note—or hiding the more sensitive parts of the design in a complete reference design or inside an IC—yields faster time-to market for the chip company's customer and builds brand loyalty.

There will always be application engineers. In fact, every year chipmakers send armies of them overseas to assist high-volume customers. (Domestic distributors have their own skilled apps engineers.) Beyond that, the Web offers greater opportunities for outreach, and the possibilities of proven reference designs, complete with layouts and bills of material (BOMs), to get the required information to the largest audience. The use of these tools is so widespread now that announcements about their release, their thoroughness, and the rationales behind their design appear nearly every week.

COMPANY SUPPORT

Texas Instruments' TI Designs reference design library spans the company's entire portfolio of analog, embedded processor, and connectivity products for industrial, automotive, consumer, communications, and computing applications.[1] Each design includes test data, a schematic or block diagram, BOM, and design files that help explain the circuit's function and performance. Additional support material may include models, software, code examples, design guides, evaluation modules, and more.



1. The Texas Instruments LDC1000 can detect very small increments of motion, either linear or radial. Its operation is based on the effect an external conductor has on the coil in a resonant LC tank circuit. Typically, the coil would be a helix on a printed-circuit board. Linear motion would be detected by moving a metal object closet to or further away from the coil. Rotation motion would be detected through the use of a portion of a disc as it turns through the coil's field.

Of course, this is in addition to the WEBENCH Design Center, which TI acquired with the purchase of National Semiconductor.[2] WEBENCH provides unique and powerful software tools that deliver customized power, lighting, filtering, clocking, and sensing designs in seconds. Furthermore, the company's TI E2E online community (http://e2e.ti.com) connects more than 120,000 engineers with TI product designers and application engineers and with each other. It provides live and on-demand training, including videos, seminars, webcasts, workshops, and conferences.

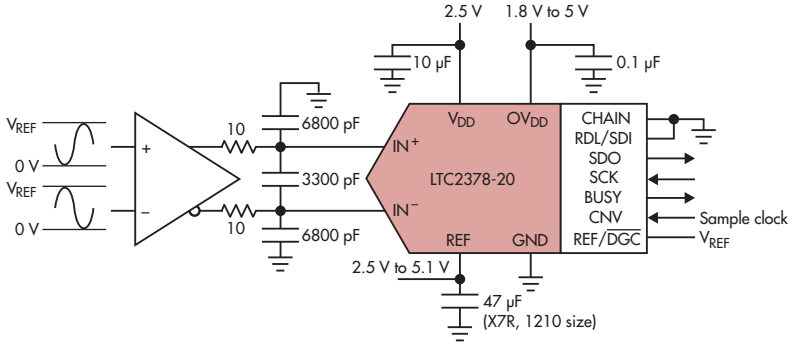
On December 6, the Society for New Communications Research awarded the

Analog Devices EngineerZone online technical support community (ez.analog.com) its Commendation of Excellence. Analog Devices first launched EngineerZone in 2009 as a global design resource that serves engineers across the semiconductor signal processing chain.

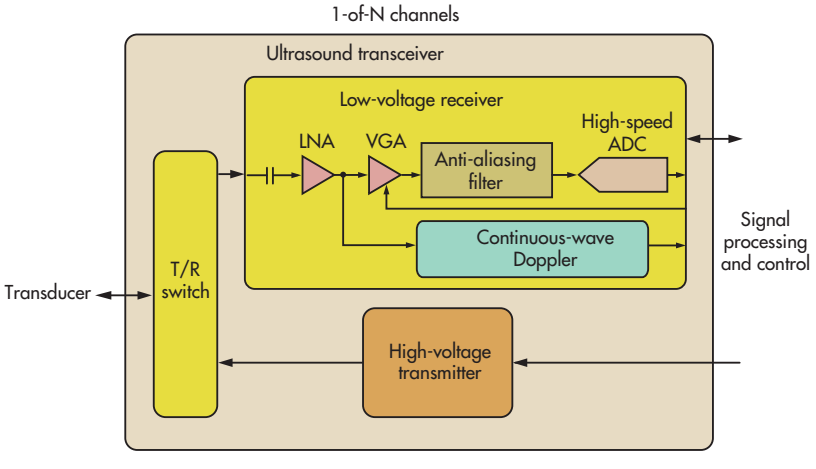
Also, Analog Devices' Circuits from the Lab offers more than 200 designed and tested solutions for process control, instrumentation, communications, healthcare, automotive, and motor control, with complete documentation and test data.[3] The latest circuits available on the site include schematics, BOMs, layout files, low-cost evaluation boards, and device drivers when applicable.

In November, Maxim Integrated launched its Carmel, Monterey, and Fremont reference designs. These fully tested subsystems come complete with schematics, layout files, and firmware. They're all available for immediate use and customization. Each integrates multiple functions for an automated factory task. According to the company, they also facilitate rapid prototyping, early software development, and speed of design.

The Carmel (MAXREFDES18#) provides high-accuracy, low-noise analog signals suitable for input to programmable logic controllers (PLCs) and distributed control systems (DCSs). It features accurate output from high voltages down to true zero, integrated error reporting, and detection of short circuit, open circuit, brownout, and over-temperature conditions. It also provides both current and voltage outputs, including bipolar signals of –20 to 20 mA and –10 to 10 V.



2. Linear Technology's 20-bit, 1-Msample/s, no-latency LTC2378-20-1 SAR ADC boasts a typical INL of 0.5 ppm and a guaranteed maximum no greater than 2 ppm. It enables the use of multiplexers to replace costly, independent ADCs with slower throughputs to reduce system cost and complexity.



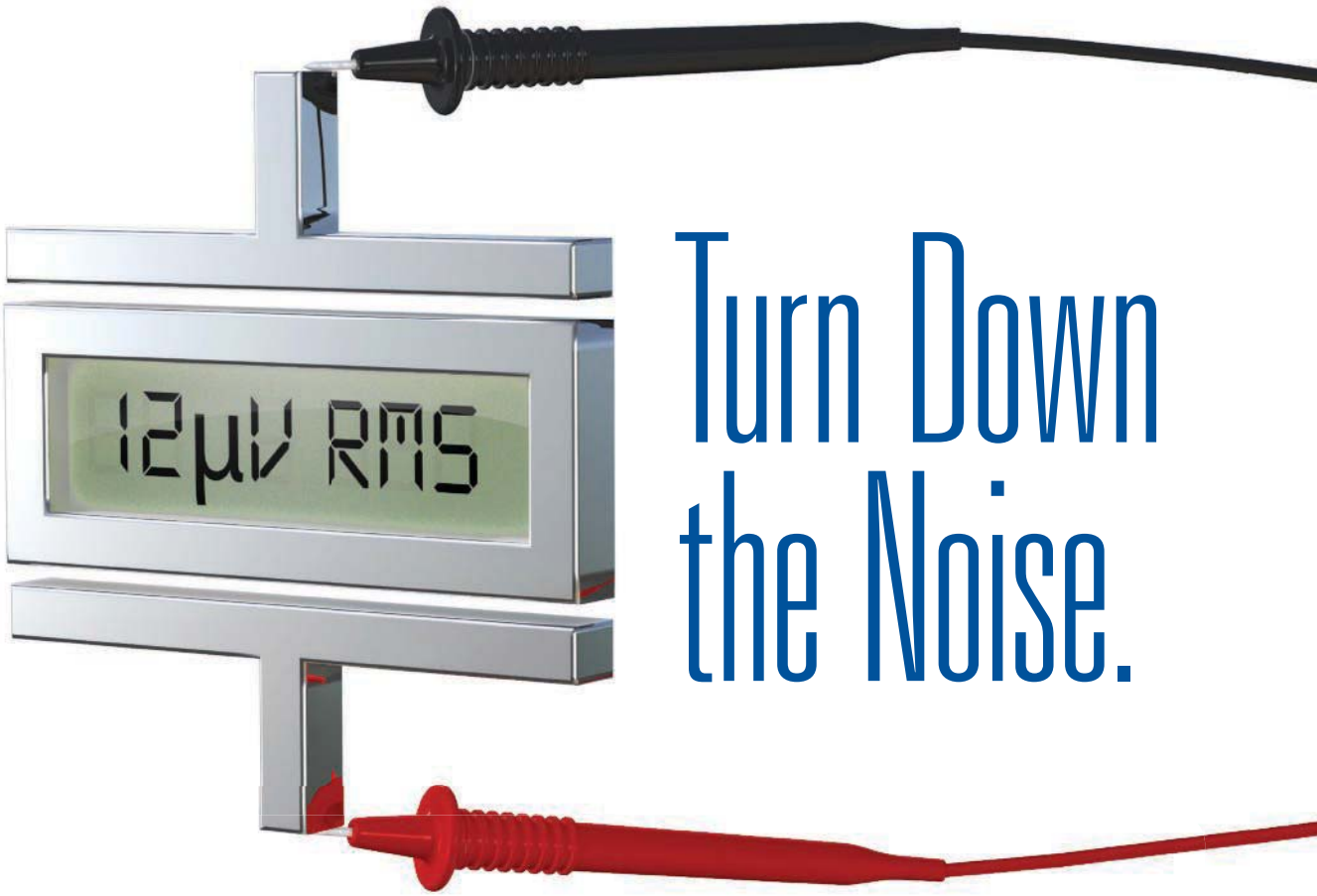
3. Maxim Integrated's MAX2082 octal ultrasound transceiver comprises high-performance, three-level 2-A pulsers that can generate pulses up to ±105 V. All eight channels have overvoltage-embedded protection diodes and integrated active return-to-zero clamps. The transmitters have their own embedded floating power supplies so no external pulser driver coupling capacitors are required.

The Monterey (MAXREFDES15#) high-accuracy, industrial, loop-powered sensor transmitter converts a standard temperature sensor input (RTD PT1000) to a 4- to 20-mA signal that is immune to noise and constant over long distances. System current consumption is less than 2.1 mA, which is a 40% improvement compared to the industry standard. It supports 0.1% system accuracy over a full process variable-input range.

The Fremont (MAXREFDES6#) low-power analog front end (AFE) accepts inputs of 0 to 100 mV. It is intended for low-voltage output sensors and for process control and medical applications. It is characterized by low-power operation (less than 300 mW typical), fast prototyping with all necessary design files included with the reference design, and simplicity as the single-ended system eliminates the need to convert to differential signals.

RECENT PRODUCTS

Even more than Web sites and reference designs, new products illustrate trends in functional integration and product performance. Again, the trend is toward system solutions. For example, the Texas Instruments LDC1000 position sensor *(Fig. 1)* goes beyond mere Hall effect sensing to open new possibilities in automotive, medical, and general industrial applications *(see "Inductance-To-Digital Converter Offers Breakthrough Sensing Performance" at electronicdesign.com).*



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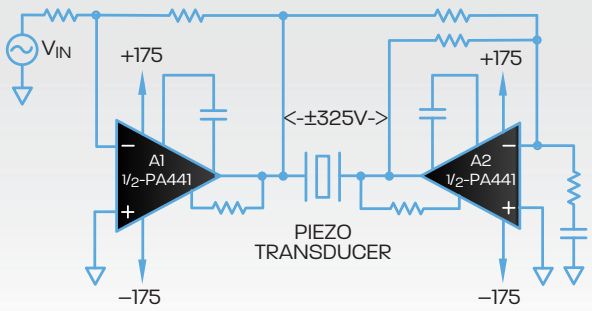
The PA441DF is a next generation high voltage power amplifier featuring a 96 percent reduction in noise and an equally impressive 2X improvement in offset voltage versus the previous IC, the PA34X series. For precision applications such as piezo-electronics, ultra low noise and offset voltage of just 5mV translates to must have signal accuracy. Voltage supply is a wide ±10v to ±175V and output current is 60mA continuously or up to 120mA PEAK. The PA441DF is a single channel device housed in a space-saving 24-pin PSOP. The PA443DF is the dual channel option.



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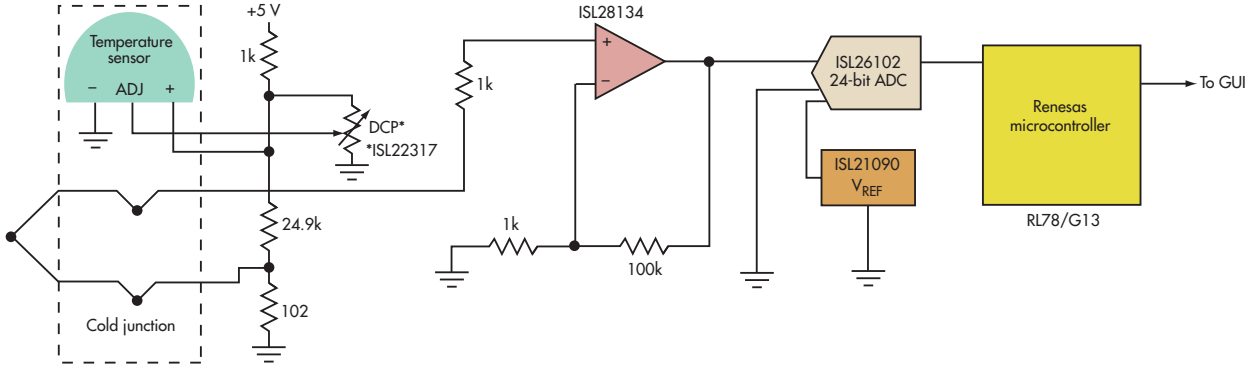

4. Intersil's "DAQ on a stick" USB drives provide complete reference designs and sets of self-contained demonstrations. For example, one stick provides a thermocouple design that uses a Renesas RL78 to process signals.

Meanwhile, Linear Technology has always fought to own the highest ground in terms of fundamental performance measures. Its 20-bit, 1-Msample/s, no-latency LTC2378-20-1 successive approximation register (SAR) analog-to-digital converter (ADC) boasts a typical integral nonlinearity (INL) of 0.5 ppm and a guaranteed maximum no greater than 2 ppm *(Fig. 2)*. Its signal-to-noise ratio (SNR) is 104 dB, and its guaranteed maximum total harmonic distortion (THD) is –114 dB from –40°C to 85°C.

According to Linear, the LTC2378-20-1's wide dynamic range and true 20-bit resolution reduce or eliminate the need for additional gain in the signal chain, improving total system accuracy and noise. With its fast 1-Msample/s throughput and no latency, it enables the use of multiplexers to replace costly, independent ADCs with slower throughputs to reduce system cost and complexity.

Over the past year, Maxim Integrated has refocused on developing very high-performance discrete devices that will serve as cores for the highest-performing ASICs, as indicated by the Carmel, Monterey, and Fremont reference designs. Also, Maxim's precise, drop-in-ready Cupertino (MAXREFDES5#) isolated 16-bit AFE subsystem reference design targets industrial sensors, process control, and PLCs.

With analog –10- to 10-V, 0- to 10-V, and 4- to 20-mA inputs, the Cupertino supports all of the common industrial sensor analog outputs. Maxim provides all of the hardware design files, example driver code, and test results needed to speed design development. Its AFE connects directly to FPGA/CPU development kit expansion ports that conform to Diligent's Pmod standard.

Maxim's highly integrated MAX2082 octal ultrasound transceiver integrates eight channels of three-level, 200-V pulsers and T/R switches, an octal ADC, an octal low-noise amplifier (LNA), an octal variable gain amplifier (VGA), continuous-wave mixers (for Doppler), anti-aliasing filters, and coupling capacitors into a package small enough to enable an entire 128-channel solution in less than 10 square inches *(Fig. 3)*. Traditional designs include more than nine components in the T/R switch alone for each channel on a typical 128-channel system, so the MAX2082 displaces thousands of discrete parts.

Last February, Intersil and Freescale jointly announced a thermocouple/strain gauge demo board that combines Intersil's precision and power products with Freescale's Kinetis L series microcontroller, with a Cortex M0+ core on one board and Freescale's FRDM-KL25Z Freedom development platform on the other.

The thermocouple design uses a K-type thermocouple with cold junction compensation, Intersil's ISL28134 zero-drift amplifier, ISL21090 voltage reference, ISL22317 DCP, and ISL26102 24-bit delta-sigma converter. The Freescale board includes the Freescale KL25Z MCU plus 128 kbytes of flash and 16 kbytes of SRAM.

The thermocouple temperature or applied strain can be monitored using a GUI on the computer powering the demo through the mini USB cable. The display shows real-time data in either a numerical or a graphical representation of the temperature or strain measurement.

Diversifying its relationships with controller companies, Intersil accompanied the Freescale announcement with another, highlighting its "DAQ (data acquisition) on a stick" series of USB drives, which include complete reference designs and sets of self-contained demonstrations. For example, one stick offers practical sensor solutions for thermocouple, pressure, and strain gauges, using a Renesas RL78 to process analog and digital signals *(Fig. 4)*.

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3. Analog Devices Circuits from the Lab, www.analog.com/en/circuits-from-the-lab/index.html

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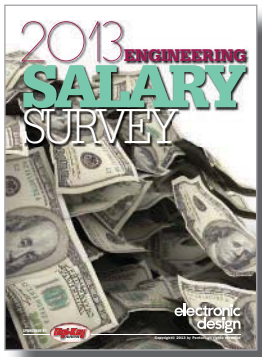

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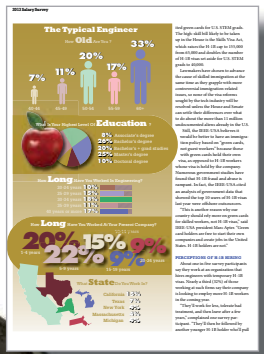

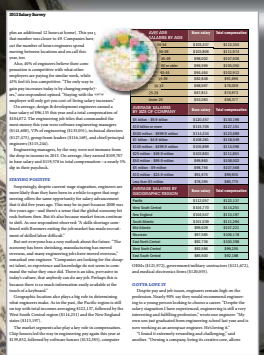

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Expect Everything (And Everyone) To Communicate

Communications networks are everywhere, and everyone and everything can access them easily, from people in remote locations to the most mundane household applicances.

COMMUNICATIONS SEEMS TO BE a part of all electronic devices these days. What electronic product doesn't have a communications function? It's hard to name one. And that trend continues as almost everything is wireless, connected to the Internet, or both.

1. With its 5.7-inch screen, the Samsung Note 3 is nearly a tablet, often called a "phablet." It is the top of the line of Samsung's Galaxy smartphone series (a). The Samsung Gear smartwatch is an accessory to The Note 3 smart phone that communicates by Bluetooth (b). The smartwatch trend is growing with Samsung clearly in the lead so far.

CELL PHONES

Smart phones dominate the consumer market, with more than 50% of subscribers now owning a smart phone. In some parts of the world, the smartphone market is already saturated. That's why cheaper smart phones like Apple's iPhone 5c are in the works. Soon there will be fewer types of cell phones as the inexpensive models morph into inexpensive smart phones.

Another big trend continues to be larger screens. Virtually every smart phone has a 4-inch or greater screen with sizes up to 6 inches becoming available. That is probably the limit as tablet screens start at 7 inches. I doubt we will see the smart phone morph into a tablet, although Samsung's Note 3 with its 5.7-inch screen and Nokia's Lumia 1520 with its 6-inch screen are truly both.

Future smart phones may have curved screens, but who needs or wants that? Since all smart phones have become just a black slab of metal and glass, the effort continues to distinguish one phone from another.

Samsung dominates smart-phone sales with its Galaxy series, and its Note series is doing well too. The Note 3 is available with a smartwatch accessory called Samsung Gear *(Fig. 1)*. Apple is in second place but still does well with its iPhone 5c and 5s models. A new iPhone with a larger screen may come along this year. And will Samsung really abandon Android for its own Tizen operating system (OS)? We shall see.

The Gear smartwatch talks to the handset by Bluetooth. It displays time, messages, and other data when you don't want to take your phone out of your pocket or purse. Smart watches from Pebble, HOT, Qualcomm (Toq), and others potentially including Apple are gradually emerging as a major accessory for smart phones. Samsung reported sales of 800,000 units to resellers of its Gear smartwatch in two months. I might try one myself. Yet it is just an accessory like a Bluetooth headset, and it may not be the big hit that everyone expects. I predict that it will be a niche.

Another wearable with lots of hype is Google's Glass. Many expect it to be a big hit. Wearable computers have been forecast and tested in various forms for years. But I am not sure about this one, since it does make users look dorky. It is amazing technology with its voice commands, clever screen, and constant video "spying" mode. This is another niche, in my opinion. However, Juniper Research expects the global forecast for smart-glasses shipments to reach 10 million units per year by 2018. We shall see.

BUSINESS AND STANDARDS

Microsoft's acquisition of Nokia's handset division will be an interesting combination like the Google-Motorola arrangement. We can expect some interesting new smart phones and tablets running Windows Mobile OS. BlackBerry, though, is slowly

fading away. It's a shame that the original smart-phone maker has lost the cachet and marketing battle and is now on its way to oblivion. It's a waste of great technology and products.

The LTE rollout continues with all the major carriers aggressively building LTE capacity to keep up with the ever-increasing demand for video connections. Average LTE download speeds are in the 8- to 15-Mbit/s range, which is better than some wired DSL or cable TV broadband connections. LTE is becoming the norm at least in the U.S. and some parts of Europe and Asia.

Interestingly, the time division duplex (TDD) version of LTE is becoming more widely used than expected. Most of the world uses the frequency division duplex (FDD) version of LTE. Yet the TDD version requires half the spectrum and is one good answer to the chronic spectrum shortage. China Mobile is the big user of TDD LTE, and we may see many others adopt it to expedite LTE rollout and added capacity.

LTE-Advanced (LTE-A) trials are under way, and some carriers could implement small areas with this aggressive, updated version of LTE. Its carrier aggregation combines multiple contiguous and non-contiguous 10- or 20-MHz channels to provide channel bandwidths to 100 MHz enabling downlink speeds up 3 Gbits/s. Higher-level multiple-input multiple-output (MIMO) up to 8x8 is also a part of LTE-A, which should lead to improved connection reliability as well as higher speeds.

2. Sierra Wireless' AirPrime HL series M2M modules are among the smallest (22 by 23 mm) available for embedded applications. They can be had in any 2G, 3G, or 4G technology with or without on-chip GPS.

According to the ITU, LTE-A is the real 4G. It will be interesting to see how the carriers promote it, maybe even as 5G. LTE-A is mostly in a field test mode right now, although South Korea Telecom deployed its LTE-A networks last July. In the U.S., we won't see LTE-A reach any critical mass until 2015 and beyond.

Another major cellular trend is the small-cell or heterogeneous networks (HetNet) movement. Small basestations called femtocells, picocells, and microcells will supplement the larger standard macrocells to provide improved coverage and higher speeds over a smaller area. The technology will be LTE and LTE-A as well as some 3G fallback.

Such networks do not yet exist except in trial test form, but you will begin seeing more of them later this year and beyond as carriers try to deal with the demand for greater subscriber capacity, higher speeds, and the continuing pressure on spectrum demands. ABI Research forecasts a 70% increase in enterprise femtocells in 2014 and a tenfold increase by 2018, driven by the increasing need for indoor voice coverage and video data capacity.

One factor aiding the small-cell movement is Wi-Fi offload. Data accesses can be diverted from the stressed cellular network to a nearby available Wi-Fi hotspot. That is why most microcell and picocell basestations will implement LTE, legacy 3G, and Wi-Fi. A recent survey by Maravedis-Rethink for the Wireless Broadband Alliance indicated that tier 1 mobile carriers say that 75% of their small cells will include Wi-Fi by 2018. Furthermore, the carriers expect about 20% of their data capacity to come from Wi-Fi. Added capacity and speed will come from active antennas with beamforming as well as distributed antenna systems (DAS).

So what is 5G? Small cells could be promoted as 5G, although a HetNet is still only LTE or LTE-A. One potential version of 5G employs millimeter-wave basestations, which will use the frequencies beyond about 30 GHz, minimizing the current spectrum shortage that most carriers experience as they build out their networks. The range is short at these frequencies, meaning that a small-cell, short-range configuration is inherent. Antenna beam forming and beam steering will make it work even in crowded metropolitan areas.

Ted Rappaport of NYU Wireless has already proven this concept and tested it in the challenging New York City area. It is a real possibility. Something new also could show up in the years to come. You won't see 5G for a while yet, so stay tuned as the real 5G emerges.

SHORT-RANGE WIRELESS

The three main short-range wireless technologies—Wi-Fi, Bluetooth, and ZigBee—continue their forward movement. We all seem to take Wi-Fi for granted, as it is virtually everywhere. Tablet and laptop users really get upset if there is no Wi-Fi connection. And while Wi-Fi could be considered a legacy technology, it continues to improve and expand.

The 802.11ac standard and certification process has been active for nearly a year. This 5-GHz-only version offers expanded data rates thanks to new modulation and MIMO configurations. Data rates can exceed 1 Gbit/s under the right conditions. However, it has yet to be widely incorporated. Plenty of silicon is now available, and you may have seen some laptops deploy it. It still has to see its way into cell phones, but that is coming. Lots of new routers and access points will need to be put into service to make its benefits emerge.

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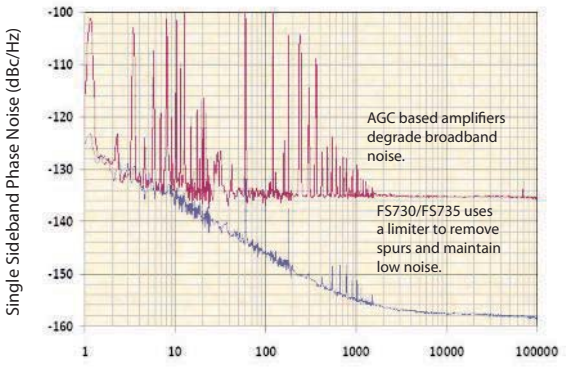

Additive phase noise in 10 MHz Distribution Amplifiers: Limiter vs. AGC Designs

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The 60-GHz version of Wi-Fi, also known as WiGig, is now available along with its product certification program. Based on the IEEE 802.11ad standard, it isn't widely deployed due to a shortage of chipsets and its limited applications. It's intended for video connectivity among consumer products and is showing up on HDTV sets, laptop docking stations, and video cameras. Versions to support the VESA standard and USB 3.0 are in the works. WiGig can support data rates to about 7 Gbytes/s with a range of up to 10 meters thanks to high-gain beam-forming antenna arrays. Greater adoption is expected as more IC vendors join the market.

Wi-Fi offload is also part of the small-cell movement, as mentioned earlier. Some vendors are making "carrier grade" access points that are more rugged, reliable, and capable. Maravedis-Rethink predicts that the number of Wi-Fi hotspots will more than double from 2012's total to reach 10.55 million in 2018. And don't forget, more airlines are making Wi-Fi available during flight to please the restless and electronically addicted. The Federal Aviation Administration (FAA) also has added new rules allowing electronic device use onboard most of the flight, though it doesn't seem like a good idea unless you want to hear dozens of one-sided phone calls.

Wi-Fi is expected to dominate the smart appliance market as well. Washers, dryers, refrigerators, and other major appliances will increasingly incorporate Wi-Fi that can connect to home Wi-Fi networks to supply data back to the manufacturer via the Internet. ABI Research predicts growth to nearly $25 billion in this market by 2018.

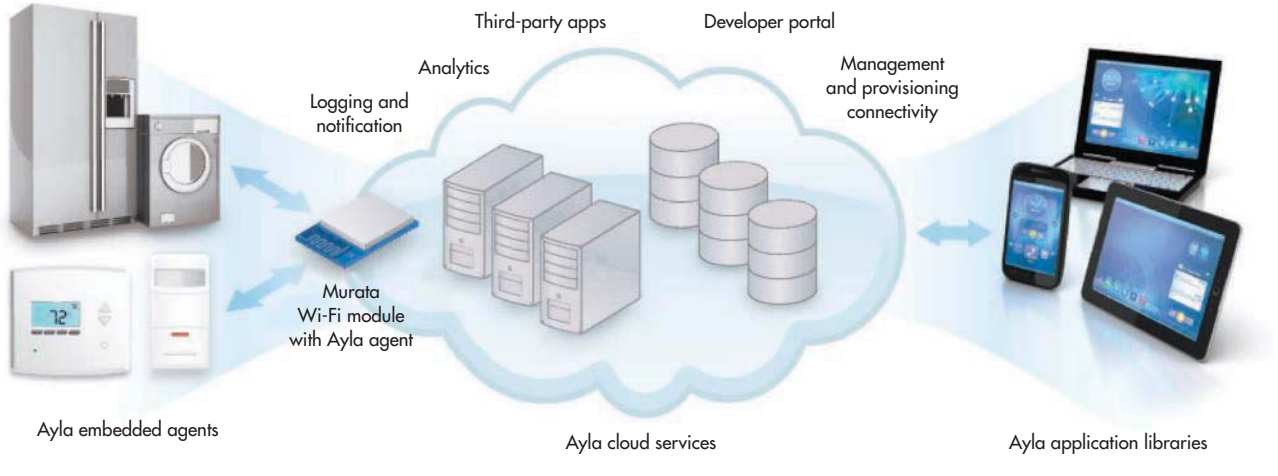
Finally, last year the Federal Communications Commission (FCC) announced the possibility of adding 195 MHz of additional spectrum to the 5-GHz band for Wi-Fi use. This potential ruling lets Wi-Fi share spectrum with some government services under the guidance of the National Telecommunication and Information Agency (NTIA), the government's spectrum regulatory arm. That will mean a great deal to the success of the 802.11ac rollout if and when that spectrum is deployed.

Bluetooth's adoption continues to increase. The latest version, Bluetooth Low Energy (BLE), is a big hit with suppliers of medical and fitness gear. In addition, the wearable electronic trend uses Bluetooth to connect watches and glasses to smart phones. Many new watch products are now available with more to come. It's an interesting trend, and we shall have to wait and see if it is just a passing fad or long-term movement.

Near-field communications (NFC), the short-range 13.56-MHz wireless technology, has yet to be widely deployed. It was expected to become the technology of choice for mobile payments, replacing or supplementing credit card payments with a tap of your phone. While some Android phones have adopted NFC and payment systems like Google Wallet and ISIS are in effect, overall usage has been sparse. NFC chips are not yet in Apple iPhones, and that has limited service. Its future is fuzzy.

One interesting development is the recent collaborative effort of the Bluetooth SIG and NFC Forum. Bluetooth uses NFC for pairing functions in connecting two devices, yet other opportunities will no doubt be explored.

ZigBee continues its almost quiet penetration of the industrial and commercial wireless markets. It is used in building automation, the Smart Grid, and home monitoring networks. The ZigBee Alliance recently announced the latest applications standard for the retail services area. It will enable items like personal shopping assistants, intelligent shopping carts, electronic shelf labeling, asset tracking tags, and employee customer concierge.



3. An M2M application embeds a Wi-Fi module such as that from Murata into an appliance or other device that connects to the Internet via a home network. Cloud servers and software such as that from Ayla Networks route the captured data to a remote device like a tablet or smart phone.

M2M AND IOT

Perhaps the hottest trend in wireless today is the rapid adoption and application of machine-to-machine (M2M) and Internet of Things (IoT) services. M2M and IoT are essentially the same thing as they both seek to connect devices, things, and non-person stuff to the Internet for various monitoring and/or control functions.

M2M applications dominate right now with most activity centered around truck and other vehicle monitoring, inventory control, asset tracking, and physical site monitoring. The connected car will also use M2M, although other wireless methods are expected as applications such as vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) systems are implemented. The IoT or Internet of Everything (IoE) movement is in its infancy but will be used to connect appliances, home energy and security systems, and other devices that require monitoring, maintenance, or repair.

M2M connectivity is primarily cellular with special embedded cellular modems *(Fig. 2)*. IoT connections can be cellular, but other technologies are used. The major appliance manufacturers have selected Wi-Fi as their wireless standard, though ZigBee is used in many home monitoring networks and Smart Grid connections.

For example, a home appliance with an embedded Wi-Fi transceiver would use the home Wi-Fi router to connect to the Internet and the cloud *(Fig. 3)*. There, cloud services would provide the link to remote devices like a laptop, tablet, or smart phone. Application software would implement the desired monitor or control function. The cloud services and software are the key to a successful IoT or M2M function.

Most of the major cellular carriers offer M2M/IoT services, and multiple vendors are emerging to provide applications development, platforms for deployment, middleware, and other related services. Approximately 50 billion to 100 billion devices will be connected by 2020. But what will we do with all that data? The projections for this sector are excellent.

Infonetics projects M2M services to total $31 billion by 2017 with a total of 4 billion M2M connections. ABI Research expects the M2M market to grow at a compound annual growth rate (CAGR) of 26% from 2012 to 2016. Strategy Analytics forecasts that M2M connections will total 2.9 billion by 2022.

In a related prediction, ABI Research forecasts that global V2V penetration will reach 69% of new cars by 2027. Cars will talk to one another and to nearby infrastructure for safety and traffic congestion purposes. The most likely technology is the Wi-Fi-like 802.11p Dedicated Short-Range Communications (DSRC) standard using the 5.9-GHz spectrum. Other technologies like LTE and Bluetooth may also be used.

The use of white spaces is another major trend. White space is unlicensed spectrum comprising the unused TV channels in the 54- to 698-MHz range. These 6-MHz wide channels can be used to carry data and provide an interesting option for broadband Internet access or wireless backhaul for Wi-Fi or other wireless services.

The number and frequency of available channels varies from locale to locale, so a system of identifying useful channels that will not cause TV interference has been developed. The system consists of cognitive radios that can seek out available unused channels and assess their potential for interfering with TV signals or with nearby wireless microphones. The radio works in cooperation with an online database of TV stations, wireless microphones, medical telemetry, and other services that may be involved in interference.

By using advanced modulation methods, data rates of about 20 Mbits/s are possible under good conditions. However, the real value of white space is the low frequency range that permits lon-

ger-range connections and some non-line-of-sight connectivity. Instead of the 100-meter maximum typical range of Wi-Fi, white space radios can deliver connections over many miles.

White spaces are not yet widely used. Several test systems have been built and successfully deployed. Furthermore, companies like Google, Spectrum Bridge, and Telecordia have developed comprehensive databases, and others have created radios for the technology's application. Wireless standards have not been finalized, although existing standards like 802.11af and 802.22 as well as several proprietary standards are being considered. Watch for future developments in this sector.

The critical factor in most wireless development and deployment is available spectrum. Most of the spectrum below 6 GHz has been assigned and is in common use. Cell-phone carriers crave new spectrum to expand their LTE and M2M services. They buy, sell, and swap spectrum to patch together nationwide networks.

The FCC plans an auction later this year to make additional spectrum available to those who can afford it. In another move, the FCC plans to announce the rules for and the availability of spectrum beyond 95 GHz. The technology is finally emerging to make these outer limits of frequency usable.

WIRED COMMUNICATIONS TRENDS

Wireless trends may dominate the market, but we cannot do without those remaining wired technologies and services. The plain old telephone system (POTS) with the vast unshielded twisted pair (UTP) infrastructure is still there and being used. Less than half of all homes in the U.S. now rely on just a wired phone, with most having a cell phone. Yet the POTS is still widely used for DSL Web access not only in the U.S. but also most of the rest of the world.

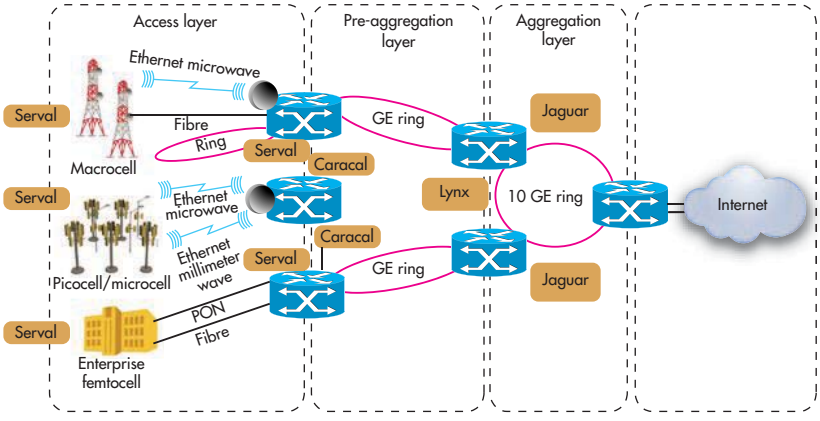
While dialup phones in the public switched telephone network (PSTN) will continue to decline, that infrastructure will still be there and continue to serve a useful purpose. The FCC and even some of the main telephone carriers have proposed a phase-out of the PSTN. It may seem inevitable but will take many years with much upheaval to accomplish.

Cable TV systems still lead the way in Internet service in the U.S. These hybrid fiber coax (HFC) systems run fiber to a neighborhood node and then connect to individual homes and businesses with coax cable, usually RG-6/U. These systems can deliver high-speed Internet service with rates to 50 Mbits/s, if you really need it and are willing to pay for it.

Most cable TV television, voice over Internet Protocol (VoIP), and Internet services are delivered over cable by a system called the Data Over Cable Service Interface Specification (DOCSIS). Developed by Cable Labs, this ITU standard is used in the U.S., Canada, the United Kingdom, and parts of Europe. The current version 3.0 uses 6-MHz (8 MHz in Europe) channels and 64 or 256 QAM (quadrature amplitude modulation) on up to 750 MHz of coax bandwidth to deliver digital TV and Internet connections. With channel bonding (combining several 6 MHz channels), data rates to several hundred Mbits/s are possible with rates into the gigabit range if the cable company decides to use enough channels simultaneously.

Cable Labs released the latest version, DOCSIS 3.1, late last year. It greatly expands the data rate and bandwidth capabilities. Version 3.1 uses orthogonal frequency division multiplexing (OFDM) in channels that may be from 24 to 192 MHz wide on coax with a bandwidth to 860 MHz. Modulation in the channel can be 256, 1024, 2048, or 4096 QAM.

New forward error correction (FEC) and low-density parity check (LDPC) improve the signal-to-noise ratio. The new 3.1 DOCSIS-based HFC systems can easily compete with direct fiber



4. Vitesse Semiconductor offers a full line of Ethernet switches for different locations in a Carrier Ethernet network. The Caracal line of small and low-power CE switches targets IoT and industrial applications. The Jaguar line targets IP edge demarcation and aggregation equipment to deliver enterprise and mobile backhaul services.

connections as they can provide downstream data rates up to 10 Gbits/s. Version 3.1 has yet to be deployed, but look for trials this year and gradual adoption and phase-in over the coming years.

Fiber to the home (FTTH) systems are growing. The latest, Google Fiber, runs the fiber directly to the dwelling, providing a 1-Gbit/s data rate for Internet service. The Google Fiber system also can supply TV as an alternative to cable TV or DSL video services. This service is now being rolled out in Kansas City and soon will be rolled out in Provo, Utah, and Austin, Texas.

Verizon's FiOS system is another fiber direct-to-the-home system. It has been around since 2005, and it is now available in 16 states with more on the way. FiOS can be an Internet access service, a TV service, a VoIP telephone connection, or all of the above. It uses passive optical networking (PON) technology such as gigabit PON (GPON) to deliver download speeds ranging up to 500 Mbits/s. PONs are inexpensive and are the connection of choice for the buildout of new cities and subdivisions.

Fiber is the backbone of the Internet. Most carriers are updating their networks to the 100-Gbit/s level if they have not already done so. Most systems have adopted dual polarization-quadrature phase shift keying (DP-QPSK) as the modulation mode for 100 Gbits/s over a single fiber. The protocol uses the optical transport network (OTN) specifications of the ITU.

This Internet Protocol (IP) system has mostly replaced legacy SONET systems. It encapsulates Ethernet packets for transport in different formats. Market research firm Ovum predicts that the global optical networks market will exceed $17.5 billion in 2018 as 100-Gbit/s systems are more widely adopted for large-scale long-haul networks

Furthermore, 400-Gbit/s systems are being implemented to further ensure that the massive demand for video over the Internet can be met in the future. Four streams of 100-Gbit/s data on different wavelengths on a single fiber gets you to 400 Gbits/s. Also, 500-Gbit/s and 1-Tbit/s systems are being developed and tested. The largest data centers (Amazon, Google, Apple, Microsoft, etc.) are already clamoring for more speed and bandwidth.

One major continuing development is the increased use of Carrier Ethernet (CE). CE includes hardware and software enhancements to standard Ethernet that allow common carriers to deploy Ethernet services in metropoli-

tan and wide-area networks (WANs). It brings carrier-grade qualities to transport networks.

Ethernet is the standard used in virtually all local-area networks (LANs) small and large. Connecting to metro and long-haul networks meant using other technologies like SONET/SDH (synchronous digital hierarchy) or older asynchronous transfer mode (ATM) or frame relay services. With such high-volume usage, Ethernet is a very low-cost technology and very attractive as a potential candidate for longer-range networks.

Ethernet provides the simplicity, flexibility, and cost-effectiveness of its well-known protocol and components. It is a best-effort service suited mainly to LANs, though, so it typically cannot deliver the reliability of other long-haul networks such as SONET/SDH. Carrier Ethernet was developed to overcome the reliability issue and other common objections to Ethernet.

The Metro Ethernet Forum (MEF) developed CE more than a decade ago to define standards that allow Ethernet to be used in metropolitan-area networks (MANs) and wide-area networks (WANs). It provides for greater connection resiliency and adds management services like provisioning and standard operation and maintenance functions. Overall, it implements greater provision for scalability and flexibility. As a result, CE is increasingly being adopted for Internet connections and other access in MANs and WANs.

Vitesse Semiconductor is providing CE switches and supporting software to implement IoT connections as well as microwave and fiber backhaul for macrocell basestations, small cells, and enterprise femtocells *(Fig. 4)*. Note how CE scales from 1-Gbit to 10-Gbit levels with standard protocols and hardware. Continued growth in CE is projected.

Software-defined networking (SDN) separates the control and data planes, allowing system administrators to configure a network of routers and switches with software to optimize connections. According to SDN Central's definition, SDN is "a new software-centric approach to networking that reduces capital and operational cost through programmatic control of network infrastructure, facilitating customization, optimization and innovation." SDN is not yet widely implemented, but watch for developments this year and beyond as it will redefine the Internet and other networks as we know them today. ed

5MBd Digital Optocouplers Targeting Low Power/ Low Supply Voltage Applications

Introduction

Digital optocouplers in electrical system provide high voltage insulation and noise rejection for data transmission. A high quality insulation barrier in the optocoupler is needed to provide outstanding reliability and durability for signal isolation.

In addition to insulation and noise rejection capabilities, Avago's new 5MBd digital optocouplers, ACPL-M21L/021L/024L/W21L/K24L, the ACPL-x2xL family offers significant improvement in power saving and efficiency for power conscious applications. Lower system power consumption is now a requirement for many electronics applications ranging from industrial, medical, power control system, communications, etc. These new digital optocouplers consume 80% lesser power as compared to the conventional 5MBd digital optocouplers in the market.

Key Features and Specifications

The ACPL-x2xL digital optocouplers are newly designed optocouplers with CMOS outputs for low power consumptions. They are designed for various applications such as computer peripheral interfaces, microprocessors system interfaces, high speed line receiver, power control system, etc. Device performance is guaranteed over a wide temperature range from –40° to 105°C, making them ideal for industrial applications.

The key features of ACPL-x2xL digital optocoupler family are as follow:

- Low LED input current allows direct drive from CMOS outputs without the need for an external buffer (refer to Figure 1)
- Low supply current and supply voltage for low power consumption
- 25 kV/µs static common mode rejection - no compromise on noise immunity!
- Schmitt Trigger input for better noise immunity
- IEC60747-5-5 certification for reinforced insulation with continuous working voltages at 567Vpeak and transient voltages of 6kVpeak for ACPL-M21L/021L/024L and continuous working voltages at 1140Vpeak and transient voltages of 8kVpeak for ACPL-W21L/K24L

Table 1 shows a selection of key technical specifications.

Low Power Consumption

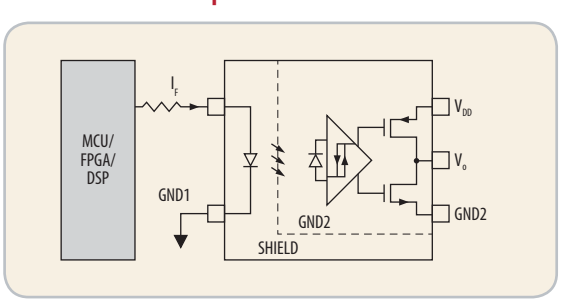


Figure 1. ACPL-M21L directly driven from MCU / FPGA / DSP without external buffer

Table 1. Key technical specifications of ACPL-x2xL

Parameter	Specification
Propagatiion Delay	250ns (max)
Propagatiion Delay Skew	220ns (max)
Pulse Width Distortion	200ns (max)
LED Input Current	1.6 to 6 mA
IDD Supply Current	1.1mA (max)
Common Mode Noise Rejection	25 kV/µs @ V_{CM} = 1000V
Supply Voltage	2.5 to 5.5V
Temperature Range	–40 to 105°C
Continuous Working Voltage, V_{IORM}	567Vpeak / 1140Vpeak
Isolation Voltage, V_{ISO}	3750Vrms / 5000Vrms

The advantage of the new 5MBd digital optocoupler family is the feature of low power consumption. The new ACPL-x2xL family of optocouplers consume less than 10mW of power without compromising signal isolation capability. With minimum input drive current of 1.6mA, maximum supply current of 1.1mA and a low supply voltage of 3.3V, the new 5MBd digital optocouplers reduce power consumption by as much as 80% as compared to the conventional 5MBd digital optocouplers and other isolators in the market.

Figure 2 shows the new 5MBd digital optocouplers having the lowest power among the other 5MBd digital optocouplers in the market.

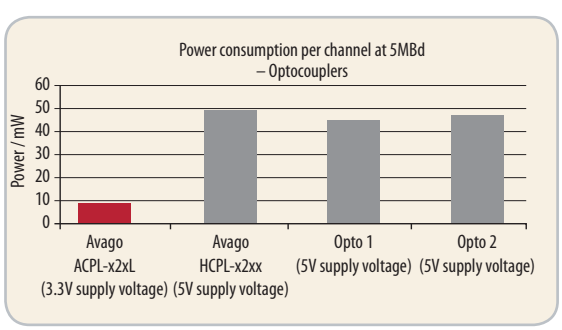


Figure 2. Power consumption comparison : ACPL-x2xL to conventional 5MBd optocouplers in the market

Better and Improved Performance

The new ACPL-x2xL family of optocouplers offered upgraded performance and improved features as compared to the HCPL-x2xx conventional optocouplers in low voltage logic applications (Refer to Table 2). The upgraded ACPL-x2xL family of optocouplers include performances such as low supply current, low LED input current, low supply voltage, higher CMR and wider temperature range. The new 5MBd digital optocouplers are used with low voltage logic applications (2.5V/3.3V/5V supply voltage).

Table 2. ACPL-x2xL Comparison to HCPL-x2xx

Type	Conventional Avago 5MBd Parts (Package)	New Product	Package/ Configuration	Advantage for Upgrading to New Product	Upgraded Features
5MBd Digital Optocouplers	HCPL-0201/0211 (SO8)	ACPL-M21L	SO5 Single Channel	Smaller footprint	• ≥80% power consumption saving • Low forward current (I_F ≥1.6mA min) • Low supply current (I_{DD} ≤ 1.1mA) • Wide temperature range (-40°C to 105°C) • Low supply voltage (2.5V to 5.5V) • Excellent CMR performance 25kV/µs @ Vcm 1000V --- Part specific (ACPL-W21L/K24L): • Offer higher working insulation voltage 1140Vpk, isolation voltage 5000Vrms with smaller footprint and with wider Creepage/Clearance (8mm/8mm)
		ACPL-021L	SO8 Single Channel	Same footprint (Direct drop in)	
	HCPL-2231/2232 (300mil DIP8)	ACPL-024L	SO8 Dual Channel	Smaller footprint	
	HCPL-2219/2200/2201/2211 HCPL-2202/2212 (300mil DIP8)	ACPL-W21L	SSO6 Single Channel	Smaller footprint	
	HCPL-2231/2232 (300mil DIP8)	ACPL-K24L	SSO8 Dual Channel	Smaller footprint	

Optocoupler CMR Performance

Common mode noise can be a significant problem in data communication applications, especially in industrial environments where electric motors, sensors and programmable logic controllers are connected together.

An internal proprietary Faraday shield which is an effective planar metal tracks around the output receiver provides ESD protection and decouples the input side and output side of the optocouplers. This unique package design also minimizes the input to output capacitance. These two factors minimize the effects of common-mode noise and thus achieving high common mode transient immunity of >25kV/µs @ Vcm = 1000V.

The "split resistor" input LED drive configuration shown in Figure 3 balances the impedance across the anode and cathode of the LED which further improves the CMR performance. A common mode noise voltage rise on the LED is symmetrical and therefore cannot switch the LED on. The series connected LED and current limiting resistor form a low pass filter that helps to filter noise transients.

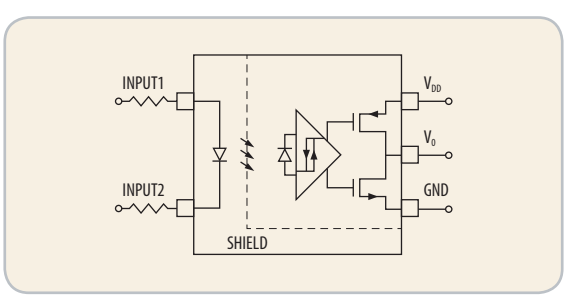


Figure 3: Typical high-CMR drive circuit configuration

LED Reliability

The quality of the LED used in an optocoupler is an important factor for determining the life time of the product. Avago produces high reliability LEDs for optocouplers at its in-house facility. The infrared, AlGaAs LED used in the ACPL-x2xL provides excellent stability over both temperature and time. As shown in Figure 4, LED degradation is minimal after the lifetime of 30 years. This is based on the typical LED driving current of 2.2mA at temperature of 100°.

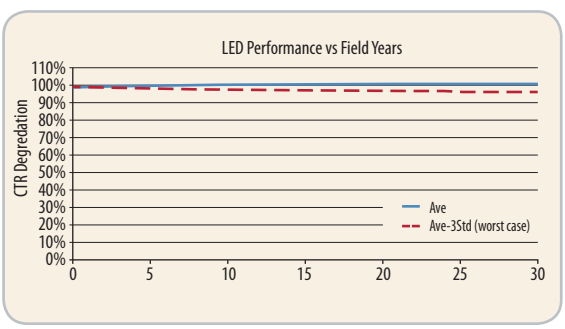


Figure 4: CTR degradation over field years

CANBus / Serial Data Transmission Applications

Digital optocouplers can be used to isolate I/O networking communication ports ranging from CANbus, RS-485, RS-232 and I²C applications. In Figure 5, the digital optocouplers are placed between the transceiver and the bus interface so as to isolate transient/burst interference and also to transmit data between the bus transceiver and the controller.

CANbus evaluation board is available. The design of this application example is for CANbus isolations using ACPL-M21L.

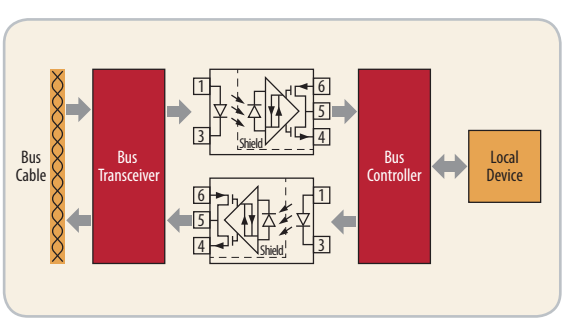


Figure 5: Optocouplers provide isolation between MCU and CANbus transceiver

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Storage And Computation Capacity Continues To Grow

Thanks to ongoing advances, today's technologies are meeting the market's growing needs for more memory, processing power, and communication between devices with an eye on the demands of the future.

IT DOESN'T MATTER IF IT'S storage, computation, or bandwidth—there's never enough. Digital trends show continued improvements across the board, though. Designers will be able to get more memory and muscle based on their current requirements at a lower cost, all while using less power too.

MORE STORAGE

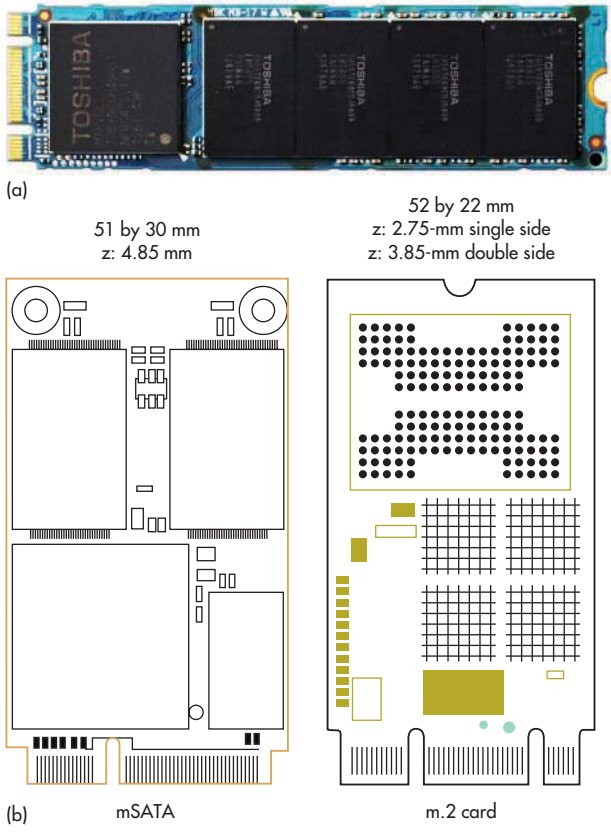
There will be plenty of action in storage this year. DDR4 will move from the labs to production. It doubles speed and triples density while cutting power by about 20%. The new crop of processors will demand DDR4 memory, especially for high-end servers where there never seems to be enough RAM or speed. DDR3 will still be the main memory for embedded applications.

On the horizon is stacked memory like the Hybrid Memory Cube *(see "Hybrid Memory Cube Shows New Direction For High-Performance Storage" at electronicdesign.com)*. It significantly improves bandwidth and capacity, but it requires a different memory controller interface and DDR4 is where the current crop of processors is headed. The memory is the last bastion of parallel interfaces on processors these days as other interfaces have moved to high-speed serial like PCI Express.

DRAM dual-inline memory modules (DIMMs) may find themselves sharing space with flash-based DIMMs such as those from Diablo Technologies, whose Memory Channel Storage DIMMs plug into DDR3 sockets to allow terabytes of flash memory to be placed on the processor's memory channel *(see "Memory Channel Storage Puts SSD Next To CPU" at electronicdesign.com)*.

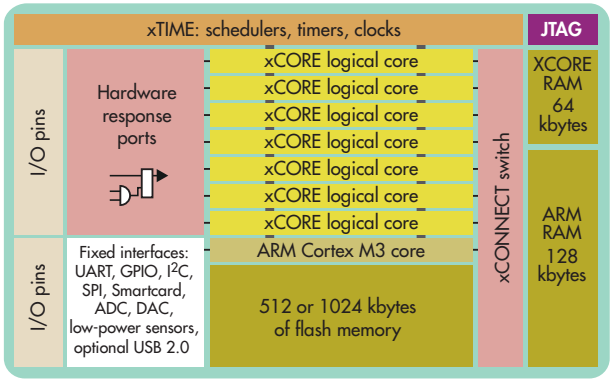
These DIMMs target enterprise platforms but are interesting for embedded applications as well. The challenge on the enterprise side is the high demand for more RAM storage, but there are many applications where large amounts of non-volatile storage are advantageous. Flash on the memory channel eliminates the overhead and bandwidth limitations of PCI Express.

PCI Express will deliver more flash bandwidth and capacity. Standards like NVM Express (NVMe), SATA Express, and SCSI Express will be found on boards, in expansion boards, and in disk-drive form factors *(see "Non-Volatile DIMMs And NVMe Spice Up The Flash Memory Summit" at electronicdesign.com)*. New form factors like the m.2 New Generation Form Factor (NGFF) are designed to provide high-speed, high-capacity replaceable storage options for mobile and embedded platforms *(Fig. 1)*. The m.2 NGFF competes with existing mSATA modules, but its modules come in SATA or PCI Express versions that differ by the number of notches in the edge connector.



1. The m.2 New Generation Form Factor (NGFF) modules (a) can have PCI Express or SATA interfaces compared to the mSATA modules that have only the latter (b).

Flash memory densities continue to grow. Even enterprise systems have been moving from the more expensive single-level cell (SLC) flash to multilevel cell (MLC) and triple-level cell (TLC) NAND flash storage. The problem is that error rates rise along with capacity while storage write cycles decrease. Memory controllers fill the gap by utilizing better error correction techniques like low-density parity check *(see "Flash Controllers Get Better Efficiency With Low-Density Parity Check (LDPC)" at electronicdesign.com)*. LDPC requires more computational resources and can introduce more latency, so fast and efficient controller operation will be a necessity. On the plus side, the controllers hide the complexity of error correction, load leveling, and other flash memory management chores.



2. XMOS and Silicon Labs worked together to build the xCORE XA multicore SoC with a Cortex-M3 core and seven xCORE cores.

Another interesting deviation from the norm is Seagate's direct-access-over-Ethernet Kinetic hard drive *(see "Object Oriented Disk Drive Goes Direct To Ethernet" at electronicdesign.com)*. The Kinetic foregoes the conventional SATA or SAS block mode interface and replaces it with a pair of 1-Gbit Ethernet interfaces and an object-oriented protocol. It targets "big data" enterprise applications that already use network-based storage. The drive handles data management of the variable-size objects and hides the underlying block architecture. This differs from an iSCSI block approach, but it lacks the storage hierarchy and overhead of a NAS device.

MORE COMPUTATION

Storage isn't the only place where there will be a lot of action this year. Changes in processing platforms will be just as dramatic as technologies and products that were announced in 2013 are delivered in 2014.

AMD's Accelerated Processing Unit (APU) multicore chips that implement the Heterogeneous System Architecture (HSA) will be generally available *(see "Heterogeneous System Architecture Changes CPU/GPU Software" at electronicdesign.com)*. AMD HSA APUs are inside the Microsoft XBox One and the Sony PlayStation 4, but they target gaming and utilize GDDR5 memory. The other APUs initially will support DDR3.

The HSA programming model that unifies the GPU and CPU virtual memory space will have a major software impact. Meanwhile, Arm also is a member of the HSA Foundation. The architecture is not processor specific, and Arm has CPU and GPU core offerings.

Standalone GPUs are disappearing from most low- to mid-range PCs and tablets, which have moved to integrated GPUs like AMD's APU, Intel's Integrated Graphics, and Arm's Mali. That still leaves this type of GPU for high-end gaming and high-performance computing. Nvidia's Kepler GPU can communicate with others over PCI Express and even through Ethernet adapters without CPU intervention *(see "GPU Architecture Improves Embedded Application Support" at electronicdesign.com)*.

Apple had its own 64-bit Arm part in 2013, but the flood of 64-bit Arm Cortex-A50 processors will appear in 2014 *(see "64-Bit And Real-Time Architectures At Arm TechCon" at electronicdesign.com)*. AMD is revving up a multicore, Arm Cortex-A50 system-on-chip (SoC) that will have its SeaMicro Freedom Fabric interface built in.

Of course, AMD will challenge Intel's Core and Xeon lines of processors, which have dominated the PC and server space. Intel is making a big push into software defined networking (SDN) and network function virtualization (NFV) with combinations like the "Coleto Creek" chipsets and its Xeon E5-2600 processors. The chipset accelerates network cryptography and compression chores.

High-performance computing will get more bang from chips like Intel's Phi and GPUs from Nvidia, AMD, and ARM. General-purpose GPUs (GPGPUs) will continue to grow in performance but programming remains a challenge *(see "GPGPU Boosts Graphics Processing In Harsh Environments" at electronicdesign.com)*. Not all algorithms can be accelerated using GPUs.

Those users needing even more hardware acceleration for high-performance computing may choose FPGAs over GPUs. Xilinx and Altera FPGA modules can plug into CPU sockets in a multisocket environment using Intel's QuickPath Interconnect (QPI). Combine this with Altera's OpenGL software development kit (SDK) to ease FGPA development for some interesting hardware acceleration projects.

Multicore solutions that are down a notch or two on the performance scale like Intel's 64-bit, eight-core C2000 SoC Atom are targeting microservers *(see "Eight-Core Atom Expands Intel's Server Strategy" at electronicdesign.com)*. Of course, they will see competition from a plethora of Arm-based solutions. These high-performance SoCs are ideal for a range of embedded applications as well.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Intel's new Quark is the low-end, single-core, 32-bit, x86 SoC designed for use as an Internet of Things (IoT) gateway *(see "How Many Quarks Does It Take To Make An IoT?" at electronicdesign.com)*. Quark will target mobile applications as well, but it too must compete with the Arm and MIPS contingent of SoCs already entrenched in this space.

Arm's Cortex A-series now includes the A7, A9, A12, and A15 based on the ARMv7A architecture versus the ARMv8 used in the 64-bit Cortex-A50 family. The Cortex-A7 can be paired with the others in a big.LITTLE combination *(see "Little Core Shares Big Core Architecture" at electronicdesign.com)*. Another change this year is the availability of big.LITTLE scheduling support that allows all cores, large or small, to be utilized at the same time.

Security hardware will be more available in chipset and SoC solutions. Secure boot, key management, and storage as well as other security-related features are standard on more parts.

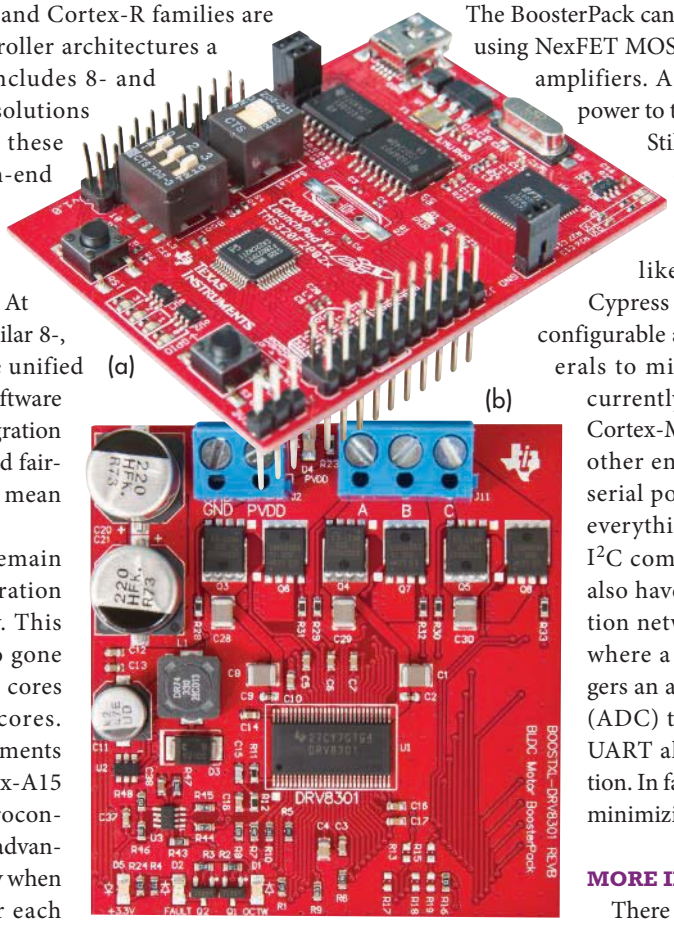
MORE MICROS

The 32-bit Arm Cortex-M and Cortex-R families are giving competing microcontroller architectures a run for their money. This includes 8- and 16-bit platforms, but 32-bit solutions continue to press down into these spaces while providing a high-end growth path too. More microcontroller vendors that had different 8- and 16-bit parts have adopted the Cortex-M0+. At this point, vendors with dissimilar 8-, 16-, and 32-bit offerings have unified their peripheral options and software development tools to make migration between platforms practical and fairly seamless, but that does not mean totally transparent.

CPU/DSP combinations remain popular for providing acceleration and programming flexibility. This type of combination has also gone multicore with multiple CPU cores as well as microcontroller cores. For example, the Texas Instruments OMAP 543x has a pair of Cortex-A15 and a pair of Cortex-M4 microcontrollers. There are a number of advantages to mixing cores, especially when the power and frequency for each core can be controlled independently.

XMOS's xCore-XA has one Cortex-M3 core and seven xCORE DSP cores *(Fig. 2)*. XMOS worked with Silicon Labs to blend Silicon Labs' EFM32 Gecko Cortex-M3 technology with XMOS's xCORE soft peripheral *(see "Micro Mixes Hard USB With Soft Peripherals" at electronicdesign.com)*. Some of XMOS's systems can handle real-time Ethernet like EtherCAT in software. The xCORE cores share 64 kbytes of RAM while the Cortex-M3 has its own 128 kbytes of RAM. They share peripherals and up to 1 Mbyte of flash memory. The xCONNECT switch connects the cores.

Specialization has been the hallmark of the microcontroller industry with hundreds of SKUs for many product families. This will continue in various venues to handle things like electric power meter and motor control. For instance, the Texas Instruments C2000 InstaSpin-FOC (Field Oriented Control) delivers self-profiling control of sensorless three-phase, synchronous or asynchronous motors *(see "Self Profiling, Sensorless, FOC System Revolutionizes Motor Control" at electronicdesign.com)*. TI's latest C2000 InstaSPIN-FOC LaunchPad board works with the DRV8301 motor drive BoosterPack *(Fig. 3)*. The BoosterPack can sink 2.3 A or source 1.7 A using NexFET MOSFETs. It has built-in sense amplifiers. A buck converter provides power to the C2000 board.



3. Texas Instruments' C2000 InstaSPIN-FOC LaunchPad board (a) works with the DRV8301 motor drive BoosterPack (b).

Still, there is a move to smarter peripherals to reduce the plethora of chip types. At one extreme is FPGA-like programmability from Cypress Semiconductor that links configurable analog and digital peripherals to microcontroller cores that currently include the M8C, 8051, Cortex-M0, and Cortex-M3. At the other end, microcontrollers with serial ports can be configured for everything from UARTs to SPI or I^2C communication. Many chips also have peripheral communication networks that allow linkages where a comparator output triggers an analog-to-digital converter (ADC) that sends its results via a UART all without CPU intervention. In fact, the CPU may be asleep, minimizing power usage.

MORE INTERCONNECTS

There will be fewer surprises but lots of action in high-speed serial interconnects. These components are based on standards that have

been well established with a long-term roadmap, and most are between transition periods. For example, PCI Express Gen 3 is out in force. It will be found on most x86 motherboards and on high-end Arm platforms. Older or lower-end products may use Gen 2, which is upwards compatible.

Low-pin-count MIPI M-PHY systems may be used to deliver a few new protocols this year. Standards now include USB and PCI Express over M-PHY. M-PHY tends to be found on mobile devices where low pin counts and low power requirements are the norm.

New form factors will highlight PCI Express Gen 3 including the m.2, which targets high-density SSD-based (solid-state disk) storage. The m.2 will find a home in mobile devices like laptops and tablets as well as embedded applications. The stick comes in different lengths for more storage using a common socket. The OCuLink PCI Express cables will be available as well to provide cost-effective box-to-box connections. OCuLink will use copper or fiber.

Fiber is also showing up on the display side where Intel Thunderbolt 2 is running at 20 Gbits/s. It is needed to handle raw 4K video. The use of an active cable hides the copper/fiber issue from the device, but fiber allows cable lengths on the order of 100 meters. VGA and DVI connectors will still be around, but HDMI and DisplayPort are needed for 4K video. The usual copper cables will work in most cases, though fiber is available as an option.

Don't expect any changes for USB 3.0 except a flood of products now that there are plenty of hosts to plug them into. Storage will no longer be the only device demanding the throughput and full-duplex operation that USB 3.0 offers. USB-based displays will also be more prevalent as well as USB 3.0-based docking stations and monitors.

What will be different this year will be USB 3.0 power management and delivery. Systems will be able to push as much as 100 W through the cable, although the connection will be intelligent at both ends so the amount of power will depend upon the capabilities of the cable, host, and device.

Keep an eye out for the proposed USB 3.1 Type-C connector, which will be orientation-agnostic. Current USB connectors only work when they're properly oriented. The specification won't be finalized until the middle of the year, so new products won't appear until 2015.

InfiniBand and Serial RapidIO are well entrenched. InfiniBand's 14-Gbit/s FDR (14 data rate) is pushing the limits of PCI Express, which is usually found on the other end of the interface. The 26-Gbit/s enhanced data rate (EDR) is on the horizon. Serial RapidIO Gen 2 is running at 10 Gbits/s with 25 Gbits/s in the next-generation roadmap.

The 12-Gbit/s SAS interface will be a boon to the enterprise, which will be able to use adapters and motherboards that will handle the higher bandwidth. The movement of flash storage to PCI Express and even the processor's memory channel does not eliminate the need for banks of hard-disk and flash drives, especially for enterprises delivering cloud-based computing and storage.

MORE FROM BILL WONG

FOR MORE OF Bill Wong's insight into embedded technologies, check out his blog, alt.embedded, at http://electronicdesign.com/blog/altembedded and see:

- Functional Programming Using F# And JavaScript
- A Look At Visual Studio 2013
- Where Has My PC Gone? It's Gone Gaming
- Managing Small Embedded Servers
- The Internet Of Thingamjigs
- Developing The Secure Cloud
- How Many Quarks Does It Take To Make An IoT?

EmbeddedForecast

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Embedded Electronics Become Even More Pervasive

Improvements in processors, servers, and storage as well as user interfaces all will combine to help the Internet of Things emerge in 2014.

EMBEDDED ELECTRONICS ARE BECOMING more pervasive, more connected, and more personal, from the ubiquitous smart phone to emerging telepresence robotic devices like the Suitable Robotics Beam and Double Robotics Double *(Fig. 1)*. In fact, these robotic platforms are being used in schools, hospitals, and other environments. And like unmanned aerial vehicles (UAVs), they are moving into the public's consciousness.

Telepresence robots are emblematic of the changing ways users are interfacing with embedded electronics. Overall, user interaction and user interfaces are going to change this year. Multitouch interfaces are becoming more accurate and less expensive, so expect them to appear everywhere. Non-touch 3D interfaces also are now available and being incorporated into more than gaming platforms *(see "3D Video Sensors Improve User Interactivity" at electronicdesign.com)*.

3D printers are revolutionizing prototyping. 3D sensors and scanners are making this prototyping easier too *(see "Matterform Interview–Low-Cost 3D Scanner" at electronicdesign.com)*. These printers and scanners are becoming more common, more functional, and easier to use.

MORE CLOUDS

The Internet connects people and all of these embedded devices together. Telepresence robots depend on the Internet to link to their remote masters. Browsers and apps provide ways to find out about and buy more of these products online. However, this year is really about the Internet of Things (IoT). Machine-to-machine (M2M) connectivity has been around for decades, but the scope, flexibility, and cooperative interaction between devices will change radically as the year progresses *(see "The Internet Of Thingamajigs" at www.electronicdesign.com)*.

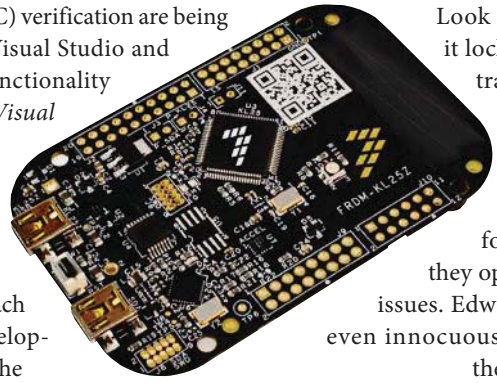
Expect massive cloud services like those from Amazon and Verizon to grow. Anyone can use the cloud to access supercomputing power, so startups will grow rapidly based on demand without any major capital investment. As demand for mobile devices and applications continues to accelerate, supporting server services will find homes in the cloud.

Development tools are quickly moving to the cloud. Team collaboration techniques like bug tracking and source code management were around even before the Internet. But these

1. The Suitable Robotics Beam (a) and Double Robotics Double (b) are just a couple of telepresence devices that are becoming more common in everyday life.

days, big jobs like system-on-chip (SoC) verification are being completed in the cloud. Microsoft Visual Studio and other platforms are moving more functionality to the cloud as well *(see "A Look At Visual Studio 2013" at electronicdesign.com)*.

Open-source development environments like mbed are specifically designed to operate online, giving developers preconfigured access to the latest compilers and tools. This approach has been heavily utilized in app development for smart phones and tablets. The development tools, delivery, deployment, and billing tools are all integrated. Developers often only need a Web browser to create and manage these apps.



2. Freescale's Freedom FRDM-KL25Z supports the mbed cloud development environment while utilizing the Arduino expansion board form factor.

Look for more of this in the future since it locks in developers and allows detailed tracking of their actions. Also, keep an eye out for security issues in these types of environments and within applications being developed. Connectivity and common platforms are speeding development, but they open up vectors of attack and tracking issues. Edward Snowden's revelations show that even innocuous devices like smart phones can be the target of criminals and the National Security Agency alike. On the plus side, it will be easier to talk to vendors about security since it is more than a checklist item these days.

CHECK OUT CHIP DESIGNS ON THE CLOUD

FPGAs ARE GREAT. Design tools like Altera's Quartus II and Xilinx's Vivado usually accompany them *(see "FPGA Design Suite Generates Global Minimum Layout" at electronicdesign.com)*. These tools enable designers to create an FPGA and to test its configuration, addressing timing and power aspects to ensure the design will perform properly.

Much of the design work is interactive, but a significant portion is number crunching to handle details like layout and timing. Working with a desktop application for this is more than adequate for an initial design. However, many stop once a working platform is available. This is fine for many applications, though more often, the design needs to be optimized before it ships. Optimization means reducing the size of the FPGA required for delivery, or it might mean reducing power requirements. Increasing performance is in the mix too.

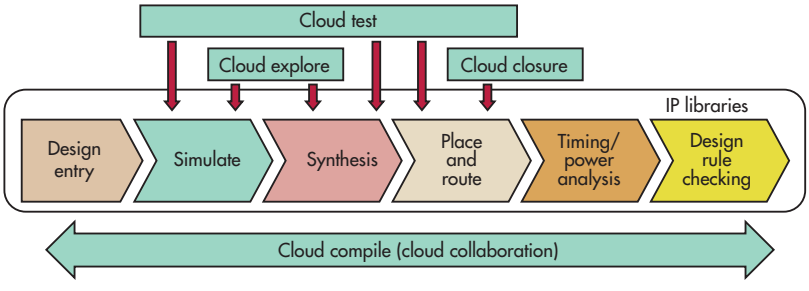
Creating and testing these variations can easily overload a designer with a desktop system. Plunify offers an alternative by taking this part of the design cycle to the cloud. It addresses simulation, regression testing, and place-and-route compilation where multiple design variations come into play with its EDAxtend cloud platform *(see the figure)*.

The cloud interface just requires a Web browser. Plunify also has some desktop support with a Xilinx ISE SmartXplorer plug-in called Explorer ++. Plunify uses the standard output from conventional FPGA design tools, so this is an extension to the designer's usual toolset.

Plunify accelerates the design process. For example, one customer had a working design that required two of the largest FPGAs on the market. The design took half a day to build. Plunify's cloud ran hundreds of builds in two days, allowing the customer to fit the final design into a single FPGA.

Plunify uses a prepaid, credit-style subscription to use its cloud. There is an estimator program based on a single place-and-route run on a PC. The system also can be run-time limited in a variety of ways including finding a desired solution, overall time, or credit usage. Different Web tools address the FPGA design cycle. Cloud closure can address timing closure experiments. It can be used to fine-tune speed, size, and power consumption.

The cloud-based approach gives designers a number of advantages. This type of work usually generates resource usage spikes, and companies typically have the functionality to address these spikes. The cloud provides that support. Likewise, rigorous regression testing and other resource-intensive tasks are very useful in delivering robust and reliable products. Plunify helps companies make this delivery faster and at a lower cost.



The EDAxtend cloud platform targets the simulation, synthesis, and place-and-route aspects of the FPGA design cycle.

MORE BOARDS AND MODULES

Online development communities and tools have grown up around module platforms like Arduino and Raspberry Pi. They will become even more important this year as more vendors adopt these form factors for development platforms. For example, Freescale's Freedom FRDM-KL25Z *(Fig. 2)* supports the mbed cloud development environment while utilizing the Arduino expansion board form factor.

3. Digilent's chipKIT WF32 board (left) reduces the need to purchase additional hardware or shields. With Digilent's chipKIT Motor Control Shield (right), applications can be developed using various motor types while enabling users to exploit extra I/O pins found on chipKIT development boards to enhance connectivity.

Microchip has expanded its Arduino compatible chipKIT ecosystem with two development tools from Diligent Inc. and an embedded cloud-software network *(Fig. 3)*. Diligent's chipKIT WF32 board reduces the need to purchase additional hardware or shields by integrating Microchip's 32-bit PIC-32MX695F512L MCU, its MRF24WG0MA Wi-Fi module, and a switch-mode power supply that uses the company's MCP16301 dc-dc converter, along with a MicroSD card.

With Diligent's chipKIT Motor Control Shield, applications can be developed using various motor types, such as servos and steppers, while enabling users to exploit extra I/O pins found on chipKIT development boards to enhance connectivity. The embedded cloud software framework facilitates the creation of Internet of Things applications with the WF32.

Diligent helps speed the development of wireless HTTP server applications with its comprehensive sample application, which supports static pages loaded from the WF32's MicroSD card, as well as dynamically generated Web pages. The WF32 offers a rapid method for evaluating Wi-Fi in embedded designs and for creating embedded cloud-computing services using Exosite.

Furthermore, look to modules to quickly deliver solutions with highly integrated SoCs with wireless communication services. Peripheral connections are easy to design compared to SoC support. This is especially true for FPGAs like Xilinx's Zynq, which incorporates dual Cortex-A9 cores. Also, check out the ever-shrinking form factor standards like the micro Qseven and the Type 6 COM Express Mini.

Board form factors like PC/104, VME, and CompactPCI have not disappeared and still command a major portion of the market compared to their newer, faster counterparts. Most new designs use boards with high-speed serial interfaces, though, especially platforms from the mid-range to the high end of the computational spectrum, because their processors use PCI Express. Matching chipsets are often utilized to deliver interfaces like PCI for legacy environments.

Still, the trend continues toward high-speed serial interfaces with legacy peripheral connections disappearing. Motherboards will have USB 3.0 and HDMI, but PS/2 keyboard and mouse ports are long gone. Even VGA connectors will be hard to find, and forget about integrated device environment (IDE) interfaces for most platforms.

MORE SERVERS, CONNECTIVITY, AND STORAGE

Cloud servers have been racks of 1U servers as well as blade-based systems. But very large clouds have moved to even more specialized designs that are far from anything that will reside outside of large enterprise environments. Platforms like AMD's SeaMicro and HP's Moonshot pack hundreds of cores into a rack with high-speed interconnects *(Fig. 4)*. The

64-bit Arm processors also will appear in this space in 2014, which should make things very interesting.

Platforms like Intel's C2000 eight-core Atom target the growing microserver market. It is also finding a home in this type of cluster environment. The original SeaMicro rack was filled with dual-core Atoms.

These multicore systems are tackling computational chores, but they also will be used for software defined networking (SDN) and network function virtualization (NFV), bringing communication closer to the computational and storage side of things. Intel's latest "Coleto Creek" chipsets for its Xeon E5-2600 processors accelerate network cryptography and compression chores. They have improved virtualization support as well, which is key to partitioned clouds. While workstations are slogging it out with 1-Gigabit Ethernet, servers are handling 40-Gigabit and 100-Gigabit Ethernet ports. At least 100-Gigabit Ethernet seems to be it for the near future.

Storage will be more active, with 12-Gbit/s SAS drives and controllers available in 2014 in time to handle the coming flood of flash drives. They also will compete with direct connect storage via PCI Express in the form of NVM Express. Even closer to the processor cores will be technology like Diablo Technologies' Memory Storage Channel dual-inline memory module (DIMM), which plugs into a DDR3 socket. The tradeoff will be in DIMM socket usage because there is an insatiable appetite for DRAM as well.

Flash storage will see challenges in the range of available options including tradeoffs in lifetime versus density with multi-

4. HP's Moonshot provides a number of high-speed fabric interconnect options between processor boards.

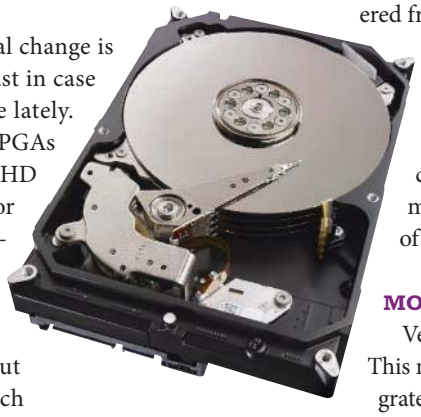
level cell (MLC) and triple-level cell (TLC) NAND flash being used in the enterprise. Yet there is likely to be more innovation in storage at a higher level this year. For example, Seagate's Kinetic hard drives sport a pair of Ethernet interfaces and provide an object-level communication protocol versus the low-level, block-oriented protocol of SATA and SAS *(Fig. 5)*.

MORE RESOLUTION

Storage isn't the only place were radical change is occurring. Displays are moving to 4K, just in case you haven't been to the electronics store lately. Those 4K Ultra HDTVs are chock full of FPGAs handling up-conversion, because for now HD content is all there is. They will be ideal for gaming, digital signage, and other generated content. HD content will look better on those large-screen 4K HDTVs.

High-resolution displays were available before the advent of 4K displays, but they will now be more common and much cheaper. The 2014 International CES in Las Vegas this month will have as many new 4K monitors as Ultra HDTVs. The standards have been updated to support these new displays, including HDMI and DisplayPort.

Intel's Thunderbolt 2 hardware interface delivers 4K video. It combines the two previously independent 10-Gbit/s channels into one 20-Gbit/s bi-directional channel that supports data and/or display. It requires an active cable as well. Users will be able to create, edit, and view live 4K video streams delivered from a computer to a monitor over a single cable while backing up the same file on an external drive or series of drives simultaneously along the same device daisy chain *(Fig. 6)*. Quite a few optical cables will be available in lengths up to 100 meters, allowing for interesting placement of displays and computers.

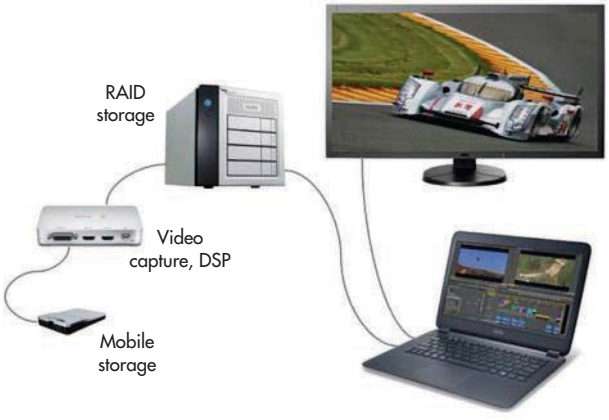


5. Seagate's Kinetic Terascale drive links 4 Tbytes of storage to two on-board Ethernet interfaces.

MORE SOFTWARE

Vendors started with free reference designs. This moved to free compilers and then full integrated development environments (IDEs). Now these software suites are bundled with operating systems, libraries, and even Web-based development frameworks.

Texas Instruments' tool suite for some platforms comes with a real-time operating system (RTOS). Freescale is bundling the MQX Lite RTOS with its tools for some chips as well. Microchip's MPLAB Harmony framework even integrates third-party software licensing. These features reduce time-to-market so hardware vendors can sell more chips.



6. Designed to deliver 4K video, Intel's Thunderbolt 2 hardware interface combines the two previously independent 10-Gbit/s channels into one 20-Gbit/s bi-directional channel that supports data and/or display.

This year will be the first time developers have access to AMD's Accelerated Processing Unit (APU) processors, which employ its Heterogeneous System Architecture (HSA). The HSA integrates the virtual memory address for CPU and GPU cores. AMD HSA CPUs are found inside the new Sony PlayStation 4 and Microsoft XBox One game consoles.

These platforms are the only ones available so far, but Arm is part of the HSA Foundation and HSA is platform agnostic. That should make things interesting in the future. HSA operating system and compiler support started with Linux, and it supports Microsoft's C++ AMP. Oracle's Java works with HSA and will have native support via Project Sumatra in Java 8.

"Big Data" parallel programming tools are moving down into the traditional embedded space, as these platforms sport dozens or hundreds of cores. Uploading data to the cloud is one way to implement the IoT, but there are times that local clouds may be more applicable.

There continues to be a trend of using more scripting languages like JavaScript or Lua on lower-end embedded platforms. IoT is driving some of this since it provides a way to run applications within a sandbox.

Whoever said embedded development was easy never had so many tradeoffs to deal with.

PowerForecast

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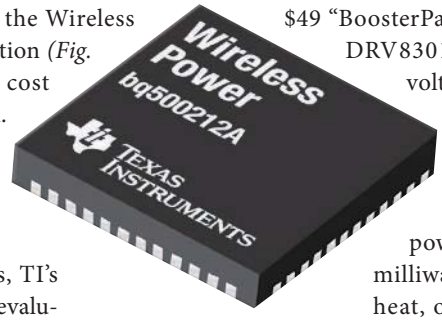
Power Semiconductor Makers Target New Products For Specific Applications

Traditionally, products have been designed with broad specifications to capture a range of applications. Now, chipmakers zero in on specific markets and uses.

TODAY'S TOP SEMICONDUCTOR manufacturers have a new goal: goof-proofing their designs. The scale of these markets ranges from huge such as the Smart Grid to micro like energy harvesting. Even the makers of gallium-nitride (GaN) devices are devoting more effort to guaranteeing (to the extent that's possible) first-pass success on new designs by tailoring parts performance to application-specific needs.

TEXAS INSTRUMENTS

Last September, Texas Instruments introduced its bq500212A transmitter, a next-generation wireless power transfer circuit designed to support the Wireless Power Consortium (WPC) 1.1 specification *(Fig. 1)*. It reduces bill-of-materials (BOM) cost and implements foreign object detection. Essentially, a wireless charger that uses the TI device won't power up unless it detects a device with a genuine WPC receiver in it.



1. The Texas Instruments bq500212A transmitter supports the WPC 1.1 specification. A wireless charger that uses it won't power up unless it detects a device with a genuine WPC receiver in it.

Designed for Smart Grid developers, TI's TMDSDC3359 smart data concentrator evaluation module (EVM) includes its own power-line communication (PLC) system. It comes with supporting software and facilitates the design of common families of data concentrators that can adapt to most worldwide Smart Grid standards. TI said the TMDSDC3359 lets developers set up a data concentrator demo with PLC connectivity in as little as 10 minutes.

On Halloween, TI's bq27741 became the industry's smallest pack-side battery fuel gauge with integrated protection against reverse connection. It comes in a 15-bump, 1.9- by 2.7- by 0.6-mm, 15-bump, chip-scale package (CSP). TI says that its Gauge Studio software supports the design of battery gauging. The company managed to squeeze the file size for the software by a factor of 10.

Four days later, TI announced the TPS92411, a 100-V, 2-Ω floating MOSFET switch for LED lighting applications. It lets designers build a flyback, buck, or boost converter with no coils or transformers.

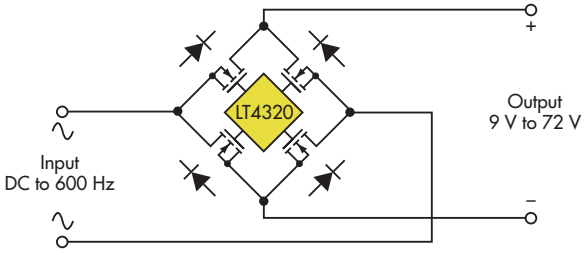
Just after that, TI announced that it could supply all the components needed to create a complete sensorless motor control system for $66. They include the C2000 InstaSPIN-FOC (field-oriented-control) LaunchPad and the DRV8301 motor drive BoosterPack plug-in module. The combination embeds all the FOC software sensor algorithms in on-chip ROM, making it possible to design a three-phase synchronous or asynchronous motor controller in a matter of minutes.

At the same time, the company announced a compatible $49 "BoosterPack" plug-in module. The motor-drive DRV8301 simplifies the prototyping of low-voltage (6- to 24-V), medium-current (up to 14-A) motor controls to facilitate prototyping in anticipation of future higher-powered systems.

In November, TI announced five power management ICs for microwatt- to milliwatt-scale energy harvesting from light, heat, or mechanical sources. The bq25570, bq25505, TPS62740, TPS62737, and TPS62736 can power wireless sensor networks, monitoring systems, wearable medical devices, mobile accessories, and other applications with limited access to power.

The bq25570 is a boost charger with an integrated buck converter that consumes 488-nA quiescent current and operates at greater than 90% efficiency at output currents lower than 10 µA. It incorporates maximum power point tracking (MPPT) and supports rechargeable lithium-ion (Li-ion) and thin-film batteries, supercapacitors, or conventional capacitors.

The bq25505 boost charger is similar, but with an even lower active quiescent current (325 nA). An autonomous power multiplexor gate drive ensures that constant power is available whenever the system needs to operate, even when no energy is available from the harvester.



2. Linear Technology's LT4320 is an ideal diode bridge controller for 9-V to 72-V systems that replaces each of the four diodes in a full-wave bridge rectifier with a low-loss N-channel MOSFET to reduce the power dissipation and increase available voltage.

LINEAR TECHNOLOGY

In June, Linear Technology announced a synchronous-switching controller that makes it possible to replace the diodes in a full-bridge rectifier with MOSFETs, eliminating losses from the forward drops of conventional silicon diodes. The LT4320 "ideal diode bridge controller" can work in 9- to 72-V systems and can switch from dc to 600 Hz *(Fig. 2)*. It can handle power levels ranging from one to thousands of watts. The integrated charge pump that provides the gate drive for the external low on-resistance ($R_{DS(on)}$) N-channel MOSFETs requires no external capacitors.

In October, the company introduced the LT4321, another ideal-bridge controller explicitly for Power over Ethernet (PoE) devices. IEEE 802.3 PoE specifications require power devices to accept dc supply voltages of any polarity over their Ethernet inputs. The power savings compared to diode bridges creates two advantages: they may enable powered devices to stay within lower PoE classification levels or they may allow designers to add additional functionality while maintaining the same class.

Announced in August, the LTC3330 regulating energy-harvesting chip decides whether the output of an energy harvesting system comes from the harvesting source, be it piezoelectric, solar, or magnetic, or from the battery. When energy is available from the energy-harvesting transducer, the LTC3330 delivers up to 50 mA of continuous output current to extend battery life when harvestable energy is available. When it is providing regulated power to the load from harvested energy, it requires no supply current from the battery and draws only 750 nA operating when it is powered from the battery under no-load conditions.

In November, Linear announced a versatile high-voltage power manager and multi-chemistry battery charger that can efficiently transfer power from a variety of sources to a system power supply rail and a battery. It is based on LTC's intelligent PowerPath topology, which reduces the voltage range required by downstream system components to that of the expected battery voltage range, rather than the full extent of the input voltage source. Instant-on operation ensures the delivery of system load power with a fully discharged battery.

The LTC4020 operates across an input voltage range of 4.5 to 55 V. Output voltage can range up to 55 V. There are three selectable termination algorithms. The device features a step-up/step-down dc-dc controller, enabling operation with battery voltages that are above, below, or equal to the input voltage. Typical applications include portable industrial and medical equipment, solar-powered systems, military communications equipment, and 12- to 24-V embedded automotive systems.

MAXIM INTEGRATED

Announced last January, Maxim Integrated's 78M6610+PSU and 78M6610+LMU single-phase energy-measurement processor chips provide simple utility-grade sensing and diagnostics without the traditional cost of a utility meter system-on-chip (SoC). The 78M6610+PSU suits real-time monitoring of data centers, servers, and telecom and data equipment. The more general 78M6610+LMU fits white-good appliances, smart plugs, electric vehicle chargers, and solar inverters. What's different here is that the 78M6610 processors do not require a separate microcontroller. Designers can add a complete energy meter to an already existing design without significant cost or redesign.

3. Maxim Integrated's MAX17050 high-accuracy battery fuel gauge uses the company's ModelGauge m3 algorithm to make continuous micro-corrections and eliminate sudden jumps in a battery's state of charge.

Last March, Maxim announced its MAX17050 high-accuracy battery fuel gauge *(Fig. 3)*. Rather than coulomb counting, it uses the company's ModelGauge m3 algorithm, which combines coulomb counting with Maxim's voltage-based ModelGauge approach. Although coulomb counting is highly accurate at first, it tends to drift over time. ModelGauge m3 makes continuous micro-corrections and eliminates sudden jumps in a battery's state of charge.

Announced last April for battery management, Maxim's MAX14920/MAX14921 high-accuracy, 12/16-channel cell-measurement analog front ends (AFEs) double the accuracy of cell voltage readings through the use of high-accuracy common-mode level shifting and an integrated high-precision amplifier that simplifies analog-to-digital converter (ADC) data conversion.

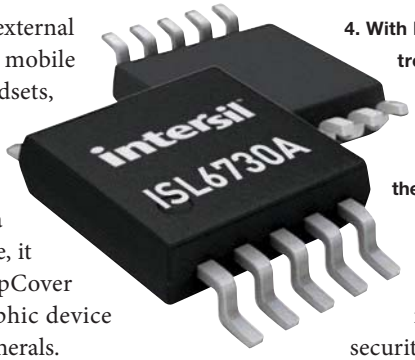
Shortly thereafter, Maxim introduced the MAX77301, a Li+ battery charger that automatically identifies the adapter type and then determines the fastest rate to charge a battery. With advanced temperature monitoring, the MAX77301 modulates the charge current and battery regulation voltage automatically to maximize safety in any temperature environment. It

performs all of these functions without an external CPU or system hardware. It's intended for mobile equipment such as cameras, Bluetooth headsets, MP3 players, and portable medical devices.

Thanks to its long association with automatic teller machine (ATM) makers, Maxim Integrated has long been a leader in secure communications. Last June, it announced sampling on its DS28E35 DeepCover Secure Authenticator, a secure cryptographic device that lets a host controller authenticate peripherals.

The DS28E35 integrates a FIPS 186-based Elliptic Curve Digital Signature Algorithm (ECDSA) engine to implement asymmetric (public-key) cryptography to operate a challenge-and-response authentication protocol between a host controller and attached peripherals, sensors, or modules. It operates over the 1-Wire single-pin interface to provide crypto-strong authentication security for applications such as medical sensors, industrial programmable logic controller modules, and consumer devices.

Essentially, the DS28E35 eliminates the need for the host controller to store and protect the authentication key required for comparable symmetric (secret-key) solutions. It protects the private key it stores through Maxim's DeepCover security technologies, which provide the strongest affordable protection against die-level attacks. DeepCover technologies include advanced die routing and layout techniques along with additional proprietary methods for private key protection and circuits that actively monitor for tampering.



4. With Intersil's ISL6730A active power factor controller, the capacitor can be moved from just ahead the bridge rectifier to the output side of bridge, allowing the use of a smaller capacitance value and reducing the size of the size of the EMI filter.

In September, the company followed with its DS28C22 DeepCover Secure Authenticator, which supports the FIPS 180-based SHA-256 authentication algorithm. The DS28C22 combines crypto-strong, bidirectional, secure challenge-and-response authentication with small message encryption. Through bidirectional authentication, the host and the peripheral authenticate one another, protecting the intellectual property (IP) in the peripheral from a non-authentic host trying to modify operation of the peripheral.

INTERSIL

In April, Intersil introduced its ISL6730A active power factor controller with what the company called a breakthrough in negative capacitance technology *(Fig. 4)*. The capacitor can be moved from just ahead of the bridge rectifier to the output side of the bridge, allowing the use of a smaller capacitance value and reducing the size of the size of the electromagnetic interference (EMI) filter. It also makes it possible to use a smaller inductor.

Announced in December, Intersil's ZL8800 point-of-load (PoL) regulator incorporates what the company calls a "ChargeMode" control loop technology that essentially eliminates control-loop compensation from the design process *(see "Power Controller And Interface Transform POL Regulation" at electronicdesign.com)*. An advanced graphical user interface (GUI) that facilitates design-ins backs it up.

FAIRCHILD SEMICONDUCTOR

In March, Fairchild Semiconductor introduced the FCM8531 analog and digital integrated motor controller, a configurable hardware and software package that includes user guides, reference designs, and evaluation boards that help motor control *(Fig. 5)*. This three-phase, hybrid brushless dc/permanent magnet synchronous motor (BLDC/PMSM) controller has two parallel processors: an advanced motor controller (AMC) and an embedded MCU on a chip.

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- 10W – 960W DIN Rail Power Supply
- 12W – 320W LED Power Supply
- 5W – 250W Open Frame Power Supply
- 1000W – 18000W 19'' Rack Power
- 30W – 1000W Battery Charger
- 5W – 220W Green Adaptor
- 0.5W – 1000W DC-DC Converter
- 100W – 3000W DC-AC Inverter

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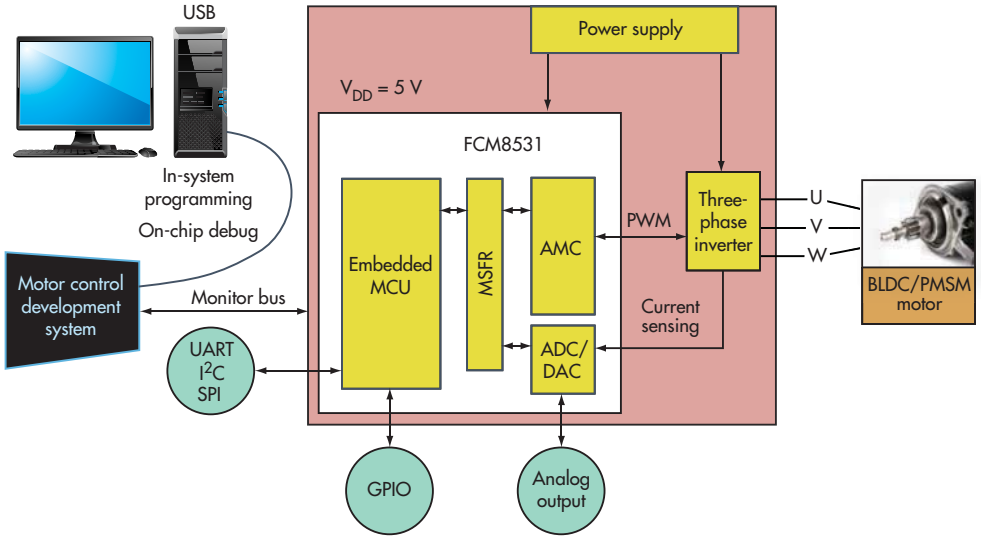

5. The embedded MCU in Fairchild's FCM8531 controls the I/O interfaces and sends commands relative to speed and rotation to the Advanced Motor Controller (AMC). The motor controller then supplies the required pulse-width modulation (PWM) drive waveforms to the brushless dc synchronous (BLDC) motor.

The two core processors work independently but collaboratively to exchange data through an internal communications interface. The AMC performs algorithms such as sine wave control, FOC, and direct and quadrature (DQ) control, using Fairchild's configurable libraries.

Also for motors, Fairchild added its SPM 5 smart power module series three-phase MOSFET inverter solution, giving designers an ac induction motor (ACIM) and BLDC motor inverter solution for motors up to 200 W, which generally includes fan motors, dishwasher pumps, and small industrial motors.

Introduced in November, Fairchild's Smart Power Stage (SPS) module family integrates a MOSFET and driver for high-switching-frequency applications such as synchronous buck dc-dc converters in computing and telecom. As modules, control can be optimized for Fairchild's high-performance PowerTrench MOSFET technology, eliminating the need for a snubber circuit in most buck converter applications.

WIDE BAND-GAP POWER DEVICES

Turning from complex parts to power switching devices, GaN MOSFETs are becoming almost mainstream, but some companies are more active than others.

Announced in September, the Efficient Power Conversion (EPC) EPC2016 GaN MOSFET is rated for 100 V_{DS} and 11 A, with a maximum $R_{DS(on)}$ of 16 mΩ with 5 V applied to the gate *(Fig. 6)*. Compared to a state-of-the-art silicon power MOSFET that features similar $R_{DS(on)}$, the EPC2016 is much smaller with switching performance that's exponentially superior, according to the company.

With Texas Instruments' LM5113 GaNFET gate driver IC used in a half-

LINEAR TECHNOLOGY

DESIGN NOTES

Generating a ±10.24V True Bipolar Input for an 18-Bit, 1Msps SAR ADC

Design Note 522

Guy Hoover

Introduction

The LTC®2338 is an 18-bit fully differential SAR ADC that is remarkably easy to drive. This 1Msps ADC operates from a single 5V supply and achieves ±4LSB INL maximum with –111dB THD and 100dB SNR. Its fully differential ±20.48V true bipolar input range minimizes the need for range scaling, and its 2kΩ resistive input greatly reduces the charge kickback from the internal sampling capacitor.

ADCs claiming similar performance require scaling to exceed what is typically a 0V to V_{REF} input range, resulting in low impedance inputs or an additional buffer stage requirement. To band limit noise and minimize disturbances reflected into the buffer from sampling transients, other ADCs require filter circuitry composed of expensive film or C0G capacitors at the driver output. In contrast, the simple driver circuit presented here requires only a dual precision op amp and two resistors to drive the LTC2338-18. Layout strategies for this circuit are also shown.

Simple Driver Circuit

The circuit of Figure 1 uses only the LT®1469 dual precision op amp and two metal film resistors to form a single-ended to differential driver for the LTC2338-18. This circuit takes a single-ended ±10.24V input voltage and converts it to the ±20.48V fully differential signal, which is required for proper operation of the LTC2338-18.

Typical offset for the driver portion of this circuit is less than the equivalent of 1LSB (156µV) for the LTC2338-18. Typical AC performance for this circuit includes THD of –110dB and SNR of 100dB. This performance can be seen in the FFT of Figure 2. The THD and SNR performance are similar to the typical performance numbers found in the LTC2338-18 data sheet—this simple driver produces negligible performance degradation.

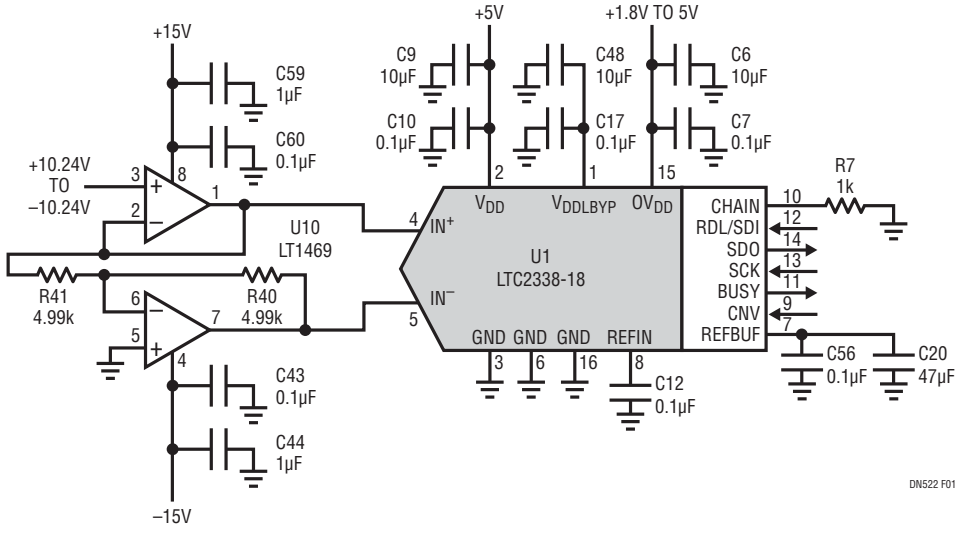

Figure 1. Single-Ended to Differential Driver for LTC2338 18-Bit SAR ADC with a ±10.24V Input Range

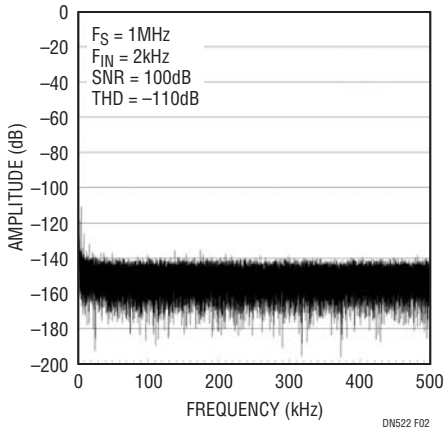

Figure 2. 131072-Point FFT Using the Circuit of Figure 1

Layout Is Important

PC board layout can have a significant effect on the performance of a high speed 18-bit ADC. When considering layout, keep the following in mind:

- A ground plane should always be used—a solid ground plane just below the component layer is recommended.
- Keep traces as short as possible.
- Keep bypass capacitors as close to the supply pins as possible, and each bypass capacitor should have its own low impedance return to ground.
- The analog input traces should be screened by ground.
- The layout involving the ADC analog inputs should be as symmetrical as possible, so that parasitic elements cancel each other out.
- The reference bypass capacitors should be as close to the REFBUF and REFIN pins as possible.

Figure 3 shows a close up of the layout connecting the LT1469 and the LTC2338-18 on a demonstration board. Device, pin and component numbers shown in the photograph of Figure 3 correspond to the numbers shown in the schematic of Figure 1. See the DC1908 demo board manual and PCB files available at www.linear.com/demo/ for the complete DC1908 schematic and layout.

Conclusion

The LTC2338-18, with its large true bipolar input voltage range and resistive input, greatly simplifies the task of driving an 18-bit fully differential SAR ADC. Using the simple driver circuit presented here, consisting of only a dual precision op amp and two resistors, it is possible to maintain the good AC and DC specifications of this ADC. PCB layout is an important consideration in achieving this level of performance. Proper use of a ground plane, keeping bypass capacitors near pins being bypassed and symmetrical layout around the analog inputs help ensure a high level of performance.

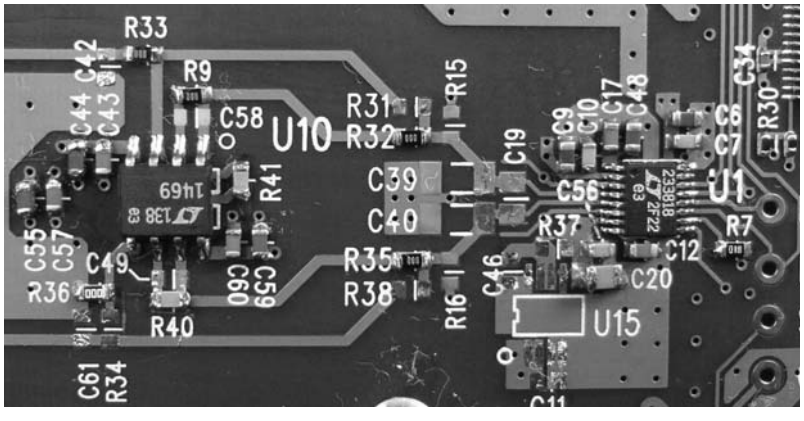

Figure 3. Close Up of Demonstration Circuit DC1908 Shows Important Layout Considerations to Achieve High Level Performance

Data Sheet Download

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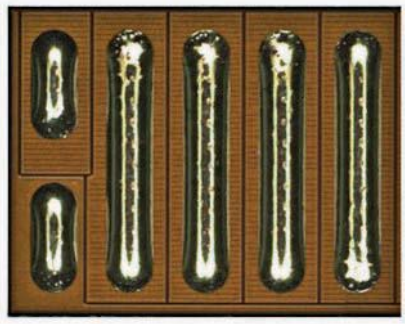

6. EPC's EPC2016 GaN MOSFET is much smaller than other state-of-the-art silicon power MOSFETs with exponentially superior switching performance, according to the company.

bridge configuration, the EPC9010 development board allows evaluation of the devices. Meanwhile, the EPC2018 is a 150-V, 12-A device with a maximum $R_{DS(on)}$ of 25 mΩ.

Later in September, EPC introduced its third generation with the EPC8000 family, which is characterized by switching transition speeds in the sub-nanosecond range, making the devices capable of hard switching applications above 10 MHz. Yet the MOSFETs also exhibit very good small-signal RF performance with high gain well into the low-gigahertz range, making them a competitive choice for RF applications.

$R_{DS(on)}$ values range from 125 mΩ through 530 mΩ, and there are three blocking voltage capabilities: 40 V, 65 V, and 100 V. The family also offers lower Q_{GD} for lower-voltage transient switching losses. Its improved Miller ratio provides high dv/dt immunity. Its low-inductance pads improve the connection to both gate and drain circuits. The orthogonal current flow between the gate and drain circuits reduces common source inductance (CSI) reduction. A separate gate return connection also helps reduce CSI.

In May, International Rectifier said that it had qualified and shipped products built on its revolutionary GaN-based power device technology platform for a home theater system manufactured by a leading consumer electronics company, but it did not go into further detail. *(For more information on IR's devices, see "GaN Modules Boost Switching Frequency While Maintaining Efficiency" at* electronicdesign.com*.)*

Meanwhile, Transphorm announced a partnership with Fujitsu Limited and Fujitsu Semiconductor in November. According to the terms of the agreement, Fujitsu Semiconductor and Transphorm, which only emerged from stealth mode at APEC 2011, will integrate their GaN power devices for power supply businesses.

Don't think that Transphorm is being swallowed, though. Both Fujitsu Limited and Fujitsu Semiconductor will take a minority equity position in Transphorm. The new Transphorm-Japan is a wholly owned subsidiary of Transphorm Inc. The acquisition gives Transphorm a wider product base that will include both low- and high-voltage GaN devices based on Fujitsu's 200-V enhancement-mode technology and Transphorm's exclusive 600-V HEMTs. ed

MORE FROM DON TUITE

FOR MORE ON analog and power from Don, check out his blog, Secondary Emissions, at http://electronicdesign.com/blog/secondary-emissions and see:

- The Best Kept Secret About Quantum Computing
- Solar-Electric Company Runs On Steam
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JANUARY 2014

Moderate Growth A Mainstay For The Electronics Channel

Distributors look for growth in 2014, citing rising demand in the medical and lighting markets and the Internet as a continued game changer.

2014 ISN'T LIKELY TO be a banner year for North American electronics distributors. But many are hoping for moderate growth, with rising demand in markets such as medical equipment, lighting, energy, and consumer electronics. They also expect the Internet to continue to transform the industry, as more companies invest in Web-based resources and purchasing tools.

Most market outlooks call for steady, not stellar, growth. The World Semiconductor Trade Statistics (WSTS) December semiconductor market outlook calls for 4% market growth in 2013 to $304 billion, driven mainly by double-digit growth in memory products. WSTS predicts similar growth over the next two years, anticipating a 4% increase in 2014 followed by an expected 3% rise in 2015. WSTS says it expects wireless and automotive markets to grow faster than the total market while consumer and computer categories remain stagnant.

"We are optimistic about moderate growth in the electronic components industry in 2014," says Steve Martin, executive vice president of sales at distributor Components Direct, an Avnet Company. Martin adds lighting and medical markets to the list of promising end markets for the coming year.

Continued on Page 52

Smart Phones, Tablets Drive Processor Growth

Demand for processor microchips continues to climb, as handheld devices such as smart phones and tablets dominate the consumer market.

SALES OF SMART PHONES and tablets continue to outpace PCs and drive new demand for processor microchips, as a new report on the processor market illustrates. The global market for processor microchips rose by nearly 25% in 2013, propelled by growth in handheld devices.

Industry researcher IHS reported in December that worldwide processor shipments would reach 1.5 billion units by the end of 2013, up from 1.2 billion in 2012 *(see the figure)*. The group also noted that each quarter in 2013 saw a "significant rise in volume compared to the same periods in 2012."

"The first half of the year, in particular, yielded solid growth, up 27% in the first quarter on an annual basis, and up 24% in the second quarter," IHS reported, adding that third-quarter and fourth-quarter growth was expected to be in line with those numbers as well.

IHS counts traditional chips implanted at the heart of machines such as desktop PCs and servers, as well as mobile counterparts used in notebook computers, smart phones, and tablets, in its calculations. Mobile versions include standalone application processors and systems-on-chips (SoCs) that combine a baseband processor with an application processor. And with a decline in demand for PCs, smart phones and tablets make the difference in the marketplace.

"The overall processor market would not be so healthy if it weren't for smart phones and

Continued on Page 54

Moderate Growth

Continued from Page 51

"The slow economic recovery globally [is contributing to slow industry growth] along with budget instability in core electronic component sectors such as military and aerospace," he explains. "However, the industry is seeing a continued drive for more electronics within certain industries. Lighting, medical equipment as well as consumer electronics such as mobile devices continue to grow, which is boosting sales for many companies."

Other distributors agree, pointing to the proliferation of electronics in just about every aspect of daily life as good news for companies throughout the supply chain.

FOCUSING ON ENERGY, MEDICAL

Marc Barnhill, chief trading officer for large independent distributor N.F. Smith and Associates, points to energy and medical markets as strong performers this year. The Houston-based distributor has long served oil and gas industry customers, which Barnhill characterizes as "extreme growth" areas this year.

"Energy and medical are two categories that we're targeting heavily," says Barnhill. "Being a corporation based out of Houston, the gas and oil segment is really close to us. That's an area where we see extreme growth, and you want to be in business with people who are expanding rapidly."

For evidence of that, look no further than the recent rise in domestic oil and natural gas production, which has increased by nearly 2.7 million barrels per day in the past four years, according to the Institute for Energy Research (IER). IER calls the growth "impressive" and expects the trend to continue. Other large distributors are honing their focus on energy markets in 2014 as a result, including connector specialist PEI-Genesis, which announced the creation of a new management position focused on oil and gas last year. A new oil and gas business development manager for North America is based out of PEI-Genesis' Houston office and charged with expanding its work with harsh-environment and explosion-proof connector brands and explosion-proof cable assemblies.

Furthermore, distributors point to ongoing innovation and development among medical device and equipment manufacturers as key reasons for strong growth in the medical market in 2014. Industry researcher IHS said global revenue for consumer medical devices would rise 4% in 2013, followed by 5% to 9% increases over the next five years. Much of that growth will be in portable and wearable medical devices, such as hearing aids, blood glucose monitors, and blood pressure monitors. "Medical has huge margins, so there's always a sense of urgency and opportunity there," adds Barnhill. "There are opportunities for lots of [companies] there."

"Energy and medical are two categories that we're targeting heavily," says Marc Barnhill, chief trading officer for independent distributor N.F. Smith and Associates.

For distributors such as Components Direct, which specializes in supplying obsolete and end-of-life electronic components, global expansion will complement its efforts to grow business in specific market segments such as medical and lighting.

"We focus broadly across all market sectors and will continue to seek growth by expanding our reach globally," says Martin. "We have seen a growing consumer base in both Europe and Asia in 2013 and will continue to expand our reach into these markets in 2014."

WEB INVESTMENTS CONTINUE

Ongoing customer migration to the Internet is another trend that has Components Direct excited about the New Year. Martin points to the distributor's continued investments in e-commerce and related tools as a way to home in on this growing opportunity.

"We are excited about the continued migration to the Internet for buyers of electronic components," he says. "Design engineers, procurement professionals, and other stakeholders are going to the Web to research product, compare prices, download datasheets, and, ever increasingly, [to] transact purchases. As an authorized distributor, we are investing in our e-commerce platform and developing new tools and products to support this growing interest."

Components Direct is not alone. There was a flurry of online activity among some of the largest electronics distributors toward the end of 2013 as companies sought to ease the research and purchasing process for engineers and buyers. TTI, for one, announced improvements to its Multi-Part Upload Tool that speed and ease the purchasing process.

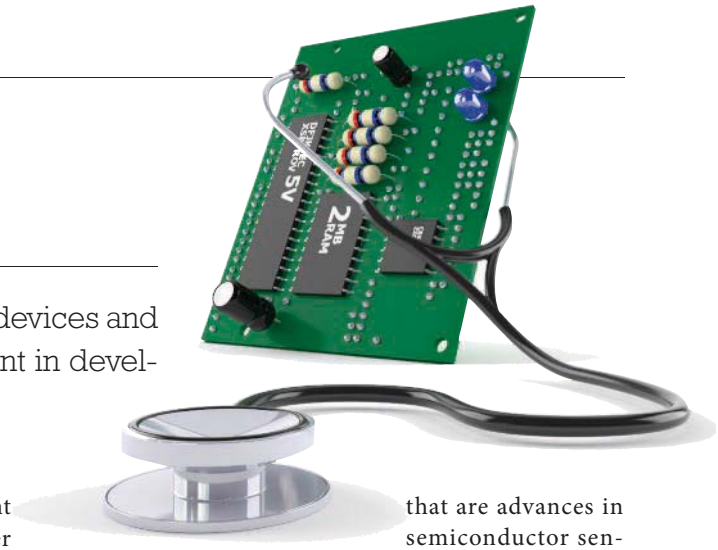
Visitors to the TTI Web site can now copy and paste their bill of materials to initiate the upload process. Once the process is complete, buyers move to familiar options such as buy now, quote request, download a quick quote, or add to project list.

"Enhancing the multi-part upload feature allows our customers to manage their bill of materials more quickly and efficiently online," explains Kevin Schubert, TTI's vice president of its global Internet business. "This enhancement supports our development efforts with the goal of providing ongoing improvements in efficiency and ease-of-use for our customers."

Continued on Page 54

Medical Electronics Set For Double-Digit Growth

Medical markets regain strength as wireless devices and increasing demand for healthcare equipment in developing countries spur growth worldwide.



THE MEDICAL ELECTRONICS MARKET has been a strong performer amid the sluggish economic conditions for electronics distributors and manufacturers over the last few years. As 2014 gets underway, those companies can count on an even bigger bang out of the medical market, as analysts predict a return to double-digit growth globally.

Worldwide growth in medical electronics is expected to speed up in the next three years after slowing since 2010, according to the 2014 edition of IC Insights' IC Market Drivers report, released in November.

The research company says medical electronics sales will grow 8% to about $51 billion in 2014 after rising just 3% in 2013 to roughly $47 billion. Sales of semiconductors used in medical systems are also expected to gain strength this year, rising 12% to about $5 billion after growing 7% in 2013 to $4.4 billion.

Also, IC Insights predicts worldwide sales of medical electronics will rise by a compound annual growth rate (CAGR) of 7.3% between 2012 and 2017, reaching $65.4 billion. Sales of semiconductors used for healthcare systems applications will rise by a CAGR of nearly 11% to reach almost $7 billion by 2017, the group says *(see the figure)*.

The researchers cite growing demand for medical equipment in China and other developing countries, along with the trend toward mobile healthcare systems, as key reasons for the expected increase in sales.

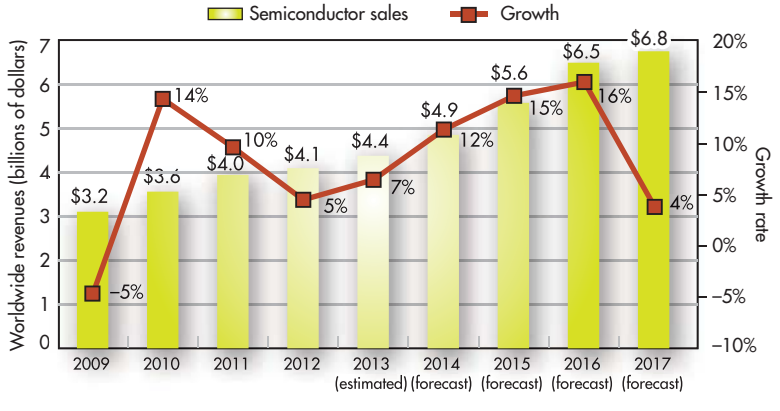
"In the years ahead, stronger growth in medical electronics will be fueled by sales of less expensive diagnostic and imaging equipment in China and other developing-country markets as well as the explosion of wireless mobile healthcare systems that monitor patients remotely and reduce the need for expensive stays in hospitals," according to IC Insights.

"The 2014 IC Market Drivers report forecasts wireless mobile medical systems and closely associated wearable fitness-tracking devices generating revenues of nearly $1.9 billion in 2014, which is a 53% increase from about $1.2 billion in 2013, when worldwide sales grew 27%," the researchers added.

IC Insights also points to two key development trends in the marketplace. The first is the drive to make new medical diagnostic systems smaller and less expensive so equipment can be used in patients' rooms, clinics, and doctors' offices instead of hospital exam rooms and imaging centers. Hand in hand with that are advances in semiconductor sensors, wireless ICs, and system-on-chip (SoC) designs that enable mobile medical devices. The other trend influencing the medical industry is the creation of more powerful and integrated systems, which are expensive but will reduce healthcare costs by detecting diseases sooner and supporting less invasive surgery for quick recovery times and shorter hospital stays.

"Computer-assisted surgery systems, surgical robots, and operating-room automation are among new technologies being pursued by some hospitals in developed-country markets," IC Insights explains.

The world's aging population and China's heavy investment in healthcare will be growth drivers over the next few years as well. China is expected to invest nearly $64 billion in medical and healthcare infrastructure this decade. ■



Sales of semiconductors used in medical systems are expected to rise 12% to $4.9 billion in 2014. *(courtesy of IC Insights)*

Smart Phones

Continued from Page 51

tablets," explained Gerry Xu, senior analyst of processor research for IHS, in announcing the report. "The PC market that traditionally drove the growth of the microprocessor segment has slowed. The new mobile platforms have more than picked up the slack, delivering both large volumes and fast growth for processor shipments."

The largest growth in the processor segment in 2013 was in tablets, up 40% to 53.5 million units. Smart phones were a close second, up 38% to 204 million units. Comparatively, chip shipments to the PC segment were generally down every quarter compared to a year earlier.

"The decline is not surprising, as PCs have struggled to compete against more popular devices like mobile handsets and tablets," IHS reported. "Sluggish PC sales, in turn, have affected processors being shipped to the space."

Within the PC segment, processor shipments to notebook computers were down 2% for the year, while shipments to desktop PCs were down a much larger 13%, IHS said. Processor shipments fared better in the server sector, rising to 4.8 million units in the second quarter compared to 4.6 million in the year-earlier period.

New processors continue to make their way to the market. IHS additionally reported that Intel remained the dominant force in PC processors, with 84% market share overall. The chipmaker is also focused on power efficiency and improved computing performance with its latest Atom processor, which will be used in PCs, servers, tablets, and smart phones, "virtually all key segments of the processor market," IHS said.

Intel's latest Atom 22-nm multicore SoC processors, for instance, are 64-bit multicore processors that feature USB 3.0 and graphics support, targeting high-performance, low-power applications such as smart phones and intelligent embedded systems.

Manufactured using the company's Tri-Gate CMOS technology, this next-generation Atom brings performance increases and improved energy efficiency compared to competing processors using planar transistor technology, "all while delivering industry-leading performance-per-watt efficiency," according to Intel.

Also new to the market, InvenSense's six-axis MPU-6515 MEMS SoC and corresponding MotionApps software platform are optimized to support new functions of the Android KitKat. The SoC incorporates an enhanced version of InvenSense's Digital Motion Processor to offload complex motion protocols and algorithms from the application processor as required by Android KitKat for low-power inertial location tracking and contextual awareness, according to the company. ■

Global worldwide processor shipments totaled 1.5 billion by the end of 2013, up from 1.2 billion in 2012. (courtesy of IHS)

"We are optimistic about moderate growth in the electronic components industry in 2014," says Steve Martin, executive vice president of sales at distributor Components Direct, an Avnet Company.

Moderate Growth

Continued from Page 52

TTI also has updated its parts search function with a feature that predicts keywords as users start typing, speeding the search process and reducing the number of clicks users need before finding the correct item.

TTI's sister company, Mouser Electronics, has added three sites to its customer resource library. Wireless Charging offers wireless charging semiconductor and passive components as well as technical articles and other resources. Its Automotive Applications and Computing Applications sites offer similar resources for engineers in those fields.

The proliferation of online tools and technologies also brings new challenges, though, as Martin points out.

"We expect the Internet to continue to be a strong influencer within the electronic component space. [But] by opening the supply chain to a more global customer base, distributors will grapple with potential channel conflict as well as diverse and regionalized regulations and compliance procedures," he says. "Distributors will continue to adapt by developing market-specific contracts, more rigorous export compliance processes, and customized tax and customs data." ■

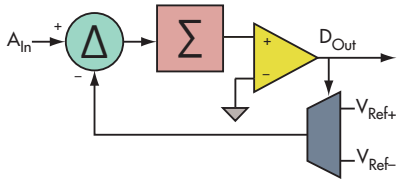
DesignSolution

DAVE VAN ESS | Contributing Technical Expert
dwv@cypress.com

Turn A Spreadsheet Into A Delta-Sigma Modulator

All engineers have spreadsheets on their computer and know how to use them. The input is just a column of data, and the output is plotted.

PULSE DENSITY MODULATION is just the analog portion of a delta-sigma analog-to-digital converter (ADC). It coverts an analog signal into a digital density stream. A recent online discussion about it prompted some readers to call it really cool.[1] Other readers asked what the output looks like compared to its analog input.



1. For this DSM, negative feedback is used to compare the quantized output with the input.

I tried explaining that it is a digital output stream where the average of its output equals the input value. Looking back, I am afraid I did not answer this well and figured I would try again here.

When looking at a delta-sigma modulator (DSM), you really have to look at the stream of data. Looking at just one operation is about as useful as trying to understand Morse code with the following example:

dit

The best way to understand a DSM is to build a modulator and visually examine the output as a function of its input. I initially thought I would explain how to build one with linear components or with switched capacitor circuitry. However, this route would have required the right hardware, a signal generator for stimulus, an oscilloscope to view the output, a workbench on which to set everything up, and, of course, the spare time we all have to do it.

So instead I decided to make a spreadsheet model. All engineers have spreadsheets on their computer and know how to use them. The input is just a column of data, and the output is plotted. The models are straightforward to understand.

It doesn't take up any physical space, so it can be set up and used in even small moments of free time, such as between compiles. Since it looks like most any other spreadsheet you use for your job, you can work on it in the presence of a myopic, short-sighted manager who discourages any tasks other than the immediate job at hand—even if that immediate job at hand requires you to wait 10 minutes for a system build.

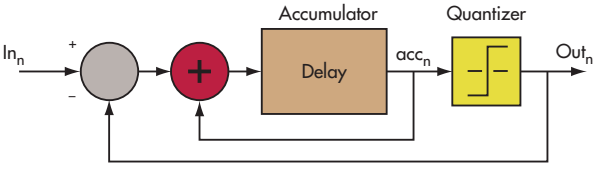
For those interested in hardware, I have shown many linear examples in previous articles,[2] and Cypress Semiconductor has a good app note on building a switched capacitor DSM with its CY8C27x family of programmable systems-on-chip.[3]

THE DSM

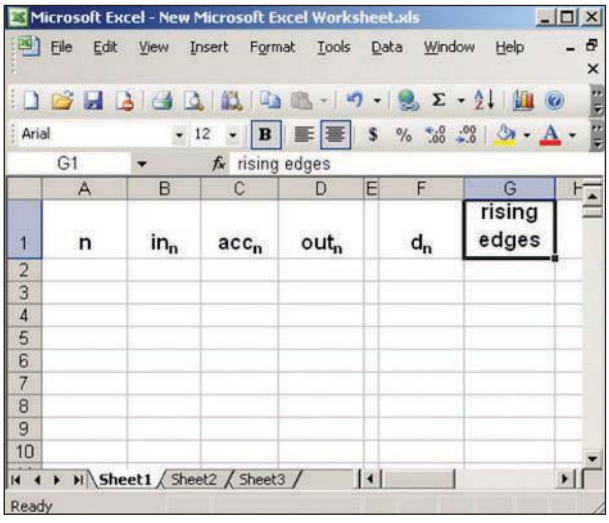
Figure 1 illustrates a single-bit sampled DSM. At first glance, this diagram makes it apparent why it's called "delta sigma." The quantized output is subtracted (delta) from the input, and the error is accumulated (sigma). This value is digitized. With negative feedback and high gain, the output attempts to match the input. Since the accumulator acts as a filter, the average of the quantized output closely matches the average of the input.

Figure 2 shows how this will be implemented. The accumulator is built from a clocked register that feeds back to itself. Here it is called delay, but it sometimes is called a register or z-1. I like the term "previous." For this block diagram, acc is equal to the previous acc plus the previous in minus the previous out. Also, out is a function in the acc. Stated mathematically:

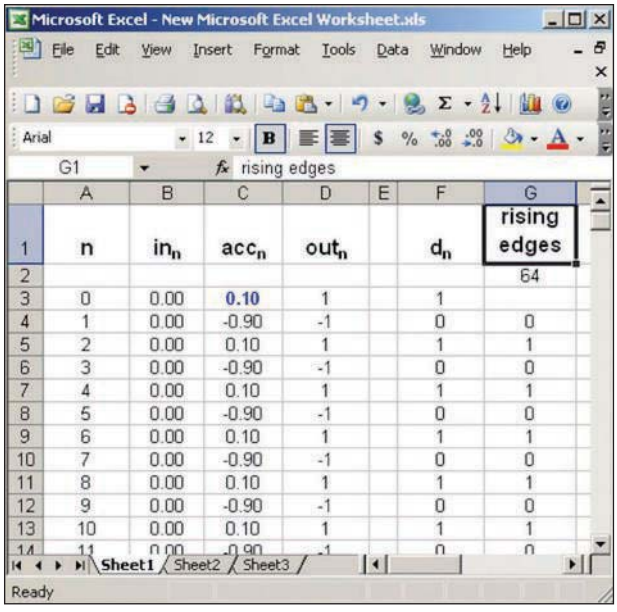
$$acc_n = acc_{n-1} + in_{n-1} - out_{n-1}$$



2. DSM implementation only requires a subtractor (delta), accumatalor (sigma), and quantizer.



3. Six columns are required to build this model.



4. Your spreadsheet model should look something like this.

$$out_n = f(acc_n)$$

You now have all the information you need to build a spreadsheet model.

BUILDING THE MODEL

This sampled DSM will start at 0 and continue until n is 128. I decided to make it only 128 because this was the largest value at which I could still see the distinct states of the output stream. You can always increase the sample length if you wish. Start by opening your spreadsheet and placing the column labels in the first row *(Fig. 3)*.

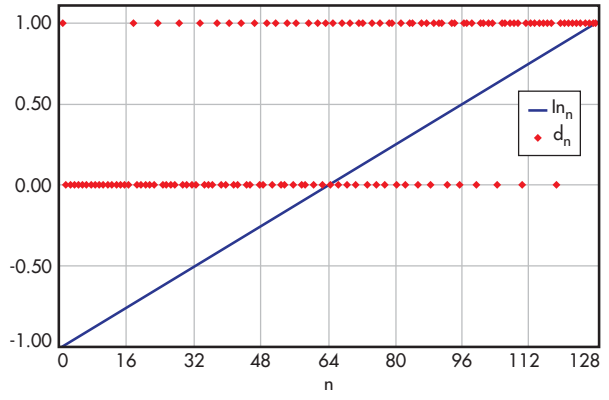
Column A includes the sample number for each row. It starts with a value of 0 in cell A3 and increments in each row ending with a value of 128 in cell A131. Column B includes the inputs for each row. It can be a function of "n" or some constant value. Start by placing a constant value of 0 in cells B3 through B131.

Column C includes the accumulator values for each row. Each value (acc_n) is a function of the previous accumulator (acc_{n-1}), the previous input (in_{n-1}), and previous output (out_{n-1}). The exception is that first one (acc_{n0}) is the initial condition. Place some initial value in cell C3. In cell C4 place:

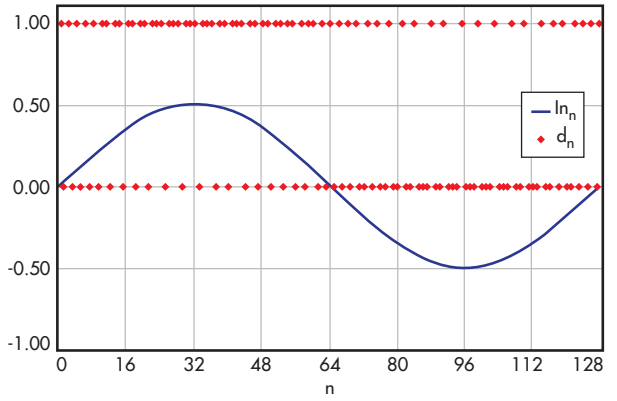
C3+B3-D3

or the previous acc + previous in – previous out. Take this entry and fill it in down to C131.

Column D includes the quantized output for each row. It is a function of the accumulator value. If the accumulator value is positive, the output is set to a reference value of 1. If negative, it is set to a reference value of –1. What if the accumulator value is equal to zero? Well, equal is a term analog guys don't



5. This plot shows that that d_n is mostly low near the negative rail, mostly high near the positive rail, and about 50% near the center.



6. With a peak amplitude of 0.5, the immediate density never gets higher than three high, one low.

have much use for. I define "equal" as just that infinitely narrow moment of time going from less than to greater than (or greater than to less than). But zero is a possibility in this noise-free model, so it is defined as positive. In cell D3 place:

IF(C3 >=0,1,-1)

The output is now one of two quantized values. Take this entry and fill it down to D131.

While column D included the quantized output (–1 or 1), column F includes the digital logic value (0 or 1). This digital value would be transmitted to be digitally processed. In cell F3, place:

MAX(D3,0)

This is now a digital value. Take this entry and fill it down to F131. There is information in the frequency of this digital output, so the rising edge for each row is calculated in column G. The rising edge calculation for cell G4 is:

IF(F4 >F3,1,0)

Take this entry and fill it down to F131. In cell G2, sum all 128 of these rising edge values. You now have a DSM *(Fig. 4)*. Presently, this model is set with an input of zero and an initial accumulator value of 0.01. The outputs cycle between 1 and –1. This makes for a density (percentage high) value of 50%. There are 64 rising edges, which is 50% of the 128 steps. Average the 128 outputs from D4 to D131, and you get zero. (Average is just a digital filter that turns the density stream into a digital value.)

Change the initial accumulator to –0.01, and you get the same cycle and rising edge value. Change the initial value in cell C3 to 5 and notice how the feedback pulls the accumulator back towards zero. Set the inputs in column B to 1.1 and verify that the DSM goes out of range. The input range for this DSM is ±1. Change the input to +0.5, and you will see that the output cycles three highs and one low (75% density), the average of the 128 outputs is 0.5, and the number of rising edges is 32 (25% of 128).

Now change the input to –0.5, and you will see the output cycles one low and three highs (25% density), the average of the 128 outputs is –0.5, and the number of rising edges remains the same at 32. The percentage of rising edges relative to the number of samples is called the output frequency and a function of the density as shown in:

$$f_{Out} = \min(\text{density}, 1 - \text{density})$$

Now modify the inputs so B3 starts at –1 and the input in each row is incremented by 1/64. B131 will be +1. Figure 5 shows the plot.

The spreadsheet provides a lot of interesting data. When the input is negative, the output stream is more lows followed by a single high. For positive inputs, the opposite is true. There are 32 rising edges, which is the same value obtained when the input was +0.5. The average of the absolute value of this signal is 0.5.

Now change the input to make a sinusoidal output with a peak-to-peak amplitude of 1. Do this by setting B3 to:

.5*SIN(2*PI()*A3/128)

Take this entry and fill it down to B131. Figure 6 shows the plot.

For the example, the stream still remains with single lows for positive input and single highs for negative inputs. The average of the 128 outputs is zero, and there are 44 rising edges for an f_{Out} of 44/128 or 34.4%. The equivalent input to generate 44 inputs would be an input dc of 1/PI(). Since the average of this sinusoid rectified is, in fact, $1/\pi$, the output frequency can be used to measure the average of an rectified signal.

This is a good place to stop. You now have a spreadsheet model of a DSM. I intend to expand on this model in my next lab—if you readers think it's worthwhile. Until then, you have a tool that allows you to change the stimulus and view the response. Experiment a bit and you'll feel comfortable with the DSM in no time. ed

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2. Dave Van Ess, http://electronicdesign.com/author/dave-van-ess
3. AN2041—Understanding PSoC 1 Switched Capacitor Analog Blocks, http://www.cypress.com/?rID=2899&utm_source=TechnicalArticle-Promotions&utm_medium=DavesED-Column&utm_campaign=A-Spreadsheet-Delta-Sigma-Modulator

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DAVE VAN ESS has been writing about analog design for **Electronic Design** since 2008. For more, go to http://electronicdesign.com/author/dave-van-ess and see:

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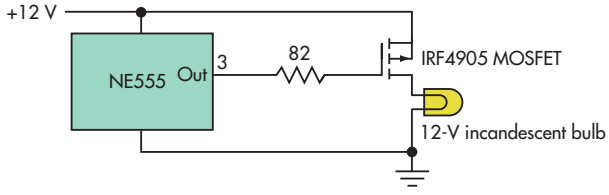
Informed Analysis Picks Better 555 Timer To Drive Power MOSFET

MICHAEL A. COVINGTON | Covington Innovations, Athens, Ga., mc@covingtoninnovations.com

THE ORIGINAL BIPOLAR 555 timer, the NE555, is excellent for driving a power MOSFET's gate. Newer CMOS versions such as the 7555, LMC555, and TLC555 use less power, but they have trouble sourcing enough current to drive a gate well and can even be damaged by load mismatch.

The figure shows part of a pulse-width-modulated dimmer for a 12-V incandescent lamp. It originally used a CMOS TLC555, which kept failing with an open output pin as the failure mode. In addition, the MOSFET (an IRF 4905) ran hot. Pin 3 of the 555 was connected directly to the MOSFET gate.

Examination with an oscilloscope showed that the gate voltage had a rise and fall time of about 2 µs and that the pulse-width modulation (PWM) switching frequency was about 100 kHz, so about 40% of each cycle was spent on the rise and fall. That explained why the MOSFET was running hot. Much of the time, it was neither fully on nor fully off, but in the lossy intermediate-state switching-transition mode.



A CMOS TLC555 can't source enough current to charge the gate rapidly and was damaged by being connected directly to the gate (a 3500-pF capacitive load). But a bipolar NE555 with an added 82-Ω protective resistor drives the IRF4905 MOSFET safely and reliably.

The input capacitance of the IRF 4905 is typically 3500 pF. Using the well-known current-charging equation $I = C\,dV/dt$, we find that the gate charging and discharging current with a 12-V square wave is about 21 mA, twice the rated output of the CMOS 555. That explains the failures.

The solution was simple. The timer chip was changed to a bipolar NE555 (rated for 200-mA sink and source current), an 82-Ω resistor was added to guarantee that the current would always be below 150 mA, and the switching frequency was reduced to 3 kHz to reduce the proportion of time spent "on the slope." The resulting circuit performed more reliably, and the MOSFET did not even get warm.

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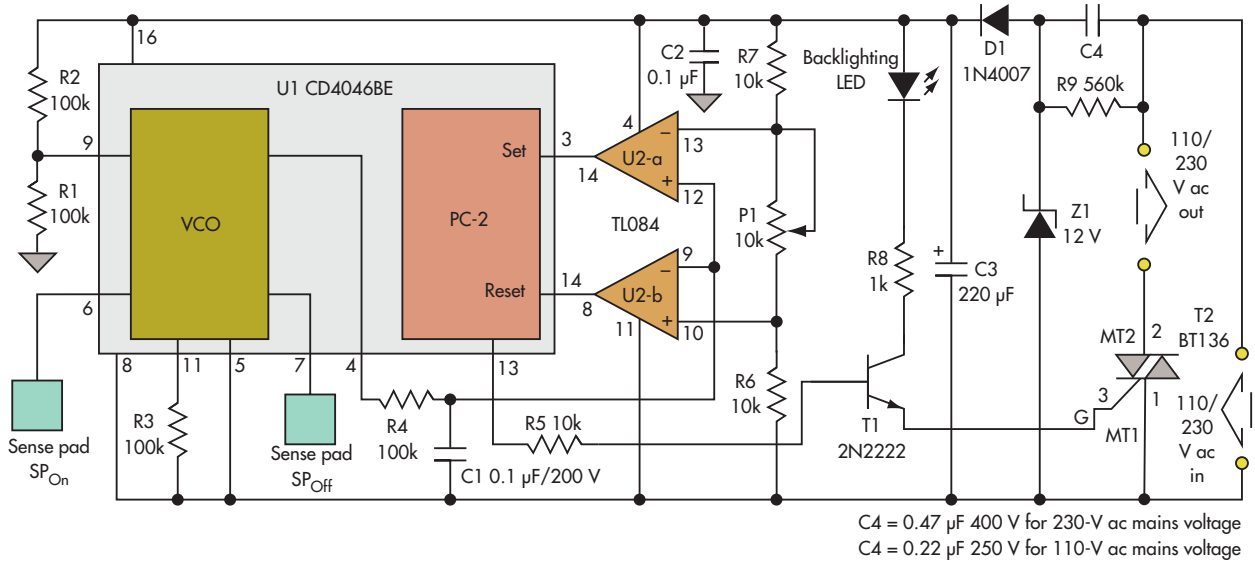
PLL Provides Ratiometric Capacitive Touch Switch For Appliances

M.S. NAGARAJ | Technical Consultant, msnagaraj.smartprojects@gmail.com

CAPACITIVE-BASED TOUCH-SENSOR SWITCHES ARE gaining popularity for appliance, automotive, and industrial applications for many reasons. They're aesthetically appealing, flexible, easy to manufacture, and easy to use. They avoid the need for buttons, sliders, and other parts needed in mechanical switches. They're also durable, since they don't have any moving parts.

Further, the absence of holes and other openings lowers the manufacturing cost. Surface contaminants and moisture have no effect on the quality of the switches. The front surface can be back-lit to indicate the switch status. And, the copper pads of the printed-circuit board (PCB) can be made to function as touch sensing plates.

The circuit in the figure uses two identical metal plates or copper pads on one side of a double-sided PCB as the sensing pads (SP_{On} and SP_{Off}). Sensing capacitors C_{On} and C_{Off} are formed by placing these sensing pads behind a thin, decorative overlaying cover film or plate of the switch. The overlay isolates the user from the mains voltage. Components C4, R9, Z1, D1, and C3 form a compact and low-cost transformerless power supply.



Based on a standard PLL IC, comparator, and triac, this circuit provides a low-cost capacitance touch switch for the ac line and is relatively insensitive to ambient temperature and dc-supply rail drift.

The capacitors act as the timing components of the voltage controlled oscillator (VCO) of a commonly used and inexpensive CMOS phase-locked loop (PLL) (CD4046). ON period T_{On} and OFF period T_{Off} of the square wave at the output of the VCO are determined by the values of the sense capacitors C_{On} and C_{Off}, respectively. Integrator R4C1 develops dc voltage V_{dc} proportional to the duty cycle (η) of the square-wave output:

$$V_{dc} = \text{duty cycle} \times \text{amplitude of the square wave}$$

where:

$$\eta = \text{duty cycle} = T_{On}/(T_{On} + T_{Off})$$

and:

$$\text{amplitude of the square wave} = 12\ \text{V}$$

Since the sensing pads are identical, the capacitors have equal values when the sensing pads are not touched. Hence, $T_{On} = T_{Off}$, duty cycle = 0.5, and V_{dc} = 6 V. The voltage divider formed by R6, P1, and R7 provides reference voltages $V_{Ref\text{-}hi}$ and $V_{Ref\text{-}lo}$ to voltage comparators $U_{2\text{-}a}$ and $U_{2\text{-}b}$.

When the sensing pad (SP_{On}) used for switching the appliance on is touched, the user's finger capacitance will be added to the value of C_{On}. This increases the values of T_{On}, the duty cycle, and the integrator output. Preset potentiometer P1 is adjusted so:

$$V_{Ref\text{-}hi} = (V_{dc} + V_{dc\text{-}on})/2$$

where V_{dc} and $V_{dc\text{-}on}$ are the integrator outputs when SP_{On} is untouched and touched respectively.

Thus, when SP_{On} is touched, the integrator output exceeds $V_{Ref\text{-}hi}$, and the output of comparator $U_{2\text{-}a}$ output goes high, setting the set-reset flip-flop, which is the phase comparator (PC-2) of the PLL IC. Similarly, when sensing pad SP_{Off} used for switching the appliance off is touched, the user's finger capacitance will be added to the value of C_{Off}. This increases the value of T_{Off} and decreases the values of duty cycle and the integrator output.

As R6 = R7, the reference voltage $V_{Ref\text{-}lo}$ tracks $V_{Ref\text{-}hi}$ such that:

$$(V_{Ref\text{-}hi} - V_{dc}) = (V_{dc} - V_{Ref\text{-}lo})$$

Hence, when SP_{Off} is touched, the integrator output falls below $V_{Ref\text{-}lo}$, and the output of comparator $U_{2\text{-}b}$ goes high and resets the set-reset flip-flop of the PLL IC. A high level on the flip-flop output drives triac T2 to switch on the electrical appliance connected to it. A low level at the flip-flop output switches off the appliance.

The variation in the ambient temperature causes equal percentage variation in the values of C_{On} and C_{Off} and hence in values of T_{On} and T_{Off}. The values of duty cycle and V_{dc} are not affected, so the touch sensitivity is not altered. Also, as $V_{Ref\text{-}hi}$, $V_{Ref\text{-}lo}$, and V_{dc} are all ratiometric to the supply voltage V_{dd}, the touch switch action is immune to the supply-voltage variations.

For better touch sensitivity, the area of the sensing pads should not be more than the area of contact of the finger with the sensor, as the finger capacitance (C_f) should be comparable to the untouched sensor capacitance (C_{un}). In addition, a thinner overlaying cover material produces a greater difference between the touched and untouched sensor pads.

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IR Introduces IR3891 and IR3892 Dual Output SupIRBuck® Voltage Regulators for Space-Constrained Netcom, Server and Storage Applications

IR introduces the IR3891 and IR3892 SupIRBuck® integrated dual output voltage regulators designed for space-constrained netcom, server and storage applications.

The new dual output devices are optimized for single rail operation from 5V to 12V inputs or 1V to 21V input with external 5V bias. Available in a compact 5x6mm PQFN package, the IR3891 and IR3892 offer an ultra-compact solution for applications requiring up to 4A per channel and up to 6A.

The IR3891 and IR3892 feature a proprietary modulator scheme that enables jitter-free and noise-free operation to allow higher frequency/higher bandwidth operation for better transient response and fewer output capacitors to reduce overall system size. Other key features include interleaved phases to reduce input capacitance, powertrain isolation to eliminate crosstalk and sequencing capability on channel two.

The IR3891 and IR3892 offer SupIRBuck standard features that include switching frequency up to 1.5MHz and 1.0Mhz respectively, pre-biased start-up, input voltage aware enable, over voltage protection, power good, optional true output voltage sensing for open line feedback and adjustable OVP, internal soft-start and minimum input voltage of 1.0V (with ext. bias) and operating junction temperatures of -40oC to 125oC. This new device and the entire SupIRBuck family are industrial qualified ensuring robust designs for durable systems.

More information is available on the **International Rectifier** website at
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Security Emerges
At The International CES

Get ready for the annual International CES in Las Vegas. The glitz and glitter will surround the latest 4K Ultra HDTVs, smart phones, tablets, cars, and intelligent household appliances. Connectivity is the name of the game with all of these products.

Thanks to the Internet of Things (IoT), connectivity will enable devices to access other devices. Smart TVs can stream content from the Internet and, if they have a built-in camera like Samsung's UN55F9000 4K Ultra HDTV, host video conferences *(Fig. 1)*. Of course, connectivity also enables companies to sell more services. Companies can watch how consumers use these electronics too, whether the consumers know it or not.

1. Samsung's 120-Hz, 55-in., UN55F9000 4K Ultra HDTV has a built-in camera. It supports gesture controls and streaming media.

Unfortunately, this type of connectivity exposes devices to third parties. Security is now on the minds of most developers. Many standards such as ZigBee incorporate encryption and authentication. These devices will be more difficult to compromise, but not impossible. If the device can load an app or receive a remote update, then it is susceptible to attack.

SECURING MOBILE DEVICES

A secured device is a good thing, and it security is easier if the functionality is locked down. Unfortunately for developers, many devices like smart phones, tablets, and HDTVs are user-programmable, as apps can be installed at the user's discretion. I have almost a hundred apps on my smart phone and use at least a quarter of them on a regular basis.

Apps can be isolated by sandboxing them, but most implementations can be bypassed, often through bugs exploited by nefarious software. That's one reason why enterprise devices like smart phones are often locked down so no new apps can be loaded. It isn't just an issue of whether the device could be compromised. Rather, it may provide a vector of attack on the enterprise network through the linkage that the smart phone may have to that network, possibly through a virtual private network (VPN).

2. Green Hills Software and ViaSat are delivering military-grade security for Android smart phones and tablets. A little red lock indicates the locked apps in the secured version of Android. Tapping them runs them in the unsecured version of Android.

Operating systems like Android and iOS have security built into them, but not isolation on the order of what a hypervisor will provide. It is easier to verify that a separation-kernel hypervisor with hardware support can isolate two operating systems from each versus isolating apps running on the same operating system.

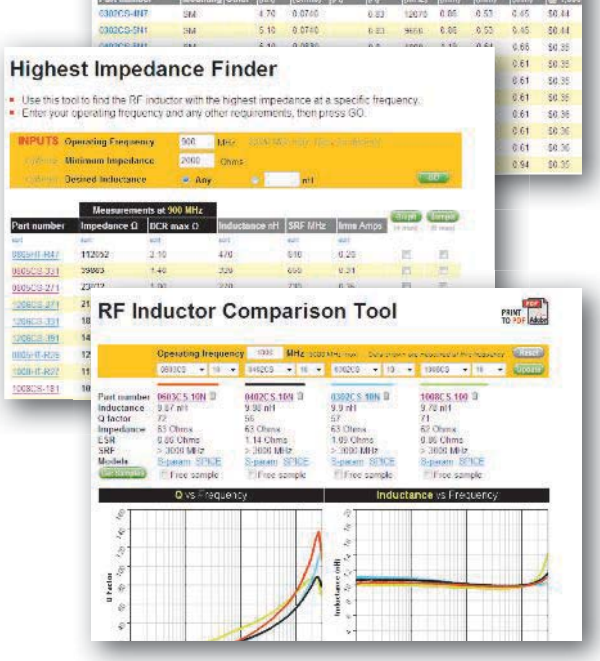
A SMART SOLUTION

Green Hills Software and ViaSat partnered to deliver military-grade security for Android smart phones and tablets *(Fig. 2)*. ViaSat Secured is built on the Green Hills Integrity Multivisor separation-kernel hypervisor. It targets dual-use smart phones and tablets in the enterprise. It would turn my wife's two smart phones into one device.

The enterprise manager has control of the hypervisor and one of the partitions that runs the enterprise version of Android populated with approved applications. The other partition runs Android as well. Switching is just a button-click away with the status LED color indicating which partition is active.

Green Hills also added a feature whereby an icon for an app that runs on the user's Android partition can appear on the secured side. This status is noted via a red lock on part of the icon. Tapping the icon runs the application as expected, but it switches to the user's partition to do so. There is not a matching mechanism for switching to apps on the secured side.

I would like a version of this where I could provide an enterprise partition that could be managed remotely. Bring-your-own-device (BYOD) will work likely work this way in the future. I will not have to worry if the enterprise wants to reconfigure or trash its partition since it will not affect mine. ED



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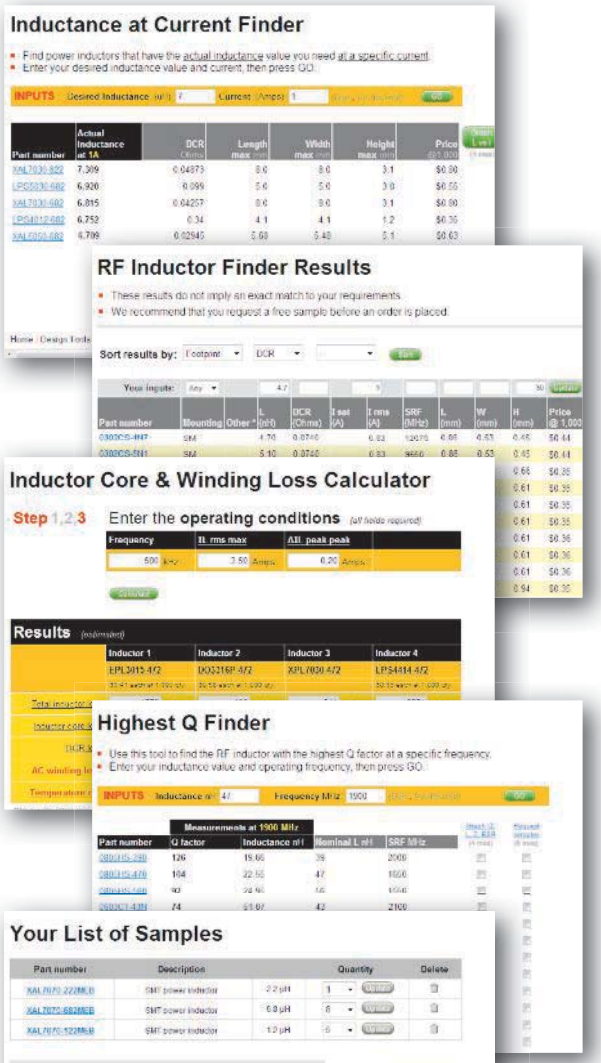

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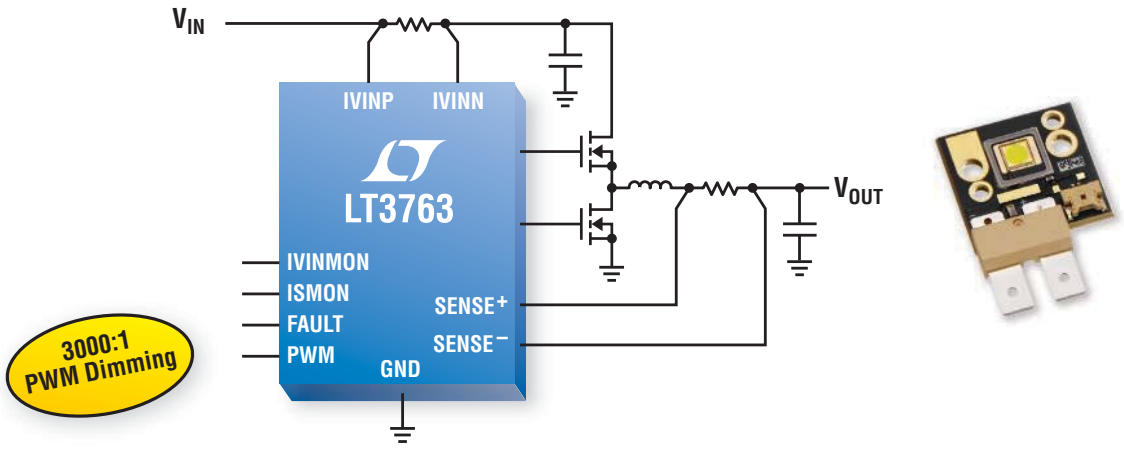

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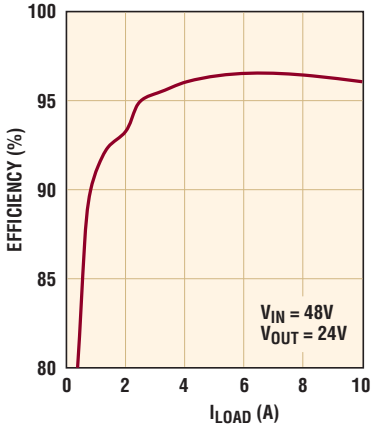

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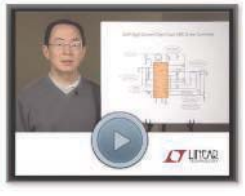

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