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WIRELESS-SENSOR NETWORKS' OPERATING POWER ARRIVES VIA THIN AIR

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A closer look at LSI's MegaRAID SAS 9260CV-4i controller
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The analog view: examining TI's audio capacitive-touch booster-pack demo board
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Which single distributor comes to mind as being 'best of class' for broadest overall product selection?
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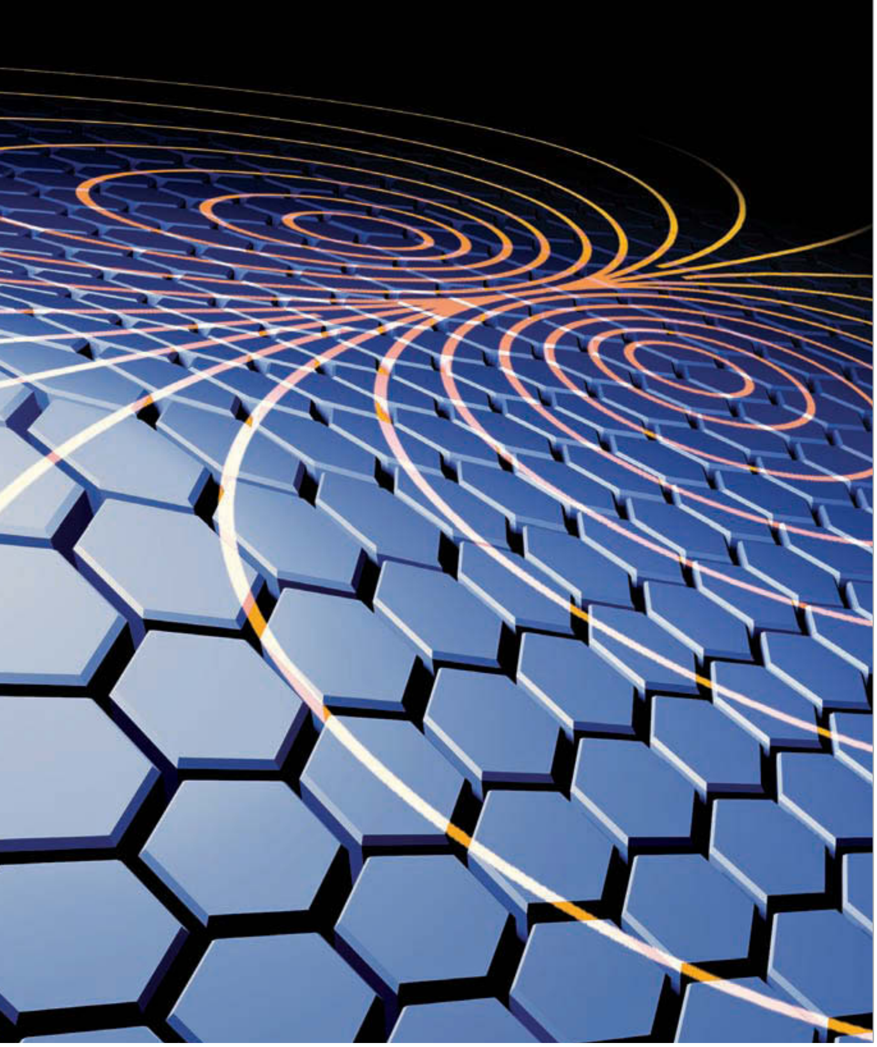

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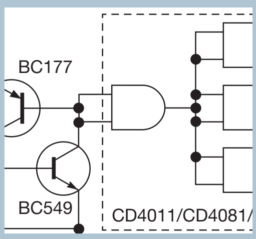

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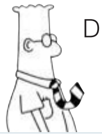

DEPARTMENTS & COLUMNS

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EDN online

JOIN THE CONVERSATION

Comments, thoughts, and opinions shared by *EDN*'s community

In response to "USB 3.0 bringing SuperSpeed connectivity to mobile devices," a technical article by Vikas Dhurka and Steven Chen of Cypress Semiconductor, http://bit.ly/JZqmc9, William K comments:

"I see USB3 as a marketing gimmick that will not deliver as promised because the hardware will never be adequate for that data rate. It is just one more effort to make current systems obsolete in order to sell new systems. We simply don't need it."

In response to Rick DeMeis's May 10 cover story, "Teardown reveals Chevy Volt's electronic secrets," http://bit.ly/JFt9KQ, Adam Perry comments:

"How would such a vehicle detect whether it was inside or outside? What about variables like parking garages and carports wherein it would be perfectly acceptable to have a gasoline engine running? And why would it matter?

Based on the description in the article, wherein they 'left some systems on,' it sounds to me like they left the car both on and doing something (heating or cooling, or perhaps just powering some lighting).

I'll bet dollars to donuts that the car's manual (which is not necessarily optional reading material on such a machine) has numerous stern warnings about not leaving the car on inside of an enclosed space due to the possibility of the engine starting.

Meanwhile, it's plainly preferable to have this functionality as it is so that it's possible to (say) wait to pick someone up in a parking garage—and—have heat at the same time, regardless of the battery's state of charge."

EDN *invites all of its readers to constructively and creatively comment on our content. You'll find the opportunity to do so at the bottom of each article and blog post.*

CONTENT

Can't-miss content on EDN.com

GaN-ON-GaN BREAKTHROUGH LED BOOSTS MR16 PERFORMANCE

A young start-up has developed the technology to grow GaN crystals on its native GaN substrate so that the crystals grow with fewer imperfections and can accommodate higher power densities. The company claims the LED emits five to 10 times more light from the same crystal area.

http://bit.ly/LPMlwd

OSCIUM'S LOGISCOPE: NOT QUITE THE SECOND COMING OF *STAR WARS*, BUT STILL A NEW TESTING HOPE

Oscium not-so-humbly claims that its product line represents "the future of test equipment." Although he has some doubts on pricing, see why one engineer can't argue with its prognostication.

http://bit.ly/KnmYvK

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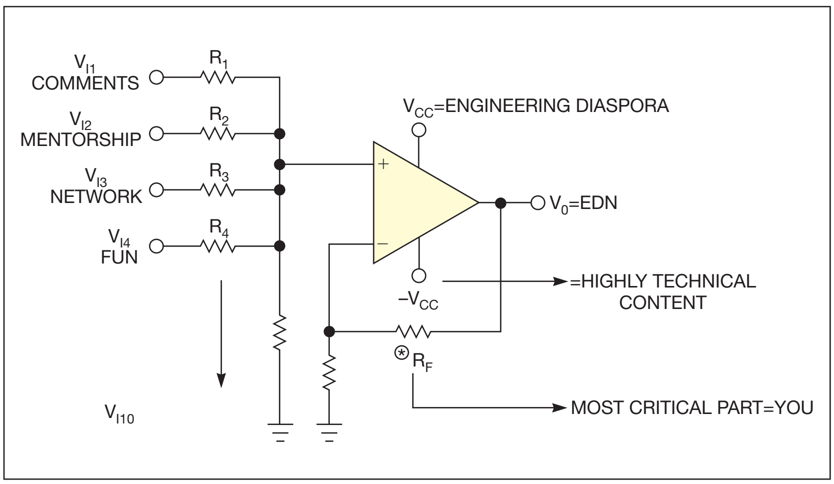
BY PATRICK MANNION, BRAND DIRECTOR

Welcome to the new EDN.com

Welcome to the new EDN.com: the Electronics Design Network for electronics engineers, innovators, and creators who want to get from concept to reality as quickly as possible, and just maybe take time out to have a little fun in the process. For many of you, the name Electronics Design Network may raise an eyebrow, and well it should. The print publication was launched originally in 1956 as *Electrical Design News*. The name later morphed into simply *EDN*, an information resource for engineers, by engineers. The word "network," however, goes to the heart of what the redesigned site is all about: empowering designers in your effort to make a difference by connecting you with the information, peers, resources, tools, companies, services, and people you need to get your ideas realized and out the door.



This sounds like a lot, and it is. That said, over the years *EDN* has remained true to its promise to provide solid technical information and insight for the working engineer, but information can take you only so far. We've seen on our site increased interaction and discussions that were for the most part hidden from view. With the new site, we've taken your voices, insights, and opinions and put them front and center. But that's just the beginning.

EDN has made the shift from a site with information you *consume* to a community platform for information, resources, and connections you can *use*. From the ground up, the site has been designed to make it just that: more useful for you. Improvements include a cleaner and more navigable look and feel, as well as added features that are a nod to the most practical and interesting aspects of social media, but in a safe environment tailored for engineers' specific needs.

Other enhancements include Profile pages: Use yours to let the world know who you are, your technical expertise, and how you like to pass your time. You can also start here to upload your own content to *EDN*, see who you're following, keep track of your *EDN* library, and view your comments and articles. And that's just for now. Look soon for points you've accrued as you've used the site. You can use these points to show your domain expertise, or you might want to cash them in for attendance at technical conferences such as DesignCon, Design West, and Design East, or spend them at the *EDN* Store.

The Electronics Design Network [is] for electronics engineers, innovators, and creators.

We've also added a tools section, more design centers, simpler comment functionality, and the ability to follow your favorite threads. Forums are now central to our offering, and we've opened the floodgates to your own open-mic blogs. Let us know if you want to get something off your chest; we now have the platform that will allow you to do so.

I could spend pages talking about what we've done to the site, but instead, I drew up a quick sketch that may save a lot of time (see **figure**).

In the end it boils down to being all about you. We hope you like the new EDN.com and can find ways to make it work for you. If there are things you'd like to see added, let us know. If there are elements you'd like to see tweaked or removed, let us know that, too. The site is a living entity that depends upon you to make it live. Six months from now, it could look different and have different elements. And that's good, because what changes will be based on your feedback. So let 'er rip! **EDN**

Contact me at patrick.mannion@ubm.com, or comment directly on the new EDN.com at http://bit.ly/KdZXHA.

EDITED BY FRAN GRANVILLE

pulse

INNOVATIONS & INNOVATORS

3-D heterogeneous FPGA targets line-card applications

Xilinx Inc has begun initial shipments of the Virtex-7 H580T FPGA, a single-chip solution for addressing key Nx100G and 400G line-card applications and functions. The 3-D heterogeneous FPGA uses the company's stacked silicon interconnect technology and is built on TSMC's 28-nm process. The all-programmable Virtex-7 H580T FPGA features up to 16 28-Gbps and 72 13.1-Gbps transceivers. Xilinx claims other monolithic FPGAs are able to integrate only a quarter of the number of 28-Gbps channels.

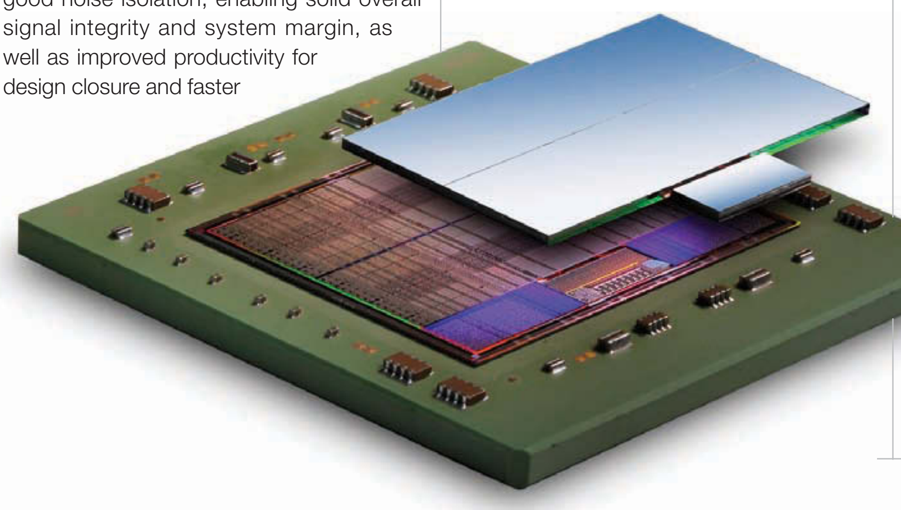
The heterogeneous implementation of Virtex-7 HT devices also enables Xilinx to make independent technology choices for the core FPGA and 28-Gbps transceiver die, which avoids burdening the FPGA with high-leakage transistors that waste system power and bring no benefit to computation tasks. Having 28-Gbps transceivers on silicon separate from the core FPGA fabric further allows for good noise isolation, enabling solid overall signal integrity and system margin, as well as improved productivity for design closure and faster time to market, according to the company.

Effectively upgrading networks to handle exponential growth in data usage requires power and port-density improvements in optical modules while reducing cost per bit. Driven by the migration to CFP2 and, in the future, CFP4 optical modules, Virtex-7 HT devices are designed to enable that integration capability for communication equipment vendors designing Nx100G and 400G line cards.

"Competing ASSP-based solutions will comprise five devices, will remain unavailable for more than a year, will consume at least 40% additional power, and will cost 50% more," says Mark Gustlin, system architect for wired communications at Xilinx.

The upcoming Virtex-7 H870T device is also 400GE ready and will be able to support future 400GE modules that require 16x25-Gbps interfaces. **—by Nicolas Mokhoff**

▷**Xilinx Inc**, www.xilinx.com.



The Virtex-7 H580T uses the company's stacked silicon interconnect technology in the 3-D heterogeneous FPGA, which is built on TSMC's 28-nm process.

TALKBACK

"I have been working in the LCD field for 23 years. The lack of standards on connectors and pin definitions has been a sore point with me also. We could never use the same circuit twice because the customer needed a slightly different display."

—Commenter GregD52, in response to an entry in *EDN*'s PowerSource blog, at http://bit.ly/K9Wwq3. Add your comments.

RAQ's

Rarely Asked Questions

Strange stories from the call logs of Analog Devices

Transformers: They're Not All Boat Anchors

Q. What is the most undervalued analog component?

A. Probably the transformer. From college, many engineers remember transformers as the large components in power supplies which contain a lot of iron and copper and which are heavy enough to do serious damage if dropped on one's foot.

This is certainly true of the large low-frequency (50- or 60-Hz) power transformers which are sometimes disparagingly called "boat anchors" (the transformers in power stations would do catastrophic damage if dropped on a battleship), but today a wide variety of inexpensive transformers may be as small as an aspirin tablet.

Even though their input supply may be the 50-/60-Hz mains, switching power supplies work at much higher frequencies. They can use much smaller, lighter, and cheaper transformers than traditional supplies of the same power rating, so even the transformers in power supplies are lighter today. Analog Devices manufactures controllers for such switching supplies, but they are not the subject of this RAQ.

For innumerable ac analog applications, a transformer is the most appropriate component. This was widely known sixty to eighty years ago when amplifiers often used transformers for interstage coupling, and as phase splitters between single-ended and push-pull circuits. About forty or fifty years ago, however, transistors—and shortly afterwards integrated circuits—started to use dc interstage coupling, so the use of signal transformers was largely forgotten.

In many applications these dc-coupled techniques are indeed the optimum solution, but where ac signals must cross an isolation barrier (where there may be a large potential difference between the signal circuitry in different parts of the system, for example) or where there is severe ground noise, the use of a transformer may simultaneously simplify the design and improve performance. It is normal for transformers to have absolute maximum interwinding voltage values of hundreds or even thousands of volts. In addition, the primary-secondary capacitance is rarely more than a few pF and may be even less for a screened transformer.

Where an ac signal must be sent an appreciable distance in the presence of ground noise, a transformer may well have considerably better ac common-mode rejection (CMR) than a differential amplifier; and where a differential ac amplifier is being fed with a single-ended signal, a transformer will probably be the best possible phase splitter.

And then there are current transformers for ac current measurements....

[1] For example see http://www.meppi.com/Products/Transformers/Pages/GSU.aspx

Contributing Writer James Bryant has been a European Applications Manager with Analog Devices since 1982. He holds a degree in Physics and Philosophy from the University of Leeds. He is also C.Eng., Eur. Eng., MIEE, and an FBIS. In addition to his passion for engineering, James is a radio ham and holds the call sign G4CLF.

Have a question involving a perplexing or unusual analog problem? Submit your question to: www.analog.com/askjames

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Wireless rechargers cut the cord to devices

Wireless rechargers cut the last cord to tablets merely by lying them on a specially wired surface.

Wireless inductive battery rechargers have cut the cable to many devices, such as electric toothbrushes, but until recently they still required a proprietary recharge station because there were no standards in place. However, now that the Wireless Power Consortium has more than 100 members for its Qi standard, analysts predict that the time is ripe for a global wireless-charging market, which is expected to exceed 100 million units annually by 2015, according to IMS Research.

Japan's Docomo has been test-marketing Qi-compatible recharge stations in public places to support its deployment of power-hungry LTE smartphones, and even automobile makers are getting onboard, with Dodge promising a Qi-compatible smartphone recharger built into its console. These and other commercial Qi-compatible rollouts are promised over the next three years.

For OEMs that want to quickly enter the Qi-compatible wireless-recharging-station market, Freescale Semiconductor has crafted three reference designs enabling users to wirelessly recharge any tablet, smartphone, or other mobile device. The company offers reference designs for smartphones that can supply as much as 5W; for tablets that supply as much as 30W; and for power tools, kitchen appliances, medical devices, and laptop computers that can supply more than 100W in wireless-recharge power, according to Ron Lowman, industrial- and multimarket-marketing manager at Freescale.

Freescale recently began a partnership with Fulton Innovation, which has more than 186 granted patents and 496 pending in the wireless-recharge area. By including the latest innovations in Freescale's reference designs, OEMs can achieve efficiencies of more than 80%, support multiple coils so that devices do not need perfect placement, and take advantage of safety features that keep foreign objects from heating up.

—by R Colin Johnson

▷**Freescale Semiconductor**, www.freescale.com.

72W LED driver targets use in outdoor lighting

The 72W, constant-voltage PDA072B-24VG LED driver from Phihong powers area, wash, and architectural lighting in harsh environments. The device has a Class 2 output of 24V dc at 3A and complies with Energy Star specifications for solid-state-lighting luminaires. With separate driver ICs to power several luminaires from one source, the PDA072B works in both damp and dry environments. The fully potted, water-resistant device has an ingress-protection rating of 65 and operates in temperatures of –40 to +60°C. It also features power-factor corrections greater than 0.9 and bears safety-approval markings from UL and CE.

The power supply's minimum average efficiency is 84% for 120V-ac input and 88% for 277V-ac input. The device has a measured lifespan of 50,000 hours at maximum load and offers overvoltage, overcurrent, short-circuit, and open-circuit protection.

The PDA072B-24VG carries a standard five-year warranty, measures 241×43×30.5 mm, and weighs 750g. Prices for the unit start at $87.84 (one).

—by Fran Granville

▷**Phihong**, www.phihong.com.

The 72W, constant-voltage PDA072B-24VG LED driver from Phihong powers area, wash, and architectural lighting in harsh environments. The device has a Class 2 output of 24V dc at 3A and complies with Energy Star specifications for solid-state-lighting luminaires.

DILBERT By Scott Adams

MEMS-based tennis racquet enhances playing experience

Movea SA, a manufacturer of motion-sensing and gesture-recognition technology, has teamed with tennis-equipment manufacturer Babolat to develop a motion-sensing-enabled racquet to analyze game play and improve performances. The companies demonstrated the first Babolat Play & Connect racquet prototype at the 2012 French Open tennis tournament in Paris.

The MEMS-enabled Play & Connect racquet aims to inform players about their skills, improve their game, and share the information on social networks.

Motion-sensing technologies are enabling a new generation of sports equipment and sportswear that can monitor, analyze, and improve the performance of sports enthusiasts and athletes. The microelectromechanical-system-technology-enabled racquet can gather and analyze game data and provide information that previously required manual measurement. It uses Movea's SmartMotion data-fusion technology to measure specific elements of a player's technique.

According to the companies, the Play & Connect racquet has three key objectives: to inform, to improve, and to share. It aims to inform by enabling measurement and analysis of game play for elements, such as stroke qualification, ball spin, power during play, and service speed. It enables improvement by allowing players and instructors to set goals and follow progress on a daily, weekly, or monthly basis. It enables sharing by letting players post their game-play data on their social networks to encourage themselves; challenge their friends; and seek tips and advice from friends, instructors, and amateur and professional players.

—by Anne-Françoise Pele

▷**Movea SA**, www.movea.com.
▷**Babolat**, www.babolat.com.

Monolithic component integrates isolation plus ADC for ac-line-voltage monitoring

Monitoring ac lines is an important requirement for systems such as smart residential and commercial power, solar-power inverters, and uninterruptible power supplies. This monitoring involves challenges, however. The line voltages are higher than electronic circuits should directly handle, a problem you can easily solve using a resistor network. Such monitoring also involves serious system- and user-safety issues, requiring advanced techniques to achieve the mandatory galvanic isolation. To solve the isolation issue and address the data-acquisition function, the Si890x trio from Silicon Laboratories Inc incorporates capacitive-based digital isolation along with a 10-bit ADC. The small, low-profile devices come in a standard IC package.

The ICs, with 2.5- and 5-kV isolation rating, meet applicable safety standards, including IEC 60950-1, 61010-1, and 60601-1, and have UL, CSA, and VDE certifications. Targeting 120 and 220V-ac mains, the devices have a 1200V working voltage, providing an isolation barrier that allows more than 60 years of operation, using standard test and data-extrapolation techniques.

The Si890x devices provide a three-channel analog multiplexer feeding an isolated ADC, thus allowing the device to monitor as many as three differential channels—typically, current and voltage, plus a spare channel. The ADC reference can be either the IC's supply rail or a separate user-supplied reference. The ADC offers a maximum of ±1-LSB integral and differential nonlinearity and a maximum of ±2-LSB offset and full-scale errors, along with a PGA (programmable-gain amplifier) with a gain of 0.5 or one. You can set the ADC to convert on demand or in burst mode. The devices also provide transient immunity of more than 35 kV/μsec and electric- and magnetic-field immunity of more than 300V/m and more than 1000A/m, respectively. The ICs operate from an input-side supply of 2.7 to 3.6V and an output-side supply of 2.7 to 5.5V; the isolated devices require separate supplies for each side.

The three members of the family differ in only their bus-interface digital I/O. Users can choose among the Si8900, with a 234k-sample/sec UART interface with automatic baud-rate selection algorithm; the Si8901, with a 240k-sample/sec I²C interface; and the Si8902, with a 2.5M-sample/sec SPI. The pinout for all three versions is identical except for the bus-interface pin assignments, so changing from one interface and IC to another requires minimal PCB rerouting.

The Si890x evaluation kit is a complete PCB with all three versions, along with a microcontroller, I/O connections, and a protective enclosure. The versions are available in a 16-pin wide-body SOIC package and sell for $1.65 (10,000).—by Bill Schweber

▶**Silicon Laboratories**, www.silabs.com/pr/isolation.

LED drivers go modular to eliminate external components

Texas Instruments' most recent introduction in the LED power-management space comprises two fully integrated LED-driver micromodules. TI claims the 450-mA TPS92550 and TPS92551 dc/dc buck modules are the industry's first to incorporate all of the required power and passive circuitry into a single IC-like package to deliver up to 23W of power to the LED array. These modules eliminate most external components as well as the complex layout decisions common in LED-driver designs by integrating the power management and control circuitry, the power inductor, and a handful of other passive components into a single 7-pin 10.16×9.85×4.57-mm package.

The TPS92550 is a high-power floating-buck LED driver with an input-voltage range of 4.5 to 36V. It requires no external current-sensing elements or loop-compensation network. The integrated power switch enables high output power up to 14W with 450-mA LED current. The TPS92551 can power up to 23W with an input-voltage range of 4.5 to 60V. High-speed dimming control input through the 0 to 5.5V V_{DIM} signal allows precision and high-resolution brightness control for applications that require fine brightness adjustment.


Together with TI's Webench LED Architect, LED-light designers can design a power-management circuit with a minimum number of components to drive a string of up to 18 LEDs at up to 96% power efficiency.

Together with TI's Webench LED Architect, LED-light designers can design a power-management circuit with a minimum number of components to drive a string of up to 18 LEDs at up to 96% power efficiency. The 14W TPS92550 is \$5, and the 23W TPS92551 is \$5.50 (1,000).

—by Margery Conner

▷**Texas Instruments**, www.ti.com.

Sub-\$1000 oscilloscopes offer powerful capabilities

Agilent Technologies has introduced the 1000B series of two-channel oscilloscopes, with bandwidths of 50, 70, 100, or 150 MHz. The devices feature color LCDs with as many as 16,000 points of memory per channel and a 1G-sample/sec channel rate. The devices display 23 automatic measurements, including those it makes with a built-in frequency counter, and a standard go/no-go mask-testing capability. A sequence mode allows users to record and replay as many as 1000 occurrences of a trigger. The user interface and front-panel labels are available in 11 languages, and the devices include USB connections. A free educator kit helps teachers and professors teach essential oscilloscope skills.


The 1000B series of two-channel oscilloscopes offers bandwidths of 50, 70, 100, or 150 MHz and features color LCDs with as many as 16,000 points of memory per channel.

Prices for the 50-, 70-, 100-, and 150-MHz versions are \$790, \$990, \$1190, and \$1589, respectively. **—by Janine Love**

▷**Agilent Technologies**, www.agilent.com/find/1000BSeries.

BY BONNIE BAKER

EMI problems? Part five: Check out amps with EMIRR specs

As technology progresses, electromagnetic interference becomes more of a threat to the proper performance of circuits, due to the fact that electronic applications are moving to wireless communication or portable platforms. With this concept in mind, consider that most interfering EMI signals eventually convert into the PCB trace as conducted EMI.

As you strive to design robust EMI circuits, you'll find that analog sensor circuits tend to be great EMI receptors because sensor circuits often produce low-level signals and have many high-impedance analog ports. These circuits also use denser component spacing, which provides more opportunities for systems to acquire and conduct noise into the traces. Operational amplifiers can be prime targets in this EMI scenario (**Reference 1**).

A standard op amp has low-impedance positive-power, negative-power, and output pins and two high-impedance input pins (**Figure 1a**). Although all of these pins can sustain an EMI hit, the input pins are the most vulnerable.

The characteristics of the inverting and noninverting pins of a voltage-feedback amplifier are essentially equivalent. However, you can easily test the EMI ruggedness of an amplifier at the noninverting input (**Figure 1b**), as the following **equation** shows:

$$\Delta V_{OS}=\left(\frac{V_{RFPEAK}^{2}}{100\text{ mV p-p}}\right)\times 10^{-\left(\frac{\text{EMIRR IN+ (dB)}}{20}\right)},$$

where V_{RFPEAK} is the peak amplitude of applied RF voltage, V_{OS} is the dc offset voltage of the amplifier, EMIRR is the EMI rejection ratio, and 100 mV p-p is the positive EMIRR to an input signal of 100 mV p-p.

You can compare amplifiers' EMI immunity with the EMIRR metric. **Figure 2**, available online at www.edn.com/4374916, shows the EMIRR positive input response of TI's OPA333 CMOS op amp. The **figure** indicates that the device can reject frequency signals greater than the device's bandwidth of 300 kHz.

An IC's internal EMI filter provides three distinct benefits over an external RC filter. First, it allows users to test the performance of the amplifier containing an integrated filter to ensure its EMIRR over a wide frequency range (**references 2** and **3**). Passive filter components suffer from nonidealities in parasitic capacitances and inductances, which limits the filter's ability to suppress noise at high frequencies. In contrast, IC processes closely match electrical characteristics of the on-chip passive components. Finally, the IC, with the internal filter, also offers reduced parts count, cost, and board area.

To reduce a circuit's EMI susceptibility, a board designer should pay attention to good layout practices by keeping traces short, using surface-mount components, and using a PCB with a dedicated ground plane for the signal returns. Keep the ground plane as complete as possible and keep the digital signals away from the analog-signal paths. Additionally, place RF-bypass capacitors on all of the IC's power-supply pins, position these capacitors close to the device pins, and make sure their impedances are as close to 0Ω as possible at the potential EMI frequencies. EDN

Bonnie Baker is a senior applications engineer at Texas Instruments and author of A Baker's Dozen: Real Analog Solutions for Digital Designers.

Go to www.edn.com/4374916 for links to the references used in this column.

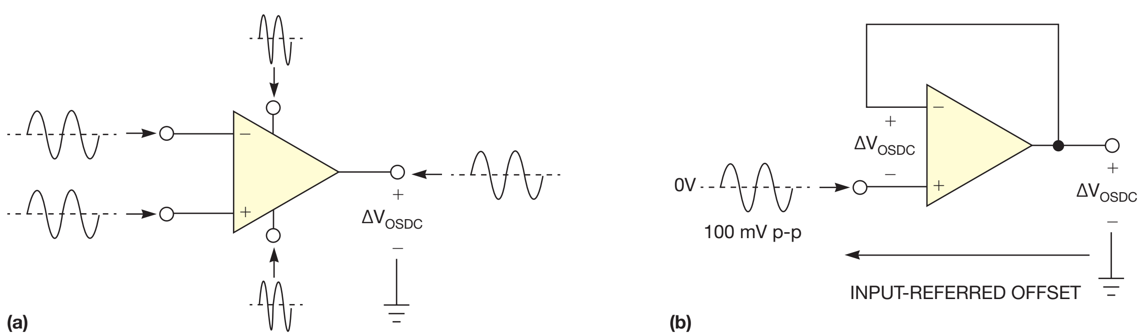

Figure 1 A standard op amp has low-impedance positive-power, negative-power, and output pins and two high-impedance input pins (a). You can easily test the EMI ruggedness of an amplifier at the noninverting input (b).


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A closer look at LSI's MegaRAID SAS 9260CV-4i controller

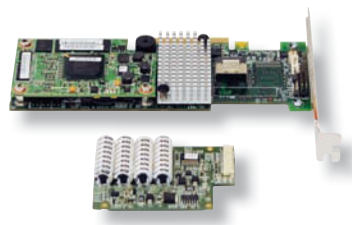
Hardware RAID (redundant array of independent disks) controllers have been around for quite some time, growing in popularity with the rise in use of ATA hard drives. A crowded market, featuring products from companies such as Intel, Adaptec, HP, and Promise, requires manufacturers of these types of cards to produce devices that will stand out against the rigorous testing and benchmarks set by users. In the relatively short history of RAID controllers, a changing of the guard took place when SAS and SATA replaced parallel SCSI and PATA as the serial interfaces of choice. LSI's MegaRAID SAS 9260CV-4i controller takes advantage of both the SAS and SATA interfaces to operate stably and offer high performance, the two biggest demands of its market.

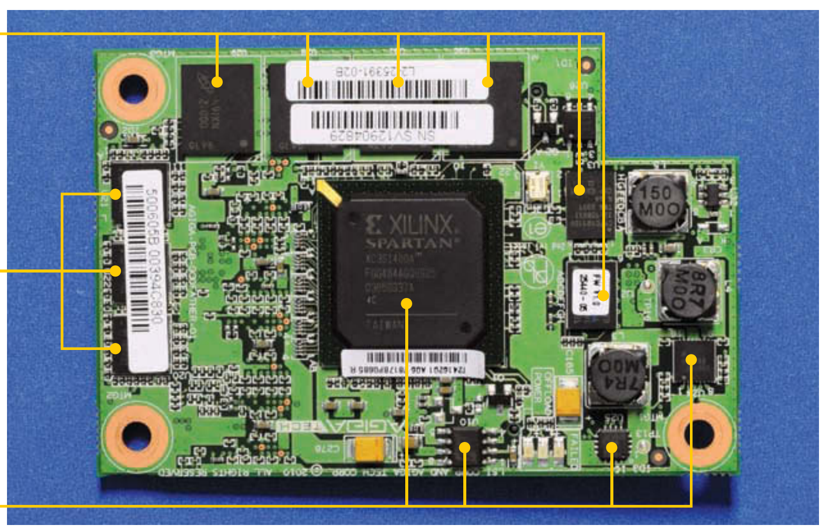
The MegaRAID controller features the proprietary 800-MHz LSISAS2108 ROC (RAID-on-Chip), 512-MByte DDR2 cache memory, and a x8 PCI Express 2.0 host bus interface. Its strongest feature, however, is CacheVault technology, which uses NAND flash memory powered by a supercapacitor to protect data stored in the MegaRAID controller cache. CacheVault technology claims to have a "greener" approach to cache protection, eliminating the need for the lithium-ion battery that traditional PCI-based RAID controllers require to protect DRAM cache memory.

In this controller, data is automatically written to the cache via the NAND flash when a power failure occurs, while the charged supercapacitor keeps current continuous during operation. Once power returns, the DRAM is recovered from the NAND flash, and the system experiences no loss of data. Based on CacheVault alone, you could see the appeal of MegaRAID controllers to IT workers everywhere.

The MegaRAID 9260CV-4i controller consists of three boards: a main board, which features the I/O of the controller; a daughterboard that houses the DDR2 SDRAM array; and the CacheVault power-module board, which is the heart of the CacheVault technology that distinguishes the MegaRAID controller from its competitors.

The primary components of the CacheVault power-module board are AGIGA Tech supercapacitors and a Cypress Semiconductor CY8C29466 programmable SOC. The Cypress SOC acts as a smart controller, while the four large capacitors are used in conjunction with this SOC to supply power in case of power failure. Cached information in the volatile SDRAM will be transferred to NAND flash before power is completely drained.





The daughterboard consists of numerous design wins from large-scale companies such as NXP, Analog Devices, Cypress, and ST Microelectronics. The notable devices on the front side of the board include Xilinx's XC3S1400A Spartan-3A FPGA and four 4-Gbit NAND flash devices provided by Micron Technology.

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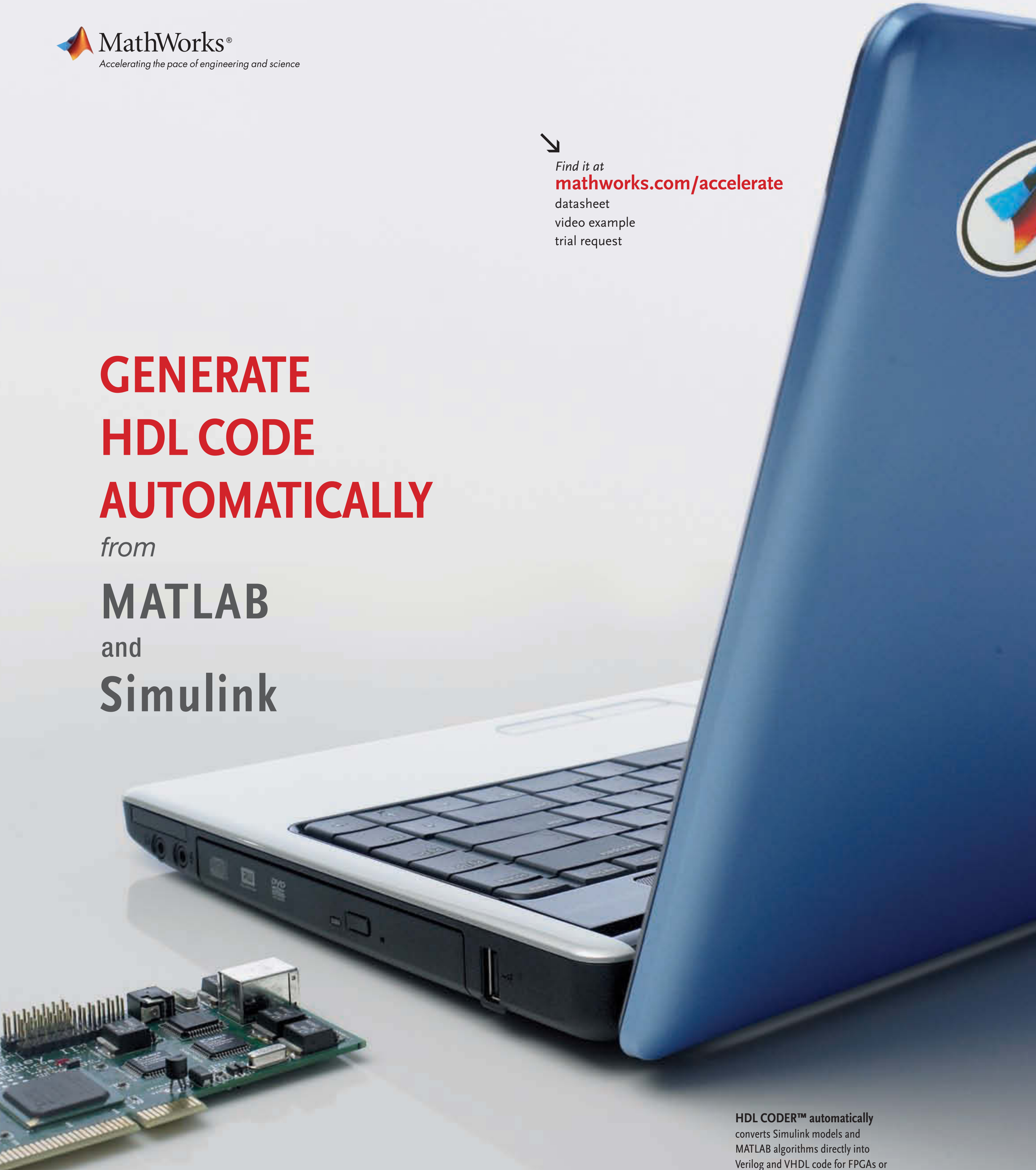

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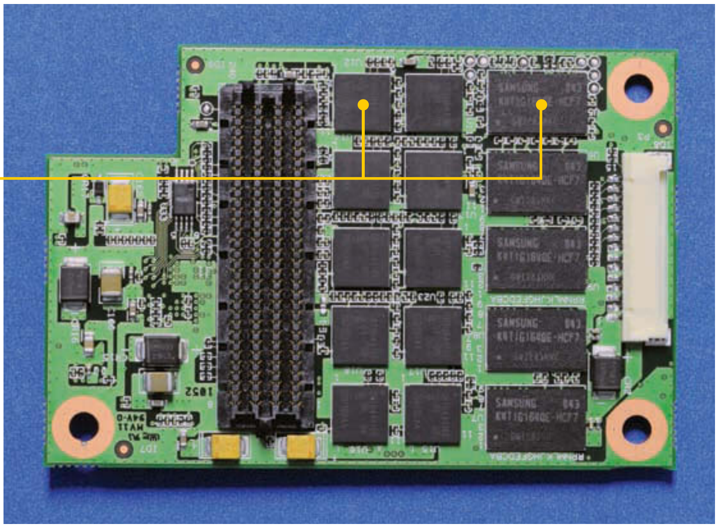
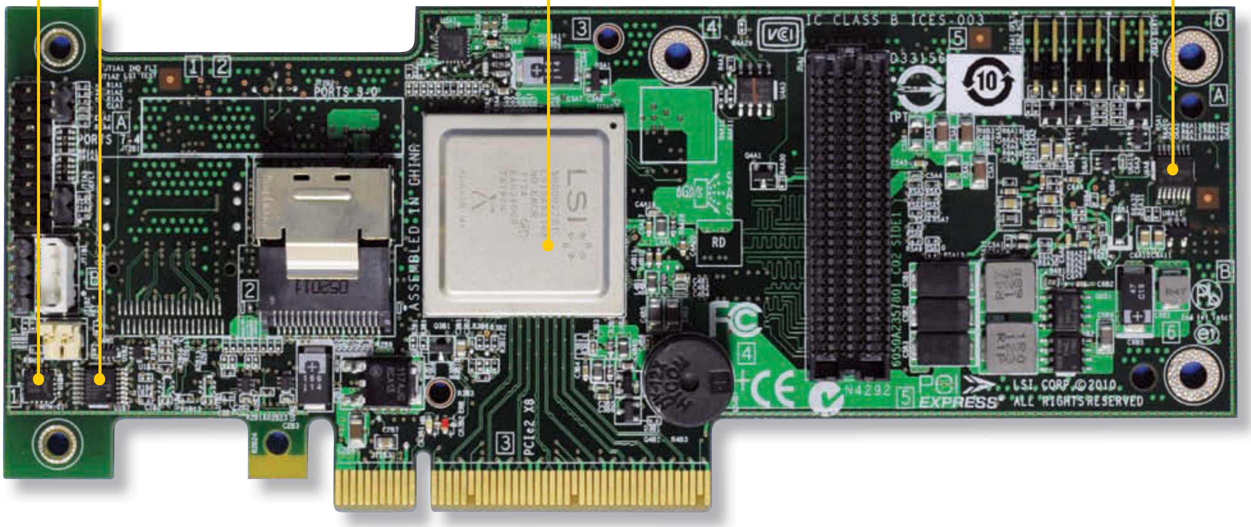
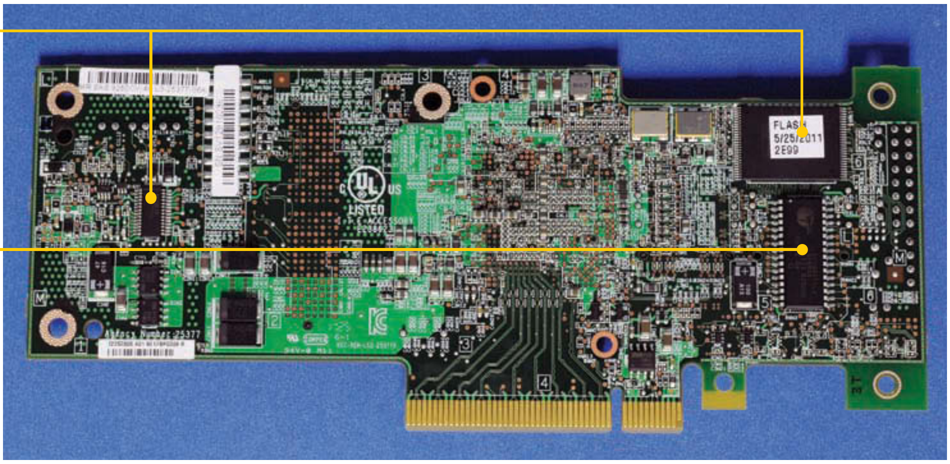
The back side of the daughterboard features five Samsung 128-MByte DDR2 SDRAM components (K4T1G164QE) and 10 NXP CBTU4411EE DDR2 SDRAM multiplexers that operate with the aforementioned Samsung SDRAM.



The third board on the RAID controller, the main board, consists of socket wins for Texas Instruments, providing the Hex-Schmitt-trigger inverter (SN74LVC14APW), and NXP, providing the I²C switch and the I²C-bus LED driver. The major IC on this board is LSI's LSISAS2108 SAS ROC, which drives the prime functionality of the RAID controller.

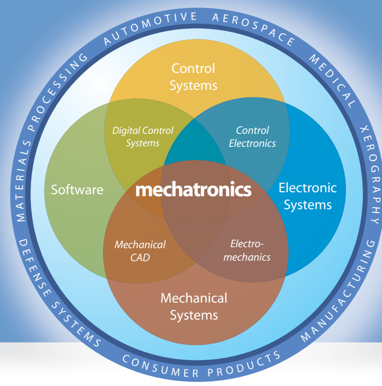


The back of the main board features NOR flash from Intel, a Maxim buck controller, and a Cypress CY14B256LA nvSRAM.



MECHATRONICS IN DESIGN

FRESH IDEAS ON INTEGRATING MECHANICAL SYSTEMS, ELECTRONICS, CONTROL SYSTEMS, AND SOFTWARE IN DESIGN



Fluid power: the hidden giant

Dynamic application of fluid power requires a systems approach.

By Kevin C Craig, PhD

Fluid-power systems: almost as fast as a speeding bullet, definitely more powerful than a locomotive, and possibly able to leap tall buildings in a single bound. They should sport a Superman logo. This pervasive, hidden technology employs a simple principle that leads people to think that implementation of fluid power is just a select-assemble-and-run task. Nothing could be further from the truth.

At the end of the 19th century, in response to the need to more effectively transmit power from one point to another, hydraulic systems replaced traditional mechanical systems. Developers during the Industrial Revolution emphasized fluid power, but most applications were steady in nature and required only static considerations for design. At the beginning of the 20th century, hydraulic-control-system development experienced a major setback, and decades of stagnation followed, with the phenomenal growth of electrical power. The stagnation ended as World War II drove the need for power transmission requiring high effort and fast response, which only hydraulic systems could provide because of their superior power density over electrical devices. Over the next 40 years, industry was the steward of technology for the fluid-power world. A resurgence of interest in fluid-power-control systems is occurring at universities, and industry/university collaboration is growing.

Unfortunately, some people consider fluid power a specialist subject. Hydraulic-control systems are essential, however, in applications requiring large forces or torques, with a fast response and high accuracy. They have a better power-to-weight ratio than electrically actuated systems, which are limited by magnetic saturation, and they excel in environmentally difficult applications. In addition, the hydraulic medium is mechanically stiffer than the electromagnetic medium. Self-lubrication and inherent heat transfer are also advantages. Fluid-power applications are numerous. They include vehicle steering, braking, and suspension systems; industrial-mechanical manipulators and robots; and actuators for aircraft and marine vessels. They are all multidisciplinary systems and require a systems approach to design and implement. The required engineering background includes fluid mechanics, electromechanics, system dynamics, computer-control systems, and electronics—in other words, a mechatronics background.

Power conversions occur throughout a basic hydraulic-control system (**Figure 1**). A variable-speed-motor-driven pump pressurizes the hydraulic fluid. A relief valve and an accumulator (not shown) regulate and stabilize the pressure of the fluid. A servovalve, driven by an electric valve actuator, provides a controlled supply of fluid into the actuator, which is either a piston-cylinder device or a hydraulic motor, controlling both flow rate and pressure. Low-pressure fluid from the servovalve is filtered and returned to the reservoir. A feedback digital-control system completes the system.

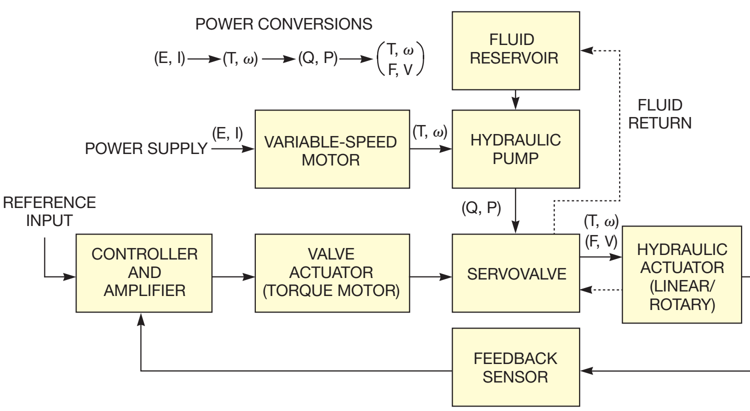


Figure 1 Power conversions occur throughout a basic hydraulic-control system.

Today, the competitive advantage of fluid power is greatest in mobile applications, such as mobile heavy equipment, human-assistance devices, mobile human-scale equipment, and hydraulic hybrid passenger vehicles. In these applications, fluid power can be a compact, efficient, and effective source of energy transmission. The opportunities are great for mechatronics engineers in this re-emerging field. EDN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A LOOK AT THE ANALOG ARCHITECTURE PROVIDES INSIGHT INTO THE DESIGN CHOICES TEXAS INSTRUMENTS MADE FOR ITS AUDIO CAPACITIVE-TOUCH BOOSTER-PACK DEMO BOARD.

BY STEVE TARANOVICH • SENIOR TECHNICAL EDITOR

Suppliers put a great deal of effort into making their demo boards show off the best performance possible for their products. They thoroughly test layouts, and designers implement many iterations to squeeze out the last microvolt of noise, the extra fraction of a decibel of dynamic range, or some other important performance parameter of the ICs or functions the manufacturer wants to highlight. Texas Instruments' audio capacitive-touch booster-pack demo board employs a DSP and a microcontroller (**Reference 1**). The microcontroller provides analog assistance to simplify and enhance design, and the DSP provides higher-level assistance to what essentially becomes an MP3 player.

Designers need first to understand the capacitive-touch mechanism (**Figure 1**). A finger disrupts the electric field, which sees the finger as a conductive foreign object, thus changing the capacitance. A ground plane beneath the touchpad helps shield the structure from other electronics in the design, such as microcontrollers, DSPs, and clocks. The MSP430 microcontroller constantly monitors and tracks slowly changing environmental effects, such as temperature and humidity, which can affect operation.

Advertorial

Benefits of the R&S®RTO Oscilloscope's Digital Trigger

Application Note

The trigger is a key element of an oscilloscope. It captures specific signal events for detailed analysis and provides a stable view on repeating waveforms.

Since its invention in the 1940s the oscilloscope trigger has experienced continuous enhancements. The fully digital trigger of the R&S®RTO digital oscilloscopes sets an innovation milestone that brings significant advantages for the oscilloscope user in terms of measurement accuracy, acquisition density and functionality.

This application note introduces the working principles of a conventional trigger system and explains the advantages of the realtime-capable digital trigger of the RTO oscilloscopes.

1 Principle of a Conventional Trigger System

1.1 Relevance of a Trigger for an Oscilloscope

The trigger of an oscilloscope has basically two main applications:

1. Ensuring a stable display
The invention of the trigger was a breakthrough for oscilloscopes as a debug tool for electrical and electronic design [1]. Triggering ensures a stable display of waveforms for continuous monitoring of repetitive signals.

2. Display of specific signal characteristics
The trigger can react to dedicated events. This is useful for isolating and displaying specific signal characteristics such as logic levels that are not reached ("Runt"), signal disturbances caused by crosstalk (e.g. "Glitch"), slow edges ("Rise time") or invalid timing between channels ("Data2Clk").

The number of trigger events and the flexibility of the trigger setup have been continuously enhanced over the years.

The accuracy of a trigger system as well as its flexibility determines how well the measurement signal can be displayed and analyzed.

1.2 Implementation of a Conventional Trigger System

Today most oscilloscopes are digital, meaning that the measurement signal is sampled and stored as a continuous series of digital values. However, the trigger, which is responsible for the detection of a signal event, is still an analog circuit that processes the original measurement signal. Figure 1 provides a simplified block diagram of a digital oscilloscope.

The input amplifier is used to condition the signal under test to match its amplitude to the operation range of the A/D converter and the display of the oscilloscope, respectively. The conditioned signal from the amplifier output is distributed in parallel to the A/D converter and the trigger system. In one path, the A/D converter samples the measurement signal and the digitized sample values are written to the acquisition memory. In the other path, the trigger system compares the signal to valid trigger events (e.g. crossing of a trigger threshold with the "Edge" trigger).

When a valid trigger condition occurs, the recording of the A/D converter samples will be finalized, and the acquired waveform further processed and displayed. Figure 2 shows an example of an acquired and displayed waveform. The digitized sample points from the A/D conversion are marked on the signal with circles. For this example the trigger event "Edge" with positive slope is applied. The crossing of the trigger level by the measurement signal results in a valid trigger event.

1.3 Impairment of an Analog Trigger

For an accurate display of the signal on the oscilloscope grid, the timing of the trigger point needs to be determined precisely. If the trigger time evaluation is inaccurate the displayed waveform does not intersect the trigger point (cross point of trigger level and trigger position) in the diagram. An example is given in Figure 3.

An inaccurate trigger position can be caused by the following:

1. Inaccurate measurement of trigger edge

In the trigger system the measurement signal is compared to a trigger threshold via a comparator. The timing of the edge at the output of the comparator needs to be measured very precisely. For this purpose a time-to-digital converter (TDC) is applied. Inaccuracy of the TDC results in an offset of an individual displayed waveform to the trigger point. The random component of TDC error causes this offset to change on each trigger event, which results in trigger jitter.

2. Systematic error sources in the two paths for the measurement signal

The measurement signal is processed via two different paths – the acquisition path with the A/D converter, and the trigger path (Figure 1). Both paths contain different linear and non-linear distortions that cause a systematic mismatch between the displayed signal and the determined trigger point. In the worst case, the trigger might not react to valid trigger events though they are visible on the display, or the trigger reacts to trigger events that cannot really be captured and displayed by the acquisition path.

3. Noise sources in the two paths for the measurement signal

The two paths to the A/D converter and to the analog trigger system include amplifiers with different noise sources. This results in delays and amplitude variances that appear as trigger position offsets (trigger jitter) on the oscilloscope screen. The trigger jitter is displayed on the right-hand side of Figure 4 as the width and height of the superimposed signal traces. On the left-hand side of Figure 4 the trigger jitter appears as a random vertical and horizontal offset with respect to the ideal trigger point. In the following chapter, the implementation of a digitally implemented trigger system is introduced.

To measure the sensor's capacitance, the MSP430 counts the number of relaxation-oscillator cycles within a fixed gate period (**Figure 2**), comparing the fixed-timing domain of the reference and the variable-timing domain of the finger's capacitance. You can implement the relaxation oscillator with a comparator or, in the case of the MSP430, using a pin-oscillator feature, in which the frequency of the oscillation is a function of the resistance and the capacitance of the circuit. The capacitance is the intended variable and increases with a touch. In the time domain, the rise and fall times increase. Conversely, in the frequency domain, the frequency decreases. With an increase in capacitance, the number of relaxation-oscillator cycles decreases within the fixed gate time.

AT A GLANCE

- TI's audio capacitive-touch booster-pack demo board employs a DSP and a microcontroller.
- The high integration in the microcontroller allows the luxury of a relatively straightforward capacitive sensor input.
- The microcontroller provides analog assistance to simplify and enhance the design; the DSP provides the higher-level assistance to what essentially becomes an MP3 player.

The relaxation oscillator feeds into a Schmitt-trigger circuit that generates a square packet and then counts the pulses. Texas Instruments offers a free capacitive-touch library, which enables buttons, sliders, wheels, and proximity sensors on all MSP430 microcontrollers, eliminating the need for developers to create complex touch-sensing algorithms (**Reference 2**).

Figure 3 shows a bus-connection diagram of all elements in the audio capacitive-touch booster pack.

Both USB ports provide 5V, but the booster pack requires 3.6V to source the 1.3, 1.8, and 3.3V power rails; the 13V for OLED backlight; and the 3.6V for the MSP430. The ACTBP USB connector feeds a 5 to 3.6V dc/dc converter to provide 3.6V from the 5V USB port. The device uses the TPS62260 synchronous-step-down converter, which touts efficiency greater than 90% with a 15-μA quiescent current. It provides as much as 600-mA output current from one lithium-ion cell. The device's high switching frequency allows the use of small inductors and capacitors to achieve a small product that comes in a TSOT-23-5 or a 2×2-mm TXFN package (**Figure 4a**).

The MSP430 launchpad connector provides power to the launchpad and the booster pack. The launchpad provides 3.6V for the main power-supply voltage from the 5V USB port. The 1A, 3.3V TPS79633 low-dropout, low-power, fixed linear regulator has a power-supply rejection ratio of 49 dB at 100 kHz and noise of 40 μV rms. It comes in an SOT-223-6 package. The TPS79633 powers most analog ICs,

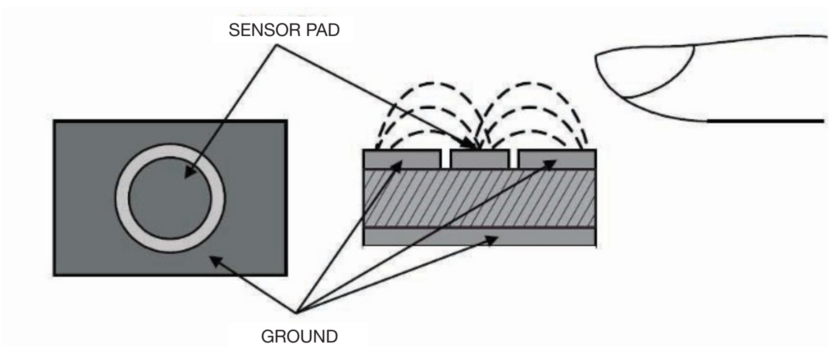

Figure 1 An opened capacitor structure acts as a single-touch sensitive capacitor sensor in capacitive-touch systems.

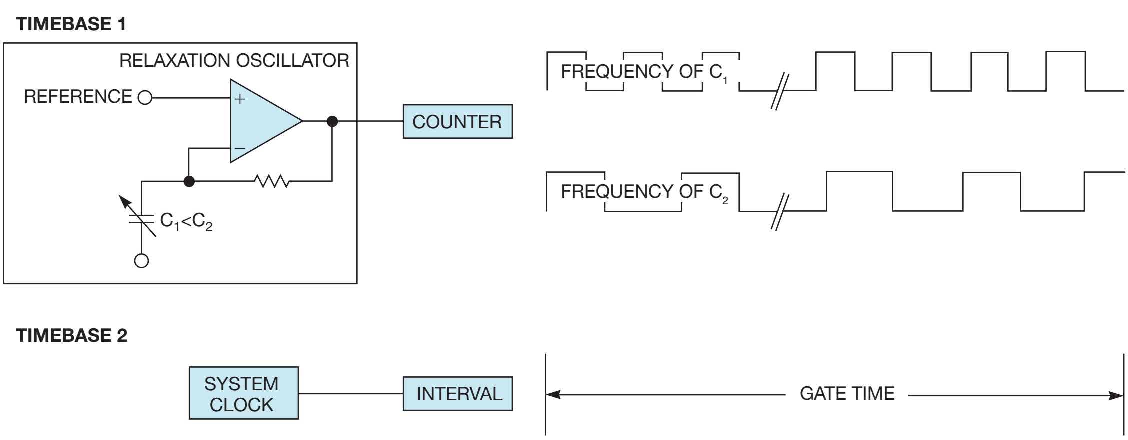

Figure 2 This design uses relaxation oscillation to sense capacitance. C_2 represents the large capacitance of a finger close to the sensor.

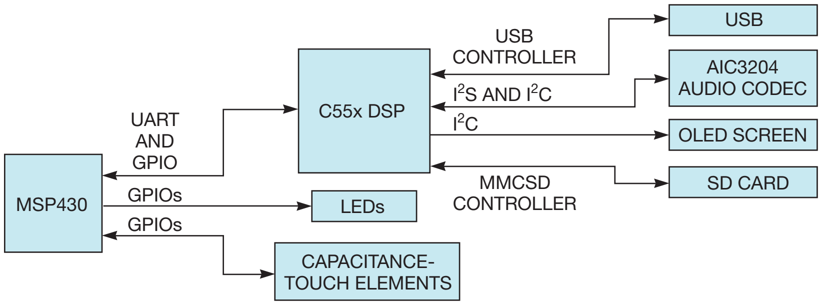

Figure 3 The audio capacitive-touch booster pack bus-connection block diagram shows a connection to an MSP430 microcontroller launchpad board. All pertinent bus structures in the design are shown.

such as the AIC3204 codec, and the TS3A225E audio switch (**Figure 4b** and **Reference 3**).

Other available power supplies for the MSP430 include the TPS79501 (**Figure 4c** and **Reference 4**) and the TPS77801 (**Figure 4d**). The TPS79501 500-mA low-dropout, low-power linear voltage regulator features a power-supply rejection ratio of 50 dB at 10 kHz in a small-outline SOT223-6 package. This device is stable with a small 1-μF ceramic capacitor on the output. The low noise and fast response time make the TPS79501 a good choice for the 1.8V supply.

The TPS77801 low-dropout regulator, in an 8-pin SOIC package, is designed to have a fast transient response and be stable with a 10-μF, low-equivalent-series-resistance capacitor. The device converts the 3.3 to 1.3V supply for the DSP (running at up to 100 MHz) digital core voltage and other core supplies in the DSP. The quiescent current is independent of output loading, making the TPS77801 a good choice for a low-power system.

AUDIO CHOICES

The booster pack has a headset jack for stereo-headset output and headset-microphone input. To support the various types of headsets, the TS3A225E autonomous audio switch with headset-type detection connects the headset jack and the stereo audio codec.

The designers of the demo board chose this codec because of its low power and because it allowed them to reuse software from other demo boards. Software reuse is a great time saver. The layout was also used on some other reference designs, so the hardware reuse saved time and allowed for the board to be introduced to designers as quickly as possible. This flexible, low-power, low-voltage stereo audio codec has programmable inputs and outputs, a low-power analog-bypass mode, power-tune features, fixed predefined and programmable microphone bias, parameterizable signal-processing blocks, an integrated programmable phase-locked loop, integrated low-dropout regulators, and flexible digital interfaces. Its high level of integration also makes this codec a space saver (**Figure 5**).

The TS3A225E autonomous audio switch with headset-type detection detects the presence of an analog microphone and switches a system's analog-microphone pin between connectors in an audio stereo jack (**Figure 6**). Some connector manufacturers allow you to swap the microphone connection in a stereo connector with the ground connection. When the IC detects a certain configuration, the device automatically connects the microphone line to the appropriate pin. The device also reports the presence of an analog microphone on an audio stereo jack and takes up little space on the PCB.

The demo board also includes four analog I^{2}C devices, which the C5535 DSP controls—an audio codec, an OLED (organic light-emitting-diode) display, the power supply's core power monitor, and the headset detector and

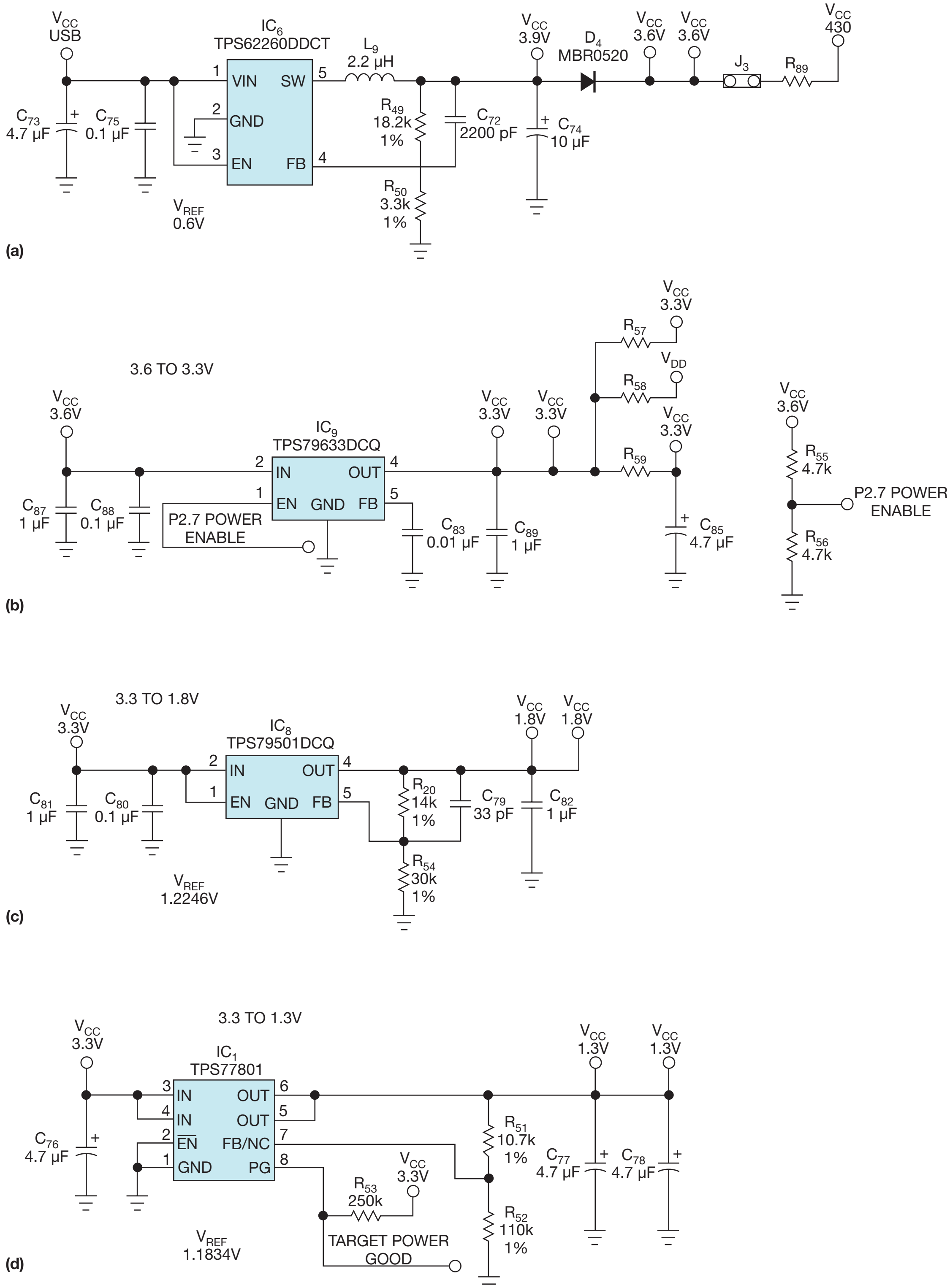

Figure 4 The TPS62260 provides USB input to 3.6V (a). The TPS79633 powers most analog ICs, such as the AIC3204 codec, and the TS3A225E audio switch (b). The TPS79501 provides 3.3 to 1.8V (c). The TPS77801 provides 3.3 to 1.3V (d).

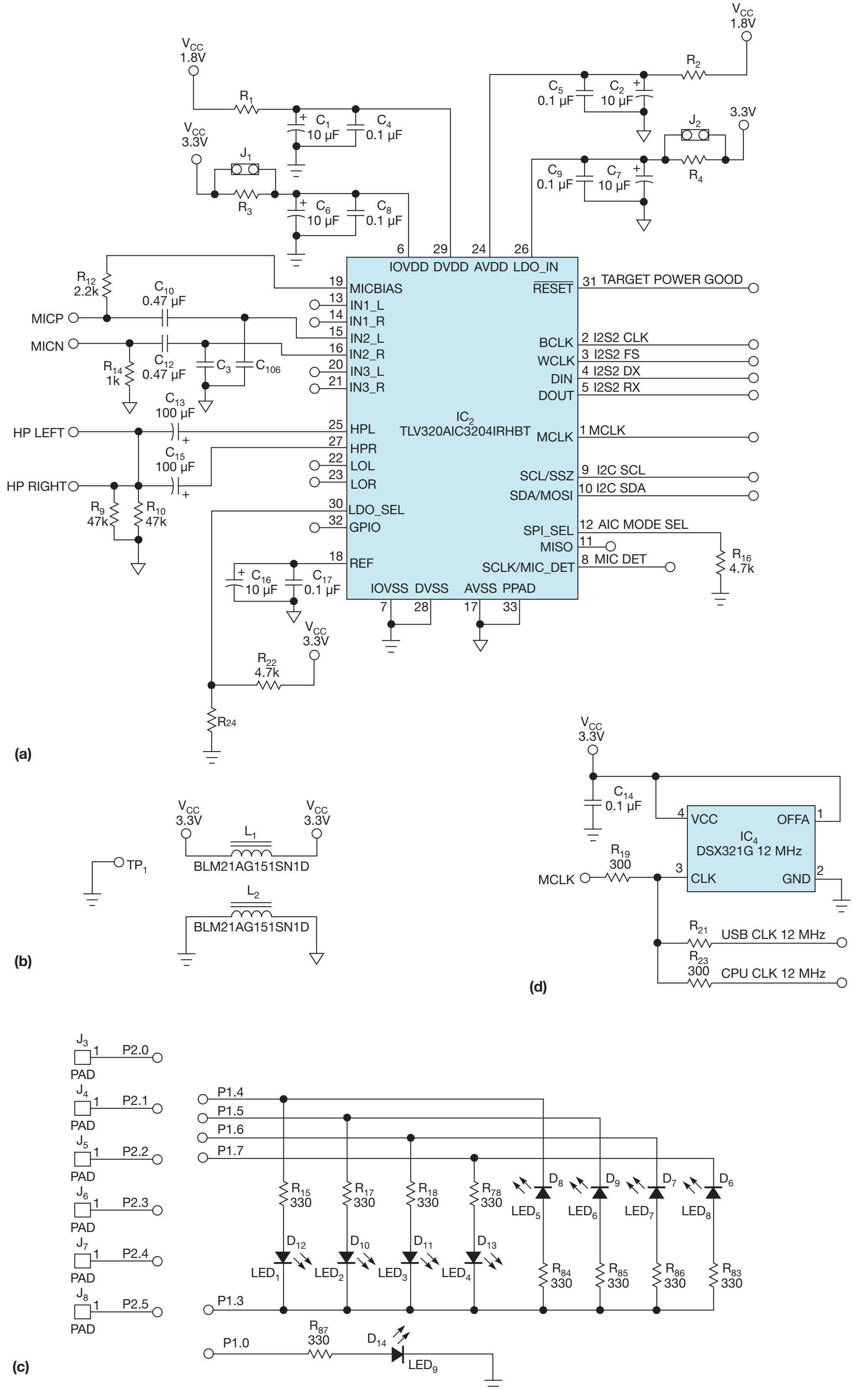

Figure 5 To support the various types of headsets, the TS3A225E autonomous audio switch with headset-type detection connects the headset jack and the stereo audio codec (a), the BLM21AG151SN1D inductors (b), the capacitive-touch sensor (c), and the 12-MHz DSX321G clock (d).

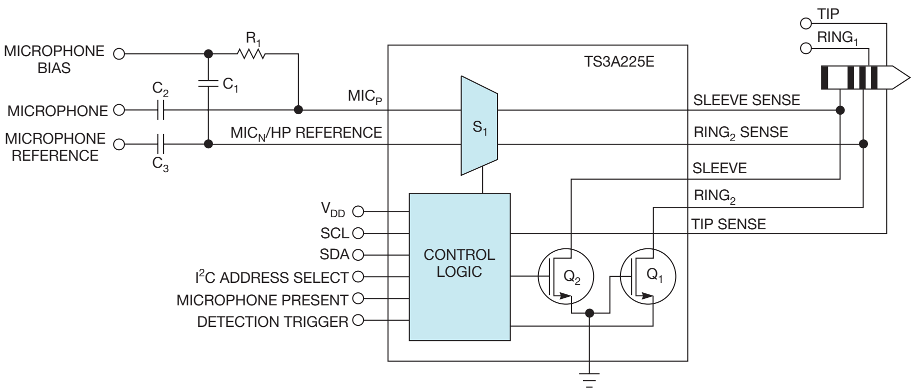

Figure 6 The TS3A225E autonomous audio switch with headset-type detection detects the presence of an analog microphone and switches a system's analog-microphone pin between connectors in an audio stereo jack.

switch. The MSP430 sends UART commands to the DSP to configure the I²C devices—writing characters to the OLED display, for example. The INA219 provides the DSP's core power usage to maintain efficient power management.

Using the INA219, you can characterize the CMOS DSP's power consumption on the application board when application code is running. You can then tailor the application code, code structure, and operating frequency for minimum power consumption. The zero-drift, bidirectional INA219 current/power monitor reports current, voltage, and power through the I²C bus and comes in an SOT-23-8 package. **EDN**

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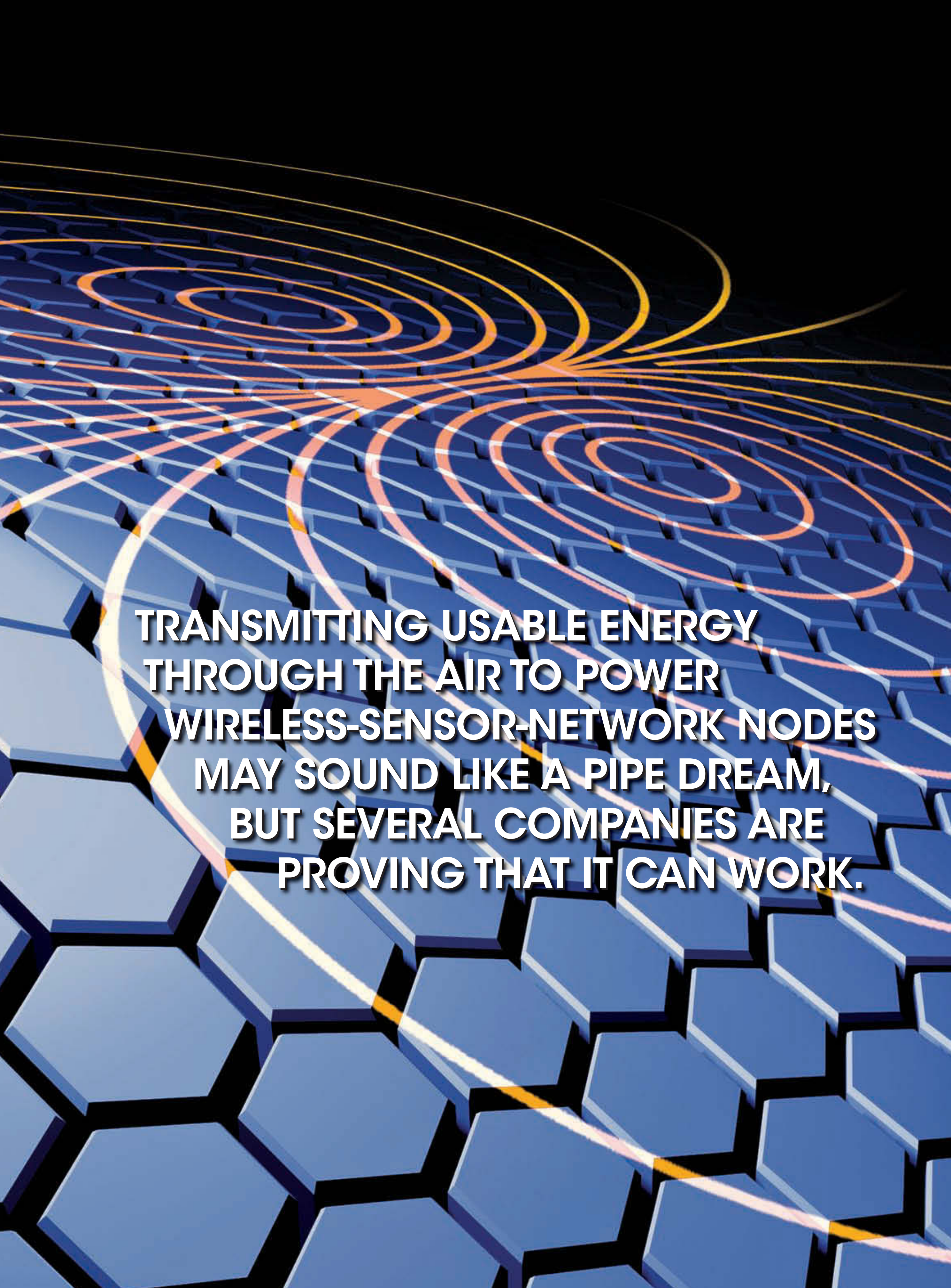
WIRELESS-SENSOR NETWORKS' OPERATING POWER ARRIVES VIA THIN AIR

BY DAN STRASSBERG • CONTRIBUTING TECHNICAL EDITOR

For several good reasons, wireless-sensor networks and the technologies that underlie them have become important topics to many EEs who work in system design. Although engineers who design systems for process or manufacturing control are familiar with distributed data acquisition and control, the architecture of systems with distributed intelligence—a common characteristic of these networks—is another topic that now appears at center stage. Wireless data communication is yet another key topic, but so are self-organizing system design, network topologies, RF design, ruggedized system design, micropower design, energy harvesting, wireless delivery of power, energy storage, and data security in wireless systems. Moreover, although wireless-sensor networks have been around in significant numbers for perhaps a decade, their structure continues to evolve, causing almost daily growth in the number and diversity of technologies with which their designers must become adept.

IMAGE: SHUTTERSTOCK



TRANSMITTING USABLE ENERGY THROUGH THE AIR TO POWER WIRELESS-SENSOR-NETWORK NODES MAY SOUND LIKE A PIPE DREAM, BUT SEVERAL COMPANIES ARE PROVING THAT IT CAN WORK.

Although these networks' architects can choose among a plethora of wireless-networking-protocol standards, in which low power consumption is a key requirement, they appear to favor ZigBee, an extension of the IEEE 802.15.4 standard. Compared with alternative protocols, such as Wi-Fi, ZigBee, with a fastest data rate of only 250 kbps, is no speed demon. However, the speed seems to suffice for many industrial applications in which a priority is low power.

Wireless-sensor networks have long relied on batteries to power sensors deployed throughout large process and manufacturing facilities. At first, designers regarded the deployment of wireless sensors in relatively inaccessible locations in these facilities as a great boon. Such arrangements eliminated the need to route signal wiring through difficult-to-reach areas and often presented hazards to not only the installers but also the signal cables.

It then became obvious that the necessary labor for replacing sensor batteries could become a major ongoing cost in keeping these networks on the air. If a network incorporates, for example, 365 sensors—one for each day of the year, each with a signal conditioner that uses one battery—and the average battery life is one year, the plant manager must budget for the time to replace the battery in one sensor per day, every day of the year, including weekends and holidays. Also, it is nearly impossible to budget for the events that can occur when a system element fails unexpectedly, perhaps because a battery required replacement earlier than scheduled or a wire broke after it flexed one time too many.

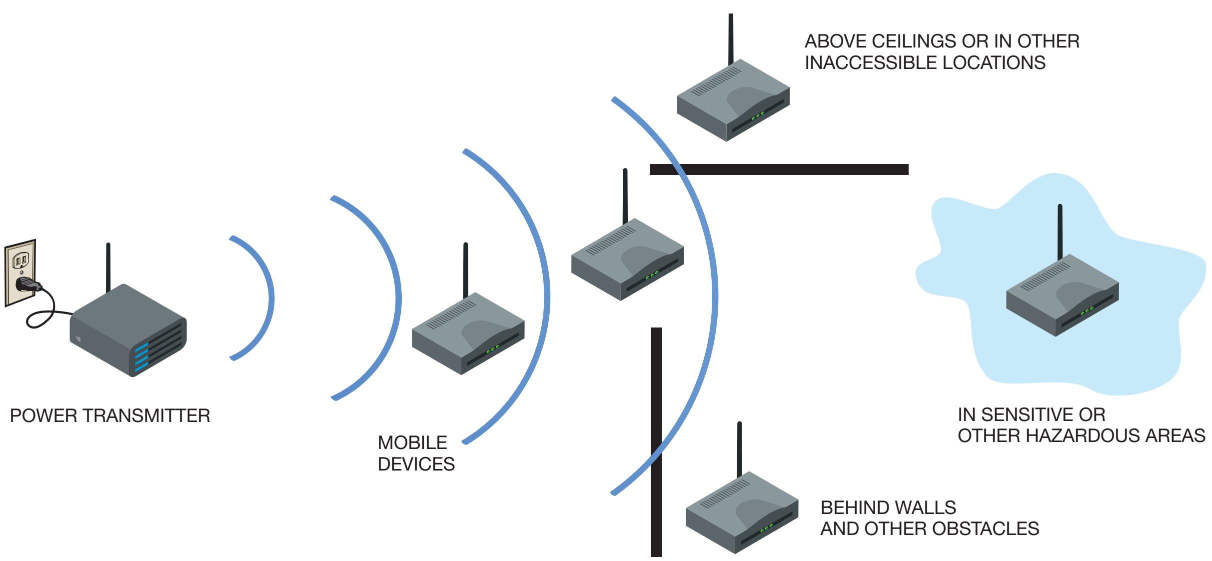
AT A GLANCE

- Traditionally, energy harvesting in wireless-sensor-network nodes captures packets of energy from environmental sources. These energy packets accumulate in a reservoir (a battery or a capacitor) until it contains enough energy for the node to acquire and send data to a system's central database.
- It is now feasible to send energy continuously to the nodes as RF. In such architectures, the system's wireless-communication protocol limits the speed of data interchange between the remote nodes and the central database.
- The popular ZigBee protocol handles data transfer at speeds as high as 250 kbps, sacrificing speed to gain energy efficiency.
- Ultracapacitors (also called EDLCs) offer many advantages; a key benefit is their nearly infinite charge/discharge cycle life. Their successful application requires familiarity with their unusual characteristics, however.

Such concerns gave rise to the idea of energy harvesting—powering wireless sensors by converting, storing, and using small amounts of energy from such ambient sources as light, heat, and vibration. This promising new technology has drawn great interest, especially among academics, and is now starting to produce commercially worthwhile results.

THE REAL OBJECTIVE

Somewhere in this scenario, some system designers, who perhaps had become fascinated with the "green" revolution, may have lost sight of the real objective. It's nice to minimize the amount of energy supplied to the network to power it, but, in most networks, that power is already low. A more important objective is often to minimize maintenance and its associated costs. A good way to reduce maintenance is to eliminate both remote power wiring—with its susceptibility to damage in rugged environments—and batteries—with their limited cycle life (the number of charge/discharge cycles they can typically withstand before their energy-storage capacity significantly diminishes). If the objective is reducing maintenance, further reducing network



A wireless power-distribution system can provide coverage for an entire facility in a manner similar to that of a lighting system or a wireless-communication system (courtesy Powercast).

power consumption can begin to appear like an unattainable goal, whereas the idea of continually supplying energy to the sensors—wirelessly through RF fields—may start to sound surprisingly intriguing.

At the core of most energy-harvesting schemes is the idea that, much of the time, available ambient-energy sources can provide packets, or boluses, of energy only at unpredictable intervals and can't continuously energize typical wireless sensors and their associated signal conditioners, ADCs, and transmitter/receivers. Therefore, energy-harvesting approaches usually accumulate these energy packets when they can and query the sensors for information on a schedule that does not exceed the average power the ambient-energy sources can supply.

Often, EDLCs (electrochemical dual-layer capacitors), often called supercapacitors or ultracapacitors, form the reser-

EDLCs' HIGH C: PERFECT PITCH FOR APPS THAT NEED LOW MAINTENANCE, LONG LIFE

Marketers describe ultracapacitors, EDLCs (electrochemical dual-layer capacitors), as true capacitors in an effort to distinguish them from rechargeable batteries. You can buy EDLCs in several surface-mountable package styles, as well as in cylindrical and rectangular packages with axial or radial leads, so it's easy to think that EDLCs' performance must resemble that of true capacitors (Figure A). However, many characteristics distinguish EDLCs from true capacitors—even from electrolytic capacitors, which, before the advent of EDLCs, provided the highest capacitance of any form of capacitor.

Controversy even surrounds the meaning of the letter E in EDLC. Some say that the E stands for electrochemical, pointing to EDLCs' use of a liquid electrolyte. Others say that the E stands for electric, pointing out that, even though the electrolyte becomes polarized when you apply a dc voltage to an EDLC's terminals, energy storage within the device—unlike that in an electrolytic capacitor—involves no chemical reactions.

Today, EDLCs with capacitance of tens of farads commonly appear in many applications. Devices with capacitance of more than 100F already exist, and EDLCs' maximum capacitance is likely to continue increasing as engineers devise new applications that require larger energy reservoirs, such as consumer, automotive, and "green" systems.

EDLCs may appear outwardly simple. Most have only two terminals, which may not even be polarized the way electrolytic capacitors' terminals are. However, you cannot successfully apply them without first familiarizing yourself with their many unusual characteristics. Even if you believe that you can skip the self-education step, you'd be wise to allot some time in your project schedule for a learning experience.

From freshman physics, you probably remember the formula for a capacitor's capacitance: $C=\epsilon A/d$, where C is the capacitance, ϵ is the dielectric constant of the insulating material between the capacitor's plates, A is the area of the plates, and d is the distance between them. EDLCs achieve their high capacitance values by reducing d by as many as three orders of magnitude and maximizing A through the use of rough-surfaced electrodes. The device manufacturer's challenge is to reliably achieve stable, high values of capacitance plus stable, low ESR (equivalent series resistance) to deliver high stability in other parameters and to produce parts in large unit volumes under tight cost constraints.

An unexpected phenomenon in EDLCs is a result of the fact that actions within the device do not take place instantaneously. For example, if you impress an ac voltage across its terminals and measure a device's capacitance, you may discover that the capacitance depends on the ac voltage's frequency. A 20F device operating at, say, 5 Hz is likely to exhibit a capacitance of less than 10% of that value at 1 kHz. Suppose you want to use the capacitive reactance, X_C, to limit the ac current in a simple circuit to which you want to apply sinusoidal ac excitation. As you increase the excitation frequency, the current decreases because capacitive reactance is inversely proportional to capacitance. This effect may require you to redesign the circuit or choose a higher-value capacitor. You would also likely find that, over time at temperatures above the rated range, the capacitance decreases and the ESR increases.

Unlike a rechargeable battery, which has a typical cycle life of hundreds of charge/discharge cycles—after which its ability to store a charge drops significantly—an EDLC may suffer no permanent catastrophic damage after hundreds of thousands or even millions of charge/discharge cycles. Nevertheless, its capacitance

Figure A AVX supplies EDLCs in a variety of cases, including these 28×17-mm units. The case thickness depends on the energy a device can store. You can calculate the stored energy using the formula $W=0.5\times C\times V^2$, where W is the stored energy in joules, C is the capacitance in farads, and V is the working voltage in volts. Clockwise from left, the values are 0.429, 1.584, and 0.756J.

voir in which the harvested energy accumulates until the system calls for information from the sensor (see **sidebar** "EDLCs' high C: perfect pitch for apps that need low maintenance, long life"). However, this approach may not always meet system needs. For example, emergencies can arise in which unforeseen conditions necessitate acquiring sensor data to make quick decisions about and enable immediate response to situations that endanger lives or property. In such cases, accumulated energy in the reservoir may prove inadequate for meeting a sensor's peak-power demands. This situation can occur at any time but is most likely to occur when a sensor returns to the air after technicians have removed it from service for calibration, maintenance, or system reconfiguration.

National Instruments offers a comprehensive line of hardware products for wireless-sensor networks. The line includes the small, rugged, real-time NI9792 embedded controller (left), with prices starting at $1647; the 16-bit, four-channel WSN-3202 high-level analog-input node (center), with prices starting at $399; and the 24-bit, four-channel WSN-3212 thermocouple-input node (right), with prices starting at $499. The WSN-3202 and WSN-3212 each include four digital I/O channels. The WSN-3202 also includes a 12V, 20-mA dc source, which can supply sensor power.

TRANSMITTING HARVESTABLE RF

Powercast's approaches differ somewhat from more familiar energy-harvesting approaches. Instead of harvesting ambient energy, Powercast can wirelessly provide energy to the sensors in the form of RF at frequencies in the ISM (industrial/scientific/medical) bands, such as 915 MHz and 2.4 GHz. In the United States, you don't need a broadcast license to use these bands at power levels that the Federal Communications Commission prescribes. The frequencies and power levels are low enough that the FCC classifies the energy as nonionizing radiation. This classification means that, employing the best information available to them, the US Environmental Protection Agency and the FCC have declared that the signals do not constitute a hazard to human health. As with any health-related information in the 21st century, however, plenty of material on the Internet disputes the EPA and FCC claims.

Among Powercast's alternative approaches is one that harvests energy from the signals of radio- and television-broadcast stations and cellular base stations. Unless your system is near the transmitting antenna of such a station, the RF signals may be too weak to avoid the need to use an energy reservoir and periodically query the sensors for updated data. Further, although most radio and TV stations seldom go off the air, you can't assume that a neighboring broadcast transmitter will always be operating or that a neighboring cellular base

after, say, 100,000 cycles may be only 90%, and its ESR may be as much as 125% of what it was after the first cycle. Moreover, these changes are likely to increase if you operate the device at elevated ambient temperatures beyond its ratings.

EDLCs have a generally well-deserved reputation for high leakage, or self-discharge current. In many cases, however, you can find ways around the shortcoming. For example, whenever the primary power source—usually, the ac line—is operating normally, uninterruptible power supplies that use EDLCs commonly keep the devices in a trickle-charge mode. This mode provides just enough current to satisfy the leakage requirement.

EDLCs can be expensive components, and most batteries store more energy than do EDLCs of the same size. Why, then, would you want to use EDLCs—especially in a wireless-sensor network? A key answer lies in their virtually unlimited cycle life. When you use them alone or in combination with primary—that is, nonrechargeable—or rechargeable batteries, EDLCs can eliminate or at least greatly reduce the need for maintenance of somewhat-inaccessible network nodes. Such maintenance represents a major operating cost. EDLCs are also an important part of those wireless-sensor networks that accept the penalty of higher node power to achieve faster response to emergency conditions in the system or the equipment they monitor.

With the aid of EDLCs, you can substantially increase the cycle life of rechargeable batteries. If you parallel an EDLC that guarantees low ESR with a battery that periodically delivers high-current pulses—a common operating condition in energy-harvesting applications—the battery's cycle life is likely to increase by a factor of 4-to-1. Thanks to their low ESR, EDLCs deliver most of the pulse current, thereby limiting the battery's contribution and limiting thermal cycling due to internal heating of the battery.

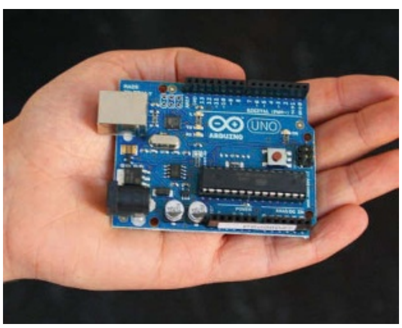
Typically, you can purchase prism-shaped EDLCs with low-profile designs and voltage ratings of 4.5 to 15V for approximately $4.50 to $7.50 each. At volumes of many millions of pieces, the unit prices are correspondingly lower.

Working with IC-supplier Microchip Technologies, Powercast has produced several evaluation/development kits for its wireless RF energy-harvesting approach, including the P2110-Eval-01 kit. The kit has (top row from left) a 915-MHz, 3W power/data transmitter; two 1-dBi omnidirectional antennas; two 6-dBi directional antennas; a Microchip PICtail/PICtail-Plus daughtercard; and a Microchip PICkit-3 programmer/debugger. It also includes two Powerharvester-receiver evaluation boards (middle row); two wireless-sensor boards (bottom row, left); and a Microchip 16-bit development board (bottom row, right).

station will be handling a message volume sufficient to fulfill your system's energy needs.

If the ambient-RF power is inadequate, however, you can use any 1-MHz to 6-GHz transmitter that produces a sufficiently powerful signal to create the necessary RF field. A properly tuned Powercast Powerharvester receiver can then capture the signal and derive dc power from it at a voltage your system can use. Using a 3W ISM-band transmitter and simple antennas, the RF-power transmissions' range is 40 to 45 feet.

Powercast recently announced an RF-based chip set, which is available through its global-distributor network. In concert with the company's licensable reference design for embedded low-power, wireless-charging, and wireless-power applications, the chip set simplifies and reduces the cost of embedding the manufacturer's core RF energy-harvesting technology in such rechargeable-battery-based and non-battery devices as wireless-sensor-network nodes, enabling them to perpetually receive their operating power from RF energy. Powercast estimates that the reference design's bill-of-material cost, including the chip set, will be less than $2 per unit (large volumes).



Design engineers use the Arduino open-source electronics-prototyping platform for quick trials of the practicality of ideas. The family includes several wireless-modem cards, such as this one, featuring a user-friendly interface in modifiable onboard firmware.

MOVING ENERGY

WiTricity has 10 US patents on its technology and has filed approximately 100 additional applications. The technology differs substantially from Powercast's but is nevertheless RF-based, albeit at 140 kHz, 6.8 MHz, and other frequencies that are lower than the ISM-band frequencies that Powercast uses. WiTricity isn't now actively pursuing the wireless-sensor-network market; it believes it has much bigger fish to fry in consumer and automotive applications. Still, these networks should be able to make good use of the company's technology, which employs a little-known phenomenon: the ability to build efficient air-core transformers even though appreciable distances separate the primary and secondary coils—in WiTricity's case this distance is as much as 8 feet.

To achieve good efficiency at significant distances, you must excite the primary winding at its resonant frequency—usually in the RF range and determined by the winding's leakage inductance and distributed capacitance. Moreover, the coils' self-resonance must exhibit high Q (quality factor), a measure of the ratio of peak energy stored to energy dissipated per cycle, and you must closely match the windings' resonant frequencies.

At a distance of 8 feet between the primary and the secondary, the efficiency of power transfer is almost 40%, according to the company. Unlike higher-frequency wireless-energy-transfer schemes, which carry energy in both electric and magnetic fields, WiTricity's energy transfer depends almost entirely on the magnetic field. The technology achieves best results if the excitation signal is sinusoidal, but the system suffers only a slight reduction in efficiency if the excitation waveform is square or trapezoidal.

The bugaboo, however, is shorted turns. Suppose that the transformer's primary and secondary coils center one

With the Solarcraft solar-energy harvester, you can deploy multiple solar-powered National Instruments wireless-measurement nodes to form a wireless-mesh network that communicates measurement data back to a network gateway for processing and analysis. Prices for the solar-energy harvester begin at $604.

The Perpetuum vibration-energy harvester can power wireless-sensor networks built from National Instruments' wireless-sensor-network components. NI refers customers who are interested in vibration-energy harvesting directly to Perpetuum for technical assistance and for application-specific energy-harvesting subsystems.

above the other in parallel horizontal planes. When you apply an excitation voltage to the primary coil, a toroidal, or donut-shaped, RF-magnetic field with a vertical axis surrounds the two coils. If you mount the coils on metal plates, you must slit each plate along a coil radius so that no low-resistance current path—that is, no shorted turn—surrounds the toroidal field's axis. If you were to create such a path, a large current would circulate in it and would counteract the field from the coils, thereby reducing nearly to zero the efficiency of the coil-to-coil power transfer. The circulating current could also cause dangerous heating of the metal plates.

A similar shorted-turn problem potentially exists with a more common power-transfer approach: ac-line-frequency inductive coupling, such as is used to charge electric-toothbrush batteries. In that case, however, the primary and secondary coils are in close proximity, and the coil supports are made of nonconductive plastic. Unlike the metal plates in the earlier example, there are no legitimate concerns about their structural integrity. **EDN**

ACKNOWLEDGMENT

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DIs Inside

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Complementary-pair dc/dc converter simultaneously doubles, inverts supply voltage

Ajoy Raman, Bangalore, India

The circuit in this Design Idea uses an intrinsic property of collector voltages in one-transformer push-pull dc/dc converters: They have a swing of twice the supply voltage. When you implement these circuits with an NPN device, the collector swings from 0V to twice the supply-rail voltage. When you use PNP devices, the collector voltage swings from V_{CC} to an equal amplitude but negative V_{CC} (**Reference 1**). In this circuit, a complementary pair of transistors, simultaneously implementing a voltage doubler and a negative-voltage source, drives the two windings of the transformer.

One of the windings of transformer T_1 connects to ground, driven by PNP transistor Q_1 from V_{CC} (**Figure 1**). The other winding of T_1 connects to V_{CC}, and NPN transistor Q_3 drives the lower end to ground. Q_2 and Q_4 drive Q_1 and Q_3, respectively. The collectors of Q_3 and Q_1 through resistors R_4 and R_3 provide cross-coupled drives to Q_2 and Q_4. R_1 and R_2 form the collector loads for Q_2 and Q_4. D_1 and D_4 prevent the reverse breakdown of Q_1 and Q_3. The drive configuration and the transformer's winding polarity provide regenerative feedback and self-oscillation so that the transformer alternates between positive and negative saturation, inducing voltages to drive transistors Q_1 and Q_3 alternately on and off.

A square wave with an amplitude twice V_{CC} is generated at the collector of Q_1, which swings nominally from V_{CC} to the equal but negative output voltage. Simultaneously, a square wave with an amplitude twice the supply-rail voltage is generated at the collector of Q_3, which swings nominally from 0V to twice the supply-rail voltage.

D_2 and C_2 provide half-wave rectification and filtering of the Q_1 collector waveform generating the negative voltage output. Half-wave rectification and filtering of the Q_3 collector waveform using D_3 and C_3 generate the doubler's output.

T_1 is 200 turns of bifilar AWG 37 enameled wire

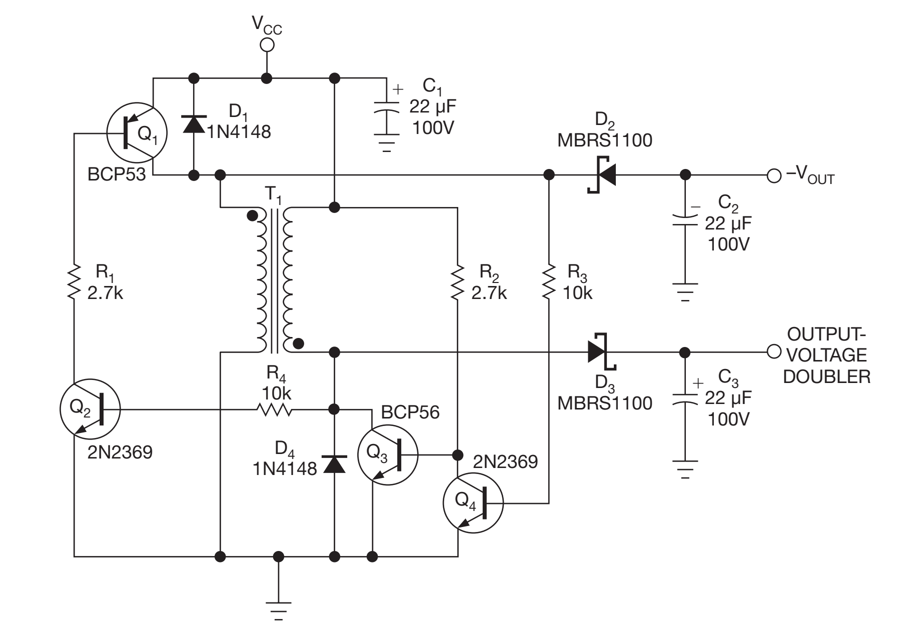

Figure 1 Cross-coupled regeneration drives switching transistors Q_1 and Q_3 and the windings of the transformer. The resulting voltage swings at their collectors are rectified to twice the positive and the negative power-supply rails.

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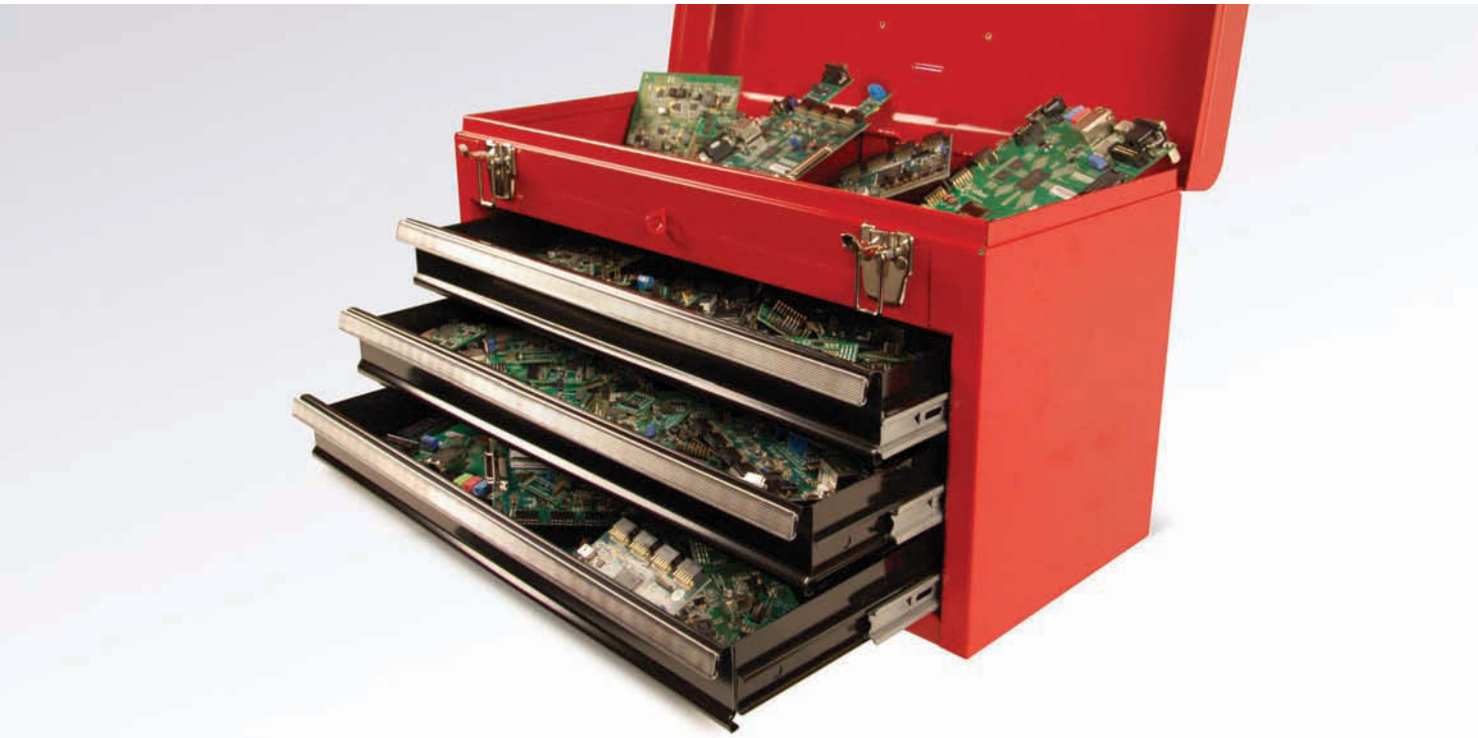

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TABLE 1 EXPERIMENTAL RESULTS

Input voltage (V)	Input current (mA)	Frequency (kHz)	Voltage doubler (V)	Current doubler (mA)	Negative voltage (V)	Negative current (mA)	Input power (W)	Output power (W)	Efficiency (%)
5	253	2.1	7.68	81.7	–3.41	–72.5	1.27	0.87	69
9.97	360	4.05	17.33	115.5	–8.65	–86.5	3.59	2.75	76.6
15	420	6.02	27.2	136	–13.58	–90.5	6.3	4.93	78.2
19.4	400	7.37	34.9	145.4	–18.33	–61.1	7.76	6.19	79.8
25	340	10.47	48.5	97	–23.8	–79.3	8.5	6.59	77.5
30	410	12.07	56.5	113	–27.6	–92	12.3	8.92	72.5

wound 1-to-1 on a ferrite toroid core (**references 2** and **3**). **Table 1** shows the experimental results with the voltage doubler and negative-voltage-generation circuit operating over an input voltage of 5 to 30V, demonstrating operation over a wide input voltage range and providing power at both outputs simultaneously at moderate efficiency. EDN

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Adjust power-efficient LED switch to any light intensity

Raju Baddi, Tata Institute of Fundamental Research, Pune, India

You can use an LED as a photoelectric sensor. A previous Design Idea shows that such a switch is highly power-efficient, consuming almost no power (**Reference 1**). However, you cannot adjust that configuration to switch at the desired light intensity. You can adjust the circuit in this Design Idea to any threshold level of light intensity necessary to maintain the on state of the photoelectric switch while retaining almost the same power efficiency of the original circuit (**Figure 1**).

Illuminating the reverse-biased green LED with ambient light causes the small current that flows through the LED to form the base current of the BC549 NPN transistor, which is amplified and passed on to the base of the BC177 PNP transistor. A magnified version of this current flows through the emitter of the BC177. The voltage drop across the emitter resistor depends on its value and the current flowing through it, which in turn determines the voltage drop across the CE terminals of the BC549.

By adjusting the value of the series emitter resistor you can set a voltage corresponding to logic zero of a CMOS gate for any desired intensity of light falling on the green LED. This intensity depends heavily on the response of the green LED and the current gains of the two transistors, so you select the resistor value by shorting out combinations of the series string of resistors and use the 10-MΩ potentiometer as a fine adjustment. Once you find a suitable value,

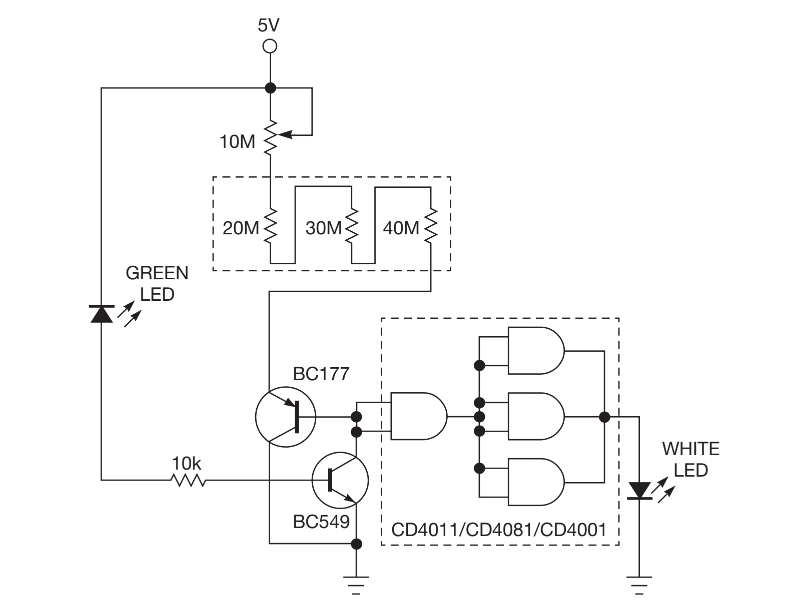

Figure 1 The photocurrent through the green LED amplifies to CMOS-logic levels to turn on the white LED when ambient light falls.

you can remove the unused resistors from your circuit.

When the ambient light intensity falls below this level, both the base current of the BC549 and the current through the emitter series resistors decrease. This decrease raises the input voltage at the CD4011 logic gate higher than the CMOS switching threshold. The typical gate sourcing current at a 3V output is approximately 3 to 4 mA per gate; running three gates in parallel delivers approximately 10 mA to the white LED. You can use inverting or noninverting gates for the same result. The circuit still retains its power efficiency because the required series-resistor values normally exceed 10 MΩ.

You can check a green LED's suitability for use as a photodiode by measuring the voltage drop across the LED with a 200-mV digital multimeter. If the LED is suitable as a photoelectric sensor, you will see a voltage of 0.3 to 1 mV across it, and this voltage changes with the intensity of light falling on the LED. EDN

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Obtain a gain of 450 from one vacuum tube

Lyle Russell Williams, St Charles, MO

A direct-conversion radio receiver required an audio gain of 450 from a pentode vacuum tube. A pentode has a high transconductance—that is, the ratio of the change in plate current to the change of the control grid voltage that caused it. To get high gain, however, it needs a high load impedance. RF applications with pentodes often used LC-tuned circuits in their plate loads in which the impedance at resonance and, therefore, the gain is high. It is typically impossible to implement a high load impedance using an untuned circuit because of the dc requirements of the tube.

RF APPLICATIONS WITH PENTODES OFTEN USED LC-TUNED CIRCUITS IN THEIR PLATE LOADS.

For instance, a 6AU6 pentode vacuum tube needs a quiescent plate current of approximately 5 mA (**Figure 1**). If the quiescent dc plate voltage is to be 60V, the load resistance must be no more than 12 kΩ. The 0.5-MΩ plate resistance of the tube and the 1-MΩ load of the next stage are negligible with respect to the 12-kΩ load. With a transconductance of 3900 siemens, those requirements demand an audio gain of 45. You can easily achieve this gain with a triode tube.

To get a high load impedance with an untuned plate circuit, you can use a transistor current source for the tube (**Figure 2**). The transistor has no gain but functions as an active load for the tube and supplies the 5-mA plate current. You adjust the 500Ω potentiometer to obtain 60V dc at the plate. The gain of the circuit is approximately 450. This gain implies a 150-kΩ load impedance that the transistor supplies in parallel with the plate resistance and the resistance of the next stage. Alternatively, you can use two triode tube circuits in series, each having a gain of 21. EDN

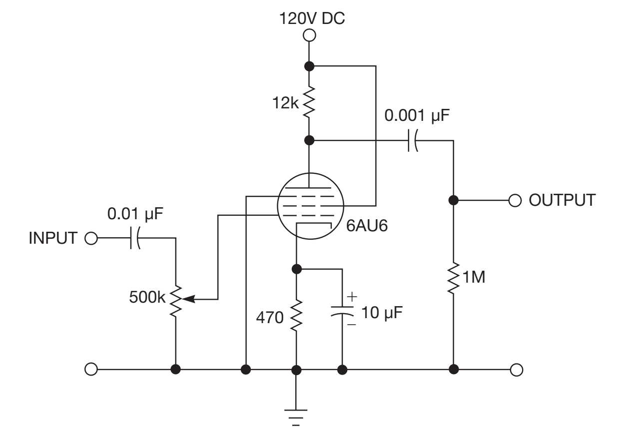

Figure 1 A 6AU6 pentode vacuum tube needs a quiescent plate current of approximately 5 mA.

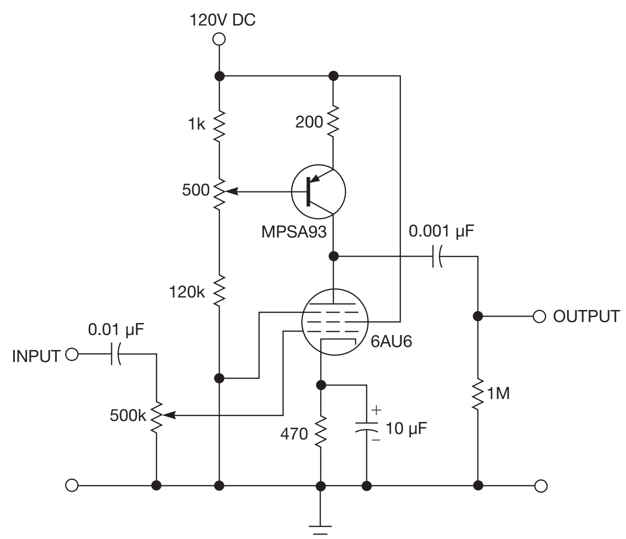

Figure 2 To get a high load impedance with an untuned plate circuit, you can use a transistor current source for the tube.

Probing system lets you test digital ICs

Raju Baddi, Tata Institute of Fundamental Research, Pune, India

This Design Idea describes a simple yet powerful handheld probe that you can use as both a logic probe and a pulse generator either individually or simultaneously. This feature makes the probe useful for testing DIP digital ICs, such as gates, flip-flops, and counters, using a socketed fixture with three-post jumpers to connect each pin to logic high or logic low or to 5V or ground. Three pushbutton switches, two dual-color LEDs, and two probe tips are built into a plastic cylinder, such as an empty 20g-or-larger glue-stick tube. The generator's probe tip hooks to fit onto the test fixture's jumper pins and mounts onto a spring, such as those in retractable ball-point pens, for flexibility, and it allows the logic-probe tip to move to the output under test. Two of the pushbutton switches set the generator's quiescent state for a high output or a low output. The third switch briefly single-pulses the output to the opposite state. If the switch is pressed for longer than 2 seconds, the output produces a pulse train.

IC_{1A}, an NE556, is a 2-sec monostable circuit, which triggers a 1-msec-pulse-generator circuit employing gate G_1, resistor R_1, and capacitor C_1 **(Figure 1a)**. G_4 buffers the circuit. The output of the monostable circuit also passes through G_2 and G_3 to mask the output of the astable component, IC_{1B}, an NE556 that provides the pulse train. To prevent any spurious pulse from reaching output Probe A when switch S_1 is not depressed, keep IC_{1B} deactivated by applying a low voltage to its reset Pin 4 through transistor Q_1, whose biasing a 0.68-µF capacitor further guards.

When you press switch S_1 for a short

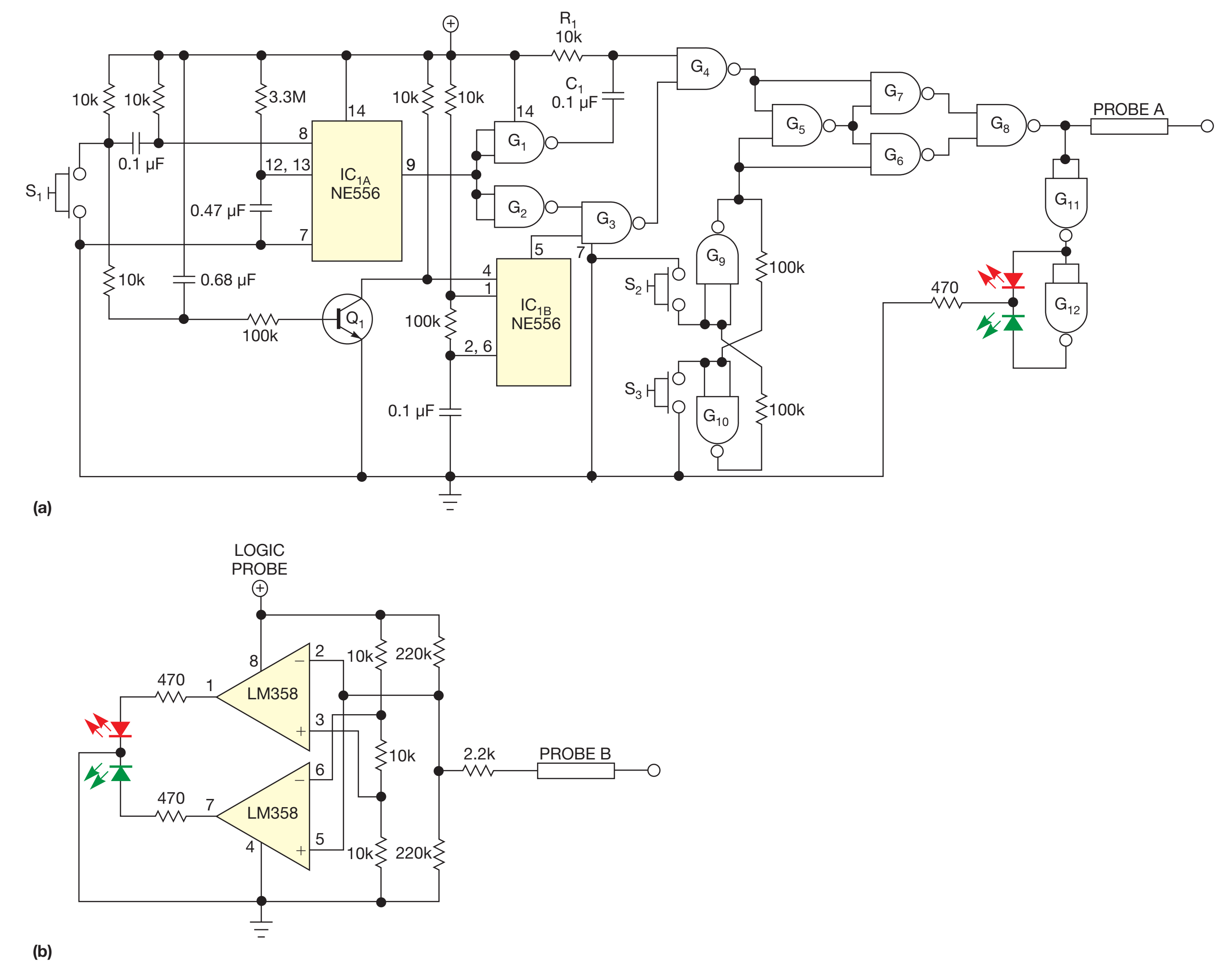

Figure 1 This circuit combines analog and digital functions. Probe A is the pulse-generator probe, and probe B is the logic probe (a). Although not shown, a 100-µF capacitor should be connected between the supply and ground. Red LEDs indicate logic zero, and green LEDs display logic one (b).

time, IC_{1A} fires and produces a high output for approximately 2 sec. The 1-msec pulse from G_1, R_1, C_1, and G_4 reaches the pulse Probe A through the XOR function comprising G_5 through G_8, and the output of the astable IC_{1B} is masked at G_3 from reaching the XOR. If you depress switch S_1 for longer than 2 sec, the monostable IC_{1A} times out. This action unmasks G_3 and allows the 70-Hz oscillation from IC_{1B} to reach the XOR.

G_9 and G_{10} form a bistable circuit, which "remembers" the most recently pressed S_2 or S_3 switch and controls the inverting and noninverting operation of the XOR function. G_{11} and G_{12} together drive the dual-color LED to indicate the pulse generator's polarity. Red indicates that Probe A's output is mainly logic zero, with the single 1-msec pulse a logic high. Green indicates the opposite.

The LM358 acts as a window-detector logic probe (**Figure 1b**). With the values in the **figure**, the red LED lights at Probe B voltages of less than 35% of the supply voltage, and the green LED lights at voltages greater than 65% of the supply voltage. Neither LED lights between these voltages. You may wish to adjust the resistor network to reduce the lower threshold to include the transistor-transistor-logic zero of less than 0.8V.

If you use CD4011 quad NAND gates, you can externally power the probe at 4.5 to 15V. Using a CD4093 Schmitt-trigger quad NAND for G_1 through G_4 ensures no spurious oscillations as a result of the slow voltage rise at timing capacitor C_1. If your design requires a higher-current generator drive, you can add a pair of NPN and PNP boost transistors to the output.

Figure 2 shows a jig for testing the digital ICs. You configure the 16-pin DIP socket for the device under test with an array of triple-post headers and push-on jumpers. You can connect any pin directly or through a resistor to power or ground to configure power or logic levels. The resistors can be any suitable value; approximately 2 kΩ is appropriate. To set a TTL low, the pin must connect directly to ground. To inject a signal, hook the flexible spring-mounted generator, Probe A (**Figure 3**), onto the appropriate input post and then move logic Probe B to the corresponding output post or pin. To see a suggested perf-board layout, go to www.edn.com/4374947. EDN

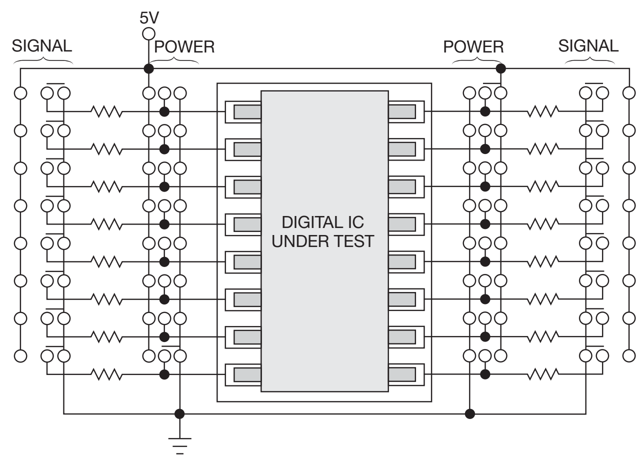

Figure 2 Program this test jig with header posts and jumpers for the IC under test.

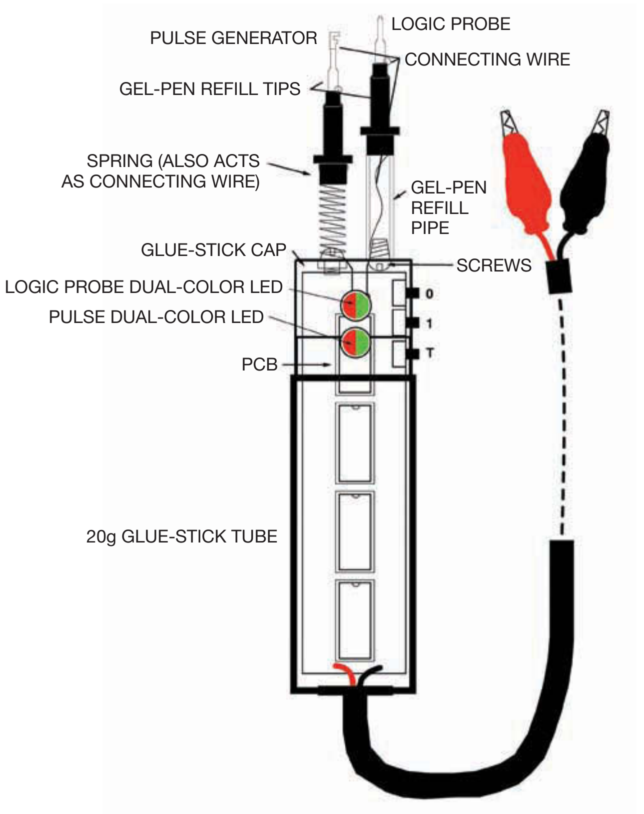

Figure 3 To inject a signal, hook the flexible spring-mounted generator, Probe A, onto the appropriate input post and then move logic Probe B to the corresponding output post or pin.

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supplychain

LINKING DESIGN AND RESOURCES

Cost analysis: Reshoring is viable

A recent report on manufacturing-site selection contains both good and bad news for the United States. According to The Hackett Group's "Reshoring Global Manufacturing: Myths and Realities," the cost gap between manufacturing in China and production in the United States is narrowing. By 2013, says the report, the total landed cost of manufacturing in China will be only 16% lower than that of the United States. This margin, analysts believe, represents the "tipping point" where manufacturers consider reshoring as a viable option.

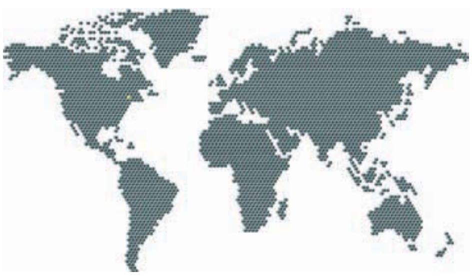
In contrast, the study also finds that companies are pursuing sites in other developing nations as a low-cost alternative to China. China has been a handy scapegoat in the debate about US jobs moving offshore. According to The Hackett Group, jobs will remain offshore, just not in China.

Countries including India, Thailand, Vietnam, and Brazil continue to successfully grow their share of global manufacturing as they become more cost-effective locations for manufacturing. "The cost increases in China are impossible ... to ignore," says Michel Janssen, chief research officer at The Hackett Group. "As Chinese wage rates rise, companies are looking to maintain their competitive edge by either bringing that production closer to developed markets, moving it to lower-wage countries, or increasing productivity in China."

From one perspective, the question now is, Will these nations become as vilified as China? They are, after all, landing jobs that 20 years ago would have existed in the United States. The answer may depend on whether the United States accepts the fact that these jobs are never coming back: "Few of the low-skill Chinese manufacturing jobs will ever return to advanced economies; most will simply move to other low-cost countries," the report concludes.

A number of other factors have contributed toward the vilification of China, including the theft of IP, human-rights abuses, unfair trading practices, and low-quality merchandise. From a purely practical perspective, however, costs in the United States and China aren't that different.

Reshoring is expected to become more viable with each passing year, as the total landed cost gap of manufacturing offshore shrinks. The Hackett Group's research found that the cost gap between the United States and China has shrunk by nearly 50% over the past eight years and is expected to be minimal by 2013. Rising labor costs in China, as well as rising fuel prices globally, which affect shipping costs, are driving this trend.



> "The cost gap between manufacturing in China and production in the United States is narrowing.

Total landed manufacturing cost continues to be the leading factor in companies' site selection. The key components of this cost are raw-material and component costs, manufacturing costs, transportation and logistics, inventory carrying costs, and taxes and duties. According to The Hackett Group, the cost differential between other developing nations and the United States is as much as 20%. As long as the majority of manufacturers—85%, according to the study—measure cost as the main driver in site selection, manufacturing is likely to remain offshore.

—by Barbara Jorgensen, *EBN* Community Editor

This story was originally posted by EBN: *http://bit.ly/Nkenb4.*

SMARTPHONES, MEDIA TABLETS PROPEL MOBILE-MEMORY CHIP MARKET

OUTLOOK

New smartphones and tablets will act as key catalysts for continued healthy growth of the mobile-memory semiconductor space in the next few years, with revenue growing a modest but healthy 6% this year, according to IHS iSuppli. Revenue for mobile memory is projected to reach $14.9 billion this year, up from $14.1 billion in 2011. The mobile-memory forecast includes the flash-memory segments of NAND and NOR, the NAND subsegment of eMMC (embedded multi-media card), and the mobile DRAM sector.

A 9% increase is anticipated in 2013 for mobile memory as more smartphone and tablet products requiring higher memory densities enter the marketplace, with revenue climbing to $16.2 billion. By 2015, mobile-memory revenue will peak at $17.9 billion.

"The mobile space has been the engine for overall memory growth in the last few years, and it continues to shape and define the success of suppliers," says Michael Yang, senior principal analyst for memory and storage at IHS. "Given the ongoing passion of consumers for mobile devices ... the outlook for mobile memory remains exceedingly optimistic."

—by Amy Norcross

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productroundup

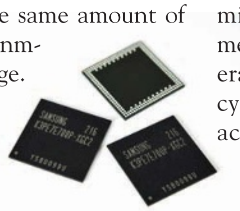
MEMORY AND STORAGE

Winbond SpiFlash features 2- to 128-Mbit densities

The SpiFlash family of serial-flash memory devices includes the 90-nm automotive-grade 2 and industrial-grade plus, which operate at –40 to +105°C, and the automotive-grade 3 and industrial grade, which operate at –40 to +85°C. The devices come in 2- to 128-Mbit densities and target use in automotive audio telematics, navigation and GPS systems, media centers, digital displays, cameras, data recorders, and safety-monitoring devices. The prices for the W25X/25Q SpiFlash devices range from 25 cents for 2-Mbit densities to $2.12 for 128-Mbit densities for full automotive-grade-2, AEC-Q100-qualified units with PPAP charge control (100,000).
Winbond Electronics Corp, www.winbond.com

Samsung LPDDR2 memory uses 20-nm-class technology

Using 20-nm-class technology, the 4-Gbit LPDDR2 memory targets mobile devices, such as large-screen tablets and smartphones. The device allows vendors to deliver 2-Gbyte products with a thickness of 0.8 mm, which stack four 4-Gbit LPDDR2 chips in one LPDDR2 package. The 2-Gbyte package can process data at speeds as high as 1066 Mbps using the same amount of power as that of a 30-nm-class, 2-Gbyte package.
Samsung,
www.samsung.com



Ramtron FM25e64 FRAM improves POS products

The FM25e64 FRAM operates on 1.5 or 1.8V power rails; offers 20-µA active-current operation; and requires 20 µsec to start up, write data, and shut down. Targeting security applications, such as point-of-sale terminals and utility-metering products, the device securely erases data during a breach or power cycle and wipes out confidential transactions in as little as 10 µsec. The FM31T378 companion processor comes with a real-time clock and other common peripherals. The FM25e64 is available from DigiKey, Mouser, and other distributors for 95 cents (10,000).
Ramtron International Corp,
www.ramtron.com

Intel SSD 330 series has affordable prices

The 330 series of SATA 6-Gbps solid-state drives comes in capacities of 60, 120, and 180 Gbytes. It contains the vendor's 25-nm multilevel-cell NAND memory, and the SATA interface provides read speeds as fast as 500 Mbytes/sec, sequential-write speeds as fast as 450 Mbytes/sec, random-read performance as fast as 22,500 I/O operations/sec, and write speeds as high as 33,000 I/O operations/sec. It comes in a 2.5-in./9.5-mm form factor and sells for $89, $149, and $234 for the 60-, 120-, and 180-Gbyte capacities, respectively.
Intel Corp, www.intel.com

Microchip SuperFlash Kit 1 enables serial-flash-memory evaluation

The AC243005-1 SuperFlash Kit 1 memory-development kit enables designers to evaluate the vendor's SPI and SQI serial-flash-memory devices. It includes three serial-flash PICtail Plus daughterboards with the SST25VF016B, SST25VF064C, and SST26VF032 flash devices, respectively. The boards interface with the Explorer 16 development board and work with the MPLab X IDE to enable quick creation of code and to shorten development time. Example code and software drivers

are available for download from http://www.microchip.com/get/9RX5. The SuperFlash Kit 1 sells for $30.
Microchip Technology Inc, www.microchip.com

WD's Scorpio Blue stores 2 million songs or 1.6 million photos

The Scorpio Blue hard drive for mobile computers touts a shock tolerance of 400g and a capacity of 500 or 320 Gbytes. The 5400-rpm drive has an average nominal latency of 5.5 msec and SATA or PATA interfaces. Buffer-to-host transfer rates for the SATA interface are a maximum of 3 Gbps. The drive is compatible with standard 9.5-mm slots, making it a storage option for use in notebook computers and Ultrabook computers requiring a 7-mm drive height. The vendor claims that the unit can store as many as 2 million songs or 1.6 million photos. The 500- and 320-Gbyte versions sell for $99.99 and $79.99, respectively.
Western Digital Corp, www.wdc.com

Toshiba Exceria memory cards provide transfer rates as fast as 95 Mbytes/sec

The Exceria SDXC and SDHC memory cards tout capacities of 8, 16, and 32 Gbytes. All devices have power-supply voltages of 2.7 to 3.6V. Type 1 devices have maximum read and write speeds of 95 and 90 Mbytes/sec, respectively; Type 2 devices have maximum read and write speeds of 95 and 60 Mbytes/sec, respectively; and Type HD versions have maximum read and write speeds of 90 and 30 Mbytes/sec, respectively.
Toshiba America Electronic Components, www.toshiba.com/taec

Alliance Memory enters SDRAM market with SC4 family

The 64-Mbit AS4C4M16S, 128-Mbit AS4C8M16S, and 256-Mbit AS4C16M16S CMOS synchronous DRAMs find use in communications, medical, and consumer products requiring high memory bandwidth. Internally configured as four banks of 1M, 2M, or 4M words by 16 bits with a synchronous interface, the units operate from one 3.3V power supply and are lead- and halogen-free. They come in 44-pin, 400-mil, plastic TSOP II packages and offer access time from the clock as low as 4.5 nsec at a 5-nsec cycle and clock rates of 143 to 200 MHz. The burst lengths are one, two, four, eight, or full-page, with a burst-termination option. Clock rates for the 64-, 128-, and 256-Mbit devices are 166 or 143; 166 or 143; and 200, 166, or 143 MHz, respectively. Prices are 80 cents, $1.30, and $1.60, respectively.
Alliance Memory Inc, www.alliancememory.com

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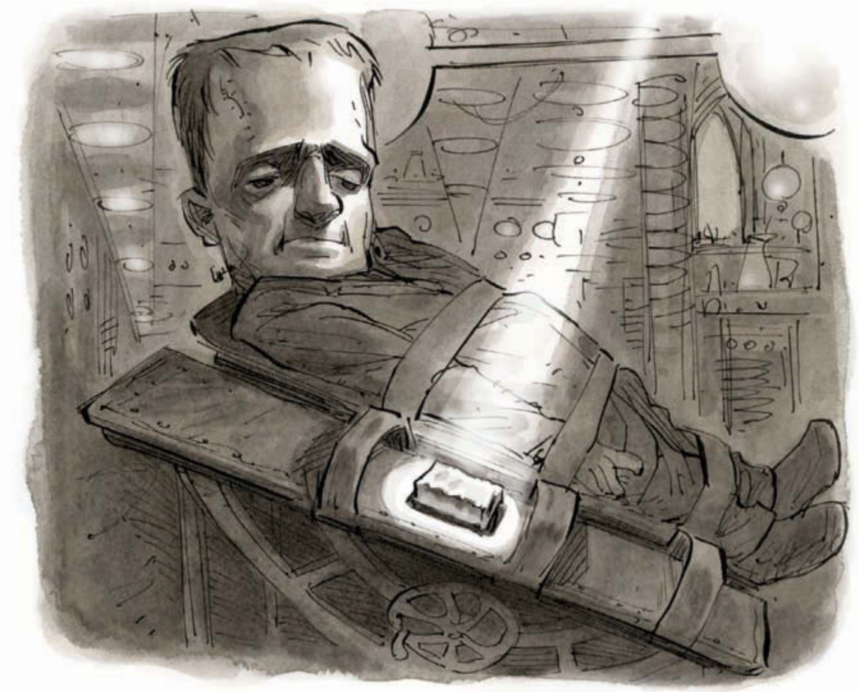
Aluminum box foils Frankenstein's monster



In the early 1970s as a fresh Perdue graduate, I took a job at a local factory. It was one of several manufacturing facilities of a large company. Except for one resident engineer, all design and engineering flowed down to us from the home office. Our plant produced thick-film hybrid circuits: a ceramic baseplate with conductors screen-printed on it, then screen-printed resistors, and, finally, discrete components soldered in place. A few parts needed resistors with close tolerances; we intentionally printed those parts with resistance lower than desired, then sand-blasted the resistors to the correct value. A final dip in epoxy produced the rectangular, multilead parts you have likely seen in old radios and other devices.

The company took an order for a part that had tight phase-angle tolerances. We needed to adjust three resistors to achieve precise phase angles with the capacitors soldered to the plate; this fix was a so-called functional adjust. This product was worth a great deal of money to the company, and we needed to get it right. In due course, the engineers arrived with a truckful of oscillators, digital phase meters, comparators, controllers, and all manner of other support gear to do the critical adjustments. It was interconnected with GPIB cables, and we were renting it by the month.

The learning curve on this part was slow and painful. We had to run the sandblasters at the lowest possible speed so that we did not overshoot the phase angle. We had low output and a high failure rate at final testing. Our resident engineer was spending a great deal of time trying to get everything working right, but it was obvious that he and the other higher-ups were worried.

I was on third shift to keep the production equipment, including the all-important functional adjust, running through the night. Although I was just a technician, I was the de facto shift supervisor, as well.

Functional adjust had me pulling my hair, too. One night, when fixing yet another problem with it, I went through the entire setup. It struck me that the biggest problem was that, by the time the phase comparator saw the proper phase angle, it could not quickly enough signal through GPIB to cut off the sandblaster. To my amazement I discovered that the manufacturer had specified all of the phase-angle tolerances at one frequency, meaning that we could perform the phase-angle adjustment by trimming to a precise time lag between the input and the output. We had all been admonished to leave the setup alone to the extent possible; after all, it was the fruit of many months of work by many engineers.

I took advantage of my third-shift situation to secretly build a box with comparators and one-shots taking the place of the ohmmeter circuits we used for more mundane resistor adjustment. When it was ready, I set up the 2×5×7-in. aluminum box next to Frankenstein's monster from the home office. I ran off about 10 parts and felt vindicated when final test showed a much tighter scatter in values, plus it ran about four times faster than the monster.

When the day crew arrived, I told our lone engineer what I had done, showed him the setup, and handed him the parts I had adjusted earlier. As I left for home, I saw him practically running to final test, giddy with the prospect of knocking me down a few pegs for insubordination and no doubt directing the heat for our poor output in my direction.

Instead, he ran tests on my box for a couple of days, and my setup was soon running in parallel with Frankenstein's to increase our output. Within a week or two, Frankenstein's monster was sitting idle, and my box was going full-tilt. Production was up, and rejects were down. We later unceremoniously packed up the rented gear and returned it to the rental company. **EDN**

Richard Oliver is an engineer working on the 4.2m Discovery Channel Telescope at Lowell Observatory (Flagstaff, AZ).

DANIEL VASCONCELLOS

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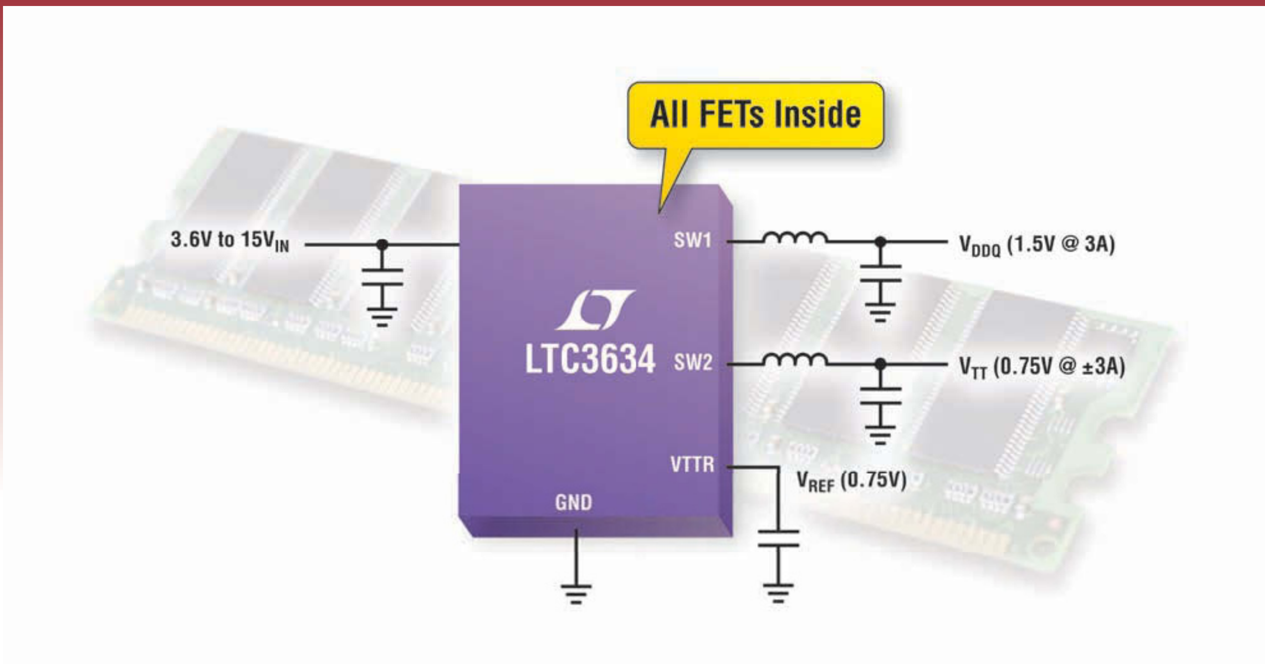

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LTC3618	2.25 to 5.5	V_{TT} ±3A & V_{DD} +3A or V_{TT} ±6A	±10	0.5
LTC3634	3.6 to 15	V_{TT} ±3A & V_{DD} +3A or V_{TT} ±6A	±10	0.5
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