A Canon Communications LLC Publication

EDN

VOICE OF THE ENGINEER

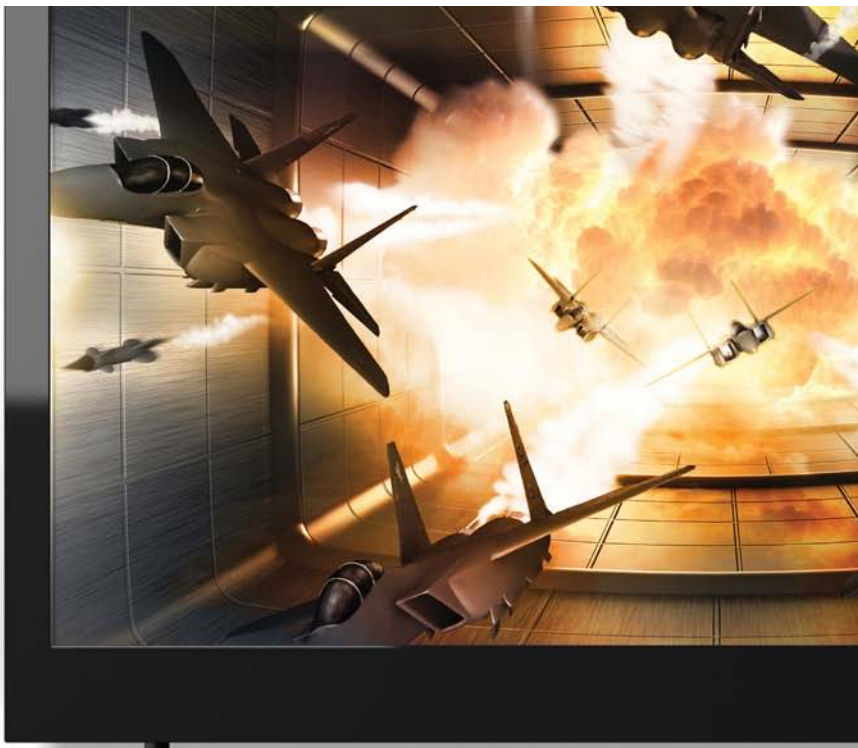
SEPT 23
Issue 18/2010
www.edn.com

THE QUEST FOR ROBUST WIRELESS HIGH-DEF VIDEO CONNECTIONS

Page 32

SILICON TV TUNERS: THE GAME IS ON

Page 24



Battery life gets an extended encore.

Discover how Cirrus Logic's new audio products crank up the volume on battery life.

At Cirrus Logic we're setting new standards for reduced power consumption. The CS42L73, our innovative new low-power smartphone codec, is engineered to significantly extend battery life by bypassing the applications processor for audio functions without compromising audio quality. Our new CS35L00 Class-D amplifier rocks with best-in-class idle power consumption in an unbelievably small package. Cirrus Logic ICs help you save power, simplify design and achieve superior sound quality in your mobile devices. Innovation has never sounded better.

Make battery life rock. Find out more at cirrus.com.

Register for free samples at www.cirrus.com/ednaudio

CIRRUS LOGIC®

TAKE CONTROL

From Prototype to Production!

SAME-DAY SHIPPING on orders entered by 8:00 pm CENTRAL
NEXT-DAY DELIVERY

1. "Always has available product"
2. "Has an excellent website"
3. "Supports your global distribution needs"
4. "Provides on time delivery"
5. "Is easy to do business with"
6. "Most preferred distributor"

Digi-Key rated #1 in all categories.
Source: *TechInsights*, Distributor Evaluation Study, May 2009.

Digi-Key® CORPORATION

Over 465,000 electronic components in stock from more than 440 supplier partners.*

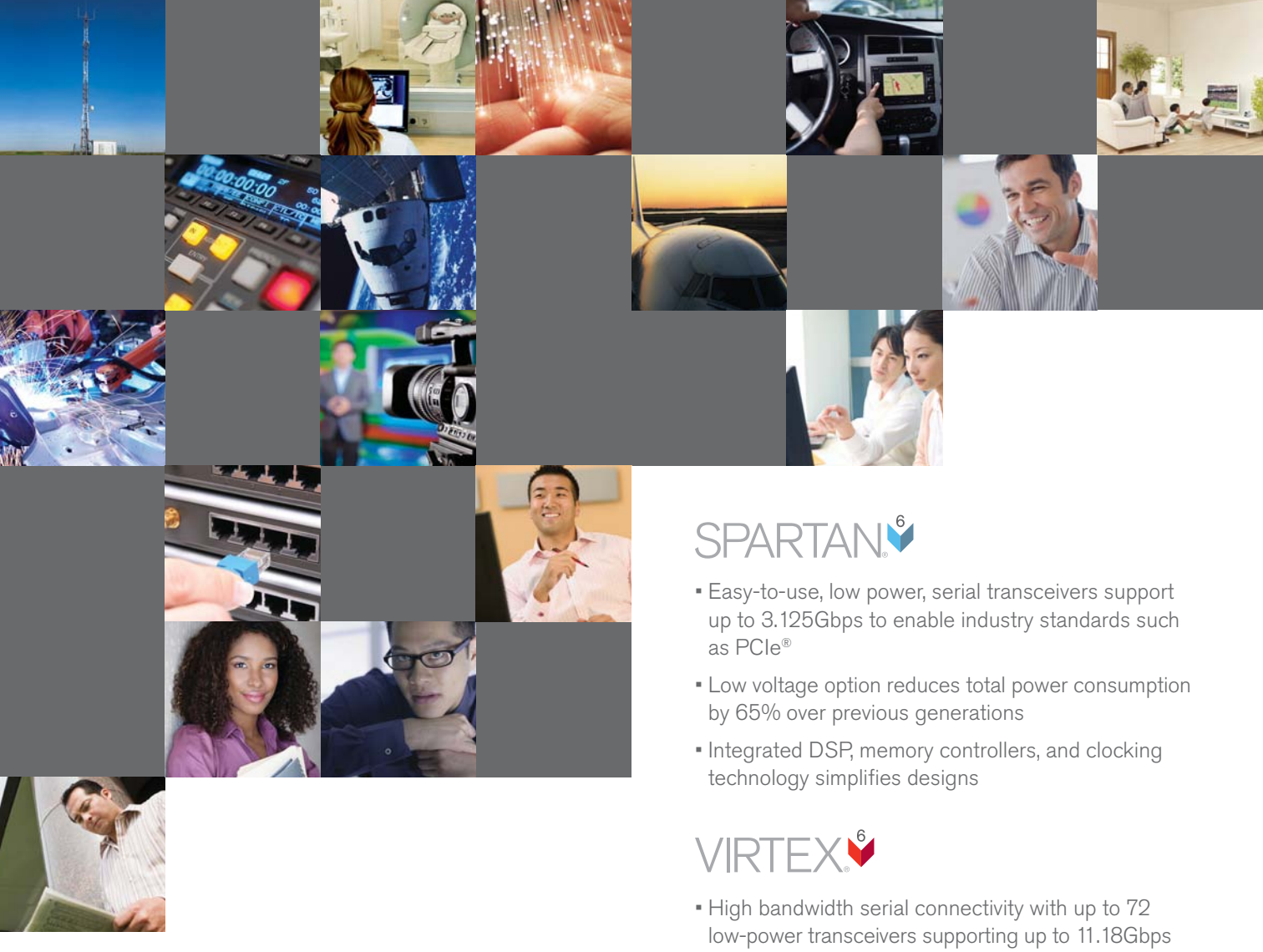
The industry's broadest product selection available for immediate delivery

www.digikey.com

1.800.344.4539

*Digi-Key is an authorized distributor for all supplier partners. New products added daily. © 2010 Digi-Key Corporation, 701 Brooks Ave. South, Thief River Falls, MN 56701, USA

NEDA Supplier Authorized Distributors



SPARTAN®-6

- Easy-to-use, low power, serial transceivers support up to 3.125Gbps to enable industry standards such as PCIe®
- Low voltage option reduces total power consumption by 65% over previous generations
- Integrated DSP, memory controllers, and clocking technology simplifies designs

VIRTEX®-6

- High bandwidth serial connectivity with up to 72 low-power transceivers supporting up to 11.18Gbps
- Ultra high-performance DSP using up to 2016 low-power, performance-optimized DSP slices
- Integrated high-performance ExpressFabric™ technology running at 600 MHz clocking and performance-tuned IP blocks
- Proven cost-reduction with EasyPath™-6 FPGAs

Potential. Realized.

Unleash the full potential of your product design with Xilinx® Virtex®-6 and Spartan®-6 FPGA families — the programmable foundation for Targeted Design Platforms.

- Reduce system costs by up to 60%
- Lower power by 65%
- Shrink development time by 50%

Realize your potential. Visit www.xilinx.com/6.

XILINX®

EDN 9.23.10 contents

The quest for robust wireless high-def video connections

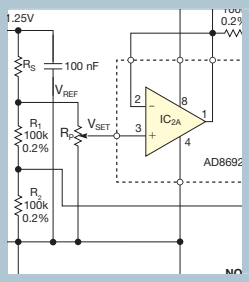
by Brian Dipert, Senior Technical Editor

Silicon TV tuners: The game is on

by Paul Rako, Technical Editor

pulse

DESIGNIDEAS



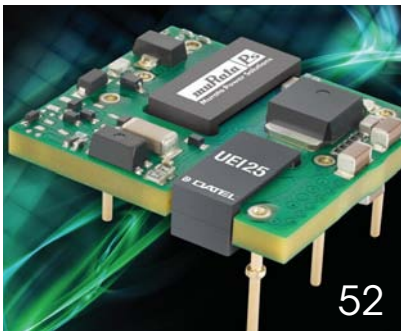
MEET THE GUY that ELIMINATED HIS TEAM'S MANUFACTURING VARIABILITY ISSUES.

FIX YOUR MANUFACTURING VARIABILITY PROBLEMS AND YOUR REPUTATION WILL PRECEDE YOU. If you're designing chips for high functionality, high speed and lower power consumption at the most advanced process nodes, you've got variability issues. We have the solution that will increase your yield, performance and prestige by a wide margin. | Get more information at mentor.com/solutions/manufacturing-variability.

Mentor Graphics®

THE EDA TECHNOLOGY LEADER

contents 9.23.10



52


54

DEPARTMENTS & COLUMNS

EDN online contents www.edn.com

ONLINE ONLY

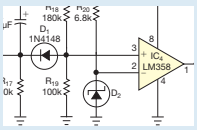
Check out these Web-exclusive articles:

A primer for successful integration of complex hard IP in physical design
The designer must address several challenges when integrating a hard-IP cell.
➔www.edn.com/100923toca

Evolutionary growth, not revolutionary
Avnet Electronics Marketing President Harley Feldberg spoke to *EDN* about inventory in the electronics supply chain, how to bring about sustainable growth, and the Asian and Japanese distribution markets.
➔www.edn.com/100923tocb

Satisfying teenagers while making money in an era of "smart everything"
During a panel session at GlobalFoundries' recent Global Technology Conference, CEOs agreed that teenagers are the drivers behind much of the collaboration work that is now taking place in the semiconductor ecosystem.
➔www.edn.com/100923tocc

WANTED: Design Ideas



Want to see your work featured in *EDN*? Submit your own Design Idea—a short, compact article that helps solve problems or shows innovative ways to accomplish design tasks. We review articles that fall into virtually any technology area: analog or digital circuits, programmable logic, hardware-design languages, systems, programming tips, useful utilities, test techniques, and so on. The idea should be useful or innovative or tricky. And if we accept your Design Idea, we pay you $150.

To learn what makes a good Design Idea entry, spend some time browsing our archive of Design Ideas at www.edn.com/designideas. For information on how to submit a Design Idea, see the Design Ideas Writers' Guide: www.edn.com/100923tocd.

EDN® (ISSN#0012-7515) is published semimonthly, 24 times per year, by Canon Communications LLC, 11444 W. Olympic Blvd., Los Angeles, CA 90064-1549; 310/445-4200; FAX 310/445-4299. Periodicals postage paid at Los Angeles, CA, and at additional mailing offices. SUBSCRIPTIONS—Free to qualified subscribers as defined on the subscription card. Rates for nonqualified subscriptions, including all issues: US, $150 one year; $250 two years; $300 three years. Except for special issues where price changes are indicated, single copies are available for $10 US and $15 foreign. For telephone inquiries regarding subscriptions, call 763/746-2792. E-mail: EDN@kmpsgroup.com. CHANGE OF ADDRESS—Notices should be sent promptly to PO Box 47461, Plymouth, MN 55447. Please provide old mailing label as well as new address. Allow two months for change. NOTICE—Every precaution is taken to ensure accuracy of content; however, the publisher cannot accept responsibility for the correctness of the information supplied or advertised or for any opinion expressed herein. POSTMASTER—Send address changes to EDN, PO Box 47461, Plymouth, MN 55447. Canada Post: Publications Mail Agreement 40612608. Return undeliverable Canadian addresses to Pitney Bowes Inc, PO Box 25542, London, ON N6C 6B2.

BY RICK NELSON, EDITOR-IN-CHIEF

The myths of carbon-spewing LEDs and e-mail attachments

Urban myths are getting a boost from *The Boston Globe* and *The New York Times* Web sites, as the newspapers amplify dubious claims appearing in *The Economist* and *Mother Jones* (**references 1** through **4**). These sources claim that LEDs will so drastically increase our power consumption that governments should make the use of incandescent bulbs mandatory.

According to the article in *The Economist*, "Precedent suggests that [the adoption of LEDs] will serve merely to increase the demand for light. The consequence may not be just more light for the same amount of energy but an actual increase in energy consumption." The magazine attributes this conclusion to another article by Jeff Tsao of Sandia National Laboratories and his colleagues (**Reference 5**). According to *The Economist*, the authors predict that the introduction of solid-state lighting could increase the consumption of light by a factor of 10 within two decades.

I admit that there is a rebound effect, which means that the more people use a product, the cheaper it gets. For example, if you improve your gas mileage by 40%, you are likely to drive 4.4% more miles. But a tenfold rebound seems patently ridiculous.

Fortunately, *The New York Times* item provided Tsao and his colleagues a chance to respond promptly in the comments section, previewing a letter they've sent to *The Economist* (**Reference 6**). They write, "Your surprisingly negative article on energy-efficient lighting technologies … appears to have resulted from a misunderstanding of our *Journal of Physics D* paper," noting that developing countries will drive a substantial growth in global light consumption over the next two decades regardless of what light sources are in use and that increases in lighting consumption will almost exactly cancel out energy savings due to increases in lighting efficiency, assuming a constant cost per unit of energy. Tsao and his colleagues believe that solid-state lighting offers a "remarkable opportunity to maintain a safe, productive, and well-lit living environment in the face of potentially rising energy costs."

Another myth—of power-hogging, carbon-spewing e-mail—appeared in a *Mother Jones* post, which quotes Matthew Yeager, who works at UK data-services company Computacenter, as saying that sending a 4.7-Mbyte e-mail attachment creates as much greenhouse gas as boiling a teakettle 17.5 times. Commenters to the *Mother Jones* piece do a good job of debunking this claim, estimating that it takes about 5.76 kWhr to boil 17.5 kettles. Gmail tells me that it now provides me with 7495.442017 Mbytes—and counting—of free storage. I don't think it could afford to do that if each 4.7-Mbyte chunk of e-mail that I send as I try to use up all that space costs Gmail 5.76 kWhr.

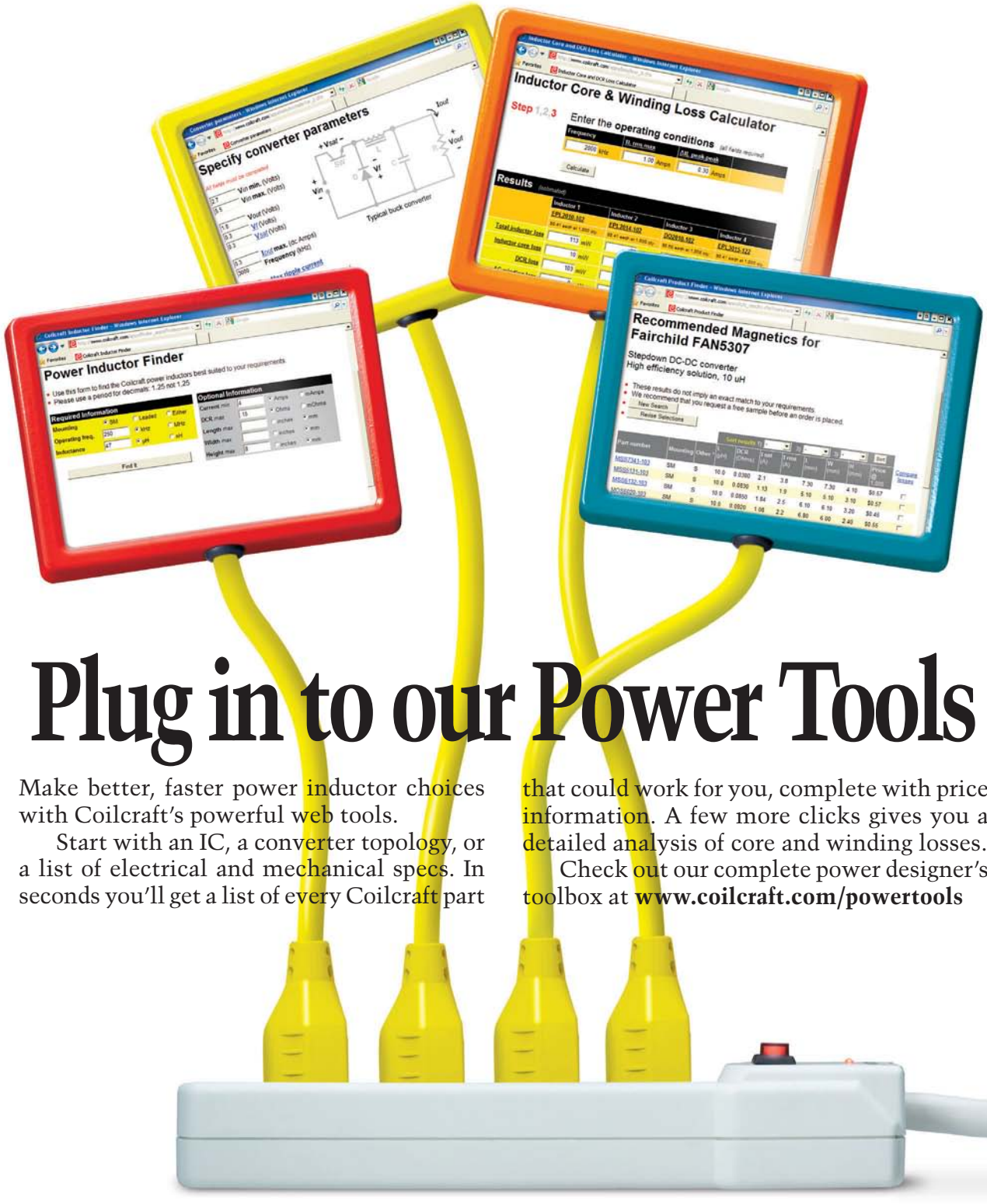
To get an idea of how unrealistic this figure is, it represents about $1 per 4.7-Mbyte message if you're paying 17 cents for a kWhr, about the average for New England residential customers, according to the US Energy Information Administration. Although West Coast industrial customers might pay less than half that amount, I still don't think Google and your Internet-service provider are subsidizing you to the tune of 50 cents per message.

A column on *The New York Times Web* site summarizes the *Mother Jones* piece and draws a similarly scathing response from commenters (**Reference 7**).

So the Web makes it easy to disseminate urban myths, but it also makes it easy to debunk them, right? Not exactly. Unaccountably, *The Boston Globe* rehashed the power-hogging-e-mail myth, exhorting us in an editorial not to forward photos in e-mail (**Reference 8**). According to the editorial, technology companies must create systems that store data with less energy, and governments should provide incentives for them to do so. I agree, but spreading misinformation isn't the way to elicit informed decisions. EDN

Contact me at richard.nelson@cancom.com.

Go to www.edn.com/100923ed for a list of the references used in this column.



Plug in to our Power Tools

Make better, faster power inductor choices with Coilcraft's powerful web tools.

Start with an IC, a converter topology, or a list of electrical and mechanical specs. In seconds you'll get a list of every Coilcraft part that could work for you, complete with price information. A few more clicks gives you a detailed analysis of core and winding losses.

Check out our complete power designer's toolbox at **www.coilcraft.com/powertools**

ORDER DIRECT
BUY.COILCRAFT.COM
800-322-2645
OVERNIGHT DELIVERY ORDER BY 5
RoHS COMPLIANT

Coilcraft®

www.coilcraft.com 800/322-2645

Accelerating Your Success.™

BELL MICRO

AVNET Embedded

Embedded Solutions

Three Times the **Power**

People. Products. Services. The powerful combination of Avnet and Bell Microproducts provides the expertise you need to accelerate your success. Our combined team gives you access to world-class resources. Bringing industry leading line cards together, we now deliver the most extensive inventory of brand name systems, embedded hardware, displays, storage and software. And, with our enhanced services you have access to Avnet's leading ISO integration centers, financial solutions and supply chain strategies.

AVNET® Embedded

1 800 332 8638
www.em.avnet.com/embedded

NEDA Supplier Authorized Distributor

Follow us on Twitter!
www.twitter.com/avnetdesignwire

EDN

PUBLISHER, *EDN* WORLDWIDE
Russell E Pratt, 1-781-869-7982;
russell.pratt@cancom.com

ASSOCIATE PUBLISHER, *EDN* WORLDWIDE
Judy Hayes, 1-925-736-7617;
judy.hayes@cancom.com

EDITOR-IN-CHIEF, *EDN* WORLDWIDE
Rick Nelson, 1-781-869-7970;
richard.nelson@cancom.com

MANAGING EDITOR
Amy Norcross
1-781-869-7971;
fax: 1-781-862-4853;
amy.norcross@cancom.com
Contact for contributed technical articles

ANALOG
Paul Rako, Technical Editor
1-408-745-1994;
paul.rako@cancom.com

MASS STORAGE, MULTIMEDIA, PCs, AND PERIPHERALS
Brian Dipert, Senior Technical Editor
1-916-548-1225;
brian.dipert@cancom.com

NEWS
Suzanne Deffree, Managing Editor
1-631-266-3433;
suzanne.deffree@cancom.com

POWER SOURCES, ONLINE INITIATIVES
Margery Conner, Technical Editor
1-805-461-8242;
fax: 1-805-461-9640;
margery.conner@cancom.com

DESIGN IDEAS EDITOR
Martin Rowe,
Senior Technical Editor,
Test & Measurement World
edndesignideas@cancom.com

SENIOR ASSOCIATE EDITOR
Frances T Granville
1-781-869-7969;
fax: 1-781-862-4853;
frances.granville@cancom.com

ASSOCIATE EDITOR
Jessica MacNeil
1-781-869-7983;
jessica.macneil@cancom.com

CONSULTING EDITOR
Jim Williams, Staff Scientist,
Linear Technology
edn.editor@cancom.com

CONTRIBUTING TECHNICAL EDITORS
Dan Strassberg,
strassbergedn@att.net
Robert Cravotta,
robert.cravotta@embeddedinsights.com

COLUMNISTS
Howard Johnson, PhD, Signal Consulting
Bonnie Baker, Texas Instruments
Pallab Chatterjee, SiliconMap
Kevin C Craig, PhD, Marquette University

LEAD ART DIRECTOR
Marco Aguilera

ASSOCIATE ART DIRECTOR
Tim Burns

PRODUCTION
Michael Ciardiello,
Director of Premedia Technologies
Jeff Tade,
Production Director
Brian Wu,
Publications Production Manager
Jeff Polman, Derric Treece,
Senior Production Artists
William Baughman, Lucia Corona
Ricardo Esparza,
Production Artists

EDN EUROPE
Graham Prophet,
Editor, Reed Publishing
gprophet@reedbusiness.fr

EDN ASIA
Wai-Chun Chen,
Group Publisher, Asia
waichun.chen@cancom.com
Kirtimaya Varma,
Editor-in-Chief
kirti.varma@cancom.com

EDN CHINA
William Zhang,
Publisher and Editorial Director
william.zhang@cancom.com
Jeff Lu,
Executive Editor
jeff.lu@cancom.com

EDN JAPAN
Katsuya Watanabe,
Publisher
katsuya.watanabe@cancom.com
Ken Amemoto,
Editor-in-Chief
ken.amemoto@cancom.com

EXECUTIVE OFFICERS
Charles G McCurdy,
Chief Executive Officer
Fred Gysi,
Chief Financial Officer
Mike Deering,
Chief Technology Officer
Ron Wall,
Senior Vice President, Publications
Kevin O'Keefe,
Senior Vice President, Events Division
Roger Burg,
Vice President, Operations
Jason Brown,
Vice President, E-media

EDN. 33 Hayden Avenue, Lexington, MA 02421. **www.edn.com**. **Subscription inquiries:** 1-763-746-2792; EDN@kmpsgroup.com. **Address changes:** Send notice promptly to PO Box 47461, Plymouth, MN 55447. Please provide an old mailing label as well as your new address. Allow two months for the change.

Canon Communications LLC, 11444 W. Olympic Blvd., Los Angeles, CA 90064-1549; 1-310-445-4200; fax: 1-310-445-4299.

CANON COMMUNICATIONS LLC

EDITED BY FRAN GRANVILLE

pulse

INNOVATIONS & INNOVATORS

Imec reports large-area silicon solar cells with high efficiency

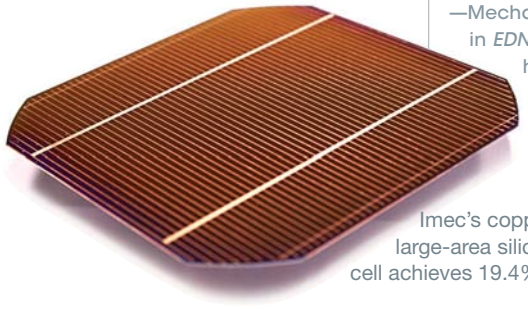
At the 25th European Photovoltaic Solar Energy Conference, which took place in Valencia, Spain, this month, Imec presented several large-area silicon solar cells with conversion efficiency greater than 19%. Imec realized two types of cells with silver-screen-printed contacts and copper-plated contacts. Efficiencies of cells with screen-printed contacts reached 19.1%, and cells with copper-plated contacts achieved efficiencies of 19.4%. Imec attributes the efficiencies to several factors, including a combination of improved texturization and optimized firing conditions. Imec achieved the results on 148-cm^2, 170-micron-thick cells, proving the industrial viability of the process.

Imec's silicon solar cells feature rear-side passivation, laser ablation, and local aluminum backside-field and screen-printed contacts or copper-plated contacts on advanced emitter schemes. Metallization schemes using screen-printed silver contacts enable compatibility with current industrial-metallization practice in the solar-cell industry, according to Joachim John, PhD, team manager for industrial solar cells at Imec. "The copper-based front-side metallization is a step toward higher sustainability and lower cost," he says.

"High efficiency, low cost, and sustainability are the main drivers in Imec's research on crystalline-silicon solar cells, eventually targeting cells that are only 40 microns thick with efficiencies above 20," says Jef Poortmans, PhD, director of the Imec energy/solar program. "We expect further improvements toward efficiencies of up to 20%," he adds.

Imec achieved the results with its silicon-solar-cell IIAP (industrial-affiliation program), a multipartner R&D program that explores and develops advanced process technologies aiming at sharp reduction in silicon use and increasing cell efficiency. **—by Rick Nelson**

▷**Imec**, www.imec.be.



Imec's copper-plated large-area silicon solar cell achieves 19.4% efficiency.

TALKBACK

"In our give-it-to-us-now world, we fail to realize that it is rare for truly great ideas to emerge overnight. So fuzzy logic could be compared to the first car. … It took a few decades for the really high-performance cars to come along, but the first car was still a great idea."

—Mechanical engineer John V, in *EDN*'s Talkback section, at http://bit.ly/cTLFfy. Add your comments.

High-voltage flyback-controller IC eliminates optocoupler

Linear Technology Corp's new LT3748 flyback-power-supply-controller chip eliminates the need for an optocoupler in the feedback loop. Because the chip senses output voltage from the primary-side flyback signal, the transformer requires no sense winding, allowing you to use standard transformers that have UL (Underwriters Laboratories) listing and speeding time to market. The device accepts 36 to 72V input voltages; the maximum voltage is 100V.

The LT3748 operates in boundary mode, which is a variable-frequency current-mode-control switching scheme. It results in ±5% typical regulation over the full line, load, and temperature range and lets you use a smaller transformer. Two external resistors and the transformer turns ratio set the output voltage. Additional features include an onboard low-dropout regulator for IC power, programmable soft start, undervoltage lockout, adjustable current limit, and output-voltage temperature compensation.

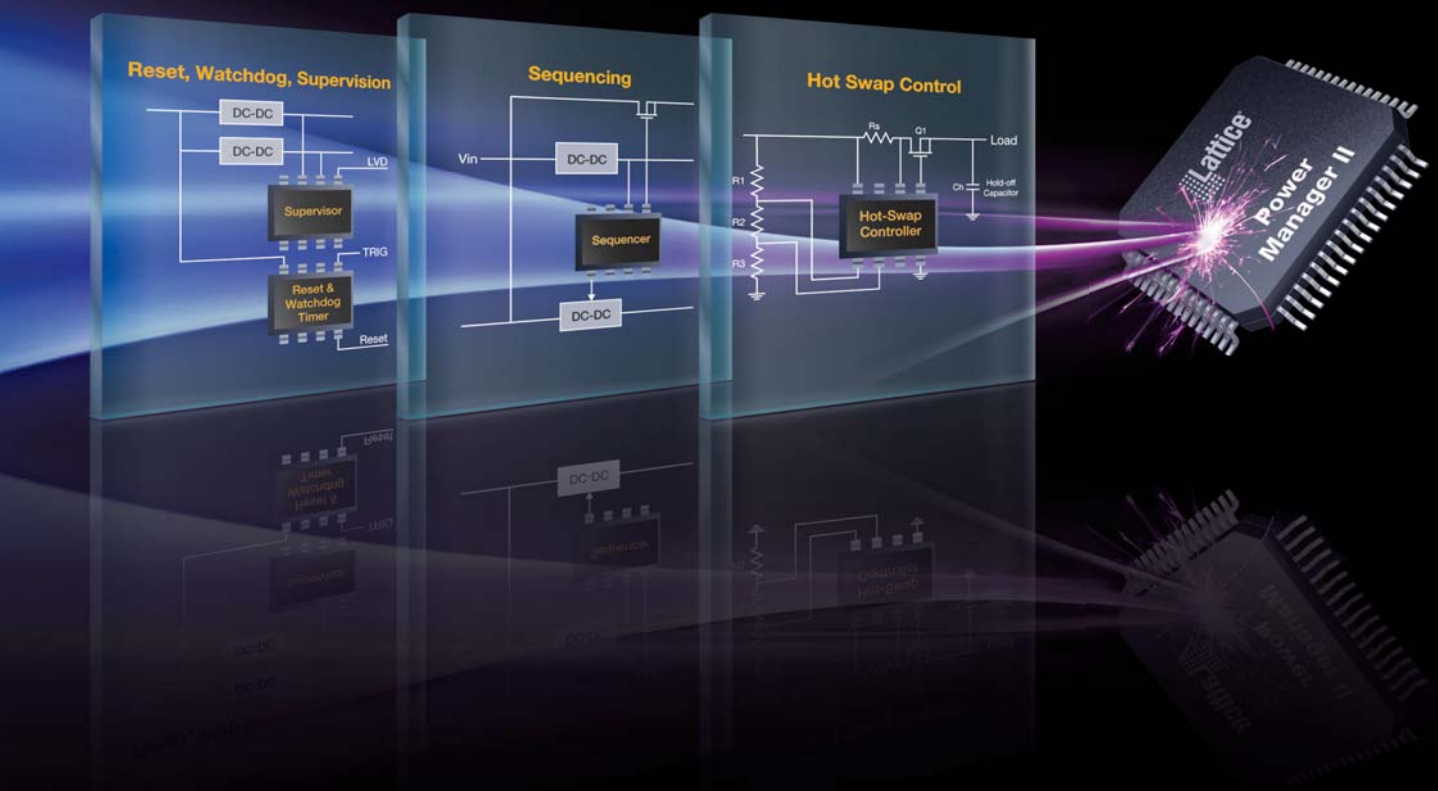
The LT3748 comes in an MSOP-16 with four pins removed to provide high-voltage creepage and clearance distances. It operates in the –40 to +125°C range and sells for $3.12 (1000). **—by Paul Rako**

▷**Linear Technology Corp**, www.linear.com.

Power Manager II.
INTEGRATE POWER MANAGEMENT. LOWER COSTS.

Power Manager II features an innovative programmable core and precision analog sensors to reduce component count and increase reliability. Lattice programmability enables your power management design to meet changing requirements without major circuit redesign or a board re-spin.

Learn more about the cost-efficiencies of Power Manager solutions at:
latticesemi.com/powermanager



Features

- Charge pumps for hot swap MOSFET control
- PLD for flexible supply sequencing and reset generation
- 0.2% error (typ.) programmable comparators for fault detection
- Differential sensing for centralized control
- 10-bit ADC with I^2C interface for system monitoring
- High volume pricing starts at <$1.00

And more...

Benefits

- Integrate multiple functions to reduce BOM cost
- Increase fault coverage
- Reduce footprint
- Increase reliability
- Wide application coverage
- Reduce risks through programmability

And more...

Lattice® Semiconductor Corporation

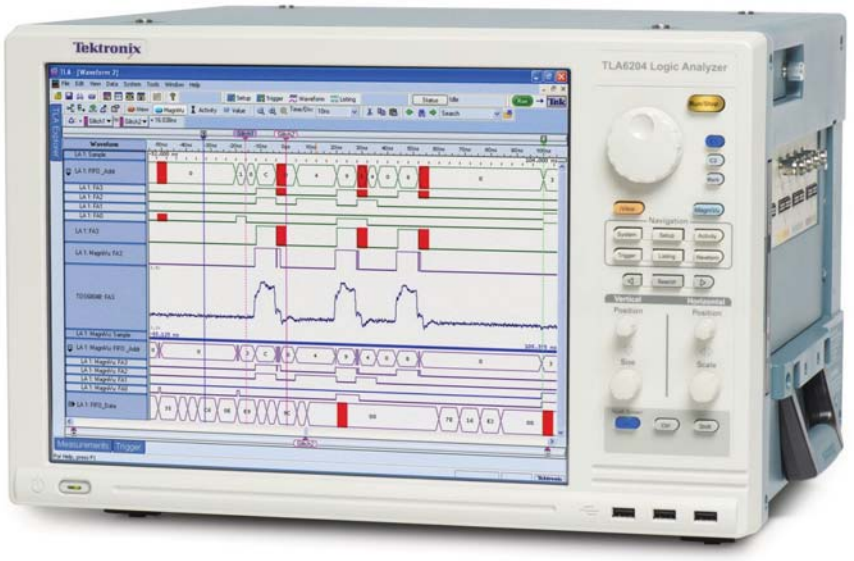
latticesemi.com/powermanager

Midrange logic analyzers lower the cost of high-end embedded-system debugging

Logic analyzers in Tektronix's new TLA6000 series bring powerful high-end debugging and analysis capabilities to mainstream embedded-system designers.

Faster signals and increased board densities often lead to signal-integrity issues, such as crosstalk, ground bounce, and ringing, which manifest themselves in digital-system functional failures. The TLA6000 series provides a tool set to help engineers quickly find, isolate, and debug these hard-to-pinpoint faults. The analyzers suit use in a range of debugging and analysis tasks, including signal-integrity analysis, FPGA debugging and verification, MIPI (Mobile Industry Processor Interface) protocol analysis, memory-system validation, and embedded-software integration and debugging.

The products provide a suite of signal-integrity tools that feature drag-and-drop triggering and advanced analysis software for digital-system applications. The TLA6000 series offers 68-, 102-, and 136-digital-channel configurations with 125-psec timing analysis on all channels, state timing to 450 MHz, and record length to 128 Mbits per channel.



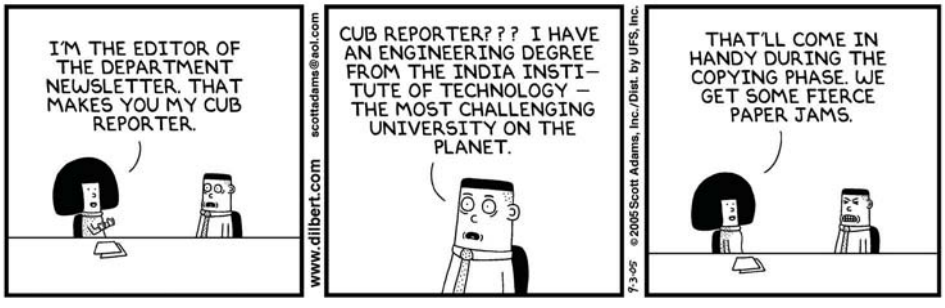
Midpriced TLA6000 series logic analyzers provide an array of high-end embedded-system-debugging capabilities that the manufacturer previously offered only on more expensive instruments.

Products in the TLA6000 series enhance productivity with such features as iCapture multiplexing, which eliminates double probing by enabling simultaneous digital and analog acquisition through a single logic-analyzer probe. Glitch trigger and storage allows you to trigger on and display signal-integrity faults. The iView feature provides a time-correlated display of both logic-analyzer and oscilloscope data on one screen. Fast, simple, and intuitive instrument setup helps to accelerate design cycles. The manufacturer's suggested US retail prices begin at $19,800.

—by Dan Strassberg

▷**Tektronix Inc**, www.tektronix.com.

DILBERT By Scott Adams



RAQ's

Rarely Asked Questions

Strange stories from the call logs of Analog Devices

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.

Make do!

Q. What is the most important characteristic of a successful analog engineer?

A. Ingenuity. I was recently given a subscription to "Make" magazine, which is devoted to gadget construction projects of surprising sophistication using, mainly, cheap everyday materials. Every engineer should read it.[1]

The words engine and engineer come from the Latin *ingenium*, which means *cleverness*. The best engineers use unexpected resources to accomplish their projects faster, better, and at lower cost.[2] Recently, I saw a small boy with a net failing to catch some little fish for a school project. With two plastic soda bottles and some adhesive tape, we made a trap in ten minutes which caught more than two dozen fish in the next hour.

A handful of simple CMOS logic, along with some basic op amp and instrumentation amplifier circuitry, can often perform precision analog functions very efficiently. Analog ASICs, FPGAs, or microcontrollers could probably do the job, but their development, which takes much longer and is expensive, may not be justified where the project is urgent and the quantities involved are small.

This is particularly true with test circuitry. I regularly rant about the necessity of verifying software simulations by checking that the behavior of hardware prototypes is congruent with the simulation results, but the common objection is that it is often hard to test them with simple test gear. Yet most of the time hardware checks are for functionality, not precision, and it is usually possible to make quite complicated signal sources from a handful of parts if their levels and timings need not be too accurate.

It is easy to make buffers, amplifiers, inverters, summing circuits, and sine oscillators with an op amp or two; and 4000-series CMOS is particularly valuable for logic functions in this sort of application because it will work with supplies from 3 V to 18 V, it is much less noisy than most logic (because it is not very fast), its Schmitt input devices can be used in oscillators and delay circuitry, and it is available in dual inline packages, simplifying construction and modification of test circuitry.

When interviewing applications engineers, I always ask the candidates what electronic engineering they have done for themselves recently. I usually hear of small projects, often improving some piece of equipment by increasing functionality using the techniques we have just described.[3]

[1] *www.makezine.com*
[2] *An engineer can do for a nickel what any fool can do for a dollar. (Henry Ford)*
[3] *When told that work is work and spare time is not for engineering I am concerned that the candidate's world view is not really that of a successful engineer.*

To Learn More About Clever Circuit Design
http://dn.hotims.com/27755-101

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

For Analog Devices' Technical Support, Call 800-AnalogD

SPONSORED BY

ANALOG DEVICES

VOICES

Deirdre Walsh: success with social media

Deirdre Walsh, social-media and community manager at National Instruments (www.ni.com), develops strategy and marketing plans for the company's Groundswell award-winning global community of 140,000 engineers and scientists. In an interview requested via Twitter and that led to a LinkedIn connection with an *EDN* editor, Walsh discussed how engineers can use social media for career advancement, education, and idea exchange. Excerpts of that interview follow. For more from this conversation, visit www.edn.com/100923pa.

Why should engineers care about social media?

A When you take a step back and don't focus as much on the technology, you focus more on why social media is helpful. I've outlined five reasons why engineers should care about social media and community. The first one is to get help. Social-media sites are really great for engineers to connect with like-minded engineers. On our NI discussion forum community, engineers answer 50% of all support questions asked by other engineers. It's not NI coming in to solve their problems; it's a peer-to-peer support network.

The second reason engineers should care about social [media] is that it gives them an opportunity to get ahead in their career. Often, news breaks first on sites such as Facebook and Twitter or in blogs. It's a good way to stay ahead of the curve.

The third reason engineers should care about it is that it's a good way to get heard. [For example, NI has] different outlets in which community members can talk directly with R&D. LabView 2010 has 14 new features … that were directly community-driven innovations. Using social media, you can actually change the future direction of the product.

The fourth reason is to stay and get connected with peers. Groups are a really good way to get connected with other engineers. Sites such as LinkedIn also provide a good way to get connected, group with other engineers, do professional networking—maybe find your next job or employee.

Last, I like to joke around that social media can also help you get famous. At NI, we have a blog, Sweet Apps, on which we highlight cool customer applications—from a Twitter-powered popcorn machine to hot "green"-engineering topics.

Keeping up with all of the social-media outlets can be time-consuming, if not exhausting. How can engineers manage this work?

A Pick the thing you are trying to do or the topic that you care about and listen and engage in that topic. Scale these things so that they are not overwhelming. People get really caught up in the technologies. It's less about the technologies and more about the conversation. Really evaluate the platforms for the types of conversations that you are interested in joining and then join that conversation.

As a group, engineers tend to be considered introverts who would rather do than talk about doing. How does NI encourage its engineers to engage in the conversation?

A We allow them to do things online. It's not about what I had for breakfast this morning or following a LabView bug. They can do things online together. We have a really strong code exchange, for example, on which engineers can download code and share their own code. Another thing is giving and providing support. We have a strong support network in which people talk through difficult engineering problems they are facing. There's also the idea exchange in which you're having a conversation directly with LabView R&D. There's no marketing filter.

People have a stereotype that engineers aren't social, but I find that, when you give them opportunities to share content and have the conversations that they care about, they are some of the best community participants out there.

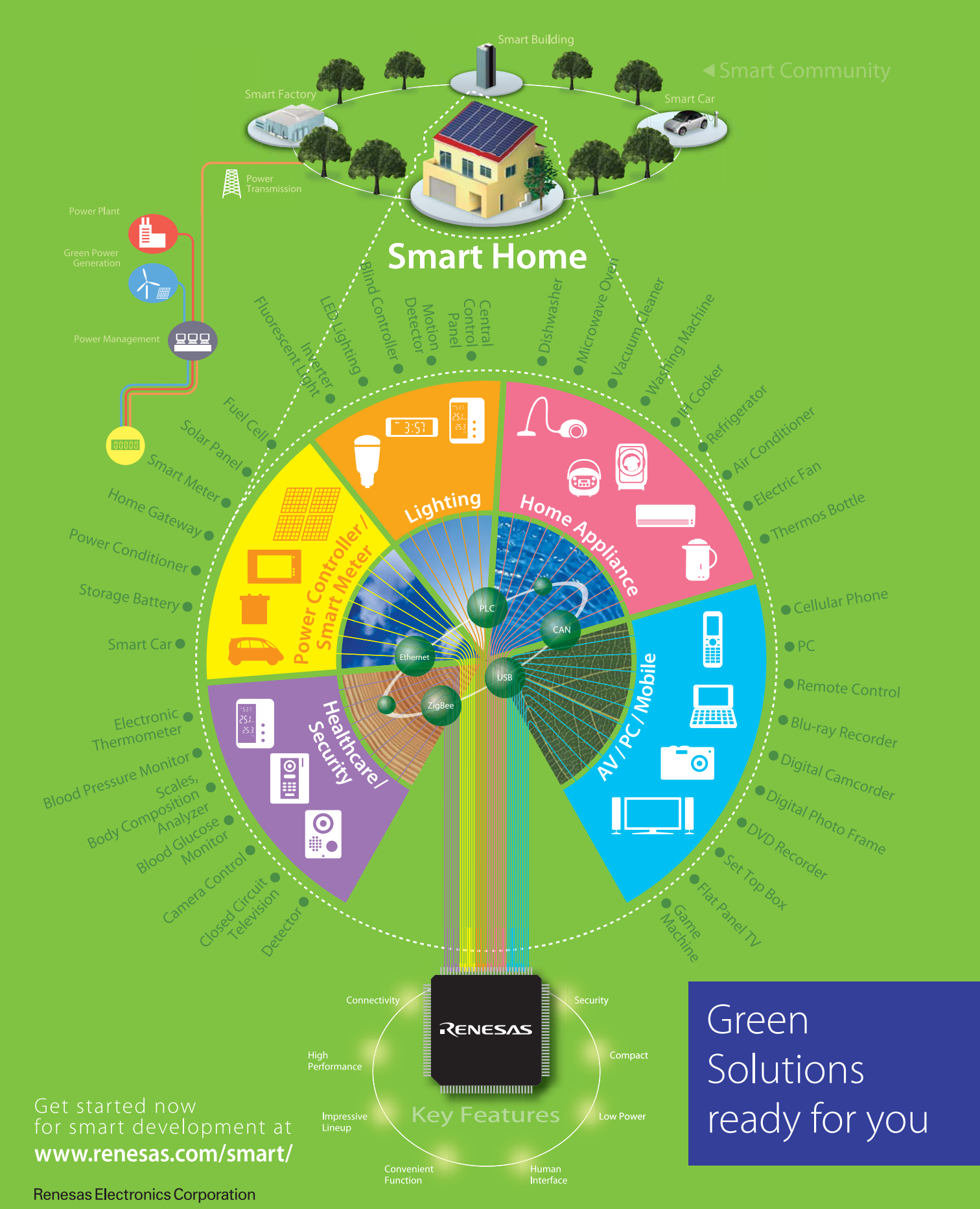
Many social-media networks are out of companies' or individuals' controls. Twitter went down during NIWeek 2009. How do you manage a community's conversation when that conversation is on someone else's network?

A We prioritize the community on our site, first of all, and we try not to re-create our community on third-party platforms. I continue to watch each one of these platforms and don't put anything on there that would risk our IP [intellectual property]. I am careful about what type of content we put on there. But it's about our users' being there and actively engaging in conversation, and we want to be there, as well.

What are your top three tips for properly using social media for engineers?

A Number 1: Don't get overwhelmed by the technology; focus on building connections with other people and having valuable conversations. Number 2: Realize that, if you start a blog or a community, you have to go engage in dialogue and make it easy for the people that would care about that [blog] to know about it. Number 3: Realize that a lot of people are using these tools for personal reasons, but there's a lot of business value, as well. Be thinking about how to use these tools that you might find fun in your personal life in your professional life, as well.

—interview conducted and edited by Suzanne Deffree



Green Solutions ready for you

Get started now for smart development at
www.renesas.com/smart/

Renesas Electronics Corporation

RENESAS

BY BONNIE BAKER

Taking the mixed-signal voltage reference to a higher level

You know from my last column that the voltage reference in a mixed-signal application can make or break a system (**Reference 1**). The greatest impact of a noisy or a marginally stable reference is at or near the converter's full-scale output. You can improve this scenario by looking for the lowest-noise, most accurate, stable reference on the market, but you may want to try to look for another approach. Cash flow is a little tight right now, so a bit of design finesse can save the day.

First, consider the ins and outs of the converter's reference-pin input. **Figure 1** shows an example of the charge spikes that can appear on a modern ADC's voltage-reference pin during a conversion. The top trace is the start-convert signal to the converter. The ADC's voltage-reference pin (bottom trace) demands different amounts of charge during the conversion. In this **figure**, an oscilloscope's low-capacitive probe captures the voltage drop across a 10-kΩ resistor between the input of the ADC voltage-reference pin and the voltage-reference output. The voltage reference for an ADC must be able to accommodate these high-frequency charge spikes.

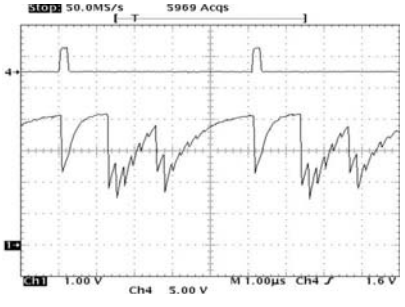


Figure 1 Charge spikes can appear on an ADC's voltage-reference pin during a conversion. The top trace represents the strobe that initiates a conversion. The ADC's voltage-reference pin (bottom trace) demands different amounts of charge during the conversion.

Voltage references are available in two-terminal shunt or three-terminal series configurations (**Figure 2**). The two-terminal shunt voltage reference implies that the entire IC chip of the shunt reference operates in parallel with its load (**Figure 2a**). With a shunt voltage reference, you apply an input voltage to the resistor that connects to the cathode. The typical initial voltage accuracy of this device can range from 0.5 to 5%, with a temperature coefficient of approximately 50 to 100 µV/°C. The shunt voltage reference is appropriate for converters with less than 8 bits.

The series voltage reference operates in series with its load (**Figure 2b**). An internal bandgap voltage, in combination with an internal amplifier, creates the output voltage of this reference. The series voltage reference produces an output voltage between the output and ground and provides the appropriate output current to the external load. As the load current increases or decreases, the series reference maintains the voltage at V_{OUT}.

The typical initial voltage accuracy of a series reference can range from 0.05 to 0.5%, with temperature coefficients as high as 2.5 ppm/°C. Because of the series reference's superior initial voltage and overtemperature performance, you can use this type of device when driving the reference pins of precision ADCs and DACs. Beyond 8 resolution bits, where the LSB (least-significant bit) size is 0.39%, or 14, where the LSB size is 0.006%, an external series voltage reference ensures that you can achieve the intended precision with your converter.

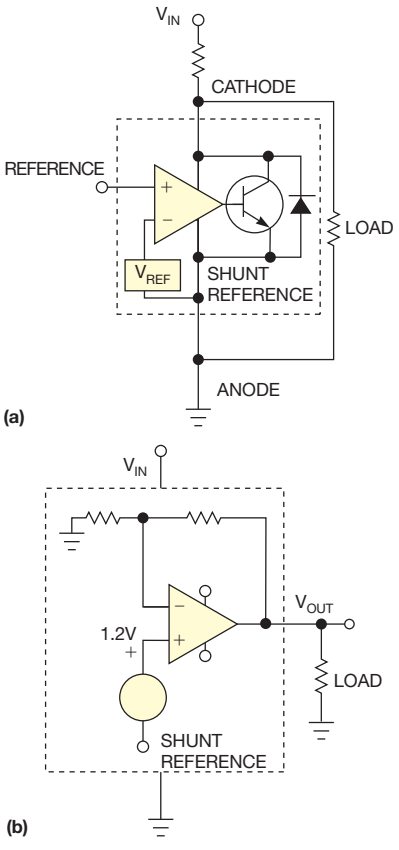


Figure 2 The two-terminal shunt voltage reference implies that the entire IC chip of the shunt reference operates in parallel with its input load (a). The series voltage reference operates in series with its load (b).

Stay tuned for next month, when I'll examine references for higher-precision ADCs. EDN

REFERENCE

1 Baker, Bonnie, "How voltage references affect mixed-signal parts," *EDN*, Aug 26, 2010, pg 18, http://bit.ly/cp4yjF.

Bonnie Baker is a senior applications engineer at Texas Instruments.

Renesas Extreme 32-bit Flash MCUs

All the real time control, signal processing, and connectivity you need….without penalty

100MHz – 165DMIPS – FPU Zero-Wait Flash – 500uA/MHz

RX600 series MCUs based on the revolutionary new RX CPU core are here. Full CPU performance is unleashed by the fast 90 nm Flash memory, feeding instructions to the CPU even at full speed. No waits, no stalls, no memory acceleration is required, just pure predictable performance for your embedded control and DSP tasks.

Product Line

RX610 — General Purpose

Up to 2MB Flash & 128KB SRAM for embedded control apps with high CPU processing capability & lots of I/O.

RX62N & RX621 — Network

Ethernet (N/A on RX621), USB Host/Device/OTG, CAN & 12-bit ADC for networked embedded control apps. Up to 2ch USB Host/Device/OTG.

RX62T — Motor & Inverter Control

Specific timers, fast 12bit ADCs, and special op amps with programmable gain for low-cost motor control & solar panel power inverters. Reduce the number of external components. Controls up to two motors at once.

Key Features

RX High-performance 32-bit CPU

- 100MHz, 1.65 DMIPS/MHz
- 32-bit FPU and MAC integrated into the CPU core (no coprocessor)
- Harvard Architecture CPU with 5-stage Pipeline
- One clock per instruction, only 5-clock Interrupt Response

Zero-Wait 90 nm Flash

- No Memory Acceleration required, making very deterministic embedded control
- 100MHz, 10 nsec access, 64KB to 2MB

Low Power Consumption

- 500 uA/MHz with all peripherals on
- Under 1uA Deep Standby (RX610)

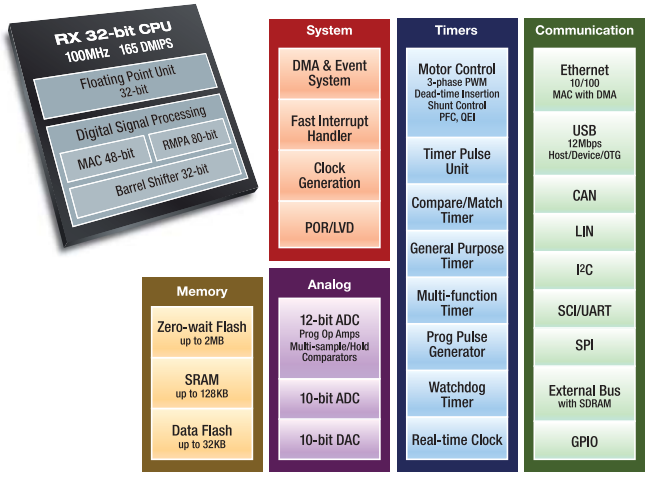
Code Efficiency

- Multiple-Length CISC Instructions
- 25% Smaller Code Size than popular 32-bit MCU architectures

Development Tools

- Full Integrated Development Environment with Renesas HEW, IAR, and GNU/Eclipse

RX62N Group Block Diagram



#1MCU REACH FURTHER

Experience the power of RX and learn about the entire family.

Register to be eligible to receive a FREE RX development kit or equivalent.

www.am.renesas.com/ReachRX600/a

Renesas Electronics Corporation

No.1 supplier of microcontrollers in the world
Source: Gartner, "Semiconductor Applications Worldwide Annual Market Share: Database" 25 March 2010. This is the 2009 ranking based on revenue.

RENESAS

PRY FURTHER AT EDN.COM

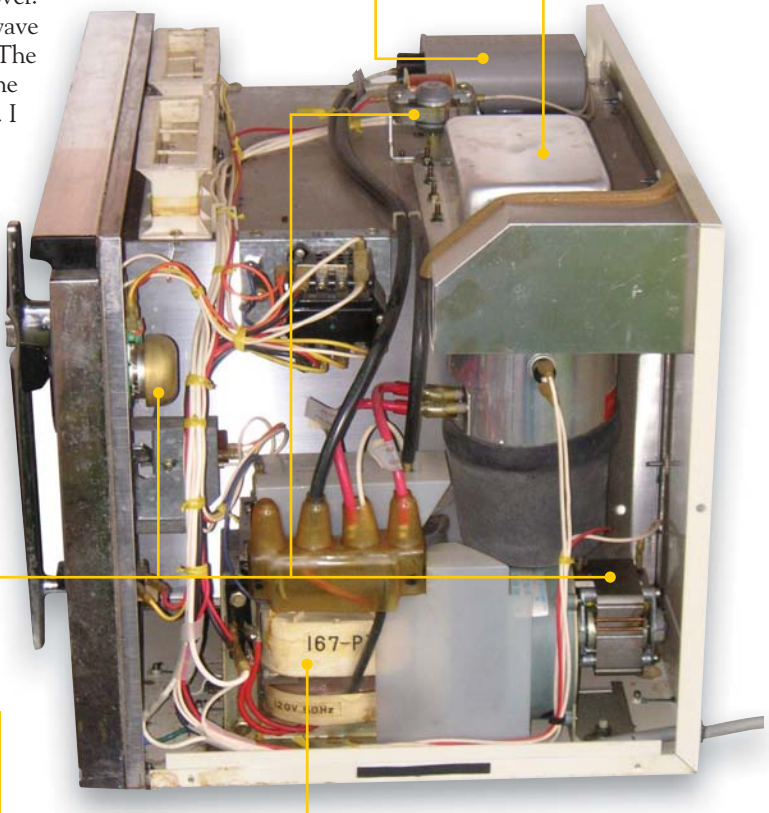
Go to www.edn.com/pryingeyes for past Prying Eyes write-ups.

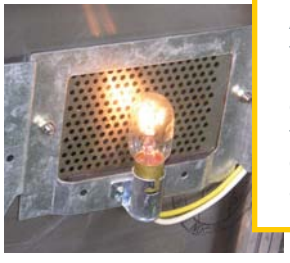
The Sharp R-6300 microwave oven

Like people, a consumer product can have dignity and integrity, although those qualities are rare in both. I have always treasured this Sharp microwave oven. The compelling feature of the unit is its analog control paradigm. You turn a dial to the desired minutes of cooking time and press a button. The microwave either times out or turns off when you open the door. There is no programming and no endless typing and poking of buttons to get the oven to operate. Everything about this oven is well-made. You can see quality in things ranging from the large Bakelite contactor relay to the crisp and uniform laminations of the motor stators. The wire routing and retention are impeccable. The designers ensured safety with a redundant door switch that deactivates the magnetron even if the latch switch fails. A resistor bleeds off residual capacitor voltage to protect service people. A schematic is glued to the inside of the cover. These days, it may be possible to buy a commercial microwave with this level of quality and serviceability, but I doubt it. The capacitor has 1972 stamped on it. The oven has worked fine for almost 40 years. I hope it keeps working for a few more. I have not been able to find a duplicate on eBay.

A Nichicon capacitor smooths the ac output to create dc power for the magnetron. Because energy storage in a capacitor is a function of voltage squared, this 0.47-µF, 2400V capacitor can store an amount of energy similar to that of a 0.1F capacitor at 5V.

The RF waveguide is constructed from deep-drawn aluminum. It sits above the magnetron, next to the cooling duct that vents forced air out of the magnetron.





A 120V-ac bulb lights the oven cavity. It is a straightforward operation to remove the bracket and clean the plastic film and perforations.

The unit has three shaded-pole motors. One runs the stirrer fan inside the oven. A Kondo Electric Works motor drives a squirrel-cage fan that blows air through the magnetron. The third motor operates the cook timer.

The thin plastic cover was obstructing the stirrer fan, causing what I had interpreted as a loss of power. This fan is not meant to circulate air. Rather, it reflects and disperses the microwaves so that the food is evenly bathed in radiation. I had pushed the cover into the fan while cleaning it. Removed to show the fan, the rear of the cover is supposed to fit into the channel in the back wall. Careful reassembly will ensure that the fan operates properly.

A high-voltage transformer steps up wall voltage to the thousands of volts the magnetron requires. A rectifying diode assembly sits on top of the transformer. The product contains no PCBs (printed-circuit boards). Rubber boots and plastic covers protect service personnel and curious engineers from electrocution.

Find it at
mathworks.com/accelerate
datasheet
video example
trial request

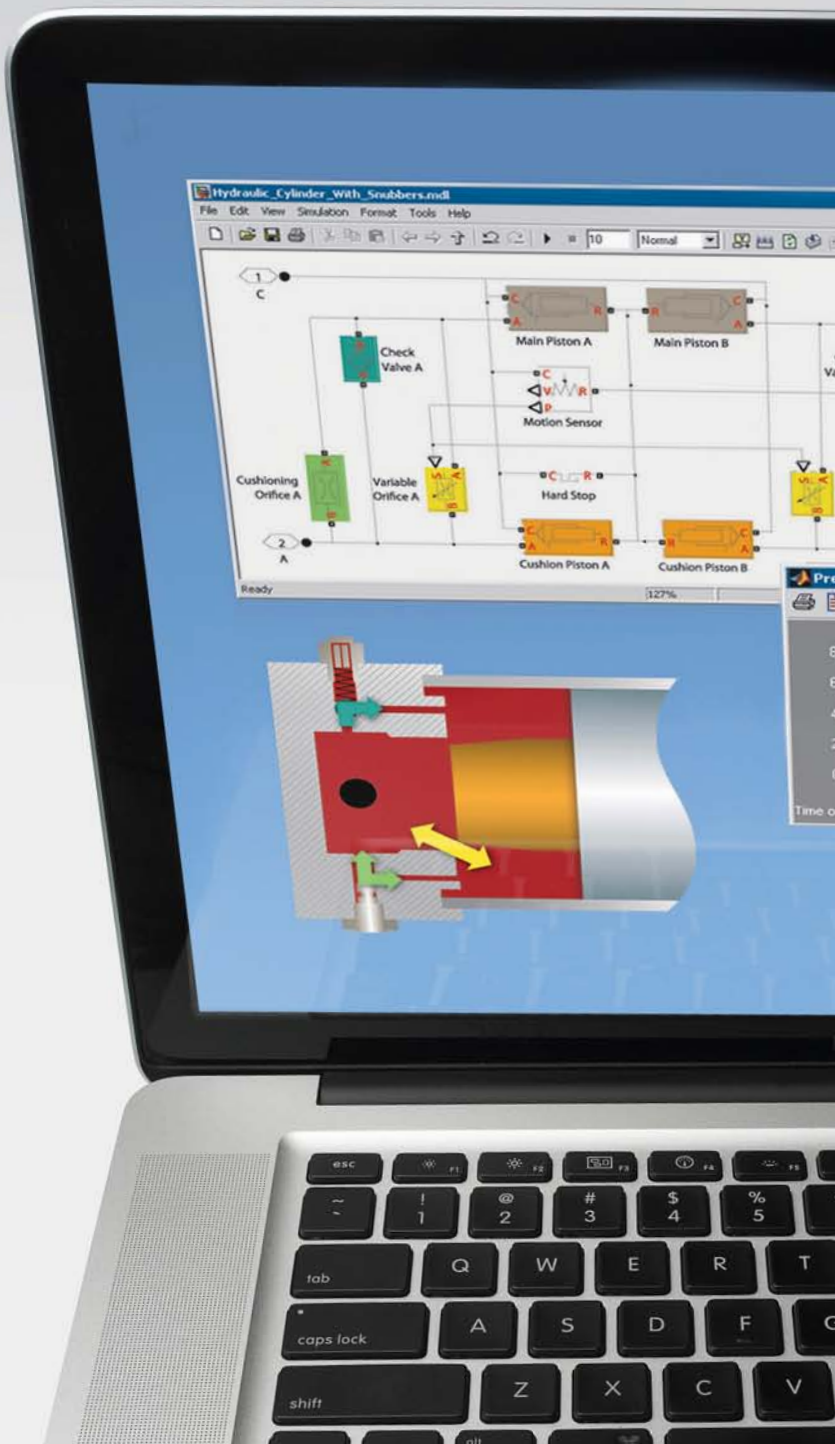
MODEL PHYSICAL SYSTEMS

in

Simulink

with **Simscape™**

- **Electrical**
- **Mechanical**
- **Hydraulic**
  and more



Use SIMSCAPE with SIMULINK to model and simulate the plant and controller of an embedded system. Assemble your model with a graphical interface, or import physical models from CAD systems. Use built-in components or create your own with the Simscape language.

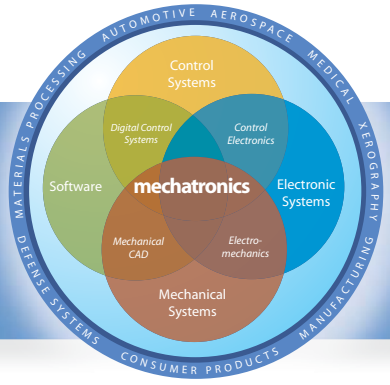
MATLAB® & SIMULINK®

MathWorks®
Accelerating the pace of engineering and science

design news EDN Test & Measurement World

MECHATRONICS IN DESIGN

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



Technologists and engineers

Bridge the gap in education and practice to invigorate US manufacturing.

A trip to Hershey, PA, in July evokes thoughts of chocolate sweets and roller coasters. For Fred Stolfi, mechatronics professor at Columbia University, and me, the two-day visit was a journey into the future of US automation, which may mean the future of domestic manufacturing. The Hershey Co's compelling vision is to empower its entire work force, from the plant operating floor to the engineering-design room. The company expects continuous personal growth, lifelong learning, and advancement for all. It is starting now at Hershey by enabling the company's maintenance personnel to evolve into technologists with a blended skill set through a certificate-driven, innovative, mechatronics-technology program.

What is the difference between a technologist and an engineer? Are there attributes in each that are deficient in the other? Is there a chasm between the two in practice, education, and advancement opportunity? Is there a potential synergy that companies are not exploiting in both practice and education? These questions are some of those that came to our minds as we toured Hershey's technology center and plant and saw raw milk coming in and Hershey products in incredible quantities rolling out 24/7. A meeting with Joe Wagner, controls-engineering manager at Hershey and our host, along with the vice presidents of manufacturing, engineering, and global operations, brought us to an understanding of the current technological situation and their transformative vision for the future. This vision is one in which Hershey's entire work force shares ownership of the processes and products, communicates effectively with insight and understanding, sees opportunities throughout the company along many career paths, and values each other's contributions to problem solving and innovation. It is a vision that Hershey cannot buy or outsource; it is local, a major cultural change, and a vision of what US manufacturing must become.

In general, the distinction between an engineer and a technologist emanates primarily from differences in their education.

In general, the distinction between an engineer and a technologist emanates primarily from differences in their education. Engineering programs are geared toward the development of conceptual and design skills, whereas engineering-technology programs are oriented toward the application of designs. The balance between theory and practice gives physical insight and understanding, a balance between the world of the engineer and the world of the technologist.

How is The Hershey Co implementing this vision? To accomplish the first step of elevating its current maintenance personnel, Hershey has partnered with RACC (Reading Area Community College). At the new Schmidt Training and Technology Center there, under the direction of John DeVere and Bonnie Spayd, Hershey has created a mechatronics-engineering-technology program, with industry experts acting as the guides on the side while the students are engaged in self-paced discovery learning, earning three certificates along the way, eventually leading to an accredited two-year associate's degree.

Hershey is meeting challenges and solving problems by changing culture—attitude and behavior—and instilling ownership. The Hershey Co recognizes this challenge and is meeting it head-on. The company is empowering its maintenance work force by providing a college-credit curriculum within the framework of Hershey's continuing-education program. This transformation will allow upward mobility and career progression within the company that was previously unattainable or invisible. Hershey's vision should spur a national discussion about the melding of the worlds of the technologist and the engineer, the worlds of the implementer and the conceptualist, in both practice and education. We need attributes of both in everyone. EDN

Kevin C Craig, PhD, is the Robert C Greenheck chair in engineering design and a professor of mechanical engineering, College of Engineering, Marquette University.

For more mechatronic news, visit mechatronicszone.com.

Visit the Mechatronics Zone for the latest mechatronics news, trends, technologies, and applications at http://www.designnews.com/hottopic/The_Mechatronics_Zone/index.php.

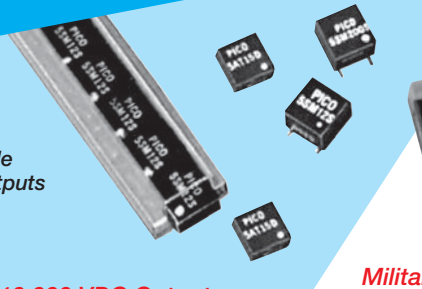
Canon Communications LLC

PICO

PROVEN **Critical Component Integrity**

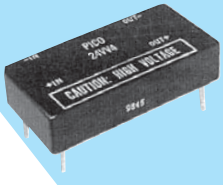
DC-DC Converters

2V to 10,000 VDC Output

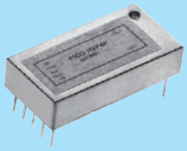


2 to 5000 VDC Outputs
Ultra Miniature
Surface Mount and Thru Hole
Single and Dual Isolated Outputs
Military Upgrades Available
AV/AV/SM/AVR Series

Military Components
-55⁰ to +85⁰C Operating Temp
Military Environmental
Screening Available
3.3 to 500 VDC Outputs
M/MV Series
Isolated - Regulated



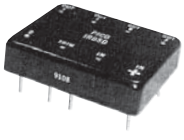
100 to 10,000 VDC Output
Proportional Control Up to 10 Watts
VV Series



Programmable to
6000 VDC Output
HVP Series

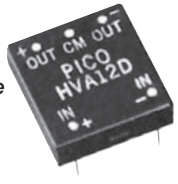
Military Applications
-40⁰ and -55⁰ to +85⁰C
Operating Temperatures
Wide Input Range
3.3 to 350 VDC outputs
in 1/2 Brick and Ful Brick
Military Upgrades Available
LF/LM/FM Series

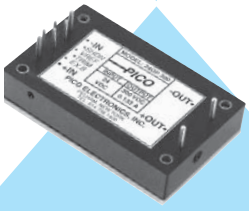
Wide Input Range
8 to 60 VDC Input
2 to 100 VDC Output
Isolated-Regulated
OR/IR/JR/KR Series
2-20 Watts



HIGH POWER-Wide Input Range
2 to 350 VDC Output
Isolated to 300 Watts
in 1/2 and Full Brick
LP/HP/XP Series

36 to 170 VDC Inputs
Terminal Strips - Thru Hole
3.3 to 48 VDC Outputs
Single and Dual Output
LV/HV Series





5 to 500 VDC Output
to 50 Watts
Wide Input Range
Isolated
Regulated
QP Series

Also Ac-DC single and 3 Phase.
Power Factor Corrected. 3 Watts to
2000 Watts Models.

PICO
Electronics. Inc.
143 Sparks Ave., Pelham, NY 10803

www.picoelectronics.com

Complete Listing of Entire Product Line
DC-DC Converters • AC-DC Inductors • Transformers
and Inductors. E Mail: info@picoelectronics.com

Call Toll Free:
800-431-1064

Fax:
914-738-8225

ISO 9001:2000
ANAB ACCREDITED BSI
AS 9100 REV. B

PERFORMANCE, COST, AND FREQUENCY ATTRIBUTES GIVE SILICON TV TUNERS THE EDGE AS THEY PLAY KICK THE CAN WITH THEIR PREDECESSORS.

BY PAUL RAKO • TECHNICAL EDITOR

SILICON TV TUNERS: THE GAME IS ON

Silicon-tuner ICs have for nearly a decade found use in set-top boxes for satellite and cable. Now, thanks to their high performance, simplicity, broad frequency coverage, compactness, and universality, they are making inroads into phones, set-top boxes, service gateways, automobiles, PCs, and even TVs. What's more, they use no SAW (surface-acoustic-wave) filters and few supporting components, making them more reliable and less costly than their can-tuner predecessors. Once TV manufacturers gain expertise in RF (radio-frequency)-PCB (printed-circuit-board) layout, you can expect silicon tuners to obsolete their predecessors, can tuners (**Figure 1**).

The venerable can tuner, so-called because TV manufacturers pack the mixer-oscillator/PLL (phase-locked loop) and associated components into a large metal can, also contains the demodulator chips that convert the RF signal from the tuner into a baseband analog-TV signal or a digital stream for HD (high-definition) formats (**Figure 2**). The shielded metal can containing the circuitry prevents interference from the external TV signal and prevents internal clocks and high frequencies from polluting signals in the TV. Although large and unwieldy, can tuners have the advantage of a huge manufacturing base that keeps cost low. However, they require designers to use different SAW-filter frequencies for various regions and TV-modulation standards. They also require dedicated factories and work forces to manually align their air-wound coils. In contrast, some manufacturers use silicon tuners directly on the motherboard rather than putting them into a can. Because of their size, silicon-tuner circuits are also less susceptible to interference and may eliminate the need for shielding around the chips.

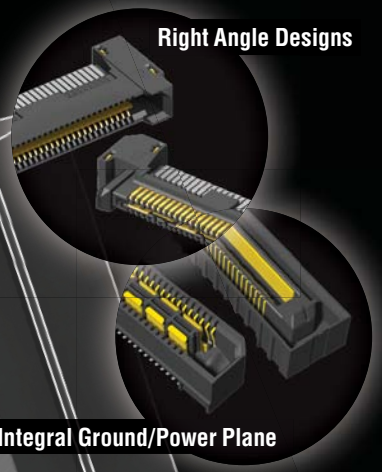
William Chu, director of RF products at Maxim Integrated Products, notes that reducing the cost of a can tuner has reached fundamental limits and that silicon tuners can provide frequency to as much as 1 GHz. The TV market represents the last frontier for these tuners. IC companies developed these chips by exploiting the fact that cable-TV channels all have similar signal strength, making it easier to tune into a station than tuning broadcast-TV signals with widely different strengths. This task also depends on the distance from the transmitter and the transmitter's power level. Satellite and cable signals with digital modulation are also easier to tune. The engineers who created the digital-modulation standards ensured that the signals were easier to tune and demodulate than those of an analog TV.

THE WOES OF ANALOG TV

An analog station has more energy at its boundaries (**Figure 3**). At the lower part of its bandwidth, synchronization-carrier energy locks the picture rasters at the left side of the screen. The audio-subcarrier bandwidth is on the right side of the screen. This scheme prevents analog TV from undergoing the "cliff effect" (**Reference 1**). Instead of losing the whole picture and sound in a weak-signal area, an analog station instead has "snow," speckles of noise throughout the picture. The higher synchronization and audio-signal energy mean that you can still watch the video and hear the audio.

FAST. SLIM. RUGGED.

- Rated at 9.5 GHz / contact at -3dB insertion loss and 7mm stack height
- Slim 5mm wide footprint
- Rugged Edge Rate™ contacts less prone to damage during unmating
- Stack heights from 7mm to 10mm
- .8mm pitch



samtec

Transmission Line Solutions

www.samtec.com/qrate

Although energy distribution in an analog signal is good for your reception, it makes it harder to keep adjacent channels from interfering with each other in a tuner. The greater power at the edges of the band easily bleeds into the channel next to it. The combination of widely different signal strength, often on adjacent channels, and the energy spectrum in an analog TV's RF signal poses a great challenge to silicon-tuner designers.

Before you discount the importance of analog reception, remember that most of the world still uses analog. In the United States, for example, analog transmission is still legal for low-power stations and legacy stations that cannot afford to convert to digital modulation. In addition, the United States' northern and southern neighbors, Canada and Mexico, still broadcast analog TV. US consumers expect their TVs to be able to receive stations from these countries. Many other countries' conversion to digital modulation won't take place for years. The problems of digital-TV reception may well slow the adoption of digital TVs in countries that have not yet converted. Furthermore, many cable-TV systems still broadcast the local channels as analog signals, and a cable-ready TV must be able to receive these signals. "Taking analog reception out of a TV is fraught with peril," says Brian Mathews, vice president of marketing at silicon-RF-tuner manufacturer Xceive. "No TV manufacturer would consider it." So, although the law no longer dictates that a TV must receive analog, manufacturers will provide it for at least the next 10 years.

Another benefit of TV-tuner ICs that work with analog signals is that, if the chip can handle the broad signal variations of an analog transmission, it can also work in rural China, where cable-TV systems' grossly overmodulated and undermodulated signals lack proper leveling. Silicon-tuner ICs also can handle future changes. The standards body for the ATSC (Advanced Television Systems Committee) can change specifications or improve the modulation so that it works for mobile TVs, and the analog tuner chip still works. The same manufacturers of analog chips also design programmable demodulator chips, so you can update firmware to provide for future changes. Silicon tuners also make practical white-space transmission of signals in bands without TV channels (see **sidebar** "TV tuners and white space" in the Web version of this article at www.edn.com/100923df). Because the silicon tuners have better blocking of adjacent channels, a 5W data transmitter near your house does not interfere with the microvolt signals from a TV station 50 miles away that happen to enter the adjacent channel.

AT A GLANCE

- Thanks to their high performance, simplicity, broad frequency coverage, compactness, and universality, you can expect silicon tuners to one day replace the venerable can tuner.
- Silicon tuners work with analog and digital demodulator chips.
- Before you discount the importance of analog reception, remember that most of the world still uses analog.
- Tuning broadcast TV is a demanding task.
- Manufacturers make tuners in CMOS (complementary metal-oxide-semiconductor) and SiGe (silicon-germanium) processes.

Figure 1 This NXP silicon-tuner evaluation board has provisions for shielding a metal can around the chip, but some applications may not require the can.

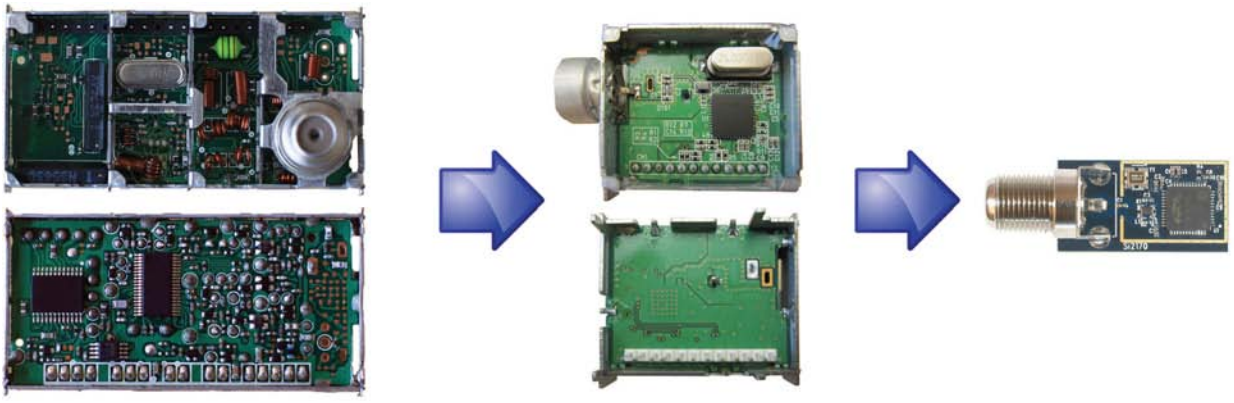


Figure 2 TV tuners are migrating from can-tuner modules (left) toward integrated silicon tuners (center) to devices that designers can integrate directly on the motherboard (right) (courtesy Silicon Laboratories).

TV-TUNER SPECIFICS

A TV tuner must downconvert a 54- to 862-MHz RF signal to an IF (intermediate frequency), typically of 38 or 45 MHz; amplify the signal to a standard level using AGC (automatic-gain-control) circuits; and attenuate or reject all the signals that are out of the band of the channel you are tuning. A stronger signal may be immediately next to the signal of interest, making these tasks challenging. When the tuner encounters UHF (ultrahigh-frequency) signals as large as 700 MHz, the filtering function must have a high Q (quality) factor. Like quartz crystals, SAW filters have high Q factors, so they can pass one narrow frequency, and the response quickly rolls off, or attenuates. To achieve the same performance as that of SAW filters, some silicon-tuner manufacturers upconvert the lower-band signals to high frequency, filter them with high-Q silicon circuits, and then downconvert the filtered signal to IF. This double conversion works well, but it consumes more power than do other methods. Other companies use novel circuits and proprietary architectures to get their chips to work better than a can tuner.

Silicon tuners also have better noise performance than can tuners. "The problem with active filters is that high-Q circuits always have more noise," says Philip Karantzalis, a filter-application engineer at Linear Technology. As a result, tuner manufacturers must use clever designs to get high Q and low noise. IC-process improvements, such as spiral inductors, also help TV-tuner manufacturers get high-Q filtering into a chip without the benefits of SAW filters. IC-design tools and process improvements now allow IC designers to use bond wires and spiral metallization as inductors and to make on-chip high-Q circuits, leading to the recent vast improvement in the performance of PLL chips, silicon oscillators, and TV-tuner chips.

A TV front end has two important functions. The tuner function downconverts and amplifies the desired channel. The demodulator function creates the baseband analog or digital signal from the RF IF that comes from the tuner. The analog signal is a classic composite-video signal, and the digital channels usually demodulate to an MPEG (Moving Picture Experts Group)-2 digital bit stream (**Figure 4**). The demodulated signals then go to an SOC (system on chip) that creates the LCD's pixel-drive signals and handles analog- and digital-audio signals. Melissa Chee, director of marketing at Fresco Microchip, notes that silicon-tuner manufacturers bring an overall system knowledge of how the silicon tuners and silicon demodulators work together. IC designers divide these blocks—but not in a standard way. For example, Maxim, Entropic, and other companies make tuner ICs with no demodulator, Silicon Labs and Xceive include analog demodulation, and Fresco makes demodulator chips that work with tuner ICs (**Figure 5**). In yet another approach, some chip sets require an external tracking filter but integrate the tuner and both demodula-

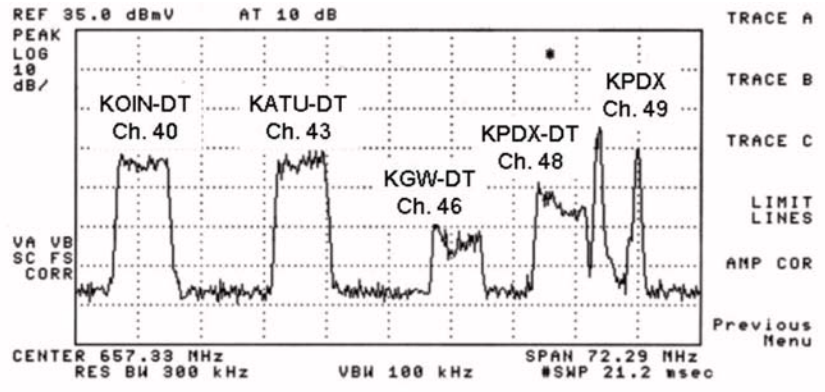


Figure 3 In this frequency-spectrum plot, channels 40 and 43 are strong digital signals. Channels 46 and 48 are weak digital stations that are either far away, low-power, or both. Channel 49 is an analog channel with significant energy at the edges of the band (courtesy Marvell).

tors into one IC. TV manufacturers evaluate each of the systems with combinations of various vendors using proprietary test screens. TV vendors, meanwhile, jealously guard their test patterns because they don't want their competitors to know how they design the TV for certain scenes and action. Be prepared for TV manufacturers to put you "through the wringer on analog performance," says Xceive's Mathews.

Vendors take an interesting approach in the processes they use to create silicon TV tuners. For example, Xceive and Maxim use a BiCMOS (bipolar-complementary-metal-oxide-semiconductor) SiGe (silicon-germanium) process because it yields higher performance and intrinsically better noise performance, especially at higher frequencies (**Reference 2**). Silicon Labs and Marvell, however, offer tuner ICs using a conventional CMOS process (**Figure 6**). Neither company reveals the specifics of the process, but a CMOS process is typically less expensive per square millimeter than a BiCMOS process. The drawback is that a CMOS IC requires many parallel transistor circuits to produce increased linearity. Using bigger transistor structures, biased at higher currents, yields better noise figures. TV manufacturers don't care about the process as long as the parts meet performance and cost goals. Vendors of parts using SiGe processes may announce CMOS parts, but they must determine the die-cost-versus-die-size trade-offs that recommend one process over another (**Reference 3**).

FOR MORE INFORMATION

Entropic
www.entropic.com

Fresco Microchip
www.frescomicrochip.com

Linear Technology
www.linear.com

Marvell
www.marvell.com

Maxim Integrated Products
www.maxim-ic.com

MaxLinear
www.maxlinear.com

National Semiconductor
www.national.com

NXP
www.nxp.com

Silicon Labs
www.silabs.com

Xceive
www.xceive.com

Sensitivity and selectivity are the fundamental specifications of tuners. Sensitivity indicates how faint an input signal can be for the receiver to successfully receive it. A sensitive tuner chip requires a low noise factor in the RF front end (**Figure 7**). The selectivity spec of a radio is a figure of merit relating to how well a tuner chip can receive one channel without disturbance from a nearby channel or intentional interferer, such as an FM-radio station. TV engineers often express selectivity as near-channel blocking. Because these signals can have larger amplitude, it makes broadcast-TV tuning a demanding engineering task.

Linearity is another important specification in silicon-tuner chips. Because analog, digital HD, and cable QAM (quadrature-amplitude modulation) all depend on accurate representation of the signal's envelope, the chip must linearly amplify the RF signal. Linearity is also essential for handling another problem: A tuner circuit must receive weak signals even though stronger signals from nearby transmitters are close to the channel you select. According to Eric Garlepp, senior product manager at Silicon Labs, linearity in a TV-tuner

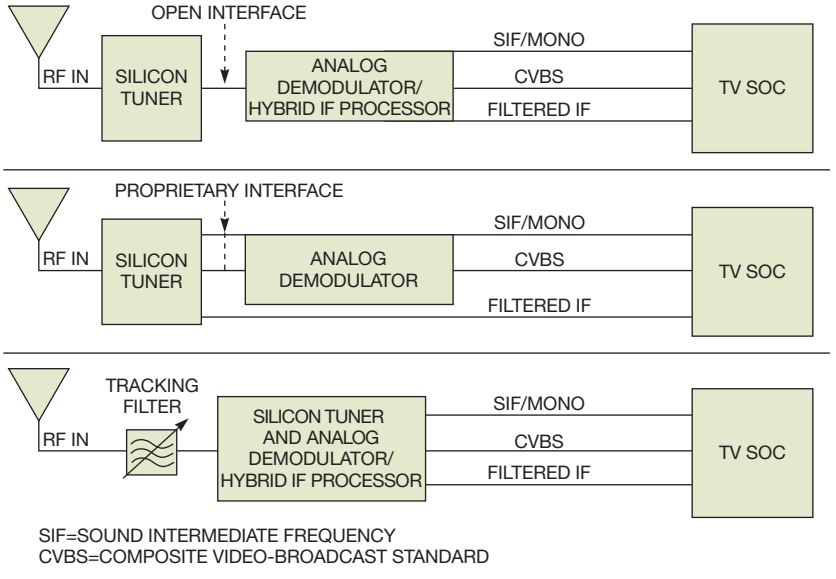


Figure 4 Silicon demodulators can work with pure tuner chips, such as those from Entropic and Maxim (top). NXP makes chip sets that use a separate analog demodulator (center). Silicon Labs and Xceive incorporate the analog demodulation into their tuner chip (bottom), although they typically do not need a tracking filter. Silicon Labs' product does require a balun (balanced-unbalanced) transformer in front of the chip, whereas Xceive's does not. All of the schemes send SIF, CVBS, and the signal IF to the TV SOC (courtesy Fresco Microchip).

“How can I tell if a power supply is reliable?”

There’s an indicator on the front.

It says “Agilent.” With a typical MTBF of 40,000 hours, over half-a-century of experience, and with more than 250 models to choose from, Agilent’s power supplies are the ones you can count on. In fact the array of our power supplies is so extensive, it wouldn’t fit on this page. For clean, low-noise, programmable power to countless DUTs, there’s an Agilent power supply with your name on it. Actually, it’s our name on it, but you know what we mean.

For free measurement tips and the Agilent Power Products brochure go to www.agilent.com/find/powertips

Agilent Technologies

Agilent and our Distributor Network
Right Instrument. Right Expertise. Delivered Right Now.

METRICTEST™
6,000 instruments. One source.

866-436-0887
www.metrictest.com/agilent

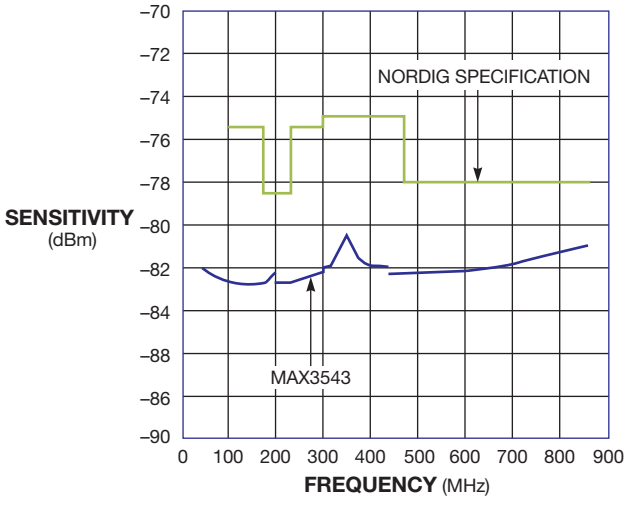


Figure 5 The SiGe process in this tuner IC allows it to achieve sensitivity performance far beyond the NorDig digital standard (courtesy Maxim Integrated Products).

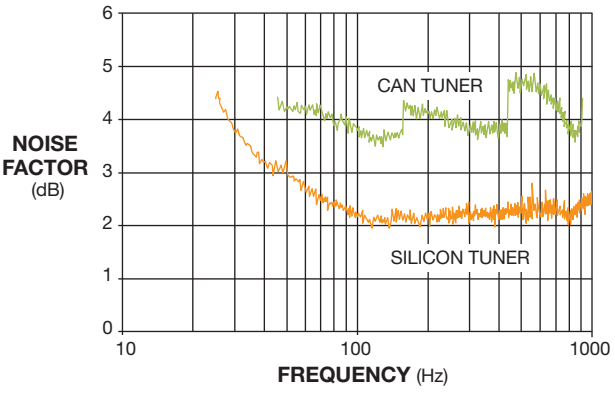


Figure 6 CMOS tuner ICs can produce lower noise than can or SiGe tuners. The upturn in the lower plot at low frequencies is the inherent flicker noise typical of all amplifiers. It is not relevant below 54 MHz, the lowest TV-channel frequency (courtesy Marvell).

chip involves two aspects: inherent broadband linearity to cope with large signals across the bandwidth and linearity after filtering out the 6-MHz band, which is important for accurate signal reproduction and picture quality. It becomes more difficult to achieve adequate performance as the received frequencies approach 700 MHz. At frequencies as low as 54 MHz, however, citizens-band-radio transmitters provide a large signal. You must prevent this signal from mixing into the TV band because that band includes nonlinear RF circuitry. Silicon Labs' CMOS tuner IC achieves the linearity and SNR (signal-to-noise ratio) for TV reception. Other important specs for silicon-tuner chips include image rejection, power, size, color fidelity, second- and third-intercept points, RF and IF AGC loops, voltage noise, and power.

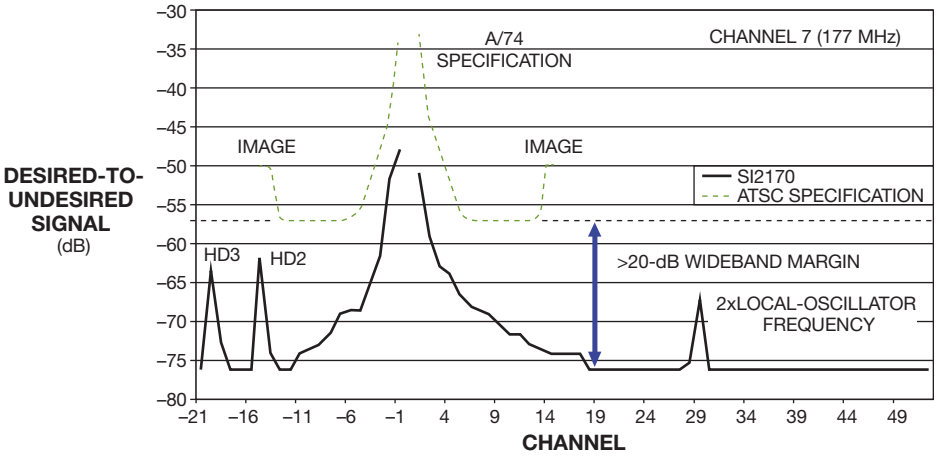


Figure 7 Selectivity, or near-channel blocking, is a critical spec for terrestrial TV. Clever IC design allows this silicon-tuner manufacturer to far exceed the ATSC-A/74 requirement (courtesy Silicon Labs).

As you can see, silicon tuners for TVs have one of the most difficult tasks of any mixed-signal IC. They must work at frequencies as low as 54 MHz without external coils or inductors, as high as 862 MHz for broadcast TV, and as high as 1 GHz for cable systems. They must handle both analog- and digital-modulation schemes and schemes that depend on regional variations. In addition to the broadcast-TV-modulation standards, silicon ICs must also handle cable-modulation standards, such as 256QAM (256-point QAM). The input signals to a tuner IC also can have signals of only –80 dBm next to signals of –20 dBm—even higher in locations near transmitter towers. To meet consumers' expectations, silicon tuners and demodulators deliver performance exceeding that of can tuners, and they fit into the small spaces of modern slim-LCD TVs.

"Any sufficiently advanced technology is indistinguishable from magic," said the late Arthur C Clarke, a British science-fiction author, inventor, and futurist, in 1961. The high performance and low cost of silicon TV-tuner ICs will soon be performing magic in a large proportion of the 500 million tuner systems people buy every year. EDN

REFERENCES

1 Dipert, Brian, "Thin air: ATSC reception isn't always easy," *EDN*, May 14, 2009, pg 20, http://bit.ly/9Zh0Aa.
2 Rako, Paul, "Silicon germanium: fast, quiet, and powerful," *EDN*, Sept 18, 2008, pg 27, http://bit.ly/cRg4EA.
3 Rako, Paul, "Integration in the other direction," *EDN*, Jan 21, 2010, pg 24, http://bit.ly/bVzlDr.

Connecting the Digital Home of the Future Today

Reduce Power and BOM Costs with Legendary Reliability and Robustness

As the world leader in Ethernet for the Digital Home, Micrel is the right choice for attaching consumer electronics to emerging home networks today.

With hundreds of millions of ports deployed, advanced physical layer and switching technology, Micrel's Ethernet family of:

- PHY Transceivers
- Single-port Controllers
- Low-port Count Switches

have been proven in major consumer electronics OEMs around the globe.

For more details on how Micrel Ethernet is changing the world, visit: www.micrel.com/ad/DigitalHomeToday.

Enables a Wide Range of Applications

- Digital TVs
- Media Players
- Set Top Boxes
- Residential Gateways

Micrel Advantage

- Highly integrated and Green designs, reducing board real-estate and power consumption
- Advanced power management
- Low EMI emissions and high EMI immunity

MICREL®
Innovation Through Technology®

www.micrel.com

THE QUEST FOR ROBUST WIRELESS HIGH-DEF VIDEO CONNECTIONS

BY BRIAN DIPERT • SENIOR TECHNICAL EDITOR

STREAMING MULTIMEDIA INFORMATION WITHOUT WIRES IS AT BEST MARGINALLY FEASIBLE WITH TODAY'S WI-FI. EVOLUTIONARY AND REVOLUTIONARY SUCCESSOR TECHNOLOGIES STRIVE TO IMPROVE THE SITUATION, BUT DO CONSUMERS EVEN CARE?

The market for merged audio-and-video transport over physical wiring remains to some degree fragmented. The dueling DisplayPort and HDMI (high-definition-multimedia-interface) camps, for example, continue to make their cases to their system-design customers and end users (**Reference 1**). And both legacy and upstart alternative-cabling approaches remain relevant to a debatable degree (see **sidebar** "HDBaseT strives for ascendancy"). The technology treadmill rolls on, however. An increasing amount of industry attention now focuses on cutting the cord by employing wireless transport from source to destination. The approach has notable merits, including enabling the portability of both the multimedia source and the destination locations and dispensing with unsightly and cumbersome wires. The display's power cable must remain for now, however (see **sidebar** "Wireless power: the hype of the hour"). The wireless approach also potentially extends the source-to-destination span beyond wires' attenuation-defined limitations, including, in some cases, routing signals not only intraroom but also inter-room, again without the need for unaesthetic, difficult-to-install, and costly wall-spanning cable-routing topologies.

This article does not focus on so-called smart media adapters that search for and pull file-based information from computers and NAS (network-attached-storage) devices (**Reference 2**). Such products undoubtedly have their place, but the substantial required processing intelligence negatively affects their cost, and they must support a vast number of file-system and network ports and protocols to create a robust design, representing an implementation and maintenance nightmare. This write-up instead focuses on implementation scenarios in which the source device not only provides temporary or permanent housing of the content but also "broadcasts" it over the network for one or multiple comparatively "dumb" playback destination devices to tune in. The promoters of IEEE 802.11n Wi-Fi have long positioned it as the Holy Grail of multimedia transport, even in high-definition-video scenarios. And it *can* act in that role, but only in certain situations. More generally, as testing last year made abundantly clear, conventional one- and two-stream 802.11n configurations cannot reliably handle large video payloads, therefore rendering the current technology inappropriate for widespread consumer advocacy and adoption (**Reference 3**).

Technologists are tackling the current generation's problem, however, initially in a more or less proprietary fashion, but with inevitable standards-based interoperability to follow (see **sidebar** "Making the best of a technology that's hard-pressed"). They're also hard at work on the next-generation standards documentation and subsequent implementations, which will make even meatier improvements. And at least one manufacturer has transformed the 5-GHz 802.11n variant into a video-tailored point-to-point transport approach, which is incompatible with the prevailing industry standards, however. Other developers feel that a more substantial frequency migration away from the 2.4- and 5-GHz ISM (industrial/scientific/medical) bands is necessary to finally transform wireless networking's promise into reality. UWB (ultrawideband) advocates include WiMedia Forum participants, along with at least one proprietary approach. The WirelessHD Consortium has focused on another unlicensed spectrum swath, 60 GHz, and a suite of semiconductor heavy hitters, the WiGig (Wireless Gigabit) Alliance, recently also directed its attention at this high-frequency spectral region.

Which of these contenders for the throne will eventually seize the crown is as yet unknown and will likely remain unclear for some time. Equally unclear, however, is how big the wireless-video-market prize will ever be and how long it will take to get to that size. This article includes the observations of a knowledgeable wireless-video-industry participant who requested anonymity. This person undoubtedly has at least a slight bias as to the preferred outcome, but, then again, doesn't everyone with some skin in the game? Nevertheless, I hope you'll still find the insider's comments informative.

AT A GLANCE

- Current-generation 802.11n can't reliably stream HD (high-definition) video plus audio in diverse implementation scenarios, but pending improvements should increase its robustness.
- Next-generation IEEE 802.11ac will combine current enhancements with additional features in the hope of delivering 1-Gbps rates.
- Amimon's WHDI (wireless-home-digital-interface) technology dispenses with some general-purpose capabilities of 5-GHz 802.11n in striving for multimedia-streaming excellence.
- Ultrawideband and WirelessHD implementers have migrated beyond conventional ISM (industrial/scientific/medical) bands, but the contending camps' implementations diverge widely.
- The WiGig (Wireless Gigabit) Alliance strives to standardize and popularize 60-GHz networking.

EVOLVING AUGMENTATION

I initially struggled last year with streaming wireless video partly because of the limitations of the gear I was using. The number of discrete streams that a piece of 802.11n equipment can handle depends on both its antenna-array configuration and its radio implementation. As the relevant Wikipedia entry concisely states, the number of antennas in use on both sides of the link limits the number of simultaneous data streams (**Reference 4**). "However, the individual radios often further limit the number of spatial streams that may carry unique data," says the Wikipedia entry. The A×B:C notation helps identify what a radio can do. The first letter, A, represents the maximum number of transmitting antennas or RF chains that the radio can use. The second letter, B, represents the maximum number of receiver antennas or RF chains that the radio can use. The third letter, C, represents the maximum number of data spatial streams that the radio can use. For example, a radio that can transmit on two antennas and receive on three but can send or receive only two data streams would be 2×3:2. The 802.11n draft allows configurations as large as 4×4:4. Common configurations of 11n devices are 2×2:2, 2×3:2, and 3×3:2. All three configurations have the same maximum throughputs and features and differ only in the amount of diversity the antenna systems provide. A fourth configuration, 3×3:3, is also becoming common, according to Wikipedia. It has a higher throughput due to the additional data stream.

I think that the authors of the Wikipedia entry are, however, too enthusiastic about the extent of near-term 3×3:3 adoption. Most 802.11n-cognizant gear now on the market is capable of two-stream—mainstream and high-end—performance or one-stream—entry-level and portable—performance. However, three-stream equipment, employing silicon chip sets from such companies as Atheros, Intel, and Marvell, is beginning to appear. Such multistream capabilities are desirable when, for example, a computer is simultaneously receiving information over the Internet and transmitting data to a LAN (local-area-network) client peer. Apple built triple-stream capabilities into the latest iterations of its Airport Express router and Time Capsule router-plus-NAS product, although the company didn't explicitly promote these enhancements (**Figure 1** and **Reference 5**). And triple-stream support is also reportedly at the heart of Intel's WiDi (Wireless Display) initiative, which the company rolled out at the January 2010 CES (Consumer Electronics Show) in Las Vegas (**Figure 2**).

At January's announcement, WiDi supported only a short list of relatively robust Intel CPUs, reflecting the fact that the video is lossy-encoded in the PC before transmission; core-logic chip sets; and Wi-Fi radios (**Table 1**). On the other end of the wireless chain is a receiver, such as Netgear's PTV1000 Push2TV adapter, with HDMI and component-video outputs to connect to a tethered display. Inside the PTV1000 is a Sigma Designs media processor, along with a single-stream Ralink 802.11n transceiver. The audio and video codecs WiDi uses are unknown, but the results at crowded-spectrum CES were impressive, with adequate frame rates and few to no visible image artifacts (**Reference 6**).

The approximately 2-second latency from the WiDi transmitter to the receiver is problematic only if, for example, the source is outputting the soundtrack while the destination is displaying images. Audio and video coming from the common wireless-link endpoint will preserve lip sync. Current-generation WiDi supports the 720p image resolution and dynamically upscales all content to that resolution before transmission; 1080p resolution capability is on the WiDi road map. Intel also plans HDCP (high-bandwidth digital-content-protection) support, which will enable DVD (digital-videodisc) and Blu-ray-disc playback (**Reference 7**). At CES, only display mirroring was possible. Intel subsequently added the ability to instead horizontally expand the desktop onto the remote display so that, for example, a PowerPoint presentation can run in full-screen mode at a destination projector while a source laptop computer displays a speaker's notes.

Also at CES, Netgear demonstrated the WNHD3004, a prototype 4×4 MIMO (multiple-input/multiple-output) 802.11n wireless video-bridge-device pair that the company based on Quantenna's transceiver technology, and a fuller-featured follow-on to the WNHDE111 that I tested in last year's hands-on project. The WNHD3004 also comes in a WNHDB3004 version in a two-adapter bundle. The product was scheduled to enter the retail sales channel this month. It signifies a notable business expansion for Quantenna, which to date has focused on carrier-grade and enterprise-infrastructure deployments. The IEEE and Wi-Fi Alliance have historically devoted most of their not-unlimited attention to one- and two-stream chip sets and systems

Figure 1 Apple's latest-generation Airport Extreme 802.11n router and Time Capsule router-plus-NAS integrate three-stream support, although the company doesn't explicitly promote this feature (a). Quantenna's four-stream silicon-and-antenna-array approach (b) just received its first high-volume consumer-electronics production embrace in the form of Netgear's WNHD3004 wireless bridge (c).

TABLE 1 WIDI-PLATFORM SPECS AS OF JANUARY 2010

System component	Requirement
Processor	One of the following: Intel Core i7-620M processor, Intel Core i5-540M processor, Intel Core i5-520M processor, Intel Core i5-430M processor, Intel Core i3-350M processor, Intel Core i5-330M processor
Chip set	One of the following: Intel HM57, Intel HM55, Intel QM57, Intel QS57
Wireless	One of the following: Intel Centrino Advanced-N6200, Intel Centrino Advanced-N+WiMax 6250, Intel Centrino Ultimate N 6300
Software	Intel My Wi-Fi Technology and Intel wireless display preinstalled and enabled
Operating system	Windows 7 64-bit, Home Premium, Ultimate, or Professional

employing them, but the organizations' standards-development and interoperability-confirmation focus are now broadening to three- and four-stream products. For example, Quantenna reported in June that its QHS600 802.11n wireless-access-point chip set had received Wi-Fi Alliance certification, including WMM (Wi-Fi multimedia) and WPA2 (Wi-Fi Protected Access 2) enhancements to the base designation.

The IEEE 802.11ac committee is looking at support for more than two streams as a key capability. The committee's target for backward-compatible enhancement is more than 1-Gbps peak PHY (physical-layer) wireless speeds (**Reference 8**). However, currently available 802.11n streams can each theoretically support only 150-Mbps maximum bandwidth even in their optional 40-MHz, wide-channel mode, so even a four-stream configuration cannot alone achieve that formidable goal. As such, the 802.11ac group is also considering increasing the per-stream channel width to 80 or even 160 MHz. The 5-GHz band therefore represents 802.11ac's primary focus. Additional bandwidth improvement of an estimated 10% may come from more efficient modulation algorithms, and the committee is also considering multiuser MIMO antennas and algorithms, which claim to enable one channel to simultaneously broadcast streams to different destinations. The current working date for 802.11ac ratification is December 2011.

TRANSPORT ADAPTATION

Another fundamental streaming-multimedia issue is the traditional router-centric, star-networking-topology model. The audio and video stream coming from the source must first go to the router before continuing to the destination; large-payload multimedia material requires dedicated spectra for each path to accomplish the desired glitch-free playback. To address this concern, the Wi-Fi Alliance is now testing and certifying Wi-Fi Direct, a peer-to-peer communication scheme employing the IEEE's 802.11s standard, and a successor to the poorly implemented 802.11 ad hoc mode.

More generally, 802.11n, like its b, a, and g predecessors, targets use as a generic networking protocol, albeit with increasing degrees of enhancement for multimedia and other latency-critical applications in each wireless generation. As such, Amimon has dispensed with some 802.11n features in developing its multimedia-optimized WHDI (wireless-home-digital-interface) technology. For one thing, WHDI has from the beginning implemented direct source-to-destination interaction without an intermediary router or switch. For another, WHDI is 5-GHz only, trading off broadcast range versus 2.4 GHz for a spectral environment with decreased interference. The company claims, however, that the technology spans 100 feet even through walls, with less-than-1-msec latency. Each 720p or 1080i video stream relies on one 18-MHz channel; 1080p streams each use two channels.

Amimon has not disclosed other implementation details of WHDI's protocols, along with their variations from 5-GHz-based 802.11a and n. Multiple documents on the company's Web site, along with multiple postings to *EDN*'s How We See CE blog, describe WHDI

HDBaseT STRIVES FOR ASCENDANCY

The members of the HDBaseT Alliance, including LG, Samsung, and Sony, yearn for an alternative to today's HDMI (high-definition-multimedia-interface) and DisplayPort wired standards. This alternative, they believe, should accommodate longer spans and encompass more functions. However, they are unwilling to standardize on one of the wireless alternatives this article describes. Instead, they have developed an RJ-45-based approach that merges in a conventional Category 5e cable not only audio and video streams but also network connectivity, USB (Universal Serial Bus) protocol data transfers, and even power over Ethernet. Coalition members forecast that the first systems employing HDBaseT technology will become available this year and that products will become more widely available in 2012.

as lossless. However, these claims also include qualifiers, such as "In video, different bits have different level of importance, and the effect of an error greatly depends on which bit was corrupted." For example, the online technical summary says, a stream of 8- or 10-bit numbers, each representing the primary-color value of a given pixel, represents a typical uncompressed stream. The MSB (most-significant bit) of each of these numbers has greater visual importance than the LSB (least-significant bit). If an error occurs on the MSB, that pixel gets a different and unwanted value. However, an error in the LSB results in a minor change in the pixel's value. According to Amimon's documentation, WHDI breaks down the uncompressed HD (high-definition) video stream into elements of importance and then maps the various elements onto the wireless channel in a way that gives those with more visual importance a greater share of the channel resources. In contrast, WHDI allocates fewer channel resources to elements that have less visual importance and therefore transmits them less robustly (**Reference 9**).

Does WHDI discard undetectable low-order bits only after transmission from source to destination, or does it also as needed discard those bits at the source? If it discards them at the source, is it accurate for Amimon to label WHDI lossless? "How Amimon achieves what it claims seems to be out of sync with physics fundamentals," says the earlier-mentioned knowledgeable—albeit anonymous—wireless-video-industry insider. "Obviously, the company has demonstrable technology, but reading the explanation of how it works raises more questions than answers. Amimon claims support for uncompressed high-definition video to 1080p." He notes that 1920×1080=2,073,600 pixels per frame; 60 frames/sec translates into 2,073,600×60 frames/sec=124,416,000 pixels/sec. Assuming 24-bit per-pixel color results in a data rate of 2976 Mbps, or 2.976 Gbps.

"Amimon claims it can support these data rates because WHDI uses joint-source coding," my source says. Joint-source coding is a form of unequal error protection giving higher FEC (forward-error-correction) protection to the MSB and less FEC to the LSB—a technique that the JPEG (Joint Picture Experts Group)-2000 codec first employed. "Any FEC, no matter how it is applied, requires incremental bandwidth," says the source. "The data rate is only going to go up—not down—when you apply FEC." Amimon claims a 40-MHz spectrum occupancy, he says, noting that a quick calculation shows that, to remain lossless, WHDI must send data at a data density exceeding 75 bits/Hz, even before applying any FEC. "Such bit density would require a QAM [quadrature-

Figure 2 A Toshiba laptop (a) combines with a Netgear receiver (b) to represent the initial hardware implementation of Intel's WiDi vision. So far, at least, it looks more successful than the company's previous wireless video effort, ultrawideband, for which some industry momentum remains (c).

amplitude modulation] on the order of more than a trillion and a dynamic range off the charts. There is something more going on here that physics—specifically, communication and information theory—cannot explain. The raw numbers speak for themselves," he adds.

My industry source notes that, at the 2008 CES, an engineer from Amimon at Gefen's booth, which was then demonstrating an FPGA-based WHDI prototype, said that WHDI doesn't use compression but instead uses compaction, a process involving the removal of some of the LSB color information before transmission and its re-creation on the receiver end of the wireless link. He recently ran the HDMI output of a Blu-ray player into a two-port HDMI splitter. The output of one HDMI splitter port ran directly to a flat-panel display. The source then connected the output from the second HDMI-splitter port to an Amimon transmitter and broadcast the video over a WHDI link, hooked up the receiver to an identical flat-panel display, and positioned the two screens side by side. He found that the video quality for the WHDI-based system, although viewable, had a washed-out color skew. When you looked at it alone, it was not too noticeable; however, once it was next to the original content on the other display, the alteration was obvious. "It appears that WHDI is manipulating the color-space conversion by dropping some of the pixels' LSBs and maybe even sending some pixels as monochrome interspersed with color pixels that change from frame to frame," he says.

Note that the degree of calibration between the two displays used in the test setup is unknown. Pixel-bit discarding and distortions between the WHDI transmitter and the receiver versus the wired HDMI-only alternative are therefore not the only possible reasons for the perceived disparity between them. Potential gaps between marketing hype and reality aside, the market success of Amimon's technology is notable. At the 2010 CES, for example, the company announced that LG Electronics and other customers had adopted WHDI (**Figure 3a**). By May, the company claimed that it had surpassed 500,000 units' worth of chip-set sales and orders. And Amimon in June unveiled preliminary details of WHDI Version 2.0, with a specification to follow next year. This version will include 3-D-video transport, support for the 4000×2000-pixel ultra-HD format, Wi-Fi integration and channel coexistence, and mobile-friendly reductions in power consumption and silicon footprint (**Reference 10**).

UWB SPANS 3.1 TO 10.6 GHz, DEPENDING TO SOME DEGREE ON REGIONAL REGULATORY POLICIES.

ULTRAWIDE RELOCATION

Although officials at Amimon feel that the company can accomplish its objectives within the 5-GHz ISM band, other manufacturers believe that other frequencies will better suit multimedia's needs. As such, the WiMedia Alliance has harnessed a UWB approach. UWB occupies a swath of spectrum spanning 3.1 to 10.6 GHz, which depends to some degree on regional regulatory policies. Its policy aspires to be friendly to other concurrent frequency-spectrum inhabitants, although the additive background broadband noise that additional UWB transmitters create may ultimately interfere with traditional narrowband and carrier-wave systems. Its backers also regularly tout peak transfer rates of 480 Mbps at distances of as much as 3m, or approximately 10 feet, and 110 Mbps at up to 10m, more than 30 feet.

People often incorrectly use the terms "WiMedia" and "Wireless USB" interchangeably. "WiMedia defined a standardized UWB-radio technology that is protocol-independent," says Mike Krell, Alereon's senior director of communications and business development. "Wireless USB implements the USB standard on this radio. It is also possible to run any other protocol on that same radio—proprietary, for example, or TCP/IP [Transmission Control Protocol/Internet Protocol] or Bluetooth." WiMedia was once the planned foundation for high-speed Bluetooth, running at frequencies higher than 6 GHz in this

WIRELESS POWER: THE HYPE OF THE HOUR

Wireless video reduces but doesn't eliminate the need for the cabling that connects to a destination device; the display still requires an ac-power feed—that is, unless you buy into the hype that Massachusetts Institute of Technology spin-off WiTricity is serving up. At the 2010 Consumer Electronics Show, the company partnered with consumer-electronics manufacturer Haier to showcase a prototype system that wirelessly beamed as much as 100W of power, according to WiTricity, across a few feet. An Amimon WHDI (wireless-home-digital-interface) setup handled audio/video transfer.

According to *Gizmodo*, a big power unit on the wall radiated "totally harmless" RF into the back of the TV, which has a coil inside to receive the juice. "It delivers full strength only if it's parallel, so you have to plan ahead and somehow set up the TV in front of the wall that has the power module. Because of all the hocus pocus, the TV itself is a chunkster, and that power transmitter is no Slim Jim either," *Gizmodo* notes (Reference A).

The coil in the display's backside measures approximately 1×1 feet and is several inches thick, thereby running counter to the thinner-is-better trend that's now predominantly driving LCD, OLED (organic light-emitting-diode), and plasma-TV developments. The wirelessly mated power unit is roughly the same size and thickness as the display it feeds and sits directly in front of it. And nobody wanted to talk about efficiency loss. Although "green" hype is often overrated and although higher-efficiency inductive coupled systems may have some merit, true wireless-power transmission is an environmental disaster (references B and C).

REFERENCES

A Rothman, Wilson, "Haier's Completely Wireless TV Hands On: No Cables for Video ... or Power," *Gizmodo*, Jan 7, 2010, http://gizmo.do/dA0dqQ.

B Nelson, Rick, "Throwing (away) power," *Test & Measurement World*, Sept 3, 2009, http://bit.ly/dqityV.

C Dipert, Brian, "Wireless power: convenient, but its shortcomings are somewhat sour," *EDN*, Oct 8, 2009, http://bit.ly/9nelz3.

case to avoid European-spectrum regulatory issues. However, the initial strategy to move WiMedia development to the Bluetooth SIG (special-interest group) and then to wind down the WiMedia Alliance hasn't happened as planned. Bluetooth's WiMedia aspirations are unclear, as is Bluetooth's broader vision for high speed, as the organization focuses most of its attention in the low-power realm.

Many observers have over the years repeatedly tested WiMedia gear and have regularly concluded that real-life speeds are fractions of the marketing claims. The long-standing standardization squabble between promoters of implementation alternatives, which never reached resolution to anyone's satisfaction and led to the shuttering of several start-ups, didn't help the market to embrace the UWB technology, either. As such, today's dominant UWB applications are in Bluetooth- and other RF- and infrared-competing, low-bit-rate wireless-USB usage scenarios that are largely insensitive to speed, such as computer keyboards, mice, low-resolution webcams, and still-image-camera transfer setups. Nonetheless, WiMedia technology backers remain undeterred; several multimedia streaming setups exist, based on chip sets from companies such as Alereon, Realtek, and Wisair (**Figure 2c**).

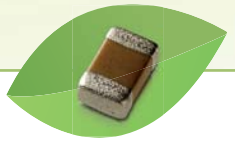
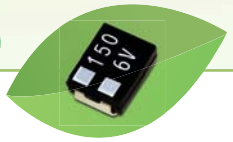
WiMedia derives from one of the two PHY contenders for the IEEE 802.153a higher-speed variant of the specification. It leverages MB-OFDM (multiband-orthogonal-frequency-division-multiplexing) technology and either QPSK (quadrature phase-shift keying) or QAM-16. An alternative approach from Pulse-Link, CWave, operates over wired coaxial cable and wireless connections. It instead harnesses BPSK (binary phase-shift keying)- and QPSK-modulation techniques and is based on the other historical IEEE 802.15.3a contender, DS (direct-sequence)-UWB. Its backers claim that it has a longer broadcast range for a given bit rate and a less costly implementation potential than WiMedia. Nonetheless, they admit that neither CWave nor any of its competitors have yet hit the price points necessary for broad market adoption. This situation may make you wonder, after years' worth of various companies' and groups' public advocacy of the wireless-video concept, why early adopters aren't creating the demand necessary to drive down costs.

Uncompressed video transmission is a desirable attribute for a number of reasons. It reduces the cost of the system implementation because it requires neither compression horsepower at the transmitter nor a decompression engine at the receiver. A compression-free approach can also minimize the overall latency of the transmission system. And video content is likely already lossy-compressed when it gets to the consumer through a codec from Microsoft, MPEG (Motion Pictures Experts Group), On2 (now Google), Sorenson, or another developer (**references 11** and **12**). Additional lossy compression that occurs before display results in incremental image degradation, especially egregious if the artifacts don't synergize with those in the source material.

As such, SiBeam has decided that a more radical spectral relocation, to the 60-GHz, millimeter-wave unlicensed band, is necessary. The company's WirelessHD technology employs a 7-GHz-wide channel, currently delivering a 4-Gbps data rate. The company claims, however, that bit rates as high as 25 Gbps are possible. WirelessHD supports DTCP (digital-transmission-content-protection) encryption for content-access control. Although line-of-sight transmitter-to-receiver linkage is normally necessary at this frequency threshold, WirelessHD uses beam-forming-MIMO-antenna techniques to create alternative signal paths that, for example, reflect off room walls. Still, WirelessHD remains an intraroom approach. Oxygen molecules create atmospheric absorption and, therefore, attenuation limits spans to 10m, or approximately 30 feet.

Eco-Friendly World Opened by Samsung's Passive Components

All people want future generations to enjoy a rich life in pristine natural surroundings. Samsung Electro-Mechanics supports that dream. Our state-of-the-art components have continued to support the divergence and convergence of electronics and we are now opening a new era for environmental conservation against global warming with eco-friendly technologies. The industry first "Carbon Footprint Certification" obtained on multilayer ceramic capacitors are under progress for all our product lines.

MLCC		EMC		Ta Capacitor		Chip Resistor		Crystal
				
• 0402 (inch) 10 μF • 0201 (inch) 1μF	• High Q Type 0201 (inch) Inductor	• 3528 (mm), 2012 (mm) Polymer Type • Low profile, Low ESR	• 2 or 4 Array • Convex & Concave Type • Reduce SMD Area	• 2520 (mm) for RF • Miniaturization

www.sem.samsung.com

SAMSUNG ELECTRO-MECHANICS

SAMSUNG

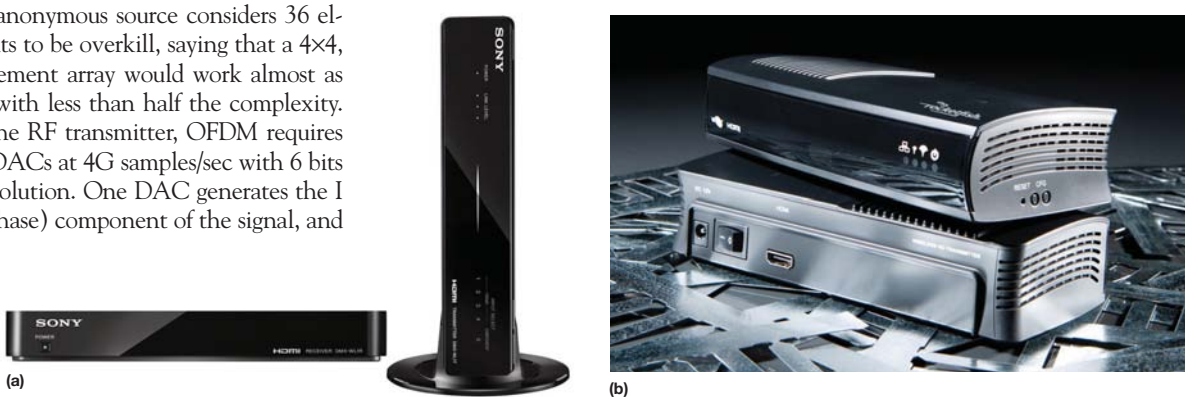
MAKING THE BEST OF A TECHNOLOGY THAT'S HARD-PRESSED

Although today's conventional 802.11n may struggle to route high-definition video-plus-audio streams around homes in some situations, you can take steps to maximize your likelihood of consistent success. For example, eliminate interference from other ISM (industrial/scientific/medical)-broadcast sources, ideally by focusing on the 5-GHz band if the resultant range is acceptable. Try enabling optional wide-channel, 40-MHz mode to maximize per-stream throughput. Only the broad-spectrum, 5-GHz band, in which nonoverlapping channels are the norm, usually offers this feature. Wide-channel mode at 2.4 GHz, in contrast, consumes roughly 80% of the band's available footprint spectrum for one channel's allocation.

Ensure that both your transmitter and your receiver can accept multistream data, with respect to both their antenna arrays and their radio schemes. Using robust switches, both stand-alone and within routers, alleviates playback glitches due to packet-transfer delays and drops. You might also consider employing an advanced video codec such as H.264, VC-1, or WebM to minimize the required bit rate for a target quality metric. If necessary, use multiple concurrent channels—one from the source to the router and another from the router to the destination—to make the best use of available per-channel bandwidth, but, if possible, use a peer-to-peer approach to eliminate the need for a router.

WirelessHD uses the 60-GHz IEEE 802.15.3c PAN (personal-area-network) specification, according to the anonymous industry insider. Current-generation WirelessHD uses 1.76-GHz-bandwidth, OFDM, QPSK, and QAM-16. Its maximum RF-power level is slightly less than 10W. Due to RF's directivity at 60 GHz, WirelessHD requires a steerable antenna array. SiBeam has demonstrated an array of 6×6, or 36, antenna elements, translating to 36 transmitting chains and 36 receiving chains. Thus, 36 low-noise amplifiers must couple to 36 VGAs (variable-gain amplifiers). The anonymous source considers 36 elements to be overkill, saying that a 4×4, 16-element array would work almost as well with less than half the complexity. For the RF transmitter, OFDM requires two DACs at 4G samples/sec with 6 bits of resolution. One DAC generates the I (in-phase) component of the signal, and the other focuses on the Q (quadrature) component. The 4G-sample/sec requirement for the DACs achieves a Nyquist sampling rate for 1.76-GHz bandwidth, including minor oversampling. Each RF-receiver/antenna chain, comprising an antenna, a low-noise amp, and a VGA, requires independent processing until it reaches an analog correlator with 36 inputs—one for each receiver chain, the source says. He adds that the correlator coherently sums the energies, parsing time to picosecond-accuracy levels, almost at the level of an atomic clock. The output of the correlator feeds two 4G-sample/sec, 6-bit-resolution ADCs for the I and Q components.

"Next, let's look at digital baseband processing, starting with the transmitter side," says the source. Each DAC, he explains, requires 24 Gbps of baseband-sourced data. Two DACs translate into 48 Gbps of digital data to drive them. This requirement is not only performance-intensive but also, even at 65- or 45-nm-process technologies, highly power consumptive. The broadcast destination, receiving QAM-16-encoded OFDM, requires recovery of its I and Q components, translating to 48G samples/sec of total data. The two ADCs generate this data and subsequently feed it into a digital baseband subsystem. "Think of a 60-GHz RF-transmitter front end with a 10W output," the source says. He then asks how many watts of dc power you must put into a CMOS RF-power amplifier to yield 10W of power at the antenna. Combining the power consumption of the ADCs, DACs, baseband circuitry, and MAC (media-access controller) yields a 60-GHz system that could easily consume more than 30W. "People don't particularly like the idea of being exposed to a mobile phone's approximately 500-mW RF output," he adds. "What will they think when they find out that the entire time they're … watching a movie, they're being exposed to almost 10W of RF energy at 60 GHz? How much energy does a small microwave oven use in comparison: 100W at 2.4 GHz?"



(a) (b)

Figure 3 Sony's DMX-WL1T Bravia Internet Link kit represented one of Amimon's first notable design wins for WHDI, although its 1080i maximum resolution and 5m peak broadcast distance undershoot the technology's target specifications, reflecting the immature silicon in use at the time (a). SiBeam also has transmitter/receiver-pair case studies for WirelessHD, namely Best Buy's RF-WHD100 Rocketfish adapter set (b).

Support **Across The Board.**™
From Design to Delivery™

Now, you can have it all.™

Faster and easier than ever before. Our commitment to customer service is backed by an extensive product offering combined with our supply chain and design chain services – which can swiftly be tailored to meet your exact needs. We have dedicated employees who have the experience to provide the highest level of customer service with accuracy and efficiency. All of our technical experts are factory certified on the latest technologies, providing you the expertise to move projects forward with speed and confidence.

Avnet offers the best of both worlds: extensive product and supply chain knowledge, and specialized technical skill which translates into faster time to market – and the peace of mind that comes from working with the industry's best. **Avnet is ranked Best-In-Class* for well-informed sales reps, knowledgeable application engineers and our design engineering services – proof that we consistently deliver:**

> Industry recognized product expertise
> Specialized technical skills

Ready. Set. Go to Market.™
Visit the Avnet Design Resource Center™ at:
www.em.avnet.com/drc

AVNET®
electronics marketing

Accelerating Your Success™

Avnet Green Initiative

Supplier Authorized Distributor

1 800 332 8638
www.em.avnet.com

*As rated by Hearst Electronics Group: The Engineer & Supplier Interface Study, 2009.

Follow us on Twitter!
www.twitter.com/avnetdesignwire

In some ways, WirelessHD revisits WiMedia, albeit with a steerable antenna array, says the source. "I sing the praises of OFDM for narrowband applications, such as Wi-Fi, Homeplug, and MOCA (multimedia over coaxial cable). OFDM works great for these applications because the effective RF bandwidths in use are tens of megahertz. As a result, the required ADCs and DACs can be more than 10 bits because of the lower required sampling rates." Each ADC or DAC bit is roughly equivalent to 6 dB of dynamic range; hence, 10 bits equals 60 dB. In contrast, both WiMedia and WirelessHD operate over hundreds of megahertz of bandwidth, limiting the ENOB (effective number of bits). Thus, their ADCs and DACs can operate at no more than 6 bits, or 36 dB of dynamic range. The use of QAM, which requires a greater-than-20-dB SNR (signal-to-noise ratio) to reliably recover the signal at the receiver, leaves little link margin for propagating the signal, translating to a fragile link. This issue hurts WiMedia's range and performance due to the technology's limited transmitting power; it is also the reason that WirelessHD needs 10W of RF power to compensate for both low dynamic range and high attenuation at 60 GHz.

60-GHz STANDARDIZATION

Observer skepticism aside, SiBeam strives onward. At this year's CES, the company announced a second-generation chip set, which is reportedly now in production. The SB9220 network processor and SB9210 RF transmitter target use in multimedia sources, and the SB9221 network processor and SB9211 RF receiver target use in displays and other destination devices. At CES 2010, SiBeam also announced partnerships with Vizio, the latest in a list of notable OEM adopters, and retailer Best Buy, which made an equity investment (**Figure 3b**). In May, the company unveiled the WirelessHD Version 1.1 specification. Reminiscent of Amimon's WHDI Version 2 specification, WirelessHD Version 1.1 ups the data rate to 10 to 28 Gbps, making the technology capable of handling so-called 4K (4096×3072)-pixel-resolution, 3-D, and other large-payload video streams. It also broadens encryption beyond DTCP to include HDCP Version 2. Networking support encompasses portable-device synchronization and IP (Internet Protocol) encapsulation, and a power-consumption reduction is equally amenable to mobile-electronics applications.

In May, SiBeam also announced dual-mode support for its 60-GHz rival, the WiGig Alliance. The support begins with the SB8110 RF transceiver and its associated SK8100 development kit, which are available now. WiGig first publicly unveiled its plans in May 2009; a press release touting the completion of its Version 1 specification followed in December (**Figure 4**). Its current board of directors includes Atheros Communications, Broadcom, Cisco Systems,

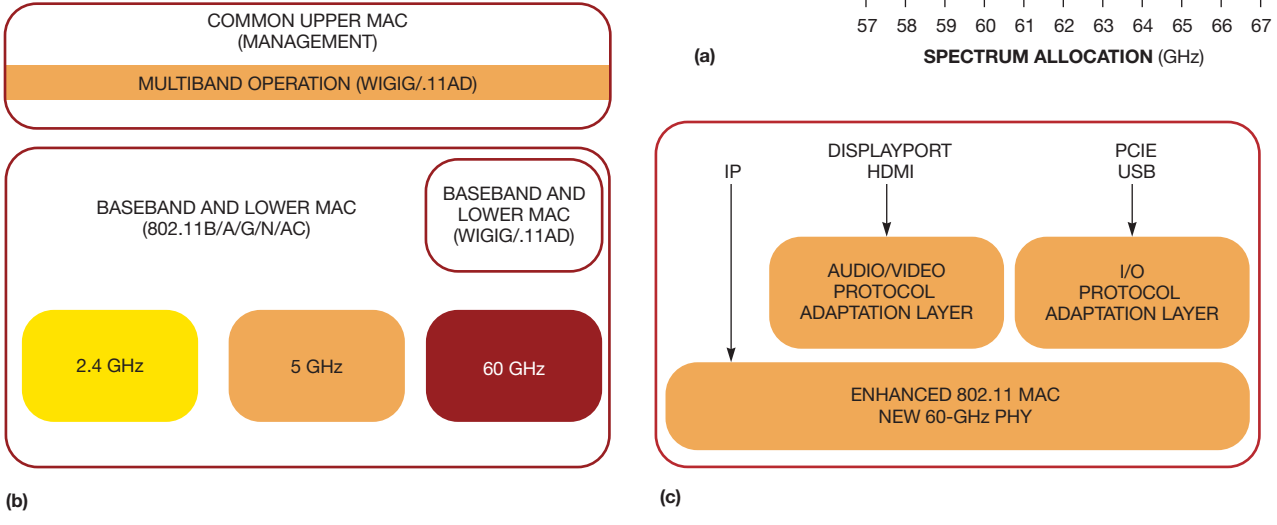


Figure 4 Both WirelessHD and the WiGig Alliance's contending technology leverage unlicensed spectrum at 60 GHz, whose availability specifics depend on the region in use (a). Publicly available documentation is unclear about whether and to what degree WiGig will employ the 802.11 MAC at 60 GHz (b). WiGig proponents plan for the technology to transport multiple data types; IP; DisplayPort and HDMI multimedia; USB and PCIe data packets; and more (c).

Dell, Intel, Marvell International, MediaTek, Microsoft, NEC, Nokia, Nvidia, Panasonic, Samsung Electronics, Toshiba, and Wilocity. The WiGig contributor list is similarly flush with notable silicon, software, and systems developers.

Single-chip-set compatibility with both 2.4- and 5-GHz 802.11 and with 60-GHz networks has been a WiGig Alliance objective from the group's founding. The alliance formalized this intention in May, when it and the Wi-Fi Alliance announced a cooperative arrangement to share technology specifications, with the goal of creating a next-generation certification program that also supported networking in the 60-GHz frequency band. The organizations intend for 60-GHz-cognizant devices to automatically down-shift to the 2.4- or 5-GHz band beyond WiGig's ultrahigh-frequency-broadcast reach, which the alliance hopes to extend beyond WirelessHD's 10m through advanced adaptive-beam-forming and other techniques.

WiGig Alliance literature also clearly documents variable-bandwidth performance that depends on a device's target power consumption. Some WiGig Version 1-based systems offer peak data-transmission rates as high as 7 Gbps, including EDAC (error-detection-and-correction) overhead. This rate leads to the claim that WiGig is more than 10 times faster than four-stream, 600-Mbps 802.11n. However, all devices, including battery-operated devices, that meet WiGig specifications can achieve 1-Gbps peak data-transfer rates. This bandwidth discrepancy is partially due to differences in the leveraged modulation and coding schemes. According to the WiGig Alliance Web site, OFDM supports communication over longer distances with greater delay spreads, providing more flexibility in handling obstacles and reflected signals. OFDM allows transmission speeds as high as 7 Gbps. Conversely, single-carrier encoding typically results in lower power consumption, so it is often a better fit for small, low-power, handheld devices. Single-carrier technology supports transmission speeds as high as 4.6 Gbps. (**Reference 13**).

This situation is analogous to that of today's 802.11n products, in which cellular handsets and other small-form-factor mobile-electronics gear might incorporate only a single-stream Wi-Fi transceiver rather than beefier radios and the associated antenna arrays in ac-powered, larger products. According to WiGig Alliance literature, modulation and coding schemes share elements, such as preamble and channel coding, simplifying implementation for manufacturers of WiGig devices. It's unclear from published documentation whether WiGig will extend the 802.11 MAC to 60 GHz or craft a dual-MAC approach that leverages 802.15.3 or another approach at 60 GHz. At least some WiGig participants will accomplish the merged-technology objective through partnerships. Wilocity, for example, announced in July that it was working with Wi-Fi veteran Atheros. Further extending the relationship between WiGig and the IEEE, the alliance also touts that its technology is the foundation of the 802.11ad specification for very-high-throughput 60-GHz networking. EDN

FOR MORE INFORMATION

Alereon
www.alereon.com

Amimon
www.amimon.com

Atheros Communications
www.atheros.com

Best Buy
www.bestbuy.com

Broadcom
www.broadcom.com

Cisco Systems
www.cisco.com

Dell
www.dell.com

Gefen
www.gefen.com

Google
www.google.com

Haier
www.haier.com

HDBaseT Alliance
www.hdbaset.org

IEEE
www.ieee.org

Intel
www.intel.com

LG Electronics
www.lg.com

Marvell
www.marvell.com

MediaTek
www.mediatek.com

Microsoft
www.microsoft.com

MPEG
www.mpeg.org

NEC
www.nec.com

Netgear
www.netgear.com

Nokia
www.nokia.com

Nvidia
www.nvidia.com

Panasonic
www.panasonic.com

Pulse-Link
www.pulselink.net

Quantenna
www.quantenna.com

Ralink
www.ralinktech.com

Realtek
www.realtek.com

Samsung
www.samsung.com

SiBeam
www.sibeam.com

Sigma Designs
www.sigmadesigns.com

Sony
www.sony.com

Sorenson Communications
www.sorenson.com

Toshiba
www.toshiba.com

Vizio
www.vizio.com

Wi-Fi Alliance
www.wi-fi.org

Wilocity
www.wilocity.com

WiMedia Alliance
www.wimedia.org

Wireless Gigabit Alliance
www.wirelessgigabitalliance.org

WirelessHD
www.wirelesshd.org

Wireless Home Digital Interface Special Interest Group
www.whdi.org

Wireless USB Promoter Group
www.usb.org/wusb/home

Wisair
www.wisair.com

WiTricity
www.witricity.com

REFERENCES

1 Dipert, Brian, "Connecting systems to displays with DVI, HDMI, and DisplayPort: What we got here is failure to communicate," *EDN*, Jan 4, 2007, http://bit.ly/bC70dK.

2 Dipert, Brian, "Accelerating consumers' NAS adoptions: assessing your product options," *EDN*, June 25, 2009, http://bit.ly/bH5qPq.

3 Dipert, Brian, "Transporting high-def video broadcasts: Are wireless networks up to the task?" *EDN*, Aug 20, 2009, http://bit.ly/agcp5n.

4 "IEEE 802n-2009, Number of antennas," Wikipedia, http://bit.ly/dt5xl7.

5 Fleishman, Glenn, "Apple's Base Stations Have Three 802.11n Streams," *WNN Wi-Fi News Net*, Dec 5, 2009, http://bit.ly/6rFzuP.

6 Shimpi, Anand Lai, "The Best Thing at CES—Intel's Wireless HD Technology," Jan 7, 2010, http://bit.ly/7WI6gC.

7 Dipert, Brian, "Blu-ray: Dogged by delays, will it still have its day?" *EDN*, July 29, 2010, http://bit.ly/cnXHW2.

8 Fleishman, Glenn, "The future of Wi-Fi: gigabit speeds and beyond," *Ars Technica*, December 2009, http://bit.ly/8MSKn0.

9 "WHDI Technology Overview," Amimon, http://bit.ly.bfQG4f.

10 Dipert, Brian, "Coming soon: 3-D TV," *EDN*, April 8, 2010, http://bit.ly/adFwXu.

11 Dipert, Brian, "Video characterization creates hands-on headaches," *EDN*, July 25, 2002, http://bit.ly/9xiE6j.

12 Dipert, Brian, "Video characterization creates hands-on headaches, part 2," *EDN*, Aug 8, 2002, http://bit.ly/dI5U9n.

13 "Defining the Future of Multi-Gigabit Wireless Communications," WiGig White Paper, Wireless Gigabit Alliance, July 2010, http://bit.ly/aJSgIE.

You can reach Senior Technical Editor Brian Dipert at 1-916-548-1225, brian.dipert@cancom.com, and www.bdipert.com.

EDITED BY MARTIN ROWE
AND FRAN GRANVILLE

designideas

READERS SOLVE DESIGN PROBLEMS

Amplifiers deliver accurate complementary voltages

Marián Štofka, Slovak University of Technology, Bratislava, Slovakia

The circuit in **Figure 1** generates two analog voltages, which you can vary in a complementary manner. When the straight output voltage rises, the complementary output voltage decreases, and vice versa. The sum of both output voltages is a constant: $V_{OUT}+V_{OUTC}=V_{REF}$, where V_{OUT} is the straight output voltage, V_{OUTC} is the complementary output, and V_{REF} is a reference voltage you derive from bandgap cell IC_1. You choose the ratio of the resistor divider that connects to the output of IC_1 so that the reference voltage is approximately 400 mV. Potentiometer R_P sets the desired analog voltage, which connects to the noninverting input of voltage follower IC_{2A}. The output of IC_{2A} provides the straight output voltage, which connects to the inverting input of unity-gain inverter IC_{2B}. The noninverting input of IC_{2B} has a gain of two and connects to the middle of the high-precision resistive divider comprising R_1 and R_2, which halves the reference voltage. The following **equation** calculates the output voltage of IC_{2B} with respect to ground: $V_{OUTC}=-V_{OUT}+2\times(V_{REF}/2)=V_{REF}-V_{OUT}$. Thus, the straight output voltage plus the complementary output voltage give the desired constant value equal to the reference voltage.

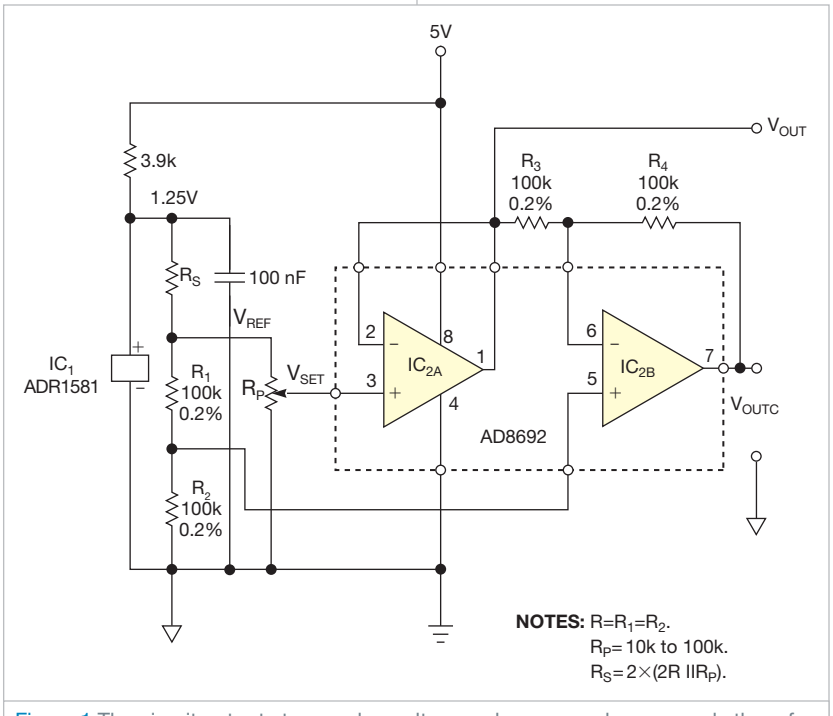


Figure 1 The circuit outputs two analog voltages whose sum always equals the reference voltage.

TABLE 1 COMPLEMENTARY VOLTAGES FOR THREE INPUT SETTINGS

V_{SET}	V_{OUT} (mV)	V_{OUTC} (mV)
V_{REF}	411.45	0.15
0	0.45	410.45
$V_{REF}/2$	205.8	205.1

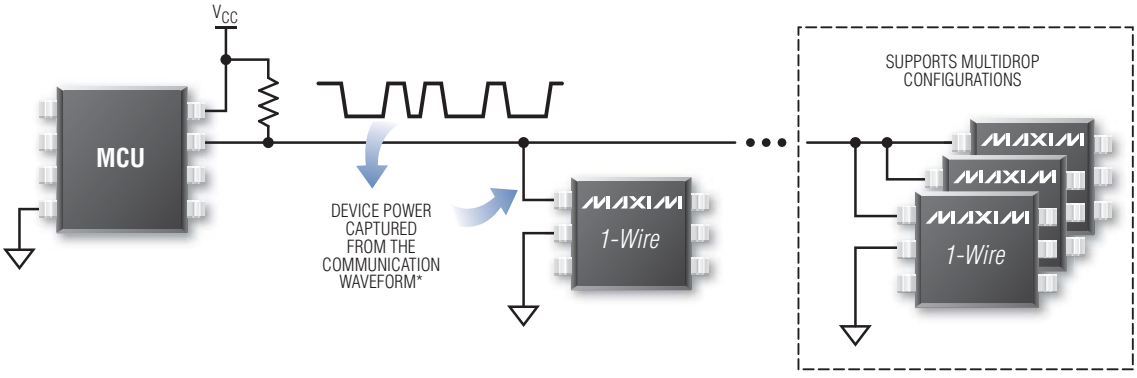
You should use either a quad resistor or two pairs of matched resistors for precision resistors R_1 through R_4. Resistors R_3 and R_4 form the negative feedback in IC_{2B}, and the other pair of resistors halves the reference voltage. You can omit these four resistors if you use an instrumentation amplifier instead of IC_{2B}. In this case, you must use an RRIO (rail-to-rail-input/output) type of instrumentation amplifier. The output of a contemporary RRIO instrumentation ampli-

DIs Inside

▶ What are your design problems and solutions? Publish them here and receive $150! Send your Design Ideas to edndesignideas@cancom.com.

1-Wire® products: one pin, thousands of innovative solutions

NV memory, security, and mixed-signal ICs that operate completely from one dedicated pin (power and data share one pin)!



Optimized for applications that demand

- **Unique, factory-programmed, electronic serial numbers for tracking or security requirements**
- **Operation over a pin-limited connector**
- **Electronic authentication and strong ESD protection for peripherals, accessories, or sensors**
- **Conservation of MCU I/O**
- **Minimized cabling complexity and costs**

A sampling of innovative 1-Wire solutions

1-Wire Product Family Functions	Customer-Favorite Maxim Device
EEPROM	**DS2431**: 1Kb EEPROM
Crypto-secure authentication	**DS28E01-100**: SHA-1 authenticated EEPROM
Temperature measurement	**DS28EA00**: ±0.5°C accurate digital temp sensor
OTP EPROM	**DS2502**: 1Kb EPROM
General-purpose I/O	**DS2413**: 2-channel switch with 28V/20mA GPIO
Unique 64-bit serial number	**DS2401**: 64-bit ROM serial number
Real-time clock	**DS2417**: 32-bit RTC counter

What is 1-Wire? Visit www.maxim-ic.com/1-pin for a Flash overview and more product info.

1-Wire is a registered trademark of Maxim Integrated Products, Inc
*1-Wire devices with special features may require an additional power source.

www.maxim-ic.com/1-pin

MAXIM DIRECT™ www.maxim-ic.com/shop

AVNET electronics marketing www.em.avnet.com/maxim

MAXIM INNOVATION DELIVERED®

For free samples or technical support, visit our website.

fier approaches the low side by a margin of approximately 60 mV, and it would severely degrade the circuit's accuracy. The output of the Analog Devices (www.analog.com) AD8692 op amp, however, typically approaches the lower rail by 0.75 mV at a 10-µA load current. The guaranteed value of the margin is 1 mV at this current.

The circuit has undergone testing for three values of test voltages: the reference voltage, which represents a full-scale; half the reference voltage; and 0V. **Table 1** lists the measured voltages at both outputs. Any of the output voltages can approach the lower supply rail with an error of less than 0.25% at 400 mV full-scale. EDN

Circuit lets you isolate and measure current

Anton Mayer, Murr, Germany

You often need to measure current during circuit design and debugging. You can perform that task by breaking a path, inserting a shunt resistor, measuring its voltage, and converting the voltage to current. Unfortunately, that approach is sometimes impractical with an oscilloscope because one side of an oscilloscope probe connects to ground. Thus, you need to isolate the oscilloscope from the circuit under test.

The circuit in **Figure 1** produces a voltage proportional to current and isolates the oscilloscope from the measurement point. The circuit uses IC_1, an HCPL7800 isolation amplifier, which adds input-to-output isolation of as much

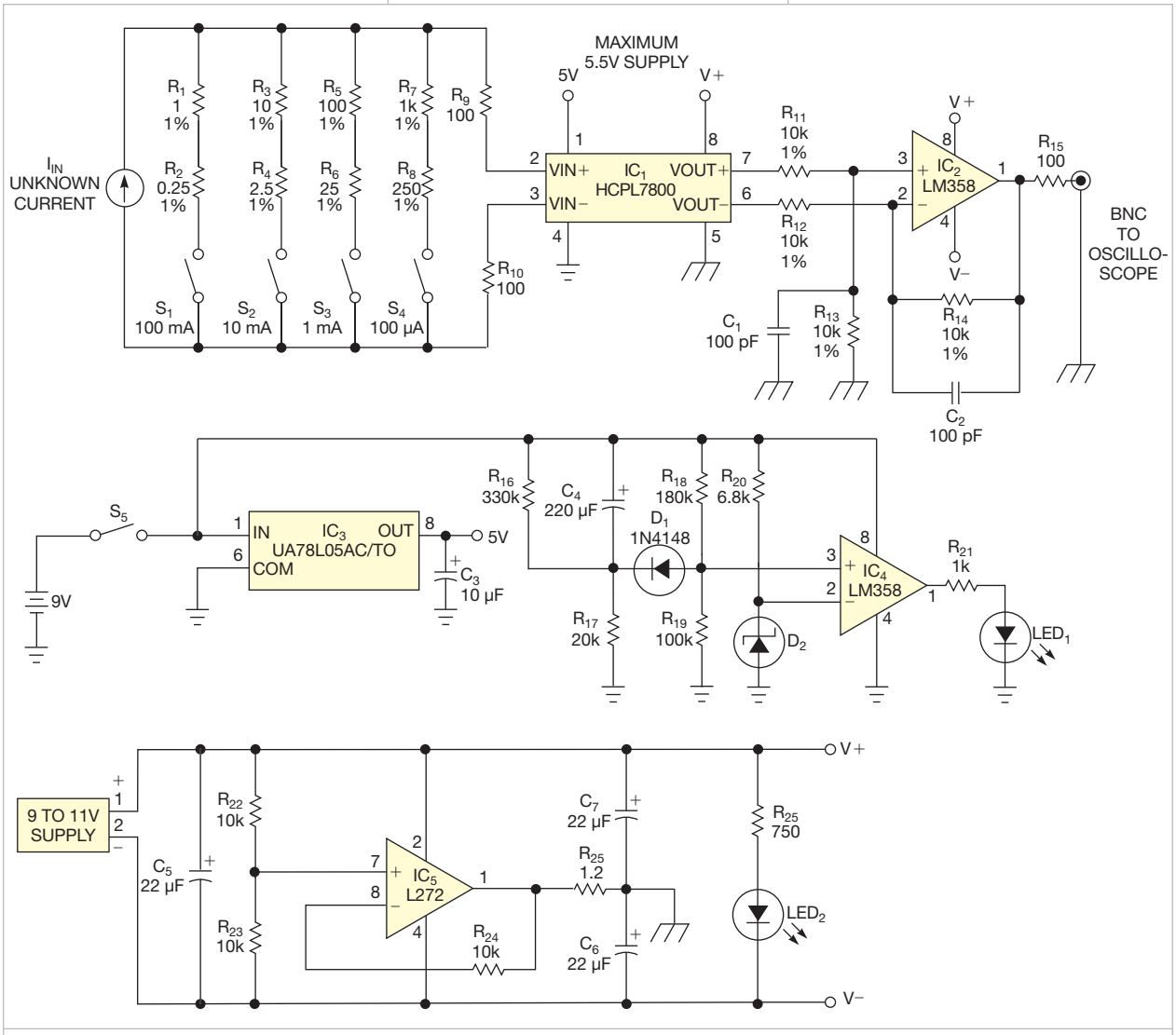


Figure 1 This circuit produces a voltage proportional to current and isolates the oscilloscope from the measurement point.

TABLE 1 GAIN FOR EACH INPUT RANGE

Switch	Gain	Maximum input current
S_1	1V/100 mA	160 mA
S_2	1V/10 mA	16 mA
S_3	1V/1 mA	1.6 mA
S_4	1V/100 µA	160 µA

as 890V. It also amplifies its input voltage by eight. **Table 1** shows the overall gain for each input range. The circuit's bandwidth is typically 100 kHz.

A set of switches lets you select a range of current to measure by inserting resistors into the circuit. Use resistors with 1% or less tolerance to minimize errors. For example, when you close S_4, you select the 100-µA range. The unknown current passes through serial resistors R_1 and R_2, which have values of 1 and 0.25Ω, respectively. Thus, the voltage at IC_1's inputs is $I_{IN} \times 1.25$ kΩ; if the input current is 100 µA, the voltage at IC_1 is 125 mV. The circuit has a gain of eight, yielding 125 mV times 8, or 1V. The LM358 acts as a unity-gain differential amplifier. For best linearity, the input voltage at IC_1 should not exceed ±200 mV.

A 9 TO 11V WALL-WART POWER SUPPLY POWERS THE OUTPUT SIDE OF IC_1 WITH IC_2, AN LM358 AMP.

The HCPL7800 has a 3% tolerance. When you are using resistors with 1% tolerance, the 3% tolerance dominates the overall uncertainty of the circuit. The circuit uses two independent voltage supplies. A 9V battery supplies the input part of IC_1. A stabilized 9 to 11V wall-wart power supply powers the output side of IC_1 with IC_2, an LM358 successive amplifier.

When battery switch S_5 closes and the voltage of the battery is sufficient for the circuit, LED_1 illuminates for approximately 3 seconds. The duration of this illumination minimizes drain on the battery. LED_2 is on when the 9 to 11V power supply is operating. IC_5, an L272, provides an additional ground potential halfway between the supply voltage. With this split supply, you can measure both positive and negative currents. EDN

Acquire images with a sensor and a microcontroller

Ioan Ciascai, Technical University of Cluj-Napoca, Cluj-Napoca, Romania, and Liliana Ciascai, Babes-Boylai University, Cluj-Napoca, Romania

The TAOS (Texas Advanced Optoelectronic Solutions, www.taosinc.com) TSL1412S image sensor, IC_2, can acquire a linear image of 1536×1 pixels, or 400 dpi (**Figure 1**). It uses a single voltage supply, and you can control it with just a few digital signals. Thus, you can design an image-acquisition system that uses the sensor and an AVR (www.atmel.com) ATmega328 microcontroller, IC_1.

Figure 1 shows how you can connect the sensor to the microcontroller. You program the microcontroller to generate the control signals for the sensor. The design uses a 16-MHz clock frequency. The microcontroller's 8-bit Timer 2 generates the command signals. In Mode 2, the timer generates hard clock signals CLK1 and CLK2 and soft strobe signals SI1, HOLD1, and HOLD2. The TSL1412S uses serial connections. The SO2 signal connects to the ICP input of TSL1412S when you activate flag ICF1.

Timer 2 generates a handler interrupt, which ensures the correct phase of the clock signal, generates the strobe signal, and acquires and saves the TSL1412S's output analog data. You can see a model for the interrupt subroutine in the online version of this Design Idea at www.edn.com/100923dia. The code sets the microcontroller's stack, register, ADC, Timer 2, and interrupt functions. To save image data, you must set the T bit in SREG to 1 and set pointer X=0×0200. You can do these settings in the last clock of time integration (R25, R24=0×0001).

By modifying the data from the register, you can set the sensor's integration time at 2.5 to 50 msec, or 100 msec with the prescaler of T2. Knowing that the sensor acquired the data in the previous cycle, you can perform a data-acquisition design using the microcontroller's internal ADC. The integration time must be greater than 50 msec.

THE SYSTEM QUICKLY PROCESSES THE SENSOR'S ANALOG OUTPUT SIGNAL.

The conversion time for a 16-MHz-frequency clock is approximately 16 µsec, which corresponds to an integration time of approximately 25 msec. Because the conversion frequency is 1 MHz—higher than that of IC_1's recommended frequency of 200 kHz—you reduce the ADC's precision from 10 bits to 8 bits. The microcontroller saves a byte for each pixel, which lets you save the data to the microcontroller's internal memory for one frame. The rest of the microcontroller's 2-kbyte memory performs stack and data-acquisition tasks.

The system quickly processes the sensor's analog output signal through the analog comparator of the microcontroller's internal schematic. You can make a comparison with a fixed voltage using an internal voltage reference of 1.25V and a resistive divider or a variable voltage you can obtain from a DAC or a PWM (pulse-width-modulated) signal the microcontroller's timer generates. EDN

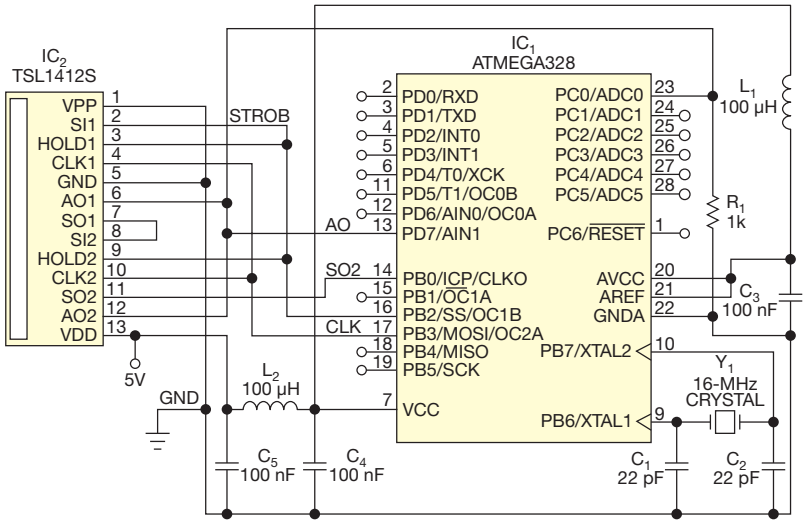


Figure 1 A microcontroller can produce control signals for an image sensor.

Power-supply circuit operates from USB port

Stefano Palazzolo, Senago, Italy

Every PC has a USB (Universal Serial Bus) port that can supply 5V±5% at 500 mA for peripherals. Powered USB hubs also provide this power. You can use a USB port to power an external circuit, which is useful when you have no other dc source available.

A USB port has V_{BUS}, the power pin; a return pin, GND (ground); and two signal pins. If you need just a simple 5V supply, you can tap the power pins from a USB connector, but you should place a 10-µF filter capacitor between the ground and power-supply pins.

You can, however, use an adjustable voltage regulator to get voltages of 1.25 to 3.75V, a range that many circuits use. The circuit in **Figure 1** covers that range. You use R_3 to change that range, as the following **equation**

New Technologies are for Geniuses.

The Newest Products For Your Newest Designs™

AVAGO TECHNOLOGIES

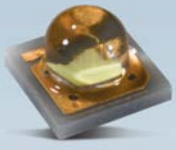
ASMT-TxBM Mini PLCC-2 Surface Mount LEDs
mouser.com/avagominiplcc2

LedEngin, Inc.

40W LED Emitters
mouser.com/ledengin40w

Littelfuse
Expertise Applied | Answers Delivered

PLED Open LED Protectors
mouser.com/littelfusepled



OSRAM
Opto Semiconductors

OSLON SSL LEDs
mouser.com/osramoslonssl

Scan with your smart phone or mobile device's camera/QR-Code reader.
mouser.com/opto-ad

WARNING: Designing with Hot, New Products May Cause A Time-to-Market Advantage.

MOUSER ELECTRONICS®
a tti company

mouser.com (800) 346-6873

shows: $V_{OUT}=1.25V\times(1+R_3/R_2)$. The 1.25V in the **equation** occurs because the LM1117-ADJ linear regulator generates 1.25V between the V_{OUT} and the ADJ (adjust) pins. Resistor R_2, therefore, has a constant current that passes through resistor R_3; the I_{ADJ} (adjusted current) is generally small enough to ignore. Selecting 100Ω for R_2 sets its current to 12.5 mA. If you use a 200Ω potentiometer for R_3, you get a voltage range of 1.25V when R_3 is 0Ω, causing a short, to 3.75V when R_3 is 200Ω.

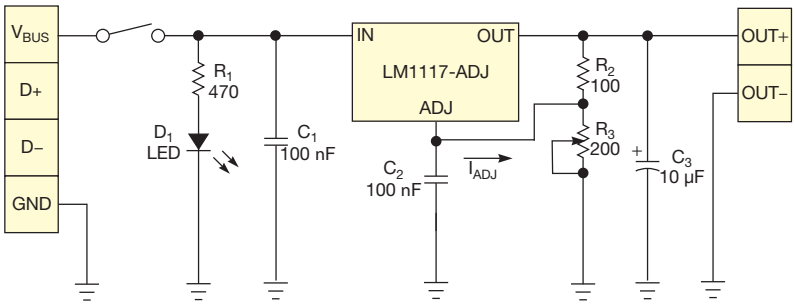


Figure 1 Resistors R_2 and R_3 set the adjustable voltage regulator's output at 1.25 to 3.75V.

To prevent circuit damage if the output becomes shorted or when you don't know the load, you can add a current-limiting circuit that keeps the maximum current at 500 mA. A polyswitch fuse or pair of transistors can easily implement this current-limiter site at the power-supply input line.

The filter capacitor shouldn't exceed 10 µF. That level keeps the inrush current under control in the absence of a current-limiting circuit. Generally, capacitors of 1 to 10 µF work best. EDN

LED-flashlight circuit works at voltages as low as 0.5V

GY Xu, XuMicro, Houston, TX

Most commercial LED flashlights use three AAA or AA batteries in series that produce 4.5V. The batteries then drive four white LEDs that connect in parallel. These LEDs can work at voltages as low as 2.7V and, in some cases, 2.4V. At those voltages, the LEDs become dim, and you must frequently change the batteries. Thus, the lowest working voltage in this case is approximately 0.8 to 0.9V per battery.

When a 1.5V alkaline battery discharges to 0.9V, it still has more than 10% of its original energy left. If you replace or discard the battery, you waste that energy. You can, however, use this small amount of battery energy with the circuit in **Figure 1**. The Linear Technology (www.linear.com) LT1932 LED driver is a step-up voltage-booster chip with constant-current capability for LED lighting. It works with input voltages of 1 to 10V, and it can drive several serial LEDs.

The trick is to choose the supply voltage. Because LT1932 can work at voltages as low as 1V, using a two-cell, 3V supply results in the lowest working voltage: 0.5V per cell. Choosing a three-cell, 4.5V supply results in a lower voltage of 0.33V per cell. A 4.5V supply can power as many as eight LEDs. Tests show that this circuit works from 4.5V to 0.94V, which is lower than the data-sheet-specified 1V. The LED driver uses a 4.7-µH inductor.

Setting the value of resistor R_1 regulates the constant current through the LEDs. Setting a higher resistance results in lower brightness. In this case, the current is 18 mA. The LT1932 is available only in a surface-mount, tiny, six-pin SOT package, with fine pitch as small as 0.037 in. So, using it requires a PCB (printed-circuit board).

USE "DEAD" BATTERIES FROM COMMERCIAL LED FLASHLIGHTS TO FEED THE LT1932.

Once you build a flashlight with this circuit, you don't throw away the "dead" batteries from commercial LED flashlights. Instead, use them to feed the LT1932 circuit. Depending on whether you use an AA or an AAA cell, it will give you a few more hours of light. Keep in mind that some battery manufacturers define 0.5V per cell as an alkaline battery's cutoff voltage and recommend that you remove the battery from the load to avoid the possibility of battery leakage and gassing effects. Don't let these effects happen to your flashlight. EDN

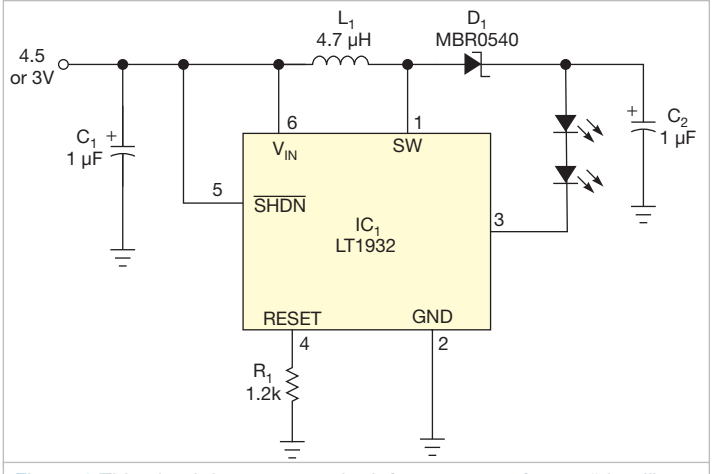
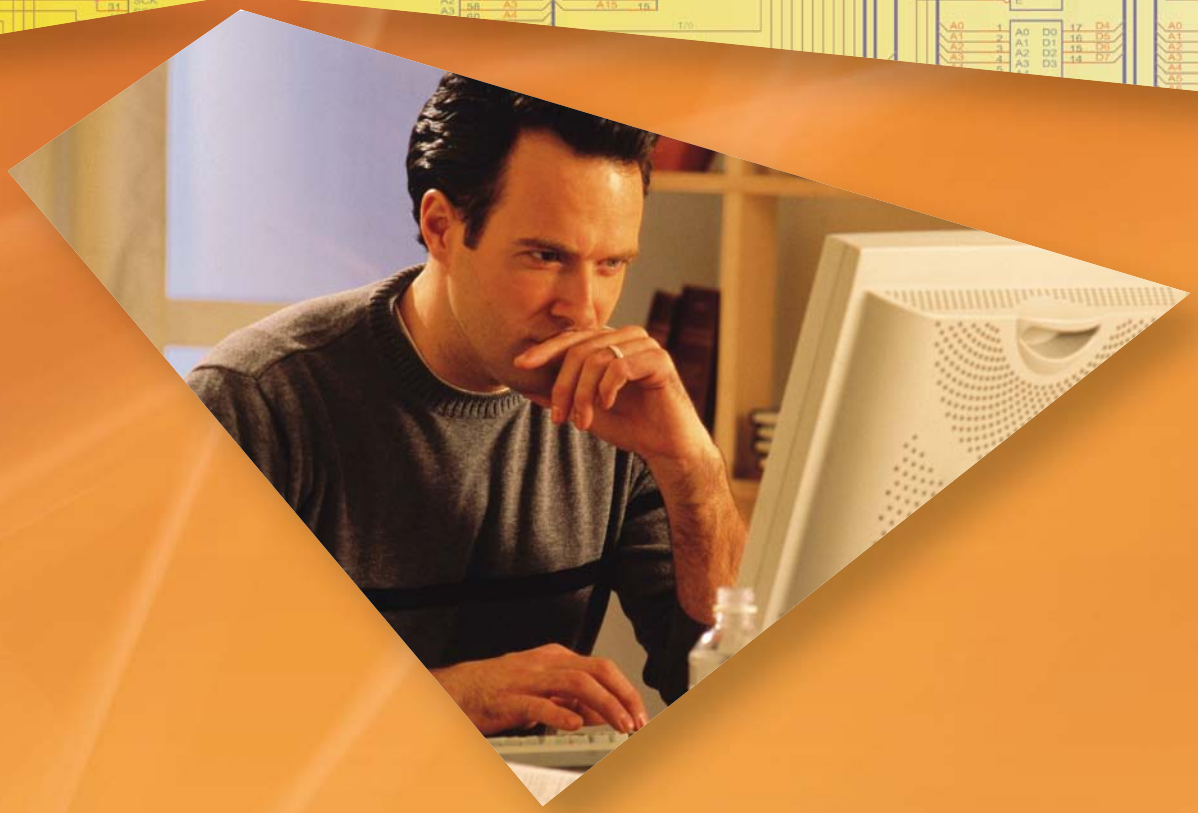


Figure 1 This circuit lets you use the leftover energy from a "dead" battery.

OrCAD MAKES IT POSSIBLE
AUTOWIRE
GET CONNECTED FASTER THAN EVER



Wouldn't it be nice if wiring could be done automatically, and intelligently?
OrCAD® makes it possible with the new Autowire feature in Cadence® OrCAD Capture 16.3. With this new functionality, wiring between component pins on a schematic is as simple as selecting a starting pin and a destination pin and letting the software add the connection – all automatically and quickly.

Truly scalable PCB technology
Cadence OrCAD PCB design technologies comprise a complete, cost-effective PCB design solution, from design capture to final output. To successfully meet project goals, PCB designers and electrical engineers need powerful, intuitive, and integrated technologies that work seamlessly across the entire PCB design flow. OrCAD PCB design technologies offer fully integrated front-end design, analog/signal integrity simulation, and place-and-route technologies that boost productivity and shorten time to market.

OrCAD makes it possible
To learn more about the power and productivity gains made possible in the latest OrCAD releases, call EMA Design Automation, a Cadence Channel Partner, at 877.362.3321, e-mail us at info@ema-eda.com, or visit us online at www.ema-eda.com/orcadpossibilities.

cadence®

EMA Design Automation™
Cadence Channel Partner

productroundup

POWER SOURCES

Open-frame dc/dc converters feature 2-to-1 input range

The UEI25-120-D48 series of dc/dc converters comes in a 0.96×1.1×0.32-in. open-frame package and features an input voltage of 36 to 75V dc, a fixed output voltage of 12V dc, isolation as large as 2250V dc, and output power as high as 25W with overtemperature shutdown in 1 in.^{2} of board area. The units offer efficiency as high as 87.5%. Prices start at $16 (OEM quantities).

Murata Power Solutions, www.murata-ps.com

Switching-regulator series adds 2A model

The 2A V78XX switching regulator has efficiencies as high as 92% in a SIP measuring 11.5×9×17.5 mm. The units are pin-compatible with industry-standard LM78XX linear regulators and have an input range of 4.75 to 18V dc and regulated output voltages of 2.5, 3.3, 5, and 6.5V dc. The operating temperature ranges from –40 to +85°C at a 100% load. The units are available from Digi-Key for $7.46 (1000).

CUI Inc, www.cui.com

48V, 1500W power supply targets industrial, COTS applications

The 48V, 1500W LZSA1500-4 power supplies target use in industrial and COTS (commercial-off-the-shelf) applications, such as factory automation, computing, and ATE. The supplies have a nominal output of 12V at 1000W; 24V at 500, 1000, or 1500W; and 48V at 1500W. They feature user-adjustable ranges of 10 to 15.75, 18 to 29.4, and 36 to 56V, respectively, to accommodate nonstandard voltages. They have integral fans and provide full-rated output power at –40 to +60°C, derating linearly to 60% load at a 71°C ambient temperature. The series accepts an 85 to 265V-ac input range at

47 to 440 Hz and can operate with a dc input of 100 to 400V dc. The devices include active-power-factor and harmonic correction. They also comply with SEMI-F47 standards for input droop as low as 100V ac at full loads. All models have a five-year warranty. The 48V-output LZSA1500-4 sells for $975 (1000).

TDK Lambda, http://us.tdk-lambda.com/lp/products/lzsa-series.htm

6A dc/dc µModule regulator comes in 9×15-mm LGA package

The 6A LTM4618 µModule regulator includes an inductor, MOSFETs, input and output bypass capacitors, and supporting circuitry in a 2.3g, 9×15×4.32-mm LGA package. It features output-voltage tracking for systems that must sequence multiple rails for proper power-up and -down and 250 to 750-kHz fixed-frequency PLL capability for applications that require the regulator's switching frequency to be a set value. For low-voltage loads, such as the core voltage of FPGAs and processors, the LTM4618 includes safety features, such as output-overvoltage and short-circuit protection and guaranteed ±1.75% maximum output dc error. Prices start at $11.30 (1000).

Linear Technology Corp, www.linear.com

Active ORing and controller target use in servers and telecom

The PI2127 active ORing integrates the PI2007 universal, high-speed ORing controller, targeting use in 12 and 48V high-side redundant-bus applications, including systems with input-voltage ranges of 36 to 75V, which also must operate for 100 msec during input-voltage transients as high as 100V. Applications include servers, high-end telecom and computing, and communications-infrastructure systems. The PI2127 has an 8.5-mΩ internal MOSFET, providing high efficiency and low power loss during steady-state operation, and it typically turns off the MOSFET within 80 nsec during input-power-source fault conditions that cause reverse-current flow. The PI2127 comes in a 7×8-mm LGA SIP and sells for $4.66 (1000). The PI2007 comes in a 3×3-mm, 10-lead TDFN and sells for $1.61 (1000).

Picor, www.vicorpower.com

EDN ADVERTISER INDEX

Company	Page	Company	Page
Adsantec	27	Mentor Graphics	6
Agilent Technologies	29	Micrel	31
Analog Devices Inc	15	Micro Crystal	14
Avnet Electronics Marketing	10, 41	Mouser Electronics	49
Cirrus Logic Inc	C-2	National Electronics Distributors Association (NEDA)	C-3
Coilcraft	9	Pico Electronics Inc	23, 34 35
Digi-Key Corp	C-1, 3	Renesas Technology Corp	17, 19
EMA Design Automation Inc	51	Samsung Electro-Mechanics	39
International Rectifier Corp	7	Samtec USA	25
Lambda Americas	11	Trilogy Design	53
Lattice	13	Vicor Corp	47
Linear Technology	C-4	West Coast Magnetics	37
MathWorks Inc	21	Xilinx	4
Maxim Integrated Products	45		
Memory Protection Devices	11		

EDN provides this index as an additional service. The publisher assumes no liability for errors or omissions.

EDN productmart

This advertising is for new and current products.

S EREN BALCI • ASELSAN

Merry-go-round-missile mishap

DANIEL VASCONCELLOS

Early in my career, I was the only engineer responsible for some missile-subassembly test equipment. I knew the system to some extent because I had written the test software, but I lacked the much-needed hardware-troubleshooting experience. I trusted myself on debugging and fixing any software issues, but what now seems like a small test station to me seemed back then like a black hole.

I had to fix a problem that had caused multiple UUTs (units under test) to fail the missile's safety-arming tests. The hardware comprised a custom-built test cabin; a VXI chassis and its cabling, both of which we had adopted from another project; and a third-party-supplied centrifuge chamber. We used the centrifuge to simulate a missile launch and test the missile's ability to arm just after traveling some distance. Rotating the centrifuge for 3 to 4 seconds was supposed to cause the application of g force onto an accelerometer in the UUT, in turn causing the missile to arm. For some reason, though, it failed to do so.

The test system was in its first months of operation, so everybody suspected a test-equipment problem. After testing many parts and a "golden" unit—that is, a device against which to test all later devices—I too was sure that something was wrong with the test hardware.

I checked my notes from previous encounters due to similar problems, interviewed the test operators and maintenance personnel, and tried to find a quick fix, but I made no progress. The problem looked impenetrable. Telemetric signals were failing to appear on scope, and the units were failing to measure the distance they were traveling.

The main obstacle in following the clues that may have led to the real cause was the fact that the test was dynamic. The UUT was riding a weird merry-go-round that prevented any chances of probing the signals. Another constraint was getting the missile to arm; testing it did not require a centrifuge run. That test—using the same mechanical path of the centrifuge fixture—ran perfectly every time. If we activated the centrifuge, however, the missile didn't fire. The problem was occurring during the "flight," but how could I possibly find it when I had no chance of inserting even a finger into the centrifuge chamber?

With little hope left, I started playing with the fixture, spinning it manually a half-circle at a time with one hand while struggling to keep the scope probe touching the UUT's connector pin with the other.

I was working for only half a week when the gods smiled on me. I saw a tiny glitch on the 5V power line that repeated when the centrifuge fixture passed a certain position in its turn. I remembered testing the same line on the first day. I didn't see this problem then, however, because the scope's trigger setting was probably a bit lower than it was when I saw the glitch. It was so small that you had to place the trigger level just below the 5V-dc level to be able to see a persisting valley on the power trace. That glitch caused the distance-measuring processor to reset on each turn. As a result, the distance calculation couldn't build up high enough to trigger the missile-arming circuitry; hence, it failed to produce the telemetry signal.

We opened the hood of the centrifuge chamber only to find a microscopic notch on the slip ring of the 5V power line. Luckily, spare rings were available, and everything started to work like an atomic clock once we switched to a clean ring.

I learned that even the most mysterious failures have a reasonable cause, and you can reveal that cause only with determined effort. EDN

S Eren Balci is an engineer with Aselsan (Ankara, Turkey).

www.edn.com/tales

NEDA Executive Conference

Competing for the Future: Are You Ready Today for Tomorrow?

October 17 - 19, 2010

InterContinental Chicago O'Hare

Plan Your Strategy

An informative, results-oriented meeting for senior management teams of electronics industry distributor & manufacturer firms

Renowned experts from industry, government and academia sharing economic news and strategic content. Speakers include:

- Dave Anderson, Corporate Executive Board
- Francois Calvarin, Souriau
- Glenn Derene, Popular Mechanics Magazine
- John Engel, WESCO International
- Lloyd Kaplan, iSuppli Corporation
- Paul Kasriel, The Northern Trust Company
- Stephen Kaufman, Harvard Business School
- Dr. Barry Lawrence, Texas A&M University
- John McDonald, GE Energy
- Ali Sebt, Renesas Electronics America
- Brad Whitworth, Cisco Systems Inc.

National Electronics Distributors Association
678-393-9990
www.nedassoc.org

Register your management team for this premier results-oriented conference.

www.formdesk.com/neda/execconf

Energy Harvesting Now

Free Power from Thermal, Kinetic & Solar Energy

Our new analog IC solutions enable the commercial deployment of energy harvesting from a variety of "free" energy sources. An appropriate transducer placed on the energy source delivers an electrical signal that our products convert and condition into usable power. These revolutionary ICs consume only nanoamps of current to provide high efficiency power conversion with minimal external components.

Energy Harvesting IC Family

Part Number	Description	Energy Source
LTC®3105	400mA boost converter with MPP control and 250mV start-up	
LTC3108	Ultralow voltage boost converter and system manager	
LTC3109	Auto-polarity version of LTC3108	
LTC3588	Piezoelectric energy harvesting power supply	
LT®3652/HV	Power tracking 2A solar battery charger	
LTC4070	Nanoamp operating current shunt Li-Ion battery charger	

Info & Free Samples

www.linear.com/energyharvesting

1-800-4-LINEAR

LINEAR TECHNOLOGY