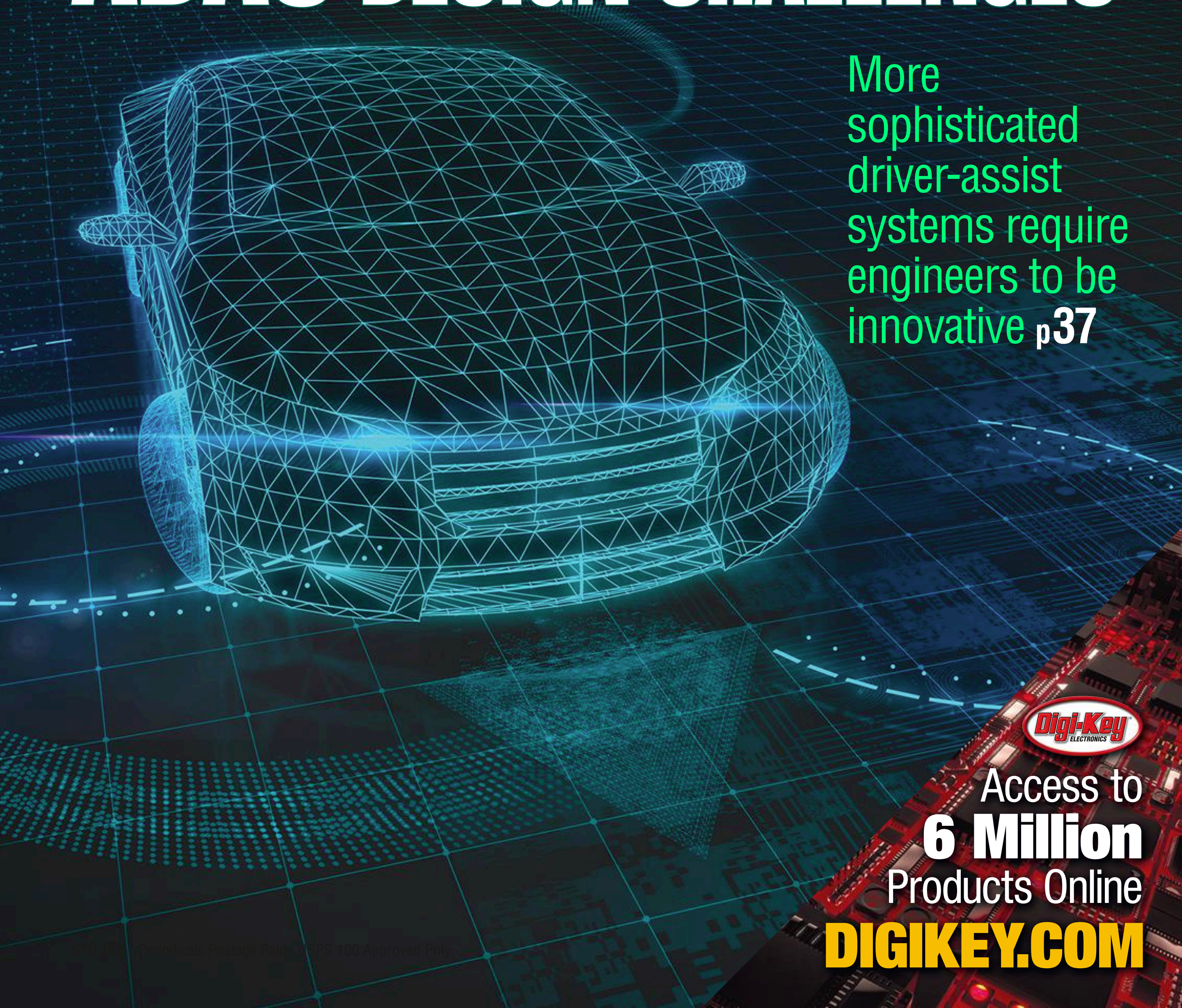
Electronic Design®

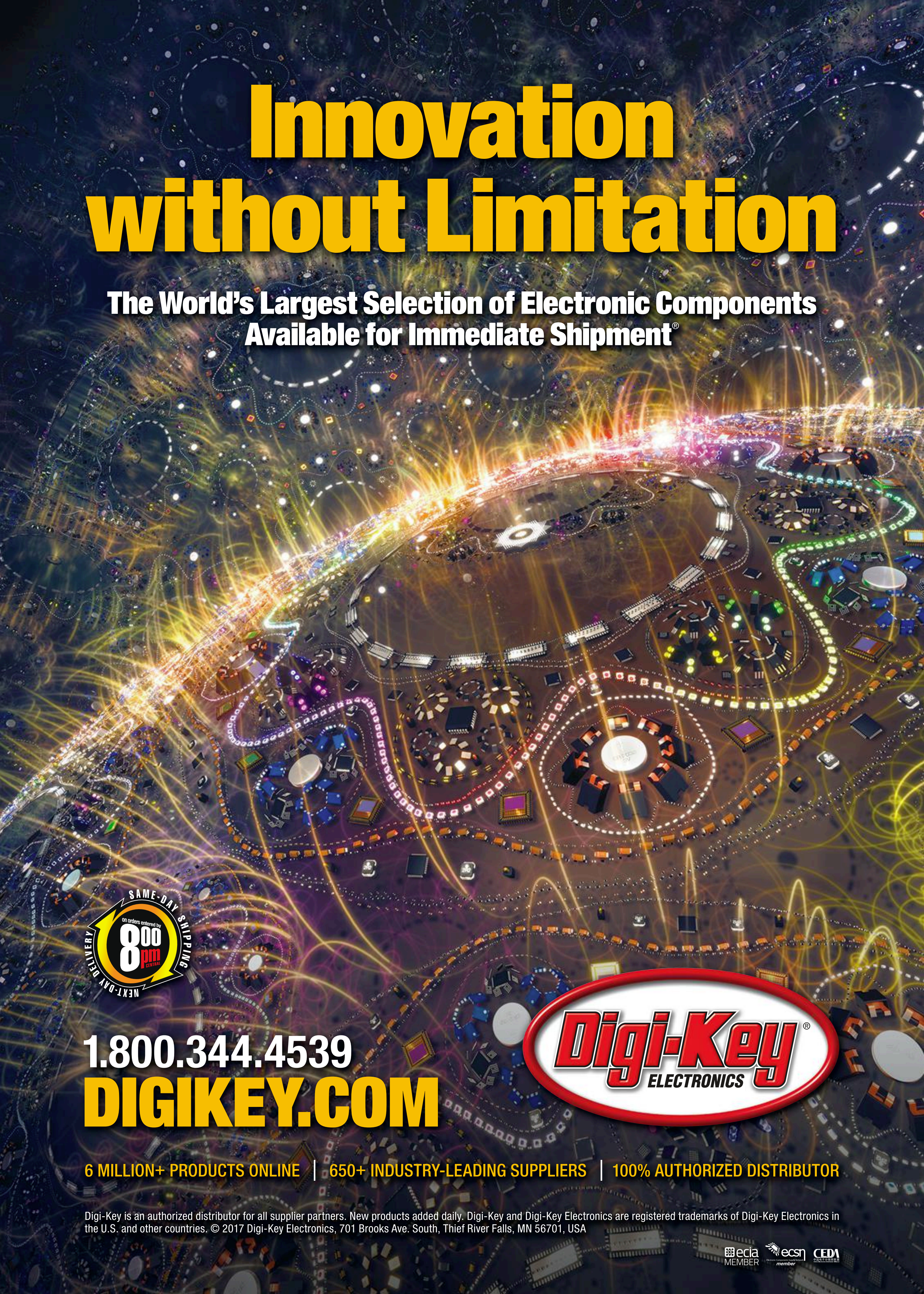
THE AUTHORITY ON
EMERGING TECHNOLOGIES
FOR DESIGN SOLUTIONS

NOVEMBER 2017 electronicdesign.com

ADAS DESIGN CHALLENGES

More sophisticated driver-assist systems require engineers to be innovative p37




Innovation without Limitation
The World's Largest Selection of Electronic Components Available for Immediate Shipment®
SAME-DAY SHIPPING
on orders entered by 8:00 pm CENTRAL
NEXT-DAY DELIVERY
1.800.344.4539
DIGIKEY.COM
Digi-Key® ELECTRONICS
6 MILLION+ PRODUCTS ONLINE | 650+ INDUSTRY-LEADING SUPPLIERS | 100% AUTHORIZED DISTRIBUTOR
Digi-Key is an authorized distributor for all supplier partners. New products added daily. Digi-Key and Digi-Key Electronics are registered trademarks of Digi-Key Electronics in the U.S. and other countries. © 2017 Digi-Key Electronics, 701 Brooks Ave. South, Thief River Falls, MN 56701, USA
ecia MEMBER
ecsn member
CEDA

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

(actual height)

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

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

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

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

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

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

Coilcraft®

WWW.COILCRAFT.COM

coilcraftdirect.com
No min order. Next day delivery.

1 mHz to 5 MHz

Impedance Analyzer

starting at
$13,530

2017 MRS FALL MEETING & EXHIBIT
Booth #13

Test Fixture included

Applications

- High-Q and polymer dielectrics, Supercapacitors, Solar Cells, LED and LCD testing
- Tissue impedance analysis
- Quantum transport, Nanostructure characterization

Key Features

- 0.05% basic accuracy
- 1 mΩ to 1 TΩ
- Compensation Advisor
- Confidence Indicator
- Full MFLI lock-in amplifier functionality

High accuracy, excellent measurement repeatability and a low temperature drift ensures fast and reliable results. In addition, the LabOne® software package includes a complete signal analysis toolset with an oscilloscope, parametric sweeper, FFT spectrum analyzer plus straightforward software interfaces to MatLab, .NET, Python, C and LabView.

Get in touch
www.zhinst.com
info@zhinst.com
Intl. +41 44 515 0410
USA 617 765 7263

Your Application. Measured.

Zurich Instruments

IN THIS ISSUE

FEATURES

COLUMNS & DEPARTMENTS

IDEAS FOR DESIGN

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

ELECTRONIC DESIGN (ISSN 0013-4872) is published monthly by Penton Media Inc., 9800 Metcalf Ave., Overland Park, KS 66212-2216. Paid rates for a one-year subscription are as follows: $120 U.S., $180 Canada, $240 International. Periodicals postage paid at Kansas City, MO, and additional mailing offices. Editorial and advertising addresses: ELECTRONIC DESIGN, 1166 Avenue of the Americas, New York, NY 10036. Telephone (212) 204-4200. Printed in U.S.A. Title registered in U.S. Patent Office. Copyright ©2017 by Penton Media Inc. All rights reserved. The contents of this publication may not be reproduced in whole or in part without the consent of the copyright owner. For subscriber services or to order single copies, write to Electronic Design, PO Box 2100, Skokie, IL 60076. POSTMASTER: Send change of address to Electronic Design, PO Box 2100, Skokie, IL 60076. Canadian Post Publications Mail agreement No. 40612608. Canada return address: IMEX Global Solutions, P.O. Box 25542, London, ON N6C 6B2.

Permission is granted to users registered with the Copyright Clearance Center Inc. (CCC) to photocopy any article, with the exception of those for which separate copyright ownership is indicated on the first page of the article, provided that a base fee of $2 per copy of the article plus $1.00 per page is paid directly to the CCC, 222 Rosewood Drive, Danvers, MA 01923 (Code No. 0013-4872/94 $2.00 + $1.00). Copying done for other than personal or internal reference use without the express permission of Penton Media, Inc. is prohibited. Requests for special permission or bulk orders should be addressed to the editor. To purchase copies on microfilm, please contact National Archive Publishing Company (NAPC) at 732-302-6500 or 800-420-NAPC (6272) x6578 for further information.

ON ELECTRONICDESIGN.COM

WPA2 KRACK: Why Security in Depth Matters

The latest attack on WPA2 is known as a Key Reinstallation AttaCK, or KRACK. The method of attack does not compromise the encryption process, but it does provide avenues of attack that can lead to various man-in-the-middle attacks that would further compromise communication.

http://www.electronicdesign.com/embedded-revolution/wpa2-krack-why-security-depth-matters

Warehouse Robots Smarten Up

Though self-driving cars may eventually move into everyday life, autonomous robots are already wandering the halls of warehouses moving materials. Here are some of the latest coming to market.

http://www.electronicdesign.com/automotive/warehouse-robots-smarten

Caution: Prevent Overcharging of Li-Ion Cells

Over the years, serious concerns have emerged about lithium-ion cell safety. So, when forming or charging Li-ion cells in manufacturing or during characterization in R&D, special attention must be paid to prevent dangerous conditions that can lead to the cell fires and explosions we've all heard about.

http://www.electronicdesign.com/test-measurement/prevent-overcharging-li-ion-cells

2017 *Electronic Design* Salary & Career Report

Asked to do more than ever with fewer resources, engineers with a broad range of expertise can command higher salaries, compete for limited jobs, and carve out a place in an industry interwoven with outsourcing. That was just one of the major takeaways from 2,000 electrical engineers surveyed by *Electronic Design*. Check out the full report for more!

http://www.electronicdesign.com/community-home/2017-electronic-design-salary-career-report

ElectronicDesign®

FOLLOW US ON FACEBOOK AND TWITTER

(ElectronicDesign) (@ElectronicDesgn)

FOR IOT SOLUTIONS YOU WON'T FIND ANYWHERE ELSE,

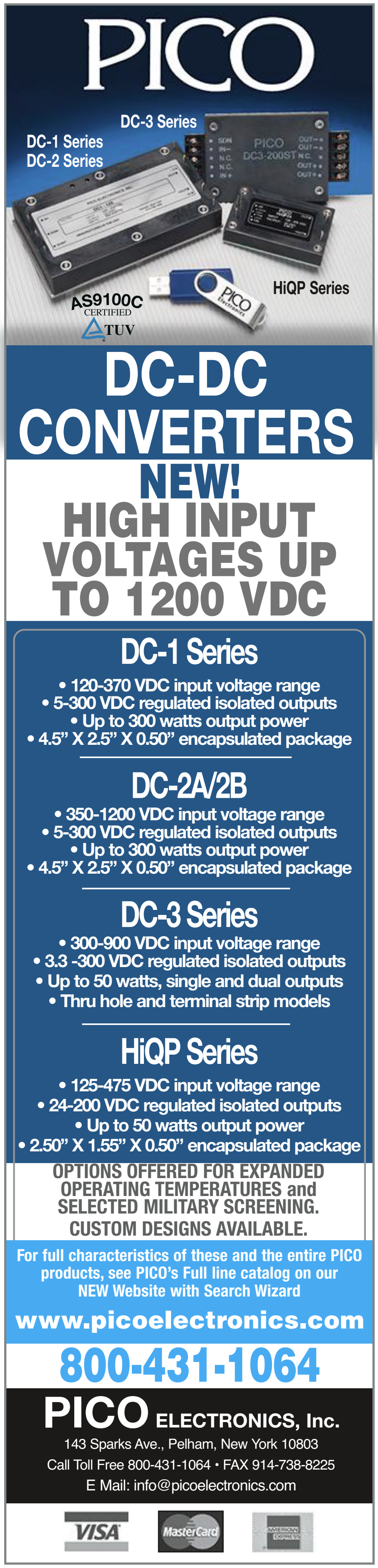
THINK ON.

Everything you need to solve any industrial automation IoT challenge

With the largest portfolio of IoT solutions for industrial automation, we have everything you need to make your system more flexible, reliable, and affordable. Our solutions include ASICs products, wired and wireless connectivity options, and best-in-class machine-vision capabilities. So when you need the smartest industrial automation solutions, Think ON.

For cutting-edge solutions, design tools, and resources, visit onsemi.com/IoTautomation.

ON Semiconductor®



ElectronicDesign. **NOVEMBER 2017**

EDITORIAL

CONTENT DIRECTOR: **NANCY K. FRIEDRICH** nancy.friedrich@penton.com
CONTENT PRODUCTION DIRECTOR: **MICHAEL BROWNE** michael.browne@penton.com
CONTENT PRODUCTION SPECIALIST: **ROGER ENGELKE** roger.engelke@penton.com
PRODUCTION EDITOR: **JEREMY COHEN** jeremy.cohen@penton.com
EMBEDDED/SYSTEMS/SOFTWARE: **WILLIAM WONG** bill.wong@penton.com
ANALOG/POWER: **MARIA GUERRA** maria.guerra@penton.com
CONTENT OPTIMIZATION SPECIALIST: **WES SHOCKLEY** wes.shockley@penton.com
ASSOCIATE CONTENT PRODUCER: **LEAH SCULLY** leah.scully@penton.com
ASSOCIATE CONTENT PRODUCER: **JAMES MORRA** james.morra@penton.com
CONTRIBUTING EDITOR: **LOUIS E. FRENZEL** lou.frenzel@penton.com

ART DEPARTMENT

GROUP DESIGN DIRECTOR: **ANTHONY VITOLO** tony.vitolo@penton.com
SENIOR ARTIST: **JIM MILLER** jim.miller@penton.com
CONTENT DESIGN SPECIALIST: **JOCELYN HARTZOG** jocelyn.hartzog@penton.com
CONTENT & DESIGN PRODUCTION MANAGER: **JULIE JANTZER-WARD** julie.jantzer-ward@penton.com

PRODUCTION

GROUP PRODUCTION MANAGER: **CAREY SWEETEN** carey.sweeten@penton.com
PRODUCTION MANAGER: **FRAN VAUGHN** fran.vaughn@penton.com

AUDIENCE MARKETING

USER MARKETING DIRECTOR: **BRENDA ROODE** brenda.roode@penton.com
USER MARKETING MANAGER: **DEBBIE BRADY** debbie.brady@penton.com
FREE SUBSCRIPTION/STATUS OF SUBSCRIPTION/ADDRESS CHANGE/MISSING BACK ISSUES
OMEDA **T** | 847.513.6022 **TOLL FREE** | 866.505.7173

SALES & MARKETING

MANAGING DIRECTOR: **TRACY SMITH** **T** | 913.967.1324 **F** | 913.514.6881 tracy.smith@penton.com

REGIONAL SALES REPRESENTATIVES:

AZ, NM, TX: **GREGORY MONTGOMERY** **T** | 480.254.5540 gregory.montgomery@penton.com

AL, AR, SOUTHERN CA, CO, FL, GA, HI, IA, ID, IL, IN, KS, KY, LA, MI, MN, MO, MS, MT, NC, ND, NE, NV, OH, OK, SC, SD, TN, UT, VA, WI, WV, WY, CENTRAL CANADA: **JAMIE ALLEN** **T** | 415.608.1959 **F** | 913.514.3667 jamie.allen@penton.com

CT, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT, EASTERN CANADA:
SHANNON ALO-MENDOSA **T** | 978.501.9116 shannon.alo-mendosa@penton.com

AK, NORTHERN CA, OR, WA, WESTERN CANADA: **STUART BOWEN** **T** | 425.681.4395 stuart.bowen@penton.com

INTERNATIONAL SALES:
GERMANY, AUSTRIA, SWITZERLAND: **CHRISTIAN HOELSCHER** **T** | 011.49.89.95002778
christian.hoelscher@husonmedia.com

BELGIUM, NETHERLANDS, LUXEMBURG, UNITED KINGDOM, SCANDINAVIA, FRANCE, SPAIN, PORTUGAL:
JAMES RHOADES-BROWN **T** | +011 44 1932 564999 **M** | +011 44 1932 564998 james.rhoadesbrown@husonmedia.com

ITALY: **DIEGO CASIRAGHI** diego@casiraghi-adv.com

PAN-ASIA: **HELEN LAI** **T** | 886 2-2727 7799 helen@twoway-com.com

PAN-ASIA: **CHARLES LIU** **T** | 886 2-2727 7799 liu@twoway-com.com

PLEASE SEND INSERTION ORDERS TO: orders@penton.com

PENTON REPRINTS: **WRIGHT'S MEDIA** **T** | 877.652.5295 penton@wrightsmedia.com

LIST RENTALS/
SMARTREACH CLIENT SERVICES MANAGER: **JAMES ADDISON** **T** | 212.204.4318 james.addison@penton.com

ONLINE

PRODUCT DEVELOPMENT DIRECTOR **RYAN MALEC** ryan.malec@penton.com

DESIGN ENGINEERING & SOURCING GROUP

EXECUTIVE DIRECTOR OF CONTENT AND USER ENGAGEMENT: **NANCY K. FRIEDRICH**
GROUP DIRECTOR OF OPERATIONS: **CHRISTINA CAVANO**
GROUP DIRECTOR OF MARKETING: **JANE COOPER**

PENTON

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

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

PENTON IS AN INFORMA BUSINESS

Powerful, Versatile and Affordable...

100 kHz Dynamic Signal Analyzer

- **DC to 100 kHz frequency range**
- **100 kHz real-time bandwidth**
- **Dynamic range**
  - **90 dB (FFT)**
  - **145 dB (swept-sine)**
- **Low-distortion (–80 dBc) source**
- **Up to 32 Mbyte memory**
- **GPIB and RS-232 interfaces**

FFT analyzers starting at $4950

The SR785 Dynamic Signal Analyzer offers state-of-art performance at a fraction of the cost of competitive analyzers. Standard features include swept-sine mode, order tracking, octave analysis, curve fit/synthesis, and arbitrary waveform source.

When compared to the Agilent 35670A, the SR785 comes out on top. It offers twice the frequency range (2 ch.) and 10 times the real-time bandwidth at less than half the price of the 35670A.

The SR785 is ideal for filter design, control systems analysis, noise measurement, audio or acoustical test, and mechanical systems analysis.

Take a close look at the SR785.

SRS **Stanford Research Systems**
1290-D Reamwood Ave., Sunnyvale, CA 94089 • e-mail: info@thinkSRS.com
Phone (408) 744-9040 • Fax (408) 744-9049 • **www.thinkSRS.com**

Editorial
NANCY FRIEDRICH | Director of Editorial Content
nancy.friedrich@penton.com

A Country Without A Carmaker

Known for their technical innovations, the Dutch have set their sights on enabling the car of the future—whether it be electric, driverless, or one that flies.

The automotive sector is evolving at a breathtaking pace. From electric and hybrid power solutions to infotainment options and autonomous driving, vehicles have become feats of electrical rather than mechanical engineering. Interestingly, I learned recently on a trip to The Netherlands that the country can provide an estimated 70% of the solutions, technologies, and materials needed for current and future automobiles—without being home to an auto manufacturer of its own.

That number is staggering in a country that is not churning out innovations to support its own car brand. This reality also spotlights two things: first, how much of what is developed for today's car exists beyond the car body and basic parts; and second, a readiness to adopt or help to create and proliferate new technologies. As one spokesperson from The Netherlands told me, he often gets asked when autonomous cars will be available because they're excited about them, not because they dread them.

Despite the country's extremely bike-friendly, green, innovative spirit, however, it is still home to a group of laggards and some late adopters just as we are here in the United States. Marco Mare'chal emphasized the varied attitudes of the population in a nationwide opinion study titled, "The Dutch Finally Have Their Say on Mobility In The Future 2030." The study reports that most Dutch people believe that streets will be dominated by EVs first and foremost in 2030. Yet they cite self-driving cars second and then eco-friendly cars, followed by responses of little/no change and more congestion and traffic jams (the last would clearly be the laggards). Amazingly, a hovering or flying car came in sixth place.

To me, this leap to the flying car is evident of a different way of thinking about these innovations and talking about them than we may experience in the U.S. Among the technical and research people I spoke with in The Netherlands, quite a few explained that they think about the autonomous vehicle as a robot. What defines a robot? It is a machine that has the intelligence to carry out a set of tasks that it is built and programmed to do. A driverless car does fit that definition. It follows that the same definition can be applied to other autonomous vehicles, such as drones. It's not such a big leap, then, to imagine flying cars in the nearer future. As we add intelligence to drones, cars, and other things that move, they do become more robot than vehicle.

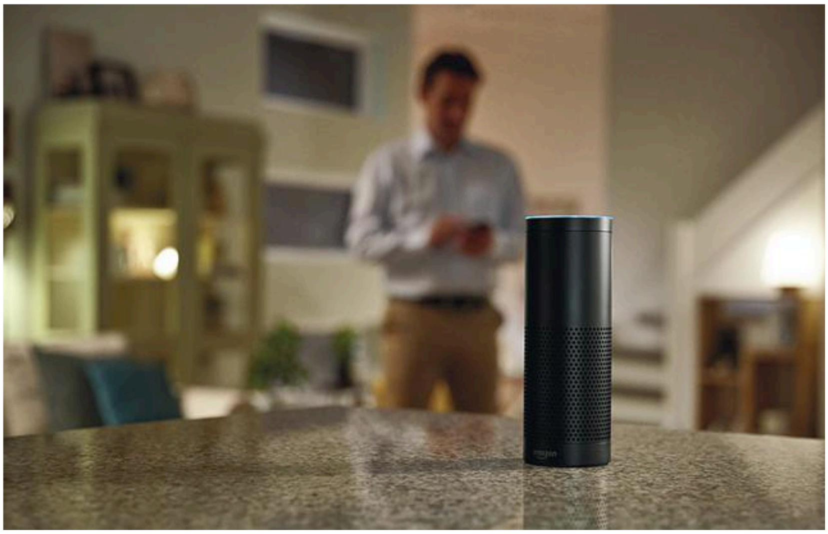
The Netherlands' next step, now that it has become a breeding ground for innovations for automotive systems, is to establish itself more prominently as a testing ground. It already has conducted tests for things like driverless cars and platooning capabilities, and the country's leaders are backing these efforts. Such tests have begun exploration into the needs of the general population, network operators, etc. For example, the country is unique in the number of bicycles used daily, so autonomous cars have to be aware that they are sharing the road with bicycles. This is just one example of the concerns and points being addressed via various regulatory groups, the government, researchers, universities and faculty, and more.

While many other countries struggle with how to begin work on autonomous vehicles and other mobility enhancements, The Netherlands has already begun experimenting with them on regular roads and in normal traffic. With this bold approach, combined with openness to innovations and deep technology roots, the country is increasingly attracting a talented international work force and student body. Certainly, its progress bears watching as the world looks to adopt enhanced mobility solutions. ed

JOIN US ONLINE twitter.com/ElectronicDesgn
become a fan at facebook.com/ElectronicDesign

News

ALEXA, CAN YOU STOP LISTENING to the Television?



On the season premiere of the satirical cartoon comedy "South Park," the foul-mouthed main character Cartman asks Amazon's digital assistant Alexa to set an early morning alarm, tell him jokes, and order weird and disgusting products online.

But the real joke was that if you were watching the episode and your Amazon Echo heard the television, it would follow all the same commands—or at least try to. This has long been one of Alexa's annoying but amusing quirks.

But it's easy to imagine more nefarious hacks as voice controls move into kitchen appliances and even door locks. Amazon released a bumper crop of new Alexa devices, and it has been trying to move artificial intelligence into things as mundane as an alarm clock and as outlandish as an animatronic talking fish. Google is trying to do the same with its Home digital assistant.

The cost and processing power of chips has also improved so that all types of devices could be controlled with a few words, and now software can clearly make out voices from across a room. But household devices may need more than microphones to react naturally to a person's requests and not be fooled by the television.

"Conversational awareness is the next big thing," says Mark Lippett, the chief executive of Xmos, which makes multicore microcontrollers that can capture voice from across a room or kitchen. "Ultimately, I think these interfaces are going to go beyond just audio," he said in a recent interview.

Xmos is not alone thinking along those lines. The company recently raised $15 million in a funding round led by Infineon, which announced that it would combine its sensors with Xmos chips to enable devices that only listen to humans. Infineon did not disclose the size of its investment, which it called a minority stake.

By coupling its automotive radar and microphones with Xmos' voice controllers, Infineon is aiming to give smart speakers and other household devices context to ignore music and voices from the television. "It is adding another dimension to that voice interface and another dimension to the user experience as a result," Lippett says.

"The microphones would eliminate the television as a source of a voice because televisions don't behave like human beings, they don't move around, and they generally don't have the characteristics of a human," Lippett says. The radar could provide other assurances that a voice belonged to someone in the room, such as reading a person's heart rate and breathing patterns.

"The audio reproduction industry is struggling—I mean it is very successful at creating something that comes out of your TV. that sounds like exactly like a human being," Lippett says. "That is a tough nut to crack and that is where I think you need a little more information that just acoustic."

Other chipmakers are betting on voice control as well. Cirrus Logic, which makes audio codecs and microphones, has released development tools for voice capture with Amazon's

Alexa. Texas Instruments and NXP are also targeting voice controls in the $81 billion smart home hardware market that Strategy Analytics predicts will exist in 2022.

Touch chipmaker Synaptics recently closed a $300 million deal for Conexant, which makes voice processors that work with both Baidu's and Amazon's digital assistants. Like its rivals, Conexant has been improving its chips to separate voice commands from background noise. Using four microphones, its voice software can determine the direction of sounds.

Xmos is also pressing ahead with investments into sound separation and software that fuses information from multiple sensors. In July, it bought Setem Technologies, whose algorithms can identify the number of people in a room and amplify individual voices in noisy situations like cocktail parties—something that Lippett calls "vocal sorcery." The software could also give gadgets an intuitive grasp of their surroundings.

For example, a smart speaker could detect music from a television and block it out to listen for voice commands. The speaker could also recall that something in that location played music before, so it will ignore a news broadcaster's voice, for example, from that direction. "You can use that historical data and build up some knowledge about the soundscape," Lippett says.

Further along, household devices could initiate conversations to tell users about the weather or traffic. They could roll with the typical quirks of human speech, like following a voice command after the person talking pauses or asks an unrelated question. But that would require lots of contextual clues that might be tough to pick out with a microphone.

"They are going to start looking at different things like how many people are in the room, where they are facing, and their body language—to make intelligent choices about when to speak, the context, and what information might be required in that context," Lippett says.

JAMES MORRA, Associate Content Producer

NVIDIA BOLSTERS COMPUTER SYSTEM for Fully Autonomous Cars

NVIDIA REPORTS THAT it has built a computer system that could squeeze the processing power required for fully autonomous driving onto a board the size of a license plate. It said that the on-board computer, Pegasus, could run more than 320 trillion operations per second.

Jensen Huang, chief executive of Nvidia, said that the computer packed more than 10 times the processing might of the company's previous Drive PX system, which is already used by Tesla, Audi, and Volvo to power autonomous highway driving and safety functions like lane-change warnings and emergency braking.

The Pegasus system is capable of processing information from 16 different sensors, including lidar and cameras, to recognize objects around it and pinpoint its position on the road within centimeters. It also provides the raw processing power also track other cars and pedestrians around the vehicle so that it can plot out the safest route to its destination.

Nvidia plans to sells the new system to companies like Nutonomy and Zoox, which are testing autonomous car prototypes. Today, these firms are stuffing cars with what resemble small data centers, equipped with racks of Nvidia's server chips. But doing that is too expensive, too bulky, and would require too much power of mass-produced cars.

Danny Shapiro, senior director of Nvidia's automotive business, said that the Pegasus system is better suited for production vehicles like taxis that can drive without human intervention and possibly without steering wheels, mirrors, and brakes. "This is the path to production," Shapiro said in an interview with news website Axios.

The Santa Clara, Calif.-based supplier said that it would release the new system in the second half of next year. The board is equipped with two graphics accelerators as well as two Xavier chips using Nvidia's newest graphics architecture, called Volta, which uses special processing cores to solve the complex multiplication tables used in deep learning.

Nvidia is targeting its graphical processors at "end-to-end" deep learning, in which algorithms learn patterns in unlabeled data with little human instruction. The company claims that self-driving algorithms can learn to drive within highway lanes, for instance, by watching the road through a front-facing camera for millions of miles.

In addition to autonomous taxis, the Pegasus system could also be used in driverless delivery trucks. On Tuesday, Deutsche Post and its subsidiary DHL said that it would start testing such vehicles next year using Drive PX on-board computers, while also using Nvidia's server chips for training neural networks. The new system also meets the most stringent safety level for automotive electronics, ASIL-D. **—JM**

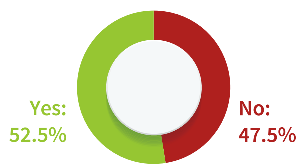
Sponsored by tti

SourceToday 2017 ANNUAL

SALARY & CAREER REPORT

Electronics procurement professionals enter the new fiscal year with generally bright salary prospects amid a strengthening economy. Expected total compensation for 2017, as reported by over 500 respondents to Source Today's annual salary survey, is forecast to rise an average of 2.4% over last year—although those increases are divided somewhat unevenly by gender.

DO YOU FEEL YOUR COMPANY ADEQUATELY COMPENSATES YOU FOR THE WORK YOU DO?



Sections include:

Salary & Benefits | Outsourcing | Workforce Trends
Continuing Education | Economic Outlook

Go to SourceToday.com

Download the full, 8-page 2017 Source Today Salary & Career Report PDF complete with high - resolution infographics.

CREATING CRYPTOGRAPHY for Tiny Embedded Devices

FOR THE TINY PROCESSORS used in identification tags, wireless sensors, and microcontrollers that control a car's door locks and brakes, security is complicated. They have little computing power and memory to reserve for digital protection.

SecureRF is trying to make it easier for these embedded devices to authenticate each other and encrypt sensitive information. Louis Parks, the company's chief executive, said that it could fit cryptography algorithms onto 8-bit and 16-bit processors sold by its customers.

The security firm, founded in 2004, built a cryptography scheme that can authenticate these simple processors in milliseconds, which cuts power consumption as a bonus. "With 8-bit or 16-bit processors, we weren't thinking about security until someone could take control of the brakes in my car with them," Parks told *Electronic Design* in an interview.

Parts of that conversation are edited and condensed below.

Forrester Research said in a recent report that network security is the most important for the Internet of Things. Why do these devices need authentication and even encryption on top of strong network security?

Parks: What we are doing specifically is securing the edge points of the Internet of Things. Let's pretend we don't need security at those edge points. Well, I put a little piece of malware inside data going into the network and then I move my malware all around so I can infect everything.

You often hear security talked about in layers. Last year, all those devices were improperly secured—this is the Mirai attack that brought down Netflix and a whole lot of other server farms—because hackers got access several thousand unsecured devices connected to very secure networks.

If I issue a command to apply the brakes in a car, you want the brakes to know that the command is coming from the driver and not someone in North Korea. If BMW wants to push a firmware update, its cars may want to confirm that BMW is sending the message and not a hacker. BMW wants to make sure that it pushes out its precious software to an authentic BMW platform and not people trying to steal the code.

Can you explain the problem with running cryptography algorithms on these relatively simple devices?

Parks: There is something called public key asymmetric cryptography, which is the foundation of initial authentication for your internet browser and smartphone. It involves multiplying and dividing large numbers—adding and subtracting 0s and 1s at the chip level.

If you can't fit the entire operation in the width of the bus, you have to break it up. That can take a very long time. You only have 8 bits of an 8-bit processor so, if a public key method needs at least 32 bits, you are going to have significant overhead to do authentication.

What sets apart your technology? How does it work with devices that have small amounts of computing power and memory?

Parks: Most of the security that you use today on your smartphone and laptop is 35 to 40 years old, but it works perfectly well. But with an 8-bit processor it does not work well at all. What we have done is brought in a branch of mathematics called group theoretic cryptography. . . . It is done with very small numbers usually 5 to 8 bits in size, which means that the numbers fit in an 8-bit processor. Our operations perform significantly faster and more efficiently.

What other benefits does your approach have?

Parks: The faster computation times translates into lower energy consumption. In the Internet of Things devices using 8-bit processors, energy is an issue because you don't want to run the battery down trying to check the security. No one wants to replace the battery in their device every four or five weeks when they think it is going to last one to two years.

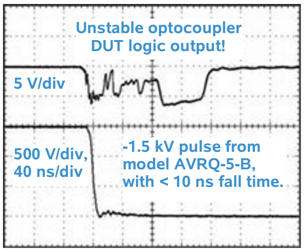
The unique thing we did is bring in this area of cryptography, which is typically used in identification and authentication but which can also support encryption and data protection. It has basically allowed us to use a smaller physical footprint in silicon and software and it has given us ultra-low energy.

In August, a bill was introduced in Congress that would set basic security standards for devices sourced by the U.S. government. It would also task officials with creating guidelines for devices with "limited" processing power. What would your advice be to them?

Parks: It's a great start. I would hope that whoever's working on the bill would reach out to a number of constituents from across the digital spectrum, especially from the device level because a lot of what they are talking about is device-level security. . . . Best-case scenario, the bill results in some kind of comprehensive security framework. **—JM**

Transient Immunity Testers from AVTECH

The Avtech AVRQ series of high-voltage, high-speed pulse generators is ideal for testing the common-mode transient immunity (CMTI) of next-generation optocouplers, isolated gate drivers, and other semiconductors.



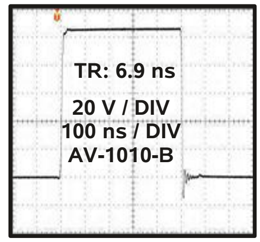
- Kilovolt amplitudes (±1, ±1.5, -2 kV)
- Transition times down to 10 ns, dV/dt rates up to 120 kV/us
- Switchable daughterboards to handle a variety of DUT package styles
- GPIB, RS-232 ports standard
- Ethernet / VXI optional

AVTECH
Nanosecond Electronics
Since 1975

Pricing, manuals, datasheets and test results at:
http://www.avtechpulse.com/semiconductor

30, 50 and 100 Volt Lab Pulsers

Avtech offers an extensive series of user-friendly 30, 50 & 100 Volt general-purpose lab pulsers. We can provide an alternative for the discontinued Agilent 8114A or HP214!



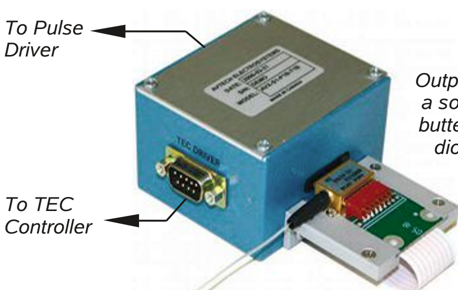
Model AV-1015-B:	**50 Volts, 10 MHz**
Model AV-1010-B:	**100 Volts, 1 MHz, 25 ns to 10 ms, 10 ns rise time**
Model AV-1011B1-B:	**100 Volts, 2 ns rise time**
Model AV-1011B3-B:	**30 Volts, 0.5 ns rise time**

Variable baseline and burst mode options and output currents to 8 Amps with accessory transformers.

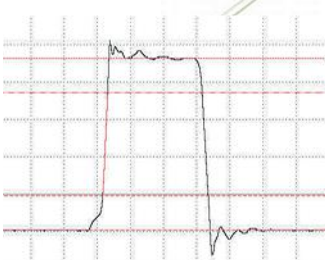
AVTECH
Nanosecond Electronics
Since 1975

Pricing, manuals, datasheets and test results at:
http://www.avtechpulse.com/general

Nanosecond Laser Diode Drivers With Butterfly Diode Sockets



Output module with a socket-mounted butterfly-packaged diode installed.



Model AVO-9A-B
40 mA/DIV
1 ns/DIV

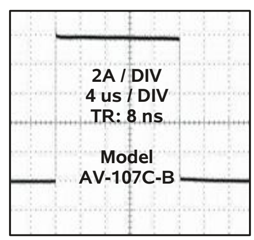
Each of the 19 models in the Avtech AVO-9 series of pulsed laser diode drivers includes a replaceable output module with an ultra-high-speed socket suitable for use with sub-nanosecond rise time pulses. Models with maximum currents of 0.1A to 10A are available with pulse widths from 400 ps to 1 us. GPIB, RS-232, and Ethernet control available.

AVTECH
Nanosecond Electronics
Since 1975

Pricing, manuals, datasheets and test results at:
http://www.avtechpulse.com/laser

2 to 200 Amp Current Pulsers

Avtech has pioneered the design of user-friendly 2 to 200 Amp constant current pulsers. We offer over 35 models in five series for laser diode, air bag, squib, fuse and other applications. The basic specifications are as follows:

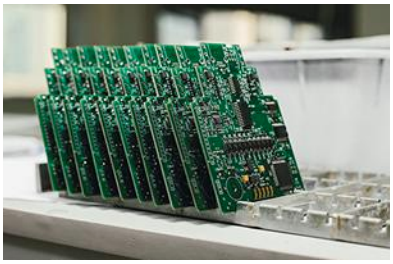


Series	I, V	PW	TR
AV-107	2 - 20 A, 60 V	0.2 - 200 us	10 - 30 ns
AV-106	5 - 100 A, 100 V	0.5 us - 1 ms	50 ns - 1 us
AV-108	12.5 - 200 A, 100V	2 us - 1 ms	5 - 15 us
AV-109	10 - 100 A, 5 V	10 us - 1 s	10 us
AV-156	2 - 30 A, 30 V	1 us -100 ms	0.2 - 50 us

Avtech has a long history of producing one-of-a-kind custom units.

AVTECH
Nanosecond Electronics
Since 1975

Pricing, manuals, datasheets and test results at:
http://www.avtechpulse.com/current



DIALOG BUYS SILEGO TECHNOLOGY to Muscle into Internet of Things

DIALOG SEMICONDUCTOR is buying Silego Technology—whose one-time programmable chips can replace standard mixed-signal products in connected cars, industrial sensors, and other Internet of Things devices—for $276 million in cash.

Silego sells configurable mixed-signal chips that it claims can be programmed in minutes to help minimize component count, board space, and power consumption. According to the Santa Clara, Calif.-based firm, these parts can integrate analog, power, and other discrete components into a single device.

"The acquisition of Silego brings a highly complementary technology," said Jalal Bagherli, Dialog's chief executive, in a statement. Dialog sells power management, charging, and connectivity chips for a wide assortment of gadgets, but it reaps most of its revenue from smartphones sold by makers Apple and Samsung. It has been trying to change that.

Last year, it agreed to pay $4.6 billion for Atmel, which sells microcontrollers for industrial sensors and household devices like refrigerators and televisions. The deal soured after Atmel agreed to be acquired by Microchip for $3.6 billion, arguing that investors would get more cash per share and that Microchip's stock had better prospects.

The Silego acquisition is a smaller bet on grittier technology. Dialog, which is based in the UK, said that it will benefit from sharing manufacturing, sales, and distribution operations with its new business. The deal is expected to close in the fourth quarter of this year, and Dialog will pay another $30.4 million if Silego hits revenue targets over the next 15 months.

"What Silego has developed is truly unique—a mixed-signal platform which customers can configure to their design requirements on the fly, drastically reducing the time to bring their products to market," Bagherli said. "Together, we will significantly increase the value we can bring to our customers."

Silego has sold around 3.1 billion mixed-signal configurable chips—also called CMICs—since it was founded in 2001. The company, which is privately-held and employs around 235 people worldwide, said that it expects to generate over $80 million of revenue in 2017, with double-digit percent growth next year. **—JM**

MARIA GUERRA | Technology Editor

A Hybrid Approach to Energy Storage

Although it is common to find supercapacitors in many power-electronics devices, hybrid energy storage technology could increase the commercial adoption of supercapacitors in grid-scale solutions.

Today, supercapacitors are found in many electronic applications. In automotive applications alone, they are used in startup systems, energy recovery solutions, and fast charge-discharge systems, to name a few. Supercapacitors can charge/discharge quickly without losing energy storage capacity over time. They also have very high power density. In contrast, batteries can store larger amounts of energy but they have a defined cycle life. A combination of batteries and supercapacitors results in a hybrid energy storage system that could help meet the needs of myriad renewable energy applications.

Supercapacitors can assist in delivering peak power while improving the performance of batteries in energy storage systems. Many supercapacitor manufacturers, utility companies, and researchers are developing hybrid capacitor-battery energy storage systems for future projects. Some are already using them in case studies and pilot projects, such as the one built by Duke Energy at its Rankin Substation in Gaston County, N.C.

Duke Energy partnered with Aquion Energy, Maxwell Technologies, and others to build a hybrid energy storage system (HESS) project. The hybrid system uses Maxwell's UCAPs to help manage solar smoothing events in real-time—particularly when the solar power on the grid fluctuates due to cloud cover or other weather circumstances *(Fig. 1)*. The Aquion batteries are used to shift solar load to a time that better benefits the utility. The hybrid energy storage system integrates patented energy management algorithms.

The Maxwell UCAPs used in this program discharge and recharge power in a subsecond-to-minutes timeframe. They also boast long operational life in a wide operating temperature window. This is ideal for stabilizing short-term PV power output fluctuation in large-scale deployments, ensuring reliable access to solar power on the grid. In addition, a 100-kilowatt/ 300-Kwh battery uses a unique Aqueous Hybrid Ion chemistry (including a saltwater electrolyte and synthetic cotton separator). These materials should result in lower costs, while the water-based chemistry will provide a non-toxic and non-combustible product that is safe to handle and environmentally friendly.

Other companies such as Hitachi also have been working on the development of hybrid battery energy storage systems. In one of Hitachi's case studies, a hybrid battery energy storage system was developed that combines lead-acid batteries and lithium-ion capacitors *(Fig. 2)*. For the development of hybrid

1. This hybrid battery-supercapacitor energy storage system was deployed at a distribution substation in Gaston County, N.C. *(Courtesy of Duke Energy)*

2. Lithium-ion capacitors are effective for addressing short-cycle frequency fluctuations. *(Courtesy of Hitachi)*

According to Navigant Research, global installed HESS power capacity is expected to grow from 78.6 MW in 2017 to 2.1 GW in 2026. The growth of interest in stationary energy storage solutions should help to boost the development of hybrid energy storage solutions. Grid-scale hybrid solutions in particular could lower cost, improve system efficiency, and increase system lifetime.

battery energy storage systems, Hitachi is aiming to cover the same range of needs as variable-speed pumped-storage hydroelectric plants. For this purpose, the company co-developed a 1.5 MW hybrid battery energy storage system with Shin-Kobe Electric Machinery Co. Ltd. (now Hitachi Chemical Company Ltd.), as part of a project subsided by The New Energy and Industrial Technology Development Organization (NEDO).

The demonstration project on Izu Oshima Island in Japan began in 2015. It has entered a new stage as a joint research project with TEPCO Power Grid Inc. The companies have been evaluating the efficiency of the monitoring control system and its effects on the operation of existing power plants. Hitachi is aiming to commercialize the system in 2018 to help stabilize the supply of power for island regions.

BATTERY PACK

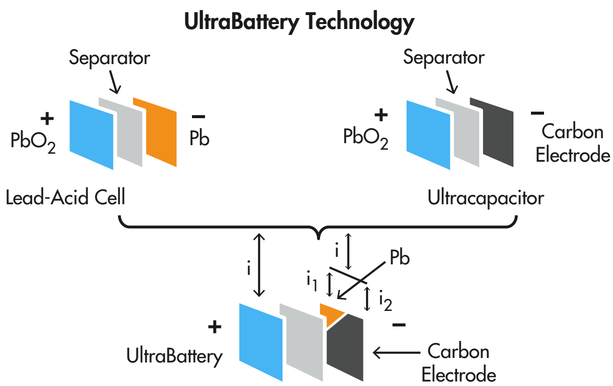
Another approach to hybrid energy storage can be seen in the hybrid battery pack system called UltraBattery. It was developed by CSIRO in Australia, built by the Furukawa Battery Company of Japan, and tested in the UK through the U.S.-based Advanced Lead-Acid Battery Consortium. The battery is a hybrid, long-life, lead-acid energy storage device *(Fig. 3)*. It combines supercapacitor technology with the energy storage potential of a lead-acid battery technology in a hybrid device with a single common electrolyte.

The specialized carbon in the ultracapacitor layer creates a strong Hermholtz layer (the driving structure of electric double-layer capacitance). With a highly conductive lattice of an extremely large surface area, it improves access to reaction sites in the battery's active material. The battery achieves a typical dc-dc efficiency of 93–95% when performing variability management applications, such as grid regulation services or renewable ramp rate smoothing at 1C peak power in a Partial State of Charge (PSoC) regime. The high dc-dc efficiency translates to lower dc-dc energy losses. Conventional VRLA batteries operating at 80% to 100% SoC lose about five times more energy to heat and electrolysis than this hybrid battery *(Fig. 4)*.

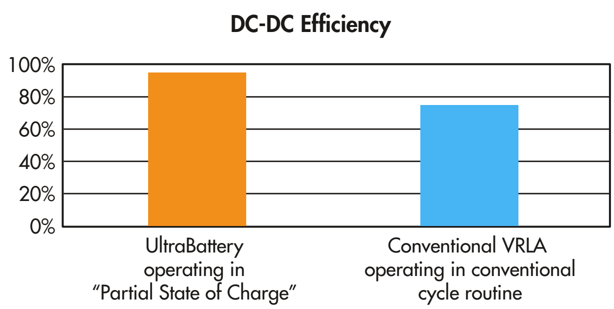
The UltraBattery operates in a Partial State of Charge (PSoC). The integrated supercapacitor inhibits the sulphation process (normal in lead-acid battery operation), allowing the battery to operate with high efficiency in a PSoC. The Ultra-

Battery technology has been used in several Megawatts-scale projects in Australia and the United States providing the following: grid ancillary services; smoothing the intermittent signal of solar and wind energy; energy shifting (storing energy for later use); and diesel efficiency optimization on standalone power systems.

According to Navigant Research, global installed HESS power capacity is expected to grow from 78.6 MW in 2017 to 2.1 GW in 2026. The growth of interest in stationary energy storage solutions should help to boost the development of hybrid energy storage solutions. Grid-scale hybrid solutions in particular could lower cost, improve system efficiency, and increase system lifetime. ed



3. This hybrid battery pack system combines the advantages of two energy storage technologies in a single cell. *(Courtesy of UltraBattery)*



4. When the hybrid battery loses less energy during PSoC operation, more energy is available to service the load. *(Courtesy of UltraBattery)*

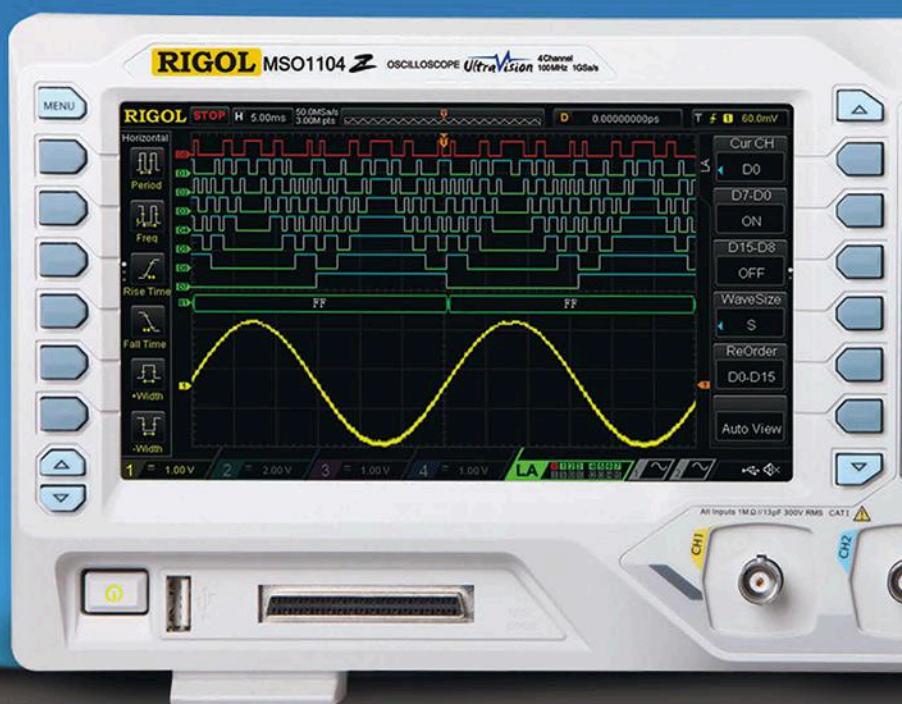
MSO Series

Mixed Signal Oscilloscopes

Completely Debug Your Embedded Designs

- 70-500MHz Models
- 16 Digital Channels w/ 2 or 4 Analog
- Up to 4 GSa/s Sampling
- Serial Triggering and Decode (Free on 4000 Series)
- Free bandwidth upgrade on 200 or 350 MHz 4000 Series purchase
- New DS1000Z Plus scope can be upgraded to MSO later
- Starting at $699

Visit Rigolna.com/MSO
or call 877-4-RIGOL-1



Uncompromised Performance...
Unprecedented Value

- Feature Rich Instrumentation
- Accelerate Your Validation Time
- Lower Your Cost of Test

RIGOL
Innovation or nothing

Oscilloscopes • MSOs • Waveform Generators
RF Test • Precision Measurement

WILLIAM WONG | Technology Editor

TRACE TOOLS Enhance System and Application Diagnostics

Debugging real-time and network communication applications can be a challenge, but trace tools provide a way to analyze what is going on without stopping the application. We take a look at the new trends in presentation and analysis of dynamic debugging tools.

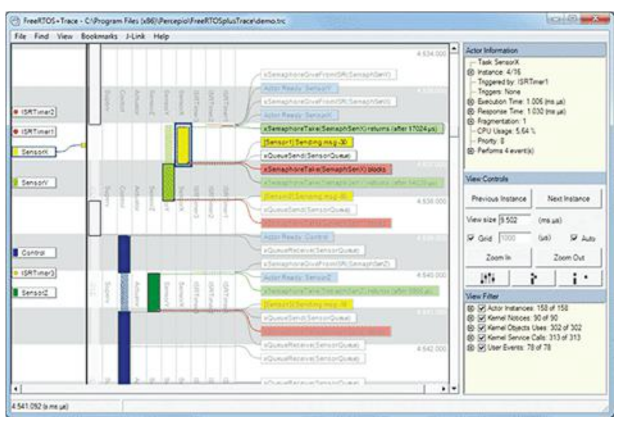
A debugger can help track down problems in an application. Setting a breakpoint and stepping through code can help developers understand how an application is really working and see where problems may occur. The problem with this approach is many applications are time sensitive and stopping them in the middle of an operation can be catastrophic. For example, hitting a breakpoint in the middle of a motor control application can do bad things to a high-speed, spinning rotor that is no longer being controlled in real time. Likewise, tracking hundreds of threads running in a GPU can be equally challenging.

Trace tools complement conventional debuggers, but they are often overlooked by developers. These tools are typically part of a development suite but take a different approach to debugging, as trace facilities capture large amounts of information that can sometimes be analyzed in near-real time or during post-analysis. Of course, raw trace data tends to be overwhelming in size with thousands or millions of entries with lots of details *(Fig. 1)*.

For example, Green Hills Software's SuperTrace Probe can capture up to 4 Gbytes of trace data at core clock rates up to 1.2 GHz and trace port speeds over 300 MHz. Instrumented software is another way to capture trace information. Hardware has the advantage of low or no overhead, whereas instrumentation incurs some overhead. Lauterbach's Trace32 family of hardware platforms even support hypervisor awareness.

The trick to utilizing all this trace information is to have good presentation and analysis tools. Percepio's TraceAnalyzer *(Fig. 2)*, can take advantage of the LTTng Project's Linux Trace Tool (LTT) output and present it in a variety of graphical formats, both to highlight workflow and timing

1. Typically the large amount of trace information is hard to analyze by simply looking at the raw trace data.



2. Percepio's TraceAnalyzer extracts useful information from a trace and presents it in one of many graphical formats that can highlight workflow or errors.

www.rocelec.com

The Semiconductor Lifecycle Solution™

Supply chain continuity – Solved.

- 100% Authorized by over 70 semiconductor manufacturers
- Over 15 billion units in stock
- Licensed manufacturing solutions – 70,000+ device types

100% Authorized, licensed, certified and guaranteed

Rochester Electronics®

©2017 Rochester Electronics, LLC – Rochester Electronics is a registered trademark of Rochester Electronics, LLC

considerations and to identify errors. Percepio has more than two dozen ways to graphically view trace details, making it easier to identify different types of problems.

Software trace instrumentation can be added to applications and some operatinSg systems have it built in. This allows tracking operating system events like thread context switches, service API calls, and system interrupts. Express Logic's own TraceX works with its ThreadX RTOS, which is also part of the Renesas Synergy solution that delivers both microcontroller hardware and matching software (including ThreadX).

The granularity of trace information can affect how the information is analyzed and utilized. For example, the Green Hills Software TimeMachine debugging suite, part of the MULTI IDE, captures the instruction counter so it is possible to step forward and backward through code that was executed. The interface is similar to what a developer has with a debugger, but a conventional debugger can only move forward through program execution. Of course, TimeMachine is limited to following threads that have already finished executing, but that is what a developer will want to examine.

The Green Hills PathAnalyzer *(Fig. 3)* provides a more compact view of an application's call stack over time. It allows developers to determine where a program may divert from the expected path. It can also highlight how interrupts or random bugs affect the desired application operation. A complementary tool called EventAnalyzer uses the trace information to track down problems like deadlock.

Finding trace support for a development environment is not always easy. Some platforms, especially embedded devel-

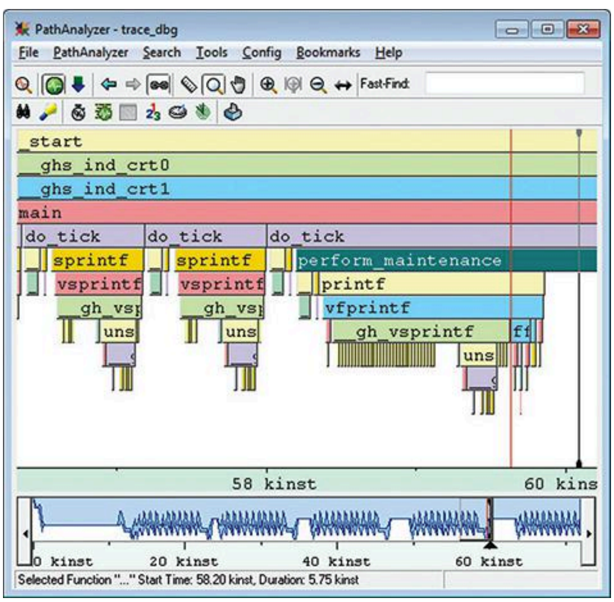
Using trace tools in a multicore or asymmetric processor environment can be challenging but very useful, since communication and synchronization issues tend to be difficult to debug using conventional means.

opment platforms, often have multiple options. Some environments may have a more limited selection. For example, Microsoft's Visual Studio (VS) IntelliTrace handles Visual Basic and Visual C# applications. Of course, VS is the only way to develop applications using these languages.

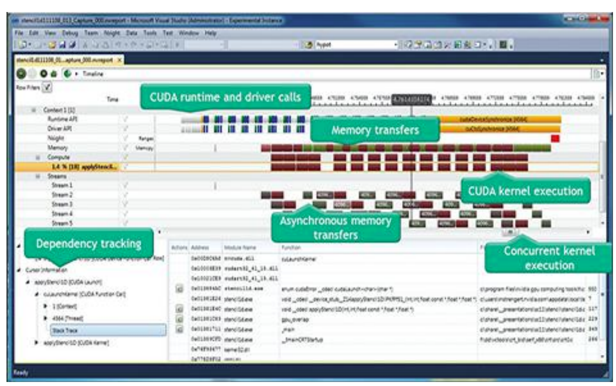
NVidia's Nsight IDE targets its GPUs with a collection of trace facilities *(Fig. 4)* including OpenCL Kernel Trace, Direct3D 11/12, OpenGL, CUDA C/C++, and OpenCL API Trace, plus OpenGL workload trace. This approach to system analysis tends to be more useful than stepping debuggers because of the large number of threads and data involved. The graphical interface allows examination of source code for related operations presented in the trace streams.

Using trace tools in a multicore or asymmetric processor environment can be challenging but very useful, since communication and synchronization issues tend to be difficult to debug using conventional means. Synchronizing the trace information is the more challenging aspect but hardware-based solutions tend to do this easily. Software-only solutions are more problematic and dependent upon the hardware, which may or may not make this possible.

Trace tools can be useful in analyzing issues such as latency and deadlines that are difficult to examine using other means. They can also be handy for examining processor utilization and finding memory leaks. ed



3. Green Hills PathAnalyzer provides a more compact view of an application's call stack over time.



4. NVIDIA CUDA trace can show the relationship between calls and memory transfers.

WILLIAM WONG | Technology Editor

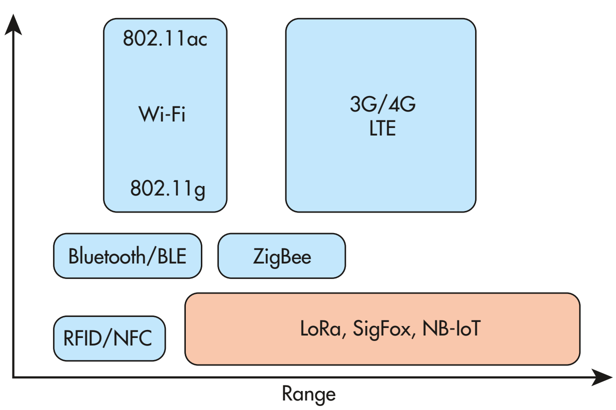
Choices Abound for Long-Range Wireless IoT

There is a variety of options for developers needing long-range wireless communications for IoT applications.

Wireless sensors are often synonymous with Internet of Things (IoT) devices. These can include high-speed solutions like Wi-Fi or mesh technologies like ZigBee. Unfortunately, when it comes to wireless technology, designers normally need to pick two out of three characteristics: low power, long distance, or high speed *(Fig. 1)*. Low power in this case would be a device that can operate continuously for more than 10 years and over a distance on the order of kilometers. Low cost is also a desirable characteristic.

There are a number of ways to address low-power, long-range IoT, but the three main competitors at this point are Sigfox, LoRaWAN Alliance LoRaWAN, and 3rd Generation Partnership Project (3GPP) NB-IoT (narrow band IoT). Each has a different set of attributes that designers may prefer, but usually a solution will utilize one or the other.

There are modular platforms like the Multi-Tech Systems Conduit gateway *(Fig. 2)* supporting a pair of mCards that can handle protocols like LoRaWAN and LTE. It also has a Power-over-Ethernet (PoE) wired network connection. Most of these low-power networks are rooted to a TCP/IP backbone like the Internet.



1. Wireless technologies like Sigfox, LoRaWAN, and NB-IoT deliver low-power, long-distance solutions, but with reduced transfer rates and high latency.

SIGFOX

Sigfox is a proprietary system supported by number of equipment vendors that uses technology licensed by Sigfox. The system is essentially a single global network, but coverage will be needed where devices are deployed. Pricing for services depends upon a number of variables such as the number of messages per day and number of devices.

There is mandatory certification so all devices are designed to work together. The devices utilize 200 KHz of public spectrum and operate with a throughput of 100 to 600 Kbits/s depending upon distance and other factors.

Sigfox uses binary phase-shift keying (BPSK). It has an asymmetric architecture that uses sensitive base stations for faster upload speeds, but more limited download capability. As with most long-distance, low-power solutions, it has a small, 12-byte packet payload that is sufficient for sensor data and limited command and control.

Access points can be low cost and are sometimes referred to as "dumb ears." A single access point can cover a large area since range is measured in kilometers. There is also the Sigfox Atlas geolocation services that has an additional monthly fee. It has a resolution on the order of 1 km, which would be suitable for tracking items over long distances such as trucks or packages.

LoRaWAN

The LoRaWAN Alliance manages LoRaWAN. It is based on Semtech's spread-spectrum technology that uses a chirped modulation scheme. Most implementations are based on chips available from Semtech.

The system has a variable packet size ranging from 51 to 222 bytes, with at least 13 bytes of packet payload. LoRaWAN uses different public spectrum depending upon the country.

There are a number of LoRaWAN service providers including The Things Network (TTN) and Comcast machineQ that support LoRaWAN. TTN has a public and private implementation using user provided access points. It is also possible to have multiple networks operating in the same environment just like multiple Wi-Fi access points or cellular networks although the actual way the spectrum is shared is different for each of these.

2. The Multi-Tech Systems Conduit modular gateway supports a pair of mCards that can include support for interfaces like LoRaWAN and LTE.

LoRaWAN also uses concentrator access pointers for routing packets to a server than manages communication. It also uses a two key encryption and authentication mechanism. One is used for network traffic while the other is used for application data that flows over the network. This allows the network to be managed independent of the application that would have an application server in the cloud.

Users can take advantage of service provider networks like machine and TTN or they can install their own concentrators and servers.

NB-IoT

3GPP NB-IoT uses licensed spectrum and is oriented toward service providers that have cellular networks in place and want to augment these with long range, low power solutions compared to 4G LTE which uses more power but at a much higher bandwidth. It uses a narrow frequency spectrum on the order of 200 KHz. Deployments can operate in a standalone mode as a GSM channel or in-band with LTE resource block or in an LTE guard band. Service providers will dictate which will be used in their area.

NB-IoT operates at 250 kbits/s. It has a latency 1.6 to 10 s. This is similar to Sigfox and LoRaWAN and highlights not only the throughput but overall bandwidth limitations. These limits are needed to support a large number of devices while guaranteeing service to all. It designed to handle 50,000 devices per cell/access point. This typically works out to 40 devices per household.

A designer's choice of which protocol to use will depend upon a number of factors, and some may force the use of one over the other. For example, developers will need to consider how devices and services will be priced. Only LoRaWAN allows complete, standalone configurations. All have service provider-based options. ed

MAKING YOU MONEY WHILE YOU SLEEP

MPD
MEMORY PROTECTION DEVICES

MPD DEVICES CAN BE FOUND IN
CRYPTOCURRENCY MINING MACHINES
AROUND THE WORKD

BATTERYHOLDERS.COM

FOCUSED

& #FIERCELY INDEPENDENT

Good work comes from determination, focus and free thinking. As engineers you know this. We hold ourselves to the same truth – a determination to bring you **bold insights** and information that **helps you do your jobs better** - with a promise to deliver **unbiased, expert content**. Penton Design Engineering and Sourcing is the only independent insight and information source holding the promise of your truth.

Penton Design Engineering and Sourcing

Electronic Design. Machine Design. Power Electronics. Microwaves&RF. SourceESB.

The Essentials of Logic Analyzers

Logic analyzers are a critical tool to be found on any serious digital system designer's workbench, whether as standalone instrument, in a modular chassis, or PC-based.

Just as the oscilloscope is the instrument of choice for analog electronics, and the spectrum analyzer is preferred for RF measurement, the logic analyzer is the go-to instrument for digital system designers.

Equipped with multiple channels, the logic analyzer characterizes the data state and timing of a large number of digital signals. Typically, these digital measuring instruments offer 16, 32, 64, or a greater number of input channels that can be displayed in a variety of formats. Among these display formats are timing diagrams, state diagrams, protocol decodes, and assembly code.

LOGIC ANALYZER FORM FACTORS

Logic analyzers come in a range of form factors, including instrument, modular, and computer-based packages. Instrument-format logic analyzers are housed in traditional, standalone cases just like an oscilloscope or spectrum analyzer *(Fig. 1)*.

Modular logic analyzers are based on standardized modular PC cards intended to operate in a mainframe crate or chassis. They're available with a fixed channel count per module; the maximum channel capacity is a function of the number of slots in the crate. Power and timing signals are shared between all of the modules in a crate *(Fig. 2)*.

PC-based instruments are small modules connected to a PC using USB or Ethernet connections. In recent years, logic-analysis capability has been incorporated into digital oscilloscopes, giving rise to "mixed-signal oscilloscopes" or MSOs. On top of that, instruments like the GoLogicXL-36 can be connected to an oscilloscope to add logic-analyzer trigging capabilities to the features of a scope.

1. Keysight Technologies' 16864A 136-channel portable logic analyzer comes in a standalone instrument chassis; others are available in modular or PC-based form factors. *(Source: Keysight Technologies)*

2. The 32-channel PXI-e 6545 from National Instruments is a good example of a modular logic analyzer. *(Source: National Instruments)*

DECODING THE LOGIC ANALYZER'S DISPLAY

A logic-analyzer display consists of multiple channels of digital data plotted as digital state versus time *(Fig. 3)*. This display from a 16-channel, PC-based logic analyzer shows a four-wire digital bus along with the three component signals of a SPI bus.

The digital bus has four component signals (D0-D3) combined with the bus state. The vertical scale is the logical state of each digital line, '0' lower state or '1' upper state. The state readout is the hex value of the parallel bus signals

The three SPI bus signals are the SPI data, clock, and chip select. The SPI bus readout shows the decoded value of the data contained in the serial SPI packet. The SPI packet is data that's occurring during the eight-pulse clock burst while the chip-select line is in the low or '0' state.

LOGIC-ANALYZER OPERATION

The logic analyzer, like the digital oscilloscope, is a digital instrument. It digitizes each input channel at a rate set by the analyzer's clock rate. Unlike an oscilloscope, each channel of the digital conversion contains just a single bit. Is the signal above or below the user-set digital threshold? The resulting digitized data has a value of either 0 or 1. Standard threshold values for TTL, CMOS, or other user-set thresholds are between 0 and 7 V.

All digital channels are clocked simultaneously, and the parallel digital data is clocked into the acquisition memory. The acquisition memory has one row of memory for each digital input. The depth of the acquisition memory determines the duration of the measurement. Data is acquired continuously in the memory until the occurrence of a trigger event. At this time, the memory contents are displayed. If the logic analyzer is set in single trigger mode, the acquisition stops until it is re-armed. In normal trigger mode, the acquisition resumes, awaiting the next trigger event.

The user can set the trigger location so that it occurs in the center of the acquisition memory. By doing so, it's possible to observe the data before and after the trigger. Therefore, if triggered by an anomalous event, the logic analyzer can show the conditions leading up to that event. Display zoom allows users to view selected sections of the memory contents.

Logic analyzers are triggered just like an oscilloscope. The trigger condition could be a simple edge transition of a single digital input or the presence of a preset logic state involving multiple digital lines. Common trigger events include specific data words, data words within specific ranges of values, after a preset number of events based on an event counter, or an external trigger signal. Conditional triggering, where a trigger event occurs only under a qualifying logic condition, takes place simultaneously. When the trigger event occurs, it locks the content of the acquisition memory, which is then displayed as explained previously.

Generally, two clocking modes are available in logic analyzers: asynchronous (timing) and synchronous (state) acquisition. Asynchronous clocking uses an internal clock of the logic analyzer that has a frequency several times greater than the device under test's system clock. The measurement clock rate, which is asynchronous with the timing of the system under test, determines the time resolution of the timing measurement. It can determine the edges of the logic signals with a resolution equal to the period of the clock signal. It's also able to detect glitches and other abnormal timing issues.

DATA BUS STATE AND SERIAL DATA DECODE

As noted in *Fig. 3*, the acquired bus data can be viewed in a condensed form, where the data state of the parallel bus is displayed. The user usually has a choice of viewing the bus value in binary, decimal, hex, or ASCII format.

Serial data, such as the SPI bus in *Fig. 3*, can be decoded and read out in the same data formats for specific serial standards. The logic analyzer used in this example can decode SPI, I2C, or UART data packets. Higher-performance logic analyzers support many high-speed serial data standards, including PCI-Express, XAUI, Rapid IO, and SATA, as well as many others.

MEASUREMENTS

Logic analyzers offer a number of tools for making measurements on the acquired data. At a minimum, they offer cursors that can measure the time between events. More sophisticated logic analyzers provide measurement parameters such as frequency, period, pulse width, duty cycle, and edge count. Note that no amplitude-related measurements are made—that requires an oscilloscope. The parameters are fully automated and save a great deal of time over manual cursor placement.

INSTRUMENT SYNCHRONIZATION

Many logic analyzers can interface with a digital oscilloscope. When operated jointly, analog waveforms from the oscilloscope are synchronized with the digital data from the logic analyzer and displayed in common. Alternatively, MSOs now offer digital along with analog channels, and display both analog and digital signals on synchronized time axes.

3. This logic-analyzer display shows a four-wire digital bus (D0-D3) and the three component signals of an SPI serial interface data (DATA), clock (CLK), and chip select (CS). The digital bus state (BUS1) is displayed along with the SPI bus decode (SPI Bus). *(Source: ClariTek, using Teledyne LeCroy LogicStudio software operating in demo mode)*

Furthermore, software packages are available that integrate the logic-analyzer output with oscilloscopes and other instruments, enabling analysis of synchronized digital and analog data. Software options for some logic analyzers allow for processor emulation and code disassembly, permitting correlation of low-level hardware activity to source code.

SPECIFICATIONS

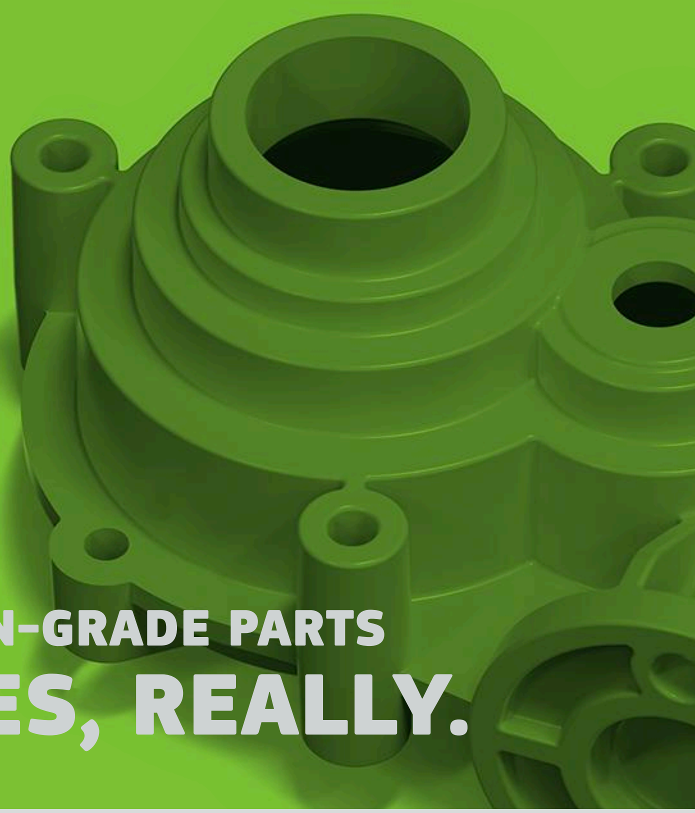
Logic analyzers come in a wide range of form factors, which determine the capabilities and cost of the instrument. All logic analyzers have a number of key specifications that determine the appropriateness of the units for the specific application. Key specifications include:

- *Channel count:* Specifies the number of digital signals that can be analyzed.
- *Channel bandwidth:* Determines the maximum speed of the logic families that can be measured.
- *Threshold selections:* Governs the compatibility with specific logic families.
- *Maximum clock rate:* Fixes the time resolution of the measurement.
- *Acquisition record length:* Controls the duration of the analysis.
- *Trigger modes:* Used to isolate the target digital events.
- *Probe type:* Determines the ease of connecting the logic analyzer and the integrity of the signal connections
- *Measurement tools:* Cursors and automated measurements help interpret acquired data.

CONCLUSION

The logic analyzer is an ideal instrument for debugging and verifying the operation of digital systems. It allows the simultaneous analysis of a large number of digital signals encountered in modern digital systems. Its timing-analysis capabilities are useful for investigating violations of system timing and finding transient events that lead to system failures. With appropriate options, it can help trace the execution of embedded software code. ed

INJECTION MOLDING THAT CRUSHES CONVENTIONAL MANUFACTURING WISDOM



- Affordable tooling
- Lower piece-part costs
- Mold life guarantee
- Inspection reports

GET 10,000+ PRODUCTION-GRADE PARTS IN AS FAST AS 1 DAY. YES, REALLY.

proto labs®

3D PRINTING | CNC MACHINING | INJECTION MOLDING

ISO 9001: 2008 Certified | ITAR Registered | © 2017 Proto Labs, Inc.

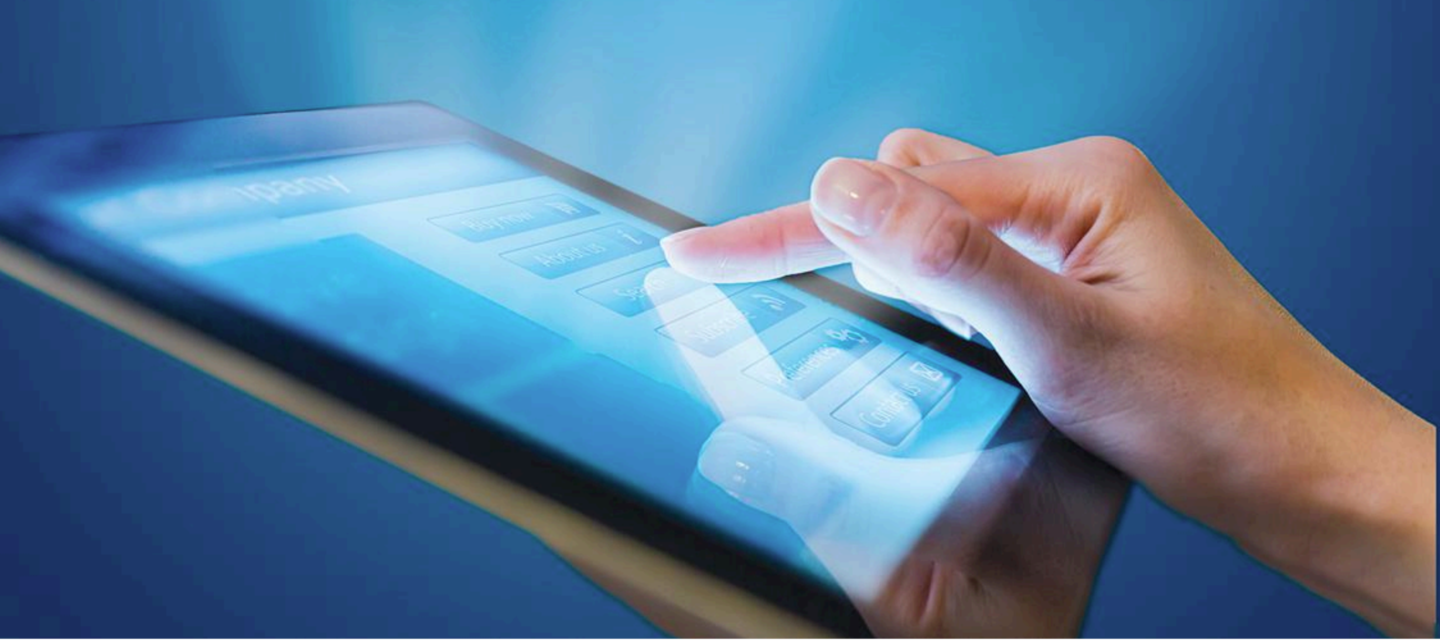
FREE CALENDAR

Request your 2018 Cool Parts Calendar at **go.protolabs.com/ED7MC**

SCOTT SOONG | CEO, Pervasive Displays

Designing Low-Power Displays for the Battery-Powered IoT

Discover how bistable technologies enable us to incorporate displays into battery-powered and even batteryless devices, and when to select an e-paper, LCD, or OLED display for your application.



Display technology is inseparable from our modern world. From "retina" screens on the latest iPhones to 4K HDTVs and watches with OLED technology, today's consumer-facing electronics feature incredibly bright and detailed displays. However, this rich graphical experience has come at the cost of high power consumption. Be it a smartphone, tablet, or laptop, the component with the highest power requirement is almost always the display.

So when it comes to the Internet of Things (IoT), where battery-powered devices are central to many applications from manufacturing, to agriculture, to retail, power-hungry TFT LCD displays are out of the question. These industrial applications simply don't have the power budget for it.

But many IoT applications can still benefit from a way to give direct feedback to the user without having to go through the cloud. Whether it's a water or electricity meter that shows usage directly on the device, an RFID logistics tag, or a cold-chain temperature sensor, the addition of an onboard display can significantly boost functionality and value. In other areas, such as retail shelf labels, onboard displays open up new possibilities.

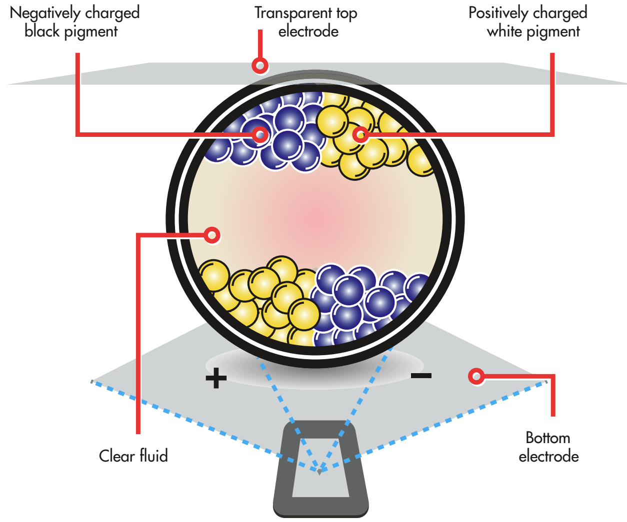
In these cases, where traditional thin-film-transistor (TFT) LCD displays are ill-suited to the requirements of the IoT, bistable display technologies—and e-paper in particular—has the power consumption, and display characteristics, that could make it the perfect match for the IoT.

UNVEILING HIDDEN VALUE IN THE IoT

Whereas our consumer electronics, like desktop computers, smartphones, and tablets, are human-facing devices focused on rich interactive experiences, the IoT is characterized by cloud-facing devices, many with an emphasis on efficiently delivering environmental information. Optimized for the demands of a specific medical, logistical, or industrial environment, they're often designed to be compact, mobile, and battery-powered.

In the pursuit of battery life, many devices in the IoT, from industrial sensors to wearable glucose monitors to RFID devices, have eschewed traditional TFT displays. In purely machine-to-machine applications, losing a human readable display is no big loss. However, many IoT applications today, especially those with a human interaction element, can benefit from an onboard display.

Onboard displays can add value in a host of IoT applications. Examples include metering applications that show usage on the device without having to go through the cloud, RFID logistics tags with shipping information displayed directly on the tag, or glucose monitors that show blood sugar levels without the user having to power up the smartphone.



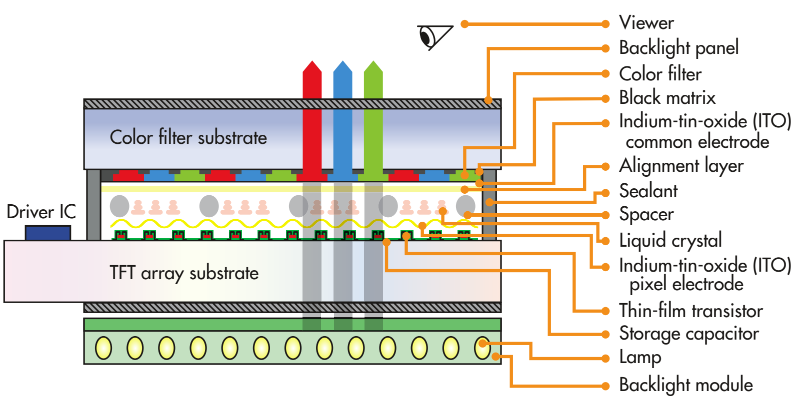
2. In an e-paper display, the images are formed by an appropriate charge applied over microscopic capsules with black and white ink particles. No backlight is needed. *(Source: E Ink)*

ULTRA-LOW-POWER-CONSUMPTION DISPLAYS

While using TFT LCD displays for many IoT applications is unfeasible, the particular kind of data that most IoT devices handle—state information—suits them for bistable display technology. Bistable display technologies, and e-paper in particular, retain image information without consuming power. Power is used only when updating an image. In addition, e-paper is a reflective display technology that doesn't depend on a backlight for visibility.

In a TFT LCD display *(Fig. 1)*, light passes from a backlight module through a twisted nematic liquid layer. An appropriate charge is applied by the TFT to untwist the crystals in the appropriate configuration, and an image is formed by the light that passes through.

In an e-paper display *(Fig. 2)*, millions of tiny capsules contain black and white ink particles. A charge applied to the top and bottom of each capsule arranges the ink particles to form an image. No backlight is needed because the image is visible from reflected light, which means e-paper displays can be much thinner than TFT LCD displays.



1. In a TFT LCD, the image is formed as light from a backlight module passes through a twisted nematic liquid-crystal layer. *(Source: Pervasive Displays)*

With the backlight dominating the power consumption of TFT LCD display modules, and often overall device power consumption, e-paper displays also achieve considerable energy savings compared to traditional displays due to their reflective nature.

Once the backlight is eliminated, power usage is dominated by the screen refresh rate, where further power savings are achieved due to the bistable nature of the e-paper display. TFT LCD displays require continual screen refreshes to maintain proper crystal alignment. In an e-paper display, once the ink particles are arranged properly, they stay that way until the next screen update. No additional power is needed to retain the image.

These characteristics mean that for applications with less frequently updated screens, e-paper modules require orders of magnitude less power than equivalently sized TFT LCD displays. With power-optimized waveforms, eTC (external Timing Control) e-paper modules like those from e-paper provider Pervasive Displays consume as little as 2 mA of current during screen update operations.

In an application where a 2-in. display is updated six times daily, an e-paper display can use as little as 0.01 mAh of power per day, whereas the typical, equivalently sized, LCD display would use 720 mAh over the same period of time to show the same image. Over the course of a year, the e-paper display would consume 3.29 mAh, or less than 2% of a 220-mAh CR2032 coin cell battery, while the LCD display would use 262,800 mAh, well over 1,000 CR2032 batteries *(Fig. 3)*.

	Screen update operation		Standby		Power consumed	
	Consumption (mA)	Duration (s)	Consumption (mA)	Duration (s)	Per day w/6 updates (mAh)	Per year (mAh)
Two-inch EPD module (V231, eTC/G2)	2.33	2.32	0	86386.1	0.01	3.29
Two-inch TFT LCD module	30	0.02	N/A	0	720.00	262,800.00

3. In an application where a 2-in. display is updated six times daily, an e-paper display module using external timing control can use as little as 0.01 mAh of power per day or 3.29 mAh per year. *(Source: Pervasive Displays)*

Not every device is suited for e-paper. Devices that need to display very frequently changing data, or which need to be primarily read in poorly lit environments, thereby requiring a supplemental backlight, reduce the low-power advantage of a bistable, reflective technology. But for many IoT applications displaying state information that isn't constantly changing, e-paper allows for an incredibly low-power consumption display.

LOW-POWER DISPLAYS DESIGNED FOR THE IoT

The low-power attributes of e-paper displays allow them to be used in devices that couldn't otherwise afford a display, or to extend the battery lives of devices already using another display technology. E-paper is so low power in fact, that it can be powered via energy-harvesting methods. E-paper modules integrated into NFC or RFID devices are able to be updated purely by scavenged RF energy or solar-energy sources that would be insufficient for other display technologies.

ULTRA-LOW-POWER DISPLAYS FOR BATTERY-POWERED IoT DEVICES

The current design philosophy of many wirelessly connected IoT devices is to sacrifice interface elements to prioritize battery life. User-facing interfaces and displays are foregone, with the only connection to the outside world a communication link to the cloud—usually Bluetooth Low Energy, ZigBee, or a narrowband technology optimized for the IoT.

The trouble is, many IoT devices, from connected meters to RFID tags to smart cards, are still human facing to some degree. Eliminating the human interface impacts the user experience—users must go through a separate device and connect to the cloud to access any and all information about the device right in front of them.

For many of these battery-powered wireless devices, a properly integrated e-paper display can bring back display and interface aspects that add value to the device, with minimal impact on battery life.

This includes mirroring some of the information sent to the cloud, such as in sensing applications where values like blood glucose, water usage, or temperature are shown directly on the device. For more remote, less frequently accessed industrial IoT devices, the display can also show maintenance and debugging information, e.g., battery life, service life remaining, maintenance schedule information, or memory dumps in case of a crash (the bistable nature of e-paper means the memory dump will remain on screen even if power is lost).

It can also extend to more complex situations where data is sent both to and from the cloud. A smart payment card with an integrated e-paper display could interact with a payment terminal to both pay for a train ticket, and then display a downloaded image of the train ticket, including barcode, directly on the payment device.

NO-POWER DISPLAYS USING RF OR SOLAR-ENERGY HARVESTING

Perhaps the most intriguing use case of e-paper is that of a no-power display for batteryless devices *(Fig. 4)*. With its ultra-low-power consumption requirements, e-paper can take advantage of energy harvesting to perform screen updates. Using solar power, RF energy scavenging, and other energy-harvesting methods, low-power IoT devices with e-paper displays can operate almost indefinitely.

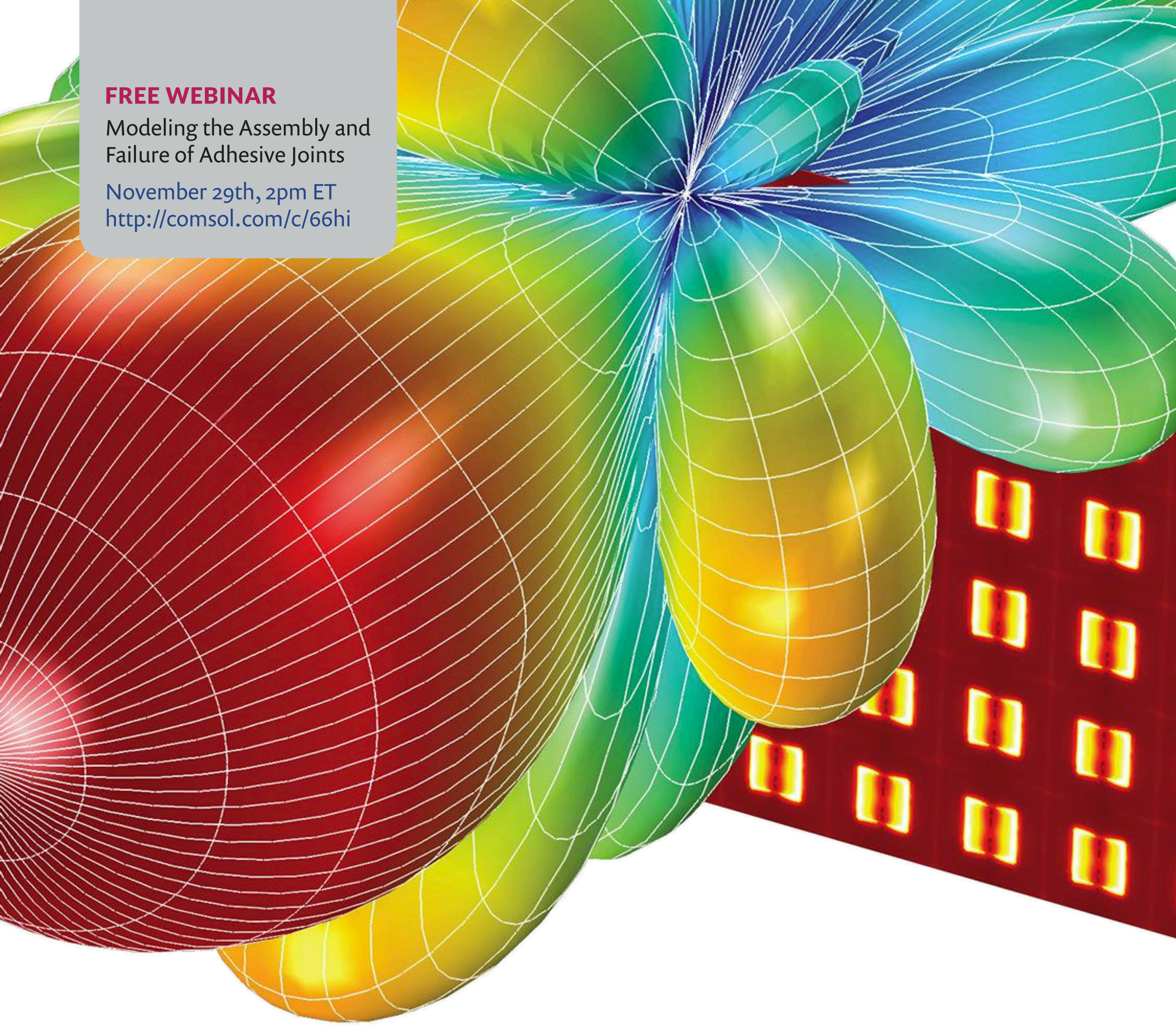
Energy harvesting is a good way to integrate e-paper into RFID and NFC devices, as these devices are often already

4. E-paper devices with NFC capability, such as this PicoLabel, can use energy scavenging to update the screen without a battery. *(Source: MpicoSys)*

FREE WEBINAR

Modeling the Assembly and Failure of Adhesive Joints

November 29th, 2pm ET
http://comsol.com/c/66hi



VERIFY AND OPTIMIZE YOUR DESIGNS

with COMSOL Multiphysics®

The evolution of computational tools for numerical simulation of physics-based systems has reached a major milestone.

Surpass design challenges with ease using COMSOL Multiphysics®. Work with its powerful mathematical modeling tools and solver technology to deliver accurate and comprehensive simulation results.

Develop custom applications using the Application Builder and deploy them within your organization and to customers worldwide with a local installation of COMSOL Server™.

Benefit from the power of multiphysics today, request a live demo at **comsol.com**

© Copyright 2017 COMSOL. COMSOL, the COMSOL logo, COMSOL Multiphysics, Capture the Concept, COMSOL Desktop, COMSOL Server, and LiveLink are either registered trademarks or trademarks of COMSOL AB. All other trademarks are the property of their respective owners, and COMSOL AB and its subsidiaries and products are not affiliated with, endorsed by, sponsored by, or supported by those trademark owners. For a list of such trademark owners, see www.comsol.com/trademarks.

COMSOL

passively energized. The e-paper display can be driven by scavenged energy from the RF field used to update the device.

The display can supplement machine-readable data stored in the tag, such as shipping or manufacturing information, with a human-readable label that doesn't require a smartphone or specialized reader. The combination of e-paper and NFC also opens up new application possibilities, such as the aforementioned payment card with integrated display, ID badges, or updatable product information labels.

Solar-powered outdoor signage is another natural application of energy harvesting with e-paper. While LCD displays need strong backlighting to be visible in the sun, e-paper is extremely readable even under direct sunlight. This makes possible applications such as bus stops with solar-powered e-paper timetables.

IS THERE A PLACE FOR LCDs IN THE IoT?

TFT LCD technology, while much less power-efficient than e-paper, can be suitable for certain use cases in the IoT where rich, multimedia experiences are important, and power is more readily available.

LCDs could be considered for devices with less serious power considerations, most obviously those with access to mains power (e.g., wall-mounted thermostats), but also devices that may be expected to be charged daily (e.g., wearables). However, even for wearables, the value of the multimedia experience offered by the LCD should be weighed against the inconvenience of frequent charging, as well as the loss, or reduction, of functionality when the device is being charged.

Since it inherently incorporates a backlight, LCDs can also be appropriate when the device is often used in dimly lit environments. In these cases, while e-paper could still be utilized, a backlight module would have to be integrated, reducing the energy savings.

Because of their widespread use in consumer electronics, modern TFT LCD display modules are quite inexpensive, making them attractive for cost-sensitive devices. However, designers should also consider the price of the extra processing hardware required to drive an LCD display. Especially when it comes to higher-resolution displays, the cost of video memory, a higher-speed MCU, and an LCD controller may offset some of the cost advantage compared to e-paper.

On the downside, due to being a backlit technology, TFT LCD displays are thick, and have poor outdoor visibility. While advances have been made with the advent of LED-based backlighting, the need for a backlight module makes it difficult to slim down TFT LCDs.

Outdoor visibility of LCDs remains a challenge as it depends on the light coming from the display keeping up with ambient lighting. Whereas reflective displays reflect more light in bright environments, emissive displays like LCDs can only improve outdoor visibility by ramping up backlight brightness. The brightness of modern LED backlights is enough to let them perform admirably outdoors, as long as they stay out of direct sunlight. However, they do so at the cost of high power consumption.

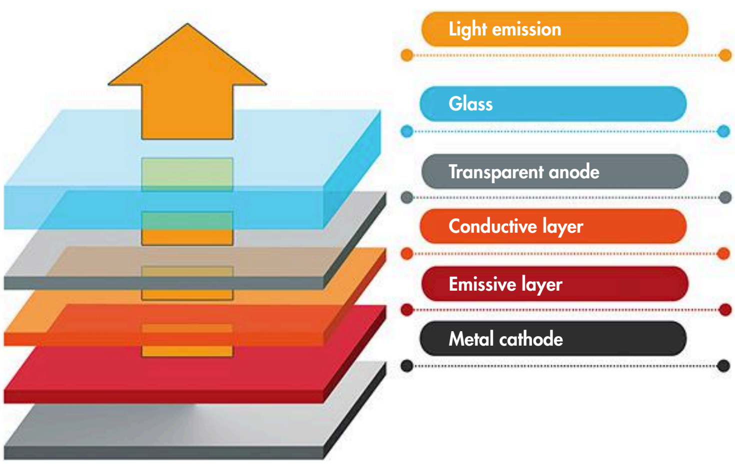
DOES OLED TECHNOLOGY FIT THE IoT?

In recent years, OLED display technology has started to make its way into high-end TVs, music players, and even smartwatches. Compared to TFT LCDs, OLED displays have better contrast ratios and theoretically better power efficiencies. Are they a good fit for the IoT?

OLED displays work due to the electroluminescence of organic semiconductors when a current is applied *(Fig. 5)*. A typical display will have a "sandwich," where electrodes surround a conductive layer and emitting layer of organic materials. When electricity is applied, electrons are deposited in the emissive layer and removed from the conductive layer. As electrons are removed from the conductive layer, the holes that remain are then filled by the electrons from the emissive layer, giving off light in the process.

Whereas the light from LCD displays originates from the backlight module, passes through liquid crystals, and then polarizing filters, an OLED's organic layer itself produces light and doesn't pass through polarizing filters. The lack of a backlight and filters not only enables OLEDs to be much thinner than LCDs, but also leads to better optical characteristics.

OLEDs are able to control brightness at the pixel level, allowing for pure blacks and high contrast ratios. Whereas some amount of backlight will always leak through on an LCD



5. Unlike TFT LCD displays, OLED displays don't use backlights or polarizing filters. *(Source: Pervasive Displays)*

DESIGN NOTES

Reference Filter Increases 32-Bit ADC SNR by 6dB

Design Note 568

Guy Hoover

Introduction

Attaining optimal SNR performance from an ADC isn't just a matter of providing a low noise signal to the ADC's input. Providing a low noise reference voltage is just as important. While reference noise has no effect at zero-scale, at full-scale any noise on the reference will be visible in the output code. This is why dynamic range (DR) which is measured at zero-scale is usually several dB better for a given ADC than the signal-to-noise ratio (SNR) which is measured at or near full-scale. Providing a low noise reference voltage is particularly important in an oversampling application where it's possible for the ADC's SNR to exceed 140dB. To achieve an SNR at this level, even the best low noise references need some help to reduce their noise levels.

There are several alternatives that can reduce reference noise. Increasing the size of the bypass capacitor or using a simple lowpass RC filter on the reference output are not good alternatives. A large bypass capacitor on the reference output by itself cannot produce a low enough cutoff frequency to be effective. A passive RC filter by itself, while providing a low cutoff frequency, will produce an output voltage that varies with sampling frequency and temperature. Paralleling the outputs of multiple low noise references is an effective alternative, but it is expensive and consumes a lot of power.

The reference filter demonstrated here produces a low noise reference voltage without significantly compromising the reference accuracy or temperature coefficient and does so with only moderate power consumption and cost.

Circuit Description

The ADC used in this example is the LTC2508-32 (U1). The LTC2508-32 is a low noise, low power, 32-bit SAR ADC with a lowpass digital filter that has four pin-selectable downsampling factors (DF) ranging from 256 to 16384. A low noise, low temperature drift reference is necessary to achieve the full performance of the LTC2508-32.

The reference used in this example is the LTC6655-5 (U2). The LTC6655-5 offers high accuracy (±0.025% Max), exceptionally low noise (0.67ppm RMS Typ) and drift (2ppm/°C Max) performance. Even with its exceptionally low noise performance, the LTC6655-5 still degrades the SNR performance of the LTC2508-32.

The LTC2057 (U3) is a zero-drift op amp that has suppressed 1/f noise. The LTC2057 has an input bias current (I_B) of less than 200pA, a maximum offset voltage of 4μV and a maximum offset volt-

LT, LT, LTC, LTM, Linear Technology and the Linear logo are registered trademarks of Analog Devices, Inc. All other trademarks are the property of their respective owners.

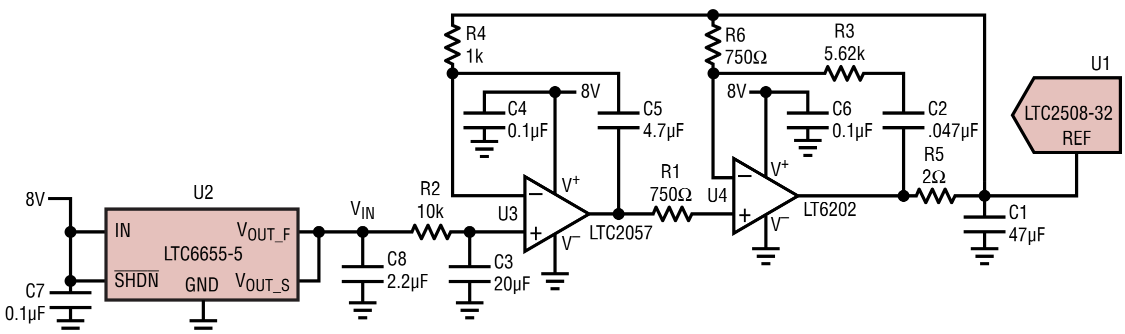


Figure 1. Filtered LTC6655 Output Increases SNR of LTC2508-32 32-Bit ADC by 6dB

LINEAR TECHNOLOGY NOW PART OF ANALOG DEVICES

Table 1. SNR Comparison of the LTC2508-32 with the REF Pin Driven Directly by the LTC6655-5 and the Filtered LTC6655-5 Using the Circuit of Figure 1

DF	DR (dB) Zero-Scale LTC6655-5	SNR (dB) Full-Scale LTC6655-5	SNR (dB) Full-Scale Filtered LTC6655-5	Delta in SNR (dB) Between LTC6655-5 and Filtered LTC6655 at Full-Scale
256	131.4	123.6	129.3	5.7
1024	137.1	129.7	135.8	6.1
4096	142.9	135.2	140.7	5.5
16384	148.0	140.7	145.2	4.5

age temperature coefficient of 0.015µV/°C. This is significantly lower than the temperature coefficient of the LTC6655-5 (2ppm/°C=10µV/°C).

The LT6202 (U4) is a low noise, fast settling op amp with the high short-circuit current capability necessary to drive the 47µF bypass capacitor required on the REF pin of the LTC2508-32.

The circuit of Figure 1 filters the output of reference (U2) using R2 and C3 to form a 0.8Hz filter. Capacitor C3 should be a film capacitor. Tantalum and electrolytic capacitors have high leakage that will produce an offset across R2. Ceramic capacitors can exhibit microphonic effects that result in increased noise at low frequencies. The filtered output is buffered by the high impedance input of U3. The 200pA max I_B of U3 results in a maximum voltage drop of only 2µV across R2. This, combined with the LTC2057's offset voltage, produces a maximum error of 6µV which is relatively insignificant compared to the LTC6655-5's maximum initial accuracy spec of 0.025% (1.25mV). U3 and U4 form a composite amplifier that has the low offset, offset temperature coefficient and suppressed 1/f noise of the LTC2057 and the fast settling of the LT6202. The REF pin of U1 draws charge from C1 that varies with sample rate and output code. U4 must replenish this charge to keep the REF pin voltage fixed. R5 is used to isolate U4 from C1 to improve the settling at the REF pin. Physically larger ceramic capacitors with higher voltage and temperature ratings have lower voltage coefficients, providing a higher effective capacitance. For this reason C1 should be X7R with a 1210 size and 10V rating.

Circuit Performance

As shown in Table 1, the LTC2508-32 exhibits nearly theoretical behavior with the dynamic range increasing by nearly 6dB for every factor of 4 increase in downsampling factor (DF) with the ADC inputs tied together and the REF pin driven directly by the LTC6655-5. Table 1 additionally shows that when the ADC is driven near full-scale, the SNR compared to the DR is as much as 7.8dB less using the LTC6655-5 to directly drive the ADC REF pin. This is due to the noise of the reference. Using the circuit of Figure 1 to drive the REF pin of the LTC2508-32 results in an SNR improvement of up to 6.1dB, as shown in Table 1.

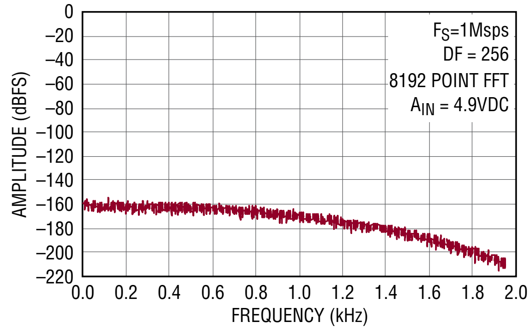


Figure 2. Noise Floor of the LTC2508-32 near F_S shows no spurious tones using the circuit of Figure 1 to drive the REF pin

Chopper stabilized op amps such as the LTC2057 often exhibit tones at the chopping frequency and its odd harmonics. The LTC2057 utilizes circuitry to suppress these artifacts well below the offset voltage. This circuitry combined with the ADC's own filter works to eliminate any visible tones from the op amp's chopping frequency as shown in the noise floor plot of Figure 2. The plot of Figure 2 is an average of five data captures in an attempt to smooth out the noise floor to reveal even the smallest trace of any spurious tones.

Conclusion

A filter circuit was demonstrated that reduces the reference output noise without compromising its accuracy or temperature coefficient while requiring only modest power consumption and cost. Applying the output of this circuit to the reference pin of the LTC2508-32, a 32-bit low noise ADC improved the SNR by up to 6.1dB over a range of downsampling factors compared to driving the ADC directly with the reference.

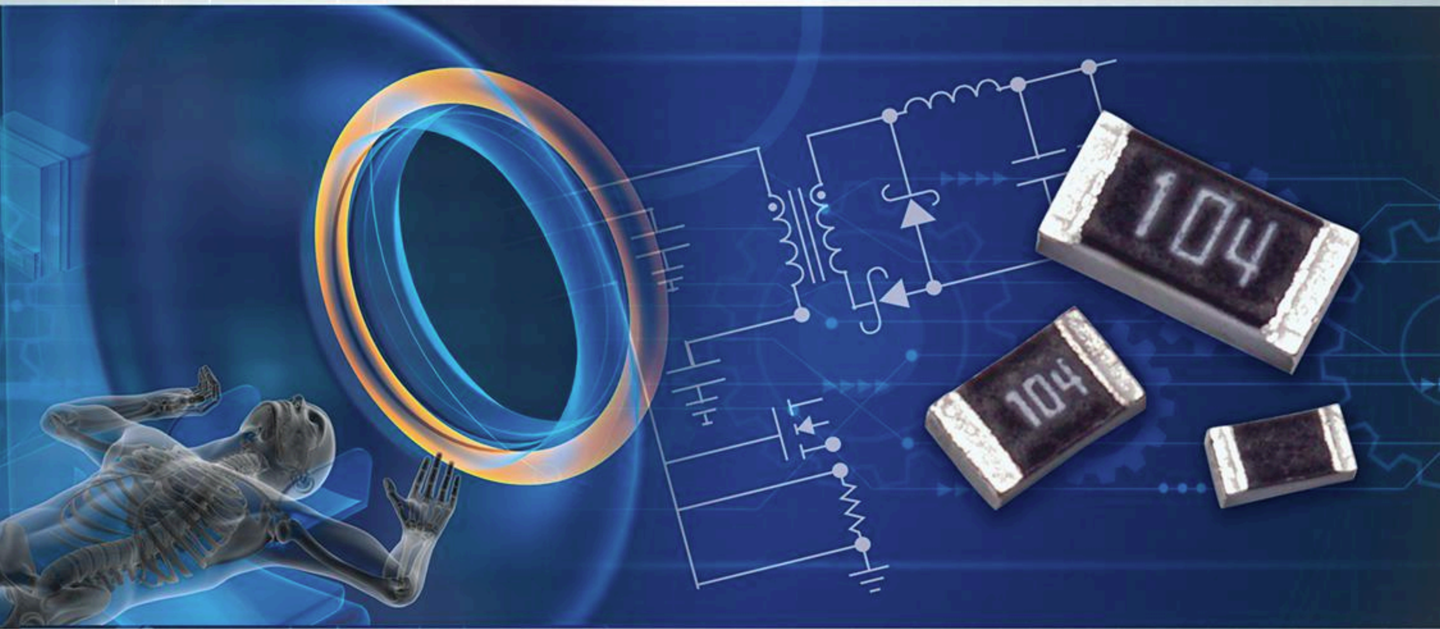
Data Sheet Download

www.linear.com/LTC2508-32

For applications help,
call (408) 432-1900, Ext. 3227

DN568 LT/AP 1117 71K • PRINTED IN THE USA
© LINEAR TECHNOLOGY CORPORATION 2017

From Concept to Reality



Our new passive component solutions will help you make the leap!

Whether you're designing the medical device of tomorrow or connecting the Internet of Things, you need cutting-edge product solutions to bring your design to fruition. At KOA Speer, we're the ideal partner to help you do just that. Our constantly expanding line of passive components will give you the solution to make your concept a reality!

More than just Resistors - yes we're the world leader in thick film resistors, but our product line is broad and growing every day, including:

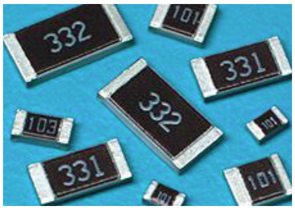
- Shunt/Current Sense Resistors
- Wide Terminal Resistors
- High Voltage Resistors
- Thin Film Chip Resistors
- Surge Resistors

Passive Component Solutions - our engineering group will work with your design team to develop the passive component solution you need. Many of the hundreds of new products we've introduced in recent years are the result of such collaboration.

Award Winning Passive Supplier - we're the industry's most recognized and awarded supplier for achieving the highest product quality, on-time delivery and responsive customer service.

NEW! From KOA Speer

Ultra-Precision Thin Film Resistors (RN73)



Surge Current Thick Film Resistors (SG73)

High Voltage Chip Resistors (HV73)

KOA®
KOA SPEER ELECTRONICS, INC.

Make the Leap from Concept to Reality, visit KOASpeer.com

While optically superior to LCD displays, OLED displays do have their disadvantages. OLED technology currently costs 20% to 30% more than similar TFT LCD displays; power consumption is only marginally better; outdoor readability is about the same or worse; and the technology has lifespan and durability issues, especially for industrial use cases.

display, an OLED display can completely turn off the light from particular pixels. Without polarizing filters, viewing angles are also improved compared to LCD displays.

Another distinct advantage of OLED displays is that the organic materials used can be deposited on a plastic substrate to create flexible displays for devices with unique form factors. This is most vividly demonstrated on Samsung's Galaxy Edge series of smartphones, which have a 90 degree curve in the display at the edges of the phone. This combination of flexibility and thinness is particularly enticing for wearables, such as smartwatches; indeed, the Apple Watch uses an OLED display.

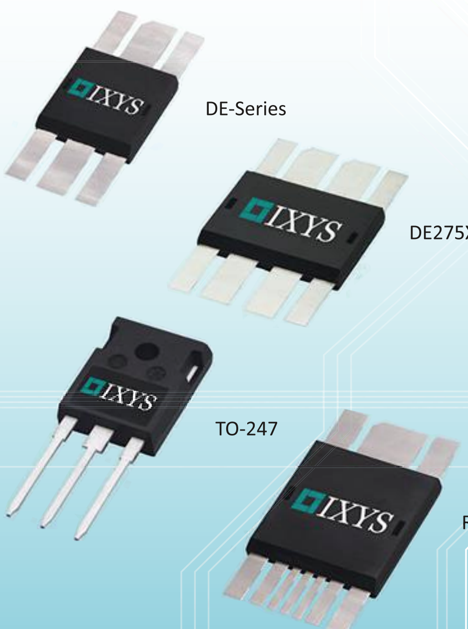
While optically superior to LCD displays, OLED displays do have their disadvantages. OLED technology currently costs 20% to 30% more than similar TFT LCD displays; power consumption is only marginally better; outdoor readability is about the same or worse; and the technology has lifespan and durability issues, especially for industrial use cases.

Since brightness is controlled at the pixel level, power consumption in an OLED display depends on the brightness of the image. Darker images and black backgrounds can result in better power consumption than TFT LCD displays, but bright images and white backgrounds in particular can lead to more power usage than TFT LCD technology.

Both LCD and OLED technology suffer when outdoors. However, the brightness of current OLED displays hasn't matched the level of LCD backlights, meaning outdoor vis-

High Voltage High Frequency Power MOSFETs and Drivers

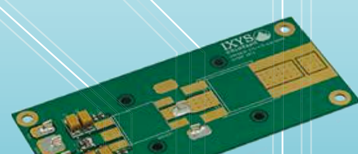
Optimized for high speed and high power applications



Power MOSFETs:
High Power 100V to 1200V devices
Low-Inductance DE-Series and industry-standard package styles
Optimized for:
- ISM band RF generators and amplifiers
- High voltage pulse generators and pulsed laser diode drivers
- Switched-mode and resonant-mode HF power supplies

Gate Drivers:
Class D and E HF RF and other high speed switch applications
Up to 30A peak current, ultra-fast rise times

RF Power Modules:
Integrated gate driver and MOSFET in a low-inductance package
500V and 1000V configurations
Designed for Class D, E, HF, and RF applications at up to 27 MHz



IXYS COLORADO

1609 Oakridge Drive, Suite 100
Fort Collins, Colorado 80525 USA
TEL +1-970-493-1901 sales@ixyscolorado.com

Evaluation boards to simplify your application design and development ibility is even worse. The organic materials used in OLEDs are also extremely sensitive to water. Combined with poor sunlight readability, this makes OLEDs a poor fit for outdoor applications and industrial environments.

Finally, OLEDs have lifespan issues. This is especially the case with the material used for blue light—it's subject to degradation over time, leading to significant color shift well before the lifespan of an average TFT LCD display.

Using electroluminescence of organic materials rather than backlighting, OLEDs are a promising display technology. Their flexibility, thinness, and strong contrast make them a strong contender for wearable applications. However, sensitivity to water, short lifespan, and power consumption when compared to LCD displays means their use in the IoT is limited to devices with waterproof enclosures or in controlled environments, and where frequent charging can be expected.

MAKING THE LOW-POWER IoT VISIBLE

As the IoT affects more industries, the amount of real world data being sent to the cloud is greater than ever before. Still, a lot of this high value information is hidden from direct view. Many of these applications can benefit from a display that shows information to users directly on the device.

The increasing use of TFT LCDs and OLED display technology in consumer electronics, and their rich multimedia capabilities, makes them tempting to use in industrial and IoT applications. However, their power requirements make them less than ideal for the often battery-constrained IoT.

With power consumption orders of magnitude less than TFT LCD or OLED displays, e-paper can be used on IoT devices without the power budget for other display technologies—it even allows for no-power displays that work purely off of harvested energy. Since much of the IoT deals with infrequently changing state information, e-paper technology with its bistable, reflective benefits is a perfect fit. ed

SCOTT SOONG, CEO of Pervasive Displays, has over a decade of experience in software in addition to 12 years working in displays businesses. During his career, Scott has been a founding partner at four startup companies, including Pervasive Displays. Scott sits on the board of several other technology businesses as a consulting partner. He was a board member of One Laptop Per Child (OLPC), which looks to provide kids in developing countries with a rugged, low-cost, low-power, connected laptop. Scott received an MBA from the Haas School of Business at the University of California, Berkeley as well as a BA from the University of Michigan at Ann Arbor.

Solid State Relays and Contactors

CARLO GAVAZZI

Chassis mount solid state relays (SSRs) available in one, two or three pole switching designs. Single phase types up to 125 amps, two pole types up to 75 amps and three phase types up to 75 amps. Also offered in our new slim-line design (up to 90 amps) and compact fast-on type (up to 25 amps).

DIN rail or chassis mount solid state contactors and SSRs which are UL508 rated for motor loads, and feature integrated heat sinks, fans and large load terminals. Designed for switching single phase loads up to 85 amps (15 Hp) and two or three pole types for switching up to 75 amps per phase (25 Hp).

Specialty SSRs for your growing demands: System Monitoring SSR for line /load voltage and load current, fused SSRs provide more protection, and 1, 2 and 3 pole proportional controllers with several switching modes: phase angle, distributed burst (1, 4 or 16 cycle), or soft start.

Carlo Gavazzi is one of the fastest growing SSR manufacturers worldwide!
Contact us if you're interested in a free evaluation sample (qualified OEMs only).

GavazziOnline.com • 847.465.6100 • Info@CarloGavazzi.com

Looking for just the right part,
at just the right price...

Connect with over 200 distributors
on the NEW SourceESB!

Part Lists Tool

- Send multi-part RFQs
- Save your part lists to work on later
- Filter by authorized distributor

www.SourceESB.com

TONY ARMSTRONG | Director of Marketing, Power Products, Linear Technology, anthony.armstrong@analog.com

What Are the Toughest Challenges in ADAS Design?

The call for more sophisticated driver-assist systems in automotive design keeps growing louder, forcing engineers to innovate ways to overcome persistent problems such as noise.

The advanced driver-assistance system (ADAS) market is expected to reach $60 billion globally by 2020, according to Allied Market Research, representing a CAGR of 22.8% from the years 2014 to 2020. Clearly, this represents a significant opportunity for semiconductor content.

Commonly found in many of today's new automobiles, an ADAS usually facilitates safe driving and can alert the driver if the system detects risks from surrounding objects such as errant pedestrians, cyclists, or even other vehicles on an unsafe trajectory. Furthermore, these systems typically provide dynamic features such as adaptive cruise control, blind-spot detection, lane-departure warning, driver-drowsiness monitoring, automatic braking, traction control, and night vision.

Consumer demands for more safety and comfort while driving, along with the continued increase of government safety regulations have been the main growth drivers of ADAS in automobiles for the latter half of this decade. However, such growth also exacerbates and/or creates new challenges for the industry, ranging from pricing pressure and inflation to design complexity and difficulty in testing these systems.

On top of that, it should come as no surprise that the European automotive industry—which represents one of the most innovative automotive market—has seen major market penetration and adoption of ADAS from its customers. But both American and Japanese automakers are not far behind that curve. What many manufacturers see as the ultimate goal, though, is an autonomous driving machine without the need for a human being behind the wheel.

SYSTEM CHALLENGES

Generally speaking, an ADAS system incorporates some kind of microprocessor to gather all of the input from the numerous sensors within the vehicle, and then process that data so that can be presented to the driver in an easy-to-understand manner. These systems are usually powered directly from the vehicle's main battery, which is a nominal 9 to 18 V. However, it could run as high as 42 V due to voltage transients within the system, and as low as 3.5 V during a cold-crank condition. As a result, any dc-dc converters within these systems must be able to handle the wide input voltage range of 3.5 to 42 V, at a minimum.

Many ADAS systems employ a 5- and 3.3-V rail to power their various analog and digital IC content; however, the typically used processor I/O and core voltages will have operating requirements in the sub-2-V realm, and could be as low as 0.8 V. Furthermore, the system is usually mounted in a part of the vehicle that's both space and thermally constrained, thereby limiting the heat sinking available for cooling purposes.

While it's commonplace to use a high-voltage dc-dc converter to generate a 5- and 3.3-V rail directly from the battery, the switching regulator in today's ADAS systems must switch at 2 MHz or greater, rather than at the traditional sub-500-kHz frequency. The key driving force behind this change is the need for smaller solution footprints while also staying above the AM frequency band to avoid any potential interference.

NEED TO KNOCK DOWN THE NOISE

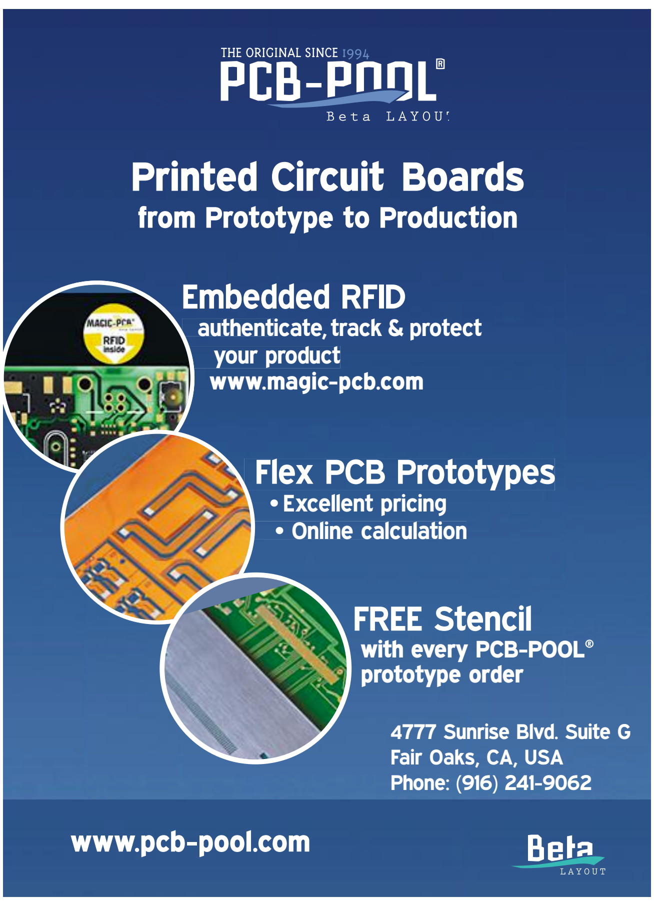
Finally, as if the designers task isn't already complicated enough, they must also ensure that the ADAS system complies with the various noise-immunity standards within the vehicle. In an automotive environment, switching regulators are replacing linear regulators in areas that require low heat dissipation and efficiency. Moreover, the switching regulator is typically the first active component on the input power bus line, and therefore will significantly impact the electromagnetic-interference (EMI) performance of the complete converter circuit.

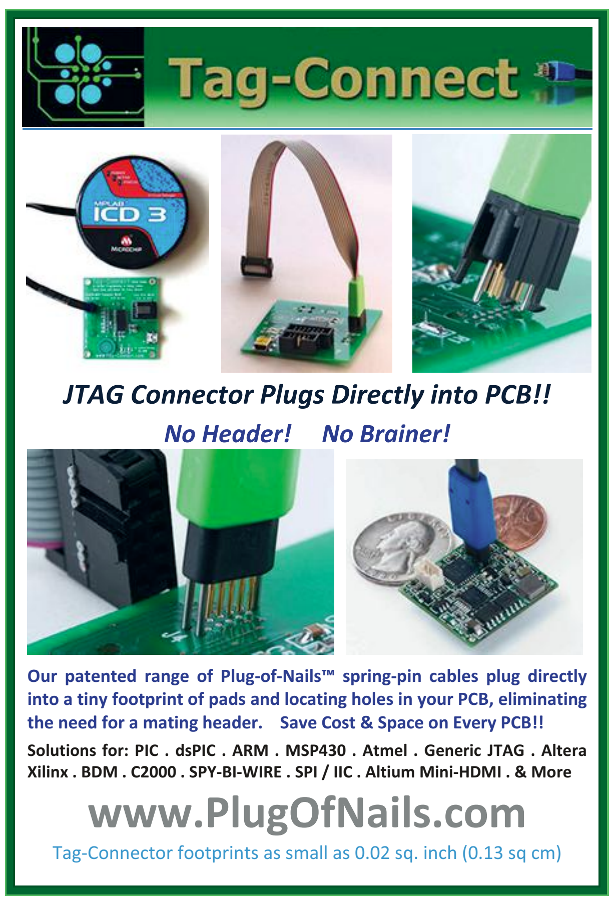
There are two types of EMI emissions: conducted and radiated. Conducted emissions ride on the wires and traces that connect up to a product. Since the noise is localized to a specific terminal or connector in the design, a good layout or filter design often can assure compliance with conducted emissions requirements relatively early in the development process.

However, radiated emissions are another story altogether. Everything on the board that carries current radiates an electromagnetic field. Every trace on the board is an antenna and every copper plane is a resonator. Anything beyond a pure sine wave or dc voltage generates noise all over the signal spectrum. Even with careful design, a power-supply designer never really knows how the bad the radiated emissions are going to be until the system is tested. And radiated emissions testing can't be formally performed until the design is essentially complete.

Designers often rely on filters to reduce EMI, because they have the ability to attenuate the strength at a certain frequency or over a range of frequencies. The portion of this energy that travels through space (radiated) is attenuated by adding metallic and magnetic shields. The part that rides on PCB traces (conducted) is tamed by adding ferrite beads and other filters. EMI can't be completely eliminated, but it can be attenuated to a level that's acceptable by other communication and digital components. Moreover, several regulatory bodies enforce standards to ensure compliance.

Modern input-filter components in surface-mount technology perform better than through-hole parts. However, this improvement is outpaced by the increase in operating switching frequencies of switching regulators. Higher-efficiency, low-minimum on and off times result in higher harmonic content due to the faster switch transitions. For every doubling in switching frequency, the EMI becomes 6 dB worse; meanwhile, all other parameters, such as switch capacity and transition times, remain constant. The wideband EMI behaves like a first-order high-pass filter with 20-dB-higher emissions if the switching frequency increases tenfold.



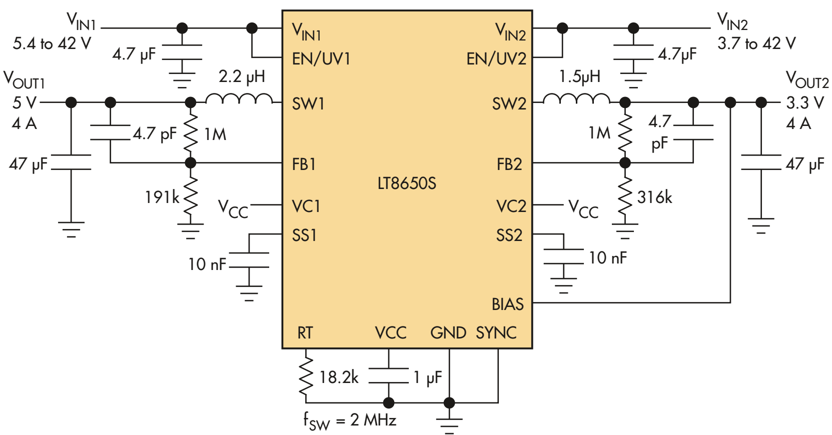


FINDING THE RIGHT SOLUTION

Savvy PCB designers will make the hot loops small and use shielding ground layers as close to the active layer as possible. Nevertheless, device pinouts, package construction, thermal design requirements, and package sizes that provide adequate energy storage in decoupling components dictate a minimum hot-loop size. To further complicate matters, in typical planar printed circuit boards, the magnetic- or transformer-style coupling between traces above 30 MHz will diminish all filter efforts. That's because as harmonic frequencies rise, unwanted magnetic coupling becomes all that more effective.

Finding a power-conversion device that meets all of the necessary performance metrics so as not to interfere with the ADAS system is a difficult task. However, there is a power converter that can help system designers overcome the challenges discussed in this article, including EM/EMI emission reduction: Linear Technology's LTC8650S *(see figure at right)*. It can also deliver all of the required performance without requiring sophisticated layout or design techniques.

ADAS will no doubt continue to proliferate in automotive designs as time wears on, so it's incumbent on engineers to find ways to maximize the capabilities of these systems to meet demands. And one step in creating such solutions is pinpointing the right components to do the job.



At 2 MHz, Linear Technology's LT8650S power converter delivers power outputs of 5 V at 4 A and 3.3 V at 4 A.

HARWiN

50 Ohm Coax
Cable Assemblies

Produced with high-grade, lightweight RG178 wire and available in 150mm cable lengths for flexible and space saving cables.

Designed with jackscrews for a secure connection and to resist extremes of shock and vibration in challenging application environments.

- Temperature range of -55°C to +125°C
- Up to 6GHz frequency range
- Tested to 100g shock*

*test reports available

Datamate Coax

www.harwin.com/datamate-coax

ideas for design

Simple Transient-Response Measurement Determines Power-Supply Bandwidth

By BOB SHEEHAN | Member Group Technical Staff, Texas Instruments

IT'S NORMAL TO ASSUME that there's an easy way to relate the bandwidth of a power-supply control loop to its transient response—no good reference exists that defines this in simple terms. It seems like a straightforward problem, which should have a simple solution. The higher the bandwidth, the faster the loop responds, and with less voltage deviation.

However, several limiting factors may get in the way of this simple relationship. The first one is the series resistance of the output capacitor. If that resistance is too high, then the load step creates a large voltage deviation before the control loop can respond. Equation 1 gives the peak voltage deviation:

$$V_P = \Delta I \cdot R_{ESR} \qquad (1)$$

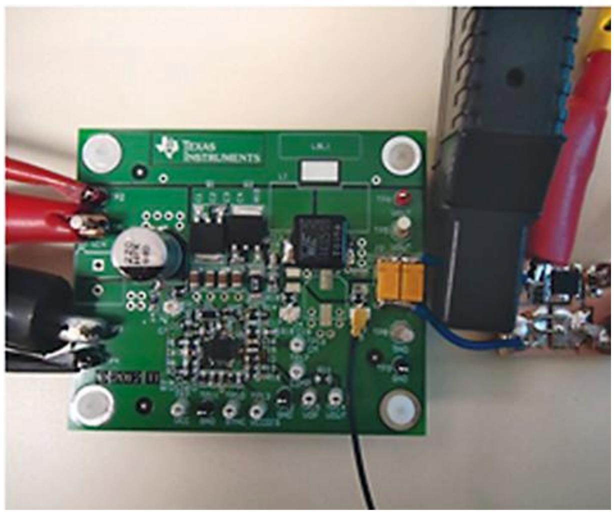
Second, the inductor can cause slew-rate limiting. This is related to the control-loop bandwidth by the voltage across the inductor, calculated with Equation 2:

$$L = \frac{V_L}{2 \cdot \pi \cdot f_C \cdot \Delta I} \qquad (2)$$

Third, there's a critical inductance limit beyond which the duty cycle will saturate. The peak transient voltage is then determined by the large-signal limiting of the inductor current into the output capacitor. This is related to the voltage across the inductor, output capacitor, and series resistance, as expressed by Equation 3:

$$L_{CT} = \frac{V_L \cdot C_{OUT} \cdot R_{ESR}}{\Delta I} \qquad (3)$$

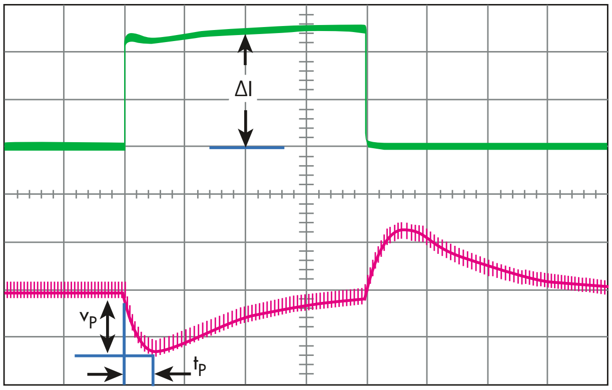
Look at the design of power supply intended to avoid these issues, and use an electronic load to test the transient response. If your control-loop bandwidth is relatively high, the output voltage may follow the load current and isn't limited by the control loop. In this case, you can use a MOSFET and load resistor on a small board for the load step, controlled by a function generator. A low duty cycle for the load on-time will minimize dissipation in the resistor.



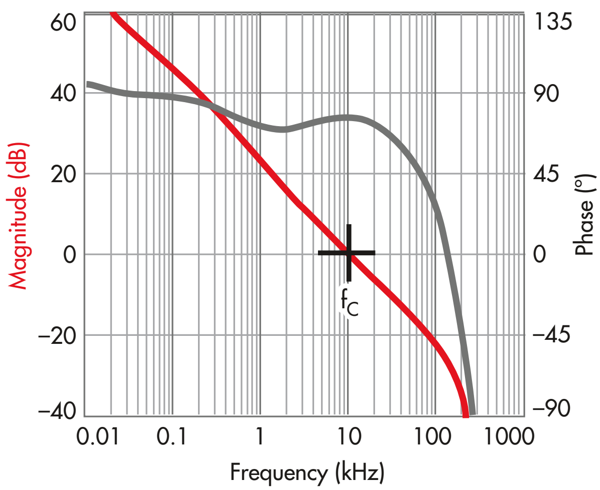
1. This typical power-supply test setup is used for fast load-transient testing; short leads with low inductance are essential for valid measurements.

It's important to mount this as close to the power-supply output as possible in order to minimize wiring inductance; *Figure 1* shows a typical setup. The small black wire connects to a surface-mount coaxial cable for the output-voltage measurement.

Figure 2 shows the measured transient response, which is directly related to the bandwidth of the control loop of *Figure 3.* With no equivalent series resistance (ESR), or slew-rate or duty-cycle limiting, the initial response time is one-fourth the effective control-loop period. This is the equivalent first quarter of a sinusoidal response at the unity-gain frequency. The peak voltage will vary based on the topology and damping, but is easily predictable with a surprising degree of accuracy.



2. The measured transient response shows t_p = 25 µs and V_p = 130 mV for a current load step of ΔI = 5 A.



3. The corresponding control-loop bandwidth for the system with transient response is 10 kHz.

With no ESR, slew-rate or duty-cycle limiting, Equation 4 calculates t_p as:

$$t_P = \frac{1}{4 \cdot f_C}$$

$$t_P = \frac{1}{4 \cdot 10\ \text{kHz}} = 25\ \mu\text{s} \quad (4)$$

For current-mode control, Equation 5 gives the single-pole approximation that results in the peak voltage deviation:

$$V_P = \frac{\Delta I}{2 \cdot \pi \cdot f_C \cdot C_{OUT}}$$

$$V_P = \frac{5\,\text{A}}{2 \cdot \pi \cdot 10\ \text{kHz} \cdot 440\ \mu\text{F}} = 180\ \text{mV} \quad (5)$$

Equation 6 calculates the critically damped case for current-mode control (as shown in Fig. 2):

$$V_P = \frac{\Delta I}{e \cdot \pi \cdot f_C \cdot C_{OUT}}$$

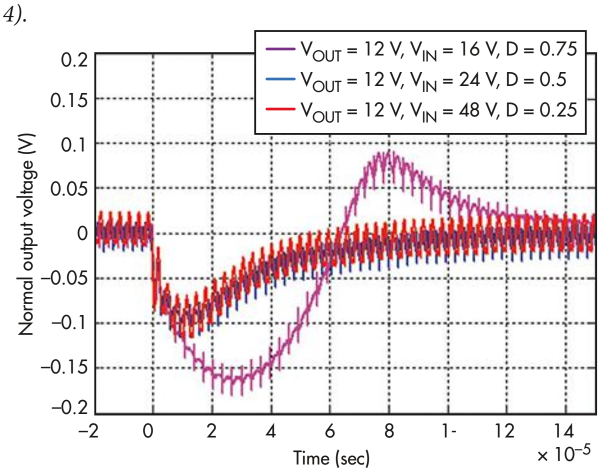
$$V_P = \frac{5\,\text{A}}{e \cdot \pi \cdot 10\ \text{kHz} \cdot 440\ \mu\text{F}} = 130\ \text{mV} \quad (6)$$

For voltage-mode control, Equation 7 gives the peak voltage deviation:

$$V_P = \frac{\Delta I}{8 \cdot f_C \cdot C_{OUT}}$$

$$V_P = \frac{5\,\text{A}}{8 \cdot 10\ \text{kHz} \cdot 440\ \mu\text{F}} = 140\ \text{mV} \quad (7)$$

It's important to verify the performance over all operating conditions. Duty-cycle limiting can cause a significant droop when operating the control loop outside its linear range *(Fig. 4)*.

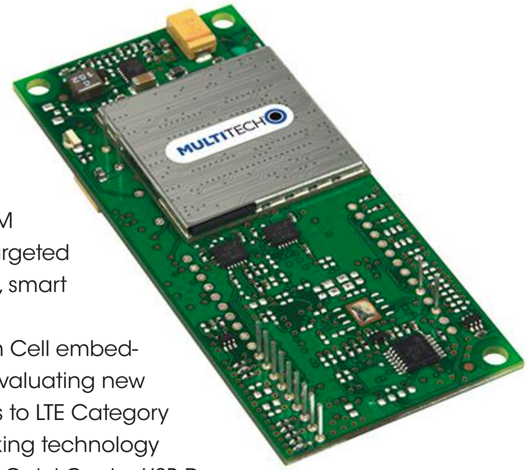


4. Output voltage is compared with different input voltages at a 5-A load step; significant output-voltage droop can occur when the control loop is operating outside its linear range.

From this, we see that the relationship between bandwidth and transient response is simple and straightforward. By observing the transient response, you can quickly get a good estimate of the control-loop bandwidth.

BOB SHEEHAN is a systems manager and Member Group Technical Staff at Texas Instruments, developing custom power solutions as part of the Power Design Services team. His main areas of expertise are control systems, modeling, and analysis. He has written several leading papers on current-mode control for switching power supplies.

Cellular Devices Support LTE Category M1/ NB-IoT



MULTI-TECH SYSTEMS is announcing the availability of its first cellular modems and devices based on LTE Category M1 and NB-IoT technologies, the 3GPP mobile broadband industry's LPWA networks being deployed now by mobile network operators. The networks operate in licensed spectrum and address the requirements of IoT applications, offering an alternative to LPWA technologies operating in unlicensed ISM spectrum. The LTE Category M1 and NB-IoT modems and devices are targeted at applications in industries such as energy, utilities, factory automation, smart cities and healthcare.

The MultiConnect Cell 100 Series cellular modems and SocketModem Cell embedded modems are sampling to network operators and their customers evaluating new IoT applications or transitioning from legacy or proprietary technologies to LTE Category M1- and NB-IoT-based networks. MultiTech is extending this new networking technology across its product lines to include the MultiConnect rCell cellular router, QuickCarrier USB-D dongle and MultiConnect Dragonfly Arm Mbed OS-programmable embedded SoM families of products.

MULTI-TECH SYSTEMS, *www.multitech.com*

Embedded Controllers Support eSPI Bus

THE MEC17XX AND MEC14XX families of embedded controllers from Microchip support eSPI bus technology. The eSPI interface allows for multiple I/O signals to be configured to support either 3.3 V or 1.8 V, eliminating the need for external voltage translators and allowing for migration of IP across multiple x86 computing platforms.

The MEC17XX family is based on an ARM Cortex-M4F core and has advanced hardware-accelerated cryptography algorithms to support secure boot, a security feature developed to ensure a system boots only from software that is trusted by the manufacturer. The family also offers two UARTS and an extended industrial operating temperature range.

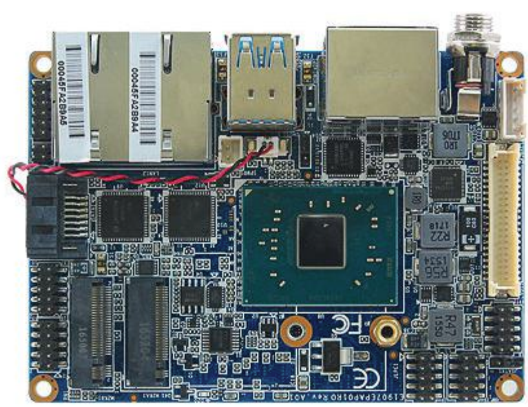
MICROCHIP TECHNOLOGY, *www.microchip.com*

Pico-ITX Motherboards Reduce Power Consumption

AVALUE TECHNOLOGY'S new EPX-APLP Pico-ITX industrial motherboards, powered by Intel Celeron N3350 processors, provide ultra-compact yet highly integrated platforms for computing performance that meets demands in compact-size, fanless operation, low power consumption and versatile I/O.

The SBCs support one 204-pin DDR3L 1,600/ 1,333 MHz SO-DIMM supporting up to 8 GB capacity. I/O deployment includes HDMI, DP++, four USB 2.0 ports, two USB 3.0 ports, SATA power, SATA III, M.2 Key A, M.2 Key B, RS232 COM port and 8-bit GPIO. The boards also support dual channel 18/24-bits LVDS and two LAN ports with Intel i211AT. Other main features include: 2 x Intel i211AT GbE; Realtek ALC662 audio codec; Realtek ALC105 stereo class-D 3 W x 2 audio amplifier; and dc in +12 V.

AVALUE TECHNOLOGY, *www.avalue.com.tw/*

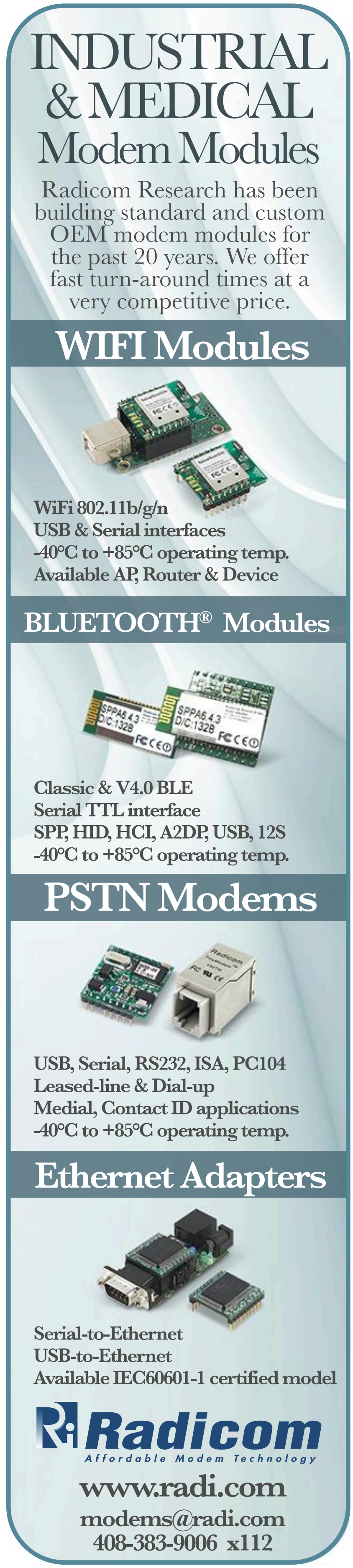


3-Wire Differential Speed Sensor Includes EMI Protection

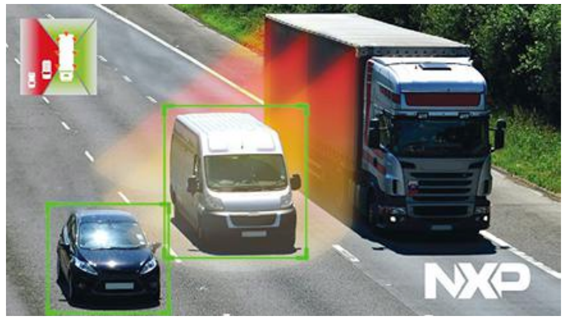
ALLEGRO MICROSYSTEMS' NEW ATS668 optimized Hall-effect three-wire differential speed sensor IC and permanent magnet pellet combination includes integrated EMC protection components to achieve true zero-speed digital gear tooth sensing. It is offered in a small single over-mold 3-pin SIP package with matte-tin leadframe plating that can be used in conjunction with a variety of gear tooth sensing applications. The component is designed for automotive transmission systems, but is also suited for non-automotive applications such as recreational vehicles, industrial equipment, white goods and exercise equipment.

A dual element Hall IC is incorporated for switching in response to differential magnetic signals created by a ferromagnetic target. A compensating circuit design eliminates the detrimental effects of magnet and system offsets. Digital processing of the analog signal provides zero-speed performance independent of air gap and dynamic adaptation of device performance to typical operating conditions found in automotive applications. High-resolution peak detecting DACs set adaptive switching thresholds. Hysteresis in the thresholds reduces the negative effects of any anomalies in the magnetic signal associated with system or target anomalies common in automotive applications.

ALLEGRO MICROSYSTEMS, *www.allegromicro.com*



Vision Processor Plus SDK Aids ADAS Networks



NXP SEMICONDUCTORS is announcing full availability of their S32V processor along with complementary S32 Design Studio IDE enablement to help simplify the deployment of ADAS vision and neural network solutions in automotive, transportation and industrial applications. Systems such as the NCAP front camera and surround view, which the S32V processor is designed for, will have the ability to locate, identify, track and classify multiple objects simultaneously.

The product blends of safety fusion and high performance processing using dual APEX-2 vision accelerators with 128 parallel computational vector units, and programmed using the APEX-CV library for computer vision algorithms. The <10 W vision processor solution features: passive cooled MPU with or without GPU enabled; up to 10 k DMIPS with Quad 1 GHz A53 cores and GC3000 Vivante GPU; functional safety for sensor fusion; and an on chip ISP. Development tools include: S32 Design Studio IDE for Vision v2.0; Vision SDK v1.0 with integrated APEX and ISP; Linux BSP for evaluation boards; and OS support for Linux (Yocto), SafeRTOS and AutoSAR OS.

NXP SEMICONDUCTORS, *www.nxp.com*

Wafer-Thin Gateway Boards are Customizable

THE LATEST MEMBER of AAEON's UP family of products, the UP2, integrates DDR4 and Intel Apollo-Lake CPU. The UP family, designed specifically for high efficiency at a minimum form factor in network security and gateway systems, also includes the UP and UP-Core which support the low-power, high performance Cherry-Trail processor. All three models come with an optimized fanless cooling design solution, facilitating thermal management and preventing the system from overheating. Airflow is also co-opted by the outer chassis, further enhancing thermal circulation and maintaining the longevity and stability of the system.

Onboard DDR3L/LPDDR4 memory and eMMC storage are additional features of the series, along with expansion choices including multi-functioning switching digital I/O by FPGA/CPLD and multi-display options. The architecture of the line is built for quick assimilation with existing systems, and supports all current operating systems. Built to address space restraints, Up products are suited for uses in robotics, drones, intelligent vehicles, machine vision, smart homes and digital signage.

AAEON, *www.aaeon.com*

Firewall Protects Against GPS Incidents

THE BLUESKY GPS FIREWALL solution, designed by Microsemi to provide protection for GPS delivered PNT data, is deployable in-line between any standard GPS antenna and stationary GPS receiver. The product filters the GPS signal in real time, removing anomalies before the signal is consumed by the downstream GPS receiver, creating a secure barrier that prevents the receiver from being impacted by such incidents. Deployment does not require any new cabling or alteration of pre-existing antenna, and the product is interoperable with standard GPS receivers. An integrated Ethernet interface allows remote management and monitoring and includes a secure web interface that any browser can use for configuration and set-up.

The firewall includes data validation rules based on real, live sky GPS threats. Microsemi maintains the software platform of the firewall by continuously tracking GPS signal manipulation including spoofing threats, jamming attacks, multipath signal interference, atmospheric activity and other issues. The software can be updated using TimePictra management system. In advance of full production, the BlueSky GPS Firewall Evaluation Kit is available for order now with delivery beginning in November 2017.

MICROSEMI, *www.microsemi.com*

Thermal FIR Sensing Offers Vehicles 24/7 Vision

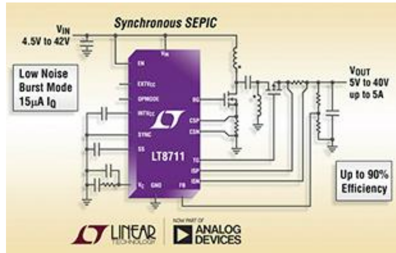
VIPER IS ADASKY'S FIRST FIR perception solution specifically designed for the automotive industry. The solution combines an FIR thermal camera with advanced computer vision algorithms to let autonomous vehicles see and understand the road and their surroundings in any conditions.

Comprised of a high-performing thermal camera and state-of-the-art machine vision algorithms, the complete solution can be added to any autonomous vehicle to enable it to see better and analyze its surroundings. The product passively collects FIR signals through detection of thermal energy radiated from objects and their body heat. AdaSky's algorithms process the signals collected by the camera to provide accurate object detection and scene analysis, giving the vehicle the ability to precisely detect pedestrians at a few hundreds of meters.

ADASKY, *www.adasky.com*

Multitopology DC/DC Controller Features 15 μA IQ

THE LT8711, a multitopology current mode PWM controller from Linear Technology, is configurable as a synchronous buck, boost, SEPIC and ZETA dc/dc converter, or as a nonsynchronous buck-boost converter. The device replaces the output diode with a high efficiency P-channel MOSFET, which increases maximum output current up to 10 A, suiting it for automotive, industrial and solar applications.



Featured specifications include: 4.5 V to 42 V input voltage range and output voltage is dependent on external component options; 15 μA no-load quiescent operating current; fixed operating frequency selectable from 100 to 750 kHz and can be synchronized to an external clock; low ripple Burst Mode operation enabling high efficiency at very light loads while maintaining low output voltage ripple; and EN/FBIN pin circuitry for input voltage regulation which prevents collapsing a high impedance input source such as a solar panel.

LINEAR TECHNOLOGY, *www.linear.com*

IXIDM1401- 10A/4000V Isolated Gate Driver Module

AC, DC motor drives, inverters, converters, medical, UPS, traction and SMPS

Key Features:

- Dual Channel Driver for Half-Bridge Switching Modules
- Blocking voltages up to 4000 V
- +15 V/-5 V Isolated Gate Driver Output Voltage to Drive IGBTs with up to 10 A Pulse Current
- 3 V TTL Logic Level Microcontroller Interface
- Single 15 V Power Supply Operations
- Operating Ambient Temperature: -40°C~+105°C
- Footprint: 50 mm x 50 mm
- UVLO, OVLO, OC, Temperature, short-circuit (SC), Active clamping protections (check datasheet for details)

Optimized for:

Phase-leg IGBT Modules:

• up to 600A/600V • up to 600A/1200V • up to 450A/1700V

4. ORDERING INFORMATION

IXIDM①②③④_⑤⑥⑦⑧_⑨

DESIGNATORS	DESCRIPTION	SYMBOL	DESCRIPTION
①	Module Configuration	1	Two Isolated Gate Drivers
②③	Isolation Voltage	40	4.0 kV
④	Gate Current	1	10 A
⑤⑥	Positive Gate Voltage	15	15 V
⑦⑧	Negative Gate Voltage	05	-5 V
⑦⑧	Negative Gate Voltage	15	-15 V
⑨	Package Information		O – Open Frame, M - Molded

PART NUMBERS AND ORDERING OPTIONS:

IXIDM1401_1505_O - two isolated gate drivers with 10 A gate current , 15 V positive and -5 V negative gate voltage, open frame version.
IXIDM1401_1505_M - two isolated gate drivers with 10 A gate current , 15 V positive and -5 V negative gate voltage, molded version.
IXIDM1401_1515_O - two isolated gate drivers with 10 A gate current , 15 V positive and -15 V negative gate voltage, open frame version.
IXIDM1401_1515_M - two isolated gate drivers with 10 A gate current , 15 V positive and -15 V negative gate voltage, molded version.

IXYSPOWER
Efficiency Through Technology

EUROPE
IXYS GmbH
marcom@ixys.de
+49 (0) 6206-503-249

USA
IXYS Power
sales@ixys.com
+1 408-457-9042

ASIA
IXYS Taiwan/IXYS Korea
sales@ixys.com.tw
sales@ixyskorea.com

www.ixys.com

SoC Designed for Automotive BLE TPMS Apps

THE SMARTBOND DA14585 BLE SoC is designed by Dialog Semiconductor for use in TPMS sensors in the automotive industry. For example, the SoC can be utilized as an electronic subsystem for monitoring air pressure and temperature within automobile tires, alerting drivers of improperly-inflated tires or other safety information in real time. The SoC replaces, typical TPMS sensors using proprietary or non-standard sub-GHz radios to transfer information to the automobile's computer. The SoC handles the entire processing required for building a BLE-enabled TPMS application, with no additional MCU needed. Further benefits include high security, upgradable firmware and connectivity to automobile computers via a single node for all BLE functions.

Available for purchase through Avnet, Digi-Key and Mouser, the SmartBond DA14585 BLE SoC supports standalone as well as hosted applications and comes with a complete development environment including SmartSnippets software, which helps profile and fine tune power consumption.

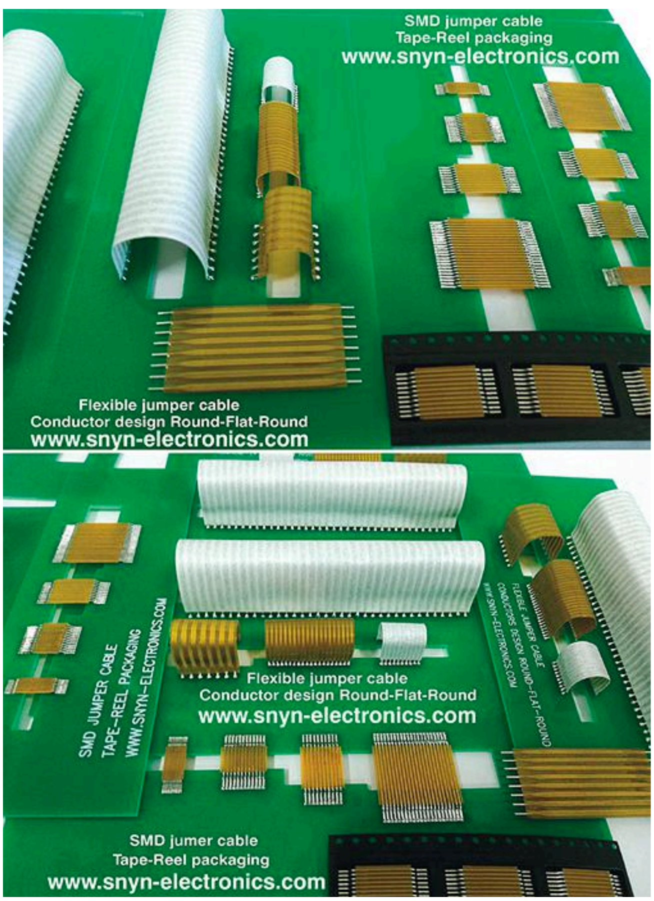
DIALOG SEMICONDUCTOR, *www.dialog-semiconductor.com*

HD Video Processor Interfaces to Automotive SoCs

INTERSIL'S NEW TW884X HD 1080P LCD video processor, with analog video decoder, two scalers, and MIPI-CSI2 SoC, is designed to interface with the latest automotive SoCs. Enabling migration from analog to digital camera systems while supporting various video interfaces and LCD panel resolutions up to full HD targets the product for center-stack units, full display rearview mirrors, instrument cluster displays, and entertainment systems.

The TW8844 with MIPI-CSI2 output and TW8845 with BT.656 output exceed the requirements of U.S. FMVSS-111 for preventing backover accidents, displaying live video with graphics overlay in less than 0.5 seconds after vehicle ignition. The processors monitor SoC and camera output to determine if they are frozen or corrupted. If any issue is detected, the SoC is bypassed and the rearview camera video displayed instantly.

INTERSIL, *www.intersil.com*



GoLogic XL Logic Analyzer

FAST PROBLEM SOLVER

Powerful & Versatile — *PC Hosted Logic Analyzer*

- 4GHz sampling
- 1 Billion samples
- 36 or 72 Channels
- ScopeLink Mixed Signal Analysis
- 1 GHz Transitional Sampling 300MHz State Analysis

NCI *Logic Analyzers*

www.nci-usa.com
Phone 256-837-6667
Fax 256-837-5221
email: contact@nci-usa.com

INDEX

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

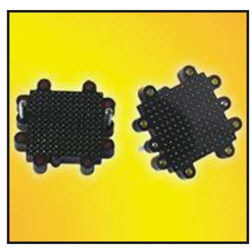
New to Penton Ad Portal?
https://penton.sendmyad.com
Your new account will give you access to begin sending ads to Penton

Texas Instruments is looking to fill engineering positions working with semiconductor technologies. We are recruiting @ various educational and experience levels:

CITY	POSITION	APPLY FOR JOB USING THIS LINK
Dallas, TX	Applications Engineer	http://tinyurl.com/m4yea5c
	Applications Manager	http://tinyurl.com/mfors5b
	Digital Design Engineer	http://tinyurl.com/k4vss9c
	Packaging Engineer	http://tinyurl.com/l3bfq4k
	Process Development Engineer	http://tinyurl.com/lpce2oz
	Program Management Engineer	http://tinyurl.com/zeo2kr2
	Software Development Manager	http://tinyurl.com/ohzev3v
	Software Engineer	http://tinyurl.com/gp8takh
	Systems Applications Manager	http://tinyurl.com/kphlzwv
Grass Valley, CA	Analog Design Engineer	http://tinyurl.com/ol88wjg
Santa Clara, CA	Analog Design Manager	http://tinyurl.com/lbjtqab
	Applications Engineer	http://tinyurl.com/l3munpc
	Digital Design Engineer	http://tinyurl.com/lyameu6
	Product Engineer	http://tinyurl.com/kkwpd5l
	Program Management Engineer	http://tinyurl.com/yc8voh6d
	Systems Engineer	http://tinyurl.com/k7dyfnp
	Test Engineer	http://tinyurl.com/lgtcyur
	Test Engineer, Production	http://tinyurl.com/y99rdf8u
South Portland, ME	Facilities Engineer	http://tinyurl.com/yc33tyyu
Tucson, AZ	Analog Design Engineer	http://tinyurl.com/m6hgk9e
	Product Marketing Engineer	http://tinyurl.com/krundg9
	Project/Program Manager	http://tinyurl.com/ycer8tg5
Warrenville, IL	Analog Design Engineer	http://tinyurl.com/y8tkrzlk

Some positions may require travel.
Please send in resumes using the individual URL code for the position listed. EOE.

Chip Size 0.65mm Pitch BGA Socket Adapter



Ironwood's new high performance socket - SFS-BGA144V-52 allows 0.65mm pitch, 8x8mm body, 12X12 array 144 ball BGA package to be placed in socket and operated without compromising performance in high speed applications. The Giga-snaP™ BGA socket adapter pair consists of SFS-BGA144V-52, patented female BGA sockets with BeCu pins assembled into a substrate that matches the male pin adapter. The RoHS compliant BGA socket is soldered to a PCB using standard soldering methods.

Ironwood Electronics, Inc.
1335 Eagandale Court, Eagan, MN 55121
T: 800-404-0204 • F: 952-229-8201
Email: info@ironwoodelectronics.com
Web Site: www.ironwoodelectronics.com

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

Security-Oblivious Design Makes TrustZone Vulnerable to Attack

Researchers succeed in attacking a design by compromising the DVFS SoC support.

Creating advanced driver-assistance systems (ADAS) and self-driving cars is a substantial technical challenge. Securing these designs is also challenging, but security hardware can make this task much easier—if it works.

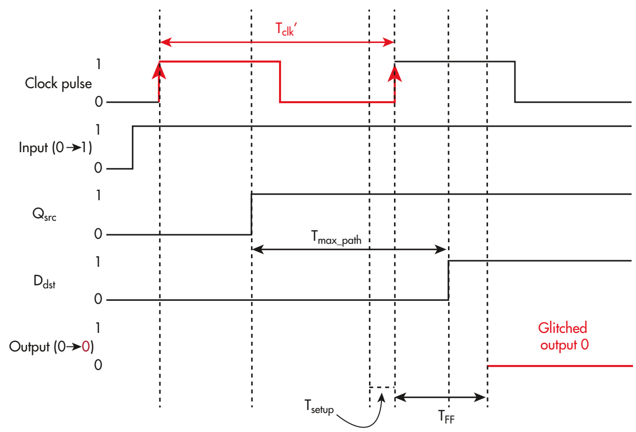
Typically, the root of trust starts in hardware with keys that must be protected and security hardware that provides secure boot support. ARM's TrustZone is one implementation that provides this support. TrustZone technology is at the center of ARM"s security message, so compromising this system would have a significant impact on automotive security.

On that front, researchers at Columbia University succeeded in attacking a security-oblivious design of a TrustZone-based ARM system-on-chip (SoC) implementation by compromising the Dynamic Voltage and Frequency Scaling (DVFS) support. Adrian Tang, Simha Sethumadhavan, and Salvatore Stolfo presented their paper, *CLKSCREW: Exposing the Perils of Security-Oblivious Energy Management*, at the 26th USENIX Security Symposium in Vancouver, BC, Canada.

With the DVFS, the operating system is able to vary the speed and performance of the processing cores to optimize power utilization. Reducing the performance or stopping cores can significantly extend the battery life of a system. As it turns out, twiddling the DVFS in ways it wasn't intended can cause errors to occur that could be used to compromise the security system.

Essentially, the approach changes bits in the system indirectly because of how DVFS works. The DVFS design was done independently of the security implementation, since timing or voltage errors should not, in theory, affect the security support. TrustZone is designed to prevent a variety of other types of attacks.

The CLKSCREW attack isn't necessarily easy, especially when implemented using software. For example, an attack must be implemented such that the code under attack is modified, but not the attacking code. Likewise, the attack should not perturb other software like the operating system. This type of attack requires very precise timing to induce a fault in the desired code.



Columbia University researchers were able to use the Dynamic Voltage and Frequency Scaling (DVFS) support to induce bit-level faults due to overclocking.

In the CLKSCREW attack, the voltage regulators are pushed beyond the operating limits. Another way to mitigate this type of attack would be to implement different power domains for the security and system. Other hardware and software methods can prevent this type of attack, so it's unlikely that this specific mechanism can be exploited in automotive systems at this point.

The researchers pushed the attack to the level of plausibility. Additional work could be done to improve the types of possible attacks as well as defenses. The challenge is that mitigating such an attack on existing hardware can be difficult, but would be significantly easier for new designs. Hardening the power-management system software will help, because most applications will not have direct access to power-management hardware.

The challenge for automotive designs is that implementations must be designed to last for decades. Software issues can be addressed with over-the-air (OTA) updates. However, hardware issues will likely require hardware replacement, which is expensive and leaves a system open to attack until the change is made. ed

Surface Mount High Voltage The Right Way

DTI'S SURFACE MOUNT HIGH VOLTAGE DIODES

The cost and quality advantages of surface mount manufacturing technology make it extremely popular in new electronic design. Limited availability of diodes has made the transition to utilize this technology hard for many in the high voltage space - until now!

High voltage surface mount diodes from Dean Technology cover a wide range of electrical performance, and with our new SL series in a longer package we can offer ratings up to 30 kV.

Custom versions are also available for customers that have specific needs not met by our standard product line. We will work with you to get the parts you need for your new designs now.

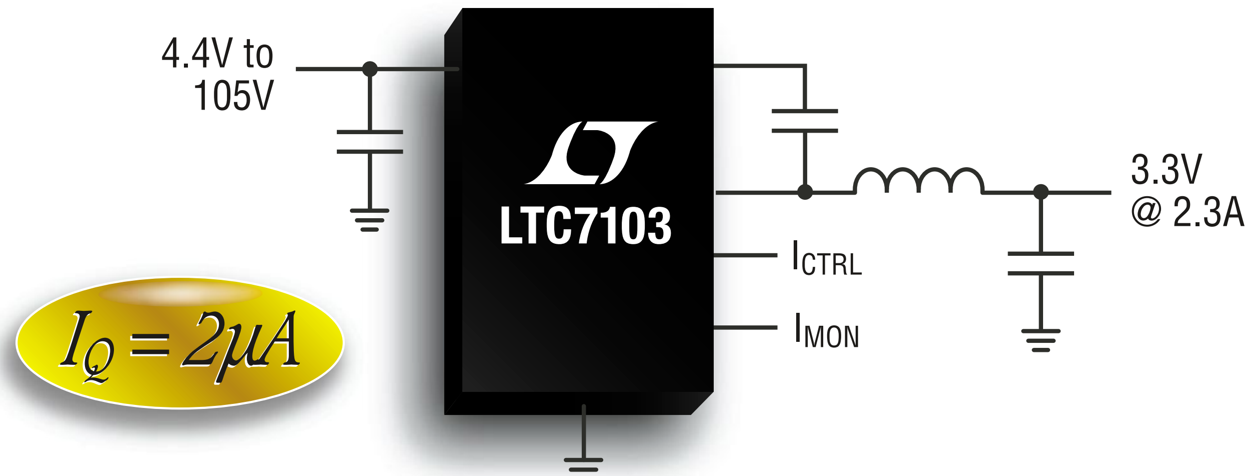
IN STOCK TODAY! Contact us for a quote or to place your order!

www.deantechnology.com

HVCA CKE HVPSI

Products By: DEAN TECHNOLOGY

105V/2.3A Sync Buck



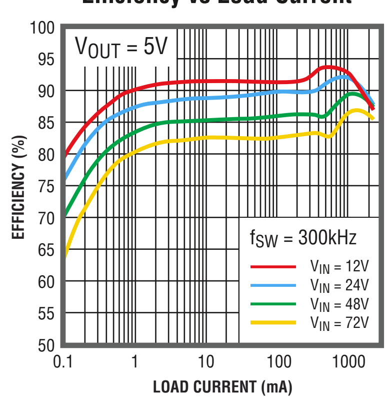
Ultralow EMI/EMC Emissions: CISPR25 Class 5 Compliant

The LTC7103 combines 100V input capability, synchronous rectification and an ultralow EMI design, providing a compact 2.3A step-down solution. It delivers up to 94% efficiency while offering a compact solution footprint for high voltage applications such as emerging 48V automotive, transportation and telecom systems. Its unique design offers ultralow EMI/EMC emissions, easily meeting CISPR25 Class 5 limits. The LTC7103 also implements fast and accurate output current programming and monitoring without an external R_{SENSE}. It consumes only 2µA quiescent current and is in a 5mm x 6mm QFN package.

Features

- 4.4V to 105V Input Voltage Capability
- High Efficiency Synchronous Monolithic: Up to 94% Efficiency
- Low EMI/EMC Emissions: CISPR25, Class 5 Compliant
- Accurate Output Current Limiting/ Monitoring
- Ultralow Quiescent Current
- Switching Capability to 2MHz
- Small/Simple/High Current Capability

Efficiency vs Load Current



Info & Online Store

www.linear.com/product/LTC7103

1-800-4-LINEAR

LT, LT, LTC, LTM, Linear Technology, the Linear logo,and µModule are registered trademarks of Analog Devices, Inc. All other trademarks are the property of their respective owners.

LINEAR TECHNOLOGY | NOW PART OF ANALOG DEVICES

Find your local sales office: **www.linear.com/contact**