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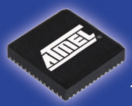

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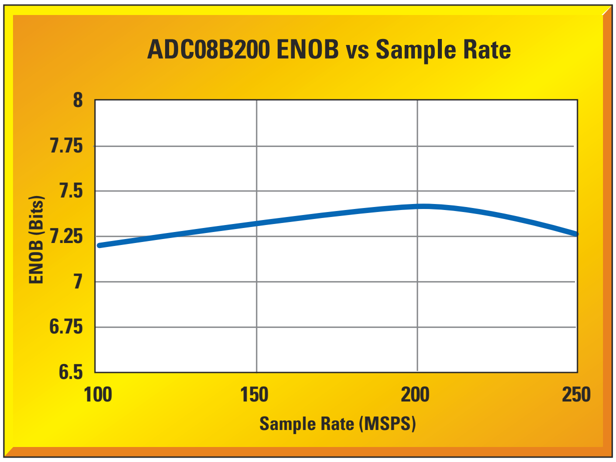

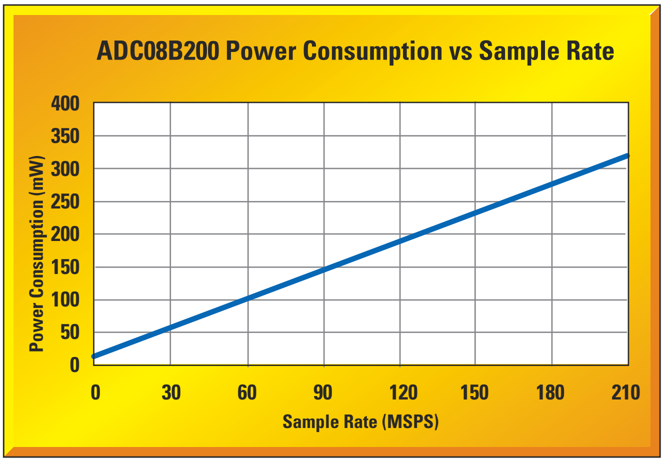

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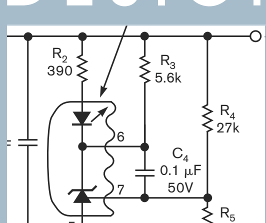

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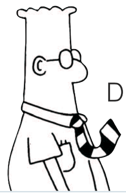

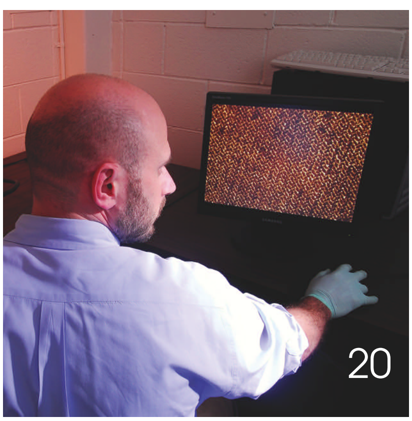

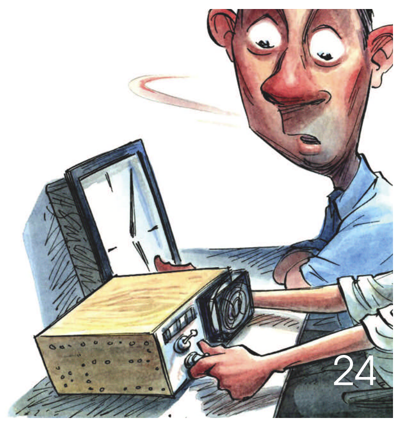

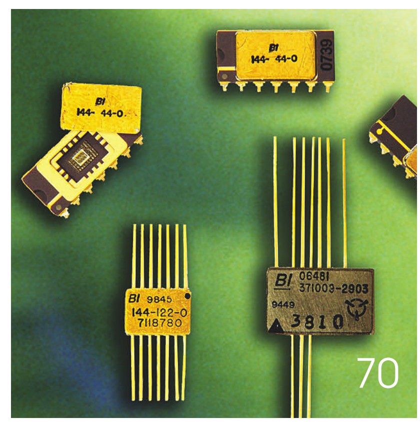

DEPARTMENTS & COLUMNS

PRODUCT ROUNDUP

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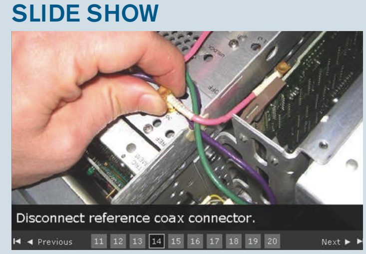

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By Paul Grohe, National Semiconductor
Step-by-step visual instructions on how to remedy a flaw common to several vintage 1980s instruments.
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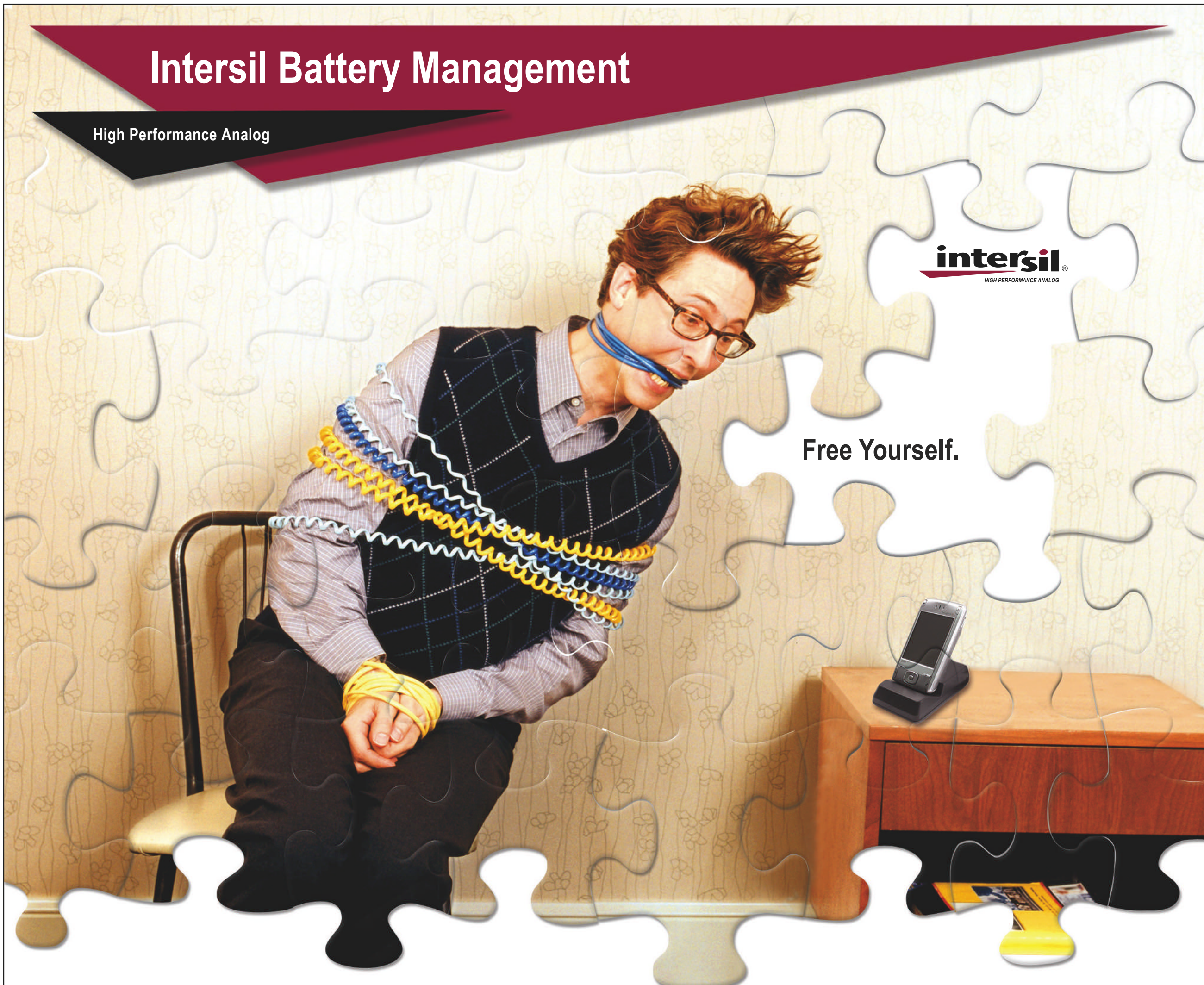

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Cradle Input: The max input voltage tolerance is 28V, programmable end-of-charge current, and the included end-of-charge latch is the default input source.

USB Input: Takes input from USB port or other low-voltage supply, fixed charge current at typically 380mA, and only charges when cradle source is not connected.

End-of-charge indicator is latched, based on completed charge.

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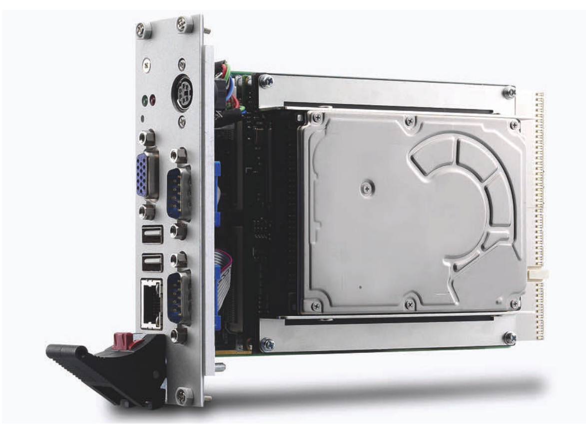
Adlink delivers 10W processor blade

With low-power military, automation, and transportation applications in mind, Adlink Technology recently announced the cPCI-3600 3U CompactPCI board, which it based on the latest AMD (www.amd.com) Geode LX 800@0.9W processor. The cPCI-3600 consumes less than 10W at full loading. With its optional soldered memory and CompactFlash slot, the cPCI-3600 series allows for integration in rugged military applications in which high vibration and adverse environments are common.



The low-power cPCI-3600 series offers optimized power/performance for use in military, automation, and transportation applications.

In a dual-slot form factor, the cPCI-3600-series memory-configuration options include 256 Mbytes of soldered, dual-data-rate, 400-MHz memory plus one SODIMM (small-outline/dual-inline-memory-module) socket that supports as much as 1 Gbyte of RAM. The cPCI-3600 also provides two 10/100-Mbps Ethernet ports, an onboard 2.5-in. IDE (integrated-drive-electronics) hard-disk-drive port, one CompactFlash socket, two USB 2.0 ports, two serial ports, one parallel port, one keyboard/mouse interface, and an AC'97 audio interface. The cPCI-3600 also supports analog display resolutions as great as 1920×1440 pixels. The cPCI-3600 is available now for prices starting at $725.**—by Warren Webb**
▷**Adlink Technology**, www.adlinktech.com.

FEEDBACK LOOP

"To finally have a battery gas gauge that is designed specifically for lithium batteries is a good thing."

—Reader David E Marlow, in *EDN*'s Feedback Loop, at www.edn.com/article/CA6488081. Add your comments.

Electronic manufacturing capacity to see global rebalancing

Electronics-contract manufacturers will begin focusing on other factors beyond labor cost when it comes to selecting a location for production in the coming years, according to iSuppli Corp. According to the company, in the early part of this decade, manufacturing capacity shifted from the high-cost regions in North America and Western Europe to the low-cost region of mainland China. However, in the second half of the decade, contract manufacturing will undergo a global rebalancing that will lead to a more distributed market. You can attribute electronics manufacturers' regional diversification to other China-centric factors, including a mobile work force, inflation, taxes, and the rising costs of transportation due to soaring oil prices, according to Adam Pick, a principal analyst at iSuppli. "Ultimately, the emphasis has greatly shifted from labor costs only to the total cost of ownership, which considers managerial resources, organizational structuring, manufacturing competencies, intellectual property, and logistics," he says.

Leading EMS (electronic-manufacturing-service) providers, ODMs (original-design manufacturers), and OEMs (original-equipment manufacturers) have recently undergone capacity expansions, revealing a number of new trends affecting global electronics manufacturing. These trends include the rising penetration of emerging regional economies; proximity to large, local markets with fast-growing product segments as ODMs' local presence in some regions helps minimize tariff costs; and OEMs' need to diversify manufacturing profiles to other locations, such as Vietnam.**—by Suzanne Deffree**
▷**iSuppli**, www.isuppli.com.

IC technology allows waveform access at previously inaccessible internal points

Several of the latest high-end digital oscilloscopes incorporate facilities for reconstructing waveforms that probes can't reach. However, Vitesse Semiconductor says that such de-embedding is no better than the device models it uses and that many of today's models are inaccurate. The company instead expects the situation to only get worse because the DSP techniques that scopes use for signal reconstruction are based on linear-circuit models, and new high-performance devices increasingly require nonlinear models to reconstruct inaccessible signals with sufficient accuracy.

To solve the problem, Vitesse has announced the VScope technology, which builds into certain new ICs circuits that can measure the inaccessible signals. It also provides the hardware with a simple means of controlling the measurements and getting the results from the IC through its pins and—both to control cost and to maximize compatibility with older devices—avoids the need to add pins. VScope also ensures that the measurement circuits have negligible impact on chip area and, hence, on chip cost. The technology makes it possible to disable the measurement circuits so that they consume power only when measuring. It also provides a software package with which users can select the measurements they need and display the results in easy-to-understand formats.

The company believes that the technology, which customers can implement for far less than the $100,000-plus cost of a high-end scope, can displace scopes in many—but not all—signal-integrity applications. Company representatives also describe as negligible the recurring cost of having the measurement circuits in every VScope IC.

> "Vitesse points to the value of VScope in tuning filters in adaptive equalization.

At the heart of VScope is a scanner within the CDR (clock- and data-recovery) circuits. The scanner's strobe point is adjustable in time in small increments over at least a full UI (unit interval). Its threshold level is adjustable in voltage in similarly small increments over somewhat more than the entire normal input-signal swing. Each scanner comprises two identical circuits, either of which you typically might assign to monitoring a reference point—usually at the center of an open eye diagram. You can control the placement of either circuit's strobe time and threshold using a bus that Vitesse describes as similar to I^2C (inter-integrated circuit).

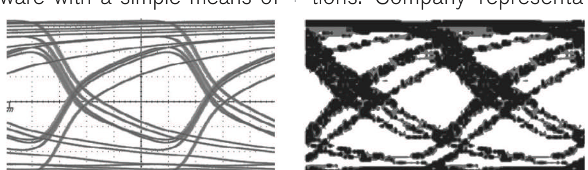
You obtain a VScope measurement set by changing the strobe time and threshold voltage typically 2^{16} times. The actual number of individual measurements is up to you, however. A satisfactory VScope hardware implementation allows increments of 1⁄64 of the time and voltage ranges, but smaller increments are possible. Nevertheless, Vitesse does not currently envision increments fine enough to replicate oscilloscope resolution.

In reconstructing an eye diagram, you might categorize the state of each time/voltage point as always a logic one, always a logic zero, one and zero approximately equal fractions of the time (say, no more than 60% of individual measurements in either state), one slightly more often than zero (say, more than 60% but less than 95% of individual measurements), zero slightly more often than one, one considerably more often than zero (say, more than 95% but less than 100% of individual measurements), and zero considerably more often than one.

Vitesse points to the value of VScope in tuning filters in adaptive equalization, such as those for ultra-high-speed serial-bus signals in backplanes and cables. These filters, which are common in backplane transceivers, pre- and de-emphasize higher-frequency components of signals whose data rates now often extend beyond 10 Gbps. In the absence of equalization, these signals' eye diagrams can be completely closed. In other words, in the time domain, the signals can be indistinguishable from white noise.

The first VScope IC, the VSC3406, a six-channel, 6.5-Gbps multirate backplane transceiver in a 10×10-mm package, costs $60 (1000/year).**—by Dan Strassberg**

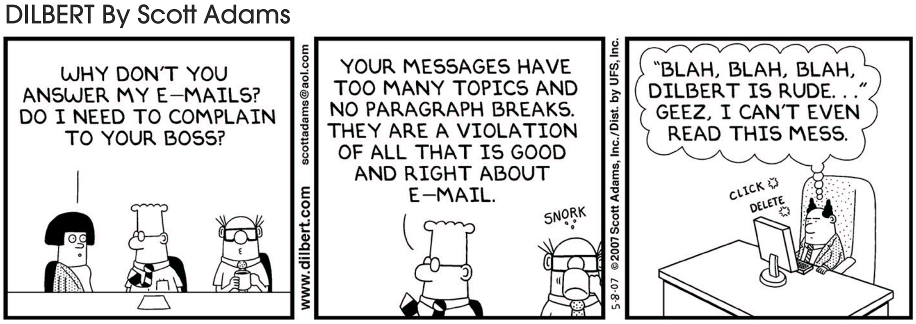
▷**Vitesse Semiconductor**, www.vitesse.com.



(a) (b)

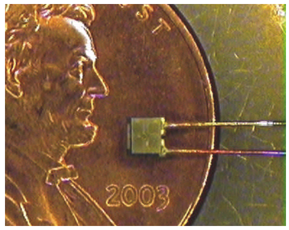
Although differences exist between the waveforms from a scope (a) and the IC's internal scanner (b), both show amplitude and phase dispersion, even in individual edges. The scanner's finite frequency response limits and distorts the slew rate compared with the scope's much higher bandwidth. The limited linear range of the scanner's signal path preceding the variable-slicing function also compresses the signal swing.

DILBERT By Scott Adams



Thermoelectric platform aims to cool hot spots

Nextreme Inc claims that its new thermoelectric platform can lower heat in specific areas of laser diodes, LEDs, and sensors. The microscale-thermal- and power-management-product maker recently announced its ultrahigh-packing-fraction OptoCooler module, targeting cooling and temperature-control requirements for optoelectronics, electronics, medical, military, and aerospace applications employing laser-diode, LED, and advanced-sensor products. In doing so, the start-up aims to solve the continuous design challenge of power leakage and hot spots, leading to uneven temperatures across a chip. Such challenges have led top industry microprocessor makers, such as Intel Corp (www.intel.com) and Advanced Micro Devices Inc (www.amd.com) to move to multicore processors as they increase performance and reduce footprints. If Nextreme's thermoelectric platform is successful, it could offer an alternative route to faster, smaller next-generation processors.



OptoCooler's size and heat-pumping capability make it well-suited for use in optoelectronics applications.

According to the company, the OptoCooler removes a maximum of 420 mW of heat at 25°C ambient temperature in an active footprint of 0.55 mm^2. As a result, the module can pump a heat density to $78W/cm^2$; at 85°C, these values increase to 610 mW and $112W/cm^2$, respectively. "The OptoCooler module is the industry's first thermoelectric device to offer a heat-pumping density in excess of $70W/cm^2$, a tenfold increase in heat-pumping capacity over conventional TEC [thermoelectric-cooling] modules," says Dave Koester, vice president of engineering at Nextreme. This development enables direct cooling of a laser diode on a scale that is similar to the diode itself, significantly improving efficiency and offering new, integrated packaging options, according to Koester.

Because the OptoCooler uses thin-film-thermal-bump technology at its core, designers can directly integrate it in electronic and optoelectronic packaging to deliver more than 45°C of cooling for a variety of thermal-management applications. The company demonstrated embedding the module within laser-diode packages to control temperatures and maintain proper operating conditions for optimal performance. Nextreme will use the OptoCooler module as the building block for all future discrete products. The company manufactures it with the proprietary thermal-copper-pillar-bump process, which Nextreme based on an established electronic-packaging approach that scales into large arrays and integrates thin-film-thermoelectric material into the solder-bumped interconnects that traditionally provide mechanical and electrical functions. Unlike conventional solder bumps, Nextreme's bumps function as solid-state heat pumps on a microscale. Designers can implement the thermal-bumping process at the system, package, or wafer level and in discrete modules. OptoCooler modules are available now for $12 (1000).

—by Suzanne Deffree

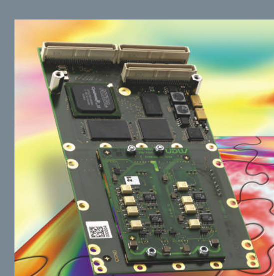
▷**Nextreme**, www.nextreme.com.

MEN MICRO EXTENDS UNIVERSAL-SUBMODULE CONCEPT

Designing unique I/O-mezzanine modules for each application can be expensive and time-consuming. MEN Micro attacks this problem with a USM (universal-submodule) concept that it based on reconfigurable-FPGA architecture. Products employing the USM concept use one or more IP (intellectual-property) cores in an FPGA to help designers easily and quickly turn individual I/O requirements into production-ready products, reducing design time and costs. MEN Micro now offers its FPGA-based USM concept on two additional mezzanine cards: the P699 XMC and the P598 ccPMC (conduction-cooled PMC). The use of Cyclone FPGAs on the two new cards enables diverse I/O combinations in a small space for moderate volumes and at a low cost.

The P699 XMC uses a Cyclone III FPGA with 24,624 logic elements, and the P598 ccPMC features a Cyclone II with 33,216 logic elements. IP cores allow users to change the functions of either card without any hardware modifications to the main module. The corresponding line drivers reside on the individually designed USM that plugs into the main XMC or ccPMC. A Nios soft-core processor, which features 32 Mbytes of main DDR2 SDRAM and 2 or 4 Mbytes of flash memory for the P598 and P699, respectively, resides on the FPGA, providing local intelligence to the main module. A USM-development package includes a main PMC with a USM; test hardware; and an FPGA package with a Nios CPU, memory control, connection to the PMC, Avalon/Wishbone bridges, and detailed documentation. The product comes with MEN's Wishbone busmaker tool for developing IP cores on the standard Wishbone bus. Prices for a USM-development kit start at $2993.—by Warren Webb

▶MEN Micro Inc, www.menmicro.com.



The P699 XMC and the P598 conduction-cooled PMC universal submodules use FPGA IP cores to quickly turn individual I/O requirements into production-ready products.

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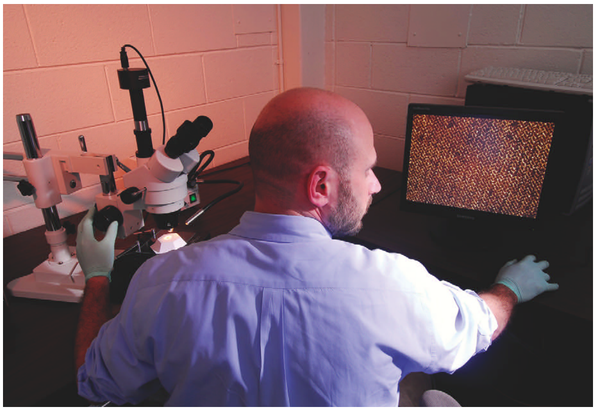

Georgia Tech researcher Jason Nadler examines copper structures that are precursors to on-chip explosives (courtesy Gary Meek, Georgia Institute of Technology).

RESEARCH UPDATE

BY RON WILSON

Getting more bang out of that chip design

The Georgia Institute of Technology and the Indian Head Division of the Naval Surface Warfare Center have developed a novel approach to the formation of nanoporous copper films. The approach is making it possible to literally fabricate an explosive device along with the circuitry of an IC. This technology in turn will make possible a new generation of smart MEMS (microelectromechanical-system) detonators for medium-caliber and smaller munitions for the US Navy.

Georgia Tech researcher Jason Nadler uses templates composed of microspheres or woven fabrics to impress a pattern on a copper-oxide/polymer paste. Nadler then removes the template and converts the paste to metallic copper through thermochemical reactions, retaining the physical pattern in the metal. The result is a uniform dot on the order of a millimeter in diameter with highly predictable pore size and density.

This dot, in turn, becomes the precursor for the formation of a dot of explosive material. Because the whole process is compatible with conventional semiconductor processing, the explosive can reside on the die with the circuitry that ignites it, forming a monolithic MEMS smart fuse measuring only a few millimeters on a side.

Such fuses will both increase the selectivity of small-caliber weapons and substantially reduce the use of toxic and unstable bulk explosives that would normally go into a much larger fuse assembly. Nadler believes there may be industrial applications for the copper-film-formation process, as well.

▷**Georgia Institute of Technology Research Institute**, www. gtri.gatech.edu.

▷**Naval Surface Warfare Center**, www.ih.navy.mil.

Carbon nanotubes boost flexible thin-film transistors

Researchers at the University of Massachusetts—Lowell and Brewer Science Inc have developed a flexible film loaded with carbon nanotubes for use in printable electronic circuits. The researchers based the technique on an ultrapure solution containing a very high density of the nanotubes and very low densities of metallic and carboniferous contaminants.

The researchers have demonstrated formation of a thin-film transistor by depositing a droplet of the solution onto a flexible substrate. They claim that the transistor has shown modulation speed of 312 MHz, well in excess of frequencies scientists have achieved with conventional thin-film materials. The researchers also claim that the solution is compatible with conventional ink-jet-printing processes, so large-scale production of high-frequency circuits should be feasible.

▷**University of Massachusetts–Lowell**, www.uml.edu.

▷**Brewer Science Inc**, www.brewerscience.com/products/carbon-nanotube-coating/print.html.

02.07.08

GRAPHENE MAY BE BEST CONDUCTOR EVER

Researchers at the University of Manchester in the United Kingdom, working in conjunction with teams at the Institute for Microelectronics Technology and High Purity Materials (www.ipmt-hpm.ac.ru/index.en.html) in Russia, the Radboud University Nijmegen in the Netherlands (www.ru.nl), and the department of physics at Michigan Technological University (www.mtu.edu), have concluded that graphene–a monatomic-thickness sheet of carbon atoms connected by sp^2 bonding–offers the greatest intrinsic mobility of any known material. To the researchers' surprise, graphene sheets, with a mobility of 200,000 cm^2/Vsec, beat out both carbon nanotubes–essentially tubes formed by rolling up graphene–and current research darling indium antimonide. That intrinsic mobility is more than 100 times that of bulk silicon.

"Graphene exhibits the highest electronic quality among all known materials–higher than copper, gold, silicon, gallium arsenide, carbon nanotubes, and anything we know," says Professor Andre Geim, director of the University of Manchester's Centre for Mesoscience and Nanotechnology. "It is the only material where electrons at room temperature can move thousands of interatomic distances without scattering." Because mobility translates directly into both intrinsic speed for MOS transistors and conductance in interconnect, the findings imply that graphene could be the material of choice for future terahertz-speed circuits.

▶University of Manchester, www.manchester.ac.uk.

BY HOWARD JOHNSON, PhD

Yao! What a handshake!

Two men of average height meet in a crowded bar. They grasp hands. One man follows through with a vigorous up-and-down motion. The other holds on with a passive, limp action. Their meeting produces a normal, hearty shake about 32 in. above floor level. Now, suppose the second man were Yao Ming of the Houston Rockets. At 7 feet, 6 in., he ranks among the world's tallest basketball players. The same shake would occur, but slightly higher. On the other hand, if the second man were Danny DeVito, the diminutive Hollywood actor, the first must reach down to his level. A handshake accommodates the characteristics of both men.

When a logic driver meets its load, it behaves in a similar way. Begin with the driver in **Figure 1**. Connect its output to a static load. Exercise the driver by swinging its output high and low. At the driver's output, you'll see something like the waveforms in **Figure 1**.

Figure 1 illustrates a Virtex-4 HSTL-I driver. The load comprises a single resistor of 50Ω leading to an adjustable terminating voltage, V_T, all simulated with Hyperlynx. It hardly matters what type of totem-pole output you choose or how exactly you load it—all totem-pole outputs exhibit the same general behavior. You can learn a lot about drivers looking at the details of this family of curves.

Start with the terminating voltage set to 0V. This value produces the red (lowest) waveform in **Figure 1**. Driving high, IC_1 fails to attain its rated V_{OH} level. Why? At this setting, the load requires more current than the driver can provide. You can check that assumption by calculating the output current. The rule for output current is that it equals the voltage drop across R_T divided by its value in ohms.

When the red waveform rises to 0.8V, then, because the terminating voltage for that waveform is zero, the output current is (0.8−0)/50=16 mA. Apparently, when sourcing 16 mA, this particular driver cannot pull all the way up to V_{OH}. That's normal. Most totem-pole drivers can't pull hard enough to meet V_{OH} when loaded with 50Ω to ground. Only an exceptionally strong driver can achieve that goal.

Yao Ming is exceptionally tall and very strong. When Ming greets DeVito, the handshake pulls the actor's arm practically out of its socket.

Now go back to the chart, with V_T still at zero (red waveform). Look at the low-side output voltage. It drops to precisely 0V. *So does the current.* Whenever the output voltage equals the terminating voltage, the output current vanishes. A driver forces an output greater than V_T by sourcing current. It draws the output below V_T by sinking current. At precisely V_T, the driver does *nothing*.

Making the output voltage equal V_T is easy for a driver. The terminating voltage is a "natural resting place." If you disconnect the driver, the load immediately relaxes, all by itself, to V_T.

When Yao Ming lets go, Danny DeVito feels relieved.

Now adjust DeVito's height. Put him on a ladder. Ming needn't reach down as far, so, if DeVito is still game for testing, the handshake occurs at a higher level. In the electrical world, raising V_T always drags the output waveform higher. Lowering V_T has the opposite effect. The trick in end-termination design is setting a value of V_T high enough so the driver can pull above V_{OH} but low enough so that the driver can sink below V_{OL}—all the time not causing any shoulder injuries (in other words, not exceeding the current capabilities of the driver or burning out the terminating resistor). The driver in **Figure 1** meets those requirements with a terminating voltage of 0.75V, producing currents in the high and low states of 9 mA and −9 mA, respectively. **EDN**

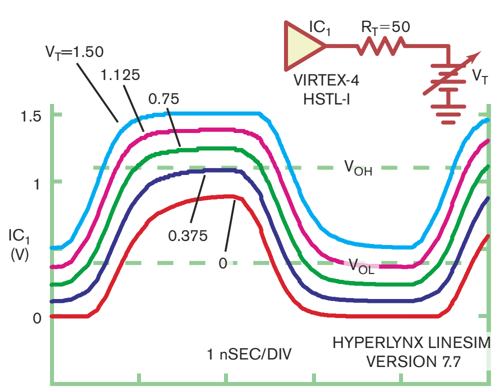

Figure 1 Raising V_T drags the output voltage higher; lowering it does the opposite.

Howard Johnson, PhD, of Signal Consulting, frequently conducts technical workshops for digital engineers at Oxford University and other sites worldwide. Visit his Web site at www.sigcon.com or e-mail him at howie03@sigcon.com.

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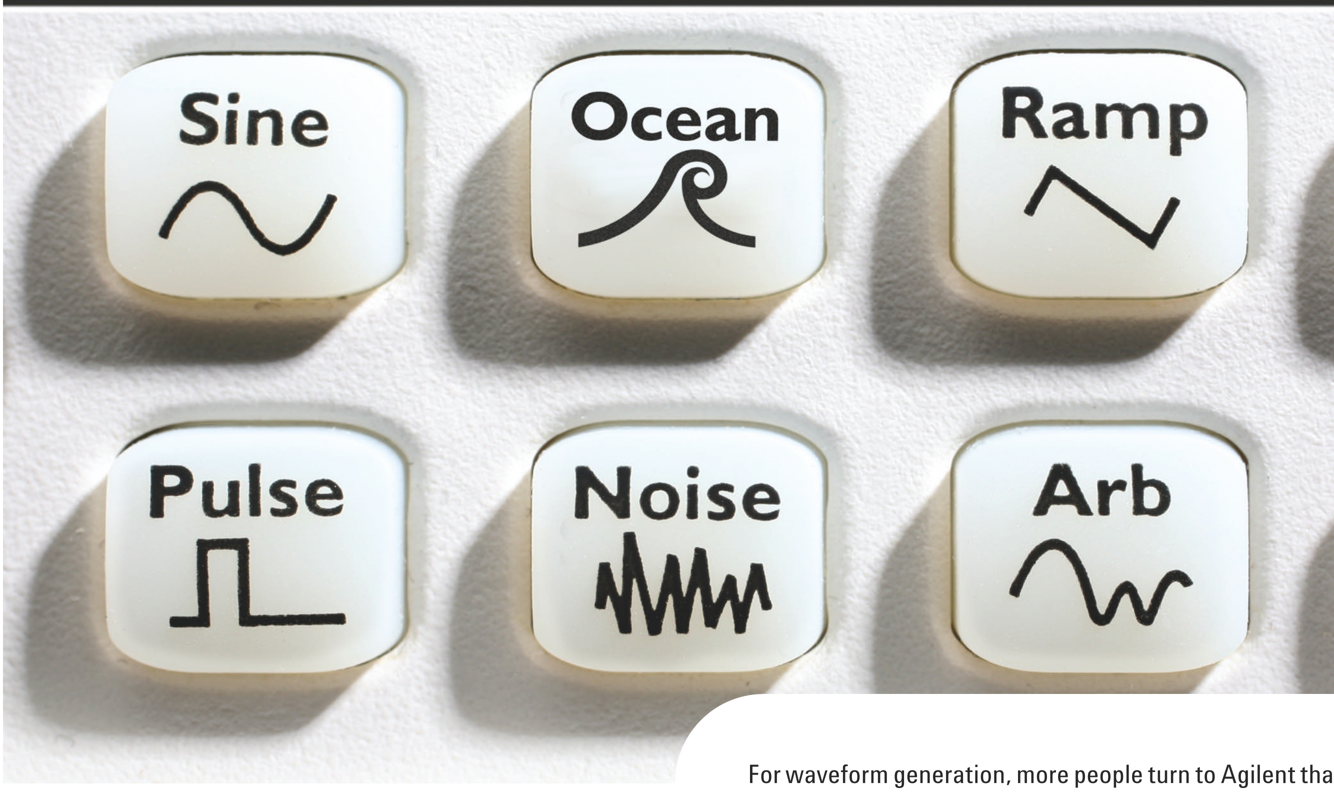

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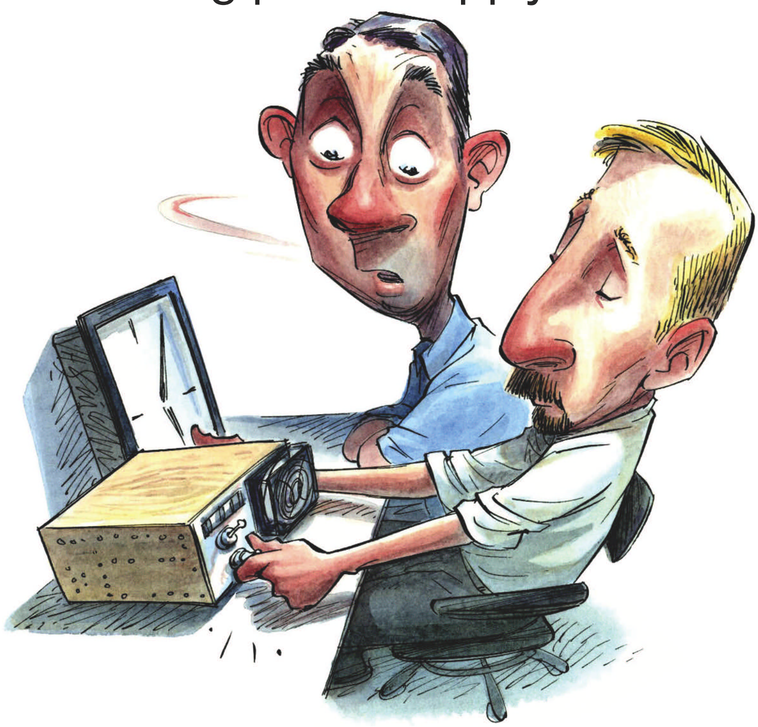
BY WILLIAM SAKS • NORTHROP GRUMMAN

The stalling power supply



DANIEL VASCONCELLOS

A few years ago, a co-worker complained that he didn't know how he was going to get his project, a radar processor, through qualification testing due to a power-supply problem. The system used two identical 5V, 300A power supplies in a shared configuration for redundancy and reliability, although either supply could handle the full load. During the prequalification testing in the lab, however, he noticed that the unit's LED indicated that one of the power supplies had shut off after a couple of minutes of operation and that the remaining power supply was carrying the full load. Although the system carried on without missing a beat, the team categorized this power-supply shutdown as a system failure.

After the power-supply vendor failed to duplicate the phenomenon at its facility, my co-worker referred the problem to a couple of power-supply engineers, who opined that the fault was with a poorly designed unit and that we would be better off going for a redesign. The program had neither the time nor the money to do this redesign. I was intrigued but first wanted to hedge my bets and asked the qualification-project engineer whether a hard failure in the power supply had occurred after the incident. He responded that no hard failure had occurred: "We just recycle power, and both power supplies come back up," he said. With that assurance, I offered to take a shot at the problem.

I instrumented and observed a power supply in the system—which, surprisingly, no one had done before. I noticed that the problem occurred once the processor applied the system clock, which phase-locked the switching frequency and caused an overvoltage in one or the other power supplies, causing it to shut down. Now that I understood more of the scenario, a trip to the vendor's site was in order. The vendor's engineer and I discussed the design. With no solutions, I recalled my bench-testing days and asked to witness an ATP (acceptance-test procedure). The technician set up a unit, and I witnessed him perform the ATP. Halfway through the test, the procedure called for applying a clock to the power supply and verifying normal operation. I noticed that, after applying the clock, the technician toggled a switch. When I asked him about it, the technician replied: "Sometimes, the clock application makes the unit latch off. I just recycle it at that point." Aha! We were able to duplicate the problem and then called the engineer over to observe the effect, which astonished him. He seemed genuinely unaware of what the technician was doing.

Schematic analysis showed that the clock input drove a PLL that free-runs in the absence of an input. Because the vendor had limited experience with PLLs, they accepted my offer of trying to solve the problem. We discovered that the power supply exhibited a frequency-to-voltage-converter effect from the input clock to the output voltage. We then discovered that the PLL was severely underdamped and would overshoot severely when we applied the input clock. We changed a couple of values and added an extra resistor in the PLL filter, damping the loop and reducing its speed to less than that of the power-supply voltage-control loop, which allowed the loop to remove the input-clock-frequency-induced changes.

We retrofitted two power supplies with these changes and put them into the qualification system. When the system applied the clock, both power-supply lights remained green, and all was well. For the cost of a couple of resistors and a capacitor, the power supplies passed qualification testing, and the production lot also operated satisfactorily.EDN

William Saks is a fellow engineer at Northrop Grumman. Like William, you can share your tale and receive $200. Contact Maury Wright at mgwright@edn.com.

ANALOG | edge℠

Powering Multi-Rail Systems Using the LM26400Y Regulator

Application Note AN-1703

Dongbing Zhang, Applications Engineer

Today's electronic systems typically have multiple DC voltage rails that are powered by point-of-load regulators. The input rail to these regulators can be an AC adapter, an intermediate bus, a battery, or a USB power rail. Often it is desirable to find a power solution that can handle a relatively wide input range, is reasonably integrated, and simple to use. National Semiconductor's LM26400Y dual buck switching regulator addresses such applications. It has an operating input voltage range of 3V to 20V and a guaranteed maximum duty cycle of 90% so it is able to handle a large range of step-down conversions. The LM26400Y device has integrated power FETs and internal-loop compensation. The two packages offered, TSSOP and LLP, have an exposed pad that allows unimpeded heat flow from the die to the PCB surface.

Many Features Enable Flexibility

Figure 1 is a simplified block diagram of the LM26400Y regulator. The device features separate soft-start, enable pins, and internal bootstrap diodes. Sequencing of the regulator can be controlled by toggling the enable pins at different times or slewing the soft-start pins at different rates. The integrated bootstrap diodes can simplify designs when a bootstrap bias is not readily available in the system. The two channels switch at the same 500 kHz frequency but are 180° out of phase, reducing the AC current in the input capacitors.

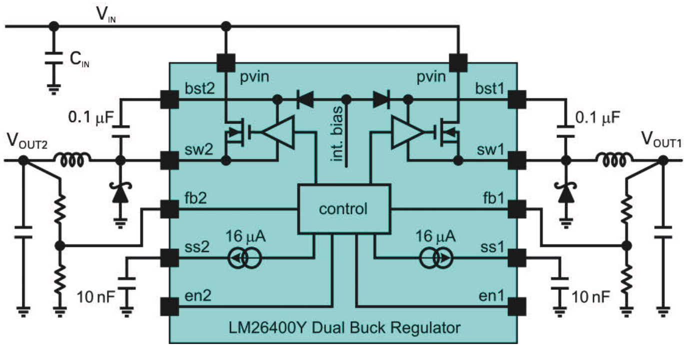


Figure 1. Simplified View of the LM26400Y Regulator

FPGA Power-Up

In this article, the LM26400Y is powering a popluar FPGA off of an input voltage range of 4.75V to 13.2V. The example uses an FPGA-based subsystem that has six functions in the chip that need power as listed below:

Supply	Function	Voltage
VCCINT	Core	1.2V
VCCAUX	Auxiliary	2.5V
VCCO_0-3	4 I/O Banks 0-3	1.2/1.5/1.8/2.5/3.3V

To interface effectively with different output buffer standards, the four I/O banks can work at five different voltage levels.

To design a power supply solution for the FPGA, more must be known about the application. The power required by the six functions in the chip can vary dramatically depending on the utilization ratio. The power estimation tool provided by the FPGA vendor translates the usage scenario into terms a power designer can readily utilize:

	VCCINT	VCCAUX	VCCO_0	VCCO_1/2/3
Voltage	1.2V	2.5V	2.5V	3.3V
Current	1.75A	0.62A	1.41A	1.27A

VCCAUX and VCCO_0 are the same voltage level and could share a voltage regulator. However, in this case, VCCO_0 needs to power up separately to satisfy peripheral device sequencing, and thus a total of four voltage rails are employed.

National Semiconductor
The Sight & Sound of Information

All four rails may ramp up independently of each other as long as they reach their nominal voltage levels within 0.2 ms to 50 ms in a monotonic fashion. The only potential concern to meet that requirement is VCCINT. According to the datasheet, if VCCINT comes up earlier than VCCAUX, there can be a surplus current (366 mA typical) on the VCCINT rail which appears somewhere after VCCINT hits 0.5V.

The board hosting the FPGA is to be plugged into two kinds of systems, one supplying an input of 12V +/-10%, the other an input of 5V +/-5%. The FPGA voltage regulators need to handle an input range from 4.75V to 13.2V. A linear solution is not an option due to the unacceptable power losses which are worst at the 12V input.

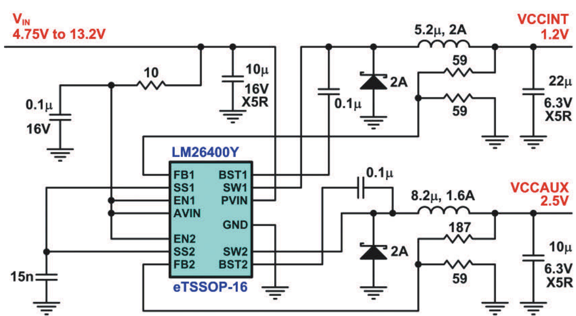


Figure 2. FPGA Power - VCCINT and VCCAUX

Based on the estimates above, plus some safety margin (because those numbers are just estimates), two switchers are required of up to 2A each for VCCINT and VCCO_0, one switcher of approximately 1A for VCCAUX and one switcher of approximately 1.5A for VCCO_1, VCCO_2, and VCCO_3 combined. One LM26400Y regulator can be used to generate VCCINT and VCCAUX and another to generate the I/Os. The schematic for the VCCINT (1.2V) and VCCAUX (2.5V) supply is shown in *Figure 2*.

The startup behavior is shown in *Figure 3*. Although the two channels share a 15 nF soft-start capacitor, VCCAUX will rise twice as fast as VCCINT due to the greater voltage-divider ratio. This allows the power

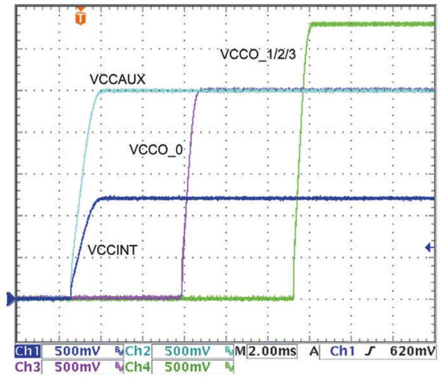


Figure 3. FPGA Solution - Startup

designer to avoid the surplus current of a few hundred milliamps mentioned above.

Regarding the other two FPGA rails, the VCCO_0 (2.5V) circuit uses the same design as VCCAUX as does the VCCO_1/2/3 (3.3V) circuit except for the upper feed-back resistor. The enable pins of the VCCO circuits are not tied to the input voltage due to the potential sequencing requirement of peripheral devices. Two separate ON signals are generated by the system to turn on the VCCO circuits independently. They also have separate soft-start capacitors which are 15 nF each.

This design has been bench verified with the typical efficiency of the VCCO_1/2/3 regulator shown in *Figure 4*.

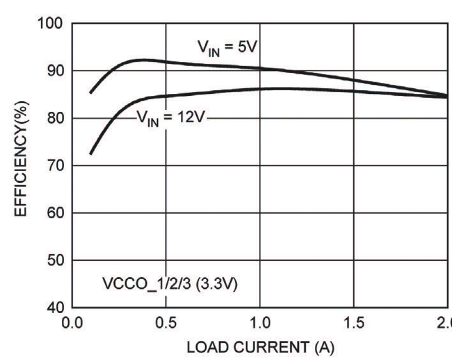


Figure 4. FPGA Solution - Efficiency

To read more about Powering Multi-Rail Systems Using the LM26400Y Regulator, including a POS systems barcode scanner example, visit www.national.com/ae5

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Rarely Asked Questions

Strange but true stories from the call logs of Analog Devices

Contributing Writer John Ardizzoni is an Application Engineer at Analog Devices in the High Speed Amplifier Group. John has been with Analog Devices for 5 years, he received his BSEE from Merrimack College in 1988 and has over 27 years experience in the electronics industry.

CAPACITIVE SENSORS: Rugged Enough for the Real World?

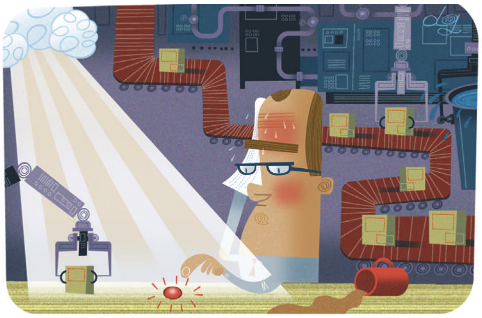
Q. I've seen cap sensors used in consumer electronics, but are they rugged enough to function in a harsh industrial environment?

A. The answer is an emphatic yes! Capacitive sensors are already used for industrial precision measurement of pressure, proximity, position and liquid levels. Capacitive sensors are rapidly replacing switches, buttons, scroll bars and jog wheels as the preferred choice for human to machine interface in industrial and consumer applications.

Capacitive sensor IC's work essentially by detecting changes in an electric field between a set of pads. The electric field is generated by the capacitive sensor. Changes in the field are caused when an object passes through the field. The electric field fluctuations are proportional to changes in capacitance. A capacitance-to-digital converter (CDC) processes the change in capacitance and provides a digital output, which can then be connected to a microcontroller or other digital interface. Since the sensors have no moving mechanical parts, they are inherently more reliable than their earlier mechanical predecessors.

In rugged industrial applications that require a control device to tolerate sustained exposure to conditions such as wide swings in temperature, humidity, dirt, electrostatic discharge (ESD), accidental spills, or prolonged exposure to moisture, capacitive sensors excel. Capacitive sensors also provide the user with the ability to select the right "tactile feel" for control device in the industrial setting.

The capacitive sensor pads are covered by a thin layer of protective plastic. The pads are therefore impervious to dirt and liquid infiltration. The plastic thickness can vary depending on the application. For these situations the sensor can be tuned to compensate for variations



in the plastic thickness. This is especially important in "wet" applications or where the sensor pad may be subjected to frequent exposure to liquids, moisture and cleansing agents. The protective plastic barrier also helps augment the sensors on-chip ESD protection.

In addition to being durable, capacitive sensors can be made to automatically adapt to their local environment. Some of the newer devices feature an Adaptive Environmental Compensation (AEC) algorithm, which continuously monitors the capacitance level of the sensor and compensates for any variations in ambient temperature, humidity and even degradation of the sensors dielectric material over time. The AEC helps ensure accurate and reliable operation no matter what the local environment is.

So, next time your design calls for a switch, button, scroll bar, jog wheel, or the need to make precision measurements, rest assured that there is a capacitive sensor that can handle the task. Capacitive sensors provide a smart and rugged alternative to traditional choices.

To learn more about Capacitive Sensors
Go to: http://rbi.ims.ca/5698-101

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EDN's 2007 Innovation finalists: The show must go on!

THOUGH *EDN*'s WRITERS ARE NOT ON STRIKE, THEY HAVE INDEED REACHED AN IMPASSE. THEY HAVE DONE ALL THEY CAN TO RECOGNIZE ENGINEERING EXCELLENCE OVER THE PAST YEAR. NOW, YOU MUST STEP IN TO HELP DECIDE THE MOST INNOVATIVE ENGINEERS, TECHNOLOGIES, AND COMPANIES IN *EDN*'S 18TH ANNUAL INNOVATION AWARDS PROGRAM.

At press time, the Hollywood writers' strike was lingering on, resulting in a work stoppage for many writing projects for television and film. Not so at *EDN*, where our editors have remained busy putting pen to paper (or hands to keyboard), writing nonstop about innovation and innovators in electronics design. Now, it's time again to recognize these innovative individuals and products. And it's your turn to put hands to keyboard (or index finger to mouse), to vote in *EDN*'s 2007 Innovation Awards program.

You needn't worry about whether to cross any picket lines. Simply check out the following pages for a list of finalists from 21 categories, including a plethora of products and technologies, Innovator of the Year, and Best Contributed Article of 2007. Then, visit www.edn.com/innovation for complete write-ups on each of the nominees, make an informed decision, and vote at the online ballot. Voting began February 1st and continues through the 29th.

Finally, the only protests you may encounter are those of the runners-up, when we announce the Innovation Award winners at a gala on April 14 in San Jose, CA. If you'd like to join us and help us celebrate innovation and recognize its leaders, you can also find event and ticket information at www.edn.com/innovation.

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2007 Innovator of the Year

BOB DOBKIN, CHIEF TECHNOLOGY OFFICER AND CO-FOUNDER, LINEAR TECHNOLOGY CORP

Determination and perseverance can be the keys to innovation and have long played a role in the amazing proliferation of the semiconductor industry. Bob Dobkin, chief technology officer and co-founder of Linear Technology Corp, exemplifies that determination and innovative spirit. Dobkin did pioneering work on linear regulators and 30 years ago designed the first three-terminal adjustable regulator at National Semiconductor (www.national.com). For all of these years, Dobkin knew that system designers would value a regulator design that could share the power load in parallel configurations and adjust to 0V. In 2007, semiconductor-process technology, including laser-trim capability, allowed Dobkin and his team to deliver the LT3080 regulator, which touts these features.

The LT3080 replaces the traditional voltage reference in three-terminal regulators with a precision 1% current source and voltage follower, allowing multiregulator current sharing. The ability to parallel regulators allows system designers to spread the power and heat load on a complex PCB (printed-circuit board) and avoid using switching regulators. A single resistor from the set pin programs the output at 100 kΩ/V. Designers can also drive the set pin with an active circuit. The design can both power and shut down low-voltage digital circuits using only three pins.

In addition to the LT3080, Dobkin has pioneered the development of a range of high-performance analog ICs and holds more than 90 patents. He began his career with Bob Pease at a small electronics company on the East Coast after leaving the Massachusetts Institute of Technology and shortly moved west to become director of advanced linear circuits at National Semiconductor. In 1981, Dobkin co-founded Linear Technology Corp with Bob Swanson.

MARK BOHR, KAIZAD MISTRY, ROBERT CHAU, TAHIR GHANI, KELIN KUHN, INTEL 45-NM-PROCESS INNOVATION TEAM

At the leading edge of process technology, delivering on Moore's Law is always a stout challenge. The creator of the law, Gordon Moore, intended his comments in 1965 as a challenge to the Intel troops, rather than as a prediction, and the engineers on Intel's 45-nm-process team are still answering that challenge.

The miniaturization effort had pushed one part of the transistor to its limits: the piece of silicon dioxide that acts as an insulation layer between the gate and the channel where current flows. With each new generation of Intel chips, this layer had become increasingly thinner, and it became harder to skim off one more atom. Intel's team embraced a radical change to the transistor's composition. For the first time in 40 years, the insulation layer would be made not of silicon dioxide, but of hafnium-oxide, a metal that helps reduce current leakage by a factor of 10.

The change brought other problems. For example, the new material is incompatible with the transistor gate. So, this team developed *another* new metal material for the gate. Although Intel has yet to publicly reveal details about this breakthrough, Moore himself calls it the "most important change in transistor technology since the late 1960s," according to Intel. In November, the company introduced a generation of 45-nm chips using these new materials. Because the 45-nm transistors are smaller than the previous generation, they require as much as 30% less energy for switching on and off, offering power savings and a performance boost.

WILLIAM DALLY, CO-FOUNDER, CHAIRMAN, AND CHIEF SCIENTIST, STREAM PROCESSORS INC

With the move to digital representations of all media types and complex applications, such as video processing, increasingly dealing with parallel data flows in real time is the stiffest system-design challenge. William "Bill" Dally has been working on the concept of data-parallel processing since the early 1990s. At last year's ISSCC (International Solid State Circuits Conference), Dally and his team from Stream Processors Inc unveiled the Storm-1 family of data-parallel DSPs and later unveiled the Storm-1 SP16HP. Stream believes that a single Storm-1 processor can replace as many as 10 traditional DSPs.

The Storm-1 SP16HP offers 224 GMAC (billion multiply/accumulate) operations at 0.1 mW per MMAC (million-MAC) operations. Equally important, Dally and his team tackled the difficulty of programming such a parallel device and offer a compiler to manage the memory hierarchy. The memory-management capability reduces bandwidth needs across the parallel architecture and supports the control flows for synchronizing tasks. The architecture delivers load balancing and eliminates a common problem in multicore systems: partitioning an application. In addition to the Storm-1 processor, Dally's work on his original stream-processing architecture is now in development or production at AMD (www.amd.com), IBM (www.ibm.com), and Nvidia (www.nvidia.com).

Dally co-founded the company in 2004. While at the Massachusetts Institute of Technology in the early and mid-'90s and later at Stanford University, Dally recognized that instruction-centric approaches to processor design were rapidly running out of instruction-level parallelism. Processor designers were facing increasingly complex power and bandwidth barriers that would limit the ability to increase performance to the levels that emerging applications required.

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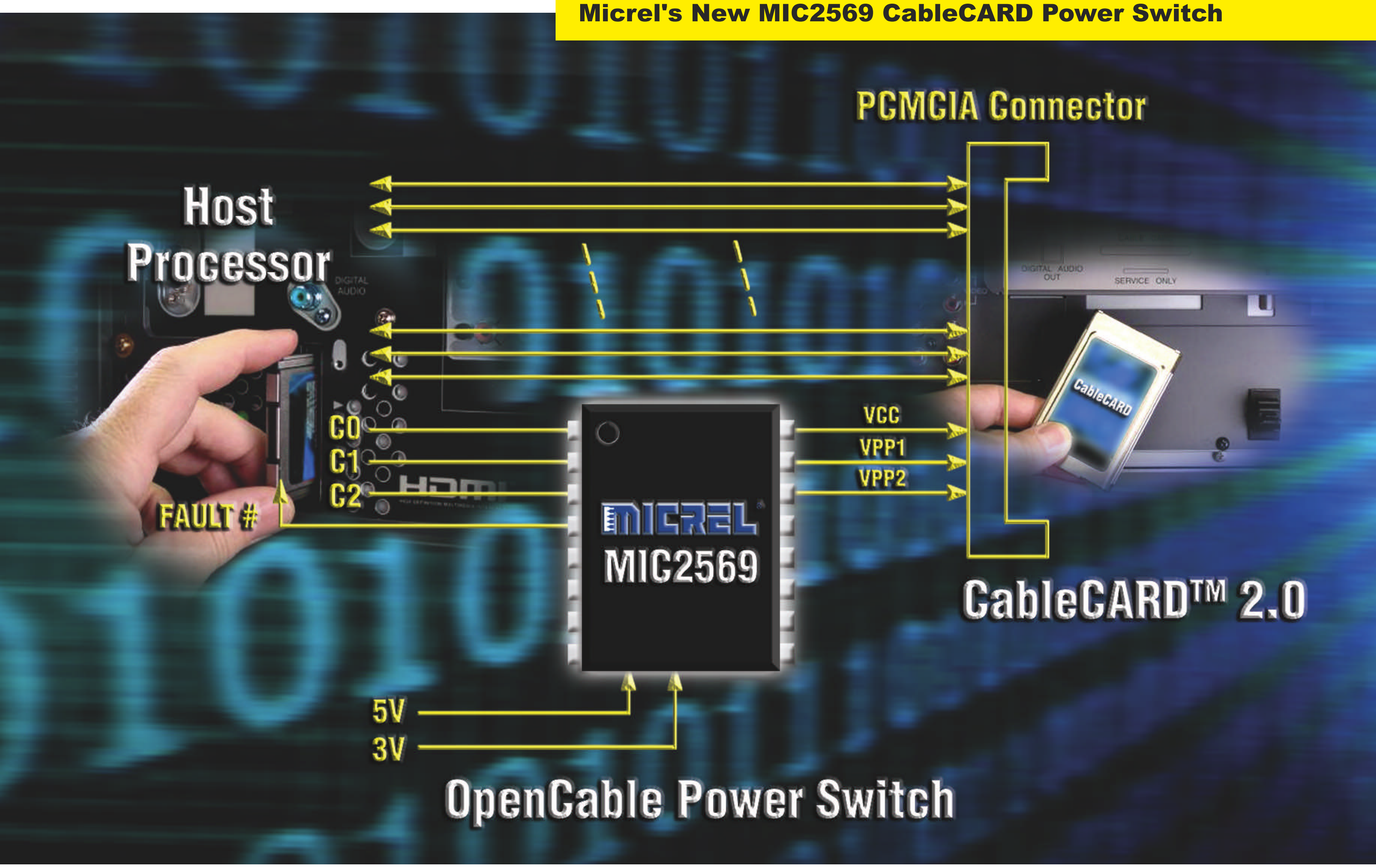

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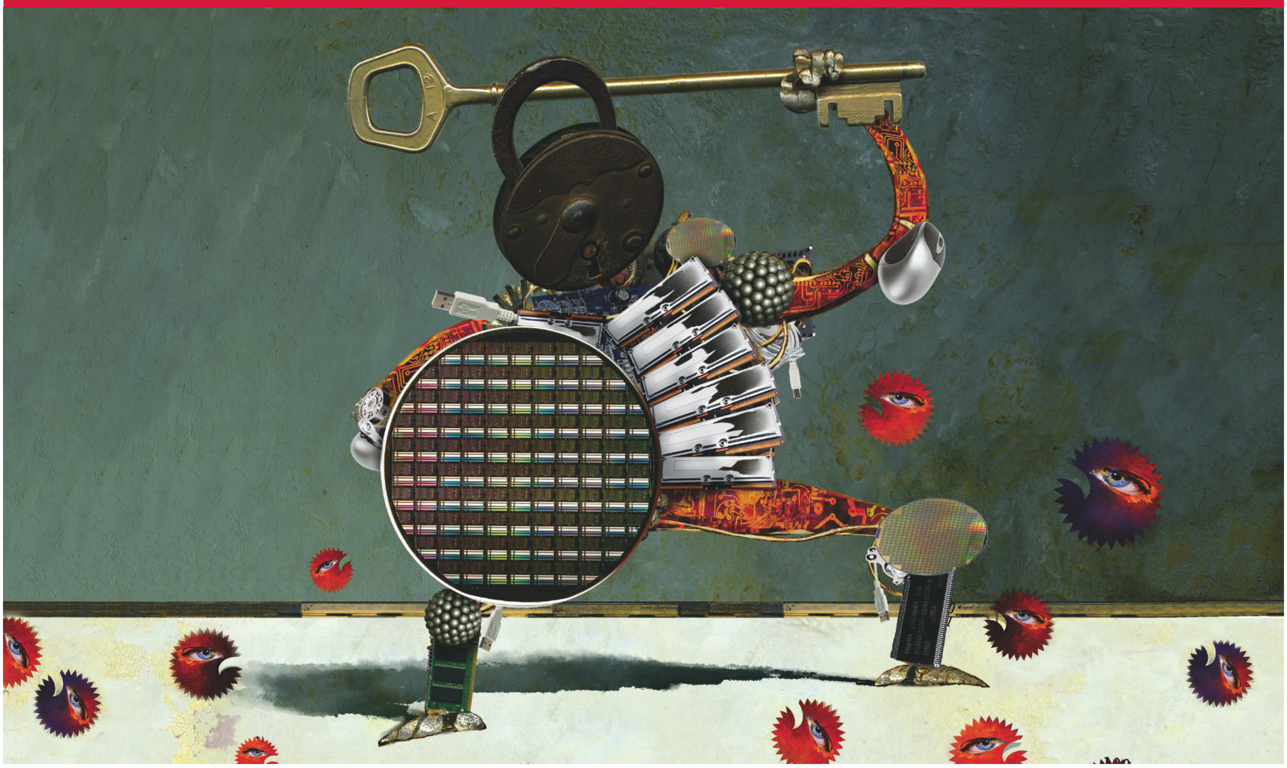

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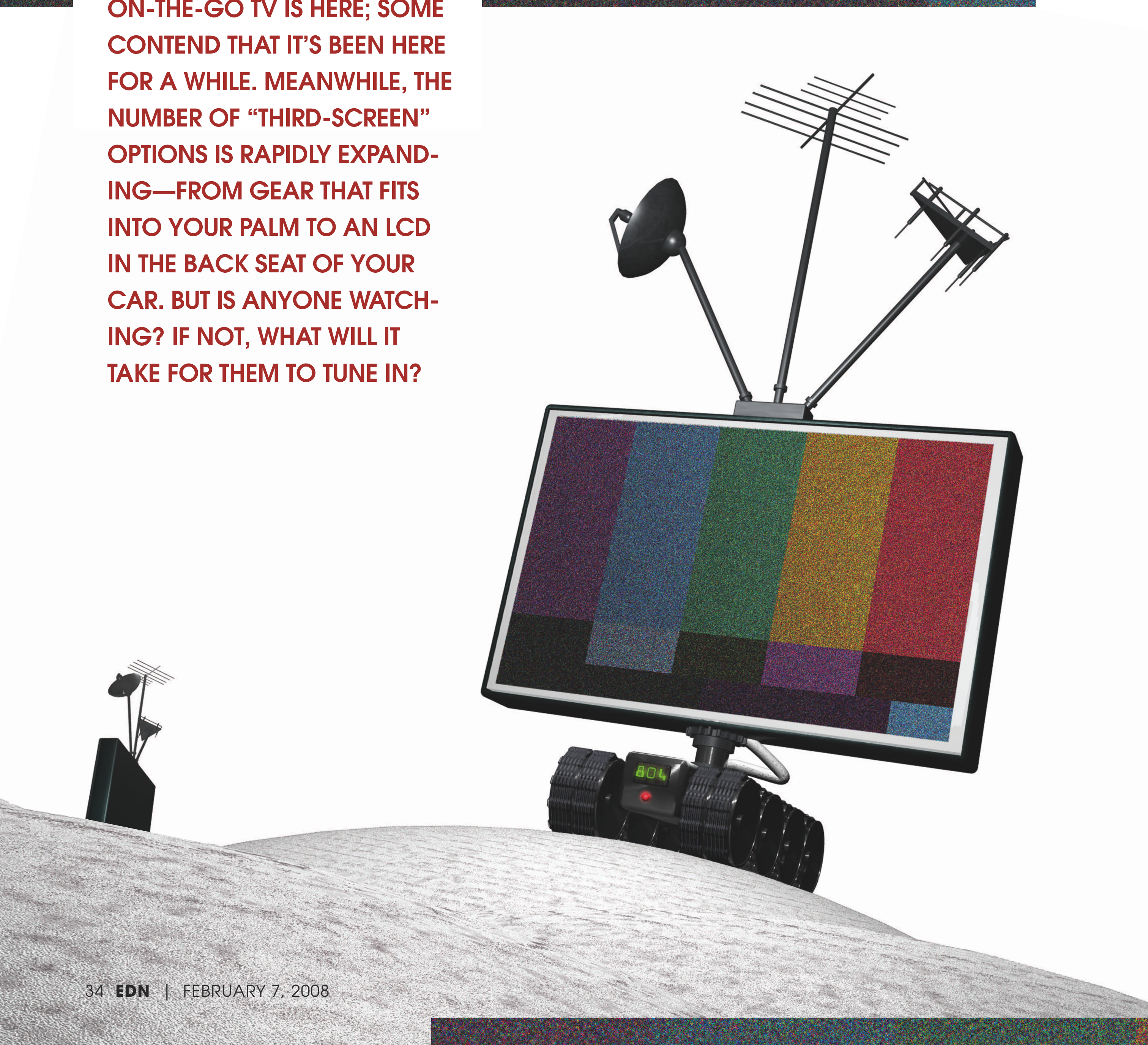
MOBILE TELEVISION: STRONG, WEAK, OR ZERO RECEPTION?

ON-THE-GO TV IS HERE; SOME CONTEND THAT IT'S BEEN HERE FOR A WHILE. MEANWHILE, THE NUMBER OF "THIRD-SCREEN" OPTIONS IS RAPIDLY EXPANDING—FROM GEAR THAT FITS INTO YOUR PALM TO AN LCD IN THE BACK SEAT OF YOUR CAR. BUT IS ANYONE WATCHING? IF NOT, WHAT WILL IT TAKE FOR THEM TO TUNE IN?



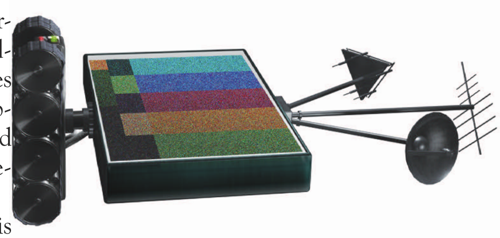
BY BRIAN DIPERT • SENIOR TECHNICAL EDITOR

I am a firm believer in the theory that science fiction not only forecasts, but also shapes the future. Those of us who grew up watching *The Jetsons* may well remember the scenes of the family watching video on portable devices and in their folds-into-a-suitcase flying car. Granted, the *Star Trek: The Original Series* communicators were audio-only. However, communication and monitoring devices that follow-on *Star Trek: The Next Generation* episodes showcased, as well as those in other outer-space-themed television shows, such as *Battlestar Galactica*, and in science-fiction movies of the era, touted full audio-plus-video capability. And don't forget about Dick Tracy's 1964 two-way wrist TV, whose wrist-radio precursor foreshadowed the cellular phone.

If my theory is correct, consumers' eventual widespread embrace of watching television while on the move should be a foregone conclusion—old news, at least in a sense. Sony in 1982 introduced its first Watchman, the monochrome model FD-210; the company had 22 years earlier developed its first "luggable" TV, 1960's TV8-301 (**Figure 1**). Many of you have seen "boomerang" analog-television antennas atop limousines; unfortunately, the current analog-to-digital-TV transition complicates this usage scenario. In the analog age, multipath distortion and weak signals may have degraded broadcast images, but, in the binary era, those compromised images will go completely blank. And DirecTV and Dish Network subscribers may be aware of low-profile vehicle antennas that enable satellite-television reception not only when you're sitting at a campground, but also when you're traveling down the highway.

To label the current situation "widespread" would, however, be a stretch, despite the fact that I know someone who's not a technology early adopter, but who uses a portable-analog television to catch up on a soap opera during lunch hour. Migrating from today's early-adopter stage to one of broad adoption requires that service providers, their systems partners, and those partners' silicon- and software-building-block partners address a lengthy, intertwined, and—at least at first glance—often-contradictory set of questions:

- What systems will contain "third-screen," or mobile, TVs, and what size displays will they have? (The third-screen device gets its name from the fact that it comes after the traditional TV, or "first screen," and the computer, or "second screen," in the time frame of consumer adoption.)
- Will users risk a drained battery and consequent missed calls to receive television broadcasts on mobile phones or other multifunction devices, or is a dedicated-function product more appropriate?
- Will the dominant human-transportation scheme be individuals in cars, in carpools, or using mass transit?
- How long will potential customers be willing to wait to access a channel or to switch between channels?
- Will consumers prefer short- or long-playing content?
- Do consumers require real-time content, particularly as they grow more comfortable with delayed viewing courtesy of DVD sets, personal video recorders, Internet downloads from iTunes and other services, and network-Web-site-based rebroadcasts? Do users need individualized content? Does mobile-unique material hold appeal?
- Will consumers expect to pay for this content on a per-minute, per-megabyte, per-episode, per-series, or per-month basis?



The answers to these questions will likely vary depending on the cultural and other norms of each target geography's and country's consumers.

The last time *EDN* covered mobile television in this degree of detail, In-Stat analyst Michelle Abraham predicted that US subscribers to mobile-video services would cross the 5 million mark in the 2006 to 2007 time frame (**Reference 1**). Although accurate actual numbers are difficult to acquire, this forecast likely overstated reality by an ample margin. Nonetheless, the long-term prognosis is still optimistic. "By the end of 2010, mobile-TV-broadcast subscribers worldwide will have reached 102 million, a giant leap from 3.4 million in 2006," Abraham now predicts (**Reference 2**). Near-term trends outside the United States are encouraging in this regard, with analysts estimating sales of 7.3 million mobile-broadcast-TV handsets in Japan through the first quarter of 2007 and more than 6 million subscribers in South Korea as of August 2007.

DOLLARS AND SENSE

An article covering mobile-television broadcast and reception must also cover cellular-data-standards evolution. As with wired-Internet access, including cable, DSL (digital-subscriber line), and fiber, video is a key driver of bandwidth, latency, and QOS (quality-of-service) improvements in wireless-communications protocols. In early 2005, US CDMA (code-division/multiple-access) cellular providers Sprint and Verizon offered only 2.5G CDMA 2000, or 1×RTT (one-times-radio-transmission-technology) service. Their GSM (global-system-for-mobile)-communications counterparts were primarily at the GPRS (general-packet-radio-service) level, and EDGE (enhanced-data-for-GSM-evolution) deployments were just beginning. Video-over-cellular per-frame resolutions were 176×220 pixels or less, and they accompanied "jerky," less-than-10-frame/sec best-case frame rates.

A lot has changed in three years. Sprint and Verizon have both blanketed a substantial chunk of the United States with Revision A of EVDO (evolution-data optimized), a two-generations-faster cellular-data approach. Both AT&T and T-Mobile offer EDGE capability, and both carriers are ramping up next-generation UMTS (universal-mobile-telecommunications-system) networks that the companies base on HSDPA (high-speed downlink-packet access) and HSUPA (high-speed uplink-packet access). HSUPA has faster upstream-data rates than HSDPA, but those faster rates don't notably apply to download-centric video-streaming applications. Given the bandwidth potential of these advanced protocols, are they now sufficient to reliably carry video streams in addition to voice traffic, SMS (short-message-service) blurbs, e-mail and Web-surfing bits, photographs, music clips, ring tones, and all of the other services that cellular providers now offer?

AT A GLANCE

- Mobile television is a seemingly perpetually "almost mainstream" application that the current analog-to-digital-broadcast transition further complicates.
- The 3G cellular-data networks lack the economic chops to satisfy most potential customers' video-delivery expectations, but the picture may become clearer in the 4G iteration.
- MediaFlo seems to have most of the US mobile-broadcast-television momentum behind it at the moment, but you still can't disregard the "muscle" of Europe's anointed technology, DVB-H (digital-video-broadcasting-handheld).
- Outside North America, mobile-television adoption is more mature, but a diversity of standards and cultural expectations complicates system- and building-block providers' strategies.
- See *EDN*'s March 6, 2008, issue for more on ATSC (Advanced Television System Committee) add-ons, WiMax, satellite-based candidates, and CES (Consumer Electronics Show) and 700-MHz auction updates.

The answer is "probably not," at least to the degree that the video streams match most potential customers' capability and cost expectations, although future bandwidth increases may change this response. The bottom line is that the service providers are in the business of turning a profit to satisfy their shareholders and to cultivate funds for future R&D investments. Except for Verizon's VCast TV, today's mobile-video services, like traditional cellular-voice capabilities, are primarily unicast—that is, one-to-one technologies. Verizon bases VCast Mobile TV on Qualcomm's MediaFlo technology. A **table** in the Web version of this article, at www.edn.com/080207cs, summarizes the variable-cost challenge that service providers face and the financial underpinnings of the current service characteristics.

The financial model that drives the data that the **table** shows, along with the information in **Figure 2**, comes from the Mobile DTV (digital-TV) Alliance, an advocacy group that promotes mobile broadcast using the DVB-H (digital-video-broadcasting-handheld) noncellular scheme. Consider the source when interpreting the results. It uses the assumptions that a network operation's variable costs are approximately 20 cents per megabit and that network operators charge consumers 99 cents—or, following the iTunes model, $1.99 for long-playing material—per episode to view video content. In analyzing the data, look first at the endpoints of the cost-versus-revenue spectrum. An average SMS message is 200 bits in size, translating to an average cost to the carrier of 0.004 cents. That same carrier charges its customer 7 cents per message on average, leading to roughly $375 of revenue per megabit of network-resource usage at a substantial profit margin. At the other extreme, consider a 30-minute, unicast, high-resolution, high-frame-rate video stream, comprising a 384-kbps average bit rate. The

(a) (b)

Figure 1 Think mobile-television reception is new news? Think again. Sony's TV8-301 "luggable" TV dates from 1960 (a), and the company introduced the first-generation FD-210 Watchman in 1982 (b).

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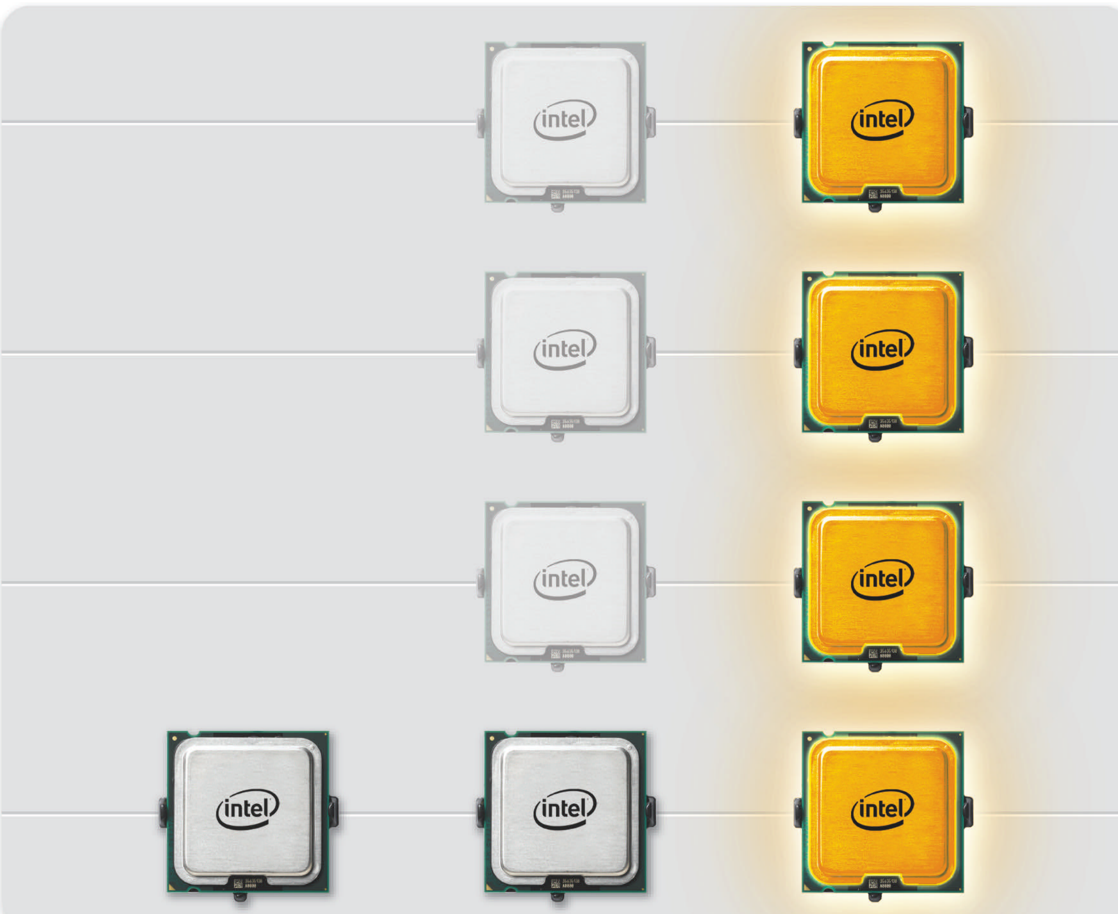

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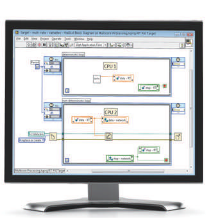

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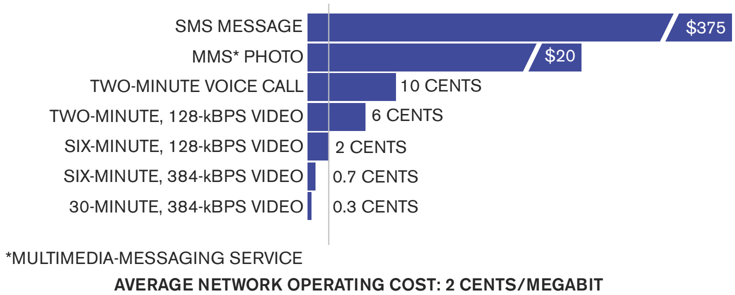

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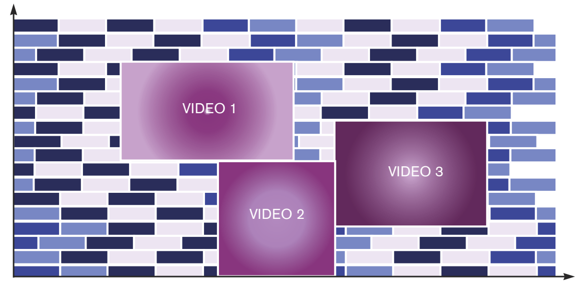

(b)

Figure 2 Economic factors define cellular providers' current reliance on low-bit-rate, short unicast video clips, as well as their encouragement for customers to send plenty of SMS messages and take lots of pictures (a). Video also consumes a substantial percentage of the cellular network's available resources (b) (courtesy Mobile DTV Alliance).

total payload is larger than 691 Mbits, translating to a highly unprofitable variable cost of greater than $138 versus $1.99 in revenue.

The break-even unicast-video threshold, given the above assumptions, is a six-minute, 128-kbps video stream, whose low-bit-rate characteristics render it unable to deliver smooth frame rates of 20 or more frames/sec or resolutions that provide reasonably artifact-free presentations on large-screen devices, such as Apple's iPhone. This fact is true even when you couple the unicast video with modern video codecs, such as H.264 and VC-1. But remember: The carriers aren't in the business to just break even. That's why two-minute-maximum, low-bit-rate unicast presentations are now the most common.

So far, I've focused only on variable costs. Cellular-network-infrastructure-construction-and-management fixed costs are equally important, and, in this regard, today's cellular-data protocols are also not up to the task. Each unicast-video stream consumes network resources equivalent to those you would use in dozens or hundreds of voice calls. Cobble together insufficient network resources, and your customers will have unsatisfactory video experiences. Conversely, overbuild your network to handle video-"pull" peaks, and you'll end up with substantial amounts of unused, cost-consuming resources during more typical and predominant demand times.

BANDWIDTH SAVIOR?

Given these eye-opening economic realities, you can probably see why the DVB-H and MediaFlo camps are successfully advocating their alternative DTV schemes to cellular providers. Both DVB-H and MediaFlo unburden the cellular-data channel by shipping their video bits at alternative frequencies, often within the 700-MHz UHF (ultra-high-frequency) band, which, unlike cellular, can easily penetrate premises from external antennas many miles away (see **sidebar** "Surf for CES and 700-MHz updates" at the Web version of this article at www.edn.com/080207cs).

"The 700-MHz range carries data farther at lower power than cell frequencies now in use," says Neal Weinstock, chairman of system integrator Be Media and principal analyst at Weinstock Media. Weather, steel barriers, and other impediments less frequently interfere in this range. "It's not perfect, and we know most—if not all—of its faults, but it is so much better than what the telephone companies have to work with now that applications riding on it will have a leg up in the marketplace," he says (**Reference 3**). DVB-H and MediaFlo also migrate from unicast to more bandwidth-efficient multicast distribution.

"Ironically, not a lot has changed in MediaFlo and DVB-H," *EDN* Editorial Director Maury Wright stated in November 2007 during an e-mail-based article-topic-brainstorming session and in reference to his Feb 3, 2005, article on mobile TV (**Reference 1**). Although he may have been correct from a technical standpoint, the US business dynamics of the two competitive low-power broadcast-television technologies have radically shifted in the past three years. This swing has generally been in MediaFlo's direction, at least for the short term, although the jury's still out on the long-term outcome. Consider that, in February 2007, AT&T announced its intention to launch a MediaFlo-based mobile-television service by the end of the year. As it turns out, the company did not meet its self-imposed deadline. Also, consider that Verizon launched the MediaFlo-based VCast Mobile TV service in March 2007 in more than 20 US markets at an incremental markup of $13 to $25 per month on top of cellular-service fees (**Figure 3**).

After a press demonstration in New York, which "coincidentally" coincided with the VCast Mobile TV rollout, Crown Castle in late July pulled the plug on subsidiary Modeo's DVB-H aspirations, citing an inability to recruit a cellular carrier to align with it. This scenario occurred despite the media's generally positive hands-on evaluations in the weeks following the demon-

(a)

(b)

Figure 3 MediaFlo-cognizant handsets from LG Electronics (a), Motorola, and Samsung (b) were ready to go at Verizon's VCast Mobile TV service launch last March.

Figure 4 Nintendo's DS Lite (a) and Sony's second-generation PlayStation Portable (b) now support Japan's 1sec mobile-digital-video service, a subset of ISDB-T, through adapter add-ons.

stration. Instead, Crown Castle leased its 700-MHz-band spectrum to a joint venture for $13 million for unspecified applications. Ironically, this shutdown came after Crown Castle had persuaded the FCC (Federal Communications Commission), in late February 2007, to allow Modeo to provide a tenfold boost in broadcast-signal power in urban markets and a 20-fold boost in rural areas for its top 30 markets.

Modeo competitor, albeit fellow DVB-H advocate, Hiwire, a subsidiary of Aloha Partners, began technical trials of its service in Las Vegas in December 2006, erecting the first towers during the week before Christmas. Hiwire, in partnership with handset developer LG Electronics and service provider T-Mobile, completed the network build-up by February 2007 and publicly demonstrated it at the April 2007 NAB (National Association of Broadcasters) conference. However, in early October, Aloha Partners sold $2.5 billion worth of its 700-MHz-spectrum licenses, along with Hiwire's assets, to AT&T (**Reference 4**).

Although DVB-H's fortunes might at first glance seem grim, the October AT&T acquisition of Aloha/Hiwire's equipment and spectrum assets, along with the delay in AT&T's MediaFlo-based service rollout, potentially suggests otherwise. At the April 2007 NAB conference, Stuart Pekowsky, DVB-silicon supplier DiBcom's vice president of strategic partnerships, and Scott Wills, president and chief operating officer of Hiwire, pointed out that AT&T's public MediaFlo plans at the time were limited in scope, with no long-term, widespread program commitment.

At the NAB conference, Wills provided data comparing his company's network characteristics with those of his then-competitors (**Table 1**). The spectrum licenses that AT&T acquired in October can reach an estimated 196 million consumers, and they cover 72 of the top 100 US service markets. Why did AT&T make a deal with Aloha? Perhaps the company generally believed that the $2.5 billion it paid represented a better deal than it could get through the anticipated January-through-March-2008 FCC-run 700-MHz-spectrum auction, regardless of how AT&T ends up using the spectrum. Alternatively, AT&T may be instead planning a nationwide DVB-H rollout.

Note, too, that T-Mobile partnered with Hiwire to evaluate DVB-H in the Las Vegas network installation. T-Mobile hasn't yet revealed its mobile-television plans. But, as a subsidiary of Deutsche Telekom, it may have a preference for DVB-H, which is a low-power, mobility-focused derivative of the DVB-T (digital-video-broadcasting-terrestrial) European DTV standard. Then again, it is also conceivable that, given T-Mobile's German pedigree, Hiwire might select the alternative T-DMB (terrestrial-digital-multimedia-broadcasting) technology, whose developers based it on the DAB (digital-audio-broadcasting) scheme, and which is locally strong in portions of Europe, including Germany and the United Kingdom.

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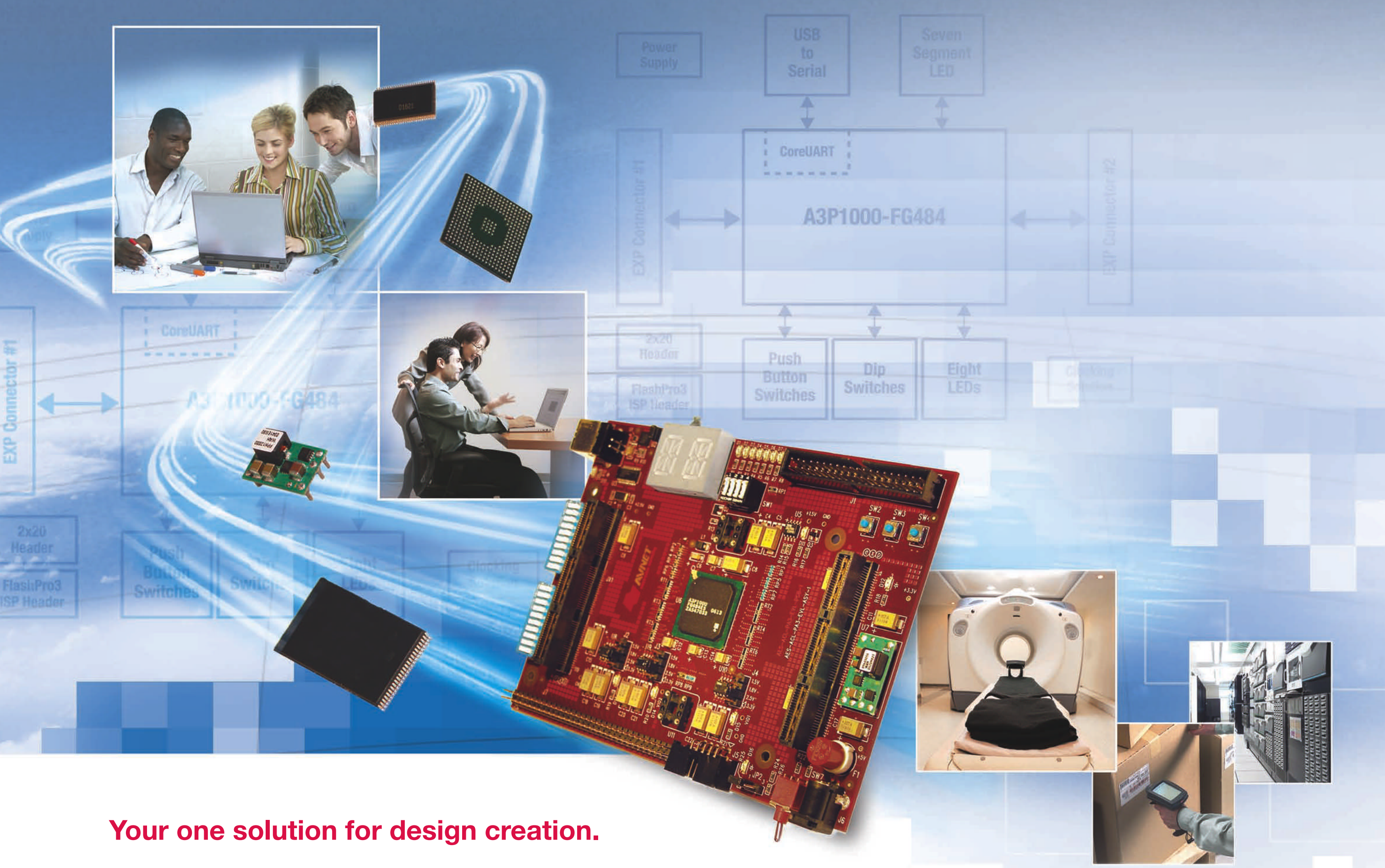

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TABLE 1 CHARACTERISTICS OF VARIOUS US MOBILE-BROADCAST-TELEVISION SERVICES, INCLUDING NOW-DEFUNCT MODEO

	Modeo	MediaFlo	Hiwire
Frequency (MHz)	L-band 1600	UHF 700	UHF 700
Available bandwidth (MHz)	5	6	12
Approximate number of TV channels possible	Nine to 12	12 to 15	24 to 30

Despite regional opposition, however, the eventual pan-European acceptance of DVB-H appears inevitable. In November, the EU (European Union) mandated DVB-H as an official standard, a move that followed the organization's formal endorsement in July of DVB-H and is reminiscent of Europe's sweeping adoption of GSM digital-cellular technology. The group officially stated, "As a result, all EU Member States will have to support and encourage the use of DVB-H for the launch of mobile-TV services, thus avoiding market fragmentation and allowing economies of scale and accordingly affordable services and devices" (**Reference 5**). Even though DVB-H now has the EU's blessing, it remains questionable whether DVB-H can achieve widespread adoption.

DVB-H employs unique broadcast spectrum and unique protocols, and today's comparably pervasive DVB-T-only equipment cannot, therefore, tune in DVB-H. Its feature advancements over DVB-T include time slicing for power reduction. IP (Internet Protocol) data grams transmit in small-time-slot data bursts as large as 2 Mbits, and the DVB-H receiver is correspondingly in fully on mode only during these time slots. Over the several years that it took to develop DVB-H, however, its DVB-T predecessor achieved power-consumption improvements of its own by virtue of evolutionary circuit-design optimizations and Moore's Law-fueled lithography reductions. Do DVB-H's lingering power benefits justify its survival in the face of the DVB-T juggernaut? That's a question that only market dynamics can address.

T-DMB may be losing momentum in Europe, but it's the DTV technology of choice in South Korea, where it has experienced enthusiastic adoption, as its subscription numbers show. The ITU (International Telecommunication Union) also in December formally recognized T-DMB as a global standard, along with MediaFlo, DVB-H, and ISDB-T (integrated-services digital broadcasting-terrestrial). Mobile television's acceptance in both South Korea and elsewhere in Asia reflects a combination of factors: widespread use of public transportation, lengthy daily round-trip commutes, and the sociological encouragement for users to cocoon themselves in an LCD screen and set of headphones while on public transit. China's mobile-video plans are still in some degree of flux. Although the homegrown CMMB (China-multimedia-mobile-broadcasting) technology currently appears to have the inside track, DVB-H and T-DMB backers continue to lobby for their approaches, as do the developers of other China-proprietary approaches.

The name of the mobile variant of Japan's DTV-broadcast technology, 1seg, reflects the fact that each ISDB-T channel subdivides into 13 segments, along with an incremental segment to separate channels. Japanese HDTV (high-definition-TV) broadcasts use 12 of the 13 segments; the remaining segment finds use for mobile reception. As you might expect, 1seg-based cell phones are increasingly commonplace in Japan, but plenty of other mobile-DTV options exist, including stand-alone receivers and portable-game consoles (**Figure 4**). Sony's second-generation PlayStation Portable even supports video recording in conjunction with its companion 1seg adapter.

4G RESURGENCE, ETC

Although cellular-service providers would prefer to focus their customers' bandwidth usage on lucrative revenue and profit pursuits, a practical limit exists to how many e-mails, SMS messages, and photos even the most prolific smartphone addict can send and receive. Higher bandwidth 4G cellular-data ser-

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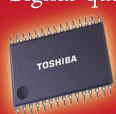

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vices, such as GSM's LTE (long-term-evolution) and Qualcomm's UMA (unlicensed-mobile-access) technologies, are emerging, and their maturation drastically reduces cost per megabit for service providers and, therefore, for consumers. As a result, television services running on them may become more economically feasible than is the case with today's 3G approaches. This reacceptance of video over cellular data is particularly palatable if 4G services encompass QOS support, a feature that today's 3G technologies lack, along with provisions for bandwidth-thrifty multicast (one-to-many) protocols. At a minimum, cellular-data-based unicast may act as a value-added supplement to broadcast-digital-video-overlay networks, such as DVB-H and MediaFlo.

In August 2006, Sprint revealed plans to spend billions of dollars on a nationwide, unified mobile-WiMax-based network, which Sprint later branded Xohm, for voice, video, and data services. The company plans to launch that network in the second quarter of this year. Clearwire, another formidable US WiMax-services supplier, currently has an 802.16d-based network in 16 states as well as in Europe and Mexico, which the company plans to upgrade to fully mobile-capable 802.16e technology. South Korea's branded WiBro is another notable WiMax deployment, with various companies' and countries' telecom providers performing additional WiMax trials worldwide. And you cannot understate mighty Intel's long-standing support for WiMax.

Many countries' and geographies' COFDM (coded-orthogonal-frequency-division-multiplexing)-based digital-broadcast-TV standards are inherently mobile-capable. Conversely, the 8VSB (eight-level-vestigial-sideband)-modulation-based ATSC (Advanced Television Systems Committee) approach, which North America and a few countries on other continents use, is not inherently mobile-capable. Its developers defined it predominantly for use with home-based receivers coupled to 30-ft roof-mount antennas (**Reference 6**). The incremental evolution of 8VSB-based receivers has minimized multipath-interference effects in stationary configurations, but mobile applications remain prone to egregious reception setbacks. Two backward-compatible enhancements aspire to improve ATSC's mobility capabilities. They also aim to garner patent-royalty-rich incorporation within the ATSC-M/H (ATSC-Mobile/Handset) specification, which is currently under development. Samsung and Rohde & Schwarz champion one of these enhancements, A-VSB (advanced VSB), and Harris and LG Electronics back the other, MPH (mobile pedestrian handheld).

All of the previously mentioned services rely on terrestrial-broadcast antennas and, as a result, operate only as far as those antennas' signals reach. Satellite broadcast is the preferred approach for pervasive coverage across an entire country or geography—that is, as long as nothing is obscuring the overhead view. Sirius is the latest player in this market, supplementing its satellite-radio service with the child-tailored content of SiriusConnect Backseat TV, which Sirius launched in partnership with silicon supplier ST-Microelectronics as an option on several Chrysler vehicles for the 2008 model year. The DVB-standards body also has its eye on satellite, having approved in February 2007 the DVB-SH (DVB-satellite-and-handheld) standard, which blends support for low-power terrestrial reception when available with more encompassing—albeit quicker to drain batteries—satellite reception. DMB backers similarly support the S-DMB (satellite-DMB) standard, which began operating in South Korea in May 2005, and China's CMMB also encompasses support for both terrestrial and satellite broadcasts.

For more information, tune in to *EDN's* March 6, 2008, edition, in which a follow-on feature article will delve into each of these topics in greater detail. **EDN**

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EVOLVING ROBOTIC-DEVELOPMENT PLATFORMS PRIMARILY FOCUS ON HOW TO JUMP-START DEVELOPERS, BUT THEY ALSO PROVIDE MUCH-NEEDED MECHANISMS TO REUSE THE SOFTWARE COMPONENTS FROM ONE ROBOTIC PROJECT TO ANOTHER.

PART 2

ROBOTS ON THE MARCH

BY ROBERT CRAVOTTA • TECHNICAL EDITOR

The line between toys, games, and "real-world" applications is blurring. Technologies that originally found use in serious real-world applications continue to find their way into the much-larger-volume electronic-toy, gadget, and computer-based-game markets. Meanwhile, increasing opportunities exist for the flow of new engineering innovations from these entertainment devices into real-world applications. The consumer market currently accepts a significantly shorter production-support life cycle for many low-cost consumer-electronic products, such as entertainment devices, than the market accepts for higher priced products, such as automobiles, other vehicles, industrial and medical machinery, and large central-office equipment. The shorter support life cycle for these consumer-electronic products permits—or even demands—a higher degree of technology movement to identify what works.

To make industrial robots and semiautonomous systems, developers use technologies that are increasingly crossing the line from being industrial technologies to consumer and home-application technologies, such as electronic toys, gadgets, games, and other personal-entertainment devices. Unfortunately, like PCs in the early '80s, software compatibility among today's robots still has a lot of room for improvement. The publicly available robotic-development platforms that have started emerging since last year are trying to address how to more quickly start robotic-design projects. They achieve this goal partly by providing a mechanism for developing software components the designers developed on one robot project and reusing them in another project. Since the publication of Part 1 of this hands-on project (**Reference 1**), I have become aware of two more publicly available robotic-development platforms—one from CoroWare and the other from Gostai (see **sidebar** "More platforms").

Robotic-development platforms and their continued growth and evolution are essential components to enable scaling the complexity of today's and future projects to a manageable level that pre-

AT A GLANCE

- A number of robotic-development platforms are available to designers.
- The development tools for robotics platforms are maturing but still have a way to go.
- Robotic-development environments allow designers to quickly iterate designs to test ideas.

serves the productivity of designers. This hands-on project focuses mostly on the Lego NXT Mindstorms platform in conjunction with the National Instruments LabView environment. I also had some time to play with the Microsoft Robotics Studio.

THE PROJECT

I based the list of hardware components for this project on a demonstration by Brady Duggan, a software engineer at National Instruments. Duggan demonstrated an unofficial reference design for an electronic "sheep dog." The value of using a hardware configuration that someone had used in a similar project helped immensely with quickly getting up and running. The hardware setup consisted of a Texas Instruments TMS320VC33-based Speedy-33 DSP module from National Instruments that connected to a prototype board from HiTechnic. That board in turn connected to the Lego NXT controller that controls the drive motors for the simple platform of Lego pieces (**Figure 1**).

The Speedy-33 includes dual microphones approximately 5 in. apart, and the board supports sampling of the microphones at 48 kHz. LabView supports the same direct programming of the board, as do any of the many hardware components that LabView supports. The Speedy-33 board acted as the ears of the robot. Because I would need to learn much information about sound in a short time, I decided that the Speedy-33 would act only as a sensor and feed the data to the NXT. A follow-up iteration of the project will include implementing two-way communication between the two units so that the sound-sensing algorithm can incorporate information from the robot platform in discerning the sound signal's location relative to the robot.

To simplify the complexity of this project, I chose an 880-Hz sound source that would remain stationary during a test run. I chose this frequency because experience with the reference algorithm had shown that the system had better success with higher frequency than with lower ones, such as 440 Hz. Looking for only one tone made it easier to use the DSP functions that the LabView DSP-module package includes. In essence, the algorithm cross-correlates the microphone signals with the target frequency and determines the relative phase difference by comparing the sample position of the peak between each microphone. For future iterations of the project, the system should be able to detect an arbitrary predefined signal with the ultimate goal of detecting the phase difference from any arbitrary sound signal in a noisy environment using motion feedback from the robotic platform. To perform this project's ultimate goal, the robotic platform must sense its inertial positioning so that, when the platform turns or moves, it can accurately convey that motion to the sensing algorithm. This feature requires the addition of gyro and acceleration sensors, such as those from HiTechnic, to the robotic platform.

The HiTechnic prototype board is basically a bridge between the Speedy-33 interface and the NXT interface so that you need create no new code on the NXT to interface the two components. The prototype board allows designers to build their own sensors and more easily interface them with the physical and logical interface that the NXT uses. The HiTechnic board presents the custom sensor to the NXT according to the NXT sensor protocol. For this project, I used the six digital ports to communicate to the NXT from the Speedy-33. The Speedy-33 came in a sealed container with ports for several of the supported peripherals. To use the six digital I/O ports, however, I had to remove the board from its case because there was no other way to access the digital I/O. This project required no direct programming of the HiTechnic prototype board, however.

In the interest of simplicity and time-saving, I implemented a one-way communication from the Speedy-33 to the NXT controller. I knew that building a two-way communication scheme could take time and that it would increase the need for troubleshooting sessions. The Speedy-33 would report the left/right direction of the sound whenever it detected the target sound. The NXT control program had to know whether the Speedy-33 had updated the entry, so I dedicated two of the six digital pins as counters and the other four pins to denote a position from left to right across 16 positions for the sound source with the other four pins. This approach allowed the Speedy-33 to send an update only when it heard the target sound, and it put the onus on the robot controller to recognize when a new sound-position update had occurred.

As with the Speedy-33, I used LabView to program the NXT. However, a subtle but important difference exists between programming for each of these targets. LabView does not formally support NXT as it does the normal hardware components in the LabView family. To build NXT code with LabView, you must use the programming constructs as NXT tool-kit add-ons. Even normal program constructs, such as loops and

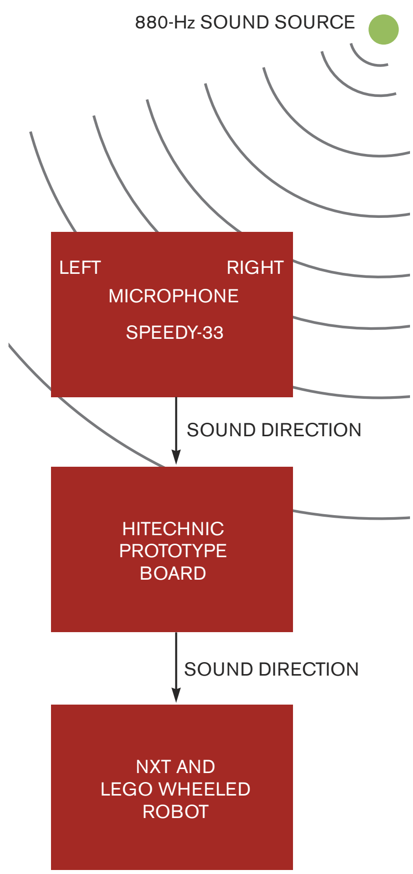

Figure 1 The hardware setup consists of a Speedy-33 DSP module from National Instruments, which connects to a prototype board from HiTechnic, which in turn connects to the Lego NXT controller.

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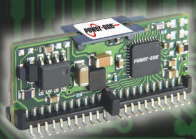

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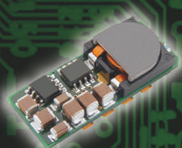

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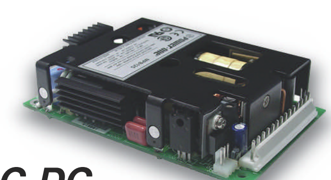

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comparisons, must come from the add-on tool kit rather than from the normal location. This limitation still allows you to open and pin down the NXT-specific tool-kit menus so they are easy to reach without accidentally pulling up the other tools for other targets.

The NXT houses a 32-bit ARM (www.arm.com) processor that provides plenty of processing capability for this system. Because the Speedy-33 sensing algorithm would update the direction information only when it heard the target sound, the NXT could display status information or remain idle between direction updates.

MORE PLATFORMS

Since the first part of this article appeared, I became aware of two additional robotic-development platforms–CoroBot from CoroWare and URBI (universal real-time-behavior interface) from Gostai. CoroBot integrates a four-wheel skid-steering platform with a color camera; IR distance sensors; and a 1.2-GHz PC-class processor running Windows XP, Xubuntu Linux, or both (Figure A). Designers can drill holes into the product's plastic top plate for permanent mounting, and it can accept various adhesives, such as those on Velcro strips, for temporary mounting. The openness of the system eases access to its various components but limits its use to indoor environments. It weighs 12 lbs and can accept payloads as large as 5 lbs.

Nine models of the CoroBot platform, starting at prices of $2799, are available to developers. Software development for the platform is available through Microsoft Robotics Studio for models with preinstalled Windows XP or through Player for models with preinstalled Xubuntu Linux. The platform is available with a dual-boot option and an optional four-DOF (degrees-of-freedom) arm with a gripper sensor. Models with the arm have 24 available servo ports, and armless models have 30 available servo ports. No C or C++ libraries currently support the platform, but the company says that it is reviewing PlusPack for Microsoft Robotics Studio to support future development.

Figure A The CoroBot platform is available in nine configurations.

Gostai is positioning its product, the URBI scripted-interface language, as a universal robotic platform for software modules. It works over a client/server architecture to remotely control a robot or any complex system. URBI presents a universal mechanism to control a robot, add functions by plugging in software components, and develop fully interactive and complex robotic applications in a portable way. The platform works with various robotic systems; operating systems; and programming languages, such as C++, Java, and Matlab.

Gostai based the object-oriented URBI on a prototype approach that allows developers to define objects in pure URBI or directly plug C++ classes, or "UObjects," into the kernel to add these classes to the language as native URBI classes. You can even unplug UObjects from the kernel and run them as remote autonomous applications, taking the IP (Internet Protocol) address of the URBI engine as a parameter.

A key consideration in the URBI language is the integration of parallelism and events into the core of the language semantics. The URBI language supports four types of temporal constraints between commands. One is that Task B must execute after Task A. A second specifies that Task B must start when Task A ends, whereas the first constraint allows a temporal gap between the two tasks. The third constraint is that tasks A and B must start at the same time, meaning that, if one of the tasks is unavailable, the other will wait until the other constraint becomes available before executing. The fourth constraint is that Task B must start at the same time or after Task A begins, but it must start before Task A completes.

Because URBI is a parallel language, it can handle concurrent accesses with more than just mutex (mutual-exclusion) techniques to ensure that only one piece of code is using a resource at a time. URBI supports seven blend modes that specify how the system should handle conflicting and simultaneous assignments. Examples of these blend modes are the add and mix modes, which add or average the calculation of the conflicting assignments to the resulting value. The queue mode implements a classic mutex mechanism.

To better support parallelism, the notion of time is part of the URBI-language semantics. For example, a simple assignment in URBI can target a variable to reach a value in a given time or at a given speed or to set a sinusoidal oscillation. These noninstantaneous assignments can execute in parallel with other assignments. As an example, consider the assignment neck.val=10 time:450ms&leg.val=−45 speed:7.5 & tail.val=14 sin:4s ampli:45;. This assignment uses "time," "speed," "sin," and "ampli" to modify the way the assignment completes. In this example, the value of "neck.val" will reach 10 in 450 msec. Other supported modifiers include "phase," "getphase," and "smooth."

URBI natively expresses parallel-event handling because several events can occur in parallel and trigger some code execution that could run in parallel and overlap. In practice, the simplest way to react to an event in URBI is to use the "at" command, which looks like an "if" statement in that it performs a command when the test becomes true. However, unlike an "if" statement, the "at" command remains in the background to trigger again and does not terminate. Another such tool is the "whenever" statement, which loops the execution of the command as long as the test is true. This statement is similar to a "while" statement except that it remains in the background when the test is false. The language can also emit events with or without parameters.

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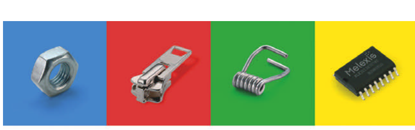

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With the sensing algorithm, the closer the sound reaches equidistance between the two microphones, the harder it becomes to discern the direction of the sound. This phenomenon is due in part to the fact that the source sound hits each microphone with a smaller time difference relative to the sampling rate. For this project, this situation was acceptable. This phenomenon also means that, because the robot has been turning, the direction of the sound gets closer to the center of both of the microphones. So, the motor movements should get smaller as the detected sound's direction becomes more equidistant between the two microphones. Otherwise, the robot, whose movement is coarse, could end up bouncing between two positions.

BUILDING THE SOFTWARE

Working with the LabView development environment took a little getting used to. My experience with programming has been predominantly text-based coding with languages such as C and assembly. Working through the tutorials helped significantly, especially as they helped me to become familiar with the location of and means of accessing tool resources. National Instruments has been improving the LabView development environment for more than 20 years, and many add-on tools extend the environment for domain-specific applications. LabView's virtual-instrumentation tools for data collection, display, and analysis are easy to use, and you can set up sophisticated displays for data analysis and troubleshooting—one of the strengths of the LabView environment.

During the 1990s, I used an early version of LabView for a tunable laser-control system. I did some of the programming with visual-language tools, but I did much of it in C because I found it hard to make the transition to a fully visual programming model. After much reflection on my current project, I can describe why the transition is difficult for me. Over the years, I have adopted coding styles that impart intent and design information "in the white space" of the code. In other words, the indenting of the code, the location of blank lines, and the splitting of long or complex command sequences across lines of code all impart valuable information to a reader who is familiar with how the software developer made these decisions. I have neither developed an analogous means to impart information in the white space of a visual-programming model, nor am aware of an industry approach for this strategy, although I have not looked for one. In doing this project, I can see how a developer could use left-and-right and up-and-down flows to impart intent and other information in the white space.

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USING A VISUAL-PROGRAMMING MODEL CAN MAKE IT EASIER TO IMPART INFORMATION ABOUT PARALLELISM THAT WOULD BE MORE DIFFICULT TO DO WITH TEXT-BASED CODING.

Using a visual-programming model, such in LabView and Microsoft Robotics Studio, can make it easier to impart information about parallelism that would be more difficult to do with text-based coding. You can position the sequencing constructs so that you can see that they can operate at the same time, and you can more easily see whether they are sharing any resources. Both of these environments allow you to mix visual programming with text-based coding by encapsulating the text-based code in blocks that work within the visual environment. An example from the Robotics Studio tutorials raised a concern about visual programming. The example showed how to implement a previous example—implemented with a variable and a loop—without using these structures. I imagine that my inexperience with visual programming hid the loop from my eyes as I looked at the rewritten code, but I get nervous when a loop is not inherently obvious just by looking at the structure of the code.

I would like to have simulated the robotics with the LabView environment, and, although you can link LabView with the MathWorks' Simulink environment, I couldn't try that approach for this project. On the other hand, I was able to download the Microsoft Robotics Studio and immediately start simulating a robot. Unfortunately, according to Kyle Johns, senior developer at Microsoft, the simulation environment provides a physical and visual model for every object in the environment but currently lacks support for simulating sound, which I needed for this project. To be fair, Microsoft's environment targets robotics, and I used only the predefined robots from the available manifest. However, it was nice to place a robot in an environment and see what it did and what features in the environment the robot could see using an intuitive highlighting method. I am not sure how much work it takes to set up a robot manifest so that you can simulate it, but a number of basic configurations exist for many of the supported robotic platforms, so you can start working with them right away. It will be interesting to see whether these two environments eventually complement each other and work together.

The visual-programming tools for Robotics Studio are less mature than the LabView environment, but the tools worked fine. I noticed an interesting problem with the Robotics Studio when it came to executing some code. One of the tutorials shows how to do looping and convert text to speech. It was fun to hear the system count. However, it was disconcerting when the program would sometimes mix up the order of the numbers if I performed a context switch during program execution. In other words, the message passing exhibited a last-in, first-out behavior, so that, if the system happened to be busy enough to receive an overrun message, it could miss the message and catch up to the earlier message later in an out-of-order fashion. This quirk may be the nature of the text-to-speech block, but it was an unexpected behavior. This type of behavior could cause troubleshooting sessions

if the out-of-order execution is less obvious than it was in the code I was using.

Another example of the maturity of the development-environment interface of Robotics Studio appeared when I performed context switching to another program in the middle of a spawned dialogue box. I sometimes had trouble getting back to the dialogue box if it was under the parent window, and the parent window would lock up waiting for the spawned dialogue to complete. The dialogue box did not show up on the task bar in Windows XP, but I eventually figured out that I could manually select it using the Alt and Tab keys.

This project is just the first step in a series of projects that I hope will build on each other and introduce more complexity to reach the ultimate goal of discerning an arbitrary sound in a noisy environment with a binaural-sensing system. In addition to the goal and value of the project, working with the development platforms provided an opportunity to demonstrate that resources are available to developers to aid in developing complex robotic-control systems. A common expressed goal is that developers should be able to design to a common hardware specification and then be able to use that specification across a variety of robotic platforms through runtime binding without having to redesign it.

I am excited about what is currently available and expect to see a flurry of activity with all of these development platforms over the next few years as they do a better job of jump-starting new robotic projects and enabling developers to reuse software and hardware components from previous projects. I am especially excited that some of these development environments are treating these systems as a set of distributed systems that can interact with each other. This feature will be a key enabling capability as designers build systems that consist of multiple robots working collaboratively. **EDN**

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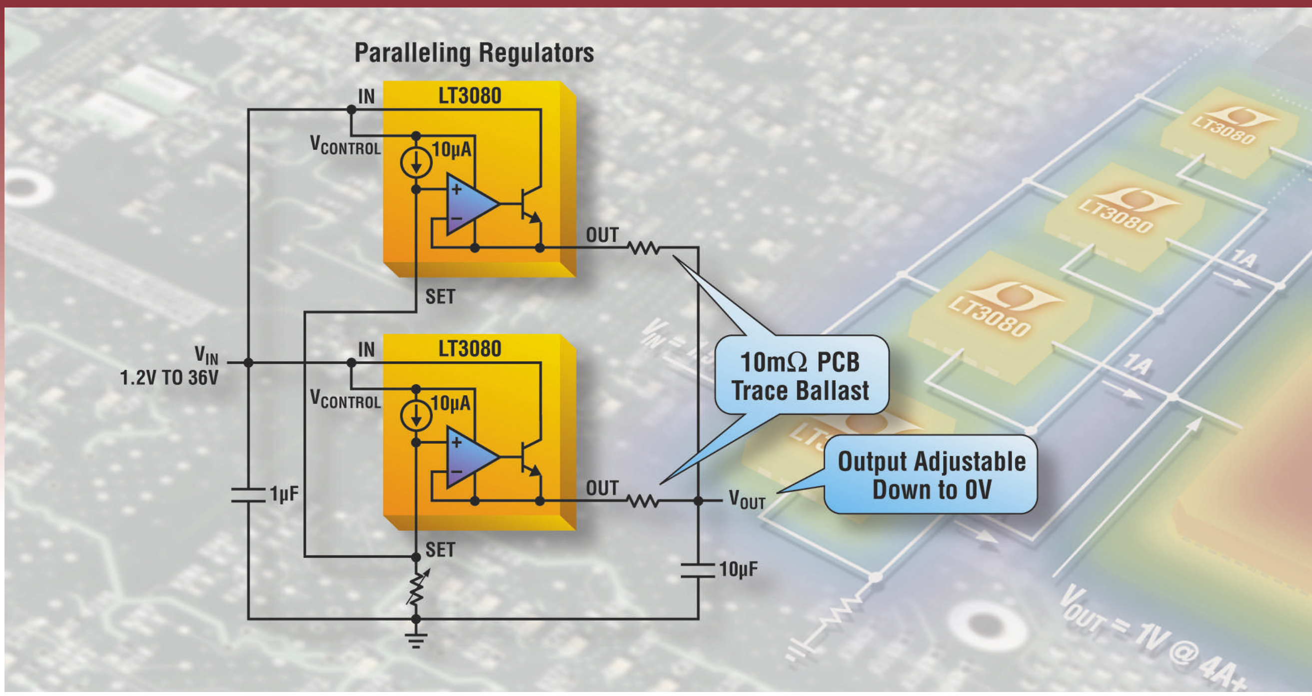
Rethinking LDO Regulators



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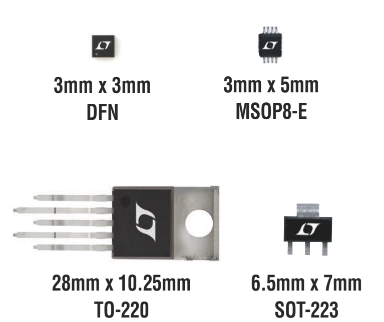
The LT®3080 is a new generation of linear regulator compatible with modern surface mount circuit design. Its input voltage is specified up to 36V, providing good margin for transients in many applications. Also, the output of the LT3080 is adjustable with a single resistor down to 0V and devices are easily paralleled for higher output current or to spread PCB heat. The input to output dropout is 1.3V when used as a three terminal regulator. The collector of the power device can be connected separately from the control circuitry to enable dropout voltages of only 300mV, ensuring high efficiency conversion.

Features

- Outputs Can Be Paralleled
- Output Current: 1.1A
- Low Dropout Voltage: 300mV @ 1.1A
- Low Noise: 40µV_{RMS} Wideband (100kHz)
- Stable 10µA Current Source Reference
- Single Resistor Programs V_{OUT}
- V_{OUT} Down to 0V
- V_{IN} Up to 36V (40V Abs Max.)

LT3080 Packaging Options



Info & Free Samples

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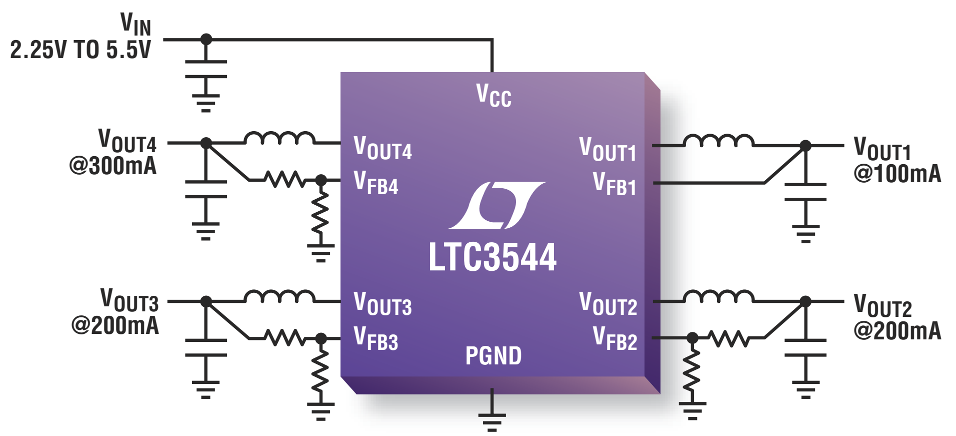
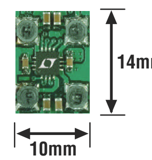
LINEAR TECHNOLOGY

Quad Buck





Actual Solution Size

9mm² Monolithic Synchronous Quad Step-Down Converter

Our growing family of synchronous buck regulators supports the increasing number of power rails in handheld applications. The LTC®3544, the latest device in this family, is a highly compact quad output buck solution, delivering 300mA, 2 x 200mA and 100mA outputs from a single input. All members of this family offer high efficiency, low quiescent current and low noise operation, as well as low profile, compact solutions.

Selected Multi-Output Synchronous Buck Converters

Part No.	Configuration	V_{IN} Range	Output Current (A)	V_{OUT} Min. (V)	Switching Frequency	Quiescent Current I_Q(µA)*	Package
LTC3547/B	Dual Synch Step-Downs	2.5V to 5.5V	0.3 x 2	0.6	2.25MHz	40	2mm x 3mm DFN-8
LTC3407/A	Dual Synch Step-Downs	2.5V to 5.5V	0.6 x 2	0.6	1.5MHz	40	3mm x 3mm DFN-10, MSOP-10E
LTC3419	Dual Synch Step-Downs	2.5V to 5.5V	0.6 x 2	0.6	2.25MHz	35	3mm x 3mm DFN-8, MSOP-10
LTC3548/-1/-2	Dual Synch Step-Downs	2.5V to 5.5V	0.8, 0.4	0.6	2.25MHz	40	3mm x 3mm DFN-10, MSOP-10E
LTC3407-2/-3	Dual Synch Step-Downs	2.5V to 5.5V	0.8 x 2	0.6	2.25MHz	40	3mm x 3mm DFN-10, MSOP-10E
LTC3417A	Dual Synch Step-Downs	2.25V to 5.5V	1.5, 1	0.8	2.25MHz	125	3mm x 5mm DFN-20, TSSOP-20E
LTC3446	Single Synch Step-Down + Dual VLDOs	2.7 to 5.5V	1.0, 0.3, 0.3	0.4	2.25MHz	140	3mm x 4mm DFN-14
LTC3545	Triple Synch Step-Downs	2.25V to 5.5V	0.6 x 3	0.6	2.25MHz	58	3mm x 3mm QFN-16, MSOP-10E
LTC3544/B	Quad Synch Step-Downs	2.25V to 5.5V	0.3, 2 x 0.2, 0.1	0.8	2.25MHz	70	3mm x 3mm QFN-16
LTC3562	I²C Quad Synch Step-Downs	2.7V to 5.5V	2 x 0.6, 2 x 0.4	0.6	2.25MHz	100	3mm x 3mm QFN-20

*All Channels On

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LINEAR TECHNOLOGY

Design an RTD interface with a spreadsheet

Robert S Villanucci, Wentworth Institute of Technology, Boston

RTDs (resistance-temperature detectors) are the preferred sensor choices for designs requiring precision. Although RTDs are approximately linear over the limited temperature range of 0 to 100°C, these sensors exhibit a slight but progressively more nonlinear temperature-versus-resistance characteristic as the measurement range widens. Consequently, over an extended span, curve fitting is necessary if the system is to achieve a high level of precision. One way to obviate the nonlinear characteristic of an RTD sensor is to design analog hardware to perform the curve-fitting mathematics before any additional signal processing occurs. This approach is especially attractive if you can keep both cost and component count low and if a microprocessor-driven design is not feasible. With low component count comes the added benefit of a small PCB (printed-circuit-board) footprint.

The most popular RTDs are made from platinum with a resistance value of 100Ω at 0°C and a metal purity that allows them to follow a standard European curve with a positive-temperature coefficient, α, equal to 0.00385Ω/Ω/°C. Less popular but still common are RTDs with a slightly higher metal purity. These RTDs have α of

DIs Inside

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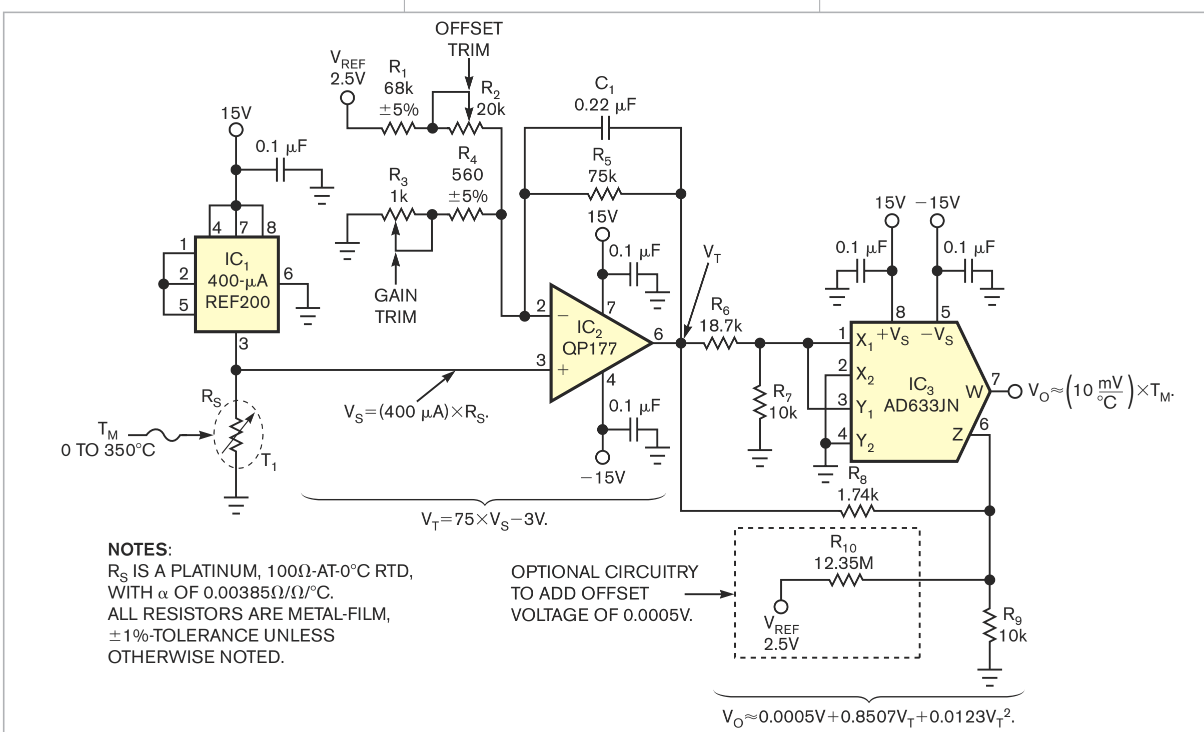

Figure 1 This RTD circuit uses a second-order polynomial to linearize the output of the sensor.

0.00392Ω/Ω/°C and follow the US curve. The circuit in **Figure 1** uses a standard RTD to measure temperature over the extended range of 0 to 350°C, an output voltage of 0 to 3.5V, and overall system accuracy greater than 0.5°C. The following linear **equation** expresses this sensor system:

$$V_O \approx \left(\frac{10\ mV}{°C}\right)T_M.$$

IC_1 is pin-configured to drive a constant current of 400 μA through the grounded sensor, T_1. Driving T_1 with this level of current—"zero-power" operation—keeps the worst-case power that the circuit dissipates in the sensor to less than 40 μW and reduces the self-heating errors to a second-order effect (**Reference 1**). Also, driving the RTD with a current source preserves its intrinsic nonlinearity and allows you to express the sensor's output voltage, V_S, as: 400 μA×R_S, where R_S is the resistance of the sensor.

IC_2 initially signal-conditions the sensor's output by first scaling the output voltage and then offsetting the result so that V_T is slightly larger than the 3.5V output at 350°C and that V_T equals 0V at 0°C. Adding gain and offset before linearization places less of a burden on the curve-fitting circuitry and helps to meet the system's precision specification. The combination of C_1 and R_5 implements a lowpass filter with a pole at approximately 10 Hz to remove power-supply noise. The following term describes the performance of IC_2 and its accompanying circuitry: $V_T=75V_S-3V$.

Next, an Excel spreadsheet creates the nonlinear-mathematical relationship between the voltage, V_T, and the system output, V_O (**Table 1**). The spreadsheet features 17 temperature entries—starting at 0°C, increasing in increments of 25°C, and ending at 400°C—for the measured temperature. Using a data set that extends beyond the intended measurement range of 350°C can reduce end errors in nonlinear systems. Values for R_S—which you derive from a standard RTD-resistance-versus-temperature table—and the **equations** allow you to compute V_S and V_T. The V_T and V_O columns are the input and output signals, respectively, for the linearization circuitry; you chart them using Excel's XY-scatter feature. You can use Excel's Trendline feature to create the following **equation**, the mathematical representation of the curve-fitting circuitry you need to linearize the sensor's output: $V_O=0.0005V+0.8597V_T+0.0123V_T^2$. IC_3 and four 1%-tolerant resistors or, optionally, five resistors implement a second-order polynomial: $V_O=a+bV_T+cV_T^2$, where a is the offset term, b is the linear coefficient, and c is the square-term coefficient.

TABLE 1 EXCEL-SPREADSHEET DATA

Measured temperature (°C)	R_S (Ω)	V_S (V)	V_T (V)	V_O (V)
0	100	0.04	0	0
25	109.73	0.0439	0.292	0.25
50	119.4	0.0479	0.582	0.5
75	128.99	0.0516	0.87	0.75
100	138.51	0.0554	1.155	1
125	147.95	0.0592	1.439	1.25
150	157.33	0.0629	1.72	1.5
175	166.62	0.0666	1.999	1.75
200	175.86	0.0703	2.276	2
225	185.01	0.074	2.55	2.25
250	194.1	0.0776	2.823	2.5
275	203.1	0.0812	3.093	2.75
300	212.05	0.0848	3.362	3
325	220.91	0.0884	3.627	3.25
350	229.72	0.0919	3.892	3.5
375	238.88	0.0956	4.166	3.75
400	247.09	0.0988	4.413	4

The curve-fitting-circuit design begins by first wiring the four inputs of IC_3 to create a positive square term that is scaled at the chip's output by an internal scale factor of 1⁄10V. Then, comparing terms, you find that the coefficient, c, must equal 0.0123. Because R_6 and R_7 form a voltage divider that attenuates the signal, V_T, you can express the coefficient with the following **equation**:

$$c=\frac{1}{10}\left(\frac{R_7}{R_6+R_7}\right)^2.$$

Select a value for R_7—10 kΩ for this design—and then use the preceding **equation** to find the value for R_6.

Resistors R_8, R_9, and, optionally, R_{10} form a passive adder to create the offset term, a, and the linear coefficient, b. You apply the output of the passive adder directly to the Z input, Pin 6 of IC_3, which adds the offset and linear terms to the square term to form the system response at Pin 7. Again comparing these terms, note that the offset term must equal 0.0005V. The offset term is only 0.5 mV, and eliminating it would add an error of approximately 0.05°C, so you can initially neglect it. Then, because the linear term's coefficient, b, must equal 0.8507, you first select a suitable value for R_9 and use the following **equation** to solve for R_8: $b=R_9/(R_8+R_9)$.

If you wish to design the optional circuitry and include the offset term, which is part of the passive adder, choose a stable 2.5V reference for V_{REF}, calculate the parallel combination of $R_8//R_9=R_{EQ}$ (the equivalent resistance of R_8 in parallel with R_9), and solve for R_{10} using the following voltage-divider **equation**: $a=(R_{EQ}/(R_9+R_{EQ}))V_{REF}$.

To calibrate this circuit, replace the sensor with a precision decade box. Set the decade box to simulate 0°C and adjust the offset trim of R_2 for an output of 0V at Pin 7 of IC_3. Next, set the decade box to simulate 350°C and adjust the gain trim of R_3 for an output of 3.5V. Repeat this sequence of trim steps until both points are fixed. The circuit in **Figure 1**—which includes optional circuitry—exhibits a worst-case measurement error at 250°C and 2.504V of 0.16%, or 0.4°C. Testing the circuit without the optional circuitry—the reference voltage and R_{10}—shows no discernible improvement in precision. **EDN**

REFERENCE

1 "IC Generates Second-Order Polynomial," *Electronic Design*, Aug 5, 1993, www.elecdesign.com/Articles/Index.cfm?AD=1&ArticleID=11502.

LINEAR TECHNOLOGY

DESIGN NOTES

Multiphase DC/DC Controller Pushes Accuracy and Bandwidth Limits

Design Note 434

Tick Houk

Introduction

Speed and accuracy don't always go hand-in-hand in DC/DC converter systems—that is, until now. The LTC3811 is a dual output, fixed frequency current mode DC/DC switching regulator controller designed for one of today's most demanding power supply applications: high current, low voltage processor core supplies.

With supply current requirements in excess of 100A and supply voltages as low as 1V, every milliohm of PCB resistance and every millivolt of IR drop count. The LTC3811 has an output voltage tolerance of ±0.5% over temperature, giving power supply designers unprecedented flexibility when making component value and board layout choices.

In addition to high accuracy, the LTC3811's low minimum on-time (typically 65ns) allows users to convert a 12V input to a 1V output at switching frequencies up to 750kHz, optimizing load transient response and reducing the solution size.

A Dual Output, 2-Phase Supply with Differential Remote Sensing and Inductor DCR Sensing

Figure 1 illustrates a dual output supply using the LTC3811. The 1.5V, 15A output is regulated using the integrated differential remote sense amplifier and tracks the output of channel 1 during start-up. Both outputs use DCR sensing in order to maximize efficiency and operate 180° out of

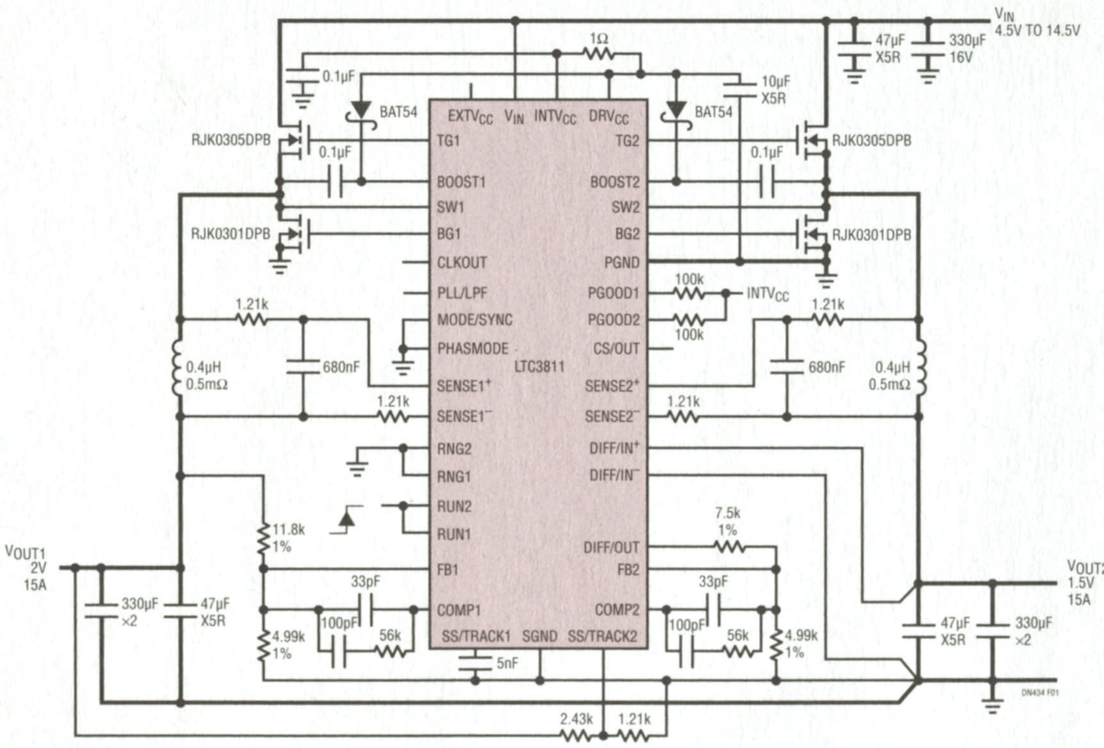

Figure 1. Dual Output, 2-Phase Supply with Differential Remote Sensing and Inductor DCR Sensing

phase in order to reduce the size of the input capacitor. Figure 2 illustrates the load step response for channel 2. Figure 3 illustrates low duty cycle waveforms for a 20V input, 1.2V output application.

For noise-sensitive applications, where the switching frequency needs to be synchronized to an external clock, the LTC3811 contains a PLL with an input range of 150kHz to 900kHz. In addition, the MODE/SYNC, PHASEMODE and CLKOUT pins allow multiple LTC3811s to be daisy-chained in order to produce a single high current output. The LTC3811 can be configured for 2-, 3-, 4-, 6- or 12-phase operation, extending the load current range to beyond 200A.

A Tried-and-True Architecture

The fixed frequency, peak current mode control architecture was chosen for its excellent channel-to-channel current matching and its robust cycle-by-cycle current limit. Current sensing can be done using either a resistor in series with the inductor or by sensing the DCR of the inductor with an RC filter. This gives the user a choice between optimum control of the maximum inductor current and maximum efficiency.

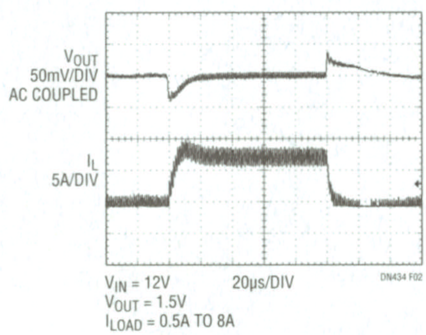

Figure 2. Load Step Response

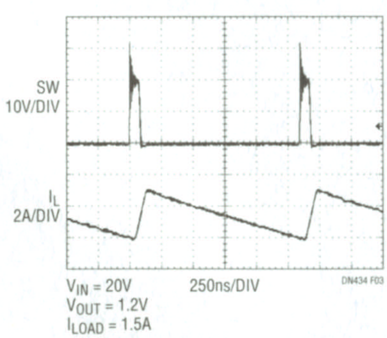

Figure 3. LTC3811 Low Duty Cycle Waveforms

In order to accommodate the use of low DCR inductors and still maintain good control over the maximum output current, the current sense voltage for each channel is programmable from 24mV to 85mV using the RNG pins.

The LTC3811 has a 4.5V to 30V input voltage range and is available in two package options: a 38-pin 5mm × 7mm QFN and a 36-pin SSOP.

Load Step Improvement with Voltage Positioning

For single-output multiphase applications, the LTC3811 contains an amplifier for voltage positioning purposes. The current sense input voltages are converted to an output current by a multiple-input, single-output transconductance amplifier, so that an error voltage proportional to the load current can be introduced at the input of the differential amplifier. This transconductance amplifier allows the user to program an output load line, improving the DC and AC output accuracy in the presence of load steps. Figure 4 illustrates the load step response for a 2-phase, single output power supply using the LTC3811.

Conclusion

The LTC3811 is a versatile, high performance synchronous buck controller optimized for low voltage, high current supply applications. With an output accuracy of ±0.5% and a remote sensing differential amplifier, it represents a new benchmark for DC/DC converters. It can easily be configured for either single- or dual-output supplies, inductor DCR sensing or a sense resistor, and it takes advantage of Linear Technology's proprietary PolyPhase® current sharing architecture. The combination of a very low minimum on-time and a fixed frequency peak current mode control architecture no longer force the power supply designer to trade off performance for protection.

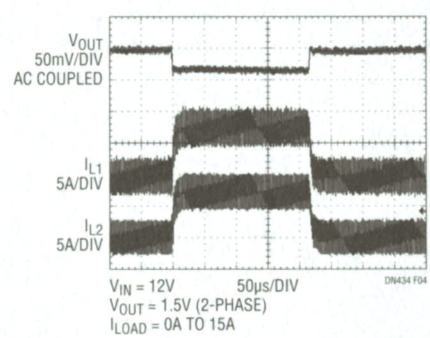

Figure 4. Load Step Response for a 2-Phase, Single Output Supply with Voltage Positioning (Forced Continuous)

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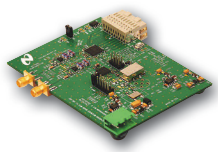

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- 15 dB noise figure
- 13.7 dB fixed gain
- 3.3V operation
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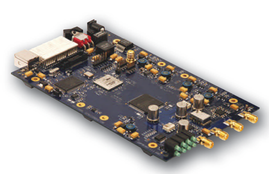
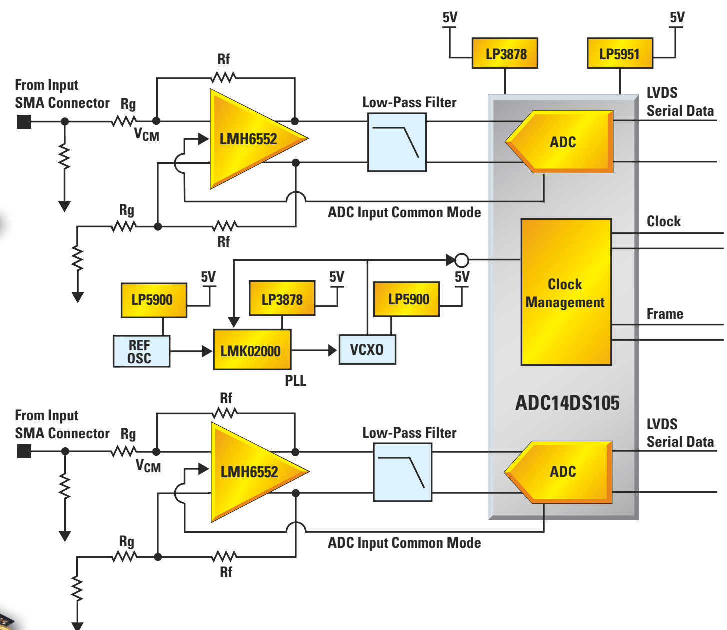
- Reference board available with LMX2531 clock conditioner and ADC083000 3-GSPS ADC



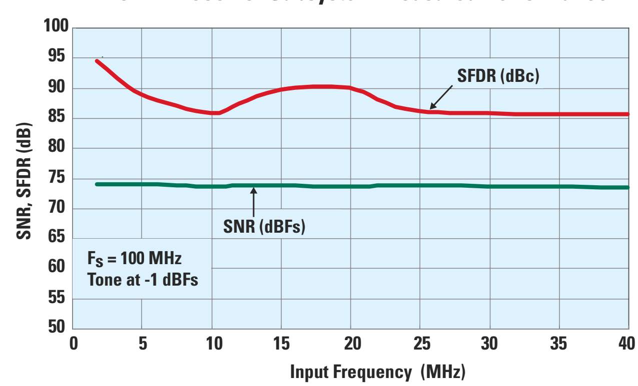
Applications

Communications receivers, high-speed differential signaling, intermediate frequency amplifiers, and data acquisition front ends

Low IF Receiver Subsystem



Low IF Receiver Subsystem Measured Performance



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The Sight & Sound of Information

Isolated supply powers DVM module

Richard Dunipace, Fairchild Semiconductor, Irving, TX

Low-cost DVM (digital-voltmeter) modules are economical and can significantly reduce design time for instrumentation. Yet, these modules also involve a significant number of design challenges. For example, their inputs are not isolated from the power supply, so you must add an isolated power supply. This task can both consume critical design time and add to system costs. Additionally, many uses for the modules require one- to four-cell-battery operation, and the modules require approximately 9V, translating to operation from 0.7 to 6V if you use new batteries until they are fully discharged. This wide input range also means that you should regulate the power-supply output.

DVM modules also have low parts count, and you can implement them using off-the-shelf components. Optionally, the modules can operate with input voltages as low as 0.25V if you replace the silicon transistors with germanium devices. However, germanium transistors are relatively expensive, so use them only in applications requiring low-input-voltage operation.

The power-supply design in **Figure 1** is a blocking oscillator that operates as a flyback converter with fixed on-time and variable off-time. The variable off-time regulates how often the transformer charges and delivers power to the load. The blocking oscillator consists of NPN transistor Q_2, transformer T_1, and capacitor C_2. The conductance of PNP transistor Q_1 controls the off-time of the oscillator in conjunction with C_2. The output of the transformer conducts to the energy-storage capacitor, C_3, through diode D_2 during transformer flyback. The error amplifier and optocoupler, IC_1, monitors the voltage across C_3. When the voltage at resistive divider R_4-R_5 exceeds 2.5V, the optocoupler conducts more and reduces the conduction of transistor Q_1, increasing the time required for the next power cycle. **EDN**

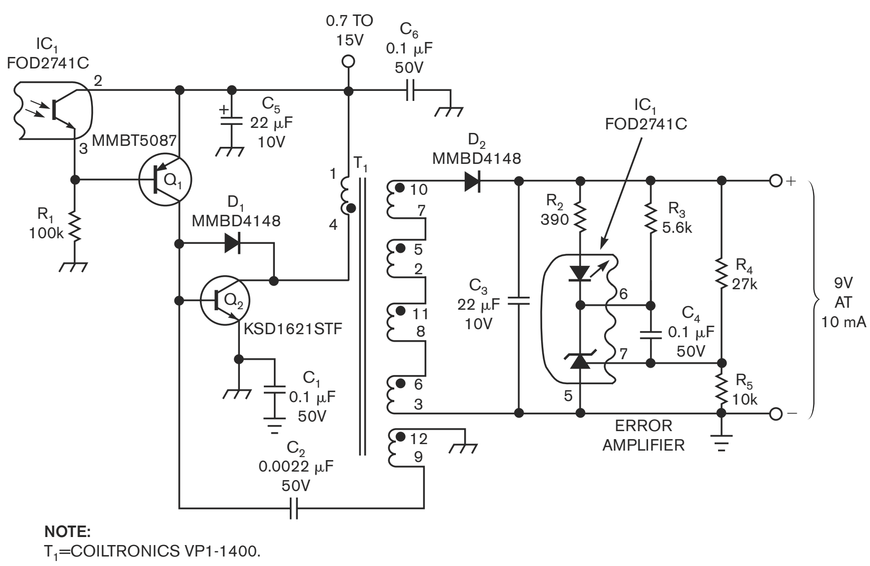

Figure 1 This isolated flyback supply powers a digital-voltmeter module from 0.7 to 15V.

IC performs delayed system reset upon power-up

Goh Ban Hok, Infineon Technologies Asia Pacific Ltd, Singapore

In most applications, the $\overline{MR}$ (manual-reset) pin usually connects to a switch to create a manual-reset signal to the supervisory chip. Subsequently, after a predetermined time-out-active period, it goes back to the high state in an active-low reset. A manual reset is a good feature for most applications; however, it requires human intervention to create the reset. In some applications, a manual reset could be a hassle because you must perform it each time the system powers up.

Further, applications involving embedded microprocessors can require the reset output to hold high—that is, inactive—for a certain period of time before you can apply the reset, or active low. The circuit in **Figure 1** proves useful during power-up when there is no need to press the reset button once the device powers up, because reset occurs automatically with the predetermined hold time before you apply the reset-low signal.

The circuit employs a reset-supervisory chip with the $\overline{MR}$ pin and active-low output, $\overline{RESET}$. Normally, the $\overline{MR}$ input has an internal pullup resistor with a value of 20 to 50 kΩ. During power-up, this $\overline{MR}$ internal resistor charges up capacitor C_1 to the maxi-

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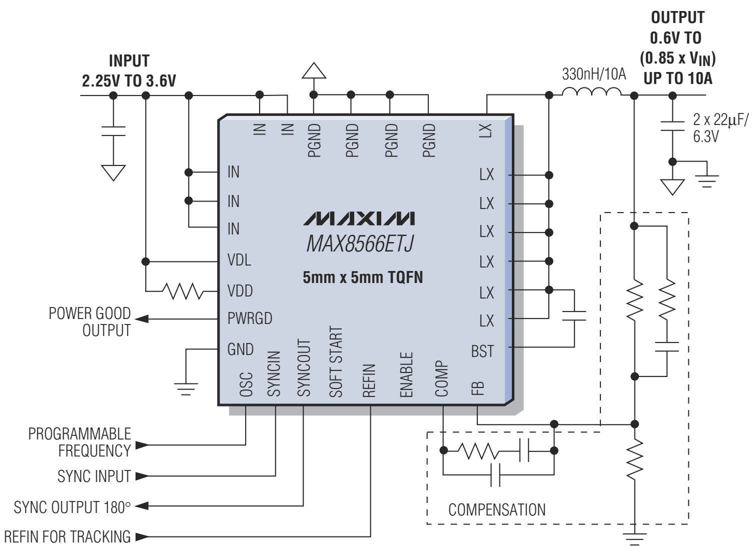

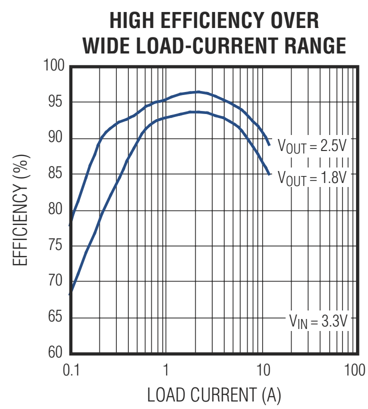

Features

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- Soft-Start Reduces In-Rush Supply Current
- All-Ceramic Capacitor Design
- 5mm x 5mm, 32-TQFN Package with Exposed Pad

Applications

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mum value to V_{DD} at the positive side. To create an $\overline{MR}$ reset input to the supervisory chip, its $\overline{MR}$ input must receive an active-low ground signal, requiring transistor Q_1 to turn on. The turn-on-time period depends on the RC-time constant of R_1 and C_2. These two components determine when Q_1 turns on and thus provide an adjustable hold time for the $\overline{RESET}$ output to hold high. To increase the hold time, simply increase the RC-time constant of R_1 and C_2.

The supervisory reset chip asserts its $\overline{RESET}$ output only when the voltage at the $\overline{MR}$ pin exceeds the threshold-trigger voltage and the supervisor's internal reset period has elapsed. This time-out period filters any short input-voltage transients. Because of Q_1's turn-on, the negative side of C_1 becomes grounded. Because the positive side of C_1 cannot instantly change its polarity, it pulls low and slowly charges up again through the internal pullup resistor of the $\overline{MR}$ input. When it reaches the threshold voltage of the reset chip, it then asserts the reset once it reaches the time-out period of the chip. The selection of C_1 is not critical. However, its value should be sufficiently large—0.1 to 10 µF, for example—that the RC time constant for C_1 and the internal pullup resistor are large enough. This value ensures that C_1 holds the voltage low at $\overline{MR}$ for at least 1 µsec.

The transistor remains on after C_2 charges toward the biased voltage of Q_1. At the next power-up or when you manually reset the circuit by pressing the pushbutton switch, the transistor discharges C_2. Once this action happens, Q_1 turns off. R_1 charges up the negative side of C_1 to the supply voltage, V_{DD}. Because the positive side of capacitor C_1 cannot change instantly, it appears to be charged to $2V_{DD}$. However, the protection diode, D_1, clamps C_1's voltage to just V_{DD} plus the diode's turn-on voltage. The cycle repeats once C_2 charges enough to again turn on Q_1. **EDN**

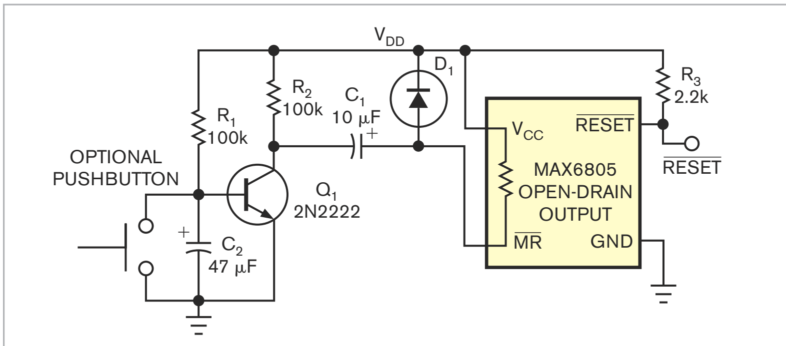

Figure 1 This simple circuit automatically resets a microcontroller upon power-up.

One microcontroller pin drives two LEDs with low quiescent current

Antonio Muñoz, Laboratorios Avanzados de Investigación del I3A, Zaragoza, Spain, and Arturo Mediano, PhD, GEPM University of Zaragoza, Zaragoza, Spain

The basis for this Design Idea is a circuit that uses three resistors and a microcontroller-I/O pin to work as input high impedance or output to independently drive two LEDs (**Reference 1**). The idea sounded good for this design, mainly because of the lack of spare I/O pins in the microcontroller and the simplicity of the implementation. Unfortunately, you cannot use the circuit in battery-powered designs because it exhibits a current leakage on the order of 2 mA even with both LEDs off. This Design Idea modifies that circuit, using only one I/O pin to drive the two LEDs but with a low current drain (**Figure 1**). Although the circuit uses a couple of diodes and a resistor, the price and the component count are low.

THE LEDs START DIMMING AT APPROXIMATELY 4V WITH A CURRENT OF 80 µA AND ARE FULLY ON WITH 4.4V AT A CURRENT OF 1 mA.

The basis for the operation of both circuits is the nonlinear characteristic of a diode, in which current grows exponentially with the voltage applied across it. To describe the operation, suppose that the microcontroller pin is configured as an input, leaving the pin in high impedance. In the first circuit, assume that LEDs need a voltage of approximately 1.5V to turn on and that the small-signal-diode voltage drop is approximately 0.6V (**Figure 1a**). So, to turn on both LEDs, you theoretically need 4.2V. In practice, the LEDs start dimming at approximately 4V with a current of 80 µA and are fully on with 4.4V at a current of 1 mA. With 3.3V, leakage current is merely 2.41 µA. The nominal voltage for this circuit can be slightly lower than 3.3V, but, in that case, you should use Schottky diodes.

The second circuit is for supply voltages greater than 5V (**Figure 1b**). Using the values in the **figure**, the LEDs start

dimming with 7V at 74-μA current and are fully on with 8.5V at 1 mA, remaining off for a 5V supply at 1.53 μA.

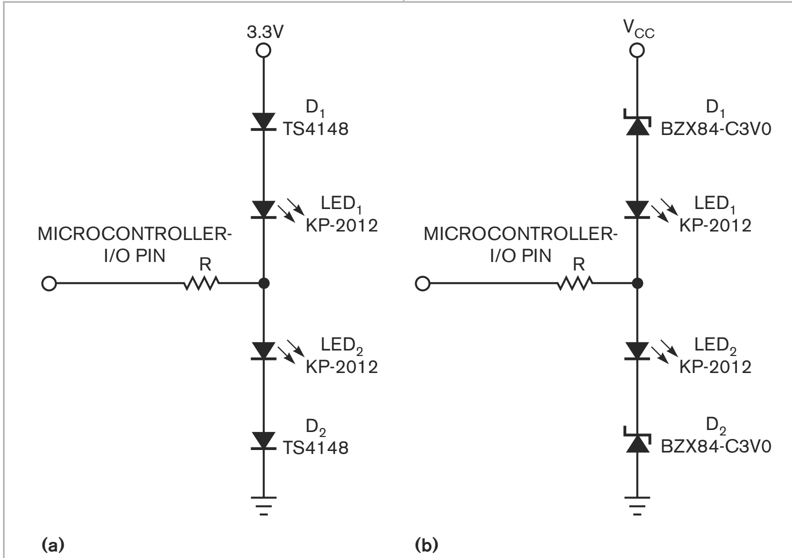

Figure 1 In these simple circuits, the LEDs need a voltage of approximately 1.5V (a) or more than 5V (b) to turn on. The circuits allow a battery-powered microcontroller to control two LEDs with only one I/O pin.

To turn on the LEDs, you must configure the microcontroller's I/O pin as an output; an output value of one turns on the lower LED, and a value of zero turns on the upper LED. If both LEDs must appear to be on, your program can cycle the port pin between one and zero with a frequency greater than 50 Hz. To calculate the value of the resistor in both cases, the following formulas apply: $R=(3.3V-V_D-V_{LED})/I_{LED}$ (**Figure 1a**), and $R=(V_{CC}-V_Z-V_{LED})/I_{LED}$ (**Figure 1b**), where I_{LED} is the desired LED-on current, V_D is the voltage across the diode when an I_{LED} current flows through it, V_Z is the zener-diode voltage, and V_{LED} is the forward voltage across the LED when an I_{LED} current flows through it. You should use a Schmitt trigger or an analog input for the I/O pin to avoid excessive current draw.**EDN**

REFERENCE

1 Pefhany, Spehro, "Circuit Controls Two LEDs With One Microcontroller Port Pin," *Electronic Design*, April 1, 2002, http://electronicdesign.com/Articles/Index.cfm?AD=1&ArticleID=1683.

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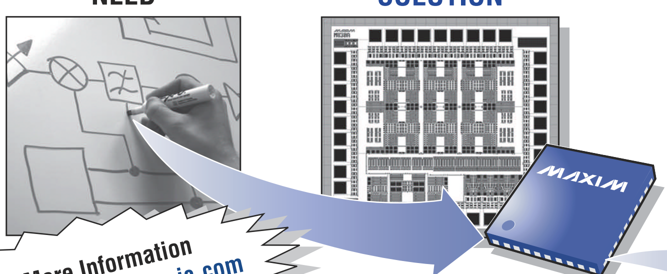

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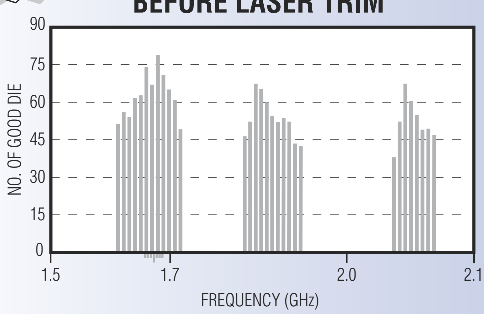

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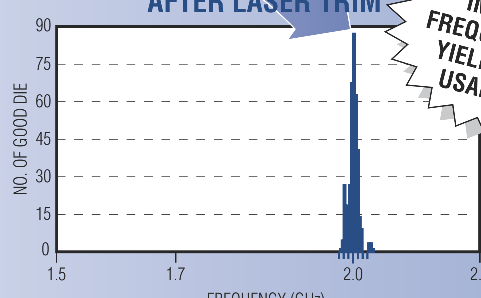

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EU ROHS exemption, definition changes to impact restricted substances, design requirements

The EC (European Commission) is set to adjust the EU (European Union) ROHS (restriction-of-hazardous-substances) directive this year to reflect additional substances and changes to exemptions.

ROHS is currently under a scheduled review, as Article 6 of the directive requires. The EC is examining the directive's current 29 exemptions, plus an additional seven requested exemptions; categories 8 and 9 of the directive, which include effects of materials on medical devices and monitoring and control instruments; and some definitions within the directive.

The EC will review each of the 29 exemptions, and, if it deems they are no longer required because substitutes now exist, the commission will delete them, according to Gary Nevison (**photo**), Newark's (www.newark.com) customer interface on legislation that affects the electronics industry. "If the consultants doing this review find alternatives, but receive no input from manufacturers who cannot replace ROHS substances, the exemptions will be deleted. It's important for all manufacturers who rely on the exemptions to submit the required technical data to the EC."

Nevison maintains that, although the EC is reviewing all 29 exemptions, it isn't certain that the commission will delete any. He notes lead in ce-

ramics and lead in the glass of electronic components as examples. "In Europe, many passive components are compliant simply because they have that exemption."

When the EU first laid out ROHS, it included eight of the 10 product categories in WEEE (waste electrical and electronic equipment), the EU recycling directive. However, it excluded two categories, 8 and 9, because of concern over the reliability of substituted materials, especially lead-free solders, according to an EC-commissioned report on the product categories. Health and safety risks are paramount in these categories, which influence products in the medical and health-care fields, as well as test equipment.

"The recommendation to the EC is that these two categories will be added to the scope of ROHS," Nevison says. "This review is going to lead to further additional components, [and] a larger set of product categories. … The EC [will then look] at adding extra substances beyond the original six [lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, and polybrominated diphenyl ether]."

"Obviously, this [development] is very significant," he continues, noting flame retardants; arsenic, which can be in infrared LEDs, some ICs, and alloys; and substances such as beryllium, which can be in springs, as possible additional substances.

Additionally, the EC is looking into clarifying some of the product definitions within the directive that have caused gray areas. Nevison cites "fixed installation," a product that would be left behind because it is fixed or permanent, such as a boiler or an air-conditioning system. "It is possible that there will be no exemptions for fixed installations, so products that we felt didn't fall within scope may well [be there]," he says.

The EC has finished the reviews of categories 8 and 9, and you can expect the organization to announce results this year. Recommendations for these product categories call for significant time for manufacturers to embrace products; expect a suggested 2012 time frame for implementation. As to adding more substances to the ROHS directive's restrictions, clarity of definitions will likely come out this year, and implementation could be in the near future, depending on manufacturer feedback.

Unfortunately, says Nevison, once the electronics supply chain moves through this stage, there will be additional reviews of the directive and more restrictions coming from other environmental regulations, such as China ROHS, an EU ROHS-like law set in China; REACH (regulation on registration, evaluation, authorization, and restriction of chemicals), an EU chemical-restriction directive; and Energy Using Products, an EU framework directive on eco-design.

A December 2007 Ernst and Young report stated that regulatory and compliance risk was the greatest strategic challenge facing global businesses in 2008. A JPMorgan Global Trade Services research note in December likewise stated that manufacturers are lagging in environmental compliance.

"After a lull of a year or more on legislation, everything is just moving so quickly, especially in Europe with the REACH chemical legislation. [It] is going to have a huge impact on industry and, to a lesser extent, Energy Using Products, and that [movement] will have the biggest impact on the design engineer," Nevison says. "An awful lot of the focus of these directives is on the design stage. There are so many things for an engineer and a distributor to think about now. Once there was just ROHS and some recycling, but now, all of a sudden, we have all of these other things and so many of them different."

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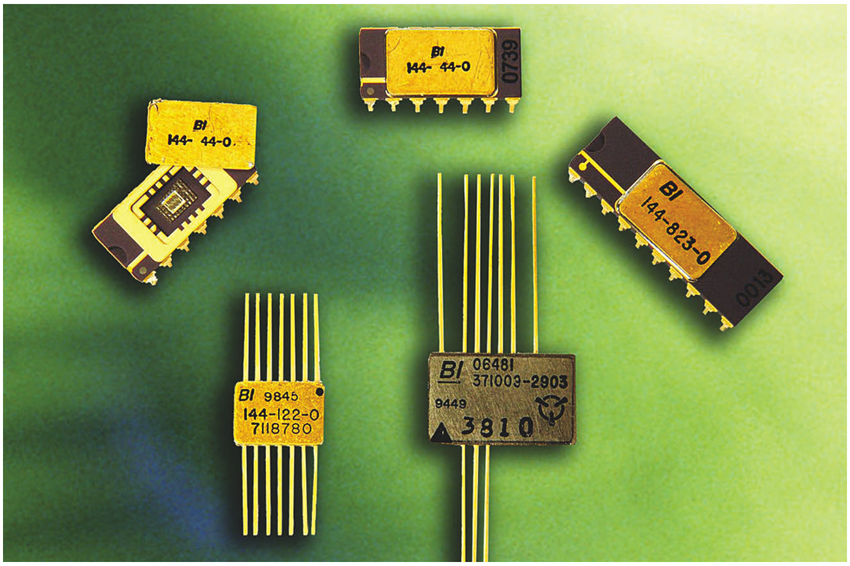

Thin-film-resistor networks have hermetically sealed packages

Suiting military and aerospace applications, this series of thin-film-resistor networks are hermetically sealed, nitrogen-filled package cavities. Features include a 10Ω to 1-mΩ resistance range, ±0.05% absolute tolerances, and ±0.01% ratio tolerances. TCR (temperature-coefficient-of-resistance) tracking is ±25-ppm/°C, and ±5- and ±1-ppm/°C TCR tracking are available. Available with hot-solder-dip, tin-lead-plate, and gold-plate finishes, the thin-film-resistor networks cost $35 (50).

BI Technologies, **www.bitechnologies.com**

Capacitor combines floating-electrode and flexible-termination technology

The FF-Cap X7R multilayer-ceramic capacitor combines floating-electrode/cascading-electrode design and flexible-termination technology. The technology provides 5 mm of flex-bend capability, increasing protection from board flex and allowing an enhanced level of mechanical flex-crack protection for low-capacitance to midcapacitance part types. The device meets requirements of the Automotive Electronics Council's AEC-Q200-Revision C and offers 100% pure-matte-tin-plated terminations, improving solderability. The FF-Cap capacitors are available in cases ranging from EIA 0603 to EIA 1210, and prices range from 0.032 to 0.657 cents.

Kemet Corp, **www.kemet.com**

Current-sense resistors come in 1206, 2010, and 2512 packages

The 2W current-sense flat-chip-resistor LR series features a copper-conductor element on an alumina substrate with wraparound copper terminations and a protective overcoat, increasing stability. Series features include a 0.002 to 1Ω resistance range, ±1% tolerances, a ±100° ppm/°C TCR (temperature coefficient of resistance), and a −55 to +150°C operating temperature. The 1206 and 2010 packages have a 0.5 and 1W rating, respectively. There is also a 2512 package. The resistors provide standard 60/40 tin/lead plating, or lead-free terminations. The LR series cost 16 cents (10,000).

International Resistive Co, **www.irctt.com**

Bridge resistors target pyrotechnic applications

Offering joule-effect ignition for 50-µsec firing times, the EPIC (electropyrotechnic-initiator-chip) thin-film, or bridge, resistor suits pyrotechnic applications with a 70% no-fire/all-fire ratio. Resistive elements of the bridge resistors convert electrical energy into heat energy in an electrothermal profile for initiating a series of pyrotechnic events in a controlled energetic reaction. The EPIC resistors suit squib-header applications in automotive-safety systems for the deployment of air bags and other safety devices; military pilot-ejection systems, explosive-bolt disengagement of airborne missiles, chaff dispensers, artillery-projectile activators, and antitank mines; and mining and demolition systems. Prices for the EPIC resistors range from 20 to 50 cents.

Vishay Technology, **www.vishay.com**

Wirewound power inductors target flat-panel TVs

Achieving 3A at 10 µH, the NR-6045T wirewound power-inductor series targets dc/dc-converter choke-coil applications in LCD and plasma TVs, as well as in other flat-panel displays. Features include a 0.014 to 0.5V-dc resistance, a 1- to 100-µH inductance, and a 0.8 to 8.5A current rating. Measuring 6×6×4.5 mm, the NR6045T wirewound inductor costs 30 cents.

Taiyo Yuden, **www.yuden.us**

Upgrade allows automatic import of Mentor Graphics' DxDesigner files

Updating the design-translation capabilities of the vendor's Designer system, the program now supports the importing of Mentor Graphics' DxDesigner files. The migration-tool enhancements allow users currently using a DxDesigner-based point-tool device to upgrade to the Designer systems, gaining the benefits of a unified design environment. An importation-wizard tool allows the translation of complete DxDesigner designs, such as schematics and library files, into Designer without converting to an intermediate format. The import-wizard tool facilitates the conversion without requiring installation on the user's system. The tool also includes user-defined controls, allowing the importing process to analyze files and suggest defaults and settings, such as project folders, links to other libraries, drawing styles, and output structures. The upgrade is free with the most recent update of the vendor's Designer system.

Altium Ltd, www.altium.com

Signal-integrity technology includes a static-timing-analysis engine

New technology in the vendor's Olympus system-on-chip place-and-route product accelerates signal-integrity closure, improving the reliability of manufactured silicon. The multicorner, multimode capability of the product's static-timing-analysis engine computes delay shift and glitch for a variety of mode/corner scenarios in a single pass. Reducing the time to achieve design closure, the analysis also allows users to address reliability issues, including crosstalk delay, glitch, power, and electromigration. Enhancements to the routing and optimization engines eliminate signal-integrity violations over a variety of scenarios. The product includes per-clock, -corner, and -mode timing-window-computation-enabling technologies. The technology also includes fast incremental signal-integrity updates over all modes/corners during implementation; routing techniques, such as signal-integrity track assignment, wire spreading, and track reordering; and signal-integrity-bottleneck identification for directed concurrent delta-delay, delta-slew, and glitch optimization. The new technology costs $870,000 for a one-year time-based license.

Mentor Graphics Corp, www.mentor.com

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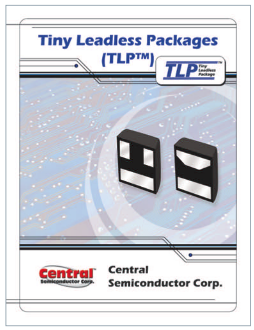

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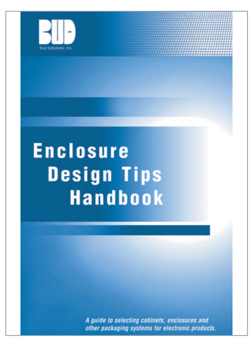

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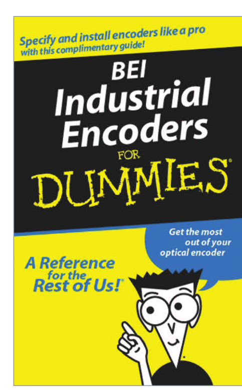

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Oldsmobile engineers and General Motors Delco Division have developed an automobile TV set for rear-seat viewing. The owner may remove the set for operation outside the car. Chief components of the experimental set are a receiver, 9-in. screen, transistor power supply, and a collapsible V-shaped aerial mounted on the car roof just ahead of the rear window. The set's power supply converts 12V dc from the car's battery into ac for operating the picture tube. Two relays automatically switch the necessary connections when the user removes the set from its mounting in the car.

—*Electrical Design News*, February 1958

LOOKING AHEAD

TO ISQED 2008

The International Symposium on Quality in Electronic Design, volume 2008, will take place March 17 to 19 in San Jose, CA. As the only conference focusing on quality in IC design, this small event continues to grow. This year, the conference will start the controversy early, with a Monday panel asking whether design for manufacturing is helping or hurting quality. Along with a variety of technical sessions on design, verification, and test issues, plenary sessions will offer keynotes on—among other topics—how enterprise-information-technology issues can help or hinder the vast collaborations that are necessary in design today, how new techniques can put bounds on the seemingly infinite loop of chip verification, and how manufacturing test must respond to the consumerization of microelectronics markets.

LOOKING AROUND

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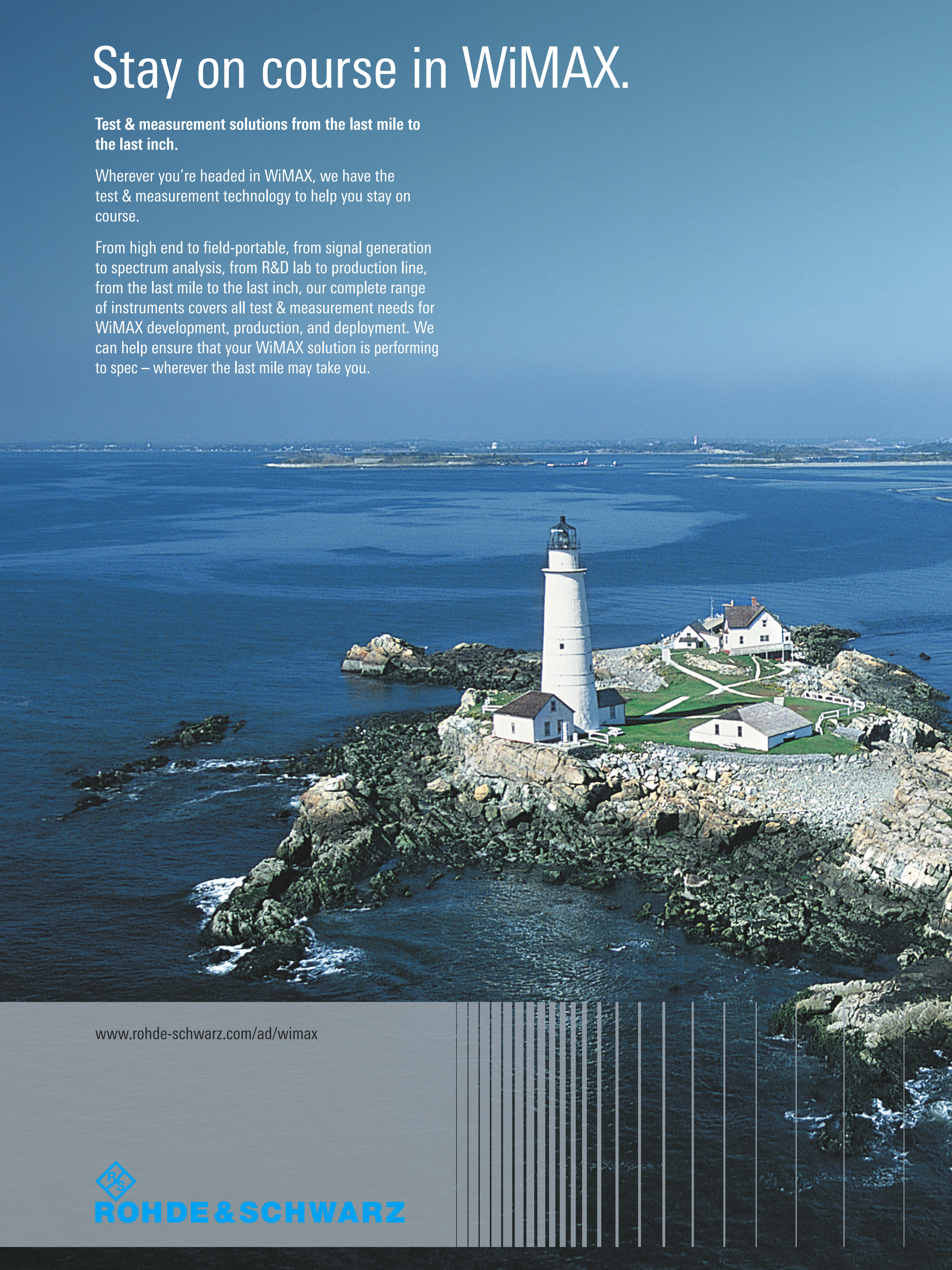
But don't bet on finding it. After World War II, the United States made a huge investment in education, not only in public schools but also in funding directly to students for higher education. Arguably, that investment contributed to the blossoming of defense-related technology into a vibrant private industry in the postwar decades, underlying much of the period's economic growth. But today's politicians assume education to be an expense, not an investment: to be minimized, not managed. The result is that the United States produces fewer highly educated engineers than it needs, and many of the engineers educated here return to their native lands to pursue their careers. Just one more vital issue that won't be showing up in the campaign speeches.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