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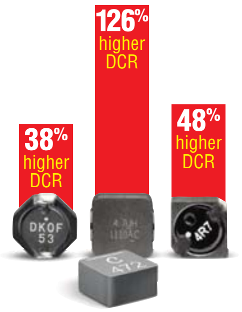

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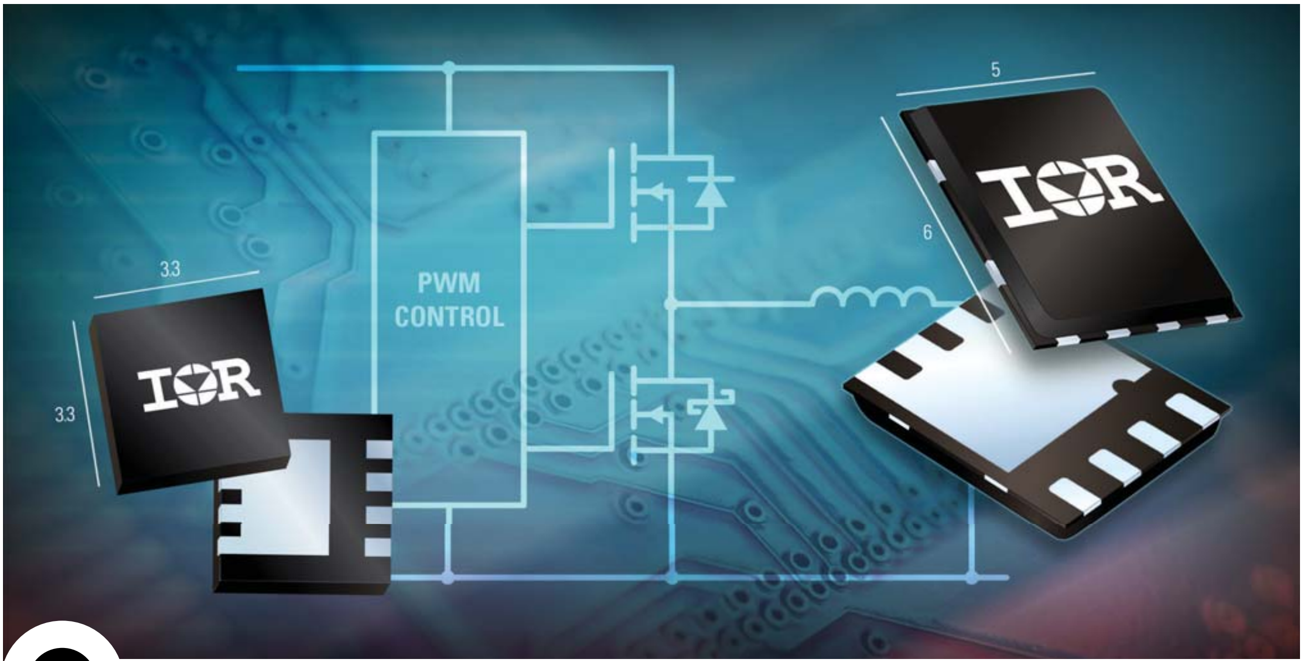

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Package	Part Number	Voltage	$R_{DS(on)}$ typical / max @10V (mΩ)	$R_{DS(on)}$ typical / max @4.5V (mΩ)	Q_G typical @4.5V (nC)	Q_{GD} typical @4.5V (nC)
PQFN 5 x 6	IRFH4201	100A	0.70 / 0.95	1.00 / 1.25	46	16
	IRFH4210D (FETKY)		0.85 / 1.10	1.10 / 1.35	36	13
	IRFH4210					
	IRFH4213D (FETKY)		1.10 / 1.35	1.5 / 1.9	26	9.2
	IRFH4213		1.10 / 1.35	1.5 / 1.9	26	9.2
	IRFH4234		3.5 / 4.6	5.6 / 7.3	8.2	3.1
PQFN 3.3 x 3.3	IRFHM4226	40A	1.7 / 2.2	2.6 / 3.3	16	5.8
	IRFHM4231		3.0/3.8	4.5/5.8	10	4.0
	IRFHM4234		3.5 / 4.6	5.6 / 7.3	8.2	3.1

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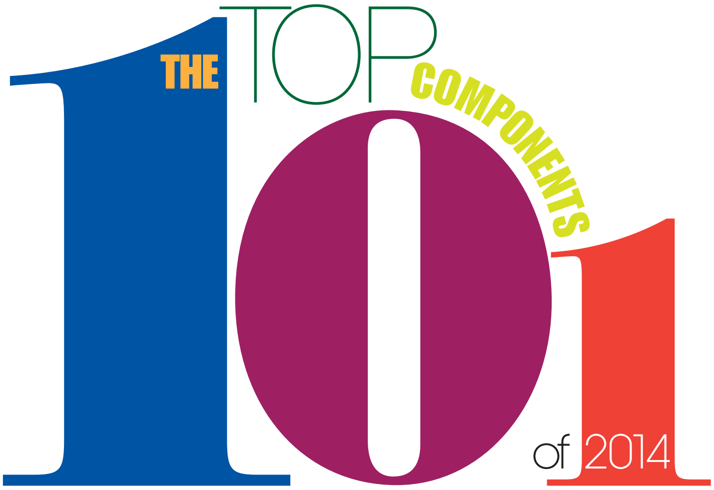

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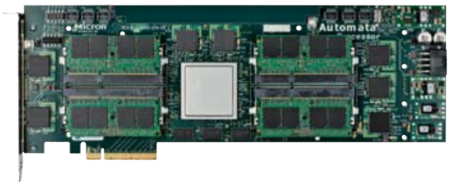

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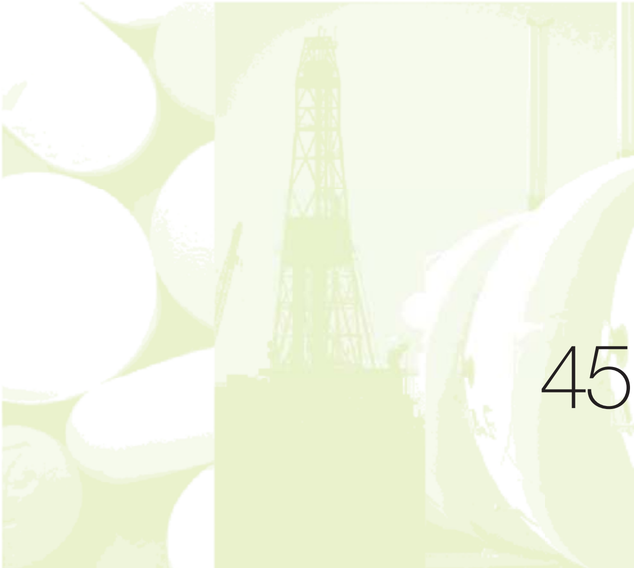
To provide the most current, accurate, and in-depth technical coverage of the key emerging technologies that engineers need to design tomorrow's products today.

ELECTRONIC DESIGN (ISSN 0013-4872) is published monthly by Penton Media Inc., 9800 Metcalf Ave., Overland Park, KS 66212-2216. Paid rates for a one-year subscription are as follows: $120 U.S., $180 Canada, $240 International. Periodicals postage paid at Shawnee Mission, KS, and additional mailing offices. Editorial and advertising addresses: ELECTRONIC DESIGN, 1166 Avenue of the Americas, New York, NY 10036. Telephone (212) 204-4200. Printed in U.S.A. Title registered in U.S. Patent Office. For subscriber services or to order single copies, write to Electronic Design, PO Box 2100, Skokie, IL 60076. POSTMASTER: Send change of address to Electronic Design, PO Box 2100, Skokie, IL 60076. Canadian Post Publications Mail agreement No. 40612608. Canada return address: IMEX Global Solutions, P.O. Box 25542, London, ON N6C 6B2.

July 2014
VOLUME 62, ISSUE 7



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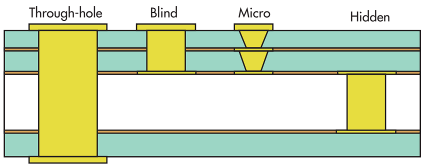

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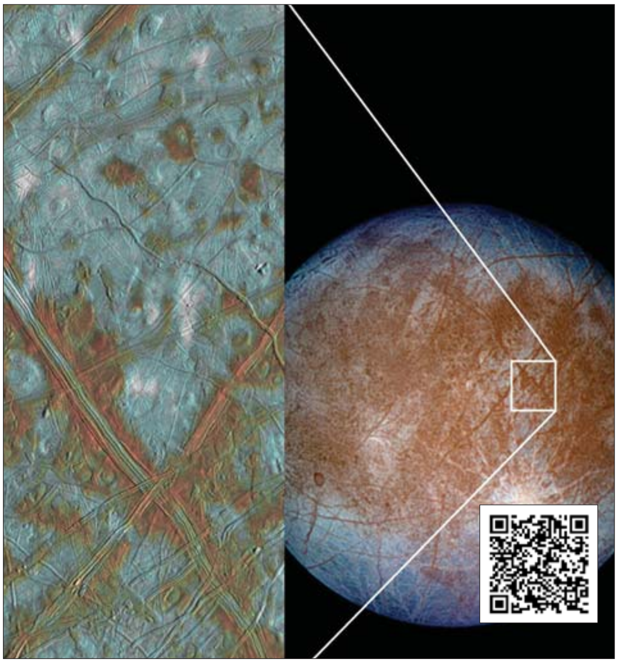

NASA SETS ITS SIGHTS ON EUROPA

A NASA request for information is asking for ideas for a mission to Europa, one of Jupiter's moons, to search for life and answer other questions.

4K VIDEO: THE NEXT REVOLUTION

As 4K UHD TVs arrive in stores, designers are gearing up for the next dramatic change in video standards.

T&M SOLUTIONS TACKLE TODAY'S COMMUNICATIONS CHALLENGES

Today's test & measurement equipment must meet the speed and volume demands of the booming communications industry.

BRUCE MCGAUGHY DISCUSSES DESIGN FOR YIELD

Yields improve over time, but low yields are always an issue. DFY helps improve this situation.

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- 50 Years Of BASIC Programming

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A Penton® Publication
JULY 2014

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Try Out Simulation With Open Virtual Platforms

Sometimes, hardware hasn't been delivered yet, or it's otherwise difficult to obtain. Instruction accurate (IA) simulators, or virtual platforms, allow developers to get their software running without having access to the hardware. Also, an IA simulator's debugging features may be more robust than those available in real hardware, even hardware with JTAG support. Virtual platforms are more than just an instruction set simulator (ISS) since they provide peripheral simulation as well.

Virtual platforms are big business because software needs to run on systems-on-chip (SoCs) before the hardware is available. Most application software can be developed on similar or more generic platforms, but a lot of software really needs to be tested on the actual platform or the best simulation available. Many alternatives are available, such as Wind River's Simics. Tools like Synopsys' Processor Designer only create an ISS, although they also work with SystemC models to create transaction level models (TLMs) that simulate the entire SoC.

Some of these tools are available in time-limited evaluation versions. This is great for developers trying to determine whether a particular tool will meet their needs, but less so for someone trying to get a handle on what a virtual platform offers.

OVPSIM'S CAPABILITIES

OVPsim is a full system simulator supported by Imperas. It is available via Open Virtual Platforms (OVP), where you can find many open-source models. Free for non-commercial use, it is a closed-source package, but most of the models it runs are open source.

The commercial version adds a multicore debugger or the QuantumLeap parallel simulation accelerator, which employs a new synchronization algorithm designed to handle the latest multicore designs. It also provides ARM TrustZone support. TrustZone, which is becoming more important, is even part of AMD's latest Beema and Mullins accelerated processing units (APUs) in its Cortex-A5-based Platform Security Processor.

The performance of the free OVPsim ranges from 100 MIPS to 1000 MIPS. It is compatible with the commercial version and works with SystemC TLM2.0. QuantumLeap runs over 16,000 MIPS. Typically, IA simulator tools like OVPsim work with standard debuggers and development environments like Eclipse. More advanced debuggers can sometimes take advantage of features found on the virtual platforms such as exposing internal system states.

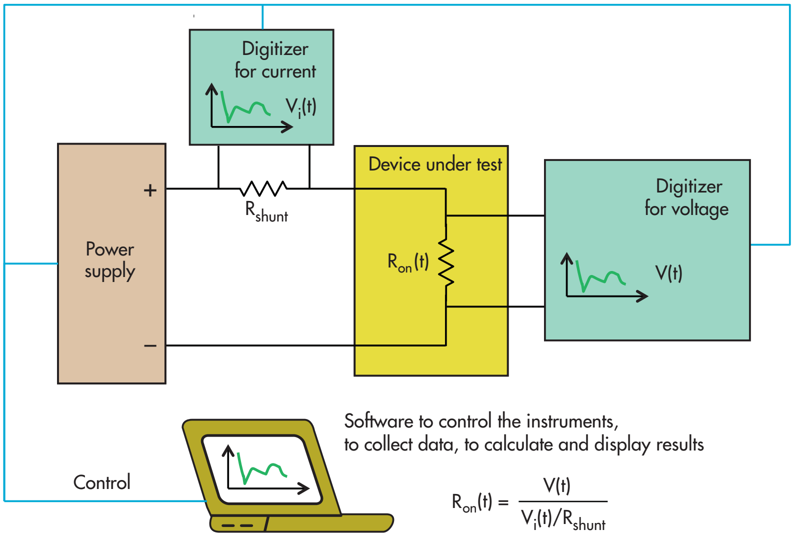
The latest models for OVPsim are for ARM's new 64-bit, ARMv8 processors, the Cortex-A53 and Cortex-A57. Many of these designs have yet to make it past prototype silicon, so there are significant advantages to having access to these simulators. Embedded developers should be familiar with simulation technology. OVPsim is one way to gain that experience. ed

BOB ZOLLO | Contributing Technical Expert
bob_zollo@agilent.com

Use A Power Supply
As A High-Current Ohmmeter

When testing semiconductors, specialized test instrumentation is used to determine device parameters. When the semiconductors are high-power semiconductors like diodes, switches, FETs, and insulated gate bipolar transistors (IGBTs), the parametric analyzers used to test these devices will need to drive the devices to high current or high voltages.

However, these parametric tests are performed on a pulsed basis to avoid self-heating within the power devices. Although the power developed by the parametric analyzer can be high, it is only for a short time. So what can you do if you want to measure the heating effects of a power device? Since the parametric analyzer cannot provide continuous high power to cause self-heating, a different approach is needed.



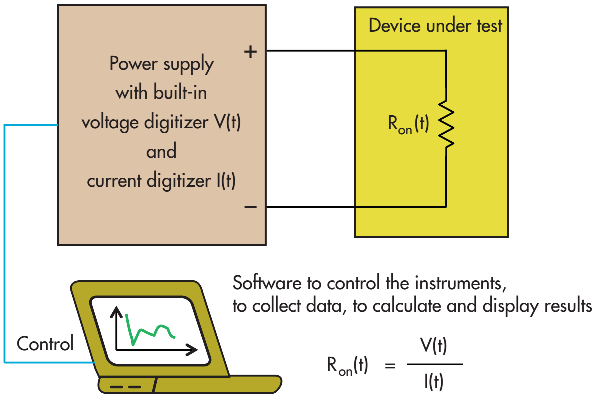
1. A test setup to measure device resistance changes due to self-heating can use a digitizer to measure voltage profile, a shunt and a digitizer to the measure current profile, and a program to setup and collect data before calculating the R_{on} profile and displaying the results.

ON THE BENCH

Let's use the example of trying to measure the change in on-resistance R_{on} of a transistor. You need to apply power for several seconds to observe the change in R_{on}, which can uncover information about the material and bonding within the device.

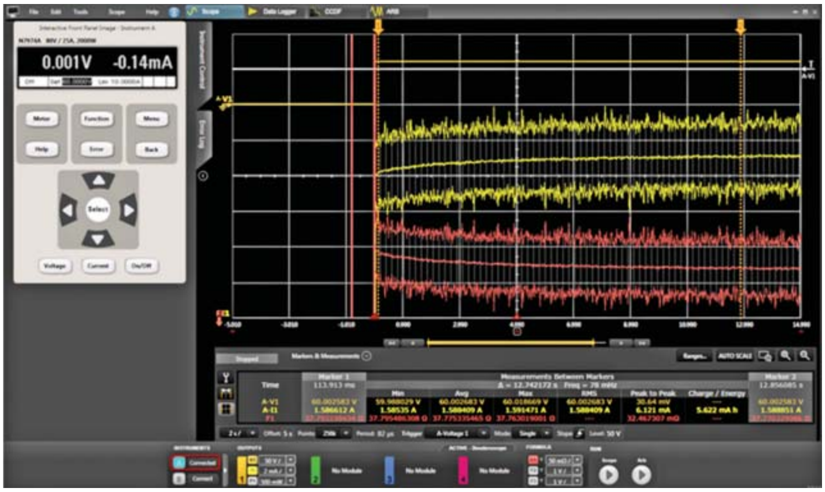
You could turn to a high-power power supply to apply a constant voltage across the device, which will drive current through the device and cause the self-heating. You must simultaneously measure the profile of the current as it changes due to the change in the device's resistance. Divide the measured current profile into the constant voltage setting, and you can see the changing resistance profile as the device heats up.

Or, you could use the built-in measurements in an average high-power power supply, but you are likely to find the current measurement accuracy of the supply is not good enough to see the small changes in the high current as the resistance changes. Furthermore, the voltage set point accuracy may not be good enough either, so you will need to simultaneously measure the voltage and the current to get the best possible calculated resistance profile.



2. A test setup to measure device resistance changes due to self-heating can use a power supply with built-in digitizers to capture voltage and current sourced into the device.

Typically, a digital multimeter (DMM) is used to measure voltage accurately. Since you are trying to measure voltage and current together to get a profile, you may instead turn to a digitizer to capture the voltage while simultaneously capturing current. High-speed precision digitizers can accurately measure this voltage.



3. Using the Agilent 14585A Control and Analysis Software, you can quickly set up and execute tests and then view results. The middle yellow trace shows the current rising slightly as the device heats up due to self-heating. The voltage is constant, as shown in the top yellow trace. The pink trace is a calculated value that is the ratio of voltage to current and thus represents the slightly dropping R of the device as it heats up.

You might be tempted to use a scope, but most scopes do not offer the measurement accuracy you need.

Measuring the current becomes the real challenge. Since it's a power device, you may need to measure high currents. Most DMMs can only measure a few amperes. Also, since you need to capture current as it changes, you will need to rapidly make DMM measurements. The reading rate of a DMM, especially when you want to measure with maximum accuracy, can be quite slow.

Instead of a DMM, you may turn to the same high-speed, high-accuracy digitizer that you are using to measure voltage, but it can't measure current. Now you'll need a high-precision shunt, with a very stable known resistance, and then calculate the current flowing by measuring its voltage drop. Simultaneously, you'll need to measure the voltage across the semiconductor. Then, you'll need to write software to set up and capture the two waveforms, calculate the resultant R_{on} profile, and present the data to get a picture of the measurement being made.

This method will work, but it is quite a complex setup requiring multiple digitizers, precision shunts, and software *(Fig. 1)*. You'll also have to determine the accuracy of the resultant measurement, as the specifications of the digitizer are not the final system specifications. You need to account for the precision shunt.

A BETTER OPTION

A more ideal solution would be to use a high-accuracy, high-power power supply *(Fig. 2)*. It should have dual digitizers to simultaneously measure the voltage profile across the device and the current profile of the current flowing through the device. If the power supply had software to collect and show this data, you would quickly get the answer you need.

The N7900 Series Advanced Power System (APS) high-performance power supplies from Agilent Technologies can provide up to 160 V, 200 A, and 2000 W. They feature 18-bit resolution and 0.1% accuracy on measurements. Also, Agilent's 14585A Control and Analysis Software can capture the waveforms, compute the R_{on} profile, and graphically present all the data so you can see the changing R_{on} without writing a program *(Fig. 3)*. ed

BOB ZOLLO is a product planner with the Power and Energy Division, Electronic Measurements Group, at Agilent Technologies. He holds a degree in electrical engineering from Stevens Institute of Technology in Hoboken, N.J.

News & Analysis

BILL WONG | EMBEDDED/SYSTEMS/SOFTWARE EDITOR

Automata Processor Piques Parallel Processing

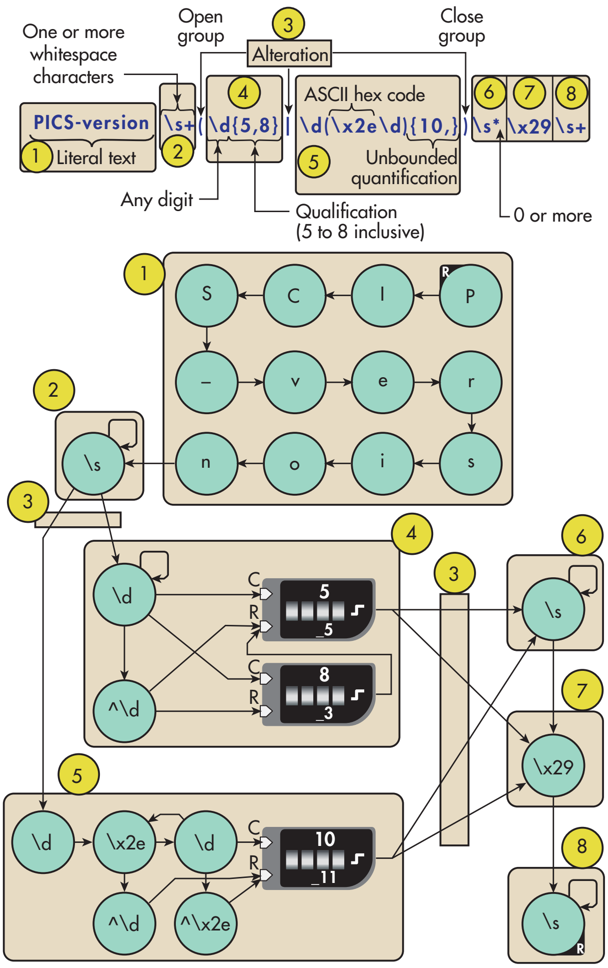
Micron's Automata Processor (AP) uses a unique parallel processing technique that exploits the company's memory technology. The parallel processor is similar to an FPGA and a content addressable memory (CAM), but it is designed to handle stream-processing tasks in parallel. It is well suited for applications ranging from regular expression processing used in deep packet inspection (DPI) and elsewhere to rule-based systems that have been limited in scope because of the processing overhead.

Processing is grouped into blocks of 256 state transition elements (STEs). The same input information is provided to each STE that also contains a value that's compared to the input. There is additional logic in each STE so it knows when it is activated. Each cycle starts with data being provided to the system. Each active STE compares the data to their value in parallel and generates an output that is sent to activate one or more STEs. There are 49,152 STEs in the initial implementation. Up to 6144 can be terminal events.

Routing to the next STE can occur within the block. Signals also can be routed to the block's nearest neighbors, enabling the construction of more complex systems. Propagation to the nearest neighbor is within a single cycle, so events can be pushed out from a central STE to remote blocks.

The routing of information and its configuration is similar to an FPGA in that a static path is set up between elements. Unlike an FPGA, the Automata Processor has a more limited and regular computational structure. It would not be used to create processors or general boolean logic like an FPGA, but it can handle matching chores and provide significantly more memory with more processing efficiently for many applications compared to an FPGA. In fact, simulating the Automata Processor in an FPGA is impractical on a large scale.

A CAM supports spatial matching but not temporal matching. The Automata Processor can do both, letting it process regular expressions *(Fig. 1)*. The example highlights a single expression implemented via linked STEs. A system would con-



1. The Automata Processor is designed to handle regular expression processing. Each element in the expression is translated into a blue STE cell that is implemented in hardware.

sist of possibly hundreds to thousands of expressions operating in parallel.

The logical view of the process makes more sense and matches the kind of development tools available for the system. The system uses an approach similar to FPGAs with the Automata Network Markup Language (ANML), which is then compiled and loaded into the configuration portion of the STEs. It essentially includes an STE's value and target STE, which are accessed as normal memory elements, allowing the system to appear as regular memory with hidden functionality.

The software tools provide simulation support, including animated operation as well as parallel debugging and trace support. The tools and techniques will be different from those used in conventional debugging, so developers will need to get up to speed to address the AP architecture and applications.

The first implementation of the Automata Processor will be on a dual-inline memory module (DIMM) that is DDR3 compatible *(Fig. 2)*. The DIMM includes eight AP chips. All eight APs can be used together, or they can be partitioned such as two sets of four APs. The first PCI Express board implementation will include up to 48 APs. ■

2. An implementation with eight APs will be in a DDR3 compatible DIMM that is accessed like memory. A PCI Express board will have up to 48 APs.

DARPA-FUNDED PROSTHETIC EARNS FDA APPROVAL

DARPA LAUNCHED ITS Revolutionizing Prosthetics program in 2006 to achieve U.S. Food and Drug Administration (FDA) approval of an electromechanical prosthetic upper limb with near natural control that enhances independence and improves quality of life. Recently, the FDA awarded its first approval to the DEKA Arm System.

Also known as the "Luke," the system allows for simultaneous control of multiple joints using a variety of input devices including wireless signals based on a proprietary protocol that runs on ZigBee transceivers. For example, innovative sensors detect how the feet are tilted, making them act much like joysticks.

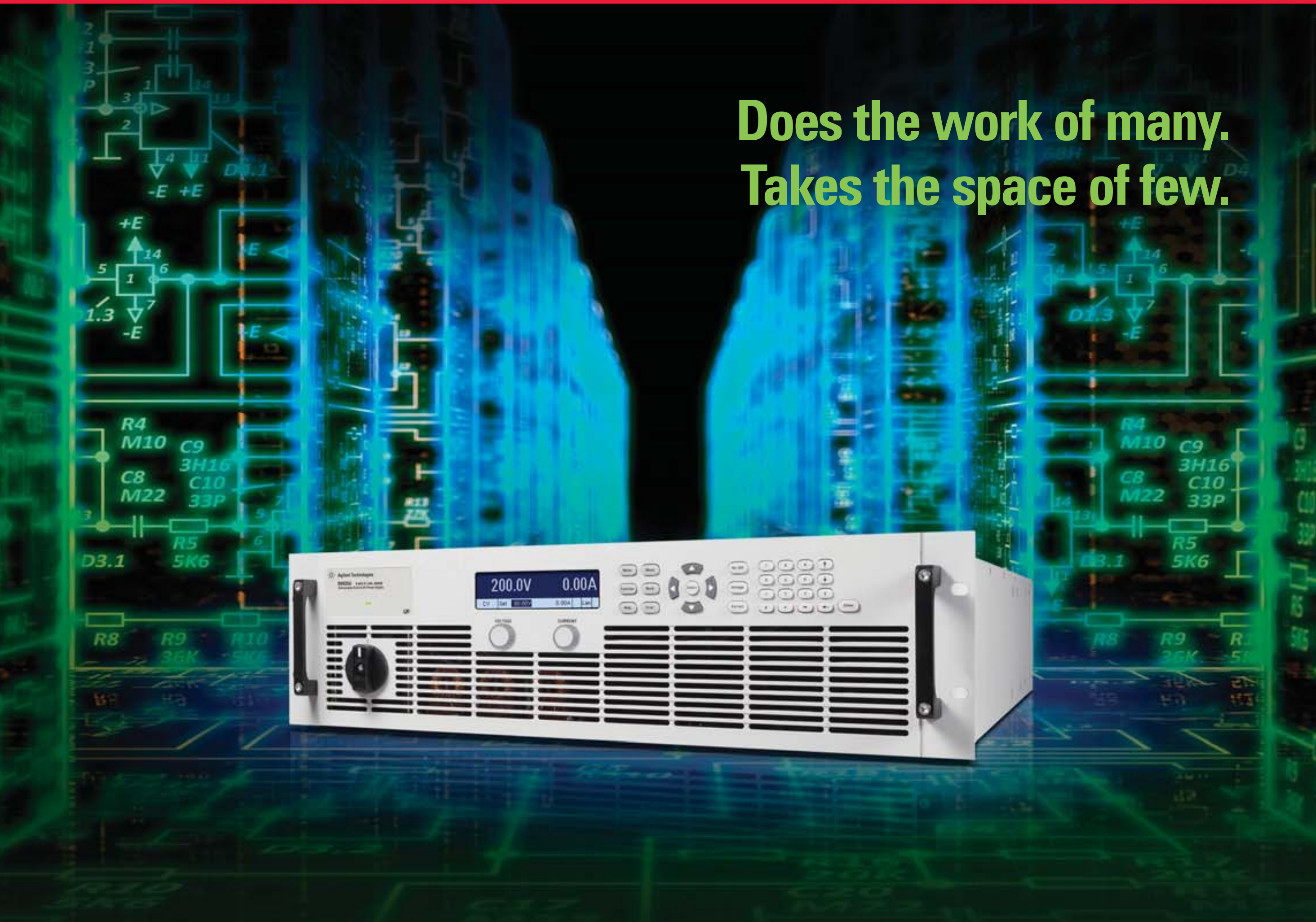
Powered by rechargeable lithium-ion batteries, the arm is of similar size and weight to a natural limb. Its six user-selectable grips can handle objects as delicate as grapes and eggs or manipulate power tools such as a hand drill. Sensors in the hand provide feedback on grip strength.

Microcontrollers ranging from 32-bit floating-point down to 8-bit fixed-point devices manage the system, which required many technological breakthroughs spanning biology and engineering alike. For example, parts for motors, computer controls, and sensors all were miniaturized, and manufacturing processes required light but strong materials.

DEKA Integrated Solutions of Manchester, N.H., developed the DEKA Arm System. The FDA approval enables the company to pursue manufacturing and commercial opportunities. It is currently working with prosthetists from Next Step Bionics & Prosthetics and with biodesigns inc. on the project. ■ **RICHARD GAWEL**

The FDA has approved the DEKA Arm System. Supported by DARPA's Revolutionizing Prosthetics program, the device allows for simultaneous control of multiple joints with adjustable grip strength.

Agilent's Electronic Measurement Group is becoming **Keysight Technologies**.



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THE TO

What's a component? Isn't it anything we design into an electronic product? That's a perennial discussion topic whenever we compile our annual list of the Top 101 Components *(see the table)*. So, here's an attempt at an answer. A component is anything we use that isn't memory or a device that executes a program from memory.

It's a resistor, a discrete semiconductor device, a switch, a transient suppression device, or a battery. It doesn't have to be a linear device. For example, if it's a voltage regulator, it can be a switcher or a low-dropout regulator (LDO). It can even be the box you put your design inside, if it's a standard product you would buy from a distributor.

TOP OF THE LIST

So, what product rose to the top of this year's survey? *(see "Readers Pick The Top 101 Components" at electronicdesign.com)* It's a box with a particular variety of mounting arrangements: DIN rails. "DIN" is the acronym for "Deutsches Institut für Normung," the standards body that developed the EN (European Norm) 50022 standard for mounting circuit breakers on electrical panels. Apparently, DIN has been widely adopted for rack-mounting small assemblies in industrial control systems.

OP COMPONENTS 01 of 2014

A series of DIN rail-mount enclosures from Automation Systems Interconnect has taken the number-one slot *(Fig. 1)*. These enclosures come in 12.5-, 17.5-, 22.5-, 35-, 45-, and 67.5-mm wide housings. Ventilating slots ensure cooler, stable internal temperatures and reduce overheating issues. Snap-in covers enclose the opening of any unused connector slots. The cover can be cut to accept various connector interfaces and LEDs.

If that seems like a strange product to lead the list, consider how many *Electronic Design* readers are engaged in industrial control, the design of which is generally customized to each implementation. If the enclosures are as versatile as they seem, and they can be hung on any convenient EN50022 DIN rail in an equipment rack, this is a great solution.

WHAT'S HOT?

Take a look at number three on the list, the Brain Sentry Impact Sensor from STMicroelectronics. Mounted on sports helmets, the omnidirectional microelectromechanical-systems (MEMS) accelerometer accurately measures accelerations produced by collisions, regardless of the direction of the contact. The light (1 oz) and compact device also taps a unique battery-life management system that lets it be active for a full year without recharging.

2014 TOP 101 COMPONENTS		
Rank	Product	Company
1.	ASI DIN rail-mount enclosures	Automation Systems Interconnect
2.	CP2130 controller	Silicon Labs
3.	Brain Sentry Impact Sensor	STMicroelectronics
4.	ADXL375 three-axis digital MEMS accelerometer	Analog Devices
5.	Hybricon AFT16 COTS OpenVPX AFT chassis	Curtiss-Wright
6.	ARK capacitive touch switch	CIT Relay & Switch
7.	iBridge connector system	ERNI Electronics
8.	MC33816 programmable solenoid controller	Freescale Semiconductor
9.	Avikrimp and VersaKrimp ring terminals	Molex
10.	Titan EP flexible electronic packaging enclosure	AMCO Enclosures
11.	XGA thin-client display	IEE Inc.
12.	Model 8101 piezoelectric accelerometer	Measurement Specialties Inc.
13.	AIIS-1240 and AIIS-1440 camera controllers	Advantech Corp.
14.	AVX 9296 connectors	AVX
15.	Motion Cookies	Sen.se.
16.	AMP-204C and AMP-208C motion controllers	Adlink
17.	SCA720 MEMS accelerometer	Murata
18.	IllumiMate 1.00-mm and 1.25-mm connectors	Molex
19.	JS Slide switches	C&K Components
20.	TP8 tantalum chip capacitor series	Vishay Intertechnology Inc.
21.	LL-01 Sentio switches	Measurement Specialties
22.	bq27421EVM-G1A fuel gauge IC	Texas Instruments
23.	SiT15xx MEMS oscillator/Telit Jupiter SE880 receiver	SiTime Corp. and Telit Wireless Systems
24.	FemtoFET MOSFETs	Texas Instruments
25.	LMP92064 digital current sensor and voltage monitor	Texas Instruments
26.	8U MicroTCA.4 chassis	VadaTech Inc.
27.	K12S key switches with LED colors	C&K Components
28.	T18 tantalum-cased electrolytic capacitors	Vishay Intertechnology
29.	12-mm EH pushbutton switch	CIT Relay & Switch
30.	VT866 MicroTCA	VadaTech
31.	7204e PCI Express serial interface adapter	Sealevel Systems
32.	AD pushbutton switch	CIT Relay & Switch
33.	IP65-rated miniature rocker switches	C&K Components
34.	FRFC 0805 flip-chip resistor	Vishay Precision Group
35.	NTC chip thermistors	Ametherm Inc.
36.	KSK-1A35/1 reed switch	Standex-Meder Electronics
37.	FOH 2-2 push-pull connector	Fischer Connectors SA
38.	TPL5000 and TPL5100 system timers	Texas Instruments
39.	MP1005M1R0D multilayer power inductor	TDK Corp.
40.	KXR94 and KXD94 accelerometers	Kionix Inc.
41.	Polymer fiber for high-resolution remote imaging	OMC
42.	SB Smart connector	Anderson Power Products
43.	SER80xx high-current shielded power inductors	Coilcraft
44.	TMR6 wide-input dc-dc converters	Power Sources Unlimited
45.	DMT of electrical double-layer capacitors	Murata Europe
46.	LSM303C eCompass	STMicroelectronics
47.	ISL29125 RGB digital light sensor	Intersil
48.	1111SQ high-frequency air core inductors	Coilcraft
49.	LTM8050 2A µModule regulator	Linear Technology
50.	Tachyon laminates & prepregs	Isola Group

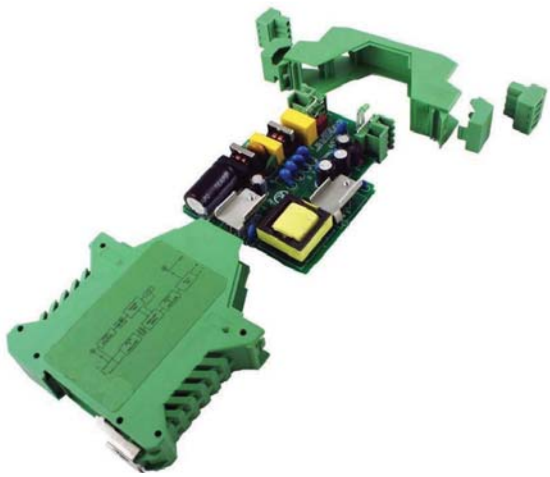
It's no wonder why the Brain Sentry Impact Sensor attracted a lot of attention. It's also not surprising that the next component on the list is another accelerometer. The ADXL375 three-axis digital MEMS accelerometer from Analog Devices will find homes in low- and high-powered wireless sensor networks employed in concussion detection, transportation, asset tracking, and other applications.

Already, the ADXL375 has been designed into the newest generation of the Blast Gauge body-worn blast detection system from BlackBox Biometrics. In addition to its low power drain, implying long intervals between charging, its integrated memory-management system consists of a 32-level first-in first-out (FIFO) memory. Its low-power modes can be used to set impact thresholds, store data, and reduce overall power consumption by offloading those functions from the host processor.

ODD OR INTRIGUING

Taking the sixth spot on this year's list, the ARL capacitive touch switch from CIT Relay & Switch offers embedded capacitive touch slider functionality that can be linear or rotary. The haptic feedback device's options include a pushbutton function and a timer for time-demand programs. Applications include audio and video equipment, automotive, lighting, instrumentation, and appliances.

Do you need to measure how much aerated liquid is in a tank? The liquid's fizziness may make that a tricky proposition. Positioned at number 21, the LL-01 Sentio series miniature ultrasonic liquid-level switches from Measurement Specialities operate when the liquid reaches their level, but no mechanical parts are involved.



1. The latest DIN rail mount enclosures from Automation Systems Interconnect come in 12.5-, 17.5-, 22.5-, 35-, 45-, and 67.5-mm wide housings. Ventilating slots help to ensure cooler, stable internal temperatures and reduce overheating issues.

10 MHz Distribution Amplifiers

- **Sine wave outputs (+13dbm)**
- **Amplitude leveling**
- **Low additive phase noise**
- **High channel-to-channel isolation**
- **High return loss**

FS730 and FS735 series ... starting at $1250 *(U.S. list)*

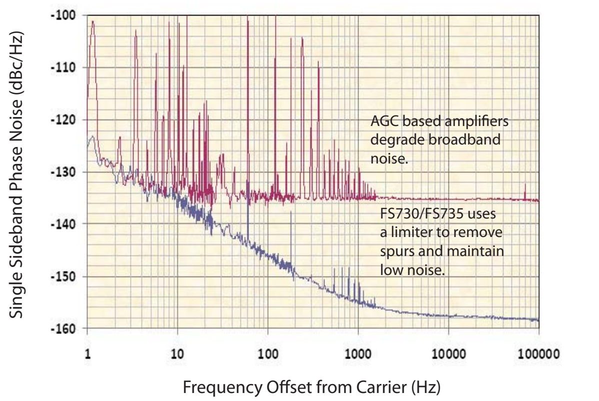
The FS730 and FS735 10 MHz distribution amplifiers from SRS provide state-of-the-art solutions to challenging signal distribution tasks.

These distribution amplifiers use an input limiter design, which removes amplitude modulation from the signal, provides fixed amplitude outputs and blocks input noise. Virtually any 10 MHz waveform with a duty cycle near 50% may be used as an input.

The FS735 model provides fourteen 10 MHz output BNC connectors on the rear panel, with status indicators on the front panel. The half-rack sized FS730 model gives seven 10 MHz outputs and is available in both bench-top and rack-mount forms.

With mix and match capability, the FS735 can also be configured with 10 MHz, 5 MHz, Broadband, and CMOS Logic distribution amplifiers side-by-side for other applications. Multiple units can be daisy-chained for easy expansion.

Please visit www.thinkSRS.com for details.



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

The sensing for these single-pole, single-throw (SPST) normally open switches is ultrasonic. They also can stand ambient pressures up to 250 psig. Versions rated for pressures up to 500 psig are available, as are normally closed versions. They run on 5 to 30 V dc as well.

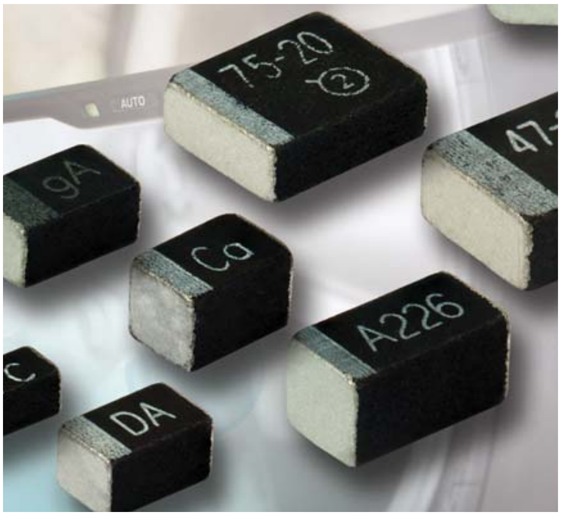
2014 TOP 101 COMPONENTS		
Rank	Product	Company
51.	LDC1000 data converter	Texas Instruments
52.	Si50x CMEMS oscillator	Silicon Laboratories
53.	VM3 snap-action switches	CIT Relay & Switch
54.	Lithium-ion capacitors	Taiyo Yuden
55.	Battery-free sensor kits	Farsens S.L.
56.	Snapdragon 800 processor	Qualcomm
57.	Model S subminiature pressure transducers	Honeywell International Inc.
58.	HCS high-current shunt resistors	Stackpole Electronics
59.	Dx35 laser distance measurement sensors	Sick Inc.
60.	CSD17381F4 and CSD25481F4 transistors	Texas Instruments
61.	70-dB analog MEMS microphone	InvenSense
62.	LSM9DS1 movement/position sensor	STMicroelectronics
63.	GLM and GLN ultra-broadband inductor series	AVX Corp.
64.	XP5 miniature pressure sensor	Measurement Specialties
65.	T4K82 13-Mpixel CMOS image sensor	Toshiba Electronics Europe
66.	MA40H1S-R sensors	Murata Europe
67.	LC898111AXB-MH IC	ON Semiconductor
68.	LTC6431-20 fixed-gain amplifier	Linear Technology
69.	DASSPLIT power splitters	Pulse Electronics
70.	Sprague T42 chip capacitors	Vishay Intertechnology
71.	ARS PRO enhanced sensor	Diversified Technical Systems
72.	VML0604 transistor	ROHM Semiconductor
73.	MGDDI-60 60-W dc-dc converters	Gaia Converter
74.	Type PFCH capacitors	Cornell Dubilier Electronics
75.	TR temperature-compensated pressure sensors	Merit Sensor
76.	AFT27S006N and AFT27S010N transistors	Freescale Semiconductor
77.	GXOS capacitors	AVX Corp.
78.	SMD power inductors	Bourns
79.	FFLC medium-power film capacitors	AVX Corp.
80.	89BSD piezoresistive silicon pressure sensor	Measurement Specialties
81.	Series IO ultrasonic sensors with pushbutton programming	Pepperl+Fuchs
82.	XR3070-78X ruggedized RS-485/RS-422 transceivers	Exar
83.	70-9155 board-to-board compression contacts	AVX Corp.
84.	IHLP high-current inductor	Vishay Intertechnology
85.	Single-side sensor	Neonode Inc.
86.	AS5162 position sensor	AMS
87.	DesignWare sensor IP subsystem	Synopsys
88.	LS32-1500 liquid-flow sensor	Sensirion AG
89.	PCX-7401 laser diode driver and current source	IXYS Colorado
90.	Model SP007 differential pressure transmitter	tecsis LP
91.	LIF400 linear encoders	Heidenhain Corp.
92.	P760 series disc magnet motor	Portescap
93.	VR and SR electric double-layer capacitors	ROHM Semiconductor
94.	SSC7102 sensor hub	Microchip Technology
95.	MC33901 and MC34901 transceivers	Freescale
96.	Versa Clock 5 programmable clock generators	Integrated Device Technology
97.	High Reliability MLCC ceramic capacitors	Yaiyo Yuden
98.	DHX91 system-on-chip	Everspring/DSP Group
99.	Python CMOS image sensors	ON Semiconductor
100.	CVC025CL-0902-0928 voltage controlled oscillator	Crystek
101.	TransGuard and StaticGuard VCLD series	AVX Corp.

Ranked at number 22, the Texas Instruments bq27421 lithium-ion (Li-ion) battery fuel gauge targets portable medical devices such as wearable health monitors and industrial devices like inventory scanners. It uses TI's impedance track advanced battery technology, which is quite a bit more sophisticated than simple fuel-gauge ICs that simply count coulombs going in and subtract coulombs out. Instead, the bq27421 provides more information about remaining battery capacity, state of charge, and battery voltage, extending the run-time of portable devices. The new and improved Gauge Studio software tool is available as well.

PASSIVES DRAW ATTENTION

Can there be anything new to say about resistors, capacitors, and coils? Can novel passives attract reader attention? There were 10 capacitors on the list, six inductors, and one lone resistor, which appeared at number 34. Vishay Precision Group's FRFC 0805 high-precision, next-generation, surface-mount, Bulk Metal Z1-Foil technology device is all about precision and long-term stability.

The resistor offers load-life stability of ±0.005% (50 ppm) at 70°C and rated power for 2000 hours. Its typical temperature coefficient of resistance (TCR) is ±0.005/°C from 0°C to 60°C and ±0.2 ppm/°C from –55°C to 125°C. Power TCR is 5 ppm at rated power, and tolerances run tight to ±0.01%. It's also small, even for a surface-mount passive. Its flip-chip configuration saves up to 35% of board space compared to



2. Vishay Intertechnology's TP8 molded, automotive-grade, solid-tantalum chip capacitor series is the first AEC-Q200-qualified lineup to deliver high capacitance-voltage ratings in 0603, 0805, and 0906 case sizes, according to the company.

3. TDK's MP1005M1R0D multilayer power inductors come in a 1.0- by 0.5- by 0.7-mm IEC 1005 case, the smallest available, for a shrink of approximately 60%.

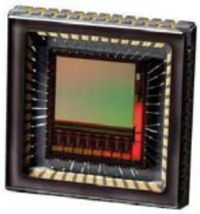
surface-mount resistors with wraparound terminations. Resistances of 5 Ω to 8 kΩ are available.

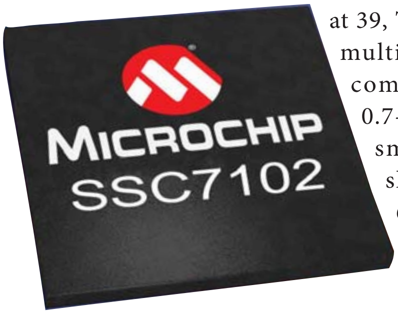
The 10 capacitors on the list ranged from the twentieth slot down to number 97. The top draw, Vishay Intertechnology's TP8 molded, automotive-grade, solid-tantalum chip capacitor series, is the first AEC-Q200-qualified lineup to deliver high capacitance-voltage ratings in 0603, 0805, and 0906 case sizes, according to the company *(Fig. 2)*.

Despite the smaller packaging, capacitance and voltage ratings still run from 1.0 µF at 40 V to 100 µF at 0.3 V. The devices offer standard capacitance tolerances of ±10% and ±20% and an operating temperature range of –55°C to 85°C, or 125°C with voltage derating. The caps are intended for energy storage, filtering, and decoupling in space-constrained automotive applications including tire pressure monitoring systems, camera modules, rearview mirrors, and remote keyless entry.

The six inductors that placed among this year's Top 101 Components ranged from 39 to 84. Ranked

4. ON Semiconductor's Python CMOS image sensor family offers 0.3-, 0.5-, and 1.3-Mpixel resolutions. These devices enable in-pixel correlated double sampling (ipCDS), which delivers CCD-like optical performance from a CMOS imaging device.





5. Microchip's SSC7102 sensor hub can "fuse" data produced by multiple motion sensors such as accelerometers, magnetometers, and MEMS gyroscopes, plus environmental sensors for properties such as light intensity, temperature, humidity, and atmospheric pressure.

at 39, TDK's MLP1005M1R0D multilayer power inductors come in a 1.0- by 0.5- by 0.7-mm IEC 1005 case, the smallest available, for a shrink of approximately 60% *(Fig. 3)*. Rated inductance and current are 1.0 µH and 500 mA. A new, low-loss ferrite material allows such high currents for their size. Applications include smartphones, tablets, digital cameras, and other mobile devices.

Number 84 in overall reader interest this year was a high-temperature-rated automotive inductor from Vishay. The Vishay Dale IHLP-2525CZ-8A high-current inductor can operate from –55°C to 180°C. It comes in a 3.0-mm high 2525 case and can be ordered in inductance values from 0.47 to 22 µH.

Typical dc resistance ranges from 3.87 to 163.0 mΩ. The guaranteed maximum range is from 4.14 to 173.0 mΩ. Also, the inductor will handle frequencies up to 1 MHz. Target applications include engine and transmission control units, diesel injection drivers, entertainment and navigation systems, noise suppression for motors, windshield wipers, and high-intensity discharge (HID) and LED lighting.

SENSORS RULE

Sensors constitute the largest category on our list, with 32 items. Ranked 99th, ON Semiconductor's Python CMOS image sensor family offers 0.3-, 0.5-, and 1.3-Mpixel resolutions. These devices enable in-pixel correlated double sampling (ipCDS), which delivers CCD-like (charge-coupled device) optical performance from a CMOS imaging device *(Fig. 4)*.

Few industrial-control applications rely only on one or two sensors. Ranked at number 94, Microchip's SSC7102 sensor hub can "fuse" data produced by multiple motion sensors such as accelerometers, magnetometers, and MEMS gyroscopes, plus environmental sensors for properties such as light intensity, temperature, humidity, and atmospheric pressure *(Fig. 5)*. It consumes approximately 4 mA while running complex sensor-fusion algorithms, extending battery life for Windows 8.1 tablets, laptops, ultrabooks, and smartphones. ed

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WHITE SPACE Gives New Life To Old

Spectrum sharing and cognitive radio create new wireless services.

White space is the name that has been given to unused TV channels in various locations around the U.S. and in some other countries. The Federal Communications Commission (FCC) usually spaces the TV channels apart to prevent one from interfering with another, leaving blank unused channels in between.

These unused channels can be deployed for other communications purposes, making free spectrum useful. Sometimes called TV white spaces (TVWS), these channels can be repurposed as needed if the requirements of the FCC are met. TVWS is called Super Wi-Fi and White-Fi as well, although it does not have anything to do with the real Wi-Fi.

1. Carlson Wireless Technologies' RuralConnect basestation is housed in a standard rack mount and covers from 470 MHz to 768 MHz for both U.S. and European systems.

THE WHITE SPACE SPECTRUM

In the United States, the TV spectrum lies between 54 MHz and 698 MHz divided into 6-MHz wide channels *(see the table)*. Any of these channels can potentially be used license-free. The availability of a particular channel depends on its location and the TV station assignments that vary widely across the country.

The exceptions are channels 3, 4, and 37, which cannot be used. Channels 3 and 4 are still reserved for connecting RF modulators to TV set antenna terminals. Channel 37 is assigned to radio astronomy for use in monitoring various RF conditions in the universe.

The most useful spectrum can be found from channel 14 (470 MHz) through channel 51 (698 MHz). At these higher UHF frequencies, the antennas are shorter and more manageable than antennas for VHF channels 2 (54 MHz) through channel 13 (216 MHz).

The great value of this spectrum is its potential for longer-range communications than are possible with other wireless services above 2 GHz. According to Friis's law, the range of a radio depends on the wavelength where shorter wavelengths (higher frequencies) travel shorter distances for a given power level, receiver sensitivity, and antenna gains. Whereas a 2.4-GHz signal may travel up to several kilometers under the right conditions, a signal in the UHF range from 470 MHz to 698 MHz can travel many miles, up to 100 miles in some cases.

While all UHF and microwave signals basically travel line of sight (LOS) from transmitting antenna to receiving antenna, the lower frequencies are better at penetrating trees, buildings, and other structures than the higher frequencies, which are more easily absorbed and reflected. So, TVWS frequencies are often referred to as non-line of sight (NLOS) spectrum. Where long range is needed and obstacles are a problem, the white spaces are an excellent option.

Besides the standard over-the-air (OTA) TV stations, this spectrum is used for other purposes, making the identification of free channels tricky. Typical of other applications are low-power local TV, TV repeaters/translators, wireless microphones, and auxiliary equipment. Some areas even use these channels for land mobile service, and some Gulf of Mexico regions use it for offshore telephone service.

One approach to finding the right channel is spectrum sensing, where the basestation receiver listens on the various channels to see what is taking place. If a signal within specific parameters is sensed, no transmission takes place and other channels are tested for activity.

The real key to finding an open channel is to know what services are nearby. An FCC-mandated master database records

RADIO Spectrum

all devices and stations using the TV channels. Before a white space basestation can transmit, it must reference the database.

HOW IT WORKS

A white space system usually consists of a master fixed basestation and one or more remote portable, mobile, or fixed terminals. All of the radios involved are frequency-agile, so they can switch quickly and automatically to a wide range of channels. Fixed basestations can operate on any channel from 2 to 51, but mobile devices are restricted to channels 21 to 51.

All fixed station units must have a geolocation capability that generally translates to an internal GPS receiver. Portable and mobile devices may have their own geolocation capability or may get their location by way of the fixed station to which they communicate.

In addition, all fixed stations must have access to the master database of stations and equipment. They also must supply their location to the database. Before a station can transmit, it must access the database to get a list of channels available for use and sense activity for possible interference. All devices must check the database periodically to see if conditions have changed.

A portable device can obtain its location information and list of available channels from the fixed station. Otherwise, it may have its own geolocation capability and database access capability. Furthermore, all devices must have an adaptable power output control so minimum power is used at all times to ensure minimum interference. In all cases, operation of a fixed station may not occur in a channel directly adjacent to an active TV channel.

The FCC restricts power levels to 1 W for basestations or 4 W effective isotropic radiated power (EIRP) with a gain antenna. Antenna height is restricted to 30 meters above ground. For mobile units, the maximum power is 40 mW or 100 mW EIRP.

A third party selected and approved by the FCC develops, maintains, and administers the database. There are 10 authorized database administrators including Google, iconectiv (formerly Telecordia), Key Bridge Global, Microsoft, and Spectrum Bridge. White space equipment and systems vendors select the database to use. Access to the database is usually via an Internet connection that operates in real time with the operation of the system.

The ability of a station or device to automatically check the database, provide location information, and select an appropriate channel means that the radios are intelligent. This is one form of what is called cognitive radio.

The Code of Federal Regulations (CFR) Title 47, Part 15, Subpart H spells out the details of operation and specifications. Another good reference is the FCC's Third Memoran-

TV WHITE SPACE CHANNELS AND FREQUENCIES ALLOWED BY THE FCC

TV channel number	Frequency (MHz)	TV channel number	Frequency (MHz)	TV channel number	Frequency (MHz)
2	54–60	19	500–506	36	602-608
3	60–66 (not allowed)	20	506–512	37	608-614 (not allowed)
4	66–72 (not allowed)	21	512–518	38	614-620
5	76–82	22	518–524	39	620-626
6	82–88	23	524–530	40	626-632
7	174–180	24	530–536	41	632-638
8	180–186	25	536–542	42	638–644
9	186–192	26	542–548	43	644-650
10	192–198	27	548–554	44	650–656
11	198–204	28	554–560	45	656–662
12	204–210	29	560–566	46	662–668
13	210–216	30	566–572	47	668–674
14	470–476	31	572–578	48	674–680
15	476–482	32	578–584	49	680–686
16	482–488	33	584–590	50	686–692
17	488–494	34	590–596	51	692–698
18	494–500	35	596–602		

dum Opinion and Order (FCC 12-36) related to Dockets 04-186 and 02-380 (http://hraunfoss.fcc.gov/edocs_public/attachmatch/FFCC-12-36A1.pdf).

WHITE SPACE STANDARDS

Current white space radios use proprietary designs, either single carrier with quadrature phase-shift keying/quadrature amplitude modulation (QPSK/QAM) or orthogonal frequency-division multiplexing (OFDM). However, some standards for white space have been developed, including IEEE 802.11af, 802.22, and Weightless.

The 802.11af standard is based on the existing Wi-Fi standards but modified for the white space bands and the unique needs of the media access control (MAC) layer. It uses OFDM with binary phase-shift keying (BPSK), QPSK, 16-phase QAM (16QAM), or 64-state QAM (64QAM) using fast Fourier transform (FFT) sizes of 64, 128, 256, and possibly 512 or 1024.

The radios may operate in a 5-MHz bandwidth, although bandwidths of 10, 20, and 40 can be used if multiple TVWS channels can be bonded or combined, contiguous or non-contiguous. The data rate is 12 Mbits/s. The access method is carrier-sense multiple access with carrier sense (CSMA/CS) and time-division multiple access (TDMA). Duplexing is time division duplex (TDD).

The standard also uses a convolutional code for forward error correction (FEC). It is designed to interface with a geolocation device and the external database as well as deploy spectrum sensing. Maximum range is expected to be <100 meters indoors, as with standard Wi-Fi, or up to about 5 km outdoors under the right conditions. The standard is still under development, but final ratification is expected in 2014.

The 802.22 standard was developed to create a wireless regional area network (WRAN) or metro network standard similar to WiMAX (802.16). Ratified in 2011, it is readily available for

THE SHARED SPECTRUM CONCEPT

THE IDEA OF sharing valuable spectrum has been around forever and is already implemented in many systems. Yet to deal with the never-ending demand for higher Internet speeds, more spectrum is needed even though there is little or none to use for growth. More sophisticated spectrum sharing methods like those used for white space radio may be the answer.

Multiple users can share the industrial-scientific-medical (ISM) bands without problems. Wi-Fi, Bluetooth, ZigBee, cordless phones, microwave ovens, and many industrial products currently share the band from 2.4 to 2.483 GHz. Yet all communications are generally successful and interference-free.

The short-range, low-power, widely different modulation and access methods ensure minimum interference. Also, successful coexistence measures taken by the Wi-Fi and Bluetooth vendors have reduced the potential for interference. The 5-GHz ISM band will have similar success.

In the cellular industry, the carriers already share their spectrum with themselves. They employ frequency-reuse methods to use the same frequencies again and again in different cells. This is possible because of the shorter range, lower power, tower height adjustments, and directional antennas.

A key technique in frequency sharing is antenna polarization and beamforming, which are part of a technique called spectral diversity. For instance, two radio signals may share the same frequency by simply using different antenna polarizations. One may use vertical polarization, and the other horizontal polarization. Alternately, one antenna may use right-hand circular polarization (RHCP) while the other uses left-hand circular polarization (LHCP).

Beamforming antennas narrow the coverage area despite any close range while boosting power. Multiple-input multiple-output (MIMO) techniques also can be deployed, as they transmit multiple data streams on the same frequency but over different antennas and signal paths. Finally, the cognitive radio techniques of white space radios can ultimately be used to share spectrum. Such techniques are already in use by the military.

Spectrum sharing is an approach whose time has come. In addition to encouraging government and the military to give up or repurpose spectrum, sharing spectrum may eventually become a common method. Many proposed approaches are being considered, including geographic, time-based, sensing, and database.

Some techniques for better sharing spectrum are being developed for the AWS3 cellular band (1755-1780 MHz, 2155-2180 MHz, and 1695-1710 MHz) and the proposed 3.5-GHz cellular band (3650-3650 MHz and potentially 3650-3700 MHz). The approaches are extremely complex. Furthermore, new policies, rules, and regulations will have to be developed and put into place. Spectrum sharing is a promising work in progress.

FOR MORE INFORMATION

Dynamic Spectrum Alliance

www.dynamicspectrumalliance.org

Industry Internet Consortium

www.iiconsortium.org

TVWS development. As a more complex and robust standard than 802.11af, it offers speed and range advantages with some cost tradeoffs.

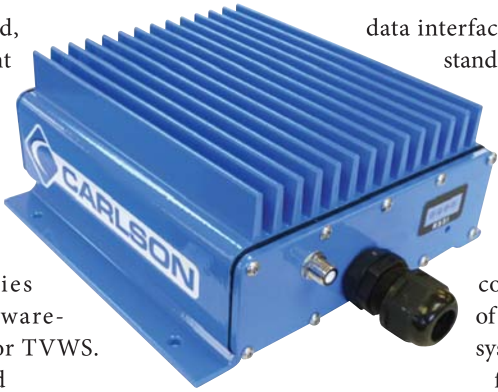
The modulation method again is OFDM using QPSK, 16QAM, and 64QAM with an FFT size of 2048. It can operate in channel widths of 6, 7, and 8 MHz. The data rate is 22.69 Mbits/s. The access method is orthogonal frequency-division multiple access (OFDMA). Like 802.11af, duplexing is TDD.

The standard additionally can use a convolutional code for FEC. However, optionally other FEC can be used such as convolutional turbo codes (CTC), low-density parity check (LDPC), or stream-based trace compression (SBTC) that further improve reliability, speed, and range because of coding gain. The typical range is 17 to 33 km with a maximum of up to 100 km under good conditions.

Until the standards are finalized, most commercial TVWS equipment will continue to use proprietary standards. This is not a disadvantage for specific applications or systems, but widespread roaming and portability will be restricted to a defined geographical area.

Carlson Wireless Technologies designed its RuralConnect software-defined radio (SDR) specifically for TVWS. Employed in multiple test sites and in several rural broadband wireless Internet services, it can be used to form both point-to-point and point-to-multipoint networks. The equipment is designed to operate from 470 to 698 MHz with 6-MHz channels or from 470 to 786 MHz in 8-MHz channels for Europe *(Fig. 1)*.

The basestation has an output power of 200 mW and feeds the antenna through a 75-Ω F connector. Receiver sensitivity for a 10^{-6} bit error rate (BER) is –93 dBm using QPSK. 16QAM is also available. Data rates of 4, 6, 8, 12, and 16 Mbits/s are possible either fixed or adaptive. The duplexing is TDD. The data interface is 10/100 Ethernet. The unit uses a standard rack mount.



2. Carlson Wireless Technologies' RuralConnect CPE unit shares the same specifications as the basestation but is smaller.

A typical situation is 10 clients with an downlink/uplink capability of 3.2/1.6 Mbits/s. The customer premise equipment (CPE) units have similar specs but with different packaging *(Fig. 2)*. The range will vary with local conditions and the coding rate. Ranges of 2 to 12 miles are possible. The Carlson system is fully FCC certified, so it is ready for immediate deployment.

Carlson also has a good matching antenna *(Fig. 3)*. It is a vertically polarized omnidirectional array that can operate over the 470- to 786-MHz range. The gain is 5.2 dBi. The voltage standing wave ratio (VSWR) is 1:1.8 using either 50- or 75-Ω cables with N or F connectors, respectively.

While the number of TVWS equipment makers is small right now, more are expected as this wireless method is adopted. Other equipment manufacturers include Adaptrum, KTS Wireless, Neul Ltd., Redline Communications, and Ruckus. MediaTek, Neul, and RealTek have TVWS-related chips.

With hardware standards still in flux, there is need for a common standard and protocol for white space applications. One growing standard effort for machine-to-machine (M2M) applications is Weightless. The Weightless SIG strives to coordinate members to foster the development of a new and more relevant standard to enable M2M applications in white space.

With M2M and its cousin the Internet of Things (IoT) predicted to enable up to 50 billion new devices by 2020, a common efficient specification is important. *(For details on the M2M and IoT movements, see "The Connected World Awaits" at http://electronicdesign.com/communications/connected-world-awaits.)*

The Weightless specification meets the needs of M2M and IoT. These basic requirements mean very low cost (e.g., $2 modules), low power and long battery life (years), small data packets (<50 bytes), low speed to high speed, TDD to fit white space spectrum limits, ability to handle many subscribers, and tolerance for long latency.

The physical layer (PHY) uses single-carrier modulation schemes of BPSK, QPSK, and 16QAM. It also supports direct-sequence spread spectrum (DSSS) with variable spreading factors. Spreading also implies long headers up to 2 seconds. Frequency hopping is supported to minimize potential interference. Speeds can range from 2.5 kbits/s up to 16 Mbits/s depending upon the need. A typical TDMA format is 24 user uplink time slots. Authentication and encryption features are said to be "cellular grade."

Neul already has a chip designed to meet the specifications. This CMOS chip, called the ICENI, operates from 169 to 960 MHz and comes in a 6- by 6-mm ball-grid array (BGA) package. Complete modules are expected in the near future.

The standard details are closely held. You must be a member of the SIG to get all the facts and features. See the Weightless website at www.weightless.org for more information. Nevertheless, Weightless seems promising as it is a standard specifically not only for white space but also M2M and IoT.

WHITE SPACE APPLICATIONS

There are many potential applications for the white space channels where other wireless technologies come up short. Those with the most potential include wireless Internet service, backhaul for other wireless services, telemetry, and M2M.

White space is ideal for providing Internet connectivity in rural areas where long distances and challenging physical environments are involved. Even in mountainous and forested areas, ranges of several miles can be achieved based on actual tests. Users who have no cable TV or DSL service can get fast interconnections even in the most remote locations. White space is a good fit for municipal broadband applications as well.

Telemetry and M2M applications are already deployed. These applications require the remote monitoring and/or control of distant facilities or infrastructure components, including pipelines, oil rigs, tank farms, electric substations and the Smart Grid, smart metering, vehicle and other asset tracking, traffic monitoring, and dozens of other industrial uses. TVWS systems are also adaptable to marine applications or used for video surveillance. Systems using supervisory control and data acquisition (SCADA) are a prime target for white space wireless.

3. Carlson Wireless Technologies' white space antenna is a vertically polarized array with a gain of 5.2 dBi that covers the entire 470-MHz to 768-MHz spectrum.

CRITICAL ISSUES

While TVWS has potential, several issues need to be monitored and considered. First, radio equipment will continue to be expensive due to the lack of specific chips designed for this technology. Now that radio standards are being finalized, someone needs to make a cheap baseband IC for 802.11af and 802.22. This will speed development considerably and make equipment more affordable.

Second, the Federal Communications Commission is planning an incentive spectrum auction in the near future that will involve selling off parts of the 600- to 700-MHz spectrum for cellular usage. The agency is asking broadcasters to give up existing channels and/or relocate channels for payment.

The existing cellular carriers will happily buy this spectrum for billions so they can expand their networks and keep up with the constant consumer demand for faster services. Some or all of the channels from 36 (602 MHz) to 51 (698 MHz), then, would not be available. TVWS will keep moving forward, but its operational range will be restricted. ed

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Hard-Won Knowledge Mitigates Effects Of Tin Whiskers

While pure tin finished surfaces have the potential to grow tin whiskers, designers can employ several mitigation strategies to prevent their growth during the soldering process.

July 1, 2014 marked the eighth anniversary of the European Union's Restrictions on Hazardous Substances (RoHS) directive. When it was enacted, the industry knew that the elimination of lead from electronic products would lead to "tin whisker" problems. Since then, the industry has learned a lot about mitigating their effects.

Tin whiskers are slim metallic filaments that emanate from the surface of tin platings *(see the figure)*. These filaments are conductive and can cause shorts across adjacent conductors—and these shorts can cause some really bad failures *(Table 1)*. But with all of this knowledge, the industry is still struggling with how to predict and prevent these "needles of pain."

Companies may avoid some potential issues by conducting a continuous and consistent effort to maintain as many possible sources of high-reliability components as possible. To do this, they must first find out if their suppliers intend to switch to pure tin electroplating or lead-free soldering. Those who indicate such intent should be provided with information intended to convince them to either reconsider switching or to maintain the capability to produce high-reliability components in parallel with lead-free components.

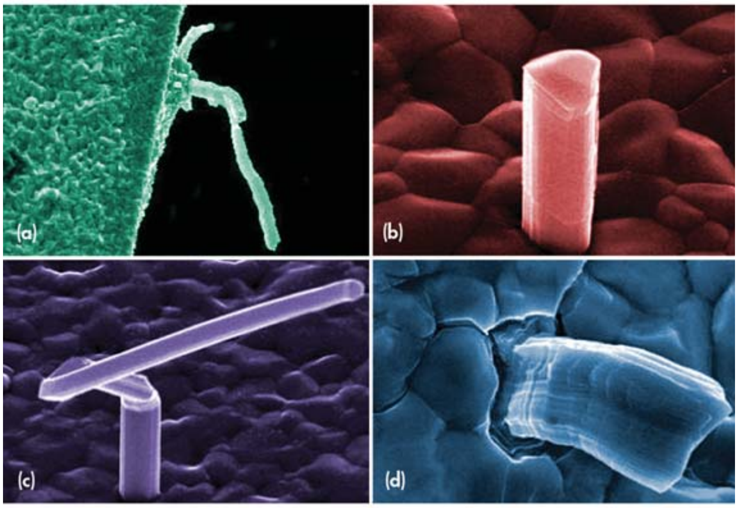
The uncertainties associated with tin whisker growth make it extremely difficult to predict if or when tin whiskers may appear. There are currently no industry-accepted accelerated test methods to judge a particular product's propensity to form whiskers. Due to the difficulties in predicting tin whisker growth, it may not be possible to completely eliminate tin whiskers as a failure risk.

Fortunately, various mitigation techniques are available. They include tin alloys, solder dip, conformal coatings, under-plating, annealing, strip and re-plate terminations, and conductor spacing/application-specific mitigation.

TIN ALLOYS

Utilization of procurement specifications that have clear restrictions against the use of pure tin plating is highly recommended. Most of the commonly used military specifications currently have prohibitions against pure tin plating. Studies have shown that alloying tin with a second metal reduces the propensity for whisker growth.

Alloys of tin and lead are generally considered to be acceptable where the alloy contains a minimum of 3% lead by weight. Although some experimenters have reported whisker growth from tin-lead (SnPb) alloys, such whiskers have also been reported to be dramatically smaller than those from pure tin plated surfaces and are believed to be small enough to not pose a significant risk for the geometries of today's microelectronics.



Whiskers are usually thin, metal films, 0.5 µm to 50 µm, that have been deposited onto a substrate material. They often grow from nodules (a). A typical whisker is 1 to 5 µm in diameter and between 1 µm and 500 µm long, as seen in this cross-section (b). They can come in different shapes, including kinked (c) or with rings (d).

It can be dangerous to rely on the part manufacturer's certification that pure tin plating was not used in the production of the product supplied. Studies have shown at several instances where the procurement specification required "no pure tin," but the product supplied was later determined to be pure tin. In some of these instances, tin whisker growths were also discovered. Users are advised to analyze the plating composition of the products received as an independent verification.

TABLE 1: TIN WHISKER-INDUCED FAILURE MECHANISMS
• Stable short circuits in low-voltage, high-impedance circuits where current is insufficient to fuse the whisker open
• Transient short circuits that persist until the whisker fuses open
• Plasma-arcing in a vacuum, where a whisker fuses open, but the vaporized tin results in plasma that is capable of conducting more than 200 A; this phenomenon is reported to have occurred on at least three commercial satellites and rendered the spacecraft non-operational
• Whiskers or pieces of whiskers that break loose and bridge conductors or interfere with optical surfaces or jam MEMS

SOLDER DIP

When pure tin plating cannot be avoided, other mitigations must be investigated. One such mitigation is the solder dip of lead-free component finishes with SnPb.

A SnPb solder dip process may be used to recoat the component leads. Solder of 63/37 or 60/40 can be used. Precautions are required to prevent damage to the parts. Possible damage can include package cracking or loss of hermeticity resulting from thermal shock, popcorning of plastic packages, solder bridging between leads on fine-pitch packages, solder bridging between leads and the component body, and handling damage such as bent or non-coplanar leads and electrostatic discharge.

The success of solder dipping as a tin whisker risk-mitigation approach depends on coating the entire exposed tin plated surface. If portions of the tin are left uncovered by the SnPb solder, they can still grow whiskers. With the exception of robust through-hole parts, all components must be dipped in accordance with GEIA-STD-0006.

A specialist sub-contractor compliant with these requirements will perform the operation using an automated robot system. Larger, more robust parts for axial or radial leaded parts, for example, can be dipped by hand and in house by the printed-circuit board (PCB) assembler.

CONFORMAL COATING

Just as the name implies, conformal coating is a coating with an inert material that can protect electronic circuit boards from the problems related to tin whisker growth: shorts, plasma arc, and debris. Four points should be considered while using conformal coating as a tin whisker mitigation technique:

- It must slow the formation of tin whiskers. We acknowledge that tin whiskers cannot be stopped until we understand how they form in the first place.
- It must prevent the outward escape of any tin whiskers that do nucleate.
- It must prevent the penetration of whiskers formed outside the conformal coat.
- It must protect the coated circuit board from loose whisker debris.

Boeing, Schlumberger, Lockheed, Raytheon, the National Physical Laboratory (U.K.), the Center for Advanced Life Cycle Engineering (CALCE), NASA, and other organizations have studied many types of conformal coatings *(Table 2)*.

No conformal coating meets all these criteria. However, the Arathane coating seems promising when applied sufficiently thick, and the conformal coating does prevent shorts from debris. Ultimately, no coating is 100% effective, and whiskers still grow. Thermal effects need to be considered if a conformal coating is used on parts that will need to dissipate heat when operating. If necessary, the device may need to be derated.

If the conformal coating fails to contain whisker formation, the effectiveness of a conformal coat in protecting against electrical leakage and corrosion will be compromised. A puncture site may provide an increased opportunity for excessive leakage currents that can produce transient or permanent failures.

Another concern related to whisker formation is the potential for whiskers to produce minor de-lamination of the conformal coating from the circuit board. The resulting capillary space could provide a void for condensation of the water vapor molecules that slowly diffuse through the coating material. This creates the slim possibility of galvanic corrosion, though it may not be of consequence.

Further, emerged whiskers that break loose may end up in other areas of your hardware that are vulnerable to conductive

TABLE 2: TYPES OF CONFORMAL COATING

Material	Relative thicknesses	Time	Results
Acrylic	1, 2, 3 mils	Five years, 50°C/50% RH	1 mil penetrated, tenting
Silicone	1 to 20 mils	150 days	Whiskers penetrated
Parylene C	0.4 to 0.5 mil	Up to five years, 50°C/50% RH	0.4 mil penetrated
Urethane (Arathane)	1, 2, 3 mils	Five years, 50°C/50% RH and 11 years	Penetration of 1 mil; none of 2 mils at 11 years
Urethane acrylate	1 and 3 mils	Okay after 150 days; 25°C/95% RH	Penetration of 1 and 3 mils

debris. However, this risk is substantially reduced compared to the scenario of not using a conformal coat.

UNDER-PLATING/INTER-METALLIC FORMATION

The formation of intermetallics in the base metal below the pure tin plating may create stresses that promote the growth of tin whiskers. Based on this assumption, a barrier layer such as nickel between the base metal and the pure tin finish may reduce the likelihood of tin whisker growth. One study indicates that tin whiskers can grow on parts with nickel under-plating. In another study, a nickel barrier layer of 1.5 μm over a copper base material significantly reduced the growth of tin whiskers on a low-stress tin finish.

Thin plating (less than 1 μm) or thicker plating (greater than 20 μm) may reduce the tin whisker formation. Unfortunately, the thin plating may reduce the ability of the finish to serve other necessary functions such as resisting corrosion. But while higher thickness may reduce internal stress in the plate, mechanical damage and/or long-term growth of intermetallics may still initiate whisker formation.

ANNEALING

Annealing after plating has become a widely accepted whisker mitigation technique. Annealing at 150°C for one hour within one hour of plating is an acceptable mitigation technique as long as the part is also conformal coated after soldering to the board. Annealing has been proved to reduce the maximum whisker length and the growth rate by relieving plating stresses, causing grain growth and increasing grain sizes while also forming a uniform inter-metallic layer of Cu6Sn5 over Cu3Sn, which slows further inter-metallic growth.

For semiconductor parts, surface finishes are subjected to various forms of annealing, such as cure bakes and burn-ins. These processes may have mitigated whisker formation on existing SnPb finishes.

While evidence of removal of compressive residual stress has been shown to significantly reduce the onset of tin whisker formation, it is not clear that whiskers will not be an issue in 10 to 30 years. Mechanical damage and other factors may induce compressive stresses sufficient to initiate whisker growth.

STRIP & RE-PLATE TERMINATIONS

If alternatives to tin plated parts cannot be obtained, it may be possible to remove the tin finish. This is normally risky on electronic components. The ability to remove the tin plating from the affected surfaces and refinish these surfaces must be made after a risk and cost analysis.

Such processes should be reviewed to determine the potential for affecting the reliability of the original product (e.g., a chemical attack on component materials). This method is not approved and should be carefully reviewed prior to any use, as it is perceived to be very risky.

CONCERNS AND RISKS

In terms of application-specific considerations, the proximately of adjacent conductors is a particular concern. For example, a 0.5-mm pitch, 208-pin plastic quad flat-pack (PQFP) package can have spacing between adjacent leads as small as 230 µm, and the spacing between adjacent pads can be as small as 100 µm.

For some high-density applications, the spacing between conductors can be 76 µm. Design rules normally call for 530-µm spacing between external conductors and 500 µm between internal conductors. Whisker growth of 250 µm can easily create shorts in high-density applications. Growths above 1 mm (1000 µm) can induce shorts under current design rules.

To remove the threat of shorts due to tin whiskers, engineers should review the criticality of the system or subsystem as well as its desired life expectancy. As noted above, a variety of application-specific considerations may be used to assess the risk of whisker-induced failures and assist in making "use as-is" or "repair/replace" decisions.

These factors include circuit geometries that are sufficiently large to preclude the risk of a tin whisker short, mission criticality, mission duration, collateral risk of rework, schedule, and cost. At present, any pure tin finished surface can be considered as having the potential to grow tin whiskers.

Tin whisker mitigation strategies are recommended due to the whisker growth phenomenon associated with tin during the soldering process. Cypress Semiconductor has acknowledged the problem and minimized it by adding lead to the soldering process.

Even after many studies and experiments, there is still no definite conclusion on how or why tin whiskers form. An established method performed at Cypress to relieve the stress of tin plating added annealing or post-bake during the solder plate process with one-hour, 150°C condition. This is adequate to significantly reduce growth, but appropriate prevention and a suitable solution for tin whisker growth are still unresolved and unknown. ed

REFERENCES
1. NASA's research on tin whiskers: http://nepp.nasa.gov/whisker./background/index.htm
2. "Whisker (metallurgy)," Wikipedia, http://en.wikipedia.org/wiki/Whisker_(metallurgy)
3. CALCE, www.calce.umd.edu/tin-whiskers/

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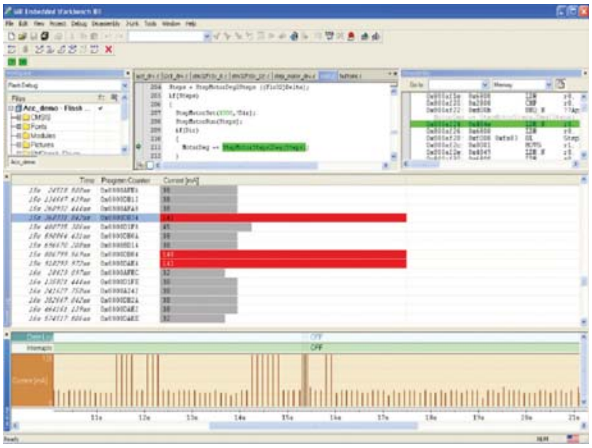
Smart Programming And Peripherals Reduce Power Requirements

Various techniques can minimize the power your microcontroller needs, extending battery life or reducing how hard your energy harvesting systems have to work.

Minimizing power requirements while maximizing performance tends to be on everyone's checklist these days. But, like security technology, there is a lot of misunderstanding and even more new technology that many designers have yet to encounter.

Developers now need to pay closer attention to details like static versus dynamic power. Static power is needed to start a device, while dynamic power changes based on the operations and peripherals involved to get work done.

They should still remember simple recommendations like using high-resistance pull-up resistors on I/O pins, especially for unused devices that cannot be turned off completely. The nanoamps saved by software gymnastics often can be undone by not employing these simple techniques.



1. IAR Systems' power debugger matches code to power usage. Breakpoints can be set based on power utilization.

POWER DEBUGGING AND VIRTUALIZATION

Many designers tend to assume that a hardware solution alone will address their needs for power efficiency. It might require the use of a couple of power-down modes, but that is often it for many projects. However, software development can play a key role too.

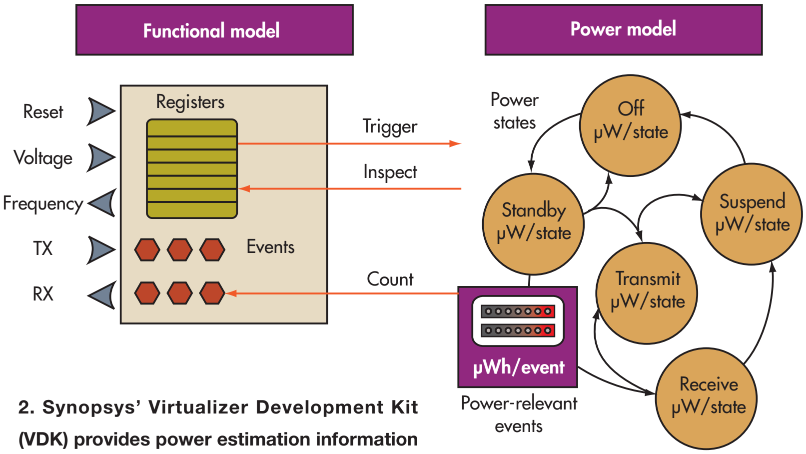
One of the biggest changes on the software side is the use of power debugging. This is not something for power users, although they might use the tools, but rather debuggers that have hooks into the power utilization monitors.

For example, IAR Systems' power debugger *(Fig. 1)* allows developers to locate program "hot spots." It normally works with a single current-sensing input that provides overall system power use. Developers can match the power usage to a particular line of code, although this is based on a combination of factors including the state of peripherals. Still, the feedback is usually useful in determining how power is utilized.

The power information is just one more piece of data that can be used for breakpoints and tracing. Breakpoints can check if power usage is higher or lower than a specified limit. Typically, a trace provides a power utilization graph. The trace is often used to apply a threshold value so the programmer can see what code was active during high-energy usage. This approach can be used to see the results of changes in power modes and other power reduction techniques.

Testing real hardware is not the only way to check out power utilization. It can be done using virtual hardware as well such as the Synopsys Virtualizer Development Kit (VDK). It allows power estimation based on a virtual machine implementation *(Fig. 2)* so developers can see how a system will react before the hardware is available. The same type of experimentation can be performed with the virtual hardware so power-efficient software is ready when the hardware becomes available.

One way to determine whether hardware can provide the power optimizations necessary for an application is to use power-based benchmarks. The Embedded Microprocessor



2. Synopsys' Virtualizer Development Kit (VDK) provides power estimation information based on virtual machine designs.

Benchmark Consortium (EEMBC) has delivered a wide range of benchmarks like CoreMark. EEMBC also has one for ultra-low-power microcontrollers and processors *(see "Interview: Markus Levy Discusses The EEMBC Ultra Low Power Benchmark" at electronicdesign.com)*. The EEMBC ULPBench (Ultra Low Power Benchmark) is a series of tests *(Fig. 3)*.

Benchmarks can be useful in determining whether a particular platform can provide the kind of power reduction techniques needed for an application. It also can be used to determine if a particular platform is more or less efficient than an existing application platform implementation.

RUN MODES AND CLOCKS

Back in the dark ages, developers generally were limited to choosing a clock frequency to adjust the amount of power consumed by the system. Power consumption was less of an issue given the limited number of mobile devices in play. These days, developers operate at the opposite extreme with multiple ways of reducing power consumption. Applications and operating systems can twiddle with operating voltages and clock frequencies.

Developers often have the choice of clock and power sources as well, adding more complexity to the mix. For example, very low-power, on-chip clocks are often available on microcontrollers, but their accuracy may be limited compared to off-chip crystals.

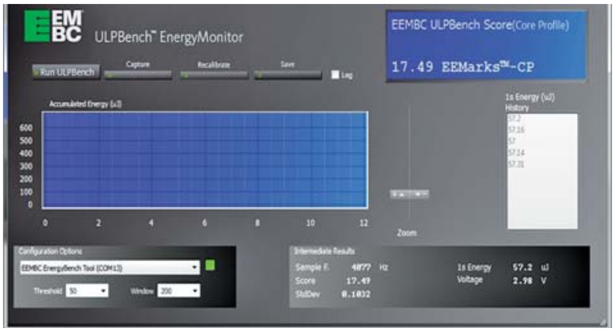
Systems are also partitioned, allowing the use of clock gating and power isolation in multiple regions. Many newer systems employ a large number of regions providing very fine-grain control. Managing all these features can be a challenge to developers who are just trying to get a job done.

Run modes provide a tradeoff between simple management and control of a complex collection of settings. A typical microcontroller may have a few to a dozen run modes that have different characteristics that affect clock rate, operating voltages, and peripheral capabilities. These modes tend to address bursty operation of many applications where high-performance compute or high-power peripherals are required for a short time period. The system then can operate using minimal power until computation or communication is required.

In general, slower means lower power, but this really depends on the application and system. Slower operation means that computation or communication needs to proceed more slowly, taking a longer time to get a particular job done. This may be the best option if the overall power utilization is better, but in many instances faster may be better. It all depends on the overall power efficiency as well as the types of the available run modes and the type of work that needs to be done.

Freescale's KL03 has a compute mode that turns off most peripherals and only runs the memory and CPU *(see "How Small A Chip Will A 32-bit Micro Fit In?" at electronicdesign.com)*. This is handy if lots of computation is needed, such as post-processing of a message or peripheral operation. A system might use a low-power sleep mode while waiting on an event, wake up and process an event when it occurs, switch to compute mode to finish the operation, save the results, and return to the sleep mode.

There ain't no such thing as a free lunch (TANSTAAFL) when selecting modes and configurations. The plethora of options makes selection a challenge. Nothing is free when it comes to power, computation, and even storage. Microchip's nanoWatt XLP technology has a deep-sleep mode that shuts down the processor core and peripherals, but the output pin state is maintained along with a few bytes of RAM. The rest of the RAM is also shut down. Half a dozen sources will wake up the system.



3. The Embedded Microprocessor Benchmark Consortium (EEMBC) ULPBench is a series of tests to check out 8-, 16-, and 32-bit microcontrollers.

DESIGN NOTES

Dual Phase Buck Controller Drives High Density 1.2V/60A Supply with Submilliohm DCR Sensing – Design Note 528

Mike Shriver

Introduction

Designers of low output voltage rails for communication, networking, server and industrial systems are challenged to achieve greater load currents and higher efficiency in diminishing board space. The LTC®3774 dual output buck controller eases this burden by interfacing easily with DrMOS devices, providing high efficiency and small size by integrating MOSFET and gate driver in the same package. The LTC3774 can sense current across the inductor's DCR, with values as low as 0.2mΩ, improving efficiency by eliminating the need for a discrete sense resistor. The LTC3774's peak current mode architecture provides cycle-by-cycle current limit, inherent cycle-by-cycle current sharing and easy to design type II compensation.

High Efficiency Converter with a Small Footprint

Figure 1 shows a dual phase 1.2V/60A LTC3774 converter operating at a switching frequency of 400kHz. The power stage for each phase is the FDMF6820A DrMOS, which comes in a 6mm × 6mm QFN package, and a 0.3µH single winding ferrite inductor with a typical DCR of 0.325mΩ. The resulting full load efficiency is 89.8%, as shown in Figure 2. The core of the converter has a current density of $50A/in^2$.

DrMOS Interface

The PWM outputs of the LTC3774 are designed to drive DrMOS devices with a 3-state PWM input. When the PWM signal is high, the top FET is on, and when the

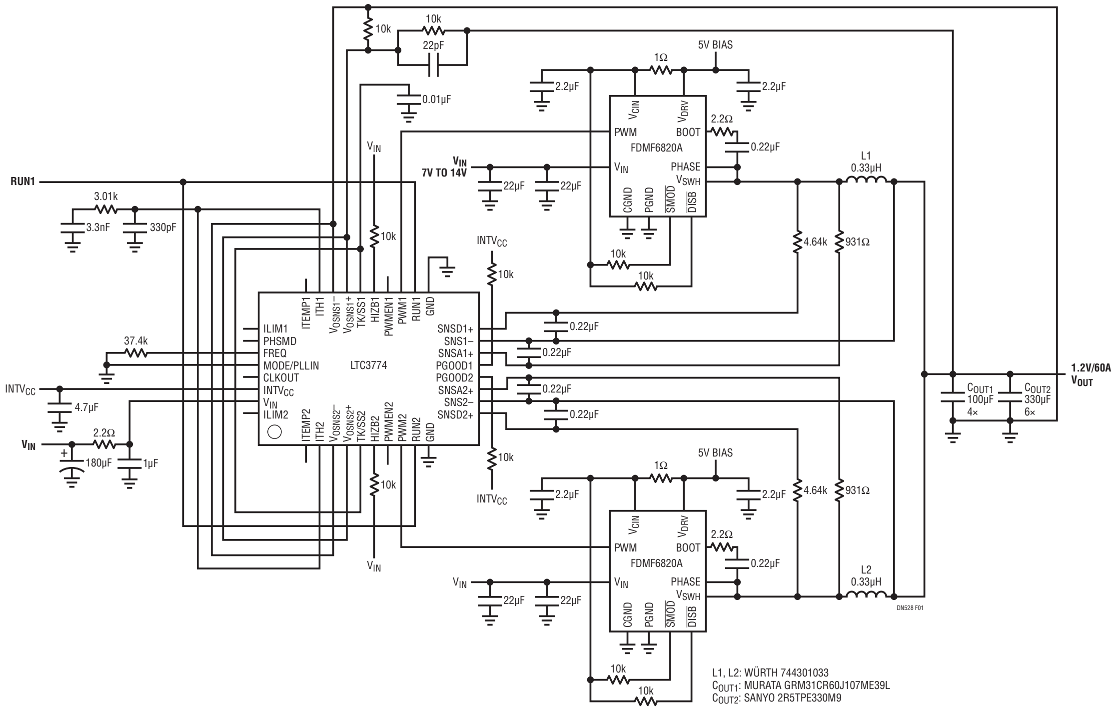


Figure 1. Dual Phase, 1.2V/60A LTC3774 Converter Operating at f_{SW} = 400kHz, 7V ≤ V_{IN} ≤ 14V

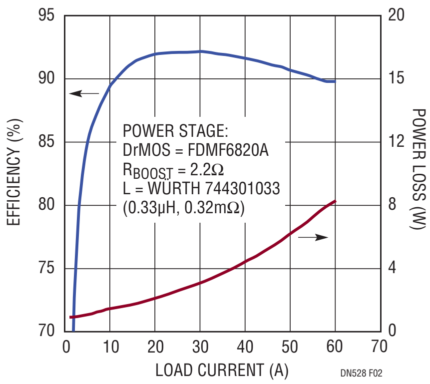


Figure 2. Efficiency and Power Loss Curves for Circuit Shown in Figure 1. V_{IN} = 12V, V_{OUT} = 1.2V

PWM signal is low, the bottom FET is on. When the PWM signal is floating, both the top FET and bottom FET are off. This state is used to block inductor reverse current when the LTC3774 is set up for either pulse-skipping mode or Burst Mode® operation providing a smooth turn-on into a prebiased output. The PWM outputs of the LTC3774 can also interface with power block devices and gate drivers with external MOSFETs.

DCR Sensing

The ultralow DCR sensing capability is a result of an innovative current sensing technique that improves the signal-to-noise ratio of the current sense signal. The external filter tied to the SNSA+ pin amplifies the AC portion of the DCR-sensed current; the DC current is sensed via the SNSD+ pin, internally amplified and summed with the AC portion. This reconstructed current sense signal seen by the LTC3774's current comparator is effectively amplified by a factor of five, allowing the converter to remain stable and retain current limit accuracy for inductor DCR values as low as 0.2mΩ.

The LTC3774 offers five current limit settings between 10mV and 30mV with a worst-case error over temperature of ±1.25mV. With current mode contol, current sharing between phases is tightly balanced, as shown by the thermal image shown in Figure 3. The 1.2V/60A converter operating at full load produces less than a 1°C temperature difference between the two phases.

The LTC3774 also provides accurate output voltage regulation. The output of each phase is sensed with a differential amplifier placed after the feedback divider to compensate for any PCB I • R drops. The total regulated feedback voltage accuracy is ±0.75% over temperature. The output voltage range of the LTC3774 is 0.6V to 3.5V.

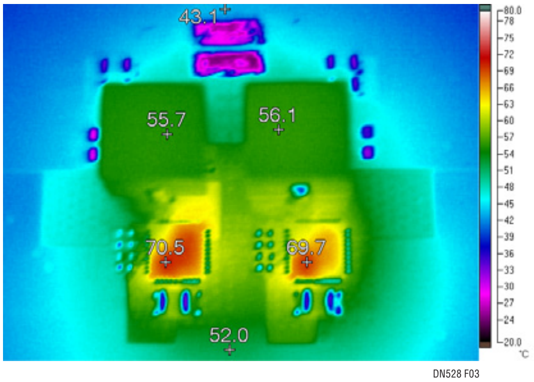


Figure 3. Thermal Image of the Circuit Shown in Figure 1. f_{SW} = 400kHz, V_{IN} = 12V, V_{OUT} = 1.2V, I_{OUT} = 60A, no Airflow and 21°C Ambient

PolyPhase Operation and Improving Robustness

The LTC3774 features CLKIN and CLKOUT pins for PolyPhase® operation up to 12 phases. PolyPhase operation reduces ripple current for the input capacitors and in cases where the phases are tied together, reduces output voltage ripple and provides faster load step response.

Further improvements in the reliability of single output, redundant (N+1), PolyPhase converters can be achieved by placing Hot Swap™ circuits on the input and ideal diode circuits on the output of each phase. If a MOSFET failure occurs, the fault is isolated and the output is protected and continues to regulate. Reliability is further improved with the LTC3774's HIZB pin, which floats the PWM output when a fault is detected, allowing for a more predictable shutdown of the DrMOS.

Other features include soft recovery from an output overload, optional NTC compensated DCR sensing, a phase-lockable switching frequency range of 200kHz to 1.2MHz and an input voltage range of 4.5V to 38V.

Conclusion

The LTC3774 is a high performance dual output buck controller intended for low output voltage, high output current supplies with DrMOS and ultralow DCR inductors. It yields high efficiency, an accurate current limit, a precise 0.6V ±0.75% feedback voltage and fault isolation.

Data Sheet Download

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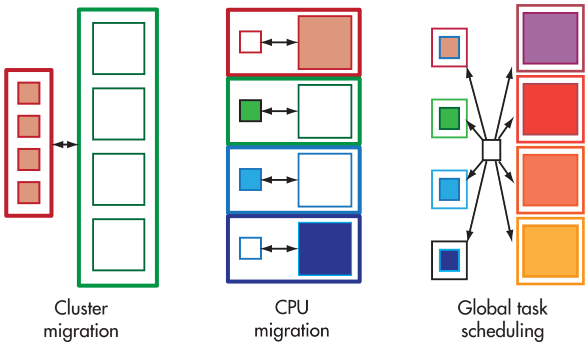


4. ARM's big.LITTLE architecture has progressed from wholesale cluster migration to a global task scheduler that allows applications to be paired with cores depending upon their requirements and core availability.

Waking up or changing modes is yet another issue to contend with because it normally takes time and power. Developers need to make sure that system requirements can be met when changing modes. Wakeup times are usually longer when less power is initially being consumed.

Long wakeup times also occur when transitioning from a state where the clocks are turned off to one where one or more clocks are running. This is due to the use of different technologies such as phase-locked loops to generate higher clock rates from a base clock. Some systems wait until the desired clock rate is stabilized. Other systems proceed at a slower rate and transition to faster clocks as they become stable.

Dealing with run modes in a single-core solution is hard enough, but the job becomes significantly more complex as more cores and cores of different characteristics are mixed together. For example, ARM's big.LITTLE architecture pairs matching low-performance/low-power cores with high-performance/higher-power cores. Applications can be switched from one core to another since they have compatible instruction execution capabilities differing only in performance.

Switching between cores turns out to be just one of the ways big.LITTLE can operate *(Fig. 4)*. System implementations initially employed simplistic cluster migration running all the smaller, low-power cores at the same time and shutting down the bigger, high-performance cores. Subsequent implementations allowed one of the cores in a big.LITTLE pair to run. The implementation of a global task scheduler eventually enabled all cores to be employed if that was the most efficient. Hardware accelerators often allowed a smaller, low-power core to handle jobs like multimedia streaming.

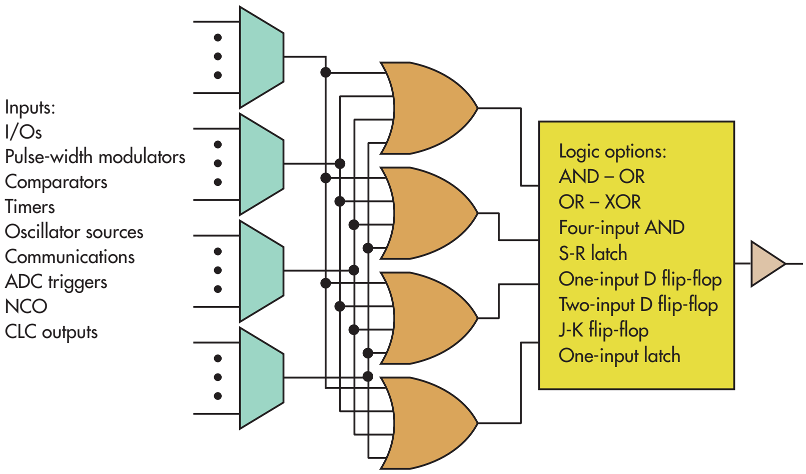
Sometimes optimizing computation while maintaining power utilization is a system requirement. This is often the case in servers where power and related heat limitations must be maintained. Intel's Turbo Boost technology is an example of how operators can specify power limitations and permit the system to adjust the number of cores and their operating frequencies to stay within the limitations. This lets cores operate at speeds higher than the rated normal speed for some period of time.

AMD's new Beema and Mullins chips, which target mobile devices, exploit the race-to-idle behavior. AMD's Skin Temperature Aware Power Management (STAPM) technology tracks the temperature of the system to see if its performance can be increased. The logic is that the current job can be completed sooner and the system can be put into idle mode, which uses significantly less power. This technology also operates with AMD's Intelligent Boost Control, which will speed up a selected set of tasks based on an internal microcontroller's observation of the system that can determine in real time which tasks are frequency sensitive.

PERIPHERAL PAIRING

Peripherals come into play with run modes, but there is more to peripheral control when it comes to power utilization. Powering down a peripheral that is not required is the simplest method of reducing system power requirements. Sometimes, a peripheral will never be used because a particular application does not need all the peripherals supplied. An off-the-shelf part that matches 100% utilization is rare even given the hundreds of SKUs that many vendors provide.

Some systems often provide multiple peripherals that provide similar functionality but with different performance and



5. Microchip's Configurable Logic Cell (CLC) links together interesting peripherals like a numerically controlled oscillator.

power characteristics. The Silicon Labs EFM32 series takes this approach.

For example, the chips have a low-speed, low-power UART as well as a high-speed, high-power UART. The developer decides how they are used, but one scenario would have a control link via the low-power UART and data would be transferred using the high-performance UART. Typical system operation has the system in a low-power sleep mode with the low-power UART operational but waiting for a byte that will signal an incoming control packet. The UART can perform basic pattern matching, so it will only turn on the processor when the desired data is received.

The Renesas RL78's "snooze mode" allows peripherals like the analog-to-digital converter (ADC) to operate while the processor is asleep. The system can detect when an ADC value is out of range and wake up the processor. Without this feature, the processor would have to be started each time an ADC value was obtained. This is not an issue if this is necessary most of the time. But if it is not, allowing the CPU to sleep can save considerable amounts of power.

This type of "smart" peripheral provides a wakeup scenario that is common in embedded applications. Of course, the simplest incarnation is the rising or falling transition on a single-input port, but more complex configurations are available on some systems that can link peripheral input and outputs together.

Cypress Semiconductor's PSoC microcontroller series provides an extreme example of configurable peripherals. They not only can be linked to any pin or other peripheral, but the peripherals themselves are constructed of blocks configured to perform the desired function. It is not as extreme as an FPGA but more akin to a logic array with many specialized analog and digital functional blocks.

A more common configuration has fixed peripheral blocks but with flexible linkages between peripherals. For example, an ADC result triggered by a timer might be sent via a UART all without CPU intervention. Typically, the CPU is asleep. Vendors have different names for this type of feature.

The STMicroelectronics STM32 has autonomous peripherals. Microchip's Configurable Logic Cell (CLC) links together other interesting peripherals *(Fig. 5)* like a numerically controlled oscillator. Silicon Labs' EMF32 has a peripheral reflex system (PRS) that performs a similar function.

SMALL-SCALE ASYMMETRIC MULTICORE

Symmetric multicore solutions are common at the high end of the compute spectrum, but single-core solutions dominate the low end. ARM's big.LITTLE architecture is more like the symmetric designs since the cores are functionally identical.

Systems with asymmetric cores like Texas Instruments' OMAP have been a common way to blend regular CPU cores like DSPs. They provide improved power utilization by delivering more efficient processing capabilities.

Asymmetric multiple-core solutions are becoming more common in the microcontroller space. ARM's Cortex-M0 and Cortex-M4 is one of the more popular combinations. The Cortex-M0 handles peripheral chores while the Cortex-M4 does the heavy computational lifting.

A 204-MHz NXP LPC4330, one of the Cortex-M0/M4 combinations, is found in the Pixy Cam from Charmed Labs *(Fig. 6)*. The Cortex-M0 interfaces with the camera chip and handles the initial data transformation *(see "A Tale Of Two Camera Kits" at electronicdesign.com)*. The Cortex-M4 works on the image analysis, providing a host computer with its object recognition results.

Delivering a power-efficient solution is easier given the wide variety of features available to developers. No one system provides all combinations of hardware and software features, but most platforms have many of the optimization attributes presented here. The challenge for developers is to determine which will have the most effect on their applications and to then utilize those features in a manner that reduces power utilization while meeting application requirements.

6. Developed by Charmed Labs, the Pixy Cam uses a heterogeneous, 32-bit, dual-core, 204-MHz NXP LPC4330 microcontroller that incorporates a Cortex-M0 and a Cortex-M4 core. The Cortex-M0 interfaces with the camera chip and handles the initial data manipulation.

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VICTORIA FRAZA KICKHAM | DISTRIBUTION EDITOR victoria.kickham@penton.com JULY 2014

Mid-Year Business Outlook Calls For Modest Growth

Medical markets as well as oil and gas represent top growth opportunities in 2014, say electronic components distributors.

THOUGH CONCERNS LINGER over the slow recovery that continues to characterize the global economy, many electronics distributors are focused on finding new business growth in a few key markets. Opportunities to expand in medical industries and oil and gas, in particular, spell opportunity for large and mid-market companies alike, according to distributors who attended this spring's Electronics Distribution Show in Las Vegas. Many distribution executives gathered for the annual event pointed to their companies' efforts to expand geographically and with new and deeper service offerings as prime routes to that growth.

Targeting design-oriented customers with new products and specialty services, expanding north and south of the border to capitalize on new accounts, and exploiting demand for more electronics in the burgeoning oil and gas markets are top on the list. Still, cautious optimism abounds following the slow- to no-growth many companies have experienced since 2011.

Continued on Page 46

Industrial Markets Stay Solid

Component distributors look for continued strength in industrial segments, planning for growth through the end of the year.

INDUSTRIAL MARKETS CONTINUE to perform well for electronics distributors, especially in North America where some say pent-up demand for capital spending projects is soon to be realized. Distributors serving maintenance and repair-focused customers in particular, especially those looking for electromechanical and industrial automation solutions, are looking for mid- to high-single-digit growth in 2014.

Allied Electronics is one such distributor. Company president Scott McLendon says that he expects to see 8% top-line growth in fiscal year 2015, following Allied's 5% growth in fiscal 2014, which ended in March. He points to growth in new markets such as Mexico as a potential bright spot in the industrial economy over the next few years.

Allied Electronics serves manufacturing customers in Mexico, primarily fulfilling maintenance, repair, and operations needs to a variety of industrial segments. The distributor plans to expand its business with oil and gas, automotive, and mining customers in the region, for instance.

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Mid-Year Business

Continued from Page 45

REGIONAL OPPORTUNITIES

"We're encouraged, but we've seen flatness in North America that makes it tough to grow," said Craig Sanderson, vice president, supplier marketing and product management, for Massachusetts-based interconnect, passive, and electromechanical (IP&E) component specialist Sager Electronics. Sanderson pointed to growth in sales and bookings in the early part of this year that bode well for modest growth ahead. "With bookings growth, we are optimistic. But we are aware of economic concerns [at the same time]."

Sanderson noted medical markets as a key growth opportunity for Sager. The distributor has long served medical industry customers, but is looking to delve even deeper with new products and services aimed at the design phase. Regional growth markets include Canada, which Sanderson characterizes as one of Sager's greatest opportunities, and Mexico, where Sager has put more field sales representatives along the U.S.-Mexico border recently.

Allied Electronics counts Canada and Mexico as key opportunities as well. The distributor of electronic components and electromechanical products continues to add to its 400-person-strong sales organization, particularly in Canada, and was preparing to launch a Spanish-language website for customers in Mexico earlier this year, according to company president Scott McLendon, who characterized fiscal year 2014 as a good one for Allied. The company grew its top line by about 5% during the fiscal year, which ended March 31, and doubled its growth rate in the second half of that year.

McLendon said he was "thrilled from an Allied perspective" because the company "chased it all year," referring to the low- to no-growth that characterized much of the industry throughout 2013. He added that his outlook for the rest of calendar year 2014 is positive, too, especially in light of the strong trading conditions in North America compared to the rest of the world.

"I think it's going to be a good year. [The Purchasing Manager's Index] is strong," McLendon said in early May. "Seventeen of the 18 industries covered are growing, and it's the most widespread growth [we've seen] in three years. I feel good about it."

Allied Electronics' Scott McLendon says he maintains a positive outlook for the electronics market in North America based on strong trading conditions compared to the rest of the world.

RX FOR NEW BUSINESS

Sager Electronics is taking a multi-pronged approach to building its business in the earlier, design phase of the product development process, and medical markets are a key part of that goal. Earlier this year, the company announced plans to invest in its power supply business, which will help fuel growth with its traditional customer base of medical, industrial, and instrumentation customers. The company furthered that goal with the acquisition of PowerGate LLC, announced in June.

"Sager is actively working on expanding our line card in the power supply area. We're expecting growth in this valuable segment within the IP&E space," company president Frank Flynn said in an interview with *Global Purchasing* earlier this year. "As we see an opportunity to support design engineers at our customers at a critical point in their design of new products, developing our power program ties into our overall strategy of demand creation especially within our medical, industrial, and instrumentation OEM customers."

Flynn went on to explain the value of medical markets to Sager's overall goals: "Medical electronics is a sweet spot for our company. As the population ages and home health care needs increase, there will be a corresponding increase in the need for portable devices and local health care centers. Medical equipment such as CPAP (continuous positive airway pressure), dialysis, and home diagnostic devices are increasing in volume as care moves away from the traditional hospital setting."

The expansion of Sager's field application engineer (FAE) program is another effort to dive deeper into design work, Sanderson added, noting that as of this spring Sager planned to double its number of FAEs by the end of the year.

NEW PLAY: OIL & GAS

For other distributors, the oil and gas industry represents a growth opportunity in 2014 and beyond. New York-based Astrex Electronics is one of those companies. The specialty distributor of interconnect products offers a wide range of value-added services, with a focus on high-reliability connectors, and has long served defense, aerospace, medical, industrial, and commercial customers.

Company president Mike McGuire said technology advances in oil and gas industries call for more and more electronics solutions—a boon to niche players like Astrex. He noted the high-pressure, high-temperature environment and the need for smaller, faster, lighter solutions as keys to serving those customers.

"It's like a space ship going on to some of these oil rigs," he said, emphasizing the high-technology products and solutions for new fracking and underwater drill-

ing applications. McGuire added that Astrex is likely to see most of its growth in 2014 from non-defense-related industries such as these. The distributor has focused on diversifying its customer base in recent years, reducing its defense-related business from 75% to 60% of overall business.

"If defense can just hold its own, [business will] be great [in 2014]," McGuire said.

Growth through strategic acquisition is also an avenue for Astrex. Last year, the distributor purchased California-based specialty connector distributor TIM-CO, which focuses on commercial aviation, space, oil and gas, industrial, and defense markets.

"We're looking at our future growth as partially organic, partially through acquisition," McGuire explained. "I expect there will be several more acquisitions over the next five years."

Pennsylvania-based connector specialist PEI-Genesis is another company focused on high-reliability products that is targeting the oil and gas sector for growth, along with commercial air, medical markets, and mass transit. It is certified to build explosion-proof connectors and cable assemblies, which president and COO Russel Dorwart said will help build business in the oil and gas industry, in particular. PEI-Genesis added an oil and gas business development manager for North America last year to help expand this opportunity as well.

New Jersey-based Powell Electronics is also seeing strong growth in oil and gas markets. Vice president of marketing John Barrington pointed to the proliferation of electronics in just about everything as a key reason for the strength. He doesn't see it slowing down anytime soon, either.

Like many other distributors, Powell has diversified away from defense-related industries and has expanded in oil and gas, commercial aircraft, and construction and agricultural vehicles. Defense markets used to represent about half of Powell's business, but today accounts for about one-third, Barrington said. Such market changes add to the excitement of being in the electronics business today, he added.

"The world is changing so fast. It's an exciting time," Barrington said. "I'm very optimistic. I will be surprised if this isn't a fantastic year for us." ■

Industrial Markets

Continued from Page 45

McLendon additionally says that he sees the market for capital equipment purchases in North America coming back after a lull last year.

Economic indicators point to industrial strength as well. The Purchasing Manager's Index (PMI), a measure of business optimism among supply managers in manufacturing organizations, grew for the twelfth consecutive month in May, increasing to 55.4 over April's reading of 54.9.

Purchasing and supply managers surveyed for the monthly report said that new orders, employment, and production continue to grow. They also noted that 17 of the 18 manufacturing segments surveyed for the report indicated growth during the month. No industries reported contraction. And, PMI survey respondents noted that inventories continue to grow and that supplier deliveries are slowing.

Taking a closer look at the electronics supply chain, purchasing and supply managers surveyed for *Global Purchasing*'s monthly Global Purchasing Index continue to report business optimism as well. The GPI has remained above the 100-point mark indicating a positive outlook among industry purchasing professionals since its launch in January. The GPI measures purchasing professionals' business confidence in five areas: new orders from customers, electronic component inventory levels, purchasing activity, pricing, and lead times. Purchasing professionals interviewed for May's GPI agree with McLendon's sentiments about pent-up demand for new projects and spending.

"It's a go. I feel there is currently a push to get lots of projects completed in the 'now' time frame," one GPI panelist said.

PMI: 12-MONTH HISTORY

Month	PMI	Month	PMI
May 2014	55.4	November 2013	57.0
April 2014	54.9	October 2013	56.6
March 2014	53.7	September 2013	56.0
February 2014	53.2	August 2013	56.3
January 2014	51.3	July 2013	54.9
December 2013	56.5	June 2013	52.5

Average for 12 months: 54.9
High: 57.0 Low: 51.3
Source: Institute for Supply Management, Report on Business

Electronics distributors focused on original equipment manufacturing (OEM) and contract manufacturing (CM) markets are optimistic as well. Mike McGuire of connector specialist Astrex Electronics agrees that some of the "holding back" that occurred in 2013 is beginning to ease, as business conditions picked up for Astrex in the early part of 2014. McGuire pointed to February, March, and May as good months for the niche distributor of specialized, high-reliability connector solutions.

"We will probably see the most growth in non-defense-related industries [this year]," says McGuire, pointing to industrial customers in particular and noting that Astrex aims to increase business in the oil and gas segment of the industrial market in 2014.

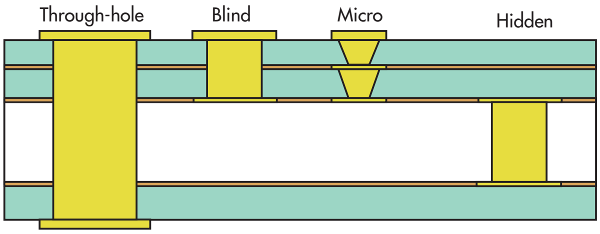
Leaders at distributor TTI Inc., which serves industrial, defense, aerospace, and commercial manufacturers, are cautiously optimistic about the near-term future. Michael Knight, senior vice president, TTI Americas, said in May that leading economic indicators pointed to an "okay second half of the year" and that the industry is prepared for more market growth beginning in mid-2015. ■

Use Advanced PCB Technology To Produce 50% Smaller Product Designs

PI ZHANG | NUVATION ENGINEERING pi.zhang@nuvation.com

HIGH-DENSITY INTERCONNECT (HDI) TECHNOLOGY allows printed-circuit board (PCB) designers to increase routing density, reduce layer count, and improve the thermal and electrical characteristics of their board designs. This approach uses advanced via technology to combine two conventional eight-layer cards into a single 18-layer HDI card. The cards can use their own power supplies or share a redesigned one, creating a product that is 50% smaller.

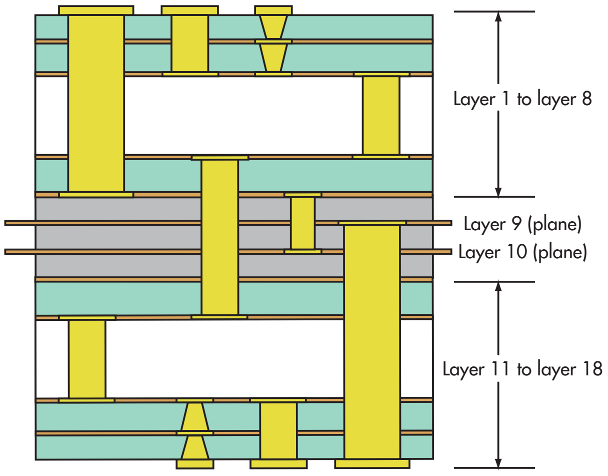
PCB vias come in different configurations *(Fig. 1)*. Through-hole (TH) vias originate and terminate at the outer layers of the PCB, while blind vias originate on an outer layer and terminate on an inner layer. Buried vias are completely buried within the board, connecting only inner layers and not reaching the outer layers at all. Microvias are a form of blind vias that penetrate only one or two layers, and they have an extremely small drill hole (from 0.008 in./0.2 mm all the way down to 0.004 in./0.102 mm).



1. Vias come in different configurations including through-hole, blind, micro, and hidden.

In addition to using microvias, blind vias, and buried vias, this technique requires careful electromagnetic interference (EMI) and thermal analysis, PCB layer stackup, and power/signal/ground distributions. When combined, the two cards look like Figure 2. To combine the boards, you'll need to:

- Ensure that the on-board power supplies can be split evenly between the two eight-layer sections, or newly designed power supplies for two cards are in place
- Change all through-hole parts to surface-mount (SMT) parts, and change the placement to single-sided
- Mirror and combine the card layouts, so layer 1 to layer 8 is the first card and layer 11 to layer 18 is the second.
- Use blind vias or buried vias for the power and ground nets that connect to or cross layers 9 and 10



2. Multilayer boards can incorporate different types of vias to minimize the number of layers required.

You'll also need to be sure that when you place the ball-grid array (BGA) components that require decoupling capacitors that there is space for the capacitors on the mirrored locations underneath those BGA packages.

In addition, if a completely new layout design for the conventional card is permitted (beyond the changes described above), the two cards can be designed back-to-back directly. In that case, the bottom sides of the two cards would be layer 9 and layer 10 after the combination. This would yield a single 16-layer HDI board over two eight-layer conventional boards.

This approach is just one case where HDI PCB technology allows us to create designs that weren't possible until recently. There are other examples as well.

PI ZHANG is a senior design engineer at Nuvation Engineering, a design firm specializing in new product development and electronic design services.

Text Encoding Simplifies Microcontroller Command Parsing

DAVID HUNTER | FIRST CONSULTING INC. drhunter@frontiernet.net

WHILE WORKING ON a Microchip PIC project, I created a set of SCPI-style (Standard Commands for Programmable Instruments) commands to control the PIC. These SCPI commands use the first four characters of text words separated by a colon.

In previous projects, I found that parsing text consumes significant computing time and code space. Typically, text parsing is handled by string comparisons or developing a parsing tree. Neither of these techniques is simple to design and implement on a microcontroller.

I knew that it would be faster to parse commands if I could convert the text into 16-bit numbers. So, I developed a method that converts the first four characters of each command to upper case and then encodes them as a 16-bit number. Each character is translated into a 4-bit representation and then packed into a 16-bit number.

But don't you need 5 bits to represent 26 letters? Yes, if each letter is treated uniquely. To reduce the letters to 4 bits, I analyzed two-letter pairs and grouped the letters based on how often they are used. This encoding worked out well for the 25 or so commands I needed. (More extensive command sets may need to be checked for duplication and the encoding changed accordingly.)

ENCODING CHART

4-bit code	Character	4-bit code	Character
0000	<space>	1000	L, T
0001	A	1001	N, R
0010	E	1010	B, D
0011	I	1011	C, G
0100	O	1100	K, P
0101	U	1101	F, H
0110	Y	1110	M, V, W
0111	S	1111	J, Q, X, Z

The encoding gives <space>, A, E, I, O, U, Y, and S single codes since they are very common. The consonants are then grouped together in sets. The table shows the encoding for the letters. One implementation in C with the space character handled separately is:

```
const unsigned char LookUpTable[] = {0x1,0xA,0xB,0xA,0x2,
0xD,0xB,0xD, 0x3,0xF,0xC,0x8,0xE,0x9,0x4,0xC,0xF,0x9,0x7,
0x8,0x5,0xE,0xE,0xF,0x6,0xF};
```

These two examples show the encoding of SCPI commands:

CLS<space> translates to 0xB870
CALCulate:AVERage:COUNt translates to 0xB18B,0x1E29,0xB459

DAVID HUNTER is an electrical engineer with First Consulting Inc. in Rochester, N.Y. He has a BSEE and an MSEE from the Rochester Institute of Technology and has worked for more than 25 years as a design engineer in embedded-systems software, digital, analog, and RF circuit hardware design.

After encoding the incoming text, parsing is just a matter of checking 16-bit numbers rather than text strings. This can be done as a CASE statement or series of IF statements, either of which is much simpler (and usually faster) than handling text strings in a microcontroller. Using this approach greatly reduced the amount of code needed.

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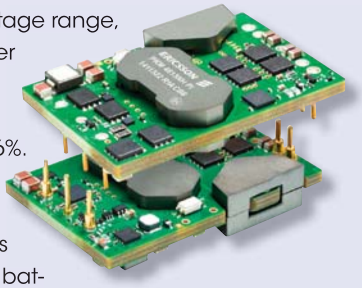
Hybrid-Regulated-Ratio Quarter-Brick Delivers Up To 600 W For Advanced Telecom

ERICSSON LEVERAGED its hybrid-regulated-ratio (HRR) topology to create the third version of its high-power-density quarter-brick power module. As a result, the PKM4613NH offers power up to 600 W across a 36- to 75-V input voltage range at an operating temperature ranging from –30°C to 90°C. HRR technology, which combines voltage and duty-cycle regulation, enables high-power conversion operation over such a wide input voltage range, while minimizing power losses. The end result is an efficiency power conversion of up to 96%. The dc-dc converter matches a variety of system bus voltages powered by multi-cell batteries or rectifiers commonly used in the information and communication technologies (ICT) industry. In addition, 580-W power remains available when reaching the low limit of the 40.5-V service voltage. Tightly regulated output voltage over the entire operational range stabilizes the voltage for the target load if there's line disturbance. Supply currents run as high as 50 A. Power is delivered through four power-pins to reduce power losses and improve thermal conduction across the motherboard. Input/output isolation is 2250 V dc.



ERICSSON POWER MODULES

www.ericsson.com/powermodules

Cost-Effective Power Modules Target Low-Power Motor Drives

INTERNATIONAL RECTIFIER utilized industry-standard footprints and processes compatible with various printed-circuit board (PCB) substrates to create the µIPM-DIP family of compact integrated power modules (IPMs). The 32-device family, packaged in 12- by 29-mm SOPs/DIPs, feature high-voltage FredFET MOSFETs optimized for variable frequency drives with 250- or 500-V voltage ratings. The devices are paired with the company's advanced high-voltage driver IC to achieve balance between electromagnetic interference (EMI) and switching losses. Their dc current ratings range up to 4.6 A to drive motors up to 150 W without a heatsink. Through-hole and surface-mount package options are available. Specific motor-drive applications include fans, pumps, air purifiers, and refrigerator compressor drives.

INTERNATIONAL RECTIFIER CORP.

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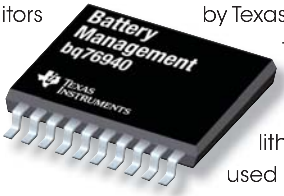
Ad Index

Multi-Cell Battery Monitors Augment Protection For 12- To 48-V Industrial Li-ions



THE SCALABLE bq76920, bq76930, and bq76940 battery monitors protect and control three- to 15-cell batteries when charging or operating in harsh environment conditions. The circuits, developed by Texas Instruments, improve battery pack safety and help reduce design time of 12- to 48-V lithium-ion (Li-ion) and lithium-iron phosphate batteries used in e-bikes, power tools, and energy-storage systems. They measure cell voltages, temperature, and pack current to determine remaining battery capacity and battery state-of-health. Cell-balancing drivers, regulated output supplies, and other features reduce external component count and enhance overvoltage, undervoltage, and overcurrent protection. The bq76920 (packaged in a 20-pin, 4.4- by 6.5-mm TSSOP) supports three- to five-series cells or typical 18-V packs. The bq76930 (in a 30-pin, 4.4- by 7.8-mm TSSOP) manages up to 10-series cells or 36-V packs. The bq76940 (in a 44-pin, 4.4- by 11.3mm TSSOP) monitors up to 15 cells or typical 48-V batteries.

TEXAS INSTRUMENTS INC.

www.ti.com/bmsindustrial-pr

Medical Power Supplies Meet Patient-Contact Requirements

THE EOS Power LFMWLT450 medical-approved series of power supplies complies with patient-contact (BF) rated applications, with proper system considerations. The single-output power supplies, developed by PowerGate, feature 5-, 12-, 15-, 24-, 30-, and 48-V dc outputs and are rated 2X Means of Patient Protection (MOPP) (5940 V dc isolation) input to output; 1X MOPP (2121 V dc isolation) input to earth; and 1X MOPP (2121 V dc isolation) output to earth. Output power is 300 W when convection cooled and 450 W with 420-LFM airflow or optional top or end-mount fan over. Other features include 90% efficiency and 0.4-W load power consumption at 120 V ac.

POWERGATE LLC

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

Hierarchical Processors
Target Wearable Tech

The Dhanush WPU Advanced triple-core chip targets high-end smartwatch applications.

Developers delivering a single product have it easy. Pick a system-on-chip (SoC) microcontroller that meets the application requirements, and refine the software until it works as desired. The design task becomes more complex if more than one product is in the mix, especially if the requirements become more demanding. The typical approach is to have a single-core solution across the board with more powerful processors covering the high end.

Now, a 32-bit processor family can provide code compatibility from the low end to the high end. The low end tends to have lower power requirements but with lower performance. The high end has more performance, but power requirements tend to be significantly higher. Nimble programming can exercise run modes to reduce the amount of power used, though it is still a challenge to hit the low end of the spectrum.

An alternative approach is to incorporate multiple processing cores, usually two. One is a small, low-power core. The other is a larger, more powerful core. Minimal power is used when the larger core is shut down and the low-power core is used alone.

FOUR-STAGE HIERARCHY

The Ineda Systems Dhanush Wearable Processing Unit (WPU) family spans four upward-compatible platforms based on Imagination Technologies' MIPS processors *(see the figure)*. The smallest, the Nano WPU, is a single-core system based on the MIPS microAptiv UC core. Designed for an always-on operation typical of the target platform, wearable devices, this low-power microcontroller can easily operate as an intelligent sensor hub. It includes the usual peripheral complement and on-chip SRAM.

The Nano is the lone single-core chip in the family. All the other chips are multicore solutions that are built symmetrically. The shared memory and peripherals are equally accessible by each core. The Micro dual-core solution adds a higher-performance microAptiv UP core. Like the Nano, it can run with just the microAptiv UC core using minimal power. The Nano is designed to run for a month on batteries. The other chips in the family should do as well if they are only using the low-end core and on-chip SRAM.

The Optima is essentially the Micro chip with a DRAM controller added. It targets applications that require more memory. By moving off-chip, significantly more storage can be included. The system can run with just the microAptiv UC core using on-chip SRAM to significantly reduce power requirements. This would be handy for delivering sensor hub support without turning on DRAM or the other core.

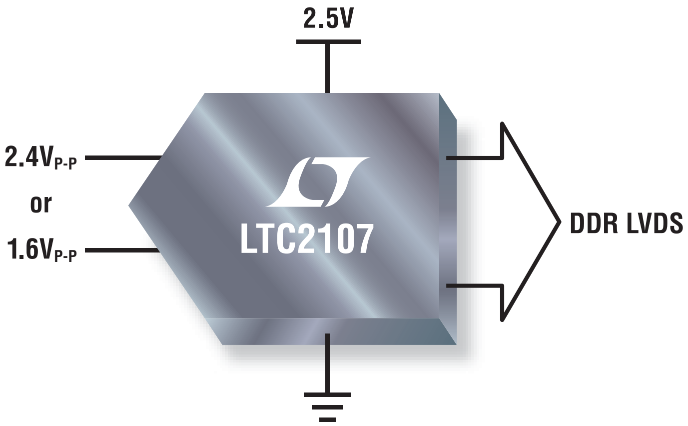
Finally, there is the Advanced chip. This triple-core solution simply adds the interAptiv dual core. The programmer must determine which core will run or if all three can provide the best platform for an application. Of course, two of the three may work at some point. This hierarchical approach gives developers more control over power utilization and performance. The compatibility between cores means programmers do not have to jump through different hoops depending upon which collection of cores is utilized.

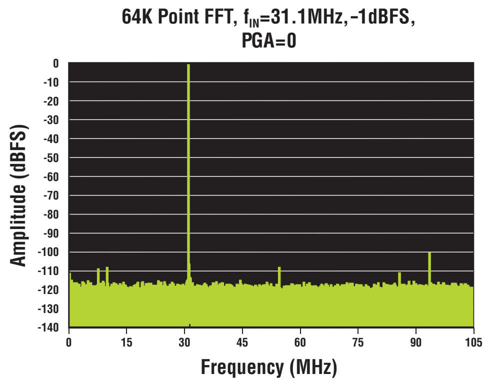
As with most microcontroller vendors, Ineda will have a collection of SKUs with different peripheral, memory, and core complements. This includes pulse-width modulation (PWM) timers, analog-to-digital converters (ADCs), and communication ports. Moving up the chain will include more compute performance as well as more memory and peripherals such as hardware accelerators. The display controller on the Advanced will have PowerVR 3D graphics acceleration along with video decode and encode accelerators.

It is possible to take the family to even higher-performance solutions. Ineda Systems has yet to tap Imagination Systems' high-end proAptiv core. This may take a while as Ineda must deliver and support the current family of chips. The company has a good start, including the SHASTRA software development kit (SDK) and reference platforms. The software includes a unified development environment and power profiling tools.

Wearable technology requires a mix of sensors and low-power operation. The WPU family looks to be an ideal platform to meet those needs, including scaling to devices that have more sophisticated display and input requirements. ed

16-Bit, 210Msps ADC 100dB SFDR





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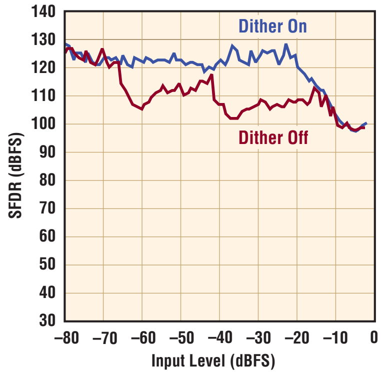
- 100dBFS SFDR
- Internal Transparent Dither
- Digital Output Randomizer
- PGA Front End, 2.4V_{P-P} or 1.6V_{P-P} Input Ranges
- CMOS or DDR/LVDS Outputs
- Single 2.5V Supply
- Clock Duty Cycle Stabilizer
- 7mm x 7mm QFN Package

SFDR vs Input Level, f_{IN}=30.6MHz, PGA=0



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