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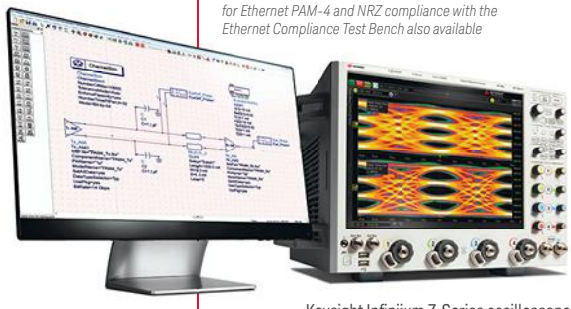

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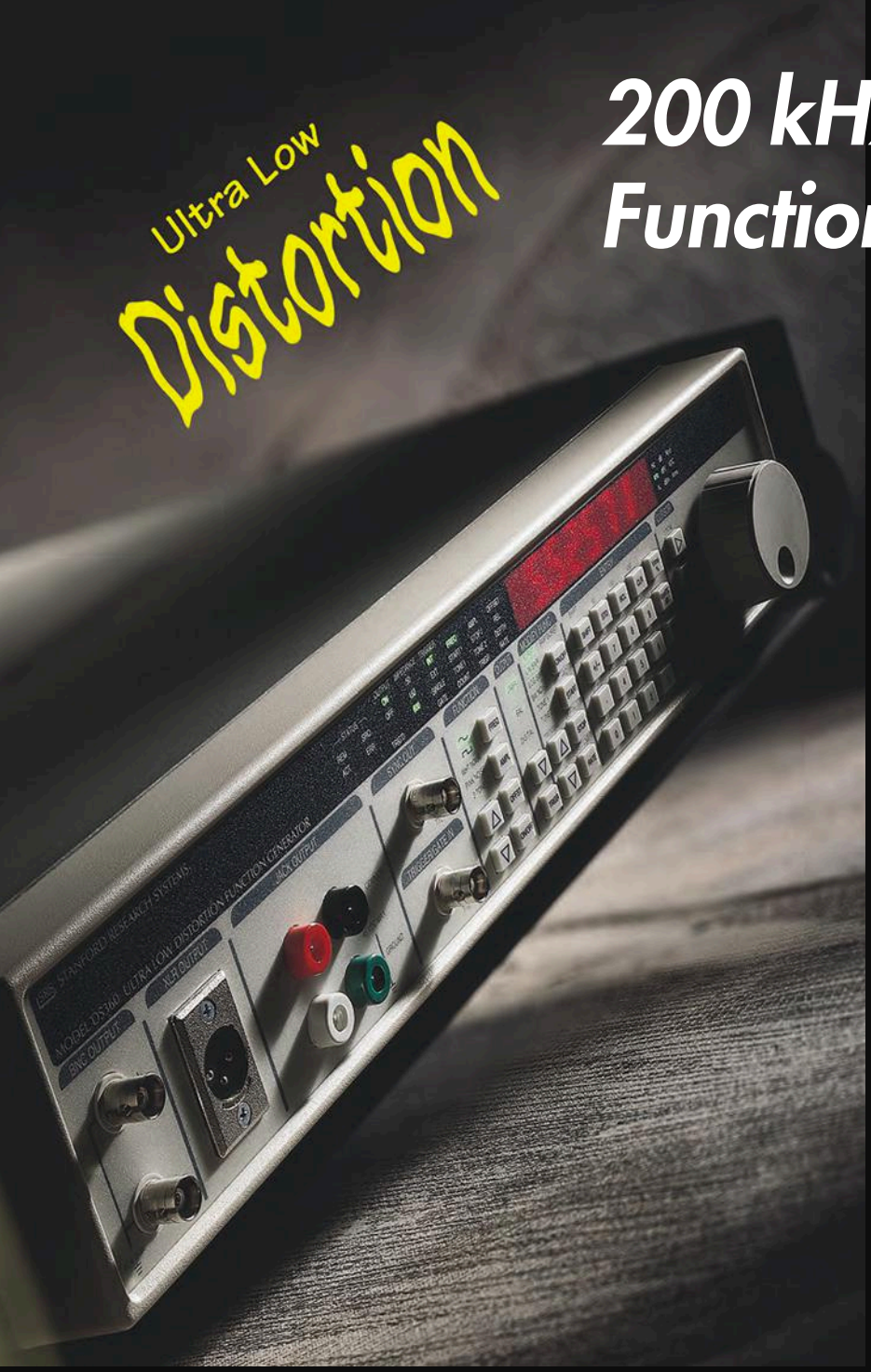
KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights



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abm The Association of Business Information & Media Companies

BPA WORLDWIDE BUSINESS

THE 2008 EDDIE AWARDS 2008 Winner GOLD EXCELLENCE IN MAGAZINE DESIGN

ASBPE American Society of Business Publication Editors 2008 Winner SILVER EDITORIAL AWARD OF EXCELLENCE

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

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5 TEST TRENDS AND CHALLENGES

http://electronicdesign.com/test-measurement/5-leading-test-trends-and-challenges#slide-0-field_images-841901

In this gallery, we look at key technology trends, the test challenges they present, and some solutions that T&M companies are making available to overcome those challenges.

WINDOWS 10, IOT, AND EMBEDDED DEVELOPERS

http://electronicdesign.com/windows/windows-10-iot-and-embedded-developers

The new Windows 10 may not have a major impact in the smartphone space, but it definitely will in its primary markets including tablets, laptops, and desktops.

blogs

LOUIS FRENZEL
COMMUNICATIONS

- DIY Makers, Hobbyists, and Experimenters Get Professional Software

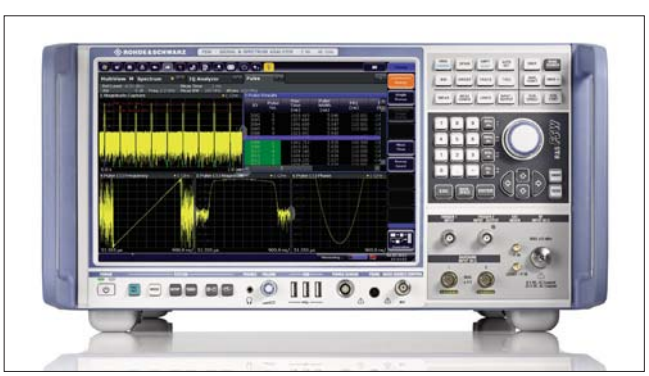
BILL WONG
EMBEDDED/SYSTEMS/SOFTWARE

- The Changing User Interface

FAA AND DRONES: WHAT'S GOING ON?

http://electronicdesign.com/robotics/faa-and-drones-what-exactly-going

Understanding the FAA's drone policy is easy…or is it? The administration lays out the do's and don'ts when using consumer drones, and limits commercial usage of these sUAS.



TEST.PASS: MEETING TEST CHALLENGES HEAD ON

http://electronicdesign.com/blog/analyzer-thread-certification-program-meet-test-challenges-head

In this new blog from Technology Contributor Patrick Mannion, we'll be providing glimpses into everything that could potentially affect how you approach test and measurement. The debut blog covers two new solutions for test challenges faced by 5G and Embedded.

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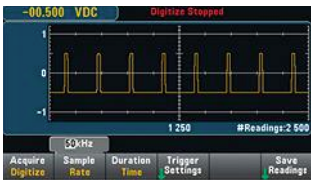
Truevolt DMMs for your next generation of insights.

As the industry leader in bench digital multimeters (DMMs), Keysight delivers more than numbers. We empower insights. Now we're raising the standard again with two new Keysight Truevolt DMMs, the 6½ digit 34465A and 7½ digit 34470A. Both models build on Truevolt's graphical capabilities such as trend and histogram charts offering more insights quickly. They provide a data logging mode for easier trend analysis and a digitizing mode for capturing transients. Also, both offer auto calibration that allows you to maintain measurement accuracy throughout your workday. Our new 7½ digit DMM offers greater resolution and accuracy for your most challenging devices.



Trend chart

Histogram

Truevolt DMMs	34461A	34465A *NEW*	34470A *NEW*
Resolution	6½ digits	6½ digits	7½ digits
DCV accuracy	35 ppm	30 ppm	16 ppm
Linearity	2 ppm	1 ppm	0.5 ppm
Reading speed	1 k/s	5 k/s (opt 50 k/s)	5 k/s (opt 50 k/s)
BenchVue software enabled	Control your DMM with other Keysight instruments via a PC or mobile device		

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NATIONAL INSTRUMENTS

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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, wh-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

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News

ROBOTICS ACCELERATOR PROGRAM Bids for Smartphone-Tech Robots

Qualcomm CTO Matt Grob presents the accelerator at a ribbon-cutting at the company's San Diego headquarters. The accelerator program will last until early September when participating companies will demo their inventions. (*Image courtesy of Qualcomm Inc.*)

The last decade has witnessed a vast improvement in machine-learning algorithms and sensing technologies, both of which have greatly accelerated the evolution of autonomous robots. In a certain sense, the technology required to build more intuitive robots is the same technology found in modern smartphones. A smartphone is equipped with input sensors—such as the camera and inertial sensors —that provide it with information on its orientation and surroundings. A simple autonomous robot uses a similar array of sensors, including computer vision technology, to move around its environment. With this concept in mind, Qualcomm Inc. has been attempting to integrate a high-performance computing platform with small, affordable robotics.

In its latest move, Qualcomm has selected 10 companies to participate in a four-month Robotics Accelerator program aimed at driving robotics innovation. Each of the development teams will have access to $120,000 in research funds. In addition, Qualcomm will provide them with a series of radio frequency (RF), circuit, and mechanical reference designs built around its Snapdragon processor. The program will conclude on Sept. 10, with the development teams presenting their designs to media, investors, and Qualcomm executives.

The high level of growth in smartphones is expected to slow down over the next few years as the market matures. And Qualcomm, which supplies a large number of semiconductors to the industry, is trying to get ahead of that decline. The robotics program is the company's latest attempt to move its line of processors into adjacent markets. A large part of that plan is in accelerating the growth of consumer robotics. All of the companies selected to participate in the program are focused on appealing to the commercial market. While three companies specialize in building drones, others specialize in robotic arms for small businesses. Another has designed a gaming robot for dogs.

One part robotics initiative and one part marketing investment, the program is aimed at demonstrating that Qualcomm's processors are an effective solution for modern robotics.

The company has already built a suite of autonomous robots that combine machine learning and sensing technologies through the Snapdragon processor. These include a standard rover and a drone hybrid, which can switch between flying and rolling. For its part, the standard rover is capable of detecting and recognizing simple patterns in information. It achieves this through Qualcomm's Zeroth machine learning platform, which allows it to classify images from a depth-sensing camera.

In addition, Qualcomm has developed the eyeRover, a small rolling robot developed by the company's Brain Corp. venture that combines onboard cameras with computer learning technology. On a similar scale is a miniature version of the Qualcomm rover, which is powered by a smartphone to support basic autonomous movement. ■

CONSUMERS INCREASINGLY OPT
For Larger Smartphone Displays

Apple's iPhone 6 and iPhone 6S measure 4.7 and 5.5 inches, respectively. With noticeably larger displays than earlier generations of the smartphone, they represent a growing trend among consumers. ***Image courtesy of Apple Inc.***

THE MAJORITY OF smartphone users have come to prefer larger display sizes, according to the latest report from the Mobile UX division of Strategy Analytics. A survey conducted in the United States and UK found that respondents were most interested in displays that were between 5.0 inches and 5.5 inches, measured diagonally across the screen. Yet users also revealed limits when it came to how large they wanted their smartphones to get. Devices with displays larger than 6.0 inches were rated as the least desirable models along with those that had displays smaller than 4.5 inches.

Participants in the survey were asked to rank a series of smartphone displays based on what they would be most likely to purchase. Of all the respondents, more than 36% ranked the 5.3-inch model either first, second, or third. Over 27% of respondents did the same with the 5.0-inch model. Furthermore, 23% and 16% of respondents chose the 5.0-inch and 5.3-inch models as their most preferred, respectively. The report concluded that a majority of consumers were interested in purchasing a smartphone with a larger display, but were mostly conservative when it came to the sizes they were willing to accept. Only a low percentage of consumers were interested in a display that was more than 1.5 inches larger than their current one.

These results were in keeping with the current smartphone market and have been for several years. In 2010, Samsung was the first company to release a smartphone with over a 4.0-inch display size, and it was well received in the market. Since then, smartphone juggernauts like Apple and Android have started to offer larger displays. For instance, the iPhone 6 and iPhone 6S measure 4.7 and 5.5 inches, respectively. Both models were immediately praised for their display size and improved resolutions.

The survey also examined the most preferred thickness for smartphones. Given the choice between 6 and 8 mm, most

respondents opted for the thinner device. When the participants were informed that thicker models would have more battery life, however, the scale tipped in the opposite direction. The majority of smartphone users would prefer a thicker smartphone if it offered a longer-lasting battery. In the end, the Strategy Analytics report noted that consumers would only accept limited device thickness. Thus, manufacturers have to find the "sweet spot" between these two elements in order to appeal to the widest audience. ■

POWER MAGNETICS KIT Provides Free Resource for Electrical Engineering Students

Coilcraft is offering a new Power Magnetics Lab Kit for free to accredited electrical engineering programs to help students apply textbook theories to power-conversion circuits.
(Image courtesy of Coilcraft.)

TO PROVIDE A more hands-on experience in classrooms and instructional labs, Coilcraft has developed a new Power Magnetics Lab Kit. The kit contains a variety of through-hole power inductors for easy soldering and is available for free to accredited electrical engineering programs. The kit helps provide students with applying textbook theories to real power-conversion circuits, helping to gain a deeper understanding of power magnetics.

The kit is part of Coilcraft's efforts to support the next generation of electrical engineers. The company also recently added a Student Resource Center to its website, offering free access to design tools, a library of application notes, and a wealth of other educational resources (including a March 2014 Basics of Design published in Electronic Design). Students can also follow Coilcraft on social media to submit photos of their design projects and receive special offers and notifications for contests. ■

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Zone Touch Triggering	Yes	No
Sample Rate	5 GSa/s	2.5 GSa/s (>= 500 MHz) 5 GSa/s (1 GHz)

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* Refer to Keysight document 5992-0140EN for product specs, and 5989-7885EN for update rate measurements.
** Competitive oscilloscopes are from Tektronix publication 48W-30020-3

LOU SOSA | Contributing Editor

TOP 50 EMPLOYERS In Electronic Design

Despite a slight drop in income growth, the top companies on our list continue their investment in R&D.

IN 2014-15, both sales growth and employment grew ever so slightly higher than the previous year-to-year comparison but for the first time in a number of years, pretax income growth declined—and significantly enough to cause a collective 1.5-point pretax margin decline. Companies had done a great job maintaining margins and leveraging profitability since the economic crisis hit in 2008. With profits slowing down reducing what can be added to equity and companies increasing their debt load to fund future growth, collective debt-to-equity ratios deteriorated significantly.

The good news here is that our collective pool of 92 companies is continuing to invest in R&D at about the same growth rate as last year, and as a matter of fact, at a higher rate than any other indicator. In addition, the hope is that companies use the increase in debt for productive reasons such as increasing investment.

The Top 50 list is based on a formula using public financial data from a pool of the 92 public companies, with bonus points awarded using the results of our annual Electronic Design Reader Profile Study *(see "Methodology: The Top 50 Employers in Electronic Design" at electronicdesign.com)*.

WHAT'S IN STORE?

According to Census Bureau Data for durable goods, business spending should grow by 4% this year vs. 5% in 2014, even though May and April showed about a 1.5% decrease in durable goods orders. Most of the weakness had to do with low demand for commercial aircraft, although that seems to be improving with Boeing now maintaining a significant order backlog. Orders for core capital goods increased by 0.4% in May after decreasing in April, which is a good sign for later in the year, as it relates to increased company spending on equipment and software.

Since its peak in 2008, real non-residential investment is up 8% and up by 35% since its low point in 2009. While investment fell in the first quarter of 2015, if you exclude the oil industry, it actually grew at a 1% annual rate.

Joblessness has fallen consistently since 2010. U.S. labor markets are tightening with reported unemployment predicted to fall to 5.1% by year-end, according to Department of Labor employment data. This means stronger income growth and higher spending by consumers. Good job growth of 223,000 in June (mainly in health care, retail, foodservice, and business services) keeps boding well for future growth.

INDUSTRY GAINS IN KEY AREAS

Category	Fiscal 2014 versus 2013	Fiscal 2013 versus 2012
Employee Growth	0.4%	0.0%
Sales Growth	3.5%	2.3%
Pretax Income Growth	–7.9%	40.6%
Pretax Margin Improvement	–1.5 pts.	3.9 pts
Debt to Equity Ratio Improvement	–12.3 pts.	0.0 pts.
Research & Development Expense	5.1%	5.4%
ED Reader Profile Survey No. of Respondents	467	512

Hourly pay rose at an annual rate of 3.3% in the first quarter.

The number of workers leaving jobs has increased as a result of more workers quitting. Stronger hiring data suggests these workers are moving on to better jobs.

Sales of new vehicles have held up well, and automobile makers are either maintaining or increasing capacity and modernizing plants. Census Bureau construction activity data also points to the housing sector rebounding, meaning increased demand for a range of industrial manufactured goods.

Department of Commerce GDP data suggest a 3.5% to 4% growth rate in the second half of 2015, resulting in a 2.5% annual growth rate. This was the same pattern that occurred last year, with weather being a major factor. First-quarter 2015 GDP showed a 0.7% decline. Since economic growth began once again in 2010, it has never beaten a 2.5% annual growth rate. It's a problem that spans beyond the United States, with Brazil and Russia facing deep recessions and China slowing down.

Department of Energy price statistics show that prices at the pump appear to be holding steady and are about 90 cents less than last year. Crude-oil prices are also holding steady and are predicted to stay in the $60-$65 per-barrel range. Although more electric utilities are burning natural gas rather than coal, there appears to be plenty of supply to meet demand.

Long-term interest rates should stay fairly stable as long as inflation stays under control, given improved U.S. and European economic growth. While the Fed is expected to raise short-term rates by a quarter point in September, a further increase will be slow to come as the Fed is aware of the dangers of raising rates too quickly, especially before increases in wages gain enough momentum.

U.S. consumer debt has declined as the ratio of mortgage debt to GDP has fallen below 80%, back to its 2002 level, according to Societe Generale. Total household debt is at 107% of disposable income, the lowest amount since at least 1980. Household net worth is at a record high in real terms and close to the pre-crisis peak as a share of GDP.

MOST IMPROVED COMPANIES, 2013-2014

Company	Rise in the ranks
INGERSOLL-RAND PLC	62
ALTERA CORP.	60
HARMAN INTERNATIONAL INDUSTRIES INC.	59
INTERSIL CORP.	51
COMCAST CORP.	49
SAIC INC.	47
KLA-TENCOR CORP.	45
ATMEL CORP.	40
MEDTRONIC INC.	39
LINEAR TECHNOLOGY CORP.	38
ST. JUDE MEDICAL INC.	38

TOP 50 EMPLOYERS IN ELECTRONIC DESIGN

Fiscal 2014 Rank	Company Name	Total Company Line Score
1	MICRON TECHNOLOGY INC.	84
2	APPLIED MATERIALS INC.	83
3	INTEL CORP.	78
4	SANDISK CORP.	76
5	TEXAS INSTRUMENTS INC.	73
6	CADENCE DESIGN SYSTEMS INC.	72
6	SYNOPSYS INC.	72
6	EMC CORP.	72
9	MICROSOFT CORP.	71
9	UNITED TECHNOLOGIES CORP.	71
11	MEDTRONIC INC.	70
11	ROCKWELL AUTOMATION INC.	70
11	LAM RESEARCH CORP.	70
14	THERMO FISHER SCIENTIFIC INC.	69
14	ALTERA CORP.	69
16	COMCAST CORP.	68
16	APPLE INC.	68
18	LINEAR TECHNOLOGY CORP.	67
18	HEWLETT-PACKARD CO.	67
18	ANALOG DEVICES INC.	67
18	HONEYWELL INTERNATIONAL INC.	67
22	TE CONNECTIVITY LTD.	66
22	QUALCOMM INC.	66
24	BROADCOM CORP.	65
25	PARKER-HANNIFIN CORP.	64
25	NATIONAL INSTRUMENTS CORP.	64
27	ST. JUDE MEDICAL INC.	63
27	INTERSIL CORP.	63
27	ROCKWELL COLLINS INC.	63
27	WESTERN DIGITAL CORP.	63
27	3M CO.	63
27	WHIRLPOOL CORP.	63
33	INGERSOLL-RAND PLC	62
33	HARMAN INTERNATIONAL INDUSTRIES INC.	62
33	KLA-TENCOR CORP.	62
33	MENTOR GRAPHICS CORP.	62
33	MICROCHIP TECHNOLOGY INC.	62
38	ATMEL CORP.	61
38	BOSTON SCIENTIFIC CORP.	61
38	RAMBUS INC.	61
38	THE BOEING COMPANY	61
42	TEXTRON INC.	60
43	LEAR CORP.	59
44	HARRIS CORP.	58
44	CYPRESS SEMICONDUCTOR CORP.	58
44	LOCKHEED MARTIN CORP.	58
47	SAIC INC.	57
47	FAIRCHILD SEMICONDUCTOR INTERNATIONAL INC.	57
47	NCR CORP.	57
47	GENERAL ELECTRIC CO.	57

Credit markets are strong as companies have issued $609 billion in debt so far in 2015, up by $40 billion from a year ago, according to Dealogic. Bank business lending is up by 12% as of April 2015, according to the Fed. While our company pool debt-to-equity ratio showed a significant deterioration, we expect that some of this debt will be used to fund new plants and equipment and software.

In summary, 2015 appears to be somewhat similar to 2014, but there is good news here. It also just seems to"feel" better than 2014. The key to continuing improvement will be for the Fed to keep interest rates low. This will continue to help households in the hardest-hit regions and ensure that the wage increases we are seeing contribute to higher spending.

There are also some exciting new technologies such as 3D NAND, FinFET, and the drive to single-digit nanometer nodes, and their continuing impact on making us more mobile and interconnected.

Following is a closer look at the top three companies in our 2015 report.

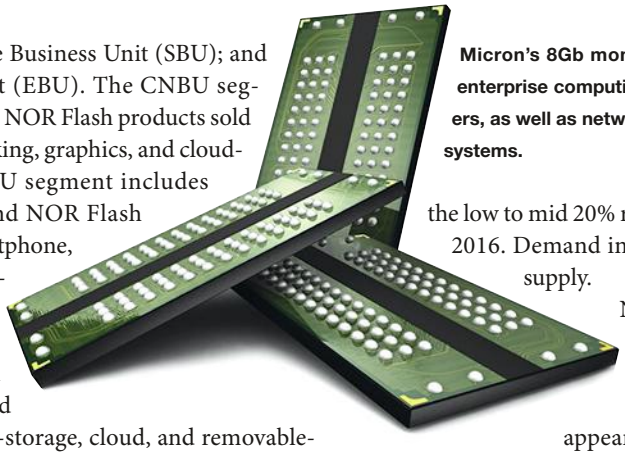
Micron, headquartered in Boise, Idaho, has more than 30,000 employees worldwide.

MICRON MAKES MOVES

Our top-ranked company, **Micron Inc.,** is one of the largest memory-chip makers in the world. It makes DRAM (Dynamic Random Access Memory), NAND Flash, NOR Flash memory, and other memory technologies. The company sells to customers in networking and storage, consumer electronics, solid-state drives, and mobile telecommunications, but its largest concentration (nearly a third of sales) is the computer market. Micron's products are offered under the Micron, Lexar, Crucial, SpecTek, and Elpida brands, as well as private labels. The company generates about 85% of sales outside the U.S.

(At press time, China's state-backed Tsinghua Unigroup Ltd was preparing a $23-billion bid for the company, in what would be the biggest Chinese takeover of a U.S. business. Whether that transaction goes through or not—Credit Suisse said the deal was "highly unlikely to get past U.S. regulators who are increasingly viewing semiconductors as a strategic industry"—it points to a growing tech war between China and the U.S.)

Micron currently operates through four segments: Computer and Networking Business Unit (CNBU); Mobile Busi-



Micron's 8Gb monolithic DDR3 is designed for high-end enterprise computing and storage systems and cloud servers, as well as networking applications and client computing systems.

ness Unit (MBU); Storage Business Unit (SBU); and Embedded Business Unit (EBU). The CNBU segment includes DRAM and NOR Flash products sold to the computing, networking, graphics, and cloud-server markets. The MBU segment includes DRAM, NAND Flash, and NOR Flash products sold to the smartphone, feature-phone, and tablet/mobile-device market. The SBU segment includes NAND Flash components and SSDs sold into enterprise and client-storage, cloud, and removable-storage markets. SBU also includes NAND Flash products sold to Intel through its IMFT joint venture.The EBU includes DRAM, NAND Flash, and NOR Flash products sold into automotive and industrial applications, as well as the connected home and consumer electronics markets.

Micron Technology was founded in October 1978 and is headquartered in Boise, Idaho.

For fiscal Q3 2015, Micron posted total revenue of $3.9 billion, within its revenue guidance of $3.8 billion to $4.05 billion. Revenue was sequentially lower as expected in fiscal Q3, driven primarily by weakness in the PC sector.

The company expects DRAM industry supply to grow in the low to mid 20% range or so in both calendar 2015 and 2016. Demand in 2015 appears to be at or exceeding supply.

NAND industry supply bit growth is expected to be in the mid to high 30% range for both calendar 2015 and 2016. Demand and supply appear to be equal this year, with demand outstripping supply in future years based on current capacity. Micron will start volume production of its differentiated high-capacity 3D NAND later this year.

The company has remained focused on three initiatives: ramping up its 25 nm DRAM technology; driving scale output of its 20 nm DRAM technology; and the launching of its 3D NAND technology.

In DRAM, while PCs might be soft at the moment, mobile DRAM consumption is expected to surge with the next round of smartphone offerings later this year. New, 3- to 4-gigabyte phones announced at the Mobile World Congress in March are beginning to hit the market. Low- to mid-priced

phones targeted at emerging markets are being built with significant memory content, including DRAM specs at 1 gb or above.

Next-generation 4G LTE chipset designs are doubling the memory content of both DRAM (from 2 to 4 gb) and NAND (from 8/16 gb to 16/32 gb). Also, the rapid adaptation of eMCPs (a combination of DRAM and NAND on the same silicon chip) in the mid-range phone market creates a significant opportunity for Micron, as they will drive increases in both low-power DRAM and NAND.

TOP 10 OEM EMPLOYERS			
Company	Fiscal 2014 OEM rank	Fiscal 2014 overall rank	Category
MICRON TECHNOLOGY INC.	1	1	Components & subassemblies
INTEL CORP.	2	3	Components & subassemblies
TEXAS INSTRUMENTS INC.	3	5	Components & subassemblies
CADENCE DESIGN SYSTEMS INC.	4	6	Test equipment
SYNOPSYS INC.	4	6	Test equipment
ROCKWELL AUTOMATION INC.	6	11	Industrial Controls
ALTERA CORP.	7	14	Components & subassemblies
LINEAR TECHNOLOGY CORP.	8	18	Components & subassemblies
ANALOG DEVICES INC.	8	18	Components & subassemblies
TE CONNECTIVITY LTD.	10	22	Industrial Controls
QUALCOMM INC.	10	22	Communications

A PC recovery could very well be based on the rollout of Windows 10 and Intel's Skylake processors. By year-end, the company could be producing 50% more DRAM bits at a 30% lower cost per bit than today, if all goes well. However, the real growth story appears to be 3D NAND. Although it won't have a huge revenue impact this year, the improved endurance and data retention of this technology may make it the must-have NAND for the next three to five years, especially with the SSD market expected to reach around $65 billion--all based on high-performance NAND memory. Future strategy is to move as much DRAM production to 3D NAND as possible, and Micron moved 40,000 wafer starts per month of DRAM capacity in Singapore to NAND production in 2014.

3D NAND is a type of flash memory that stacks memory die on top of each other within a single package using specialized interconnects. The vertical stacking allows for a significantly higher density of memory cells and improves performance and reliability. 3D NAND is a breakthrough in overcoming the density limit currently facing the planar (2D) NAND architecture and floating gates used in conventional flash memory, as well as yielding speed and endurance improvements.

3D NAND has a denser chip with twice the write performance and 10 times the reliability of planar NAND. 3D NAND cell architecture enables significant performance and cost improvement relative to planar technology.

TrendForce currently projects 3D NAND will account for only 3% of the NAND Flash industry's overall supply, since the majority of the manufacturers are still in the testing and sample delivery phase. However, the market intelligence provider expects the 3D NAND market share to reach 20% by

PERCENTAGE OF COMPANIES THAT SAW GROWTH IN KEY AREAS		
Category	Fiscal 2014 versus 2013	Fiscal 2013 versus 2012
Sales Growth	70%	53%
Pretax Income	57%	39%
Employee Growth	48%	45%
R & D	67%	63%

2015. According to IHS research, 3D NAND technology will account for the majority of total flash shipments, equivalent to 65.7% by 2017.

Micron also has a joint venture with Intel to develop 3D NAND (Intel Micron Flash Technology). They currently own a joint facility in Utah producing planar NAND. The company has long-term supply agreements with Intel to supply planar NAND, and they anticipate building 3D NAND for Intel out of Singapore as well. While Samsung is already a step ahead, an early entry can help Micron increase share versus competitors such as Sandisk, Toshiba, and SK Hynix.

According to *Forbes*, Samsung, which accounts for 27.9% of the NAND Flash market, launched its 3D V-NAND storage technology in August 2013 and has already started mass production of the technology. SanDisk (18.2% market share) and partner Toshiba (21.9 %market share) won't have a 3D NAND offering until 2017. SK Hynix (11.4% market share) has yet to reveal specific 3D roadmaps, methodology, and timing. While Samsung clearly has the first-mover advantage, Micron can also benefit from early entry into 3D NAND technology. By the time SanDisk, Toshiba, and SK Hynix come up with a 3D NAND offering, both Samsung and Micron will be several generations ahead and will have solved the growing pains of controller design and other architectural issues.

SEMICONDUCTORS SUPPLIED BY APPLIED

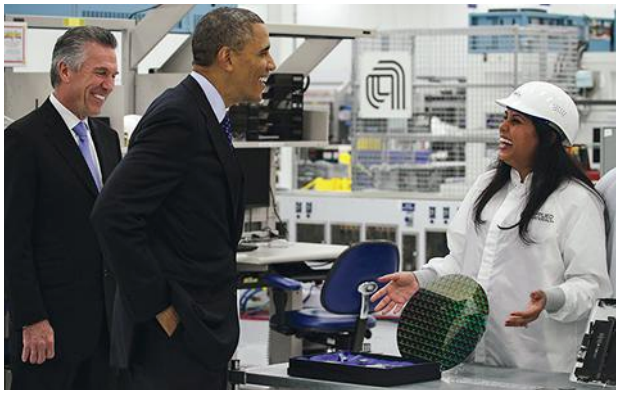
Our second-ranked company, **Applied Materials,** dominates the market for semiconductor manufacturing equipment. With the acquisition of Applied Films, Applied Materials moved into the market for equipment used in making solar-power cells. AMAT vies for supremacy in many segments of the chip-making process, including deposition (layering film on wafers), etching (removing portions of chip material to allow precise construction of circuits), and semiconductor metrology and inspection equipment. The company dropped its proposed merger with Tokyo Electron, the second-biggest equipment maker, due to antitrust concern from U.S. regulators.

Applied Materials provides manufacturing equipment, services, and software to the global semiconductor, flat-panel display, solar photovoltaic (PV), and related industries. The company operates through four business segments: Silicon Systems Group;, Applied Global Services; Display; and Energy and Environmental Solutions.

The Silicon Systems Group segment develops, manufactures, and sells equipment used to fabricate semiconductor chips, also referred to as integrated circuits. The Applied Global Services segment encompasses services, products, and integrated solutions to optimize equipment and fab performance and productivity. The display segment provides manufacturing of liquid crystal displays, organic light-emitting diodes, and other display technologies for televisions, PCs, tablets, smartphones, and other consumer-oriented devices. The Energy and Environmental Solutions segment includes systems for manufacturing wafer-based crystalline silicon (c-Si) cells and modules. These systems are designed to increase the conversion efficiency and yields of solar PV devices in order to help reduce the cost per watt of solar-generated electricity.

Applied Materials was founded in 1967 and is headquartered in Santa Clara, Calif.

The company reported better-than-expected financial results for fiscal Q2 2015. Revenues were $2.44 billion, slightly above analyst expectations of $2.4 billion, with net income at $364 million, a significant year-over-year increase from $262 million. The company continues to lead the nano manufacturing industry. For example, in the semiconductor manufacturing equipment industry, the company's etch (a critical wafer manufacturing process), conductor etch, and wafer fab equipment segments grew by approximately 7, 12, and 1.5 points in market share over the past two years. In 2014, Applied also added 2 points of market share to its PVD (photovoltaic solar panels) and Epi (epitaxy is the only affordable method of high-quality crystal growth for many semiconductor materials and makes faster chips) segments.



Applied Materials CEO Mike Splinter and President Barack Obama on a 2013 tour of the Austin, Texas, manufacturing clean room, where Applied employee Nilam D. Bhakta-Sahib explains the complex chip-making process.

The company is investing to gain market share in emerging technologies such as 3D NAND and FinFet, which are criti-

cal in moving the industry forward as single-digit nanometer nodes are reached (7 nm and beyond). With Moore's law starting to experience a slowdown, newer technologies like 3D NAND and FinFET offer a way forward.

NAND flash memory is a type of non-volatile storage technology that does not require power to retain data. An important goal of NAND flash development has been to reduce the cost per bit and increase maximum chip capacity, so that flash memory can compete with magnetic storage devices like hard disks. NAND flash has found a market in devices to which large files are frequently uploaded and replaced. MP3 players, digital cameras, and USB drives use NAND flash. New developments in NAND flash memory technology are making the chips smaller, increasing the maximum read-write cycles, and lowering voltage demands.

3D NAND flash is a type of flash memory that stacks memory cells on top of each other. Stacking cells vertically has several benefits: it provides a higher capacity/volume ratio in a smaller physical space and improves electrical performance by shortening the interconnect length between cells (which also reduces power consumption).

FinFET technology is becoming more widespread as feature sizes within integrated circuits fall and there is a growing need to provide much higher levels of integration with less power consumption within integrated circuits. The main characteristic of the FinFET is that it has a conducting channel wrapped by a thin silicon "fin" from which it gains its name. The thickness of the fin determines the effective channel length of the device. Among the advantages are much lower power consumption, ability to pass through the 20 nm barrier, significantly reduced static leakage current, and operating speed in excess of 30% faster than non FinFET versions.

Around 40% of the company's 2015 NAND investments are expected to be in 3D NAND and they are experiencing 30% to 40% growth in the 3D NAND and DRAM segments. With foundry leaders like Intel and Taiwan Semiconductor competing for market dominance on the FinFET and 3D NAND front, Applied Materials should experience strong demand in these segments.

With skyrocketing global smartphone sales and the general growing usage of other semiconductor-based technologies (e.g., automotive electronics, computerized watches, etc.), there is little reason to believe that semiconductor demand will slow down. In addition, exponentially increasing percentages of global populations are now able to afford such technologies, with the growing Chinese and Indian middle classes serving as a prime example. Gartner Inc. stated worldwide semiconductor sales were expected to reach $354 billion in 2015, a 4% increase from 2014, and could go higher.

Applied Materials should experience increasing demand for its products as chip-based technology use is expected to grow dramatically. Applied Materials is squarely at the forefront of the nano manufacturing arena, apparent in its very strong focus on the 3D NAND and FinFET segments, and their long-term demand trend looks stronger than ever.

Intel has approximately 80% of the market share for microprocessors that go into desktop and notebook computers, smartphones, tablets, and computer servers.

INSIDE INTEL

Our third-ranked company, Intel, has followed Moore's law to the top spot in manufacturing and selling semiconductors. Company co-founder Gordon Moore determined in 1965--making 2015 the 50th anniversary of his law--that microprocessors would regularly get more powerful, smaller, and less expensive. Intel has followed that formula to grab about 80% of the market share for microprocessors that go into desktop and notebook computers, smartphones, tablets, and computer servers. The company also makes embedded

Intel's Atom X5 and X7 were created for mainstream and premium tablets, such as the new Microsoft Surface 3 (pictured).

semiconductors for the industrial, medical, and in-vehicle infotainment markets. Intel's technology roadmap calls for releasing a new Core processor and a Xeon processor every two years. Most computer makers use Intel processors. In June 2015, Intel agreed to buy chipmaker Altera for $16.7 billion.

The company operates its business through the following groups: PC Client; Data Center; Internet of Things; Mobile and Communications; Software & Services; and All Other.

The PC Client Group includes platforms designed for the notebook, desktop, and certain tablet market segments, as well as wireless and wired connectivity products. The Data Center Group offers products designed to provide leading energy-efficient performance for all server, network, and storage platforms. The Internet of Things (IoT) Group offers platforms for customers to design products for the retail, transportation, industrial, and buildings and home market segments. The Mobile and Communications Group offers products that incorporate hardware, software, and connectivity for tablets, smartphones, and other mobile devices. The Software & Services Operating segment includes software products for endpoint security, network and content security, risk and compliance, and consumer and mobile security from its McAfee business; software-optimized products for the embedded and mobile market segments; and software products and services that promote Intel architecture as the platform of choice for software development.

The company was founded in 1968 and is headquartered in Santa Clara, Calif.

Intel's fiscal first quarter 2015 was a challenging one. The PC segment was impacted by slowing desktop sales, particularly in small to medium-sized businesses, but the good news is that year-over-year revenue was flat due to double-digit growth in its Data Center, Internet of Things, and NAND segments. While the desktop segment slowed, notebook volume grew year over year for the fifth consecutive quarter. The company exceeded expectations, given its competitive advantage produced by its latest 14 nm processors (5th-generation Core and Core M).

In addition to launching the high-volume, 5th-Gen Core products at CES, the CCG Group also reached some important product milestones—including launching its newest Broadwell-based vPro notebook SKUs that feature aspects of the Company's No Wires vision (technologies to remove the clutter of power cords, display connectors and peripheral cables). Intel also expanded their mobile product portfolio to adjust a range of price points and form factors, including the Intel Atom X5 and X7 for mainstream and premium tablets, formerly called Cherry Trail, which is powering the new Microsoft Surface 3. They also started shipping the Atom X3, formerly SoFIA 3G, the company's first single-chip integrated baseband and apps processor, designed for entry in value-smartphones and tablets. This product was not even on their roadmap a year and a half

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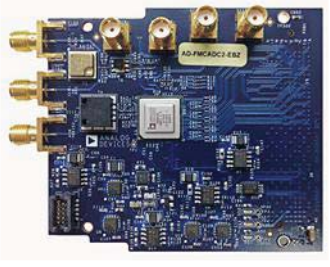
A Special Section to PENTON'S DESIGN ENGINEERING & SOURCING GROUP 07/08 2015



HIGH-SPEED ADCs Tame Wideband EW Receivers

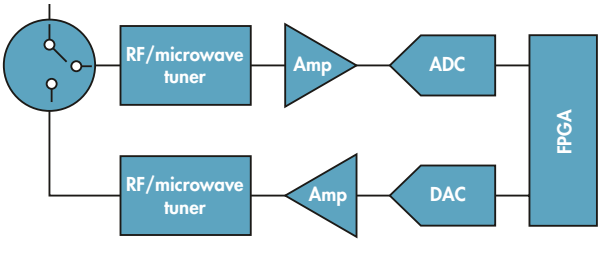
MODERN ELECTRONIC-WARFARE (EW) system designers are facing numerous challenges when attempting to develop effective solutions, including increased spectral congestion and more sophisticated surveillance techniques. Designers also are being pushed to reduce development times, driving them to employ custom hardware and firmware to achieve required levels of performance within size, weight, and power constraints.

Fortunately, by properly applying high-speed data converters and fast digital-signal-processing (DSP) components, such as field-programmable gate arrays (FPGAs), effective EW solutions are possible. To demonstrate, a reference design employing high-speed analog-to-digital converters (ADCs) from Analog Devices (www.analog.com) and FPGAs and channelization IP from Altera (www.altera.com) offers an effective solution for EW systems—one that enables fast time to market for EW and digital RF memory (DRFM) systems.

EW systems, which identify and counter electronic threats such as tracking radar systems, are commonly categorized either as electronic-support (ES), electronic-attack (EA), or electronic-protect (EP) systems. ES systems intercept and measure signal parameters to identify the source and perform threat analysis. EA systems generate jamming signals to overpower the pulsed signals from a target radar.

Radar systems can also be "confused" by the use of a DRFM, an integrated circuit or subsystem that can generate false radar return signals to deceive a radar. EP systems concentrate on processing and storing incoming signals to construct a signal database.

Traditionally, these systems were developed on an analog electronic platform, but newer systems rely more on digital circuitry to take advantage of the signal-processing capabilities available in modern programmable logic devices (PLDs).



1. This signal chain is found in typical electronic-warfare (EW) receivers.

Threat detection from unknown targets in these systems requires a receiver that can operate over a wide frequency band

(continued on p. 20)

STRONG GROWTH PROJECTED for Military Radar Systems

VISIONGAIN (www.visiongain.com) has announced the availability of a massive 10-year (2015-2025) projection of global military radar markets, with strong growth projected for the next decade. The report includes reviews of leading defense contractors, including BAE Systems, General Dynamics, Lockheed Martin, Northrop Grumman, and Raytheon Co. Predictions refer to the three major forms of radar systems: airborne, naval, and land-based.

The 279-page report contains over 220 tables of data and predictions on the major radar markets and systems. It projects the global military radar systems market to reach $9.42 billion in 2015, with growing demand for military radar systems and technology throughout the forecast period. Growth is spurred by the needs of many nations to upgrade their radar technology, to perform surveillance and weapons control, and even to monitor their borders for potential terrorist threats.

Applications for radar systems continue to expand in air, naval, and ground-based applications, and many other military applications, such as electronic countermeasures (ECM) and electronic-warfare (EW) systems, depend on radar systems for their successful operation.

(News continued on p. 6)

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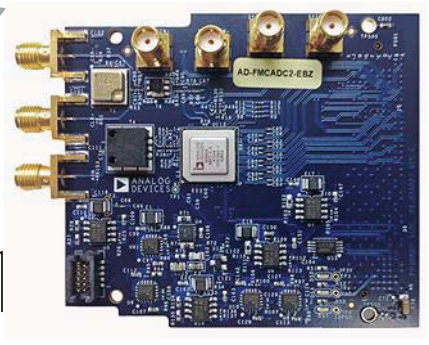

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Radar Grows Beyond Military Needs

RADAR SYSTEMS and technologies have long been synonymous with military applications. Starting with World War II, as vehicles and weapons began their march toward greater sophistication, requirements for radar systems have followed suit. With their capabilities to "see" targets from a distance, radar has long been invaluable.

Radar technology has evolved into many different forms of systems, from basic continuous-wave (CW) systems to more complex systems with different lengths of pulses and modulation formats. In most cases, military radar systems are attempting to detect and identify targets that are not supposed to be detected. But radar technology has grown a great deal over the years, and is increasingly used in non-military applications for detecting such things as weather patterns and vehicle speeds on interstate highways.

With regard to the latter, radar has been used by law enforcement professionals since the 1950s for vehicle speed detection. Ironically—following the behavior practiced by military forces when using electronic countermeasures (ECM) systems to detect and thwart enemy radar, electronic-warfare (EW), and other military electronic systems—civilians now purchase radar detectors for their vehicles to help locate police radar sources.

In the hospital, the use of radar systems is growing quickly for medical purposes—specifically, for noncontact monitoring and measuring of vital signs. Radar technology detects the movements of key organs, such as the lungs and heart. Initial medical radar systems involved CW signals, but more recent systems have been designed to use pulsed signals as in advanced military radar systems. The pulses provided more capabilities, like measurements of organ movements.

Non-military uses for radar technology continue to expand. Vehicular radar systems, for example, are now employing 77-GHz with Doppler techniques for such functions as adaptive cruise control and pe-crash collision-avoidance warnings. As leading semiconductor suppliers develop more affordable millimeter-wave devices at such high frequencies, radar developers can offer competitive prices that spread these radar-based products to the masses.

Military users depend more on radar with each new conflict and advance in weaponry. But they are no longer alone, as civilian and industrial users continue to appreciate the benefits of this versatile technology. de

JACK BROWNE, *Technical Contributor*

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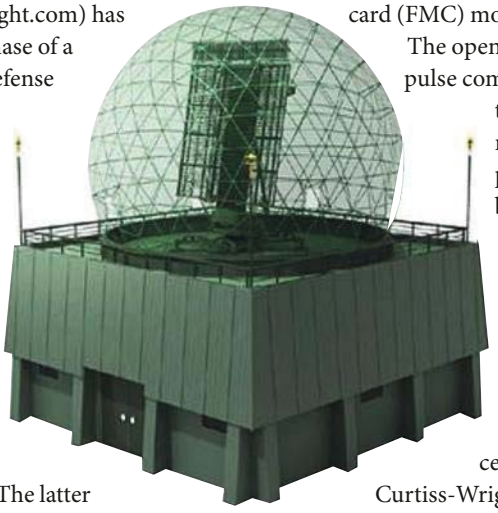
RADAR TECHNOLOGY Strengthens Korean Surveillance Efforts

THE DEFENSE SOLUTIONS DIVISION of Curtiss-Wright Corp. (www.curtisswright.com) has completed the development phase of a contract from South Korean defense contractor LIG Nex1 (www.lignex1.com) to supply commercial-off-the-shelf (COTS) radar processing module technology. The technology is targeted for the Korean Army's Next-Generation Local Air Defense Radar and Korean Air Force's Long-Range Surveillance Radar programs.



As part of the contract, Curtiss-Wright provided its latest OpenVPX modules to LIG Nex1, along with a variety of supporting modules. The latter includes a high-performance field-programmable gate array (FPGA), single-board computer (SBC), digital signal processor (DSP), network switch, and FPGA mezzanine-card (FMC) modules.

The open-architecture modules enable the pulse compression and beamforming functions for LIG Nex1's surveillance radar systems. The development phase for the two radar systems began in 2012 and was recently completed. LIG Nex1 has shown advanced radar-technology capabilities during the three-year development period. These include performing multiple digital beamforming and pulse-compression techniques using radar signal-processing algorithms with several of the Curtiss-Wright SBC modules. The company manufactured the modules for this contract at its facility in Ottawa, Ontario, Canada. ■

LITHIUM-ION BATTERIES Drive Military Vehicles

THE XCELION 6T LITHIUM-ION (Li-ion) battery has been developed by Saft (www.saftbatteries.com) as a drop-in replacement for traditional lead-acid batteries in military vehicles. The new battery is claimed to provide the equivalent power of two lead-acid batteries for a fraction of the weight and volume. The Li-ion battery was recently selected by leading defense contractor Lockheed Martin (www.lockheedmartin.com) for its Joint Light Tactical Vehicle (JLTV) products. The new batteries, which will be used to power modern communications and sensor systems in military vehicles, offer higher energy densities and longer operating lifetimes than lead-acid batteries.

Saft has been involved in a two-year program to develop the batteries as a commercial-off-the-shelf (COTS) product at reduced cost, for use in industrial and commercial markets. According to Thomas Alcide, president of Saft America and general manager of Saft's Specialty Battery Group: "By reducing the cost and time to build the Xcelion 6 battery, Saft is ready to offer this product to replace lead-acid batteries, not only on all military vehicles worldwide, but also for many commercial applications."

The Saft 6T Li-ion battery is a +28-V dc unit capable of 60-Ah current that has been designed within the dimensions of a traditional lead-acid battery for vehicular use. It can be used for vehicle starting, lights, ignition, and other military systems, including jammers, communications, and control equipment on board the vehicle. ■

REPORT EXPLORES LEAD-FREE ELECTRONICS for Military and Aerospace Applications

LEAD-FREE SOLDER has had considerable effects on commercial and industrial electronics assemblies and printed-circuit boards (PCBs), and may have growing impact on military and aerospace applications. This assessment comes courtesy of a market research study by IPC—Association Connecting Electronics Industries (www.ipc.org). The IPC report, "Issues and Outlook for Lead-Free Electronics in Military and Aerospace Applications," explores current and future expectations for lead-free solder use within high-reliability applications.

The study examines the costs of reworking circuit assemblies into

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lead-free formats and how such transformations will affect production processes and costs. As Sharon Starr, IPC director of market research, notes: "Many manufacturers today must depend on a dual supply chain to accommodate both leaded and lead-free processes. The study finds that maintaining dual processes, along with the growing scarcity of some leaded components, adds extra costs." The study also investigates the expected effects of scarce leaded components, as more electronic parts move to a lead-free format. The cost of the report is $250 each for IPC members and $500 each for nonmembers. ■

ROYAL CANADIAN NAVY Enlists Wideband Radios

ROCKWELL COLLINS recently completed delivery of 85 wideband radios to the Royal Canadian Navy (RCN) fleet in support of the advanced SubNet Relay (SNR) system. The model 721S radios enable data rates to 2 Mb/s within 500-kHz channels. The drop-in, software-defined-radio (SDR) technology is a replacement for legacy Rockwell Collins AN/GRC-171 radio systems, weighing 60% less than its predecessor. "The RCN is a strong supporter and early adopter of the Canadian-developed SNR capability, which is now fielded internationally," says Alan Prowse, vice president and managing director for the Americas for Rockwell Collins (www.rockwellcollins.com).

The model 721S radio incorporates the firm's patented Clarity technology, which eliminates background noise in both transmit and receive modes and provides four times the communications coverage compared to legacy radios. The radio is fully interoperable with legacy radios in use by coalition armed forces. ■

IFS TOOLS Help DynCorp Manage in Afghanistan

MANAGING AND MAINTAINING systems in Afghanistan under pressure is not easy, but tools from software developer IFS (www.ifsworld.com) have helped DynCorp. International (www. dyn-intl. com) to literally keep the peace. DynCorp. International upgraded its IFS Applications software tools to support ongoing U.S. Department of Defense (DoD) projects in aviation maintenance deployed within Afghanistan. DynCorp supports several DoD contracts and is using IFS Applications to provide additional capabilities for two of the company's aviation programs. Consequently, this will assist in the transition of capabilities to national organizations within the country.

DynCorp is exploiting the IFS Fleet and Asset Management software program—along with its supply-chain capabilities—to support helicopter maintenance in Afghanistan, helping to manage a fleet of more than 100 aircraft. As Steven Schorer, president of DynCorp International, explains: "We chose IFS Applications to gain a wider range of tools. Their solution enables us to increase our maintenance management and logistics functions, access information from multiple locations, and empower our team members to best support our global customers."■

TACTICAL RADIOS Build Upon Embedded FPGAs

CERTIFICATION BY the National Security Agency (NSA) requires a radio that can provide secure voice and data communications across a wide range of conditions. The Falcon III wideband tactical radio from Harris Corp. (www.harris.com) has earned Type-1 certification from the government agency.

Inside each radio, field-programmable gate arrays (FPGAs) from Altera (www.altera.com) help the systems achieve lower size, weight, and power and lower cost (SWaP-C), in addition to enabling the NSA Type-1 certification. The Cyclone V FPGAs are fabricated with a 28-nm semiconductor process.

To earn the security approval, Altera successfully completed the NSA Information Assurance Directorate (IAD) Secure Implementation Guidelines (SIG) document, which provides unified government recommendations on the use of security settings. The FPGAs help the radios to achieve radio modem and cryptography functionality, while also reaching SWaP goals with longer battery operating lifetime in the field.

Altera is also working with the NSA IAD on SIG documents for its 20- and 14-nm FPGAs, as well as its systems-on-chips (SoCs). ■

DARPA PROGRAM Pushes for Hypersonic Materials

HRL LABORATORIES, LLC (www.hrl.com) will be developing new materials for hypersonic vehicles as part of the Materials Development for Platforms (MDP) program managed by the Defense Advanced Research Projects Agency (DARPA). The new materials are intended to reduce the weight and cost of vehicle aeroshells while withstanding the challenging conditions encountered during hypersonic flight.

The MDP program was introduced to compress the development time of typically 10 years for new materials to a more-manageable 2.5 years. Materials for hypersonic flight must travel through air at more than five times the speed of sound, which can generate exterior temperatures in excess of several thousand degrees Fahrenheit.

The HRL team will attempt to combine innovative additive-manufacturing techniques with new high-temperature

materials. It will take advantage of such materials as polymer-derived ceramic materials and sandwich architectures to create optimized structures.

The team leader, Dr. Tobias Schaedler, explains: "Sandwich panels are used throughout the aerospace industry for lightweight, load-bearing structures, but their use in high-temperature applications has been limited by the availability of structurally robust high-temperature cores and scalable fabrication techniques. Our goal is to solve these challenges and develop ceramic sandwich structures that enable weight savings across a wide range of high-temperature applications." ■

PROGRAM SEEKS Improved Assessment Of Targets

AS PART of a two-year contract with the U.S. Air Force Research Laboratory, Modus Operandi (www.modus-operandi.com) is developing improved software components for an Air Force targeting platform known as CATALiST. This targeting platform is designed to improve the analysis and assessment of battlefield targets, and Modus Operandi's workflow modules will provide enhanced "intelligence" for the battlefield tool. The Melbourne, Fla.-based software developer's workflow modules will also automate what is now a time-consuming manual process for the identification of battlefield targets.

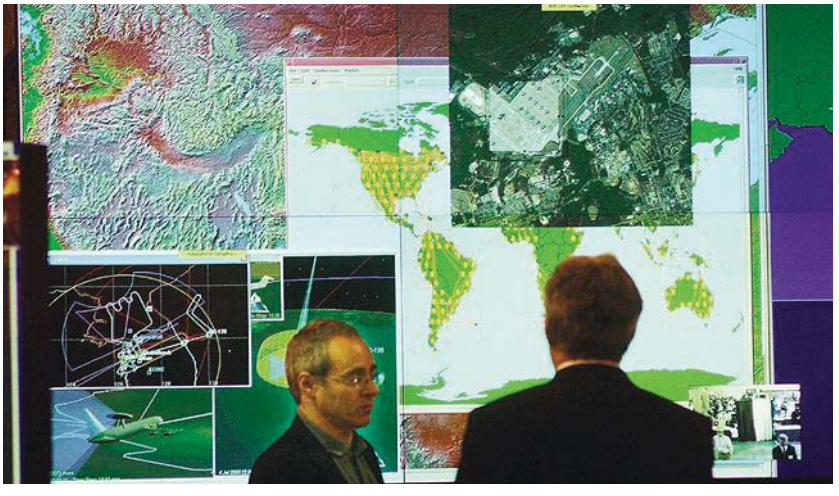
The workflow modules will be based on automating the processes for collecting and assessing targeting information, using a semantics-based approach similar to the well-known Internet-based Facebook application. The smart targeting solution will also use open-source software along with the software tools already developed by the AFRL, working in a Rome, N.Y. research facility.

The targeting software tools employ knowledge management technology, as well as data analysis and visualization technologies to perform effective identification and processing of targeting information. The AFRL admits that it currently works with manual targeting processes and hopes to automate these functions with the new software modules. The intent is for the modules to assist in avoiding collateral damage, such as the identification of false targets, and other sensitive phased of target selection. The modules will be part of a full-featured targeting process that will leverage analytical tools to reduce human error. ■

Navigation Systems
Steer Military Vehicles

KVH INDUSTRIES (www. kvh.com) has received a $1.5-million contract for the delivery of tactical navigation systems for an undisclosed armored vehicle application. The system in question is a variant of KVH's TACNAV TLS and TACNAV Light, which helps military vehicle personnel maintain full situational awareness. KVH's TACNAV military vehicle navigation systems, which are used by U.S. Army and Marine Corps customers, provide unjammable precision navigation, heading, and pointing data for vehicle drivers, crews, and commanders. According to the terms set forth in the contract, hardware shipments for the order are expected to be made in 2015. Program management and engineering services will be provided as part of this order.

"KVH's TACNAV navigation solution is an important tool for U.S. and allied warfighters, providing precision navigation as well as coordination of vehicles in critical situations," says Dan Conway, executive vice president of KVH's guidance and stabilization group. "The system serves as a crucial resource for navigation and battle management, keeping soldiers safe and out of harm's way wherever they travel." ■



Portable Scanner Sought for Improved Threat Detection

AS PART of the war on terrorism, the United States Department of Defense (DoD) has awarded a $2.1-million contract to Decision Sciences (www.decisionsciencescorp.com) for development of a new type of portable electronics scanner for threat detection. The contract is from the DoD's Combating Terrorism Technical Support Office (CTTSO) for Decision Sciences International Corporation (DSIC)—an advanced technology provider of security and detection systems—to build a scanner for use in domestic and overseas applications.

"We are very pleased to once again have an opportunity to work with the Department of Defense through CTTSO and support its critical mission to combat terrorism at home and abroad through technical innovation," says Dr. Gene Ray, chief executive officer of DSIC.

As part of the contract, DSIC will create a prototype system capable of detecting small amounts of explosive materials within portable electronic devices, such as mobile telephones and laptop computers. The MMPDS uses muons and electrons to detect shielded and unshielded nuclear and radiological threats, as well as explosives, narcotics, and other materials within electronic devices. ■

Navy Tunes to Mercury Systems for Radio Spares

THE U.S. Naval Warfare Center, Crane Division (NSWC) has awarded a $7.1-million indefinite-quantity/indefinite-delivery (IDIQ) contract to Mercury Systems (www.mrcy.com) for advanced RF tuners, digital receivers, and related equipment. The radio gear is meant to serve as spares during the installation of the AN/SLQ-32(V)6 electronic countermeasure system on U.S. Navy and Coast Guard ships. Work on the contract, which will be performed at Mercury's Chelmsford, Mass. facility, is expected to be completed by May 2020. The AN/SLQ-32(V)6 is part of the Navy's Surface Electronic Warfare Improvement Program (SEWIP), an upgrade to the AN/SLQ-32 electronic warfare (EW) anti-ship missile defense system.

According to Charlie Hudnall, general manager of Mercury's Embedded Sensor Products group, "The Navy's requirement to deny or degrade hostile uses of the electromagnetic spectrum has placed new demands on existing electronic warfare systems…"This contract reaffirms Mercury's leading-edge capabilities in RF, digital signal processing and data movement." ■

JACK BROWNE | Technical Contributor

Radar Technology

Guards from Land to Sea

Since World War II, radar technology has been evolving worldwide into many types of CW and pulsed systems for commercial, industrial, and military/aerospace applications.

RADAR SYSTEMS are essential elements in any military organization's defense efforts, whether on land or at sea. They are simple in concept: transmit a pulse and then receive the reflections from a target to extrapolate information about that target. To civilians, radar technology is considered important but fairly standard among the different armed forces.

Nevertheless, the number of different radar systems and technologies in use by the armed forces is quite staggering. These systems are constantly undergoing improvements as RF/microwave components and subsystems evolve—for instance, the availability of higher-power gallium-nitride (GaN) semiconductors in smaller packages.

Radar technology has evolved a great deal from its origins in World War II. Not only is it now integrated into systems for land, sea, and air defense-related applications, but it has been adapted for prediction weather, medical use, and even at millimeter-wave frequencies for automotive use in collision-avoidance systems.

In its simplest form, a radar consists of a transmitter that broadcasts pulsed signals in search of a target, whether known or unknown. A radar receiver detects pulse reflections from a target and the amplitude of those signals—along with the differences in time of arrival and the time that the pulses were transmitted—to determine information about the target, including size, location, and direction.

Military radar is used to detect a wide range of targets, including land vehicles, ships, aircraft, projectiles, missiles, and satellites. Radar is also used to guide weapons to a particular target, and helps navigate ships and aircraft. Pulse radar systems are the most essential forms of radar, using repetitive strings of short pulsed signals to identify a target. Some of these systems rely on simply receiving the reflected pulse echoes to determine information about the target from the nature of those returning signals.

Some rely on decoding the Doppler frequency shift of the returning signals in order to reject the radar returns from targets that are not moving. This simplifies the detection of, for example, a ground vehicle, from the surrounding environment (known as clutter). Some of these pulse Doppler radar systems are further designated moving-target-indicator (MTI) radar for their capabilities in detecting moving targets from the objects and environment around them.

MTI pulse Doppler radar systems tend to use low pulse repetition frequencies (PRFs) to achieve an unambiguous target range measurements, such as a PRF in the hertz range. Standard pulse Doppler radar systems are more likely to use a higher PRF—more in the kHz range. A low PRF enables accurate measurements of target range while a higher PRF is more capable of accurate measurements of target speed.

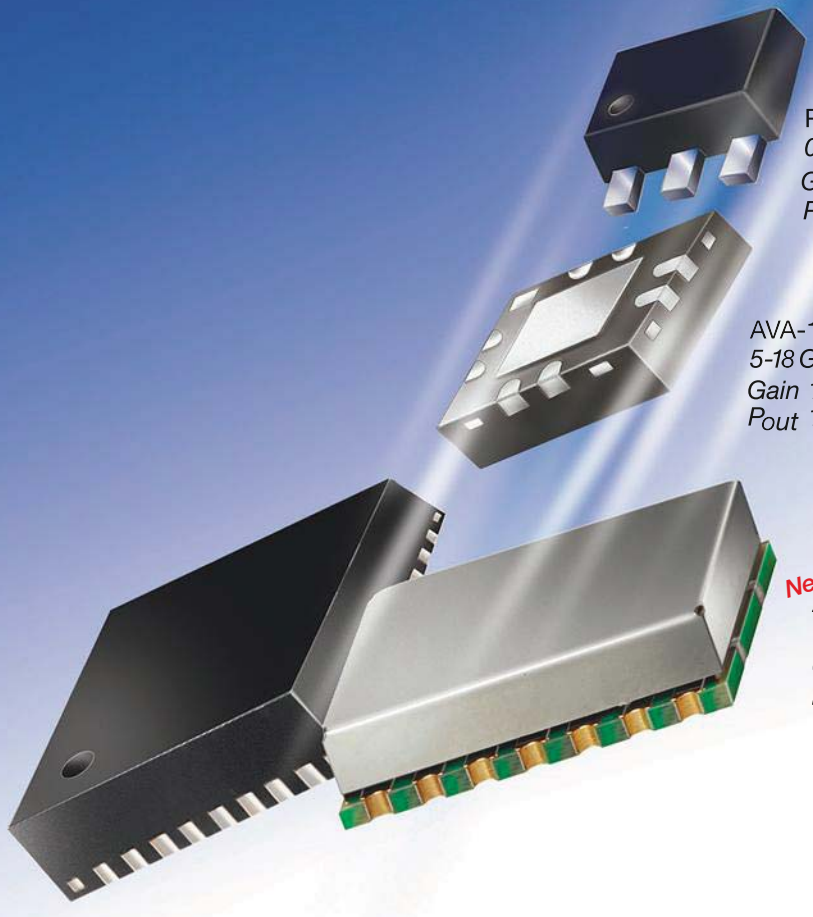
Because aircraft themselves are moving as they attempt to make MTI radar measurements, they employ a variation of the MTI radar system known as the airborne moving-target-indicator (AMTI) radar. Since stationary clutter is moving relative to the moving radar system on the aircraft, these additional Doppler effects must be corrected in an AMTI to execute accurate moving-target measurements.

Synthetic-aperture-radar (SAR) systems are typically moving systems, such

The next-generation AN/SPY-6 air and missile defense radar (AMDR) system is planned for the DDG-51 destroyer starting in 2016. *[Photo courtesy of Raytheon Co. (www.raytheon.com).]*

50 MHz to 26.5 GHz

MICROWAVE MMIC AMPLIFIERS



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as on satellites or aircraft, with an antenna beam oriented perpendicular to the direction of travel. An SAR system analyzes sequentially received signals and adds them for analysis, creating a high-resolution image of a target. An inverse SAR (ISAR) works with Doppler frequency shift to obtain movements of a target relative to the movement of the radar system, such as on an aircraft.

SAR and ISAR systems also are referred to as imaging radar systems. The U.S. Defense Advanced Research Projects Agency (DARPA) currently is seeking a radar system that's able to provide the performance of an SAR system, but one that's more cost effective, through its recently announced Advanced Scanning Technology for Imaging Radar (ASTIR) program.

These are just a few examples of the many types of pulsed radar systems used on land, at sea, and in the air by military forces. Radar systems can also operate with continuous-wave (CW) signals. CW radar systems transmit and receive signals at the same time, and depend on the Doppler frequency shift of a moving target to identify it from returned signals from non-moving objects.

CW radar systems can measure the radial velocity of targets from their Doppler frequency shift and determine the direction of arrival of a received signal—but not the range of the target. This basic radar format is typically used for such applications as target tracking and vehicle speed detection.

By using a variation of this radar type, frequency-modulated CW radar (FM-CW radar), the transmitted frequency is continually changing. With such a system, the frequency of the reflected radar signals will differ from the frequency of the transmitted signals according to the changes with time, and it is possible to determine the range of a target according to the proportional changes in modulated frequency with time.

The range of a target also can be determined by using CW signals and changing the phase of the transmitted signals, with the received changes in phase corresponding to the range of the target.

Of course, radar technologies continue to evolve and advance, as major military contractors explore different approaches to improve radar performance at lower power levels. For example, Lockheed Martin (www.lockheedmartin.com) announced encouraging results of testing on a new type of radar system the firm calls a digital beamforming system.

The new technology overcomes the classic shortcoming of phased-array radar systems to seamlessly track mul-

tiple targets at the same time, using a dedicated radar beam for each target of interest. It combines advances in digital-signal processing and antenna technologies to synthesize multiple beams from a large array of data that has been received by a radar receiver and digitized.

For the air, Northrop Grumman (www.northropgrumman.com), a pioneer in the active electronically scanned array (AESA) radar system, has outfit F-35 fighter planes with this scanning beam radar system for some time.

For the sea, Raytheon Co. (www.raytheon.com) has developed a next-generation AMDR system in its AN/SPY-6 system. It features a modular design with S- and X-band radar subsystems. It is planned for installation on the DDG-51 flight destroyer *(see the figure)* starting in 2016. The advanced radar system is claimed to be 30 times more sensitive than previous seaborne radar systems.

Mobile counter target acquisition (CTA) radar systems provide a 360-deg.threat detection capability against incoming weapons. Deployed as the AN/TQP-53 truck-mounted mobile radar system and the AN/TQP-50 Humvee-mounted lightweight counter mortar radar, the radar technology uses pulses at different wavelengths and directions to detect different targets.

MORE ROBUST SEMICONDUCTORS

Radar systems are building on progress in high-power RF/microwave semiconductors, notably higher output-power levels available from GaN discrete transistors and monolithic-microwave-integrated-circuit (MMIC) amplifiers. Such semiconductor devices are supporting generation of more than 100 W per device at frequencies through 18 GHz, enabling the miniaturization of high-power land-, sea-, and air-based radar systems. They also enable less reliance on electron-tube amplification, such as traveling-wave-tube amplifiers (TWTAs) for higher power levels at microwave frequencies.

However, with these higher-power semiconductor devices comes a need for improved heat dissipation, and advanced materials are making GaN amplifiers, and higher power levels from microwave semiconductors, possible. In fact, GaN devices often are fabricated as a combination of materials, such as GaN on silicon carbide (GaN-on-SiC) transistors.

Heat-tolerant SiC materials are used in the transmit/receive radar modules so that they can handle higher power levels without overheating, as well as achieve longer detection ranges with high accuracy. Such capabilities are invaluable in tracking multiple enemy targets. de

AHMET TASSEKI | Project Manager MAXIMILIAN SCHOBER | Marketing Manager

Packaging Solutions

Fly in Aviation Applications

Due to the special requirements of aviation applications, system enclosures must provide proper thermal management while also holding up against high levels of shock and vibration.

ELECTRONIC COMPONENTS and systems in aviation applications must endure extreme stresses and strains. Altitudes of over 16,000 m and speed of more than 800 km/h at wide temperature ranges can challenge even the best-designed packaging. Fortunately, air-transportation-rack (ATR) housings have become the *de facto* standard for electronic equipment used in aircraft.

Known as ARINC 404, these ATR cases essentially define equipment dimensions for avionics applications, offering standard mounting options and integrated hardware and cooling. With modular one-half, three-quarter, full, and one-and-one-half ATR sizes, these cases can be cost-effectively used in avionics installations—they're able to withstand shock and vibration to levels of 40 g. The cases also provide excellent protection against equipment-endangering elements such as moisture, sand, and dust.

In general, ATR chassis are designed for operating temperatures from −55 to +85°C. Ambient temperature is about +50°C. If power dissipation in an avionics electronic system is less than 120 W, passive cooling usually is the norm. All heat sources will make contact with the housing shell to dissipate heat, enabling heat sources such as the central processing unit (CPU) to transfer heat to the clamshell, and then to the equipment case via wedge locks.

The case surface can be equipped with cooling fans to aid in the conduction of heat, even in an airtight (IP67 or higher) enclosure. This protects system circuit boards and the power supply from environmental influences and minimizes maintenance under harsh conditions.

1. This lightweight ATR chassis system is designed with thermal management, EMC, and dust/dirt protection. *(Photo courtesy of POLYRACK)*

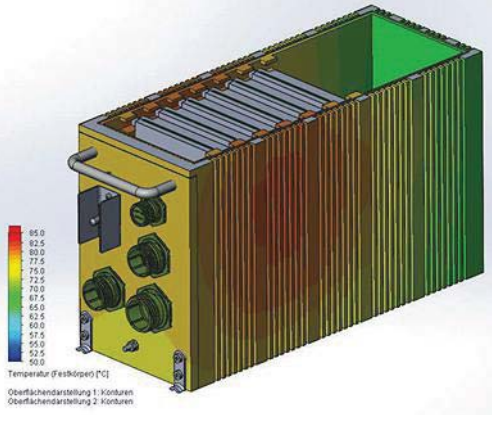
For systems at higher power ratings, additional forced cooling is usually in order. Cooling fins, which are arranged in the direction of ventilation, are covered with an outer plate. Ventilation channels thus form between the outer plates and the actual case. Ventilation is generally installed at the rear of an ATR chassis; the air inlet can be located either at the front or at the sides.

Cool air is pulled in via the air inlet vents and transferred through the ventilation channels, with cooling accomplished by means of conduction and forced-air cooling. This requires fans that are suitable for use at high altitudes, and that deliver the required performance under challenging conditions.

At the same time, the ventilation device must suit the prevailing operating temperatures and atmospheric moisture to ensure a steady air flow even at high pressure. In aviation applications within dry, dusty regions, a washable, electrostatic-discharge (ESD) air filter can help screen out dirt and dust. Hermetically sealed thermostats and fan-fail functions that provide early warning of overload further boost thermal-management reliability.

"Ruggedized" cases typically employ conduction cooling. An aluminum thermal conductor forms a stable mechanical reinforcement; a circuit board can be affixed to them at several points. Double walls guarantee a shock-resistant construction, as do module rails, covers, screws, and other assembly hardware. ATR cases are usually made of aluminum to achieve the lightest weight possible.

Aluminum construction offers an additional benefit: It provides protection against electromagnetic (EM) radiation and permits open grounding across the conductive surface. Electromagnetic compatibility (EMC) plays an important role for system integrity in avionics systems and must be incorporated into the design of a case from component level. To guarantee high EMC, a system should be constructed hermetically.



2. This thermal image shows the temperature flow through an ATR electronic equipment chassis. *(Image courtesy of POLYRACK)*

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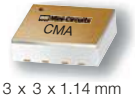

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	Model	Freq. (GHz)	Gain (dB)	P_{OUT} (dBm)	IP3 (dBm)	NF (dB)	DC (V)	Price $ ea. (qty 20)
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	CMA-63+	0.01-6	20	18	32	4	5	4.95
	CMA-545+	0.05-6	15	20	37	1	3	4.95
NEW	CMA-5043+	0.05-4	18	20	33	0.8	5	4.95
NEW	CMA-545G1+	0.4-2.2	32	23	36	0.9	5	5.45
NEW	CMA-162LN+	0.7-1.6	23	19	30	0.5	4	4.95
NEW	CMA-252LN+	1.5-2.5	17	18	30	1	4	4.95

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Removable parts require an EMC/IP combination gasket to prevent interference from external sources and limit emission of interfering signals. Within a system, interference between different boards can be prevented by mechanically separating signal and power areas.

At POLYRACK, one-half short ATR chassis are equipped with plug-in boards completely encased in a metal frame or two metal half shells (clamshells) and screwed to the board *(Fig. 1)*. This not only guarantees EMC protection, but also optimum heat dissipation. The boards are secured in card guides with extractor handles that are easy to manipulate.

Wedge locks provide additional stability against shock and vibration, plus protection against ESD. They also establish the thermal contact between the card and the case wall to dissipate the heat.

Packaging systems for aviation applications must be designed so that they can withstand high levels of shock and vibration. Each has a different impact on an electronic system's components. Shock is a single-pulse event with a certain force, with shock values ranging between 5 and 10 g in industrial systems and to 100 g in military or naval systems.

Shock can subject card and connector contacts to a high level of stress and contact surfaces may become damaged. To counteract this, the type of construction, the choice of material and components, and the application and the installation mode of the system at the site of operation are important packaging considerations.

Vibration, on the other hand, is defined as continuous oscillation with a variable force along one or more axes. Because of vibration, electronic components or materials can resonate, components can break or be damaged mechanically, and screws can loosen over time.

To protect an electronic system from shock and vibration, a POLYRACK ATR chassis interconnects parts by means of dip soldering. This ensures good stability and avoids screw failures, while also enhancing heat transfer. The chassis incorporates VPX backplanes with pilot pins to ensure extra stability of plug-in cards; the slots can be coded by way of the pilot pins. In addition, POLYRACK secures critical components by means of adhesion and uses a "free-floating" assembly concept when mounting assemblies and subassemblies in the case.

Passive isolators are an additional option for damping shock and vibration in electronic-equipment enclosures. Such an isolator consists of a spring that absorbs the shock or vibration and a damping element to dissipate the energy, sometimes as much as 80% of the initial load. The

spring is either a wire-rope isolator made of stainless-steel stranded cable or an air spring system.

A one-half short ATR chassis from POLYRACK meets all military requirements for thermal management and EMC/ESD protection *(Fig. 2)*. It complies with the ARINC 404A standard and was designed in accordance with the strictest specifications from security and defense technology. It is qualified to MIL-STD-810G, which tests the reliability of devices subjected to extreme temperatures, high atmospheric pressure, and acceleration forces, among other factors.

This ATR chassis also complies with standards for electrical supply systems in aircraft to MIL-STD-704 and with EMC requirements in accordance with MIL-STD-461. It is suitable for use in airborne fighters and helicopters, as well as in land-based and naval systems.

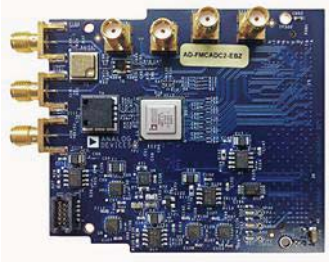
New materials were deployed in the ATR chassis—e.g., aluminum 606–T651 and other certified materials. Such advanced materials enable lightweight construction, optimal heat dissipation, protection against shock and vibration, and the capability to function at high altitudes. Salt-bath brazing supports the lightweight construction vital for aircraft.

The POLYRACK ATR chassis operates with a conduction-cooled power supply in accordance with VITA 62. Other ac and dc inputs are also available as options. Thanks to a special power supply and the use of special connectors, the chassis meets EMC requirements. All removable case components are sealed with a two-component (2K) material for IP and EMC protection.

The chassis backplane employs OpenVPX technology in accordance with VITA 65 requirements. This allows the extrusion to be scaled and configured to almost any specification and offers a flexible basis for specific technologies with various standards. It works at bit rates to 10 Gb/s, with five 3U slots available in the ATR chassis. In addition to VPX, the system can be configured with CPCI, VME, and VMEX backplanes.

The standard POLYRACK ATR model is available in 13 sizes and versions for compliance with different standards; further customization is also available. In addition, POLYRACK can adapt chassis and shells according to individual custom requirements or on the basis of particular standards, to meet specific custom requirements for equipment packaging. Especially in military and aerospace systems, such packaging needs tend to be quite specialized, and these customization capabilities are able to fill a wide range of provisions. de

(continued from p. 1)
to identify threat signals and initiate countermeasures. Typical EW systems may operate from dc to 20 GHz. In addition to wide-bandwidth requirements, practical EW systems should provide high dynamic range, high sensitivity, and accurate pulse characterization; new systems are being pushed to examine the bandwidths of interest faster with greater levels of detection sensitivity.



2. This 2.5-Gsample/s FMC board provides synchronization support for high-speed AD9625 ADCs.

More complicated situations arise when incoming signals to an EW system arrive from numerous sources, each of which must be identified. Independent of intentional interference from adversaries, increased spectral congestion has made effective detection of threat signals even more challenging.

Demands for EW systems with smaller size, lighter weight, and lower power (SWaP) are making development cycles for new systems longer and more difficult. However, next-generation off-the-shelf solutions coupled with programmable building blocks are providing EW systems that can meet these difficult challenges. Two of the key building blocks critical for any EW system are the ADC and real-time channelization intellectual property (IP).

In many cases, the transition from analog to digital realms is a limiting factor in ES, EA, and EP systems. A system designer is often faced with the tradeoffs of minimizing cost and system size, as well as achieving an optimal balance between the need to increase instantaneous surveillance bandwidth and the requirement to minimize the effects of in-band high-power signals. Even if the ADC has excellent performance, the radio front end must be capable of preserving the signal quality, which results in a relentless push for high performance and low cost.

Figure 1 shows a simple EW system. The key features of the system are the RF receiver, used for frequency downconversion and selection of the frequency band of interest for interrogation; the ADC(s) used to convert signals from the analog domain to digital form; and the DSP engine—typically an FPGA—configured to detect, determine, analyze, and manage the storage of signals of interest. DRFM and EA systems also include a corresponding transmission signal chain with a high-speed digital-to-analog converter (DAC).

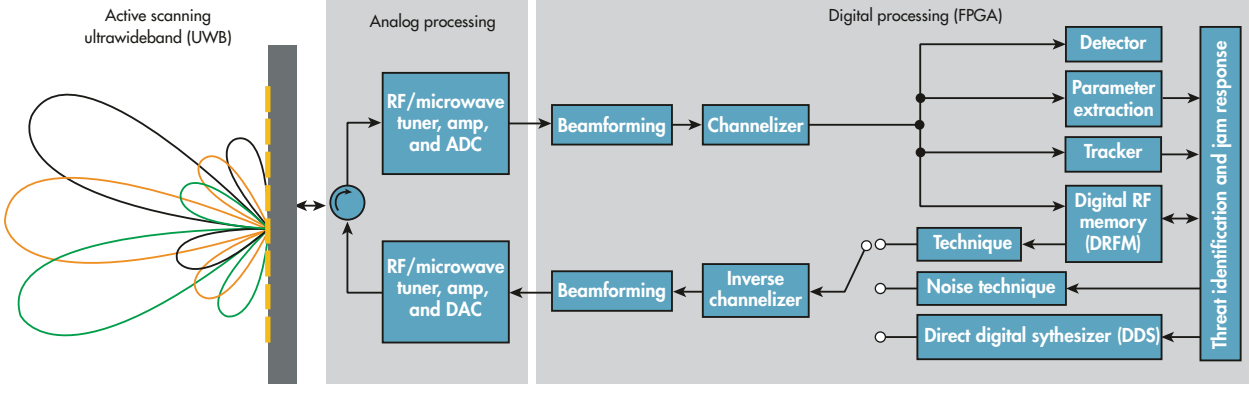
Historically, any increase in the instantaneous bandwidth of an EW receiver required either multiple overlapping receivers or an interleaved system architecture. Overlapped receivers each digitize a portion of the required bandwidth with digital signal processing that recombines the data contributions and observable spectrum from each channel.

An interleaved system architecture, in contrast, is often used with calibration to minimize the phase, offset, and gain differences between multiple data converters. Both approaches are generally expensive to implement, with DSP often customized for optimum performance.

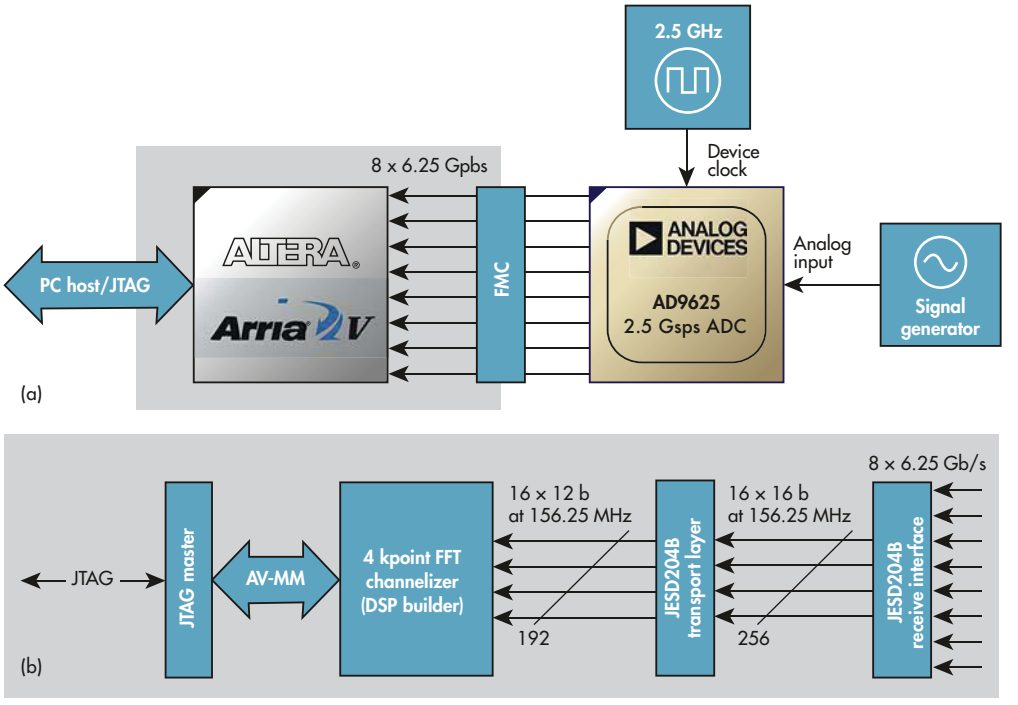
Newer high-speed sampling ADCs—such as the model AD9625 from Analog Devices—represent solutions for next-generation EW systems. Model AD9625 is a 2.5-Gsample/s, 12-b ADC designed for high-bandwidth ac performance.[1] It provides typical wideband signal-to-noise ratio (SNR), and spurious-free dynamic range (SFDR) of 57 and 80 dB, respectively, for a 1-GHz input bandwidth.

The AD9625 ADC can handle a small-signal analog bandwidth of more than 3 GHz, providing a system designer with significant intermediate-frequency (IF) location flexibility. This data converter is one of many signal-processing devices from Analog Devices that supports both parallel and serial interfaces, including the JESD204B standard.[2]

To facilitate rapid prototyping and system developments, the AD9625 ADC is available as a VITA 42/FPGA mezzanine connector (FMC) card platform *(Fig. 2)*. This platform provides reference designs showing how to optimize the signal conditioning prior to the ADC in a receiver design.



3. This block diagram represents a typical electronic-warfare (EW) system.



4. This system block can be used to demonstrate the ADC interface and the channelizer function in a typical EW receiver.

NEW CHANNELIZER MODEL

One common component in these systems is the digital channelized receiver or channelizer *(Fig. 3)*. The channelizer splits a wide input bandwidth into smaller component bandwidths to separate signals of interest from noise and interferer signals. Most digital channelized receivers consist of a filter bank and fast Fourier transform (FFT) processing.

One of the challenges in developing new EW receiver systems is that every new EW design or upgrade usually requires a more complex channelizer. To accelerate the development of the channelizer and reduce internal research and development (IRAD) costs, Altera developed a super-sample-rate FFT IP and finite-impulse-response (FIR) filter IP core that is capable of handling multi-gigasample-per-second data-converter inputs.

An example test setup can be used to demonstrate the ADC interface and the channelizer function in a typical EW receiver *(Fig. 4)*. In this setup, a signal generator produces a sinusoidal tone as the input to the AD9625 ADC. The digital output of the ADC is connected to an Altera Arria-V system-on-chip (SoC) development kit using an industry-standard FMC interface.

The samples received by the JESD204B interface are fed to the channelizer IP, which is configured to receive 16 samples concurrently using 16 input wires. Depending on the number of FFT points, a full FFT frame is divided into multiple time slots.

The channelizer IP was developed using the DSP Builder Advanced (DSPBA) software, a model-based design flow tool from Altera Corp.[3] It enables signal-processing engineers to design, evaluate, and verify algorithms in Matlab/Simulink simulation environments. Once an algorithm has been optimized, the software can be used to generate a code that's able to be deployed on Altera FPGAs for the EW receivers.

The channelizer output is stored in on-chip memory and verified through an Altera system-in-the-loop (SIL) tool. The SIL tool uses a Matlab API to trigger on-chip registers to begin logging for data visualization. Once triggered, a single iteration of FFT processing is executed and the resultant data is stored in on-chip static random-access memory (SRAM). The Matlab API extracts data through an Altera Avalon memory map from the SRAM to a Matlab host.

Integration of the IPs is performed by means of the Qsys integration tool from Altera Corp.[4] A Qsys project was created to integrate the channelizer IP and JESD204B IP. In addition to channelizer IP integration, the project incorporates control functionality to support an SPI configuration interface to the ADC. The channelizer can switch to different FFT sizes easily, ensuring future upgrade paths and potential design reuse. de

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4. Altera Corp., "Avalon verification IP suite user guide," www.altera.com/content/dam/altera-www/global/en_US/pdfs/literature/ds/digital_channelizer.pdf.

Power Dividers Run 0.5 to 6.0 GHz

THE WMPDXX-0.5-6-Y series of power dividers includes two-, three-, four-, six-, and eight-way dividers with continuous frequency coverage of 500 MHz to 6 GHz. Available with Type-N or SMA connectors, these power dividers measure just 6.500 × 4.000 × 0.800 in. As an example, model 4PN325 is a four-way power divider/combiner that operates from 0.5 to 6.0 GHz with 1.7-dB typical insertion loss and 1.60:1 VSWR. It achieves isolation between ports of 17 dB and can handle power levels to 50 W. The power divider/combiner boasts amplitude balance within 0.5 dB and phase balance of ±4 deg. The component is actually usable to 250 MHz with some degradation of performance.

WERBEL MICROWAVE LLC,

51 Chestnut St., Livingston, NJ 07039; (973) 900-2480, FAX: (973) 716-9430, e-mail: Sales@werbelmicrowave.com, *www.werbelmicrowave.com*

LDMOS Amp IC Aids Avionic Designs

MODEL AFIC10275N is a wideband LDMOS-based integrated power amplifier from Freescale, including support from Richardson RFPD, that is designed for avionics applications from 978 to 1090 MHz. It integrates two amplification stages in a plastic package and achieves 250-W output power across its frequency range, with 31-dB gain and 64% drain efficiency. The single-ended amplifier also incorporates RF and temperature sensors to reduce the need for those external components. Available in 14-lead and 14-lead gull-wing plastic packages, the amplifier operates on +50-V dc supplies and can be supplied with a reference circuit that reduces cycle time and development costs. The compact plastic package makes it possible to trim weight in avionics systems.

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THE SMS series of printed-circuit-board (PCB) electromagnetic-interference (EMI) shields has been expanded with the addition of 30 new shielding styles and sizes. The expanded shielding structures are constructed of tin-plated steel or Alloy 770 materials as a cost-effective shielding option for many automated pick-and-place circuit-assembly processes and large-volume manufacturing processes. The EMI shields provide as much as 60-dB shielding effectiveness (SE) for circuit boards that do not require ventilation holes in the shielding covers. Samples of the unvented shields are available for shipment in as little as 24 hours.

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2420 Race Track Rd., Tampa, FL 33626; (866) TECH-EMI (832-4364), (813) 855-6921, FAX: (813) 855-3291, *www.leadertechinc.com*

Amplifier Cuts Noise from 100 MHz to 18 GHz

OFFERING A wide bandwidth from 100 MHz to 18 GHz, model AF0118273A is a broadband low-noise amplifier (LNA) that can be used in a multitude of commercial and military applications. It features 27-dB gain across the frequency range, with gain variations reaching a maximum of ±1.2 dB. The noise figure is a respectable 2.8 dB even at 18 GHz, while the VSWR is 2.0:1 across the full frequency range. The output power at 1-dB compression is +10 dBm. The amplifier, which draws 100 mA current from a +50-V dc supply, is designed for operating temperatures from –55 to +85ºC.

HEROTEK INC.,

155 Baytech Dr., San Jose, CA 95134; (408) 941-8399, FAX: (408) 941-8388, e-mail: info@herotek.com, *www.herotek.com*

Isolators Channel Signals to 35.5 GHz

A PAIR OF microstrip isolators has been developed for applications through 35 GHz. Model T001110 operates from 29.6 to 30.6 GHz while model T001111 runs from 34.5 to 35.5 GHz. These components integrate ferrite circulator/isolator substrates on printed-circuit-board (PCB) materials to provide high performance at practical cost. Typical insertion loss for these isolators is 0.8 dB across their respective frequency ranges, with isolation between ports of 20 dB and return loss of 20 dB. The isolators handle the power levels required for typical applications in phased-array radar systems and satellite-communications (satcom) tracking antenna systems. Typical power levels are 20 W (average) and 500 W or more (peak power).

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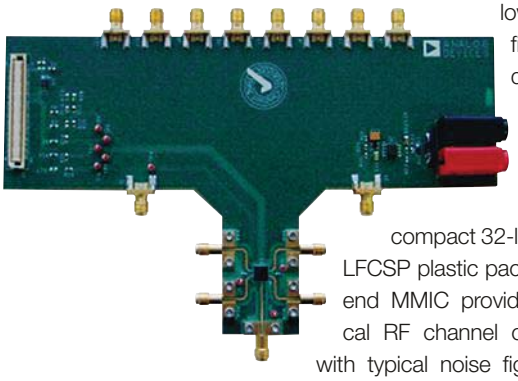
SUITABLE FOR both commercial and military applications, including automotive-radar and military-radar sensors, model ADF5904 is an integrated, four-channel receiver downconverter monolithic microwave integrated circuit (MMIC) with 250-MHz RF signal bandwidth at 24 GHz. Each channel contains a single-channel RF input signal path with on-chip balun, differential low-noise amplifier (LNA), and downconverter mixer with differential output buffers. Supplied in a compact 32-lead, 5- × 5-mm LFCSP plastic package, the front-end MMIC provides 22-dB typical RF channel conversion gain with typical noise figure of 10 dB. The MMIC, which easily connects to a high-speed analog-to-digital converter (ADC) for straightforward receiver front-end design, also contains an integrated temperature sensor to simplify calibration over wide operating temperature ranges. The LO-to-RF isolation and RF-to-intermediate-frequency (IF) isolation levels are typically 30 dB or better.



ANALOG DEVICES INC.,

One Technology Way, P.O. Box 9106, Norwood, MA 92062; (781) 329-4700, (800) 262-5643, *www.analog.com*

Pulsed TWTA Powers 32 to 36 GHz

MODEL DB-3861 is a high-power traveling-wave-tube amplifier (TWTA) for pulsed Ka-band applications from 32 to 36 GHz. Well-suited for such applications as radar and electronic-warfare (EW) systems, the amplifier delivers 400-W peak output power with 56-dB minimum gain at a 25% duty cycle. It is designed for 0.2- to 50.0-µs pulse widths at maximum pulse repetition frequency (PRF) of 300 kHz. Harmonic levels are –20 dBc or better, while spurious levels are –50 dBc or better. The TWTA uses a wideband periodic-permanent-magnet (PPM) focused, conduction-cooled TWT for power amplification. It is designed for altitudes to 10,000 ft. and operating temperatures from –20 to +55ºC. Provided in a 19-in. rack-mount configuration with integral forced-air cooling, the TWTA is equipped with WR-28 waveguide input and output ports and runs on 115/200-V ac supplies. It measures 24.5 × 19.0 × 7.0 in.

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RUGGED MODEL 10A4NAJ-2S-S is a high-power, S-band, two-channel power divider that has been space-qualified for use in remote applications. With a frequency range of 2.1 to 2.4 GHz, the two-way power divider limits insertion loss to just 0.4 dB while providing at least 20-dB isolation between ports. It features amplitude balance of 0.2 dB for the divided signals and VSWR that is maintained at 1.20:1 or less. The space-qualified power divider can be used in transmit as well as receive applications. It handles 50-W average input power. It measures 1.86 × 1.10 × 0.417 in. and works over an operating-temperature range of –30 to +70ºC.

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ago, but is now launched in the market, demonstrating the renewed speed to market of the company.

In the Data Center, Intel's manufacturing and architectural leadership combined with opportunities driven by the values of cloud-computing continued to yield impressive results. Revenue grew 19% year-over-year and the Xeon E5 Version 3 product line, formerly known as the Grantley platform, now represents more than 50% of its two-socket volume. (A CPU socket or CPU slot is a mechanical component that provides mechanical and electrical connections between a microprocessor and a printed circuit board, or PCB. This allows the CPU to be placed and replaced without soldering). New products like Grantley and their increased support of custom versions of the product helped achieve record cloud revenue.

Intel also introduced its first Xeon-based SoC processor, optimized for micro servers, storage, network, and IoT devices. Growth in the Data Center also benefited their NAND business, which grew 14% year-over-year.

Intel and Micron formally announced a jointly developed 3D NAND technology. Intel 3D NAND will be available in the second half of 2015, and offers roughly three times the stated capacity of computing technologies, which aren't expected until 2016. 3D NAND, for example, can provide greater than 10 terabytes of storage in a 2.5-inch solid-state drive and is the first 3D NAND solution to be architected to be lower cost than 2D NAND. The company's Internet of Things Group grew 11% over the first quarter of last year, based on strength in the retail and digital security market segments.

For the balance of 2015, the company expects the PC market to remain challenging, leading to a mid-single-digit decline in the overall full-year PC segment forecast. That said, Intel is launching its 14-nanometer Skylake microprocessors and is excited about the capability that this product family will enable on a variety of operating systems. In particular, Intel is very optimistic about the release of Windows 10 later this month, especially when combined with Skylake.

Intel's purchase of smaller chipmaker Altera will help improve the performance of its chips. The acquisition brings Altera's programmable gate array (PGA) into Intel, which can accelerate performance considerably, up to 200% improvement, as a result of the combination of the products For the big cloud providers, that performance improvement provides them not only with a competitive advantage but a cost advantage as well. With Moore's law showing signs of slowdown and nanometer nodes approaching single digits, Altera's technology could be the key to better performance at lower costs.

Intel has been looking for growth beyond the struggling PC market, which has been declining since its peak in 2011. Altera chips are used in a variety of markets, ranging from communications to consumer electronics. Altera's devices can have their function updated, even after they've been installed in end devices. While they're sold in relatively small volumes, programmable logic usually requires the latest in production technology because they are some of the largest chips in the industry.

Acquiring Altera may help Intel defend and extend its dominance in its most profitable business: supplying server chips used in data centers. While sales of semiconductors for PCs are declining as more consumers rely on tablets and smartphones to get online, the data centers needed to churn out information and services for those mobile devices are driving orders for higher-end Intel processors and shoring up profitability. Cloud companies such as Google, Amazon, and Facebook are still building out their server operations. As a part of Intel, Altera will continue to support designs that couple its chips with others designed on ARM Holdings Plc technology. ED

BILL WONG | Technical Editor

More Intelligent Signal Processing Targets IoT

Digital signal processing is more than just ADCs, DACs, and algorithms. Moving processing closer to the peripherals can improve performance and power usage.

Digital signal processing brings DSPs (digital signal processors) to mind. The DSP algorithms need I/O so they tend to be surrounded by analog-to-digital converters (ADCs) and digital-to-analog converters (DACs). Microcontrollers often handle DSP chores and often include DSP instructions. Microcontrollers also have ADCs and DACs on-chip.

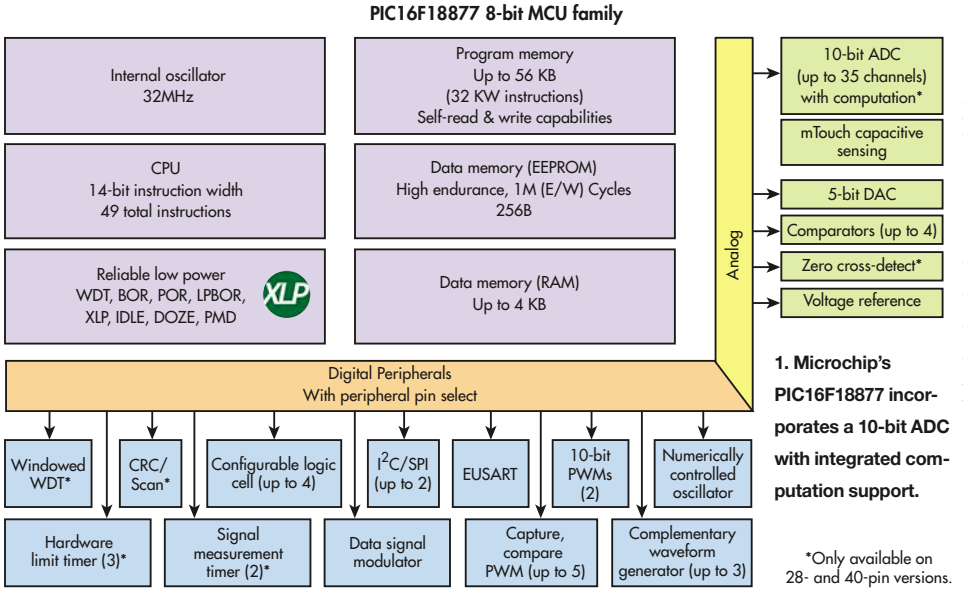
The trend in microcontrollers is to allow peripherals to operate when the processor is in one or more sleep modes. This reduces power requirements as the peripheral controller uses much less than the processing core or cores. Many sensor or data-logging applications can use significantly less power if the processor only runs when sufficient data has been obtained.

Microcontrollers have supported this power-down regimen almost since their inception, but the approach was usually very simple. For example, comparators are often used for checking error conditions when a threshold is reached. This is akin to a digital input that can wake up the processor when a switch closes. Both are very useful, but very limited.

More robust platforms allow ADCs to capture data before they wake up the processor and some can even be linked to a DMA controller so information is saved in memory without alerting the processor. The latter normally occurs once a specified number of samples is available. Likewise for DACs, a DMA and a timer can be combined to deliver analog outputs over time.

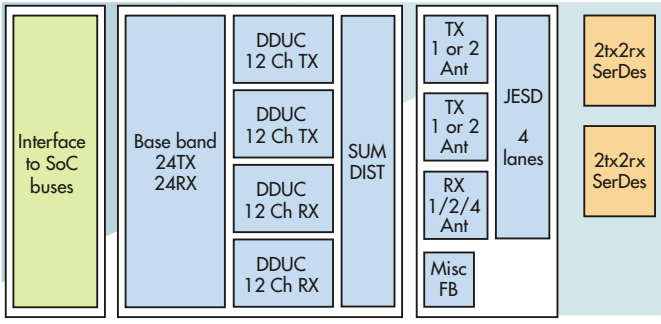
Many of the latest microcontrollers have the capability to programmatically link peripherals together to implement more complex operations. They allow the outputs of one device to be used by another instead of the processor. The processor normally gets involved in configuration and processing data at the end of the chain.

These combinations have normally been done using conventional peripherals with additional linkages between them. Cypress Semiconductor's PSoC series actually has configurable digital and analog peripherals (*see "Custom Peripherals Surround Cortex-M0 Platform" on electronicdesign.com*). This provides flexibility similar to FPGAs, but with simpler, albeit more limited, configuration.



1. Microchip's PIC16F18877 incorporates a 10-bit ADC with integrated computation support.

The PSoC tends to be the exception in microcontroller architectures, but the trend toward more functionality is clear. More intelligent or flexible peripherals are being incorporated into microcontrollers. Microchip's PIC16F18877 incorporates a 10-bit ADC with integrated computation support. (*Fig. 1*). The computation support



2. Texas Instruments' 66AK2L06 Keystone family has a software-configurable digital front end (DFE) that can often replace an FPGA.

can handle chores like accumulation and averaging as well as doing low-pass filter calculations in hardware. This support is in addition to the Core-Independent Peripherals (CIPs) from Microchip that provide the linkage between peripherals.

These types of features can provide significant power savings for Internet of Things (IoT) applications where low power and long battery life are important. Often the sensors employed need constant monitoring, but only need analysis or communication by an application running on the processor at infrequent intervals. The added intelligence allows an IoT platform to be more powerful, but use little power since the processor is idle most of the time. Likewise, this approach can be used to build an IoT solution around a less powerful processor because the hardware is doing the heavy lifting when it comes to analog data.

HIGH-END SOLUTIONS

Low-end systems are not the only place where peripherals are gaining more intelligence. Texas Instruments' 66AK2L06 Keystone family has a software-configurable digital front end (DFE) that can often replace an FPGA (*Fig. 2*). The Keystone system-on-chip (SoC) platforms target high-performance systems needing digital down-conversion (DDC) and digital up-conversion (DUC). The DFE also has programmable FIR filters.

These types of high-end solutions are often delivered to provide more power efficient implementations that are running continuously rather than the normally off IoT solutions. Implementations like Keystone offload the processor while eliminating the need for hardware-based processing implemented in an FPGA or a higher performance processor to handle the data processing chores.

Moving algorithms into hardware has always been a successful approach to improving performance, reducing costs and minimizing power requirements. This is likely to continue in the signal processing space. ed

WILLIAM WONG | Technical Editor

Signal Processing ANALYSIS

Mixed-signal analysis continues to often rely on advanced—and usually costly—software, but the results can justify the investment.

Mixed-signal analysis continues to depend heavily on advanced software to simplify design tasks and handle the massive amounts of data generated by test equipment. Vendors continue to deliver high-performance equipment and then build on this hardware using new software products. Sometimes these software tools are free while others are available for an additional charge.

For example, Keysight Technologies' N9040B UXA Signal Analyzer (*Fig. 1*) handles signals from 3 Hz to 26.5 GHz. Its full-band real-time spectrum analyzer capabilities have a 100% probability of intercepting signals with a duration as short as 3.84 µs.

The N9040B runs Microsoft Windows that supports the measurement and analysis applications. The standard suite includes the 89600 VSA software that is a set of tools for signal demodulation and vector signal analysis. Keysight's PowerSuite provides one-button power measurements.

Keysight has added new software including the N9068C phase noise, N9069C noise figure, and N9063C analog modulation measurement applications. These are available for an additional cost. The N9063C application has features like one-button measurements to calculate metrics such as AM depth, FM deviation, total harmonic distortion (THD), and signal-to-noise-and-distortion ratio (SINAD). The N9068C phase-noise application provides one-touch measurements for analyzing phase noise in frequency domain (log plot) and time domain (spot frequency).

1. Keysight Technologies' N9040B UXA Signal Analyzer handles signals from 3 Hz to 26.5 GHz.

2. Teledyne LeCroy's Summit T24 Protocol Analyzer can handle new protocols such as NVMe.

3. Textronix's AWG7000 Arbitrary Waveform Generator can host HDMXpress to test HDMI 2.0 applications.

Teledyne LeCroy's Summit T24 Protocol Analyzer (*Fig. 2*) can tackle x1, x2, and x4 PCI Express 3.0 lanes. It can handle up to 64 Gbytes of analysis storage, but the Summit T24 is not limited to the basic PCIe protocols—which is handy because protocols like NVMe and SATA Express are built on PCIe.

The new NVMe software takes advantage of the long trace recordings so the new NVMe Queue Analysis can operate on several hours of data. This includes the ability to measure the NVMe queue distribution over a sustained time period. The software also provides NVMe/SATA Express SSD performance and analysis reports.

Tektronix's DPO7000 Oscilloscope and the AWG7000 Arbitrary Waveform Generator (*Fig. 3*) can host Tektronix's HDMXpress. HDMXpress supports HDMI 2.0 receiver testing. It supports HDMI test pattern generation, autocalibration, and margin testing. This can eliminate the need for manual pattern creation. The tools can be used to automate compliance and validation testing.

In many cases, the software costs may exceed that of the hardware used to generate signals or record information. The advantage is the extensibility of these systems and the ability to handle new protocols or requirements.

WILLIAM WONG | Technical Editor

Vision Systems Give Robots a Glimpse at their Work

Camera use is exploding in industrial robots, improving both efficiency and safety.

Machine vision has been used in industrial automation and robotics ever since cameras were first attached to computers. Improved cameras and faster computational platforms are providing improved image analysis at rates often faster than a person can react to. Lower costs and more compact sensors are enabling robots to have (in many cases) dozens of cameras that provide more input about their environment. This is leading to more autonomous systems, as well as entities that are safer to work around.

Robotics and industrial automation have been partners for decades, with robots doing the heavy lifting and repetitive work on assembly lines found everywhere from automotive plants to bakeries. At first they were simple mechanical devices that had a limited set of movements, which were triggered by mechanical switches. Mechanics and hydraulics still play a major part in many assembly lines, often eliminating the human element for much of the process, but advances in robotics (and especially, sensing and process control) are changing this. Vision systems are one piece of the puzzle having a major impact on the capabilities of industrial robots.

Rethink Robotics' one-armed Sawyer and two-armed Baxter *(Fig. 1)* are examples of more human-friendly robots that are designed for more flexible assembly lines *(see "These Robots Are*

1. Sawyer (left) and Baxter (right) are a pair of robots from Rethink Robotics that use embedded vision in a number of areas, including each hand.

2. The iRobot 510 PackBot has a number of built-in cameras, along with mounting points for more specialized cameras and sensors.

No Danger, Will Robinson" on electronicdesign.com). They are designed to be easy to program *(see "Programming the Baxter Robotic Platform at Rethink Robotics" on engineeringtv.com)* because of their low impact arms and grippers, as well as their advanced imaging system.

The tablet-like eyes provide visual feedback, but there is a camera built into the tablet. And this is only one of many cameras: Others are hidden in each hand, along with range finders that allow the software to view what the gripper will come in contact with. There are two cameras in the chest, as well, designed to view objects moving by on an assembly line.

An example of a mobile robot with numerous cameras is iRobot's PackBot *(Fig. 2)*. This robot actually is a tele-operated device designed for tasks such as hazmat operations, public safety, and bomb disposal. The robot has multiple cameras, sensors, and range finders. Some are located in the base, providing an operator with a fixed orientation, while others are situated on the arms. These often are used to watch a gripper in action. Other cameras are found on attachments; these typically are specialized devices like high-resolution or thermal cameras. They may be combined with range finders.

Can you find the cameras in ABB's IRB 360 *(Fig. 3)*? The IRB 360 is at home on an assembly line, but it is designed for faster and repetitive operations than a platform like Rethink Robotics' Baxter and Sawyer. The IRB 360 can handle up to 8 kg; watching it in action can be dizzying.

3. ABB's IRB 360 can move 8 kg and its tool flange can handle a range of large grippers.

As for the cameras, they are built into the housing that mounts above the assembly line. They provide a downward looking view that includes the IRB 360's arms. Additional cameras may be included in an installation, depending on the operations required.

Not all robots will be picking up objects. Many perform visual inspection of everything from circuit boards and chips to Ford F-150s coming off the assembly line *(see "Ford Rouge Factory F-150 Assembly Line Tour " on engineeringtv.com)*. Visual inspection by robots is usually faster and more accurate than what a person is capable of, but they also can utilize a wider range of visual sensing ranging from infrared to ultraviolet.

SENSOR VARIETY

Image sensors that deliver 1080p HD and now 4K are becoming more common and less expensive because of their use in other applications, from camcorders to automotive applications. Higher resolution is both an advantage as well as disadvantage. Obviously the advantage is more resolution providing a more accurate image. The disadvantage is the larger amount of data the must be processed. Luckily processing power has been increasing and multicore solutions work well with this type of data. Hardware specifically for video analysis is also more common. Even specialized applications like knitting streams from four cameras into a 360-deg. surround view for automotive applications can be useful in providing a safer robot.

Another technology that has been gaining more mindshare is the sensors that deliver 3D range information. Microsoft's original Kinect used one approach *(see "How Microsoft's PrimeSense-based Kinect Really Works" on electronicdesign.com)*, but the Kinect 2 and a number of other solutions utilize a time-of-flight (ToF) approach *(see "Time-Of-Flight 3D Coming to a Device Near You" on electronicdesign.com)*. These types of sensors often are combined with a camera that captures an image in the visible color space so a pixel has a color and a depth component.

Full-frame depth imaging is not the only use of ToF technology. Leddertech's IS16 *(Fig. 4)* directs 16 beams across a 45-deg. span. It delivers an angular and distance result. The sensor works with a range of solid and liquid targets up to 50 m away at 50 Hz. The system is immune from interference from ambient light. It is designed for harsh environments in its IP67 weather-resistant enclosure. It has a USB and serial interface. There is a quick mode that allows defining a zone with a near and far limit.

Other sensor technologies include thermal imag-

ing and radar. Flir is well known for its wide range of consumer and industrial thermal imaging solutions. It also has OEM products. Its Quark 2 is an uncooled, longwave, thermal imaging camera that has a 640 × 512 pixel resolution at 60 Hz. It is compact enough to be used in mobile applications including quadcopters where the Quark 2's high shock and vibration tolerance are important features.

Rohm Group's Lapis Semiconductor has a medium-resolution IR image sensor. The ML8540 has a 2,256 pixel resolution. It operates at 6 Hz but only needs 5 mA of power at 5 V. Its operating range is –30 to +85°C.

Ultraviolet sensors are less common. They often are found in EUV (extreme ultraviolet) applications like semiconductor lithography. IMEC has a number of solutions in this space, as well as numerous image sensors for visible spectrum light.

4. Time-of-flight sensors like Leddertech's IS16 provide depth information up to 50 m along 16 segments spanning a 45-deg. view.

INTEGRATED SOLUTIONS

Imaging hardware does not operate in isolation. Imaging software is needed to analyze the data stream. Filters and analysis libraries are just the starting point. 3D image processing requires support like the open-source Point Cloud Library (PCL) from Open Perception. PCL can work with both 2D and 3D images. The cross-platform system has a BSD license that allows commercial use without the need to expose the application's source code.

Applications such as surface and object inspection can often be more focused allowing more complete solutions to be created. One example is National Instruments' (NI) Vision Build for Automated Inspection system *(Fig. 5)*. It works with NI frame grabber, NI Compact Vision System, NI Embedded Vision System, and NI Smart Cameras, as well as USB3 Vision, GigE Vision, IEEE 1394, and USB DirectShow cameras.

It includes machine-vision tools like geometric matching, optical character recognition (OCR), and particle analysis. This allows the software to locate, count, measure, identify, and classify objects. Applications can also be integrated with Programmable Logic Controllers (PLC) and other automation devices. The system allows quick and easy construction of complex pass/fail decisions so applications can provide system control messages.

NI has other vision-system support, but solutions like NI's Vision Build for Automated Inspection system are designed

5. National Instruments' Vision Build for Automated Inspection software works with NI's Smart Cameras.

for users WHO want to concentrate on the application rather than customizing the vision system. They are designed to work with off-the-shelf cameras and to integrate with existing automation systems.

HARDWARE ANALYSIS

Software image analysis systems take advantage of the multicore computing resources that are currently available. Tools like OpenCL and NVidia's CUDA allow applications to tap multicore GPUs. Altera has opened FPGAs to OpenCL, as well *(see "OpenCL FPGA SDK Arrives" on electronicdesign.com)*.

Still, hardware that targets image processing can provide significant speed, making many applications practical. One example is the use of neural nets in hardware. These are designed in a fashion similar to neurons in the brain. A net can be implemented in software, but the inherent parallelism is more efficient when implemented in hardware.

Cognimem Technologies' Cognimem PM1K is a hardware implementation of neural net support *(see "Neural Net Chip Enables Recognition for Micros" on electronicdesign.com)*. It supports pattern recognition, allowing the system to be used for a range of chores including object recognition, anomaly detection, target tracking, and template matching. This chip can be used for any type of pattern recognition, including images. The interesting aspect of the design is that PM1K chips can be used in parallel as well, allowing more patterns to be stored.

Automotive Advanced Driver Assistance Systems (ADASs) already are including parallel processing systems in the system-on-chip (SoC) solutions targeting new cars. Freescale's S32V234 ADAS system-on-chip (SoC) uses Cognivue's APEX-2 Image Cognition Processor (ICP). The ICP is a SIMD parallel processing array that incorporates specialized DMA and sequencing units along with hardware accelerators to handle images from streaming video in real time.

Real-time image processing is still a relatively new technology for industrial applications, but new hardware, sensors, and software have moved it from the lab to the production floor.

DESIGN NOTES

Micropower Op Amp Drives 8-Channel 18-Bit Simultaneous Sampling ADC without Compromising Accuracy or Breaking the Power Budget

Design Note 541

Guy Hoover

Introduction

The op amps used to drive 18-bit analog-to-digital converters (ADCs) typically draw as much supply current as the ADC itself, often with a maximum offset spec that is well above that of the ADC. If multiple ADC channels are required, the power dissipation from these drivers quickly rises to unacceptable levels.

If 18-bit precision is required (SNR, THD, V_{OS}), but not high sampling rates, and the input signals are low frequency or DC, the simple buffer presented is capable of driving the LTC®2348-18 8-channel simultaneous sampling ADC. It also achieves performance equivalent to typical specs for SNR, THD and offset performance with very low power dissipation.

Circuit Description

The LTC2348-18 is a low noise, 8-channel simultaneous sampling 18-bit successive approximation register (SAR) ADC with wide input common mode range. With a ±10.24V input range, the LTC2348-18 achieves –109dB THD (typical), 96.7dB SNR (typical) with an offset of ±550µV (maximum) while dissipating only 140mW (typical) at 200ksps. When operated at the 10ksps rate of this application, the ADC's power consumption drops to 45mW (typical) by using the device's NAP mode.

The LT6020 is a dual micropower, 5V/µs precision rail-to-rail output op amp with input offset voltage of less than 30µV (maximum) that draws only 100µA per amplifier (maximum).

The circuit of Figure 1 shows the LT6020 op amp configured as a noninverting buffer driving the analog inputs of the LTC2348-18. Maximum power dissipation of each op amp is only 3mW. For all eight channels this adds up to only 24mW, approximately half the ADC power consumption at 10ksps.

The RC filter at the buffer output minimizes the noise contribution of the LT6020 and reduces the effect of the sampling transient caused by the MUX and the input sampling capacitor. For a chosen RC time constant, the R value should be kept as small as possible to reduce the voltage drop across the resistor. This results in a gain error if the filter output is not allowed to settle completely. The R value must be large enough to prevent excessive ringing at the op amp output, which adds to settling time and increases distortion.

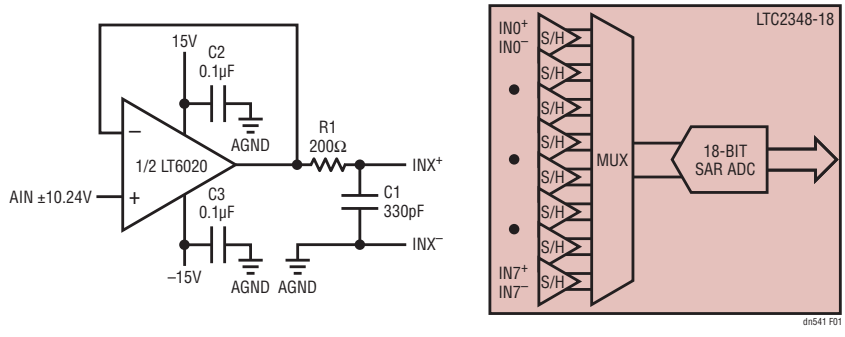


Figure 1. LT6020 Buffer Driving the LTC2348-18 8-Channel Simultaneous Sampling SAR ADC

The LTC2348-18 allows two different modes of operation. The first is a fully differential mode, which requires both analog inputs of each channel to be driven by a separate amplifier. The second is a pseudo-differential mode, which drives only a single analog input while grounding the other input. This second mode is used by the circuit of Figure 1. Using pseudo-differential drive means fewer components are required, as well as lower power dissipation. The disadvantage of using this mode is that the INL is slightly degraded.

Circuit Performance

Figure 2 shows an 8192-point FFT of the LTC2348-18 driven pseudo-differentially by the buffer of Figure 1. THD is –108dB and SNR is 95.8dBFS at 10ksps, which compares well with the typical specs of the LTC2348-18.

Figure 3 shows SNR and THD vs sampling rate. SNR stays fairly flat near 96dBFS up to 10ksps. THD starts to rise above –108dB at 10ksps.

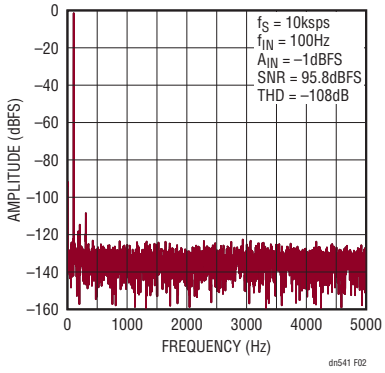


Figure 2. 8192-Point FFT for the Circuit of Figure 1

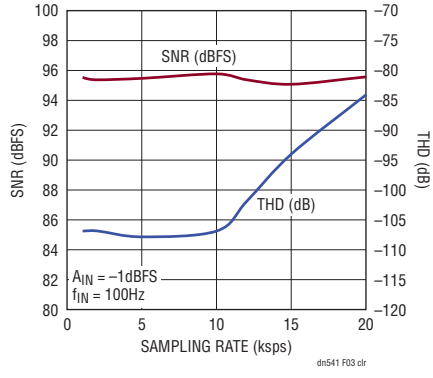


Figure 3. SNR and THD vs Sampling Rate for the Circuit of Figure 1

Figure 4 shows SNR and THD vs input frequency. Both SNR and THD slowly degrade from the typical specs of the LTC2348-18 above 100Hz until at 1kHz SNR is 94dBFS and THD is –85dB.

Figure 5 shows the combined offset error of the LT6020 driver and ADC vs sampling rate. Offset is initially less than 1LSB and starts to degrade as the sampling rate exceeds 10ksps.

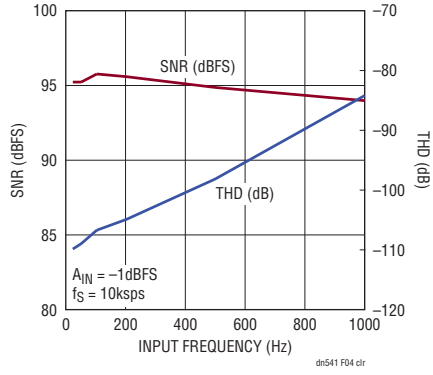


Figure 4. SNR and THD vs Input Frequency for the Circuit of Figure 1

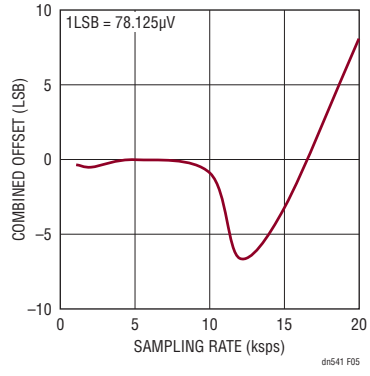


Figure 5. Combined ADC and Driver Offset vs Sampling Rate for the Circuit of Figure 1

Conclusion

A simple driver for the LTC2348-18 18-bit, 200ksps, 8-channel simultaneous sampling SAR ADC—consisting of the LT6020 low power precision dual op amp configured as noninverting buffers—dissipates only 3mW per op amp (maximum), and at 10ksps the LTC2348-18 dissipates only 45mW. At a sampling rate of 10ksps, SNR is measured at 95.8dB, THD –109dB and offset is measured at less than 1LSB.

Data Sheet Download

www.linear.com/LTC2348-18

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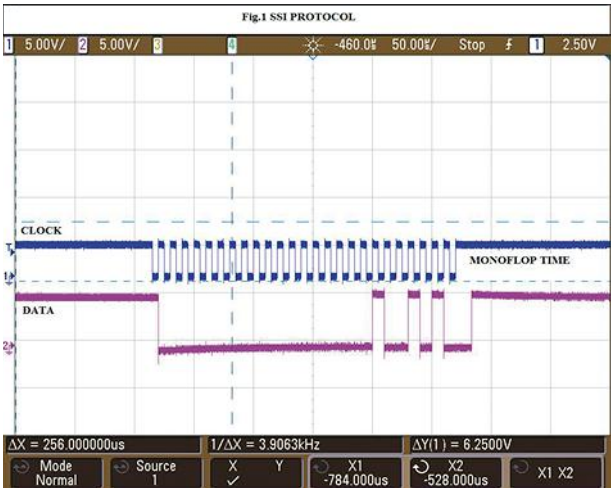
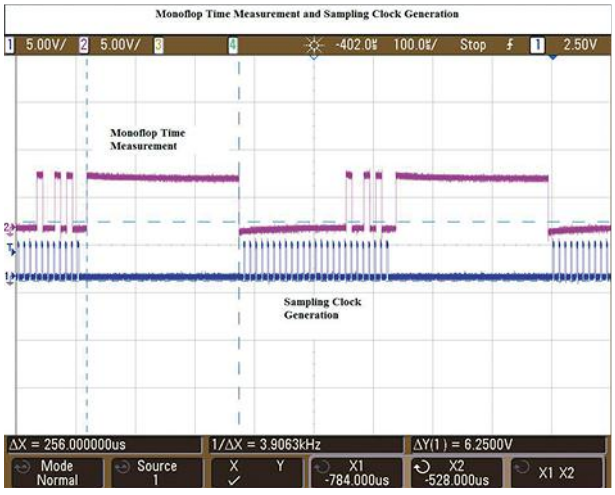
Extend Point-to-Point SSI Protocol to Support Multipoint Communications

G.V.KISHORE AND K.PALANISAMI | Power Electronics Section, Electronics & Instrumentation Division, IGCAR, Kalpakkam-603102, Tamilnadu, India

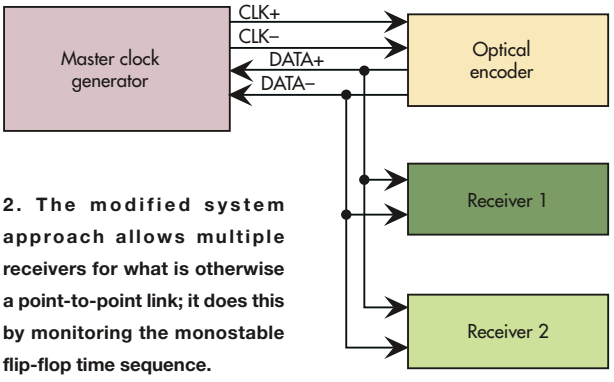


1. In the SSI protocol, the differential data shifts out of the register after a loading period and delay of between 10 and 40 µs.



3. The timing relationship between the encoder data (pink) and sampling-clock generation (blue) shows synchronization with the incoming data.

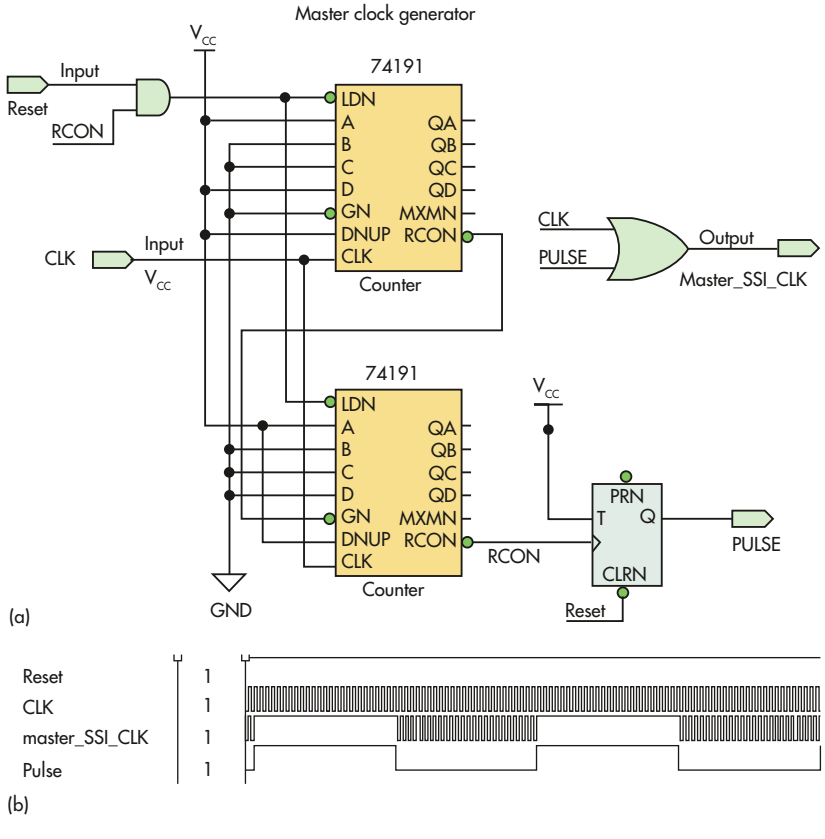
THE SERIAL SYNCHRONOUS Interface (SSI) protocol, which implements a point-to-point communication channel for digital data and signal interface with optical encoders, is used for transmission of absolute position information as differential data in serial format. Since the SSI protocol is intended only for point-to-point communication, the receiver electronics must have an Ethernet interface to broadcast the position information to multiple indicating units. This design provides a method to remove the limitations in SSI and use it for multipoint communication.



2. The modified system approach allows multiple receivers for what is otherwise a point-to-point link; it does this by monitoring the monostable flip-flop time sequence.

SSI uses a clock pulse train from a controller to initiate a differential serial output from the sensor. The number of clock pulses generated depends on the resolution of the encoder (both single-turn and multiturn types). Also, position data is continually updated by the sensor and made available to the receiving electronics. Between each clock pulse train, a minimum of 10 to 40 µs (monoflop time) is required by the sensor to load fresh position data into the sensor. When the sensor receives a pulse train from the controller, differential data (beginning with multiturn and single-turn position values) are subsequently shifted out (*Fig. 1*).

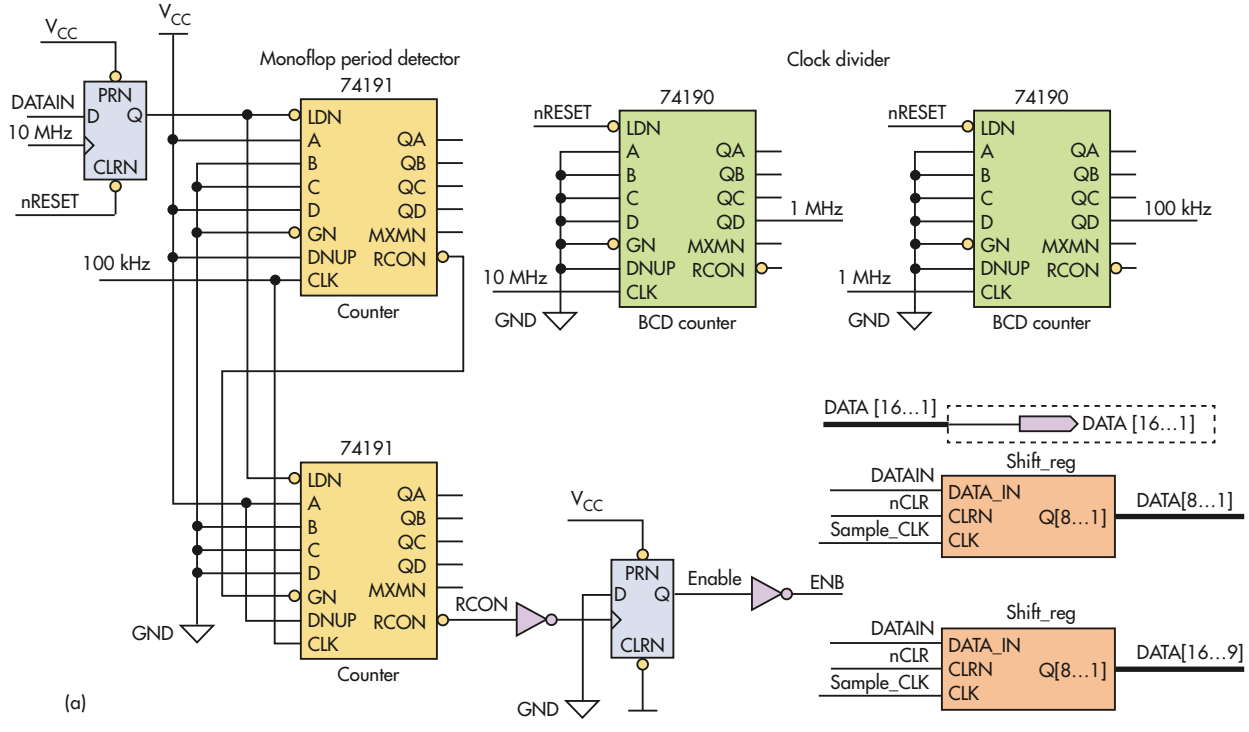
In the modified approach (*Fig. 2*), a master transmits the SSI clock to the encoder while multiple receivers receive the data from the encoder simultaneously. Since SSI is a synchronous protocol with the absence of start or stop bit, this simple design technique incorporates the data retrieval via observation of the monoflop time sequence, then generates the internal sampling clock that synchronizes with the incoming data (*Fig. 3*).



4. The schematic (a) and simulated results (b) for the master-clock generator show how cascaded counters and a flip-flop are used to set the necessary timing and delays.

The master clock sends the synchronization clock to the encoder interleaved by the monoflop time, which is intentionally elongated to differentiate with the encoder's data transitions. The digital logic in the receiver electronics detects and measures the monoflop time period (MTP). Since encoder data follows the MTP, a sampling clock is generated after the falling edge of MTP and the data is stored in a serial-in/parallel-out shift register.

The master clock generator uses 13-bit single-turn and 12-bit multiturn absolute encoders (*Fig. 4a*). Its base frequency is 100 kHz with a MTP of 250 µs. The master clock generator uses cascaded 74191 4-bit synchronous counters, a T-flip flop, and an RS-485 transmitter (not shown). The counter is pre-loaded with a count of 25 (binary) corresponding to the resolution of the encoder (multiturn + single turn). Ripple carry out (RCON) is used to auto-load the counter and the T flip-flop output (PULSE) is ORed with main clock (100 kHz) to generate the desired SSI clock sequence. *Figure 4b* shows the simulated results.



The receiver electronics comprise the monoflop period detector, sampling-clock generator logic, and a serial-in/parallel-out shift register (*Figs. 5a and 5b*). The monoflop period detector consists of cascaded 74191s configured as a down counter. If the duration is greater than 250 µs, the RCON enables the sampling clock generator circuit, whose output is fed to shift register. A microcontroller can be used to read the parallel data from the shift register and use it for local processing. A reset sequencer circuit is used to reset the shift register, so that it can acquire fresh data. (The simulated waveforms in *Figure 5c* can be compared to the experimental waveform in Figure 3.)

Note that redundant hot-standby, real-time, motion-control systems don't use the SSI protocol, because the standby system is unable to decipher the position-data information due to absence of a synchronous clock. By using the approach shown here, it's possible to effectively retrieve the position information on redundant systems, and thereby avoid the need to use more complex, higher-end encoder protocols such as Profibus or CANopen.

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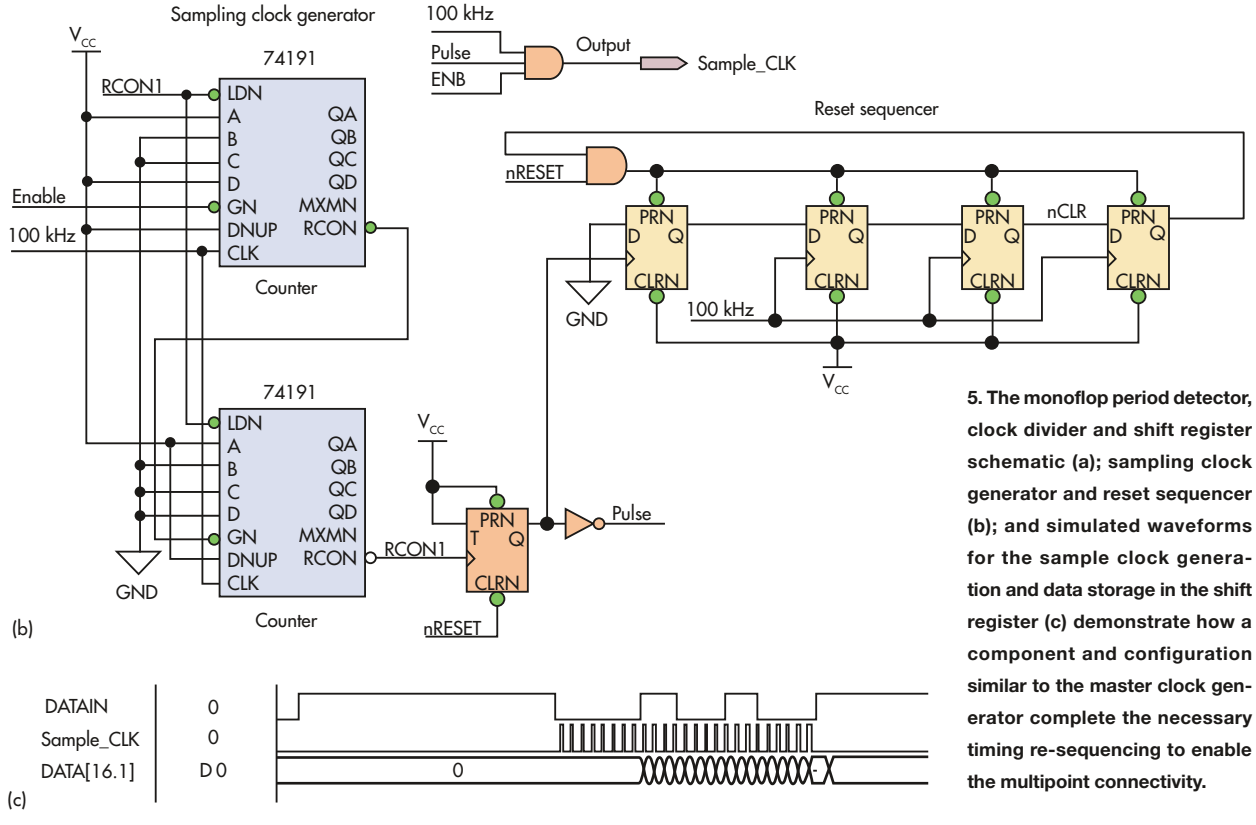

5. The monoflop period detector, clock divider and shift register schematic (a); sampling clock generator and reset sequencer (b); and simulated waveforms for the sample clock generation and data storage in the shift register (c) demonstrate how a component and configuration similar to the master clock generator complete the necessary timing re-sequencing to enable the multipoint connectivity.

150 W Quarter Brick dc/dc Converter Achieves 93% Efficiency

THE NEW QSW 150 W dc/dc converter from Calex offers a 9 to 36 Vdc input range with an isolated, precisely regulated 12 V output. The converter achieves efficiency of 93% through the use of high efficiency synchronous rectification, advanced electronic circuitry, packaging and thermal design. It operates at a fixed frequency and follows conservative component de-rating guidelines. The converter features 2,250 Vdc input to output isolation, 275 kHz switching frequency, +/-1% output voltage setpoint accuracy, 120 mV peak to peak output noise, and will operate from a no load condition up to the maximum 12 A output current. Line regulation is 0.2%, same as load regulation. Load transient overshoot is 5% and the load transient recovery time is 500 µs. The converter features ON/OFF with a low OFF idle current of 20 mA. The device is protected by overvoltage protection, input reverse polarity protection, thermal overload protection and short circuit protection. The case operating temperature range of the RoHS compliant QSW is -40 to +100°C, storage range is -55°C to +125°C, and unit weight is 2.36 oz.

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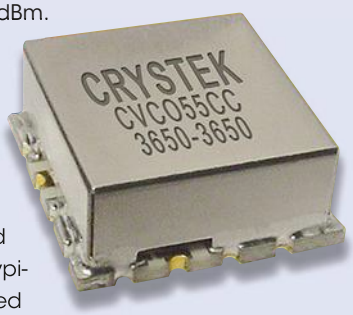
CRYSTEK'S NEW 3,650 MHZ VCO, model CVCO55CC-3650-3650, provides 0.5 V~4.5 V control voltage range, a typical phase noise of -108 dBc/Hz @ 10 KHz offset, and features excellent linearity throughout its tuning range. Output power of the device is typically +7 dBm.



Engineered and manufactured in the USA, the coaxial resonator based VCO is packaged in the industry-standard 0.5" x 0.5" SMD package. Input voltage is typ. 8.0 V with a typ. current consumption of 35 mA. Pulling and Pushing are minimized to 1.0 MHz and 0.2 MHz/V, respectively, and second harmonic suppression is -15 dBc typical. The CVCO55CC-3650-3650 VCO is suited for use in applications such as digital radio equipment, fixed wireless access, satellite communications systems, and base stations.

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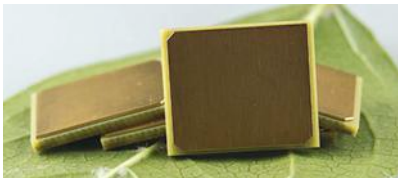

conditioners. A step-function reduction in conduction and switching losses for high-speed switching is now achievable due to multiple inventions from VisIC. The 650 V, 50 A fast GaN blocking voltage transistor, with its 12 mΩ Rdson, is particularly suited for use in power conversion switches, the fundamental building block for virtually all energy conversion subsystems. Based on a new design for GaN HEMTs, the 650 V blocking voltage transistor accelerates the push to extend GaN-based technology from communications subsystems into power conversion subsystems.

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ROCHESTER ELECTRONICS has been licensed by Freescale to provide a continuing manufacturing solution for the Freescale MC68040 32-bit microprocessor product family. Freescale announced the discontinuation of the 68040 devices and will be shipping the last products they will produce until November 2015. The agreement between Freescale and Rochester provides customers of the legacy MPUs with access to a secure and reliable source of parts for continued product supply. Rochester Electronics is fully stocked with original Freescale packaged parts and silicon die from which it will manufacture a variety of device options. Freescale has also provided access to full design and test IP, making it possible for Rochester to continue manufacturing products even if all existing wafer stocks are exhausted.

In addition to the 68040 family, Rochester legacy support includes 68020, 68030, 68060, and the 68882 floating-point coprocessor.

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Atom-Based Fanless Embedded Box PC Is Rugged and Sealed

THE XPAND6903 FROM X-ES is a rugged, sealed, and compact fanless embedded-box PC utilizing the Intel Atom E3800 family of processors. Specifically designed for IPC, HMI, industrial automation, and transportation applications, with its sealed design, it is particularly suited for medical and food-safe environments. The computer can be DIN-rail mounted for installation into an industrial cabinet. Internal SATA SSD memory modules combine the convenience of high-capacity off-the-shelf storage with the reliability of solid-state non-volatile memory. The standard configuration includes dual VGA video, two GbE ports, four USB ports, and RS-232/422 ports. The system also can be configured to provide up to two DVI-D interfaces in place of VGA. Internal expansion options allow it to be customized to offer a flexible array of additional I/O options, including WLAN, cellular, GPS, and CAN bus.

The box PC supports a 12 V to 28 V input voltage range, with additional power input voltages supported by request. The device can operate under demanding shock and vibration requirements, as well as the water-immersion requirements of IP67. The XPand6903 box PC supports operating temperatures from -40°C to +70°C ambient.

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High-Brightness TFTs Target Outdoor Environments

KOE'S THREE NEW TFT displays, the 7.0-in. TX18D203VM-2BAA, 8.0-in. TX20D200VM2BAB, and 10.4-in. TX26D-200VM2BAB, all feature a 1500 cd/m² brightness rating, high-brightness LED backlights, and a -30°C to +80°C operating temperature range, enabling them to be used in environments with high levels of ambient light. The 7.0-in. and 8.0-in. displays provide WVGA with a 15:9 aspect ratio, and the 10.4-in. display has SVGA resolution with a 4:3 aspect ratio.

The 10.4-in. module has a contrast ratio of 800:1, a 20-pin LVDS supporting 8-bit RGB for up to 16.7 M colors, mechanical outline dimensions of 230 x 180.2 x 10.1 mm with an active display area of 211.2 x 158.4 mm, and a 70 K hours to half-brightness LED backlight.

The 8.0-in. module has a contrast ratio of 800:1, a 20-pin LVDS supporting 6-bit RGB for 262 K colors, mechanical outline is 189 x 122 x 10.2 mm with an active display area of 174 x 104.4 mm, and a 70 K hours to half-brightness LED backlight.

The 7.0-in. module has a contrast ratio of 600:1, a 40-pin CMOS supporting 6-bit RGB for up to 262 K colors, mechanical outline is 165 x 113 x 7.5 mm with an active display area of 152.4 x 91.44 mm, and a 40 K hours to half-brightness LED backlight.

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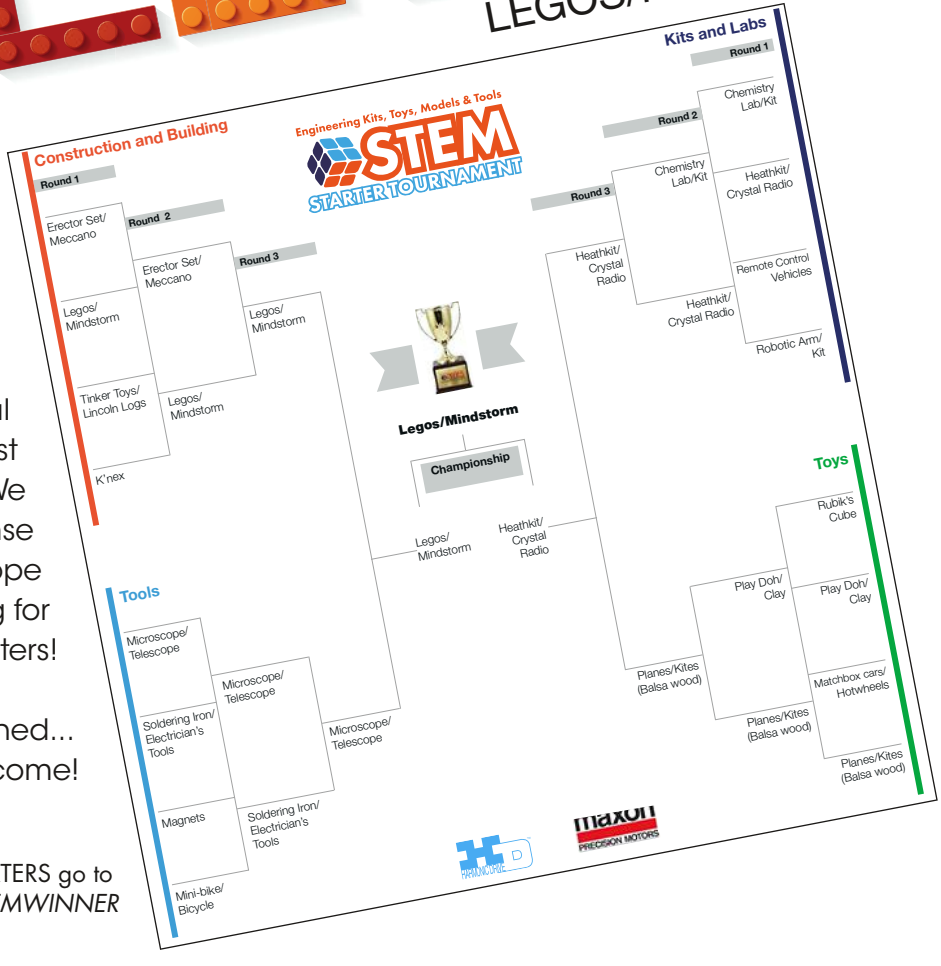

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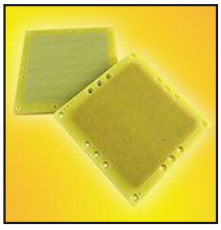

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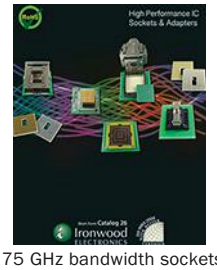

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Really—It's a Feature, Not a Bug

Shutting down a whole system for an isolated error is too much of a good thing.

To err is human, but you need a computer to really screw things up. Of course, some human programmed the computer, so we get the blame for the whole thing.

My latest lament is about my Canon MX860 inkjet printer. The printer is about six years old but still runs well, save for a recent spate of B200 errors. The non-descript error message directs the user to tech support instead of giving any clue to what the problem is. A thorough cleaning of the removable print head fixed the problem in my case, but the error notification and documentation is less of an issue than the real problem.

It seems the designers thought that the B200 error was so catastrophic that it should bring the multifunction printer to a grinding halt. It's a feature, probably intended to keep you from making the problem any worse (although that does not seem to be the case). Unfortunately my wife ran into the error when trying to scan a document. This is, of course, a multifunction device, and the scanner was not the problem. The problem is that it was inaccessible because of the bug-reporting feature. It took me a day to figure out the issue and to properly clean the print head.

This design problem is not unique; it crops up in designs all over the place. Another recent mess was having to fix the climate control on our Ford Fusion Hybrid. The temperature controls were all messed up and a system reset—which also erased all the settings and address book—did not solve the issue. As I recall, changing a voice command setting fixed the problem, for some reason.

These kinds of problems will be compounded with the ever-growing number of IoT (Internet of Things) devices cropping up, as well as the increasingly interconnected cars and work environments. It can lead to silly but annoying (and possibly dangerous) situations like not being able to drive a car because the tire-pressure sensor indicates a flat.

Often these issues are related to corner cases in system design. Developers already are tasked with so many other issues, ranging from safety to security, that they overlook what may eventually be a common case problem. The IoT craze compounds the problem because the pieces to the puzzle can involve dozens of devices and applications, leading to some interesting race conditions or dependency problems.

The Canon MX860 is a great printer, but the B200 printing error can bring it to a halt even though the rest of the machine is operational.

Imagine an environment where a control app on a smartphone has a bug and through a change of communication links locks up an application on a particular device. All the devices in the chain use secure boot, keys, etc., and each is linked and dependent upon their neighbors in the chain so it cannot be broken. That's a feature.

IoT interdependencies are going to make differentiation between features and bugs harder. This actually be something a developer will consider when their company controls the entire chain, but that will be less likely as time goes on. Often the IoT framework will be coming from a third party simply because the complexity of the entire system is too great for one company to handle.

So I encourage developers to add a little flexibility into their solutions, especially when it comes to error handling. Unfortunately, most devices these days lack a real power or reset button. ed

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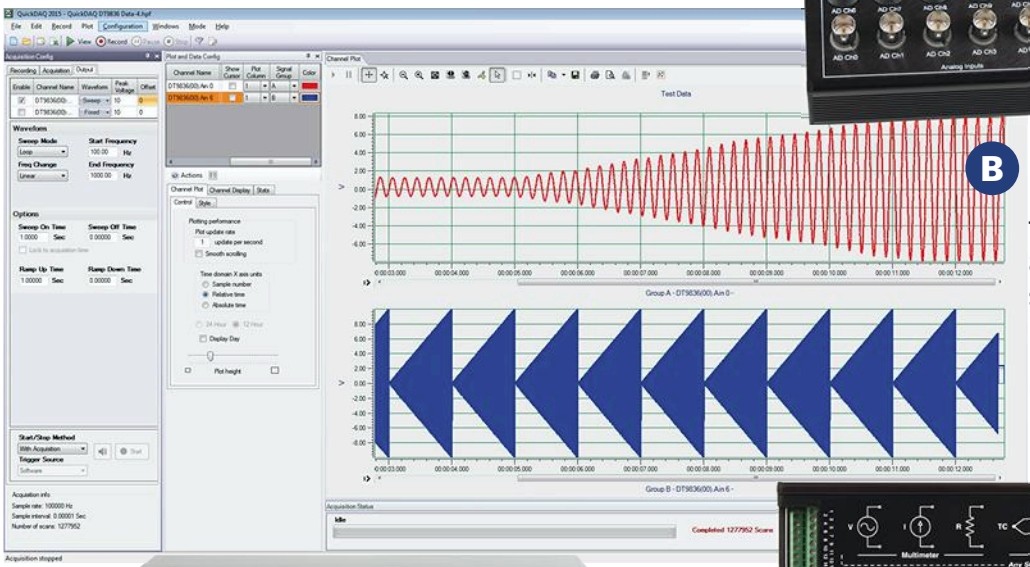

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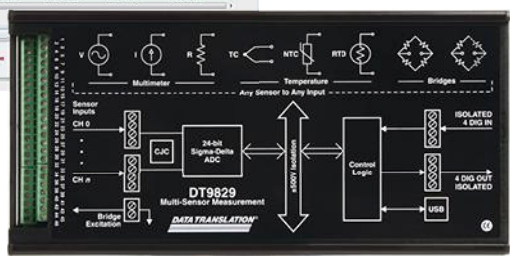

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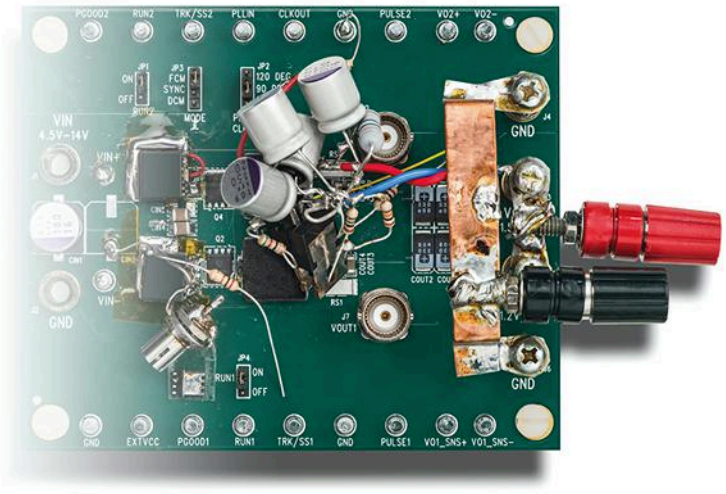

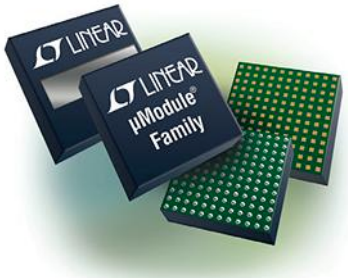

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