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**analysis 10**

**Special Focus**
  
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## CONTENTS MAY 2011



### Mobile apps bring momentum to DRAMs. 8

## OPINION

4 **Uncommon Market:** 11 tablet trends from TI's OMAP chief

50 **Last Word:** Engineering software updates to the future

## NEWS & TECHNOLOGY

6 Magnetic graphene harnesses Kondo effect  
Magnetic effect could yield optical battery

8 Mobile apps bring momentum to DRAMs

14 Malcolm's corner

## DESIGN + PRODUCTS

### SPECIAL FOCUS: MEDICAL ELECTRONICS

16 The high potential of wireless body-area networks in healthcare

20 Making life less difficult

22 Telehealth: huge opportunities for established technologies

24 Designing an artificial retina for sight restoration

26 Low EMI isolation for medical equipment applications

### SPECIAL FOCUS: MOTORS & DRIVES

30 The end of sensor-based BLDC control?

33 Precise magnetic position sensors for more efficient control of BLDC motors

35 Increasing motor efficiency with power factor control

### SPECIAL FOCUS: DISPLAY TECHNOLOGIES

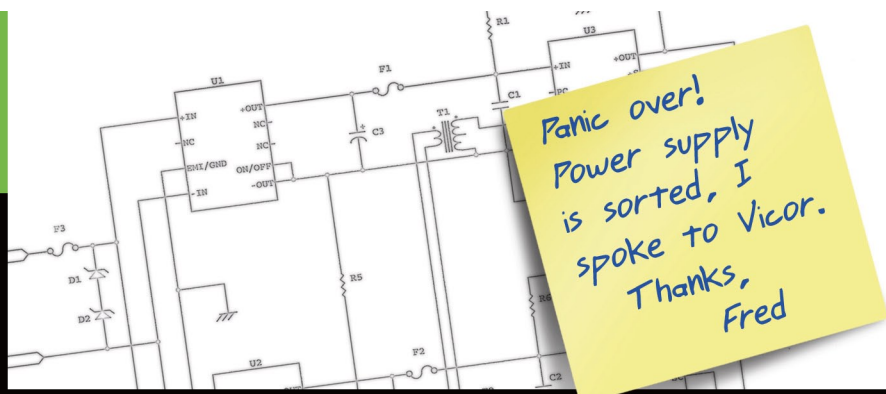
40 Cutting costs with custom LCD and LED technology

42 The future belongs to DisplayPort

## READER OFFER

49 STEricsson gives away five Snowball developer board kits

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# 11 tablet trends from TI's OMAP chief

By Dylan McGrath

**USER EXPERIENCE**, - as opposed to raw processor performance - is what sells media tablets, according to Deepu Talla, general manager of Texas Instruments' OMAP mobile computing business unit.

Speaking to an audience at the International Data Corp (IDC) Smart Technology World conference, Talla noted that the PC industry has emphasized processor speed in marketing campaigns for many years. "Unfortunately, smartphone marketing seems to be going that way," Talla said, in an address titled, "The year of the tablet: Transforming mobile experiences."

"At the end of the day, user experience is what sells," Talla said. "Apple has proven that."

Talla added that few people know much about the technology inside Apple's A4 or A5 processors, but the iPhones and iPads they power are near universally praised for the user experience that they provide.

Talla joked that the estimated 100 or more tablets that were showcased at the Consumer Electronics Show in January gave rise to the acronym JAAT - just another Android tablet. With so many tablets of similar appearance and planning to run the Honeycomb version of Android, people wondered how any would differentiate themselves in the market, Talla said.

"This is just the first step into the market," Talla said. He noted that two years ago the Android operating system was in its infancy and the dominant smartphone OS was Symbian, now all but left for dead. Two years later, IDC projects that in 2011 Android will hold nearly 40 percent market share in the smartphone market.

Talla noted that Honeycomb - version 3.0 of Android, the first optimized for tablets - was just rolled out earlier this year. The next version of Android for tablets should be comparable or even better than Apple's iOS, Talla predicted.

He noted that the tablet product category has caught the eye of a host of vendors, from traditional PC OEMs to content providers

like Amazon and Barnes & Noble, which offer the Kindle and the Nook, respectively - both of which are marketed as e-readers as opposed to tablets. But he cautioned players in the market not to underestimate companies such as Barnes & Noble, which has reportedly shipped an estimated 3 million colour Nooks.

**"The PC industry has emphasized processor speed in marketing campaigns for many years. Unfortunately, smartphone marketing seems to be going that way too"**

"They [the tablet makers] are all excited about the opportunity, but nobody knows what the ending will be," Talla said. Talla said tablets could one day displace all netbooks and even "thin notebooks."

## 1. Tablets that support multiple operating systems

Motorola Mobility's Atrix 4G smartphone has already pioneered this concept, running the Froyo version of Android and, when docked, Motorola's own proprietary web-based desktop environment.

Talla said TI also demonstrated this concept on a tablet at the Mobile World Congress in February. "We think that multiple operating systems are going to happen because end users want to have a mobile profile and an enterprise profile on the same device," Talla said.

## 2. Multi-screen computing.

Some vendors, including Toshiba and Acer, already offer dual-screen tablets. According to Talla, supporting multi-screen computing is less about the number and speed of processors on a chip and more about "the

right infrastructure to pump 1080p video to three screens."

## 3. HD video conferencing

"Anyone who can do video encode and decode can claim to have video conferencing," Talla said. The key here is bandwidth and the ability to interface with other types of devices, Talla said.

## 4. Cloud computing.

This has become a buzzword concept for devices of all types. But Talla noted that security is a key feature to enabling it.

## 5. Computational photography.

Using computational techniques to enhance images is resource intensive, and Talla suggested that using the processor of an SoC was inefficient.

He said chip firms have as of late been acquiring firms that have technology for image processing, referencing Intel Corp.'s February acquisition of Silicon Hive BV.

## 6. Augmented reality.

## 7. Premium content sharing.

At Mobile World Congress in February, TI highlighted the OMAP 4's M-Shield security features on Android through a Netflix HD video streaming demo.

## 8. Gesture recognition/projection.

Talla described gesture recognition and projection interface technology akin to Microsoft Corp.'s Kinect for the Xbox 360 - but using much less expensive technology. Again, Talla emphasized that for efficiency's sake this work must be offloaded from CPUs and GPUs and performed by other parts of the SoC.

## 9. Mobile/secure transaction support.

## 10. Immersive 3-D gaming.

## 11. Stereoscopic capture with audio convergence. ■



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## Magnetic graphene harnesses Kondo effect

By R. Colin Johnson

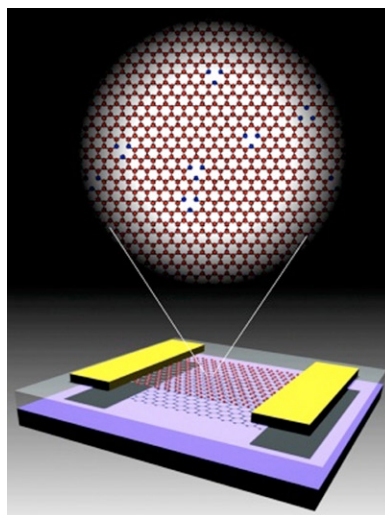
**PURE SHEETS OF CARBON** - graphene - can be made magnetic by introducing patterns of vacancies into their crystalline lattice, according to researchers at the University of Maryland. By controlling the magnetic properties of graphene semiconductors with vacancy-doping, the researchers hope to enable the pure carbon material to tackle new applications as magnetic sensors and random access memories (MRAMs).

Semiconductors are usually made magnetic by doping with a metallic material such as iron or cobalt, but the University of Maryland team, led by professor Michael Fuhrer, claim that just introducing empty spaces into graphene's otherwise perfect hexagonal pattern—called vacancies—can dope the material for magnetism. Others have used surface treatments to make graphene magnetic, but the new method is said to work better by virtue of eliminating the need for any other material except carbon.

Fuhrer's Lab was one of the first to characterize the carrier mobility in graphene as being more than 10-times higher than silicon

(15,000- compared to 1,400- $\text{cm}^2/\text{Vs}$ , square centimeters per volt second). Now the team claims that their newest characterization attempts for the first time explain how magnetic properties can also be introduced into graphene—namely by adding vacancy defects to its crystalline lattice.

Semiconductor defects are usually caused by doping, which in this case are vacancies instead of a different material, each of which acts like a nanoscale magnet with its own "moment." The researchers demonstrated that these vacancy defects strongly interacted with any electrical currents in the material, potentially making it semiconducting



Artist's rendering of a graphene transistor showing gold electrodes (yellow), silicon dioxide (clear), silicon substrate (black) and graphene (red), with inset showing graphene lattice vacancy defects (blue). Source: University of Maryland

properties tunable by virtue of the Kondo effect. The researchers measured the temperature of the Kondo effect in graphene with vacancies and found it to be about the same as in metals with electron densities much higher than un-doped graphene—about 90 degrees Kelvin.

Next the researchers are attempting to arrange the vacancies in a pattern that could exhibit ferromagnetism by forcing all the magnetic moments in a domain of vacancies to line up by virtue of the Kondo effect, potentially allowing them to be electrically switched to make pure carbon magnetic memories and sensors.

Funding was provided by the National Science Foundation and the Office of Naval Research. ■

## Magnetic effect could yield optical battery

By Julien Happich

**RESEARCHERS AT** the University of Michigan discovered a magnetic effect from light that could lead to solar power without traditional semiconductor-based solar cells.

The researchers found a way to make an "optical battery," according to Stephen Rand, a professor in the departments of Electrical Engineering and Computer Science, Physics and Applied Physics.

Until now, scientists thought the effects of the magnetic component of light were so weak that they could be ignored. What Rand and his colleagues found is that at the right intensity, when light is traveling through a material that does not conduct electricity, the light field can generate magnetic effects that are 100 million times stronger than previously expected. Under these circumstances, the magnetic effects develop strength

equivalent to a strong electric effect.

"This could lead to a new kind of solar cell without semiconductors and without absorption to produce charge separation," Rand said. "In solar cells, the light goes into a material, gets absorbed and creates heat. Here, we expect to have a very low heat load. Instead of the light being absorbed, energy is stored in the magnetic moment. Intense magnetization can be induced by intense light and then it is ultimately capable of providing a capacitive power source."

What makes this possible is a previously undetected brand of "optical rectification," says William Fisher, a doctoral student in applied physics. In traditional optical rectification, light's electric field causes a charge separation, or a pulling apart of the positive and negative charges in a material. This sets

up a voltage, similar to that in a battery. This electric effect had previously been detected only in crystalline materials that possessed a certain symmetry.

Rand and Fisher found that under the right circumstances and in other types of materials, the light's magnetic field can also create optical rectification. "It turns out that the magnetic field starts curving the electrons into a C-shape and they move forward a little each time," Fisher said.

"That C-shape of charge motion generates both an electric dipole and a magnetic dipole. If we can set up many of these in a row in a long fibre, we can make a huge voltage and by extracting that voltage, we can use it as a power source." The university is pursuing patent protection for the intellectual property. ■



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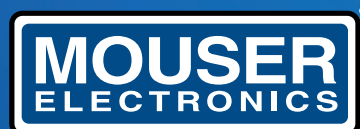
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# Mobile apps bring momentum to DRAMs

By Mark LaPedus

**AS THE WIDER DRAM MARKET** sputters along, the mobile DRAM segment is firing on all cylinders, scrambling to keep pace with the volume demand and bandwidth requirements of the fast-moving markets it serves.

Mobile DRAMs are specialized DRAMs that incorporate low-power features. Vendors of the devices, such as Elpida, Hynix, Micron and Samsung, face inventory shortfalls as OEMs of hot-selling smartphones and tablets race through the stock now on the shelves. Elpida Memory Inc. alone is shifting much of its production from PC DRAM to mobile DRAM to meet demand from Apple Inc.'s iPad 2, sources said.

At the same time, mobile market bandwidth requirements are lapping the capabilities of current-generation mobile DRAM technology, forcing a lane change to next-gen standards.

"The requirements for bandwidth are going through the roof," said Jim Venable, president of the Serial Port Memory Technology (SPMT) consortium, a group that is devising a next-generation memory technology. Low-power double-datarate 2 (LPDDR2) mobile DRAM, the latest and fastest mobile DRAM technology, "is already seeing the end of its life," Venable said.

Various factions have rolled out rival next-gen mobile DRAM technologies in response to the urgent need for more bandwidth. The contenders are LPDDR3, LPDDR4, the Mobile Industry Processor Interface Alliance's M-PHY, Rambus' Mobile XDR, Silicon Image's SPMT and wide I/O. Samsung and others are backing wide I/O; Micron is pushing LPDDR3.

Mueez Deen, director of mobile DRAM at Samsung Semiconductor Inc., said it's still too early to predict a technology winner, but he noted there is only room for "one new technology" or a "maximum of two" for mainstream devices in the future.

Bandwidth concerns cry out for new technology. In one example, LG Electronics recently rolled out the Optimus 3D, a 4G smartphone that features a "glasses-free" stereoscopic 3-D display, a dual-camera and HD video.

The LG smartphone is built around Texas Instruments Inc.'s OMAP 4 dual-core applications processor as well as mobile DRAMs based on LPDDR2. Apple's iPad 2 also uses LPDDR2 mobile DRAM.

Some believe that LPDDR2 is obsolete even before the parts ramp in volumes. Mobile DRAM based on LPDDR2 technology has a maximum of 8.5 Gbytes/second of peak data throughput at an estimated power consumption of 360 mW. By 2013 at the latest, the industry is shooting for data rates of "12.8 Gbytes/s at 500 mW," said Herb Gebhart, vice president of strategic development at Rambus Inc.

Brian Carlson, product line manager for TI's OMAP 5 applications processor, said mobile DRAM may need to run at 25.6 Gbytes/s in the future. The challenge is to devise a faster technology, while also reducing the chip size and power consumption to extend battery life, he said.

The stakes are high in mobile memory. Before the onslaught of snazzy smartphones and tablets, mobile DRAM was considered the "sleepy backwater" in the memory market, said Mike Howard, an analyst at IHS

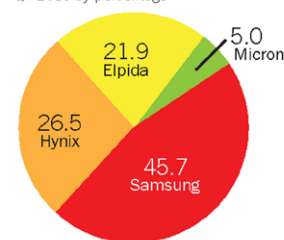
## Mobile DRAM standards race

Technology	Backers	Availability
LPDDR2	Elpida, Hynix, Micron, Samsung	Shipping today
LPDDR3	Micron	Unknown
LPDDR4	Unknown	Unknown
Mobile XDR	Rambus	Unknown
SPMT	ARM, Hynix, LG, Marvell, Samsung, Silicon Image	Second-half 2011
Wide I/O	Hynix, Samsung, Sematech, Semiconductor Equipment and Materials International, Semiconductor Research Corp.	2013 for single Mobile I/O devices; unknown for stacked TSV devices

Source: EE Times

## Mobile DRAM market share

Q4 2010 by percentage



Source: IHS iSuppli

iSuppli. Now, thanks to smartphones and tablets, the mobile DRAM sector is expected to grow by 71 percent in 2011, Howard said.

Mobile DRAM is outpacing the overall DRAM business. Amid a slump in PCs, the DRAM market will total \$35.5 billion in 2011, down 11.8 percent from \$40.3 billion in 2010, according to IHS.

The average DRAM content in smartphones and tablets is increasing from 512 Mbytes today to 1 Gbyte in the future; in contrast, PC DRAM content averages 3.4 to 3.5 Gbytes, said Hans Mosesmann, an analyst





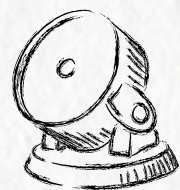


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    printf  
    ("Hello World!\n");  
}
```



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A mobile DRAM costs two to four times more than a PC DRAM because of mobile apps' stringent size and power demands. The mobile DRAM business is based on a build-to-order model, with pricing driven by cost reductions rather than the fluctuations of supply and demand, as in commodity DRAM, IHS' Howard said.

But as competition mounts, the predictable supply/demand model is cracking. Supply and demand are in "balance right now, moving into oversupply in the second quarter," Howard said. "We see tighter supply in the second half."

Broad changes are expected on the technology front. The previous-generation mobile DRAMs were based on low-power synchronous DRAM technology, and, more recently, LPDDR1. LPDDR1 mobile DRAMs are 1.8-V, 200-MHz parts, enabling 400-Mbyte/s throughput.

Now that LPDDR1 is hitting the performance wall, vendors are ramping up to provide LPDDR2-based devices, which are 1.2-V parts said to reduce power consumption by more than 50 percent. LPDDR2 cuts power by using such techniques as partial array self-refresh.

LPDDR2 runs from 100 to 533 MHz, resulting in data transfer rates from 200 to 1,066 Mbytes/s. Up to four devices can be housed in a package-on-package, resulting in a total data transfer rate of 8.5 Gbytes/s.

Just as vendors are pushing LPDDR2 devices into the channel, Micron Technology Inc. is leading the charge toward LPDDR3,

## Phone, tablet DRAM densities: Upwardly mobile

Platform	Average density (Mbytes/unit)							
	Q1 '10	Q2 '10	Q3 '10	Q4 '10	Q1 '11	Q2 '11	Q3 '11	Q4 '11
Smartphones	197.7	244.2	329.1	342.9	394.0	418.4	459.3	529.4
Tablets	256	256	268.8	281.6	391.68	588.8	645.12	849.92

Source: EE Times

which is said to operate at 800 MHz, or 1.6 Gbytes/s. With four devices, LPDDR3 has a peak throughput of 12.8 Gbytes/s, said Dan Skinner, director of mobile DRAM architecture for Micron.

LPDDR2 will satisfy most mobile system requirements, but in the near term, the "top 10 percent [of high-end systems] will need LPDDR3", said Skinner, who chairs Jedec's LPDDR3 task group. A final draft specification for LPDDR3 will be completed by year's end.

## Mobile DRAM pricing is driven by cost reductions rather than the fluctuations of supply and demand

Rival Samsung is lukewarm on LPDDR3; LPDDR2 has long legs and will be the "memory of choice" at least until 2012, said Samsung's Deen.

Samsung is now shipping 533-MHz, 4-Gbit mobile DRAMs based on LPDDR2 and

30-nanometer-class technologies. The new devices will enable lighter mobile products with a longer battery life, Deen said.

Previously, four 2-Gbit LPDDR2 chips had to be stacked to create a 1-Gbyte package. Stacking only two 4-Gbit LPDDR2 devices will achieve the same 1-Gbyte density, while reducing the package height by 20 percent and cutting power consumption by 25 percent, according to Deen.

Beyond LPDDR2, Samsung has announced support for SPMT and wide I/O. Wide I/O operates at lower frequencies to reduce power. Traditional DRAM has up to 32 data lanes. In contrast, wide I/O DRAM is a four-channel, 128-lane technology, which enables a total of 512 I/Os and a total bandwidth of up to 12 Gbytes/s, according to supporters of the technology.

By 2013, vendors hope to roll out robust wide-I/O DRAMs. In the distant future, vendors believe they can stack multiple wide-I/O memories using through-silicon via 3-D stacking technology, but for now TSV remains hampered by high implementation costs and scant EDA tool support.

"TSV is not ready for prime time," said SPMT's Venable, while LPDDR2 is running

## HANDICAPPING THE MOBILE DRAM RACE

Which next-generation mobile DRAM technology will ultimately prevail in the market? Though it's far too soon to call a winner, wide I/O DRAM technology was fast out of the gate and has a slight lead. Nokia reportedly has endorsed the spec, and Hynix and Samsung have jumped on the bandwagon.

But other cell phone companies aren't talking. Motorola and Research In Motion did not respond for interview requests. And Apple is perhaps the world's most secretive OEM.

One possible clue is to watch the applications processor vendors. Apps processors support functions such as wireless connectivity, power management, audio and video in smartphones, tablets and other mobile devices. Each apps processor also supports a given OEM-endorsed mobile DRAM standard.

One applications processor vendor, Texas Instruments Inc., is watching all standards but says one technology appears to be leading by a nose. "Wide I/O has a lot of advantages," said Brian Carlson, OMAP 5 product line manager for TI. "Ultimately, that's where the industry will move."

Raj Talluri, vice president of product management for applications processors at Qualcomm Inc., said it's still too early to predict a winner, but he noted the industry is begging for "more CPU power" for new and data-intensive applications.

Indeed, the exploding demand for more bandwidth in mobile devices has given rise to more powerful apps processors. That leg of the race is being run by companies such as Nvidia, Qualcomm and TI.

Earlier this year, Qualcomm rolled out its next architecture for its Snapdragon family of applications processors. The processor microarchitecture, code-named Krait, is said to provide speeds of up to 2.5 GHz per core. Built around an ARM-based architecture and a 28-nanometer process, the devices will be available in single-, dual- and quad-core versions.

TI recently rolled out the multicore OMAP 5, based on a 28-nm process. The processor will come in two versions: the OMAP5430, targeting smartphones, and the OMAP5432, for mobile computing and consumer products. — Mark LaPedus



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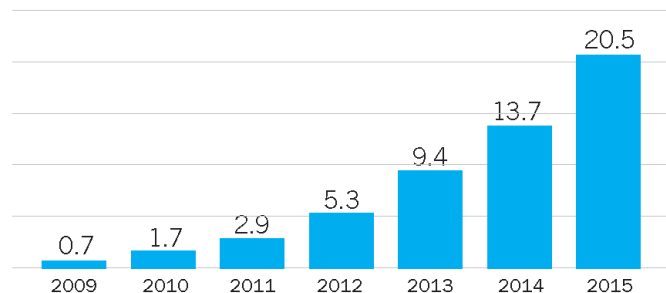


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## Worldwide mobile DRAM shipments rise ...

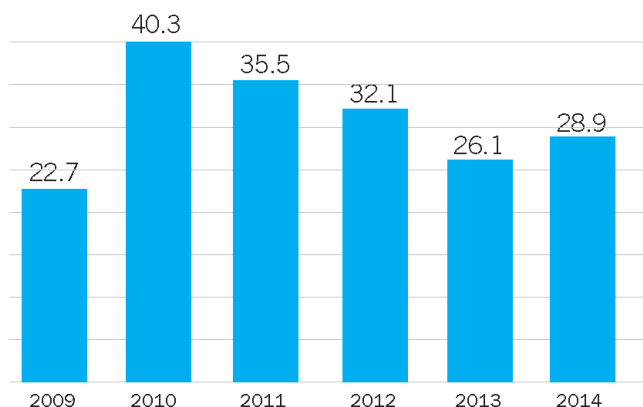
Billions of gigabits



Source: IHS iSuppli Research, February 2011

## ... as total DRAM revenues slip

Billions of U.S. dollars



Source: IHS iSuppli Research, February 2011

out of steam, and LPDDR3 is a "stopgap" technology that is faster but will consume more power.

SPMT claims it has the right solution although it remains unproven. Last year, SPMT scrapped its original serial approach and rolled out a hybrid parallel/ serial technology. Called Serial- Switch, it runs at 1.6 Gbytes/s in parallel mode and up to 6.4 Gbytes/s in serial mode per channel.

SPMT group members include ARM, Hynix, LG, Marvell, Samsung and Silicon Image. The first SPMT-based DRAMs are due by year's end.

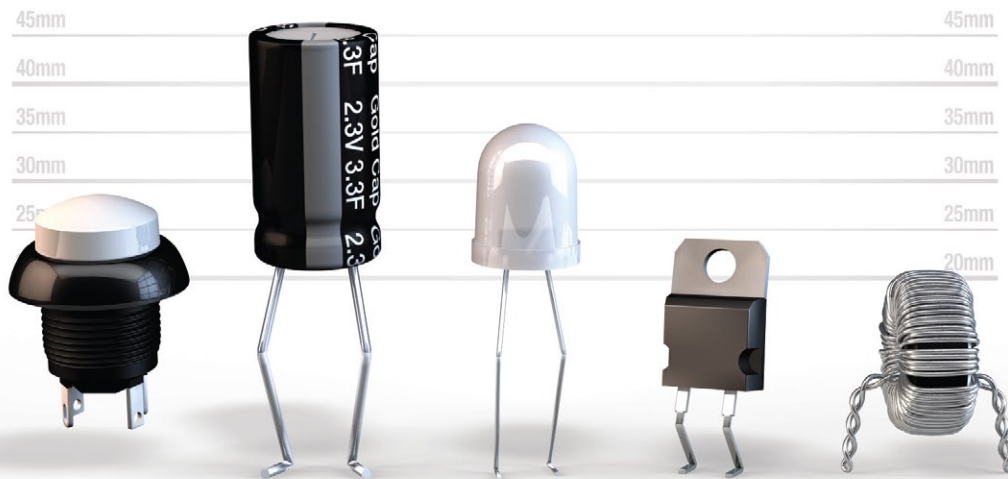
Rambus' Mobile XDR, meanwhile, reportedly delivers up to 17 Gbytes/s of bandwidth. But Rambus burned bridges in an earlier attempt to push its technology for PC main memory, and any ill will that lingers from that affair might work against its new spec.

Mobile XDR addresses "the shortcomings" of LPDDR3, said Gebhart. LPDDR3 is "well over" the industry goal of meeting a power consumption threshold of 500 mW in the future, he said. "There is plenty of bandwidth [with LPDDR3], but the power is way too high."

What's next? Some market trackers are already talking about LPDDR4, which may or may not materialize. Another technology to watch is M-PHY, backed by the Mobile Industry Processor Interface Alliance. MIPI's spec is for a chip-to-chip interface for display, camera, audio, video, memory, power management and communications from baseband to RF chip. It is indirectly competitive with mobile DRAM, but it has some implications for memory. ■



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# TI's Analog Applications Journal

**Analog Applications Journal is a collection of analog application articles designed to give readers a basic understanding of TI products and to provide simple but practical examples for typical applications.** Written not only for design engineers but also for engineering managers, technicians, system designers and marketing and sales personnel, the book emphasizes general application concepts over lengthy mathematical analyses.

## Data Acquisition

### Clock jitter analyzed in the time domain, Part 2

High-speed ADCs are often used in undersampling applications. At higher input frequencies, clock jitter can become a dominant factor in limiting SNR. This article presents a method of calculating the ADC's SNR by using the combined clock and aperture jitter determined in Part 1. The results are then compared against actual measurements.

### The IBIS model: A conduit into signal-integrity analysis, Part 1

TI is developing a new arsenal of digital input/output buffer information specification (IBIS) simulation models to meet a variety of customer needs. This article, the first of a three-part series, shows the fundamental elements of IBIS models and how they are generated in the SPICE environment.

## Power Management

### A low-cost, non-isolated AC/DC buck converter with no transformer

Off-line equipment such as a smart meter or a power monitor has electronics that require non-isolated DC power under 10 W. Until recently, the typical low-power DC rail circuit was extremely inefficient and cumbersome to design. This article presents a unique solution for an ultra-low-cost DC power rail with an innovative gate-drive circuit for a hysteretic buck controller.

### Save power with a soft Zener clamp

Flyback converters are popular because they are inexpensive, they can be isolated, and they can have multiple output voltages. Multiple outputs, however, can be a problem if tight regulation is required on more than the main output. This article shows how a soft Zener clamp can be used as a compromise in limiting output voltages when the load on the main output voltage suddenly changes.

## Interface (Data Transmission)

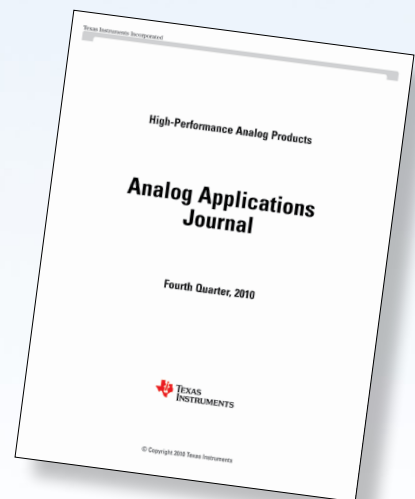
### Interfacing high-voltage applications to low-power controllers

Industrial applications often require interfacing high-voltage potentials to input ports of low-voltage microcontrollers and processors. This article is about a new generation of interface circuits called digital-input serializers. These low power and cost-effective devices can sense input voltages ranging from 6 V up to 300 VDC and can convert them into 5-V serial data streams.

## Amplifiers: Op Amps

### Using single-supply fully differential amplifiers with negative input voltages to drive ADCs

Split-supply amplifiers are not required to amplify signals that swing around ground. This article discusses how to use a fully differential amplifier (FDA) like the THS4521 with a single +5-V supply to condition single-ended input signals that swing around ground ( $\pm 0$  V) to drive a differential-input ADC. A link to a TINA-TI™ SPICE file is included to illustrate implementation.



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## Malcolm's semiconductor update

**THE CHIP INDUSTRY** took March's one-two-three knocks with remarkable calm, hit first by the spike in oil prices following the politic unrest bordering on civil wars in North Africa, then the dreadful 11 March earthquake and Tsunami in Japan, culminating on 19 March with a multi-state coalition military intervention in Libya to implement United Nations Security Council Resolution 1973.

Last year any of these events would probably have been enough to deal the industry a knockout blow, as with the September 2008 Lehman Brothers collapse; this time around, despite the still fragile global economic confidence, the industry seems to have taken these events in its stride.

Whilst it is far too early to quantify exactly what the industry impact will be, the oil price and North Africa situation pales into insignificance when compared with the aftermath of the Japanese earthquake.

Japan is a major producer of semiconductor components accounting for around 22 per cent of global semiconductor production. The Flash memory market sector – cru-

cially mobile phones, iPads and their derivatives, digital cameras, and portable storage devices, account for approximately 50 percent of the market, almost all of which are produced by one Japanese firm, Toshiba/Sandisk.

Damaged buildings and infrastructure and halts to some semiconductor fabs will without doubt have a knock on affect upon the global semiconductor supply chain, with many of the big names i.e. Nokia, General Motors and Apple already experiencing supply shortages.

Many manufacturers, not directly hit by the earthquake, have experienced power failures interrupting production; just a micro-second power supply glitch can result in the scrapping of weeks of in-process production, and with manufacturers no longer holding inventory it will impact IC supply availability in Q2. To what extent, still remains to be seen. As in any shortage situation, component price increases are inevitable and this has already happened in memory, although



it is not yet clear how much of this is panic profiteering and how much is sustainable. But shortages are inevitable and recovery due to the long production cycle times and already tight capacity – will not happen over night.

The automotive semiconductor market grew 37 per cent in 2010, clearly leaving the problematic 2009 behind. However the

recent earthquake in Japan has once again awoken auto manufacturers concerns about the industry. Even before the earthquake purchasing managers had expressed concern about supply levels; inventories were unusually low, resulting in heightened concern from purchasing executives around the world.

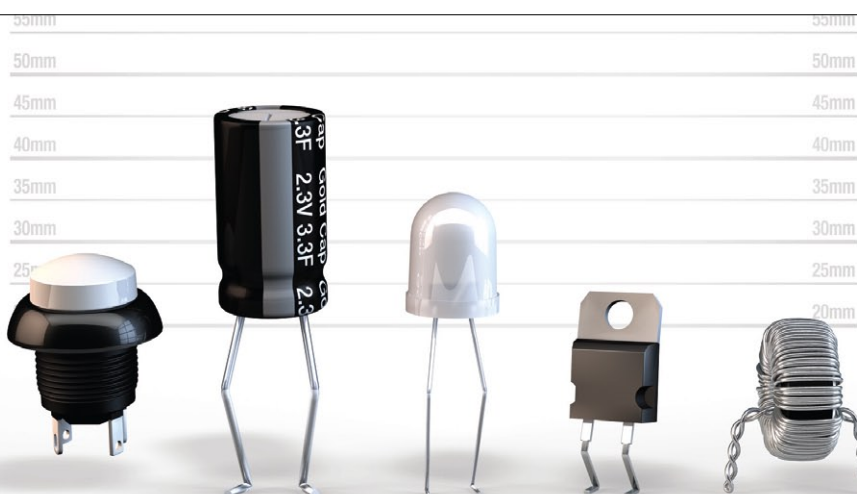
It is difficult to estimate the extent auto manufacturers will be affected, but following an official announcement from Japan that car production will be down 33 percent from its normal monthly production level of 750k cars per month to 500k it looks as though the 2010 market growth may be short lived. ■

Malcolm Penn is Chairman & CEO of Future Horizons - [www.futurehorizons.com](http://www.futurehorizons.com) - he can be reached at [mpenn@futurehorizons.com](mailto:mpenn@futurehorizons.com)

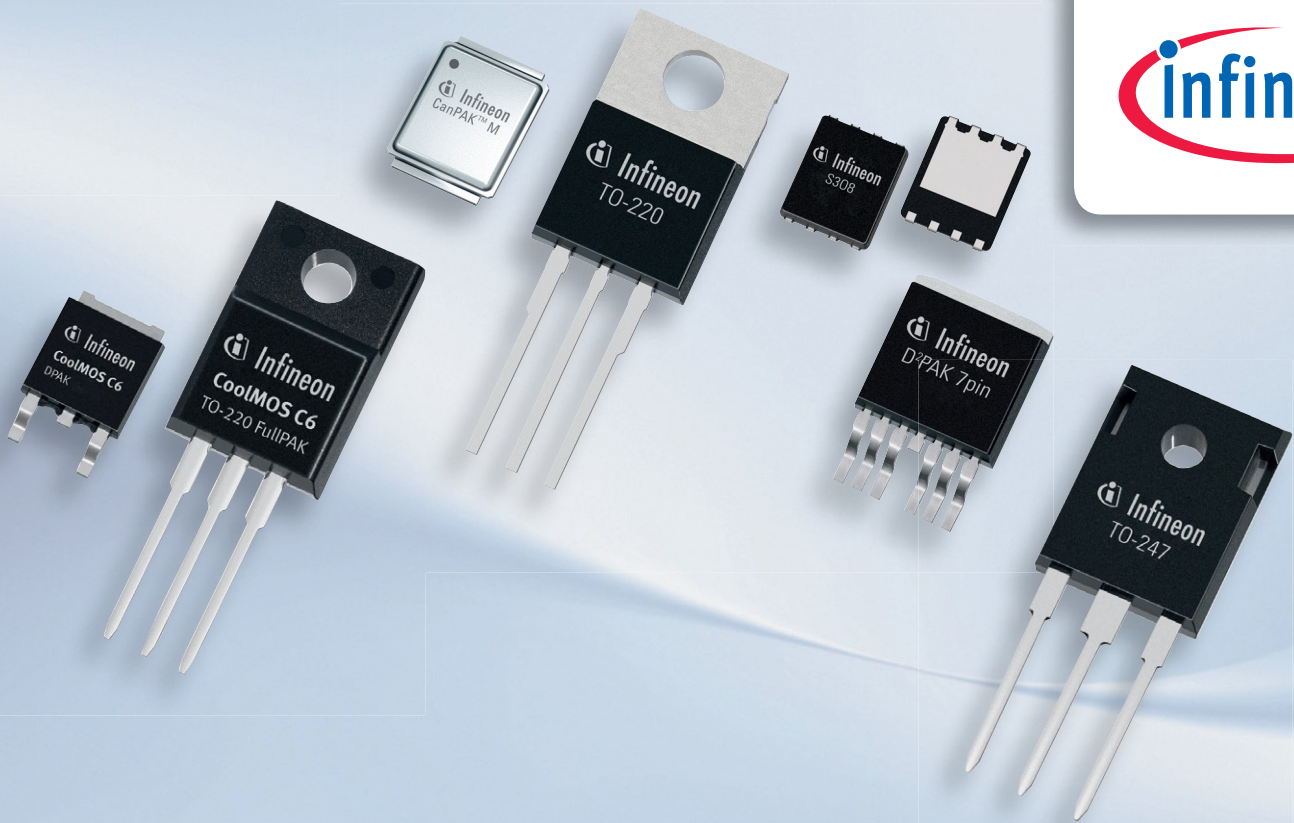
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## The high potential of wireless body-area networks in healthcare

By Jan Provoost and Julien Penders

**WORLDWIDE**, an estimated 50 million people suffer from epilepsy. Many of them would be greatly helped if they could be warned of an oncoming epilepsy attack. It would allow them the time to take seizure blocking medication, get to a safe place, or call for assistance.

As a matter of fact, such an alert service



**Fig. 1: Necklace with prototype heart monitor (imec/Holst Centre).**

already exists, albeit for a happy few. Seizure alert dogs detect an oncoming seizure minutes, sometimes hours, before it occurs. Some of the people who own such a dog say it gives them a second chance at life, allowing them to move around without constant fear.

But seizure alert dogs are expensive: few dogs have the talent to feel upcoming seizures, and it is impossible to train them to give a predictable alert. So only a small number of patients can be helped, and the help is not consistent.

Now imagine that all epilepsy patients could wear small, inexpensive sensors: an EEG scanner (electro-encephalogram) woven

into a comfortable cap, and a few other patch-like sensors, all wireless and unobtrusive. These sensors would measure relevant body parameters and send them wirelessly to a base node, for example integrated in a wrist watch.

The wrist watch crunches the data, scanning for patterns that point to an attack. When such a pattern is found, the watch sends out an alert, in time to take measures. For some of the patients, this would be a welcome, but minor help; for others, such technology would be life changing. And because this is a potentially cheap technology, unlike with seizure alert dogs, this could be a life-improver for all sufferers of epilepsy.

### A wireless network for your body

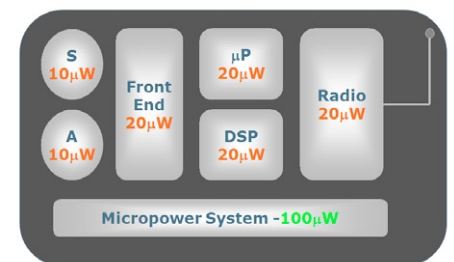
Networks of miniaturized sensors worn on the body, that continually measure body parameters and send these wirelessly to a base station are called body area networks (BAN). BANs are one of the emerging technologies in ICT-driven healthcare; they drive what is sometimes referred as the second telehealth wave.

Eventually, BANs could become as ubiquitous and cheap as mobile phones, allowing continuous, individualized medical or wellness monitoring for existing conditions, identifying when a medical intervention or change in therapy is needed, or monitoring stress levels.

Epilepsy patients are only one of many groups that would hugely benefit from such cheap, wireless sensors that track body parameters. Think for example of diabetes patients, people at risk from a cardiac arrest, or people suffering from stress-related diseases and high blood pressure.

### Dirt cheap, no hassle, forever on

To be universally accepted and used, BANs should consist of cheap, small, intelligent nodes. Worn close to the skin or woven into clothing, they should be conformal to become



**Fig. 2: Power budget of components for a 100µW sensor node.**

unobtrusive. BANs are intelligent and capable of doing multi-parameter data acquisition and data analysis, data which they can send and receive wirelessly. Installing a BAN should be hassle-free; you add a new node, and it automatically starts working with the other installed nodes. They should be autonomous or near-autonomous, driven by an intelligent power management.

With today's technology, several companies have already made BAN-like devices, but compared to the plug-and-play sensors that we envision, these are still orders of magnitude too large, too expensive, and too power-hungry. A BAN node, for example, powered by energy harvesting from the body, would have a power budget of around 100µW, for all components together. But even without relying on energy harvesting, these nodes would still have to be ultra-low power, so as to be sufficiently autonomous with few battery replacements or recharges.

Further advances are needed in ultralow-power sensors, ultralow-power DSPs, and ultralow-power radios before we can reach this ultimate BAN concept. Even after such components are developed, you would still want to win another order of magnitude in cost, size, and power budget, through co-optimization of the components with a specific application in mind.

Ultimately, all the technology for a BAN node should be integrated on one chip that can be mass-produced and packaged in an IC fab. It would be a cheap flexible microchip of a few square millimeters integrating the

Jan Provoost works at imec as a science writer – [www.imec.be](http://www.imec.be) - Julien Penders is imec program manager body area networks and can be reached at [julien.penders@imec-nl.nl](mailto:julien.penders@imec-nl.nl)



# Get an Edge: Universal USB Charging

## *Mess vs. Less*

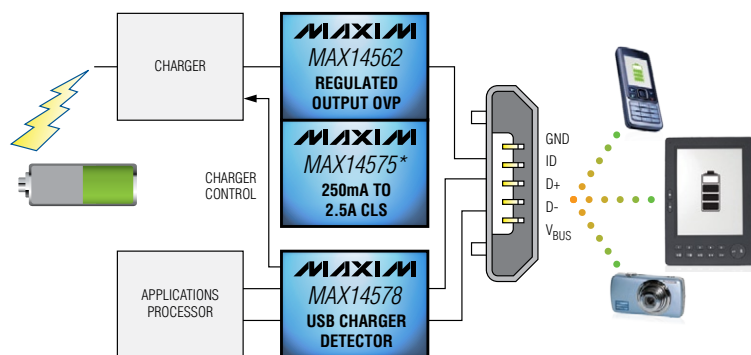


As consumers buy more portable devices, they become overwhelmed with managing power adapters that have a variety of connectors. Solving this issue, the micro USB interface has become the standard for battery charging and data transfer. Maxim's charger detection, overvoltage protection, and current-limit switching ease design-in of micro USB ports to simplify the user experience.

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**Fig. 3: Prototype for EEG-sensing headset.**

sensor, DSP (digital signal processor), wireless radio, and energy harvesting together power management.

This vision of telemedicine with wireless sensors has sparked a lot of interest of R&D labs around the world. The brain monitor and the heart monitor demonstrators developed at imec (Leuven, Belgium) and Holst Centre (Eindhoven, Netherlands) illustrate some of the technological challenges and the breakthroughs that have already been made.

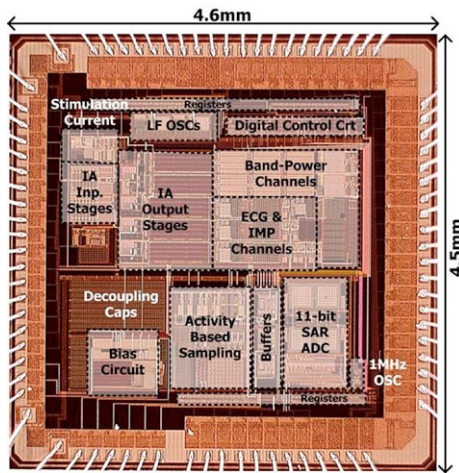
## Brain monitor – capturing signals

A first step in building a sensing node for body parameters is to come up with a low-power analog solution to capture the signal and amplify it.

In a brain monitor, for example, you want to measure a brain signal with a very small amplitude, typically between  $1\mu\text{V}$ – $20\mu\text{V}$ . But you somehow have to hear that signal against a backdrop of a few mV noise caused by the environment (e.g. mains). You do that by ensuring that your amplifier has a sufficiently high common mode rejection ratio (CMRR), of around 120dB, to extract the much smaller brain signals.

But to obtain such a high CMRR, you need powerful instrumentation amplifiers, and these are traditionally very bulky and power hungry. Imec and Holst Centre's scientists were able to integrate this functionality on a chip, a low-power ASIC that can handle 8 input channels. It includes the instrumentation amplifiers (120dB,  $55\text{nV}/\text{VHz}$ ), low-power analog-to-digital converters (11 bits), and calibration and electrode impedance measurement modes. While finding brain signals, the chip consumes a mere  $200\mu\text{W}$ .

This ASIC was further integrated into a full sensor node, adding a commercially available low-power radio, microcontroller, and power circuit. The total node measures  $35\times 25\times 5\text{mm}$ , excluding the battery. It can transmit data wirelessly to a base station for real time dis-



**Fig. 4: imec and Holst Centre's  $30\mu\text{W}$  ASP for biopotential signal monitoring.**

play, storage and analysis.

With this sensor node, designers and engineers made a comfortable EEG-sensing headset. To make contact with the skin they use dry electrodes, which drastically improve the ease-of-use and set-up time. The wireless sensor node consumes  $9.2\text{mW}$  when measuring 8 channels of EEG at  $1024\text{Hz}$ . This allows for an autonomy of 45 hours with a rechargeable battery of  $140\text{mAh}$ . For some applications that can do with single-EEG channel recording at a lower sampling frequency, up to 5 days of autonomy are possible.

Tests have proved that signals captured with this wireless headset are comparable to signals recorded using commercially available wired systems. But because this headset is wireless and quasi-autonomous, the wearer can have brain signals measured in a much wider range of situations, at work or at rest in a natural environment.

## Heart monitor – processing and transmitting signals

Once the signals have been captured, sensor systems may still waste a lot of power. They have a DSP that continuously processes biopotential signals (e.g. from an electro-cardiogram or ECG), or a radio that continuously transmits raw data over the wireless link. Free-moving, wireless sensors also result in motion artifacts, glitches in the signal caused by movements of the sensor. Trying to compensate for these glitches demands even more processing power.

imec and Holst Centre have built a prototype heart monitor with a greatly reduced power budget. They did so by designing new ultralow-power components: an ASP (analog signal processor), DSP, and radio chip. In parallel, they made another important gain by carefully optimizing the distribution of functions over the analog and digital domains, exploiting the characteristics of the application.

The new DSP, for example, is a versatile

ultra-low power biomedical signal processor, codenamed CoolBio, made in collaboration with NXP. It consumes only  $13\text{pJ}/\text{cycle}$  when running a complex ECG algorithm at  $1\text{MHz}$  and  $0.4\text{V}$  operating voltage. The chip is voltage- and performance scalable supporting a frequency range of  $1\text{MHz}$  up to  $100\text{MHz}$  with an operating voltage from  $0.4$  to  $1.2\text{V}$ . The result is a highly reduced power consumption at low operating frequencies, while maintaining the possibility of high-performance computing for multi-channel biomedical signal processing.

Integrating ultra-low power components for an application will not necessarily make for the most energy efficient solution for a given application. It is possible to make additional energy gains by exploiting the characteristics of the application and its signals. In the case of the heart monitor, for example, an important part of the signal processing may be implemented much more economically in an analog way. In addition, the engineers have found a way to severely limit the consumption of the wireless radio, also thanks to a small, energy-efficient analog intervention: in the ECG-sensor the analog-to-digital converters on the signal acquisition IC use a sampling scheme that adapts based on (analog) activity detection. As a result, the DSP has to crunch less signals and the radio transmits less data. And as a third energy-saving intervention, the motion artifacts are detected in the analog component, via continuously monitoring the electrode-skin impedance, not in the DSP via energy-intensive computation.

## Smart, cheap BANs, a game changer in healthcare

Further R&D is working towards the ultimate BAN that is cheap, comfortable and easy to use. The brain and heart monitor demonstrators point to some of these devices' potentials to replace and extend the functionality of today's much larger and more expensive medical devices.

With the technology that is becoming available, it is possible to make relevant demonstrators that can be compared and validated successfully against commercial equipment that is orders of magnitudes larger and more expensive. In contrast to such equipment, BANs could be used at home, by everyone, not only in case of emergencies, but also for prevention. We expect BANs to appear first in wellness, sports and gaming applications, and later on in healthcare devices, which have much more stringent requirements and approval procedures. ■



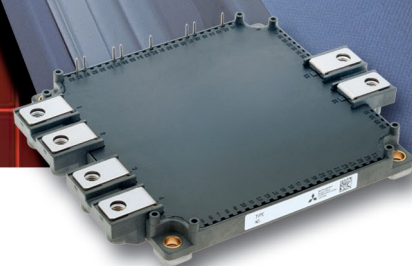
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# Making life less difficult

By Philip Ling

**THINK OF ANY TREND** present in any of the vertical sectors where embedded electronics plays a role today and it will almost definitely apply to the medical market. It's a long list: low power; high integration; ease of use; high reliability; low cost; stability of supply; fast time to market; quality assurance and, some may say, there are many others.

A subset of these are present in all markets; consumer demands low cost, networking demands high performance, the defence & aerospace market needs stability of supply, while industrial control increasingly needs greater integration. But arguably it is only one market, the medical market, where they are all likely to influence developments.

The unique requirements of the medical market mean that for a long time not all suppliers were keen to enter it, however current socio-economic trends mean that the medical market is both changing and growing, bringing with it opportunities that may be difficult to address but are even harder to ignore.

One of the most significant impacts on healthcare is that despite

an increase in chronic illness, we have a longer life expectancy. While our ageing population has helped demand grow for consumer medical devices, which bring their own unique requirements, it is also impacting on how the traditional healthcare market operates, particularly on how equipment targeting professional healthcare providers is being developed.

The bottom line is, an ageing but demanding population is driving up the cost of healthcare, as ST Microelectronics' Matteo Lo-Presti, IMS Group vice president, systems Lab and technical marketing general manager, explained: "In most developed countries, healthcare costs are running at 15 to 20% if GDP and are acknowledged to be out of control."

It is widely believed that the semiconductor industry can help make healthcare more accessible and affordable, not least through telemedicine. Freescale's Medical Segment Lead for EMEA, Mickael Viot, believes this sub-segment will see double-digit growth for the

next five years.

As mentioned, the medical market demonstrates all the main challenges present in other vertical markets and for Tom Zemites, director of marketing for Microsemi's High Reliability Group, the medical market can be addressed in terms of three sub-categories; clinical, imaging and home applications. "The trends in all these are common," he stated, but adding: "In clinical applications, reliability takes centre stage, where decisions are based on data collected."

Increasingly, however, the data is collected at the point of interest, often not in a hospital environment. This imposes its own demands on the devices, as Microsemi's product marketing manager, Medical Solutions, Minal Sawant explained: "Electronic content continues to grow and with it so too does the need for greater accuracy of sensor technology, analog to digital conversion and processing power. To address the rising cost of health care, more out-of-the-office monitoring will emerge, and the transmission of patient monitoring information over wireless networks will continue to grow."

General manager for Texas Instruments' Medical and High Reliability Business Unit, Karthik Vasanth, agrees: "The ability to remotely monitor vital signs such as blood pressure, heart rate, glucose levels, temperature, and weight takes healthcare out of hospitals and doctors' offices and in to patients' homes via technologies such as Bluetooth, Bluetooth Low Energy, ZigBee, ANT and WiFi. We believe that this can significantly reduce healthcare cost and allow people to better manage their health and maintain a good quality of life."

The senior manager of Microchip's Medical Product Group, Steve Kennelly, believes this is driving innovation not only from integrated device manufacturers (IDMs) but also from their customers: "Infusion pumps, patient monitors, surgical tools, imaging systems and many other devices that are used by doctors and other trained professionals are being reinvented with modern electronics."

However this is putting new pressure on the IDM to create products that are both flexible enough to meet the different customer demands, but robust enough to meet regulatory requirements. Kennelly added: "In most countries, government regulations make the OEM responsible for determining the impact of any changes in purchased components, in turn they tend to impose requirements on the IDMs to communicate the details of any changes, prior to their implementation."

Jan-Hein Broeders is the healthcare business development manager in Europe for Analog Devices, he explained that the medical



**Steve Kennelly, Senior Manager, Medical Products Group, Microchip: "The average product life cycle of medical devices is coming down".**

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market almost demands the economies of scale that come with the consumer sector, but with the reassurances of the defence market: “You rarely find million unit opportunities unless it is really consumer or disposable; when this is not the case the challenge is to come up with smart solutions that are flexible with all kinds of ‘bells and whistles’.” However the danger is this will make the solution too expensive for some applications, Broeders added: “It really is a balancing act, making trade-offs between functionality, flexibility, performance, power and finally cost.”

Microchip’s Kennelly echoed this point: “The OEMs are being constantly challenged to invent new devices and improve old ones. Each generation must be smarter, safer, faster, more reliable and less expensive, at the same time competitive pressures are squeezing development times, while the design process has to keep up with an evolving regulatory environment.”

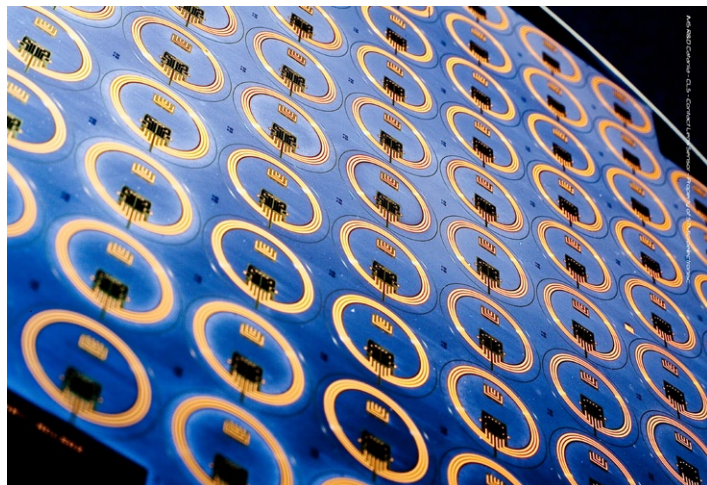
While, in general, IDMs are successful by making general purpose products that can be used across many vertical markets, the unique demands of the medical market means that ultimately some products are developed to meet these specific and unique demands. Broeders explained how ADI sees the medical market as five distinct segments; imaging, patient monitoring, instrumentation & lab equipment, consumer care, and implants. “For these segments we are making unique products,” he confirmed. ST’s Matteo Lo-Presti explained: “We are working on diagnostic-quality acquisition systems for several biological sensors. These will cover many different types of diagnostic equipment, from electrocardiography to electromyography.”

The increased activity around patient-based healthcare can give the impression that it’s becoming more like the consumer sector where the time-to-market is being driven ever lower and the time-in-market is shrinking with it. In some cases, this is true; changes in regulatory requirements aren’t uncommon, particularly for devices operated by the patient, such as insulin pumps. Coupled with the fact that these devices are used on a daily basis, often constantly, means they may be replaced as often as every year and, as with all electronics products, the consumer expects the next version to be better, smaller, last longer or be easier to use.

Microchip’s Steve Kennelly said: “The average product life cycle of medical devices is coming down, but I think that the decreasing average is mainly driven by a mix of factors. One example is the portable blood-glucose monitor; the companies making these have embraced the mobile phone model of multiple new versions every year. As an IDM this highlights the fact that our customers expect us to continuously enhance and add to our portfolio of new parts, but they don’t want us to remove older products from production.”

While tele-health is a strong driver in the short-term, mid- to long-term growth may come from other areas. Director of Freescale’s Metering, Medical and Connectivity Division, Bruno Baylac, commented: “The drug delivery market is also changing rapidly as a result of the pharmaceutical companies. We see more and more demand for electronic features in auto-injectors or dry powder inhalers. Knowing the pharmaceutical industry volumes, this is going to be a huge opportunity in the mid-term.” Further out, Baylac believes sensors worn around the body and integrated into medical bandages are key applications of the future, adding: “It is the next step in terms of medical remote monitoring, providing more comfort to the patients.”

Microsemi’s Tom Zemites sees opportunities for greater integration: “We will continue to support the implantable medical device



**A batch of ST’s MEMS technology to be used in Sensimed’s contact lens sensor, developed for the continuous monitoring of fluctuations in intra-ocular pressure (IOP) of glaucoma patients.**

market coming from our FPGA and mixed signal analog devices. Adding our RF capability, we can offer the medical world the brains, the brawn and the communication link.”

ST’s Matteo Lo-Presti added: “The healthcare market, more than the classical medical market, is opening new scenarios for people and companies; home healthcare is the first example of this trend. The possibility to manage the personal care from one’s own home will be a big opportunity for many OEMs.”

ADI’s Jan-Hein Broeders believes the opportunities are only just emerging: “There are still a lot of companies that make their money in the medical market with plastics and disposable products. The need for medical support and services are increasing and this will bring us in to resource limitations, as well as an increased risk of making mistakes. Making products smarter to anticipate possible failures and improper use will help the population and care providers to improve the overall level of medical care. It is also one of the goals that the healthcare insurance companies proactively drive; improve the level of care at a lower cost. Electronics can help make this happen.”

Microchip’s Kennelly concluded: “I see new OEMs entering the medical market all the time and I expect that to continue. There is lots of room for innovation and new solutions in consumer devices, tele-health, surgical instruments, patient monitoring, imaging and other sub-segments. The best part of my job is when I get to meet a device designer who is making something that has never existed before and will improve peoples’ lives.” ■

# Solder?

die  attach

# No.

# Telehealth: huge opportunities for established technologies

By Christoph Hammerschmidt

**AT THE DESIGNMED** trade fair that recently took place in Stuttgart (Germany) the close ties became visible that link medical technology and electronics. The exhibition also made clear how electronics and software can contribute to future applications in the greater health technology market place. At the exhibition in close vicinity to Stuttgart's airport, vendors of communications technology, semiconductors, real-time software and measurement technologies were canvassing manufacturers of medical equipment, and during numerous presentations and seminars future electronic helpers to doctors and nurses took shape.

The market for medical technology products is huge. According to European medical technology industry association Eucomed, annual sales volume reached 72.6 billion euros - and Europe accounts for just one third of the World market. There are numerous opportunities for the electronics industry to join this growing segment. A variety of social, political, demographic and economic factors is currently creating an environment which greatly encourages the electronics industry to contribute with its expertise in generating cheap, small,

versatile and reliable products to the medical technology industry.

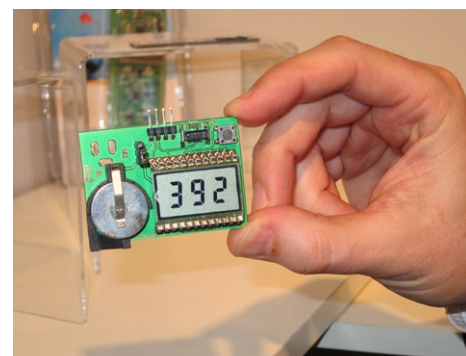
Measured by the number of forum presentations, the industry sees particular good market chances in one specific segment of medical electronics: Telehealth. "Telehealth is not the same as telemedicine", explained Iboun Sylla, business development manager for Texas Instruments. "Telemedicine includes the communication with remote specialized physicians, such as surgeons. Thus, telemedicine is part of the cure. Telehealth, in contrast, focuses on remote monitoring of chronic diseases and does not contain any elements of the treatment."

This differentiation has important consequences for the technology. In telehealth, an increasing number of consumer electronic devices and products are being deployed, including HMI concepts. Consumer electronics technologies have a number of properties highly desired in the realm of telehealth: they are proven and available, they are produced in high quantities and thus they are affordable. "In an environment characterized by cost pressure and an ageing population driving mass demand for telehealth products, it is important that telehealth can leverage existing technologies", said Ross Mitchell, industrial systems solution engineering manager for Freescale Semiconductor. For this reason, telehealth solutions will widely be based on popular terminal devices such as smartphones or tablet computers.

Wireless communication technologies being a crucial part of any telehealth application scenario, one could wonder which wireless technologies will be the favorites in product design. Since cost and reliability reasons widely rule out the development of new telehealth-specific communication technologies, product designers will have to select from the spectrum of available technologies which however offers a wide range to choose from.

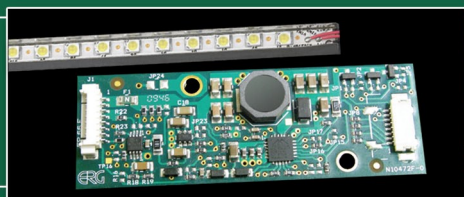
A typical telehealth scenario consists of various elements, arranged to some extent in a hub-and-spoke manner. An aggregation manager application forms the hub while several personal health devices (PHDs) form the spokes. Examples for PHDs are sensors for blood pressure, glucose level, temperature, motion or heart rate. They send their data to the aggregation manager which in turn communicates with a health service provider such as a physician or a hospital.

On the sensor side, the communication technology of choice depends on factors such as data rate, transmission range or power requirements.



Medical electronics for the masses have to be cheap like this disposable insuline pump display.

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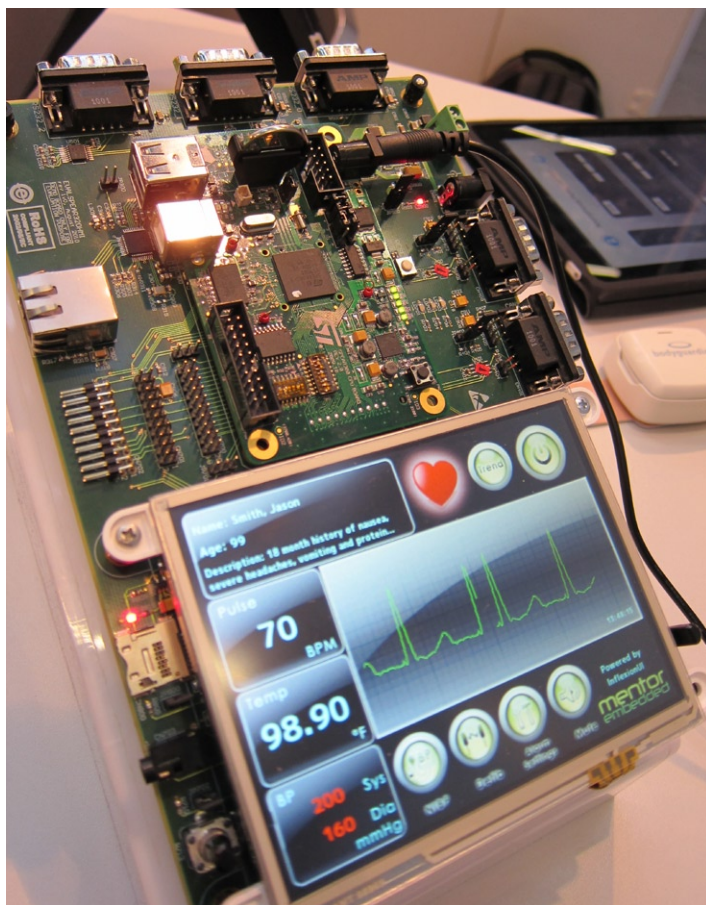
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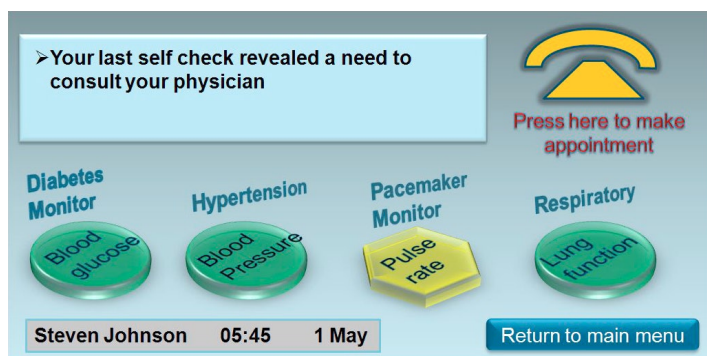




**Ease-of-use is a critical success factor for telehealth applications. Vendors are experimenting with intuitive user interfaces. A test platform from STMicroelectronics.**

Engineers can select from established technologies such as Bluetooth, Zigbee, WiFi or even USB. "All standards are already in place," said Sylla. In some cases, it might be necessary to develop additional protocol layers - for instance to define application profiles or specific security functions. At the WAN side, the application aggregator will use existing communications technologies such as fixed telephone line, GSM or UMTS.

The availability of many technology building blocks for telehealth solutions does not mean that this application field is free of challenges. Data security and reliability issues demand that engineers go back to their desks and labs in order to solve some existing problems. The same holds true for the sensor devices, in many cases



**"Keep it simple" is the golden rule interface design in telehealth applications. (Image: courtesy Freescale)**

they will have to work for long periods on very low power, and they must not degrade over time.

The security requirements result from the nature of the application. Since the systems transmit highly sensitive personal data, privacy and thus encryption is an important ingredient of telehealth systems. It is also crucial that the data is trustable and correct since the practitioner might take therapeutic action based on the collected data. Vendors of secure real-time operating systems such as QNX and Green Hills software see a chance to benefit from the requirements of security, reliability and connectivity associated to telehealth applications. "There is a link between safety and security", said Green Hills business development manager Chris Tubbs, adding that the company's Integrity and  $\mu$ -velOSity RTOSes with their separation kernel meet a number of relevant certifications including IEC 61508, SIL B and FDA Class 3. With a similar feature set, QNX sends its Neutrino RTOS into the race.

Again at the sensor level, the industry tries to lean on available technologies and solutions. "We see synergies for medical solutions with existing sensor product portfolios", an engineer at the STMicroelectronics booth explained. "MEMS, Gyros, accelerometer, pressure sensors - for all of them we see a demand in medical applications".

This does not mean that there is no new territory in telehealth. Fraunhofer Institute IPA (Stuttgart) is developing motion detection sensors and related sensor fusion algorithms. "In telehealth, and in general in medical monitoring applications, motion is a critical variable to determine the health status of a person", explained Fraunhofer researcher Urs Schneider. While the institute provided a glimpse into its research topics, no ready solutions were provided.

With all these sensor data available, the processing algorithms take centre stage for future applications. After all, the physician at the other end of the information chain is very often overloaded and does not have the time to constantly keep an eye on the monitor which displays the health status of his patients.

And, if someone has failed to move for a certain time, would this mean that he / she has fallen and needs help - or could this mean that the patient is simply taking a nap?

Intelligent processing schemes for this kind of application will be key to success, believes Freescale's Ross Mitchell. "Where can the line be drawn between the urgency to see the patient and to know that it is OK not to see the patient?" Mitchell asked. "This is a matter of data quality and smart algorithms". ■



# Designing an artificial retina for sight restoration

By Ra'anan Gefen

ACCORDING TO WORLD HEALTH ORGANIZATION data for 2010, 285 million people (65 percent of whom are over 50-years-old) suffer some degree of visual impairment, and 39 million people (82 percent over 50-years-old) are estimated to be blind. The three leading causes of visual impairment are cataracts, glaucoma and age-related macular degeneration (AMD).

Retinal degenerative diseases such as AMD, diabetic retinopathy and retinitis pigmentosa have no cure to date. These degenerative conditions cause a gradual loss of vision, and within ten years of their onset, high degrees of blindness ensue. For some of these conditions there are medications, but they entail risk and can only slow the progression of the diseases.

Headquartered in Herzliya, Israel, Nano Retina's sole mission is to develop a functional artificial retina. Maybe

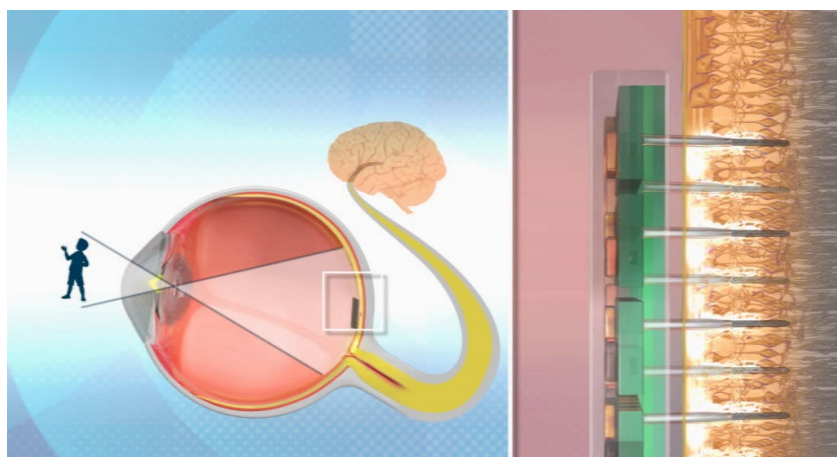


Figure 1: Nano Retina implant "glued" to the macula (left) and its interface electrodes.

one day, properly designed artificial retinas will be able to replace damaged human retinas. Resolution and visual acuity are key parameters for artificial vision, which can contribute to the independence of patients following implantation of an artificial retina.

Nano Retina's tiny artificial retina can be inserted into the eye and attached to the original retina in a minimally invasive procedure that is no more complicated than conventional cataract surgery. The implant, shown in figure 1, consists of a small imager, similar to that used in a digital camera, and an electronic interface including a network of electrodes designed to stimulate the optic nerve so that it sends the visual data – collected by the chip – to the brain.

The implant's power source is an infrared, wireless beam transmitted from specially designed eyeglasses that the patient will have to wear. Although the concept is simple, implementation poses a significant technical challenge.

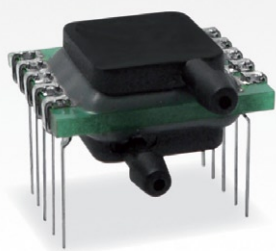
Scientific researchers have set the level of 600 (distinguished) gray scale pixels as the threshold for functional vision, i.e. vision sufficient for independent activities such as walking along a street or eating at a restaurant. Beneath the threshold of functional vision is ambulatory vision, which is achieved by the 60 pixel black&white Argus II Retinal Prosthesis System designed by Californian company Second Sight Medical Products. The company has just obtained the CE Mark, approving the Argus II for sale in the European Economic Area. Following implantation of this device, ambulatory vision was attained with a 50% success rate for basic daily challenges such as walking through a door and its next generation devices could feature up to 240 electrodes (that translate again to black&white pixels).

## Talking the neuron language

The human retinal network consists of millions of neurons which receive an analog image in the first layer of 100-150 million photorecep-

Ra'anan Gefen is the managing director of Nano Retina – [www.nanoretina.com](http://www.nanoretina.com) He can be reached at [gefen@nano-retina.com](mailto:gefen@nano-retina.com)

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- **space saving:** miniature PCB-mountable housings

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tors, convert it to the neuron digital language in the second bipolar layer, and connect to the third ganglia layer that transfers the information to the brain – see figure 2.

Along the way, processing takes place that reduces the data by a factor of 100 and emphasizes important features such as motion detection and edge enhancement. An artificial retina must be integrated into this natural process so that its stimuli will be efficiently converted to an image recognizable by the brain.

## Localizing the response

Within the retina there is a photoreceptor every 5 micro-meters, creating a very condensed visual network in the central area of the retina, i.e. the macula, where vision is sharpest. Due to stimulation technique requirements, the electrode surface area of an implant should consist of hundreds of square micrometers on a totally different scale.

Placing such electrodes over the retina (epi-retina) or under the retina (sub-retina) requires a lot of power for retinal stimulation. This standard approach stimulates hundreds of neurons at a time, sometimes affecting an area ten times larger than the electrode size itself, thus it greatly reduces achievable resolution.

New studies suggest that proximity to the neurons reduces necessary activation charges and thereby decreases the affected area. Nano Retina's innovative approach will use more than 600, 3D electrodes that penetrate the retina and achieve close proximity to the neurons, while providing a large electrode surface. This method can use small stimuli charges, retain localized response and provide good resolution perception.

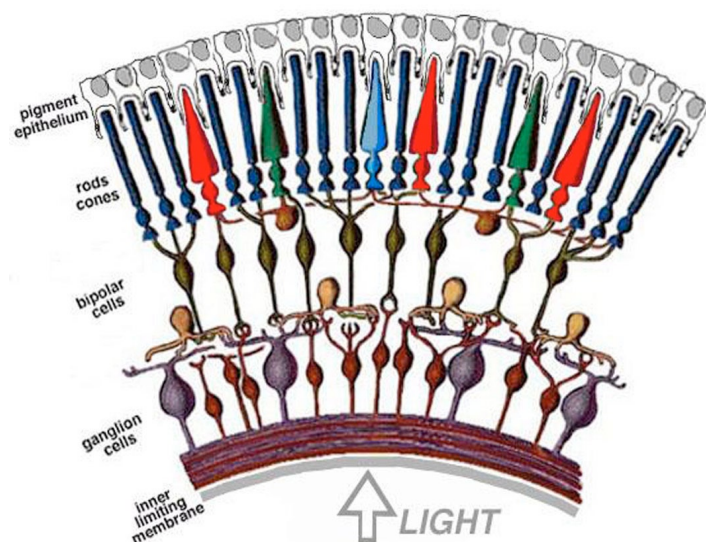


Figure 2: Natural neuron structure within the retina.

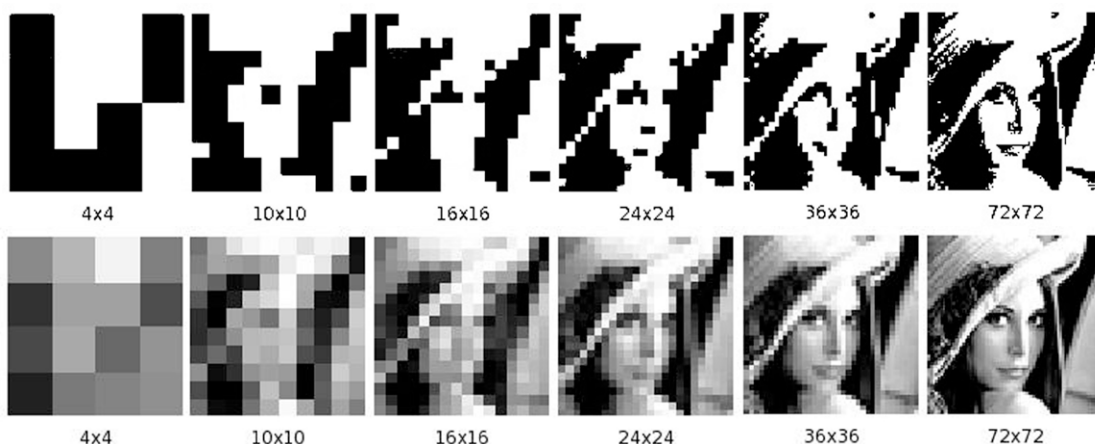


Figure 3: Gray scale resolution of a facial image compared with black and white resolution. The 600 (24X24) pixel threshold provides marginal acuity even on the gray scale.

## Gray scale

The gray scale provides a simple representation of the visual environment when color information is in short supply, but offers better clarity than black and white, as can be seen in figure 3. The real challenge is to convey this information so that it can be decoded by the brain.

So far, most devices avoid this challenge and seek black and white solutions (pixels are either On or Off). Some have tried to interpret this information on the stimulation level (amplitude), but this enlarged the stimulation area, reduced resolution and created difficulties in translating the intensity level.

Recent studies show that a new paradigm should be used to provide the basis for retinal implants: frequency modulation instead of intensity modulation. This makes sense, given that neuron language is dependent upon frequency, like any serial communication channel.

Accordingly, Nano Retina has translated 100-shade gray scale ladder into the frequency domain, so that intensity information can be combined with high resolution to create understandable images at the highest possible resolution.

Restoring sight to the blind is an ambitious mission being pursued by only a few companies around the world. Nevertheless, as artificial retina prostheses become a reality, we will be better able to compare the benefits of the various solutions under development. ■

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# Low EMI isolation for medical equipment applications

By Don Alfano

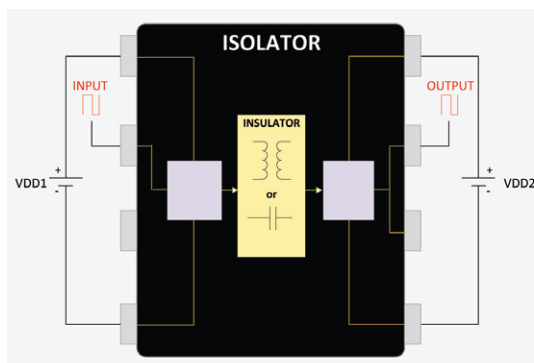
**ELECTROMAGNETIC INTERFERENCE** (EMI) is defined as any electromagnetic disturbance that interrupts, obstructs or otherwise degrades or limits the effective performance of electronic equipment. Unfortunately, EMI sources are plentiful and give rise to seemingly endless combination of disturbance characteristics. For this reason, the Industry categorizes different types of EMI by their characteristics.

Medical environments are electrically

levels. EMI is especially problematic in medical systems that acquire low-amplitude signals, such as electrocardiographs (ECGs), where signals collected from patients can range from 400µV to 5mVpk with 3dB corner frequencies at 0.05 and 100Hz. Looking forward, the trend towards higher-frequency, lower-power medical systems will complicate EMI management by emitting broader bandwidth RF noise at higher energy levels.

From a design point-of-view, EMI effects

can be minimized by designing system circuitry for high EMI immunity and low emission. Traditional practices include proper printed circuit board (PCB) layout and grounding and limited trace lengths. Electronic components must be optimally placed on a PCB, and the system enclosure design, cable shielding and filtering must be adequate. Obviously, the use of EMI-hardened semiconductor components (i.e. low-emission and high-immunity) should be used in critical signal paths. This is especially true for EMI issues that exist within the system itself, such as in mixed-signal or wireless data transmission applications.



**Figure 1: Block diagram of a typical silicon isolator**

noisy; RF interference (RFI) generated by communications devices and local equipment can produce RF fields of 50 V/m or more. In addition, certain types of medical equipment use RF energy for diagnosis or treatment (e.g. MRI systems) or wireless communication (e.g. medical telemetry systems). Given these numerous and potent sources, EMI management in medical environments can be challenging.

EMI can cause medical devices to malfunction with potentially catastrophic results. For example, errant signals induced by EMI can cause portable life support systems to malfunction, corrupt measurements in patient monitoring equipment and change patient intravenous medicine dosage

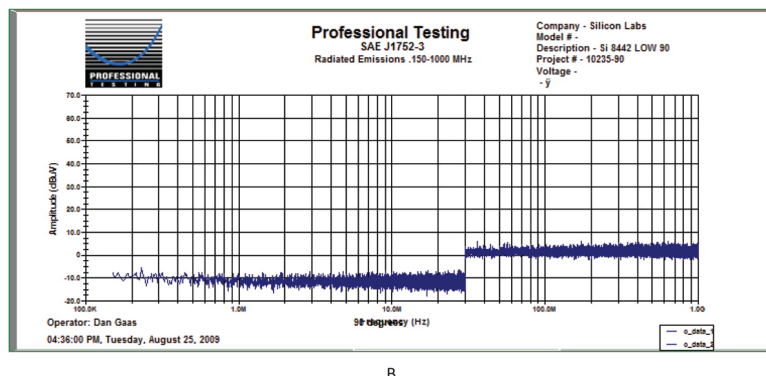
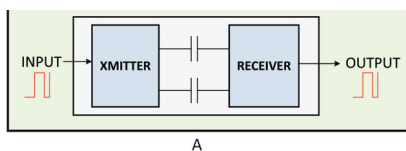
## Isolation in Medical Systems

To ensure that medical electronic systems are immune to disturbances from localized fields and other phenomena, isolators are safety tested to a number of IEC-61000 standards using test limits specified by IEC 60601-1-2.

For example, electrostatic discharge (ESD) is tested to IEC 61000-4-2 and uses the test limits specified by IEC 60101-1-2. RF emissions, and power line perturbations are tested using methods from CISPR11 test methodology, a subset of automotive specification J1750. (CISPR does not specify test limits - it is a test methodology standard only. Limits for emissions and power line sensitivities are specified in IEC 60601-1-2).

The criteria for passing these tests are





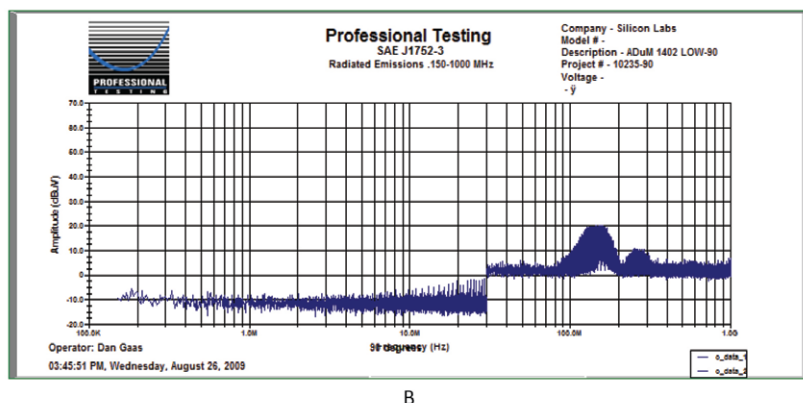
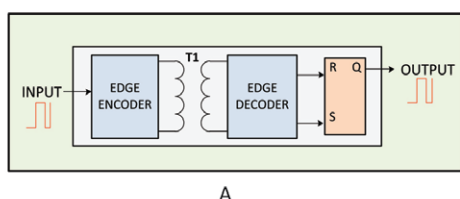
**Figure 2A: A transformer-based silicon isolator**

**Figure 2B: The measured radiated EMI of a transformer-based silicon isolator**

very stringent. The system cannot exhibit any component failures, parametric changes, configuration errors or false positives. In addition to external field immunity, the system under test cannot generate significant radiated or conducted emissions of its own.

Specifications published by various agencies place limits on conducted and radiated EMI. One of the more common specifications is FCC Part 15, which covers circuit assemblies used in or near the home. Testing to this specification is conducted in an open-air environment using a 10 meter antenna positioned approximately 5 meters above the ground plane. Another specification, SAE J1752-3, is more IC-centric in its test methodology and recommends mounting the IC to be tested on a small shielded circuit board (i.e. "TEM cell", per CISPR11 test methodology) designed to measure only the radiated emissions from the isolator itself while operating within the actual application environment.

Many medical systems incorporate galvanic isolation to protect patients and equipment from hazardous voltages, to level shift signals between ground voltage domains and/or to mitigate ground noise in highly sensitive circuit areas. Medical electronic systems often use transformers and/or optocouplers for signal isolation,



**Figure 3A: A capacitor-based silicon isolator**

**Figure 3B: The measured radiated EMI of a capacitor-based silicon isolator**

neither of which are optimal. Transformers generate EMI and are highly susceptible to signal corruption by external magnetic fields. Optocouplers offer the benefits of low EMI emission and high immunity but suffer from poor reliability and low common-mode transient immunity (CMTI), which can negatively impact isolator data transmission integrity.

As an alternative to transformers and optocouplers, silicon isolators leverage advanced process technologies to dramatically improve EMI characteristics and create significant gains in performance and reliability. These isolators fabricate insulating devices directly on the semiconductor die using process oxides or other native process materials as shown in Figure 1. The more successful silicon isolator suppliers implement the insulator (aka isolation barrier) using either transformers or capacitors.

The silicon isolator of Figure 2A operates by encoding the logic state of each incoming digital edge, transmitting this data through isolation transformer  $T_1$ , then decoding and storing the data in an output latch. Figure 2B shows the radiated EMI response from this device, as measured using the CISPR test methodology standards. The measurement shown was made with all isolator inputs low and 90 degree rotation. Note that the device generates EMI resonant peaks as high as +20dB between 100 and 300MHz. While the exact cause of these resonant peaks is unknown, it is assumed they are at least partially caused by  $T_1$ 's structural size, inductance and Q.

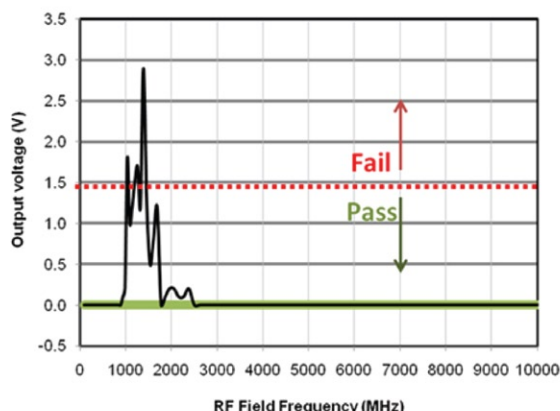
The silicon isolator in Figure 3A operates by transmitting a

carrier wave across the differential capacitive isolation barrier when the isolator input is logic-high. The receiver asserts logic-high on the output when sufficient carrier energy is detected. Unlike the transformer design, there is no Q-dependant resonant peak in the capacitive isolation path to selectively boost incoming EMI frequencies. Figure 3B shows the radiated EMI response from this device as measured using exactly the same methodology used in the transformer-based isolator test. This device exhibits a flat, lower amplitude radiated EMI response compared to the transformer implementation. As a result, this device passed FCC Class B Part 15 in a test using 6-channel differential capacitive isolators with all inputs tied high to maximize internal transmitter emissions.

## High Yield?

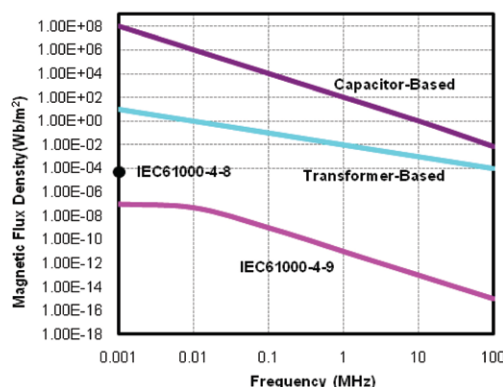
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## Yes.



**Figure 4: A comparison of the electric field immunity for a transformer- and capacitor-based silicon isolator**

Figure 4 shows an electric field immunity comparison between the transformer and capacitor-based silicon isolators where isolator output voltage is monitored while the external RF field frequency is swept from DC to 10GHz. Both the transformer and capacitive isolators have grounded inputs to hold their outputs low continuously. The capacitive silicon isolator output (green trace) remains low across the frequency range from DC to 10GHz, whereas the transformer-based isolator output is high (corrupted) between 1 and 2GHz. The capacitive isolator demonstrates high EMI immunity because local common-mode fields are rejected by a combination of the differential capacitive isolation path and high receiver selectivity. That is, signal levels on each side of the internal differential signal



**Figure 5: A comparison of the magnetic field immunity for a transformer- and capacitor-based silicon isolator.**

curve shown by the purple line at the bottom of the chart. Values at or above the purple line are acceptable, while values below the line are failures. The point placed midway up the Y-axis is the single-point equivalent specification (61000-4-8). Note that both silicon isolators meet the criteria for both specifications, but the capacitive isolator demonstrates a much higher degree of magnetic field immunity compared to the transformer-based isolator. As shown, silicon isolators can offer many performance advantages over optocouplers and transformers, and typically implement the isolation barrier using chip-scale transformers or capacitors. However, as transformer-based silicon isolators characteristically have lower EMI immunity and higher emissions compared to capacitor-based silicon isolators, for EMI-hardened applications such as medical electronics, capacitive silicon isolators are put forward as the best solution. ■

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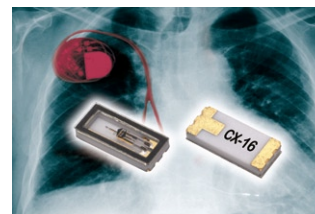
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The ceramic package with glass lid design prevents out-gassing and contamination which is crucial to achieving its excellent ageing characteristic



of better than  $\pm 3$ ppm max over the first year. The specific Co/Cr ratio, Q and ESR levels which the CX-16 crystal can meet ensures that it is suitable for medical applications where remote communication between devices such as pacemakers and defibrillators and consultants/medical support staff is required.

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of output voltages including 12 V, 13 V, 14-16 V, 18-19 V, 20-21 V, 24-25 V, 28-29 V, 30-32 V, 36-38 V, or 46-50 V. The TMP135 models come equipped with the IEC 320/C14 AC inlet for the Class I models and the IEC 320/C18 AC inlet for the Class II models. The fanless units come with a power-on LED indicator and a 4-pin circular DIN output connector. TRUMPower also offers many other connector options and can accommodate special requirements. The TMP135 units are protected against overvoltage and overcurrent conditions.

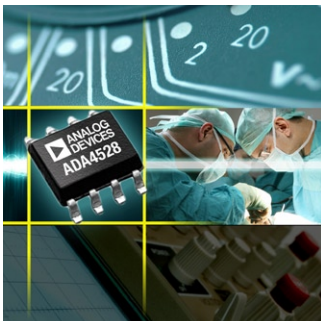
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over 150 kHz in A/D converters while improving system accuracy. The 5.3-nV/rtHz voltage noise density allows designers for the first time to use the zero-drift amplifier in broadband applications, such as piezoelectric transducers and precision data acquisition systems. The ADA4528 zero-drift amplifier offers low offset

voltage of 2.5  $\mu$ V max and the industry's lowest guaranteed offset-voltage drift of 0.015  $\mu$ V/C maximum. The device has a 140 dB gain and a common-mode rejection ratio of 135 dB and a 130 dB power-supply rejection ratio.

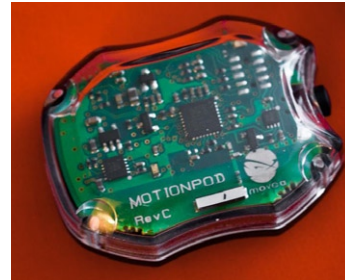
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## 9-axis inertial measurement unit

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RM Ingénierie is using Movea's miniaturized MotionPod, Inertial Measurement Unit (IMU) to enable a new generation of joint assessment and rehabilitation applications. The MotionPod is a patented hardware solution for motion sensing that incorporates



a 3-axis accelerometer, a 3-axis gyroscope and a 3-axis magnetometer in fully integrated package complete with software and wireless interface. The device is a wireless inertial measurement unit that uses MEMS sensors to accurately measure 9 degree-of-freedom motion with a PCB module that is about the size of a small wristwatch.

The miniaturized MotionPod is now an off-the-shelf component, ready to be used in a wide range of applications including fitness, gaming, and sports.

RM Ingénierie, which specializes in medical and paramedical management software, uses Movea MotionPods in their Physical Rehabilitation solution. The MotionPods capture limb movement and provide precise information on limb orientation and mobility. MotionPods provide a fast and accurate record of a patient's progress to be used for biofeedback into evaluation and exercises, making limb rehabilitation interesting and fun by engaging the patient. A single MotionPod can provide information like range of motion, rotation, speed, and acceleration. Multiple MotionPods can also be networked to gather information simultaneously from different parts of the body for applications such as performance analysis and full body motion capture. The MotionPod measures 33x22x15 mm and weighs 14g. It is designed to clip onto a strap

for easy attachment to the body or even to be patched directly onto the body. Each MotionPod has a built-in, 2.4 GHz wireless

transmitter that uses Movea's proprietary wireless technology to deliver a range of up to 30m with low power consumption to support up to

eight hours of use. Data from the MotionPod is transmitted wirelessly to a receiver that's connected to a computer via a standard USB connection. Up to 32 MotionPods can be connected to a single MotionController.

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# The end of sensor-based BLDC control?

By Thomas Freitag

**VEHICLE MANUFACTURERS** are increasingly appreciating the benefits of brushless DC (BLDC) motor control as a response to the challenges of making their fleet meet legal fuel economy regulations. Brushless DC motor control typically increases efficiency 20% to 30% compared to equivalent speed controlled DC solutions. Furthermore they may offer a weight and size reduction of up to 50% especially in high temperature environments like in the power train. Electric and hybrid vehicles generate less noise especially at lower speeds, making low noise BLDC motors the preferred solutions for pumps and fans that have been taken off the belt.

Brushless motor control requires the accurate knowledge of the commutation points to achieve the praised (lauded) efficiency. A first method requires the application of Hall Effect based sensors in order to detect the rotor position. Next to the cost of the sensors, their implementation renders the motor and pump design larger and more complex. For fuel pumps the implementation of commutation sensors incurs prohibitive sealing costs from the aggressive fuel environment and is therefore not considered. A second sensor less method detects the commutation points via the stator coils. This technology does not suffer the above limitations and has been in

production for some years in high end car models mainly for fuel and water pumps, engine cooling fans and HVAC blowers.


In the first generation sensor less solutions the commutation points were captured using BEMF sensing on a free running coil. For noise sensitive applications like HVAC blowers, sine wave BLDC motor control, also referred to as Permanent Magnet Synchronous Motor (PMSM) control, is applied. For PMSM control there is no free running coil, but instead Field Orient Control (FOC), also called Vector control was applied using multiple shunt inputs in combination with DSPs, making component, development and validation cost such that sine wave motor control was only viable for high end models. Additionally FOC control had to be complemented by sensor-based operation for reliable start up and operation at low speeds.

Based on their experience with the first generation of such solutions, automotive electronic suppliers have developed a range of application specific standard product (ASSP) solutions and control algorithms to expand sensor less BLDC technology into a wider range of applications, reducing development complexity and component cost. An example of a basic BLDC application is a speed controlled fuel pump that should replace a legacy DC solution. In so called Mechanical Returnless Fuel delivery Systems (MRFS) the fuel pressure is mechanically regulated so that the motors don't see significant load changes, and the speed regulation is only to optimize for fuel economy and extend service life, not to respond in real time to a change in demand. Standard zero crossing BEMF detection in 6-step, or so called block mode is enough.

The only challenge here is to start up in a reliable and fast way. Current solutions often still rely on rotor pre-positioning during start up. During rotor positioning the BLDC motor is forced twice in stepper mode to a predefined motor state, in order to ensure that the motor will start in the correct direction. Starting up is done in an open loop mode by applying the maximum allowed current to accelerate the motor as fast as possible to a speed where BEMF can be captured. When no BEMF signal is available, today's state of the art is to sense the rotor state by measuring its influence on the stator coil inductance values, so called reluctance sensing. The MLX81200 Melexis BLDC motor controller is able to perform reluctance sensing as part of its TruSense sensor less technology. For low inertia applications like fuel pumps the MLX81200 has demonstrated the benefits of reluctance sensing by reducing start up times from approximately 200ms to 50ms. By applying reluctance sensing at start up and dur-



**Fig. 1: Integrated electronics inside an electrical water pump**




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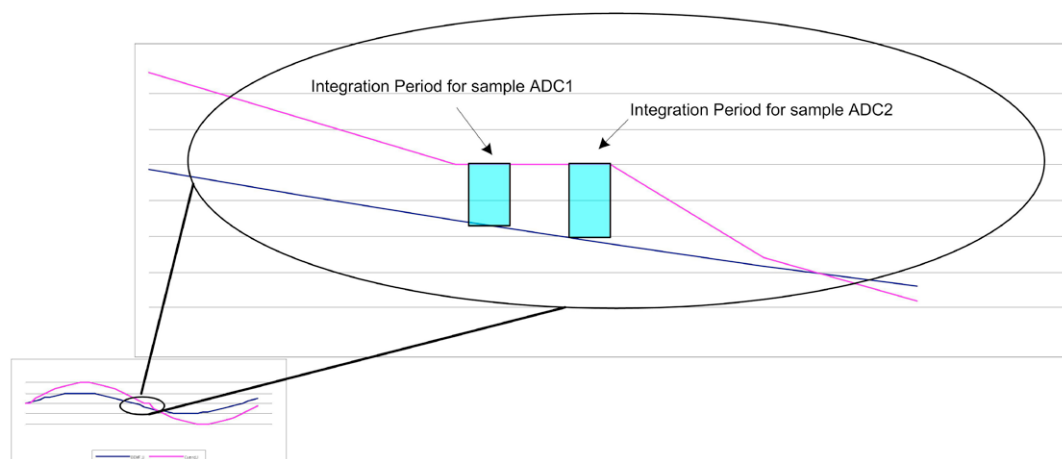
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**Fig. 3: Phase integration guarantees tracking of the zero-crossing under severe load conditions with a narrow measurement window, enabling robust and high performing On-Demand operation. Blue line: BEMF Voltage / Pink line: Phase Current**

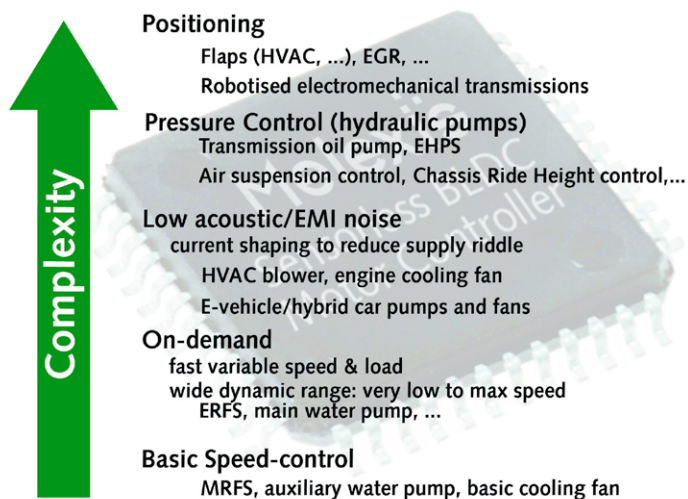
ing acceleration the startup time tolerances are also significantly reduced, making the application very robust.

## On demand: fast speed and load changes

In mechanical returnless fuel delivery systems, some headroom in flow rate has to be maintained. So called Electronic Returnless Fuel delivery Systems (ERFS) do not imply a spill valve, and therefore offer a better fuel efficiency. The engine control unit (ECU) dictates the required flow rate to the fuel pump electronics based on feedback from a fuel line pressure sensor. In return the fuel pumps in ERFS have to be designed with minimum inertia to vary flow rates with very fast response times. In a similar way water pumps have to operate under sudden load changes due to air bubbles, ice, etc.

When applying such fast acceleration/deceleration, or due to

## TruSense sensorless BLDC applications



**Fig. 2: Sensor less BLDC application classification**

sudden pressure changes the BEMF zero crossing may fall outside of measurable window. The MLX81200 measures the phase voltages, and extrapolates the position of the zero crossing from the voltage measurements. This ensures robust detection of the zero crossing, even when it falls outside of the measurement window - see figure 3.

## On demand: wide dynamic range

On demand water pumps have proven to have one of the largest impacts on fuel economy by reducing as much as 7g CO<sub>2</sub>/100km. Water pumps are required to operate at very low speeds to distribute

the little available heat in an even way during engine cold start. On the other hand this same water pump has to be able to deliver maximum flow rates under maximum towing conditions. In traditional engines with belt driven water pump, the water conduits had to be oversized to limit the water pressure at high motor speeds. Therefore an engine designed to operate with an on demand water pump can be made more compact and lighter.

To ensure robust operation at very low operating speeds the MLX81200 integrates the BEMF voltage using phase integrators. At low speeds, voltage integration results in a net amplification of the BEMF signal, whilst filtering any switching noise. Typically the application of phase integrators allows the reduction of the minimum possible operating motor speed using classical control schemes by a factor of 2 to 4.

Alternatively at maximum speeds the zero crossing may be masked by the flyback pulse. Comparator-based technologies can only make best guess assumptions as to the exact position of the zero crossing, limiting the maximum torque, and leading to increased torque ripple. Phase voltage measurements allow to accurately extrapolate the zero crossing. In exceptional conditions, for instance for a water pump operating under maximum towing load, efficiency is less of a concern. Then phase integrators allow to further boost the motor speed by increasing the lead angle at the expense of motor efficiency, disregarding any fly backpulse masking effect.

As the TruSense sensorless technology is not depending on the width of the BEMF measurement window to ensure robust zero crossing detection the maximum motor speed can also be increased by applying overlapping motor states. The overlaps can be realized as slopes, in so called trapezoidal control to reduce torque ripple, acoustic noise and conducted emissions. The TruSense technology can also be applied in full sine wave, or PMSM motor control if noise is the critical design parameter – see figure 3. As more and more electrical motors are applied to optimize fuel efficiency they also increase the electrical load

## Highest Reliability?

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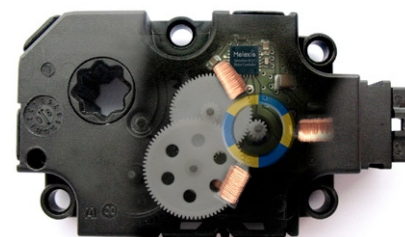
# Yes.

on the battery. To minimize this electrical load any possibility to reduce the minimum operating speed is highly appreciated. The ratio between minimum and maximum speed (RPMmin/RPMmax) is referred to as the dynamic range. On a fuel pump application the TruSense features of the MLX81200 reduced the dynamic range to approx. 5% (400rpm/8000rpm) compared to approx 22% of a standard DSP based solution (1800rpm vs 8000rpm).

## Pressure control

Hydraulic systems leverage the control capabilities of Brushless DC motors one step further by rendering an expensive pressure sensor obsolete. From motor speed and torque output information corrected for temperature effects and combined with specific pump information it is possible to control the hydraulic pressure.

A key challenge to implement hydraulic pumps in a sensor less way is to ensure



**Fig. 4: Sensor less BLDC HVAC flap with LIN communication interface**

reliable and fast startup under a wide range of loads. For instance a 500W transmission pump should start up to 12 Bar in less than 50ms, and this at -40°C with a highly viscous fat load, as well as at maximum engine temperature with liquid oil.

The MLX81200 have shown that its TruSense sensor less technology is able to meet these requirements in a very robust and reliable way.

## Positioning applications

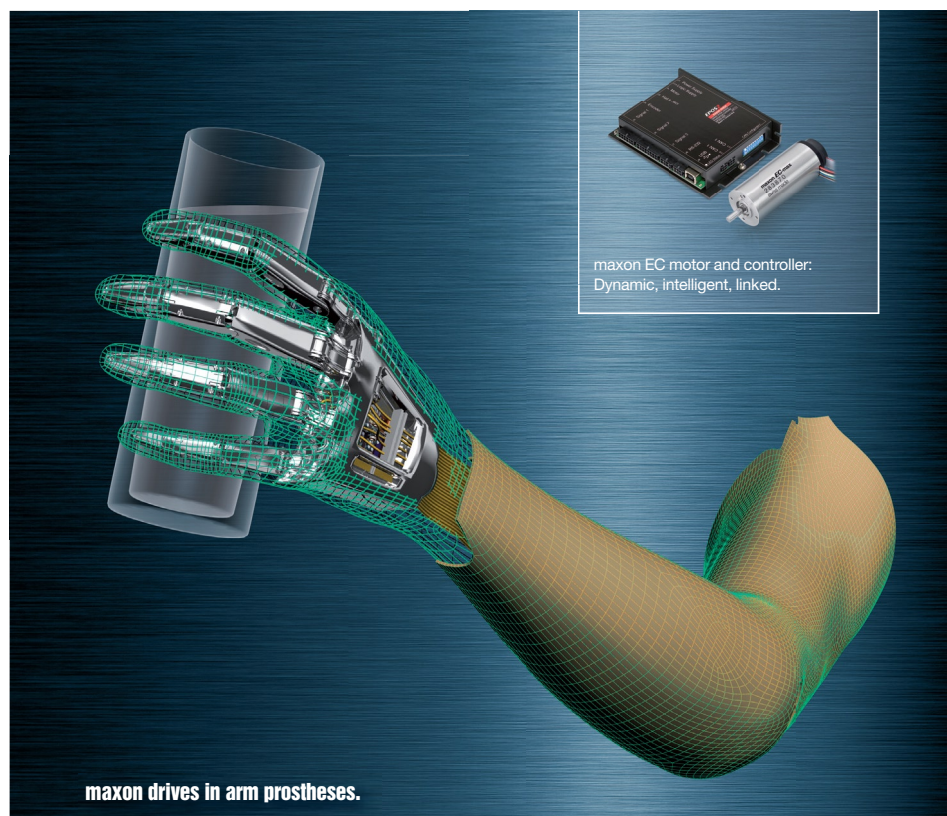
Combining reluctance sensing at low speeds with BEMF sensing at higher speeds, today's state of the art sensor less BLDC motor controllers like the MLX81200 are able to track in a robust way the rotor position over the complete speed range and independent from the applied load. Not only for pumps and fans, but also for positioning application sensor less technology might find its applications.

The core idea here is to use the sensor less rotor position detection algorithms and to calculate and regulate to a given position of the actuator as this is required for a flap and valve control or for car seat positioning. As example HVAC flaps can be given.

Feeding back the sensor information of the remote BLDC motors into the ECU requires up to 12 wires in the wiring harness, and an equal amount of connector pins on the ECU printed circuit board, each connector pin and sensor being a potential cause for reliability problems.

Removing the commutation hall sensors and reducing the connector size not only reduces costs, but also reduces actuator size. By replacing the sens-based pre-driver by an MLX81200 the application is optimized in cost, reliability and removes the motor control tasks from the ECU.

Additionally the MLX81200 is able to increase the maximum speed and reduce EMC by applying more intelligent motor control, like overlap, current shaping as discussed above. ■



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# Precise magnetic position sensors for more efficient control of BLDC motors

By Shawn Rezaei

**BLDC MOTORS CONSIST** of a rotating permanent magnet (rotor) and minimum of three equally spaced fixed windings (stator) as shown on figure 1. By controlling the currents in the stator, a magnetic field of arbitrary direction and magnitude can be produced.

Many implementations of brushless DC (BLDC) motor control use the 'trapezoidal commutation' technique to control the current applied to the fixed stators. Trapezoidal commutation operates by switching the stator coils on and off in sequence, generating a rotating magnetic field that acts on the rotor, and thus producing torque. As figure 2 shows, this is a simple technique to implement, and requires the processing of a small number of position data inputs (as few as six steps per revolution for a two-pole rotor) in order to control the current delivered to each stator winding. Position data in such systems are normally derived from three Hall switches or, in sensorless systems, by back-EMF sensing.

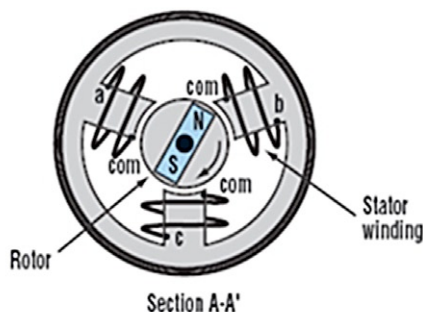


Fig. 1: The basic construction of a BLDC motor.

For efficiency and maximum torque, a stator field should be applied that is orthogonal to the rotor field.

A technique, such as trapezoidal commutation, that switches the stators using crude position data is not precise enough to achieve this. As a result, trapezoidal schemes are plagued by undesirable torque ripple: this causes vibration, acoustic noise, heat and speed fluctuation in BLDC motors. In demanding machine tool applications, torque ripple can even lead to speed oscillation, and to vibration that leaves visible patterns in high-precision machined surfaces.

Implementing enhanced motion control schemes requires precise position data. To eliminate torque ripple and provide a smoother output, advanced BLDC motor control designs have implemented sinusoidal commutation: here, position feedback is provided in the form of phase-shifted sine waves, which determine the delivery of

Torque in a BLDC motor is produced by the attraction and repulsion between the rotor and stator field. A stator field (d) in the same direction as the rotor field produces no torque. A stator field (q) orthogonal to the rotor field produces maximum torque.

Therefore, for best ef-

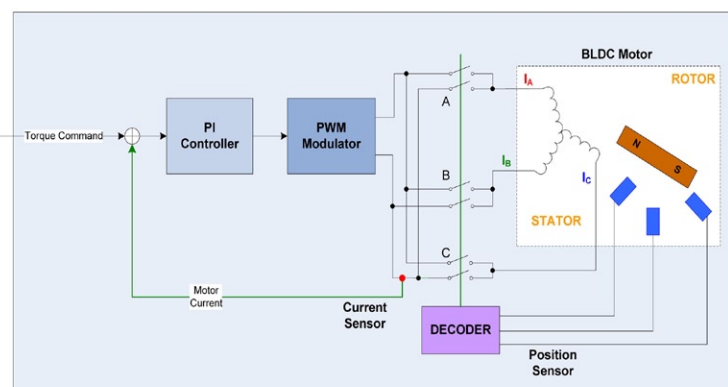


Fig. 2: Trapezoidal commutation is a simple control scheme for BLDC motors.

pulse-width modulated currents to the stator coils - see figure 3. The aim of sinusoidal schemes is to produce maximum torque at any angle and speed, adjust speed and torque independently from each other and minimise the generation of heat and audible noise.

While basic sinusoidal control is very effective at low speeds, however, performance deteriorates at higher speeds due to the increased frequency of the position feedback signal resulting in negative torque.

An enhanced sinusoidal control scheme called Field-Oriented Control (FOC) commutation, however, solves the problem of controlling the motor efficiently at high rotation speeds. An FOC scheme achieves this by controlling the rotation of the stator current space vector in the (static) d-q reference frame of the rotor. Instead of controlling an AC signal (as in the trapezoidal commutation scheme shown on figure 2), the PI controllers only need to control a DC signal, independent of rotation speed - see figure 4. This isolates the controllers from the time-variant winding currents and voltages, and therefore eliminates the limitation of controller frequency response and phase shift on motor torque and

Green?

die attach

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speed. Using FOC, the quality of current control is largely unaffected by the speed of rotation of the motor.

In FOC schemes, the motor current and voltages are manipulated in the d-q reference frame of the rotor. This means that the measured motor currents must be mathematically transformed from the three-phase static reference frame of the stator windings to the two-axis rotating d-q reference frame, prior to processing by the PI controllers. Similarly, the voltages to be applied to the motor are mathematically transformed from the d-q frame of the rotor to the three-phase reference frame of the stator before they can be used for PWM output. These transformations typically require the fast mathematical capability of a DSP or high-performance processor.

### Requirements for position sensing to support FOC

In order to run the motor smoothly at its maximum efficiency, the exact position of the rotor must be known at any given time. FOC therefore requires a high-resolution position feedback device. Providing absolute as well as incremental position data enables optimal performance from a stationary position.

To appreciate the requirement for high resolution, it is helpful to compare an FOC application with a trapezoidal commutation appli-

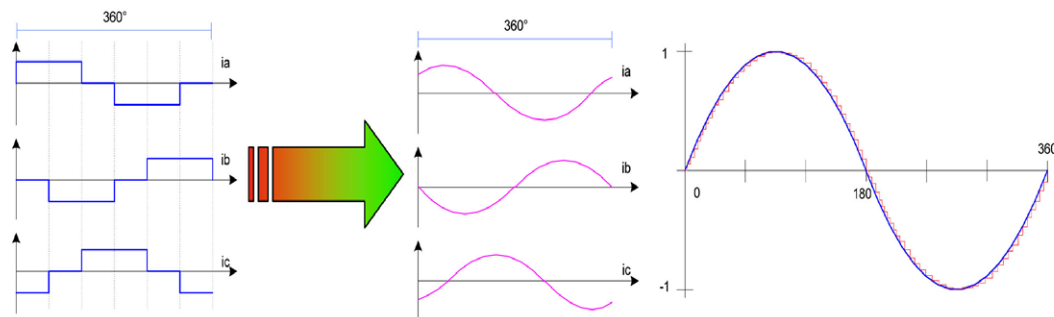


Fig. 3: Sinusoidal commutation schemes produce a smoother output.

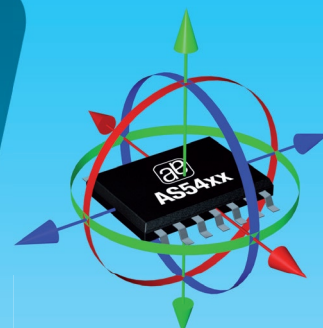
cation. The most common implementation of BLDC motor control today uses three Hall switches for position sensing. This provides for resolution of six steps/revolution for a two-pole rotor, 12 steps/rev for a four-pole rotor and 18 steps/rev for a six-pole rotor. An FOC scheme demands much more precise position feedback than this.

A variety of position-sensing technologies is available that provides the required level of resolution. But the implementation of magnetic encoders is emerging as the best suited to the particular conditions of a BLDC application. Optical encoders, which use an LED shining on or through a rotating disc, provide high-resolution measurements, but are impractical in smaller motors. This is because they are large devices, a drawback exacerbated by the need for complete encapsulation to protect them from dust, grease and other contaminants which would otherwise impair their sensing performance.

In addition, optical encoders usually offer only an incremental

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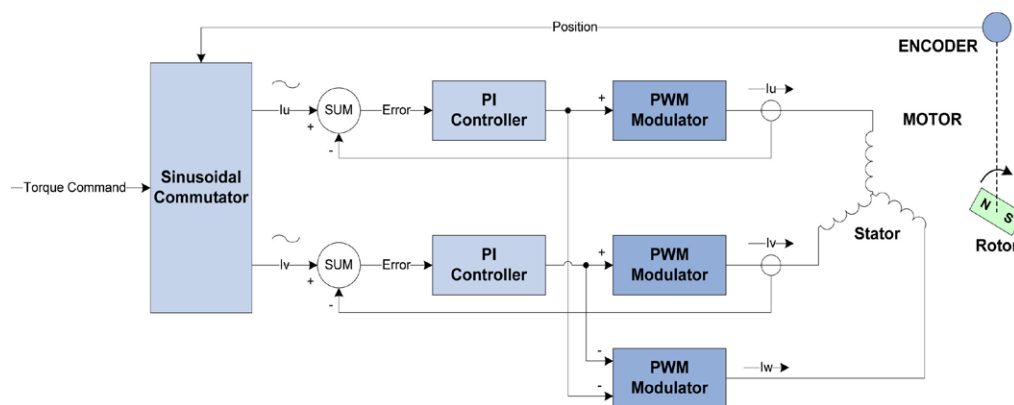
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**Fig. 4: Using a reference frame translator isolates PI controllers from time variances in current and voltage.**

output, which means that they have no absolute position information at start-up. This means they need up to one full turn before they know the absolute position of the rotor. Absolute optical encoders are available, but are more expensive.

Resolvers use an inductive magnetic sensing technique to produce high-resolution outputs, but these devices are bulky and expensive, and their mounting (flanged directly on to the rotor shaft) is inflexible from a design point of view and expensive from a production point of view. By comparison with both of these technologies, a magnetic encoder is far better suited to BLDC motor control. The benefits of a magnetic encoder derive from its basic operating principle, and from the high level of integration in the CMOS imple-

All of this functionality is contained in a small monolithic IC. The AS5134's package measures 5.3x7.2mm and when mounted on the rotor shaft, the magnetic encoder is small enough to be used even in space-constrained BLDC motors. This assembly can be used in any size or configuration of BLDC motor.

Due to the magnetic principle of operation, it is immune to dust and other contaminants as well as to stray magnetic fields, and is not subject to mechanical wear and tear. The emergence of a new breed of magnetic encoders from suppliers such as austriamicrosystems offers motor control system designers the opportunity to deploy FOC control in more systems. ■

mentation of this principle. Magnetic encoders of the type manufactured by austriamicrosystems contain an array of Hall sensors. The sensors, configured in pairs, produce a differential output that is amplified and digitised before being processed by an on-board DSP. The outputs of the DSP include a serial bit stream and a PWM signal. It can operate at speeds up to 30,000rpm, and provides high resolution of from 360 steps/revolution (in the case of the AS5134) up to 4,196 steps/revolution (AS5145).

## Increasing motor efficiency with power factor control

By Mark Steinmetz

"GLOBAL WARMING, CARBON FOOTPRINT, and energy efficiency are becoming mantras for the industrial manufacturing sector. With energy costs constantly rising leading to increased overhead costs, the need to use electrical energy in a more efficient manner by reducing the amount is at the fundamental basis of this crisis.

Over 40 million electric motors are used in manufacturing operations in the United States alone and electric motors account for 65 to 70% of industrial electrical energy consumption and approximately 57 percent of all electrical consumption worldwide. Governments around the world are mandating regulatory pressure to increase motor efficiency. Though, many motor applications use an oversize motor for their required mechanical load while other applications employ a motor's full speed operation and control the output by mechanical means. These types of implementation for motor applications waste precious energy, since they

are ran at full speed. Currently, the average motor in use today has an efficiency of 88% in converting electrical into mechanical energy. Even an efficient compliant motor can reduce energy by no more than 10%, even under optimum operating conditions (i.e. full line voltage). Industrial motor users are finding that further energy savings can be realized by using electronic speed controls (i.e. inverter based), which can reduce energy by 30%, and mechanical energy by 60%.

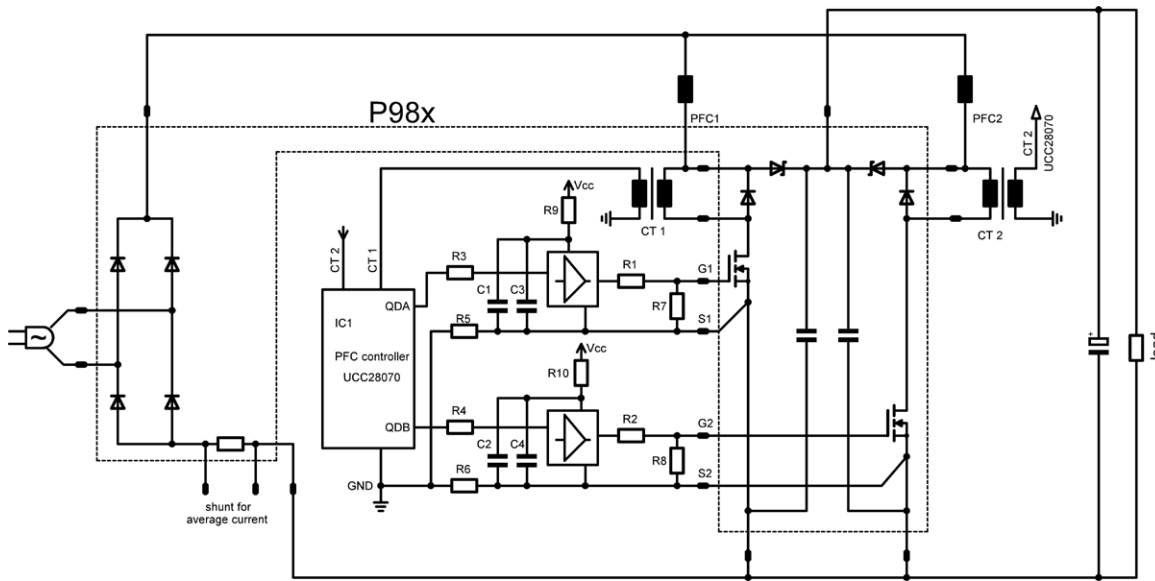
Numerous motors operate at light loads and according to a Department of Energy study, 44% of motors in industrial facilities operate at 40% or less of full load and are thus, operating inefficiently. A drive's contribution to energy savings lies in its ability to allow you to manage motor operations to reduce output power by controlling its speed. Managing motor speeds, ramps, and available torque translates directly into managing power consumption.

Sinter?

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Mark Steinmetz is field applications engineer at Vincotech GmbH - [www.vincotech.com](http://www.vincotech.com)



**Fig. 1: The TI interleave controller IC along the Vincotech flow 0 power module (i.e. P98x) shown within the dotted line. The flow 0 module comprises of a bridge rectifier, a current sense resistor, two high speed MOSFETs or IGBTs depending on the version, two silicon carbide or ultra fast boost diodes and two high frequency noise capacitors.**

## The power factor

Electronic designers are now looking to maximize the energy efficiency of a motor drive application using Power Factor Control (PFC).

Using an electronic drive to regulate the output speed of the motor for the mechanical load required, with the addition of Power Factor Control improves efficiency of the drive by correcting the out of phase voltage and the current being used. The power factor is defined by the relationship between the instantaneous voltage and current waveform being applied. When the  $PF=1$  (maximum), both the voltage and current are completely in phase with one another. This happens when the load is purely resistive.

If the current and voltage are out of phase, the power factor is less than one. This happens when the load looks inductive (the case of electric motors) which causes an out of phase condition. Thus the power being applied is not used optimally and energy is being wasted. Since the voltage at the motor input is fixed, the current increases to compensate for this phase shift to supply the necessary mechanical power required. Not only does this situation cost more money to operate, it impacts infrastructure cost having to use larger conductors to power motors and larger circuit breakers. Finally, more heat is generated by the motor yielding a shorter operating life for it. Thus implementing a power factor design in a drive will yield less energy usage, lower implementation cost (size, mechanical, wiring, safety), flexibility (speed), and longer motor life.

## Types of power factor control

A classic single boost topology is often used for the power factor control circuits present in many drive applications. Recently, Interleave Power Factor (IPF) has gained much interest in the drive community. Each of these types of PFC topologies has distinct benefits. Let's take a closer look at what each has to offer the designer.

## Inductors

The single boost PFC requires a single boost inductor and power switch. However, in high power motor applications (i.e. 3HP or greater), the boost inductor becomes quite large. In addition, this larger coil

has increased losses, it is bulky and costly due to the large amount of copper being used.

In comparison, the interleave PFC features two parallel boost stages working  $180^\circ$  out-of-phase with each other. It requires two small current sense transformers for feedback control, because the two boost circuits work  $180^\circ$  out-of-phase. This unique technique reduces both the input and output ripple current, which also reduces the total inductor boost volume and the size of the EMI filter. Thus this topology yields overall lower systems costs.

## Link capacitors

Depending on the allowable motor ripple current, the single boost inductor will require a large amount of electrolytic capacitors to smooth the output from the PFC. Again, the interleave PFC roughly requires 50% less high-frequency output capacitor current than a single-stage topology. This reduction in current can translate into a 25% reduction in boost capacitor volume.

## Complexity

Single boost PFC circuits are supported by a wide variety of controllers and as a mature technology, advanced designs from various IC suppliers already integrate the functionality into a controller, making this type of circuits easy to implement.

Previously, designing an interleave PFC circuit was rather complex and required a lot of analogue circuitry. However, Texas Instruments has made designing this topology much simpler using their UCC28070 controller. Although more support discrete components are required over the single boost type of PFC, the two out of phase boost circuits are identical which simplifies the design.

## Efficiency

Both the single boost and interleave will increase the drive's efficiency over the full 10% input voltage range.

The TI UCC28070 interleave controller has additional provisions to improve light load conditions by turning off a phase under these conditions. The size reduction of the boost inductors, along with the lower electrolytic capacitor requirements give the interleave PFC topology a clear advantage over single boost PFC, both for density and overall drive size.





## Power module solutions

Based upon these two power switch technologies, Vincotech has designed a large portfolio of power modules from which to choose, based upon using silicon carbide boost diodes for performance, or stealth types for lower cost considerations. The right power switch





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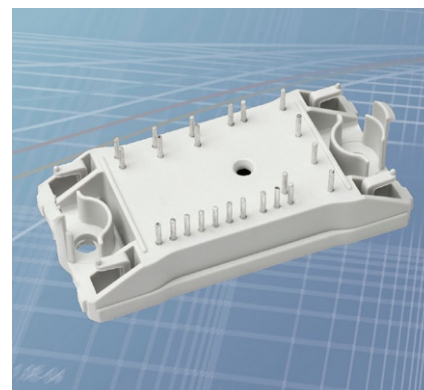
and diode combination will depend on the designer's requirement of switching frequencies, losses, and cost.

## Module versus discrete solution

With drives becoming a commodity product, especially in the lower horsepower ranges, cost is the driving factor. Many designers have used low cost discrete packaged power switches and have ignored the benefits of a module solution.

From a design standpoint, Vincotech's modules are designed to have very low inductance and extremely tight current loops. This keeps the effects of electrical noise to a minimum.

This means that fewer components are required to filter out noise, cutting implementation costs. Fully assembled and conformity-tested modules offer higher reliability from a component's standpoint than multiple point to point connections found in discrete



**Fig. 2: The Vincotech flow 0 power module.**

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solutions. Using Vincotech's flowSIM simulator, a designer can determine the exact losses, die temperature, and other electrical characteristics for a given drive application. Each component that Vincotech qualifies has numerous actual measurements taken under a wide range of electrical test conditions.

This results in a very accurate model for each component used in the database's simulator, hence the power modules' electrical parameters are true to real world results. This further saves design time and guess work. Finally, assembly becomes much easier since a single component (versus many discretes) is used on the PCB.

## Single boost type

The V2390-P802 provides designers with a diode bridge (D30) or 1/2 controlled inrush SCR (D40) front end plus a 500V CoolMOS power switch. For the interleave type, where small size and low losses are the driving factor, a PFC module using advanced CoolMOS CP plus a SiC boost diode will be the best solution.

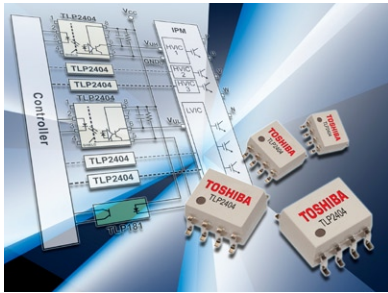
If you need to keep the magnetics and capacitance small by using a high switching frequency, the FZ062TA99FH-P980D18 will give you the ability to switch up to 200 KHz. In applications where size or volume is not a major consideration but cost is, the FZ062TA030FB-P983D18 using IGBT plus Stealth diode technology comes as a good compromise. As for the single boost type, either a full diode bridge or a 1/2 control SCR can be specified.

For a more integrated approach such as incorporating a six pack inverter with a PFC solution, a broad range of modules is available from Vincotech. Offered in a low cost but ruggedize flowo package, the PIM [PIM (C +PFC) i.e. P37x series] will meet both performance and cost considerations for single boost PFC applications on motor sizes 2HP to 3HP range. ■



## Extended temperature photocoupler for industrial motor control

Toshiba Electronics Europe (TEE) has unveiled an ultra-compact, extended temperature photocoupler that provides a space-saving solution for industrial applications that require an isolation interface between intelligent power modules (IPMs) and IC control circuitry. Ideally suited to industrial motor control and general-purpose inverter applications, the new TLP2404 provides a minimum isolation voltage of 3750 Vrms. Operation is guaranteed across the extended industrial temperature range of -40 to 125 degrees C. Toshiba's TLP2404 features an inverter



logic, open collector output and offers transmission rates up to 1 Mbps. Maximum transmission delay time is only 550 ns and maximum switching time dispersion is just 400 ns. The new photocoupler is based around a GaAlAs LED that is optically coupled to an integrated, high-gain, high-speed photodetector. A wide input capability supports input voltages from 4.5 V to 30 V and an internal Faraday shield ensures a guaranteed, minimum common mode transient immunity of  $\pm 15$  kV/ $\mu$ s.

**Toshiba Electronics Europe**

[www.toshiba-components.com](http://www.toshiba-components.com)

## 24h motor prototyping

from Haydon Kerk Motion Solutions' website

A premier manufacturer of engineered linear motion products, Haydon Kerk Motion Solutions launched a new website with enhanced look and navigation, including new tabbed navigation, access to 24 hour prototype ordering, configurable 2D drawings, and 3D CAD model downloads. The "buy online" feature allows the customer access to a wide range of standard off-the-shelf products for 24 hour shipping. This is perfect for a designer or engineer wanting to quickly prototype a concept while deciding what customizations will be necessary for the final component or subassembly design. Another tool for the engineer

is the 2D/3D Model Downloads feature. The Haydon Kerk 2D/3D download allows a designer to configure a part using multiple parameters including stroke



length, screw lead, motor step angle, operating voltage, and other technical specifications. Once configured, the file can be downloaded in various 3D file formats or a 2D dimensioned outline drawing.

**Haydon Kerk Motion Solutions**

[www.haydonkerk.com](http://www.haydonkerk.com)

## Text and graphics controller board for Fujitsu printer mechanisms

GeBE Elektronik und Feinwerktechnik GmbH launched the GCT-6692, a text and graphics controller board developed for printer mechanisms with a cutter for the series FTP-627/637 from Fujitsu. The compact and low-cost GeBE controller works with both the extremely small 12V as well as the 24V printer mechanisms of this series, helping them show off their print speed of up to 150 mm/s. The customizable controller board allows firmware to be altered by the OEM customer

himself. The board can be upgraded easily and supports a very large range of applications.



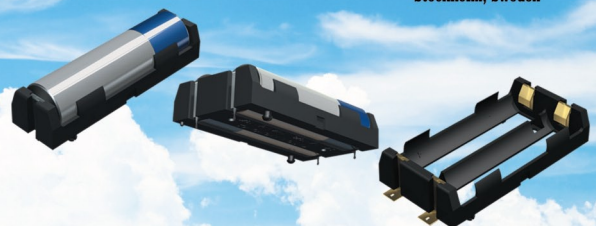
It can be connected to RS232 or USB interfaces.

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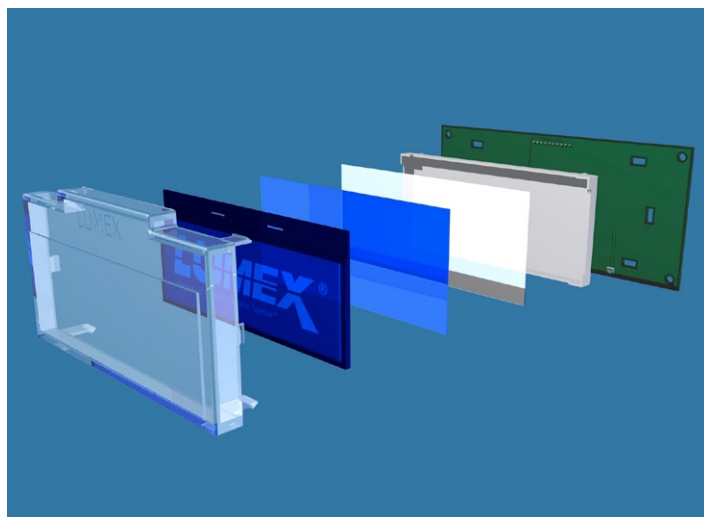
# Cutting costs with custom LCD and LED technology

By Jeff Oliveros

**ONE OF THE MOST** significant developments in the global optoelectronics and display markets over the past few years has been a complete revolution in the value proposition offered by custom technologies. Recent technological advancements have radically redefined industry notions about the inherent benefits and drawbacks of custom versus standard technologies. Understanding how custom technology has evolved, the unique benefits it provides end users, and the process through which quality providers create custom solutions can help brands speed time to market, identify cost savings, improve product performance and enhance brand differentiation.

## Updating outdated assumptions about LCD and LED technologies

For much of the past 20 years, custom LCD and LED technologies were commonly associated with enhanced application-specific performance but also with higher costs, long lead times and reduced reliability. Over the past five years- technological advancements have



completely redefined how custom technology performs on each of these fronts. As custom tooling has been simplified and quality suppliers have developed expertise in the specific challenges of custom technology development, processes have been streamlined resulting in shorter lead times. Whereas previously a custom technology could have a lead time of three to four months, today custom technologies can have lead times as short as two to four weeks for LEDs and four to six weeks for LCDs.

It is also no longer appropriate to view custom technologies as less reliable than standard products. A good supplier can deliver products with less than 50 to 100 parts per million (PPM) failure rates. Identifying the most effective technology for a particular application and creating a streamlined production process that integrates various components (like light pipes, switches, connectors, PCBs, etc.) in the most efficient way possible will generate cost savings in a number of different ways.

As a single custom LCD or LED supplier can provide a comprehensive custom solution, the number of suppliers needed is reduced, reducing procurement costs. Acquiring various components through a single supplier allows for a single bill of materials, simplifying accounting processes and reducing transaction costs. Complimentary product integration support from your supplier will cut your design engineering costs as design engineers no longer need to spend time and money researching individual components and integrating them in a way that ensures maximum efficiency. This also translates into faster time to market. Because the product is custom-tailored to specific application requirements, cost savings are achieved by identifying the components that most exactly fit specific product demands. For example, energy savings can be generated if a high output / low power consumption technology can meet and fulfill all performance expectations (rather than over spending on high power that is not needed).

Jeff Oliveros is director of OEM products at Lumex – [www.lumex.com](http://www.lumex.com)

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Over the past five years, there has been a radical improvement in the quality, cost and speed of custom LED and LCD product creation.

### Case study

A LCD solution recently created for the medical industry illustrates how custom technology can generate both performance enhancements and cost savings compared to off-the-shelf solutions. A major manufacturer of portable defibrillators wanted to increase the operating range of their premier brand of equipment primarily used in mobile emergency transportation.

The customer was experiencing cold start issues with the display having slow response times and segment inconsistency. In addition, they wanted to ruggedize the face of the display against blunt force and bodily fluids. The Lumex Custom design team was able to create a unique LCD module designed to function in the most strenuous temperature conditions (-40°C to 85°C). A fluid and polarizer combination was created that was stable enough to survive repeated high/low temperature cycling while maintaining the contrast and performance. Thus the performance offered by the custom solution was superior to any available standard technology and the brand was able to eliminate their cold start screen performance issues.

At the same time, the custom solution allowed for significant cost savings by working closely with the customer's design and manufacturing teams throughout the process, coming up with the highest performance integrated display solution. After significant lab testing, Lumex was able to integrate the display within a custom LCD module including integrated PCB, backlight, holder, connectors and a scratch/impact resistant cover. The integrated solution reduced procurement, transaction and design engineering integration costs while simplifying the bill of materials and ordering processes.

Thus by selecting a custom solution- the brand was able to enhance performance and reduce costs compared to available standard products.

### The Custom LCD & LED product development process

The first step of a custom design process should always be to ask questions in order to understand exactly what the customer's needs are for a particular application. Rather than pushing a customer towards a particular product solution already in their portfolio, a quality supplier will instead put their focus on customer needs and identify a solution that is custom-tailored to an application's specific performance and cost requirements.

Expert and complimentary product design support should be provided flexibly enough to best match the application needs, whether it be designing a solution from scratch or helping tweak an existing product design. Several design options should be presented that meet and exceed expectations, with complementary custom product de-

sign support for small, medium and large volume products.

### Streamlining the entire production process

Custom product development is not completed until the product has passed through the entire production process – from in-bound inspection, to production, to in-field performance. A quality supplier not only provides tips on how to streamline the entire production process for maximum efficiency, they also have experts available worldwide to provide assistance in each step of the process. This helps ensure that the custom product designed for maximum efficiency and performance can in fact provide superior performance as the product moves out of design and into production and distribution. Representatives worldwide should guide products out of the development process and through production in tangent with any contract manufacturers or other production partners. ■



A major manufacturer of portable defibrillators was able to enhance performance and reduce costs with a custom LCD technology solution.

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# The future belongs to DisplayPort

By Zeljko Loncaric

**THE VIDEO GRAPHICS INTERFACE (VGA)** has firmly established itself since IBM launched the first graphics cards in 1987 in order to display graphics on a CRT monitor. Over time, VGA signals were complemented by a confusing variety of interface options such as DVI, LVDS, HDMI and, most recently, DisplayPort.

The success of flat panel displays has greatly helped drive this development forward.

Modern computer modules such as COM Express and Qseven allow the flexible implementation of customized applications and support a variety of display interfaces for an optimal solution. The latest COM Express Type 2 modules from congatec already support the DisplayPort graphics interface, which looks set to become the standard of the future for internal graphics control in embedded applications.

Image quality is the driving factor behind the development of new display technologies. Current display interface technologies already take the increase in the amount of data to be transmitted into account. While the analogue VGA connector is still by far the most common video interface, it looks likely to die out soon because the current alternatives offer clear advantages.

The Digital Visual Interface (DVI) is a borderline case. Depending on the implementation, this interface enables analogue and digital video data transmission via a single connector. DVI has established itself firmly in the high-end



Fig. 1: A wide variety of interface options

PC sector, but it has not managed to replace VGA entirely.

The all-digital High Definition Multimedia Interface (HDMI) has found broad acceptance in private television and video applications due to the growing use of HDTV (High Definition Television). HDMI also enables encryption of video data, a function that is very much in demand by the film and entertainment industry. HDCP (High-bandwidth Digital Content Protection), an encryption system developed by Intel, is used for Digital Rights Management (DRM).

To enable even higher resolutions, UDI (Unified Display Interface) was launched. However, this standard did not succeed due to a lack of support by the manufacturers. By contrast, DisplayPort – which was introduced by the Video Electronics Standards Association (VESA) – is enjoying increasing popularity. As more and more modern chipsets and devices support DisplayPort, it seems likely that this very powerful interface will soon replace VGA ports.

In addition to these interfaces for external devices, there are other definitions for use within systems. Small displays with up to 12" and resolutions of 800x600 pixels can be controlled via a simple parallel data interface (often called TTL interface). Internal displays with higher resolutions are usually directly controlled by Low Voltage Differential Signalling (LVDS).

## A comparison of VGA, DVI, HDMI and DisplayPort

After more than 20 years, the VGA interface standard is by now significantly restricting the uses of modern displays. The fact that the resolution is limited to about 1280x1024 pixels is an issue as is the fact that the analogue video signals need to be digitized in the display or monitor.

On the computer side, the original digital image data needs to be converted to analogue signals. Even if both transformations - digital to analogue, then analogue to digital - are executed perfectly, systematic rounding errors will occur on both sides leading to a visible reduction in image quality. The analogue VGA signals are also transmitted in the DVI-A variant of the DVI standard. The advantage of the DVI connector over the older 15-pin VGA D-sub connector is higher data bandwidth. While it is possible to achieve higher bandwidth and thus higher resolutions with DVI-A, this is not a real alternative to purely digital transmission. The DVI standard was published by the Digital Display Working Group (DDWG) in 1999 and became the first digital display interface with a wider distribution. DVI comes in two forms: DVI-I supports both

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analogue VGA and digital display signals; and DVI-D, which works only digitally. The group also defined a third form, DVI-A, which transmits only analogue signals and is really just another connector for VGA. Depending on the required data bandwidth, the digital interface can contain up to two links. A DVI link consists of three data pairs and one clock pair permitting data transfer rates of up to 4.8 Gbit/s. The optional second link adds another three data pairs thereby increasing the raw capacity to 9.6 Gbit/s. DVI-I with a single link can be used to control displays with up to 1915x1436 pixels at 60 Hz refresh rate and an aspect ratio of 4:3. The two link version increases the maximum resolution to 2708x2030 pixels.

Since DVI is not optimally suited for the consumer devices market, leading companies have joined forces to define a special variant of the DVI specification for TV applications. The result was the above-mentioned High-Definition Multimedia Interface. HDMI is essentially a single-link Transition Minimized Differential Signalling (TMDS) as an electrical interface (like DVI), as well as a standard for embedding digital audio signals into the video stream. HDMI also supports Intel High Definition Content Protection (HDCP) for copy protection. While HDCP is optional according to the specification, it is implemented in virtually all HDMI consumer devices. DVI displays can be connected to HDMI ports without a problem via a simple adapter.

In addition to image data, HDMI transmits up to 8 channels of audio at 192 kHz sample rate and 24 bit resolution from version 1.2 upwards. The maximum pixel rate for video data is currently 340 Mpixels/s. This means that all current consumer electronics image and sound formats, including HDTV (up to the highest 1080p resolution) can be transmitted at the highest quality. Other image resolutions of up to 2560x1600 pixels at 75 Hz refresh rate are also supported. With HDMI 1.3, the transmission of colour depths up to 48 bits can be transmitted. HDMI is not a free standard; companies that develop devices with HDMI capabilities have to pay license fees to the HDMI organization - [www.hdmi.org](http://www.hdmi.org).

DisplayPort which was defined in late 2005, it has now been accepted as a display interface specification by the VESA. It differs from TMDS-based interfaces such as DVI and HDMI primarily because it follows a packet-oriented communication protocol. This allows the optional transmission of audio signals along with the video information. In the future, it will be possible to realize multiple video channels per cable or a screen tiling (where multiple screens make up one overall image) without changing the specification.

A DisplayPort can consist of one, two or four "lanes" (differential data pairs). Depending on the required data rate the interface is configured automatically to make the best use of the transmission capacity. If all four lanes are used a data bandwidth of 10.8 Gbit/s is available. This is adequate for resolutions up to 4096x2560 pixels at 60 Hz frame rate and 24 bit colour depth. Version 2.0 of the DisplayPort specification doubles the capacity along with the possible number of pixels.

DVI is currently the most popular and widely used digital display interface. For private television applications, HDMI is now the dominant solution. However, because of its efficiency and the direct support of chip makers, the role of DisplayPort has started to accelerate even more rapidly now, in particular since Intel and AMD have announced that as of 2015 they will no longer support the VGA display interface in their products.

Intel will stop supporting LVDS as of 2013 and AMD is also planning to drop support from most products. Together with Dell, Lenovo, Samsung and LG Display, Intel and AMD plan to radically speed up the change over to the digital display interfaces DisplayPort and HDMI. DisplayPort and HDMI enable the construction of compact, low-power

Graphics Interface	Max. Resolution	Type	Encryption	Special	Defined by	Web
VGA (Video Graphics Array)	1280x1024*	Analog	-	-	IBM, later maintained by VESA (Video Electronics Standards Association)	<a href="http://www.vesa.org">www.vesa.org</a>
TV Out (S-Video)	575x720	Analog	-	-	CCIR (Comité Consultatif International des Radiocommunications)	<a href="http://www.itu.int">www.itu.int</a>
DVI (Digital Visual Interface)	1920x1200@60Hz**	Digital & Analog	-	Dual link for higher resolution	DDWG (Digital Display Working Group)	<a href="http://www.ddwg.org">www.ddwg.org</a>
HDMI (High Definition Multimedia Interface)	2160p@100Hz	Digital	HDCP	Royalty (\$5.10k per year + 4.15 cent per system)	HDMI Licensing, LLC	<a href="http://www.hdmi.org">www.hdmi.org</a>
DisplayPort	4096x2560@60Hz	Digital	HDCP	AUX channel for Touch, USB	VESA (Video Electronics Standards Association)	<a href="http://www.displayport.org">www.displayport.org</a>

\* Higher resolutions are possible with some limitations for the image quality

\*\* Single Link DVI

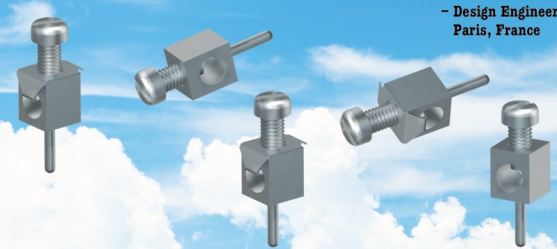
**Table 1: The different interface options at a glance.**

applications. HDMI will remain the preferred interface for home TV applications. Because of the licensing costs it incurs it is unsuitable for industrial applications as a rule. Both DisplayPort and HDMI can transmit audio signals, but with DisplayPort enabling about twice the data bandwidth as compared to HDMI or DVI, it can handle extremely high resolutions.


DisplayPort can be used both for external and internal display control. A specific definition - the so-called Embedded DisplayPort (EDP) - enables cheap internal connection of displays. DisplayPort's differential data lines allow cable lengths of up to 15 meters. But even for short distances within a computer system DisplayPort looks likely to replace the LVDS interface. According to the COM Express specification DisplayPort support will not be available until the release of Type 6 pin assignments. Many of congatec's COM Express Type 2 modules, such as conga-BM67 with Intel Quad Core, or the conga-BAF with AMD Fusion technology, already support the DisplayPort video interface today. The DisplayPort signals are transmitted via the PEG lines without violating the specification. ■

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### LED-backlit wide VGA LCDs

target industrial, medical and handheld applications

LCD manufacturer Optrex America has launched a new family of compact LCDs with a range of advanced features for a variety of industrial, medical and handheld applications. The 5" diagonal LED-backlit WVGA (wide VGA 800x480 resolution) TFT-LCD features Optrex's Super Wide View

(SWV) technology with viewing angles of 85/85/85/85 and true outdoor readability. It has a slim design, with a total thickness of only 3.9 mm, and provides high brightness (800 cd/m<sup>2</sup>), a 900:1 contrast ratio, a wide operating temperature range of -20 to 70°C,

and a standard LVDS interface. A touch screen version is also available. This display is well suited for industrial handheld applications, GPS, medical

diagnostic devices, and more. The company also launched a 3.5" QVGA (Quarter VGA 320 x 240) TFT-



LCD with a 400 cd/m<sup>2</sup> brightness, a 750:1 contrast ratio, viewing angles of 80/80/80/80, and a long lifetime LED backlight (50 K hours on average).

**Optrex America**

[www.optrex.com](http://www.optrex.com)

### 15.4" wide WXGA TFT

for industrial applications

With its 15.4" TFT for industrial applications the Taiwanese display specialist CHIMEI-Innolux (CMI, former CMO) has followed the market trend for displays

in wide-format with LED backlight. The G154Ir-LE1 supports a WXGA resolution (1.280x800 dots) with a 6-bit/8-bit LVDS interface and

has a contrast ratio of 700:1 with a brightness of 450 nits/m<sup>2</sup>.

The converter for the backlight unit has already been built in. Measuring 352x230x9mm, the unit is compatible to the earlier version with CCFL backlight. The LED lifetime is specified

with a minimum 50,000 hours. The LED light bar is replaceable. CMI guarantees for all G-modules an availability of at least 5 years starting from the date of

design-in at the customer. Thus the display is suitable for industrial applications that require both optimal optical perfor-



mance and long-time availability. Data Modul offers fitting driving solutions and certified accessories for the new G154Ir-LE1 as well.

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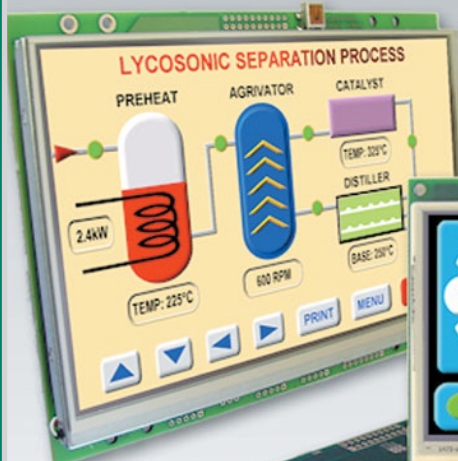
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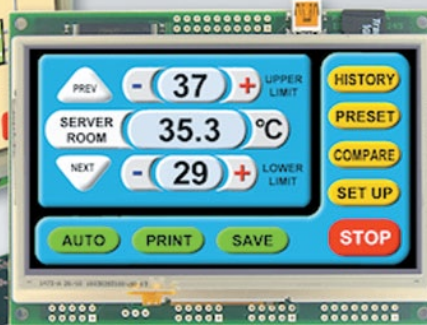
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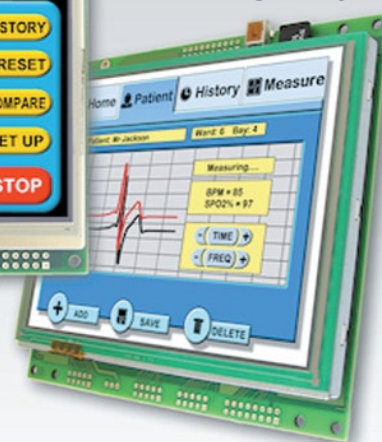


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# Widescreen colour TFT LCDs target industrial applications

By Julien Happich

**IN FACTORY AUTOMATION** applications where high reliability and a long life backlight are really mandatory, TFT-LCD modules are gaining in popularity with wide format displays very much in demand.

Addressing the industrial market, Mitsubishi Electric has designed TFT-LCD modules relying on LED backlights rather than cold cathode fluorescent lamps (CCFL). This ensures a longer lifetime, typically 100,000 hours at 25°C, and also eliminates the need for high-voltage inverters which require safety and electrical noise reduction measures. The product portfolio ranges from 4.3" to 17.5" colour units operating in the -30 to 80°C

temperature range and under all kinds of environments where extreme vibrations and shock loads are present. According to the company's figures, the luminance of the LED backlight-equipped LCD modules tops LCD modules employing CCFL backlights over the entire temperature range.

Mitsubishi Electric has also developed LCD materials that maintain image quality at high temperatures as well as structural designs that minimize increases in local temperature by efficiently releasing the heat generated by the CCFL/LED backlights.

The display modules are checked at an in-house EMI evaluation centre to ensure that they meet the standards for industrial products. For enhanced results, the units use Natural Color Matrix colour conversion technology to reproduce colours as closely to the true colours of objects. Wide viewing

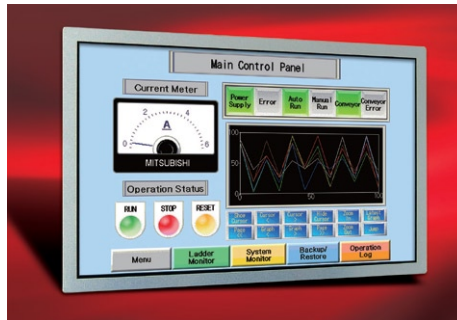


Fig. 1: a 12.1" TFT-LCD module with built-in LED backlight driver



Conventional LCD



Super-wide viewing

Fig. 2: Comparison of a conventional and super-wide viewing angle from different angles

angles models extend their display capabilities to 170 degrees in both the vertical and horizontal directions, ensuring a clear image regardless of the screen position.

Four widescreen LCD modules versions are available, namely the 9.0, 12.1, 14.1 and 17.5-inch diagonal units with the same height as the more conventional 4:3 aspect ratio LCD modules measuring 6.5, 8, 10.4, 12.1 or 15-inch. ■

15.0XGA 1024x768	→	17.5WXGA 1280x768
12.1XGA 1024x768	→	14.1WXGA 1280x800
10.4XGA 1024x768	→	12.1WXGA 1280x800
6.5~8.4VGA 640x480	→	9.0WVGA 800x480

Same height

Fig. 3: Widescreen TFT-LCD modules accommodating 4:3 aspect ratio configurations.

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Plug-In units meet the requirements of QPL-MIL-PRF 21038/27. Surface units are electrical equivalents of QPL-MIL-PRF 21038/27.

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Input voltages of 5V, 12V, 24V And 48V. Standard Output Voltages to 300V (Special voltages can be supplied). Can be used as self saturating or linear switching applications. All units manufactured and tested to MIL-PRF-27.

## 400Hz/800Hz Power Transformers

0.4 Watts to 150 Watts. Secondary Voltages 5V to 300V. Units manufactured to MIL-PRF-27 Grade 5, Class S (Class V, 155°C available).

Delivery-Stock to one week  
for sample quantities

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[www.picoelectronics.com](http://www.picoelectronics.com)

**Pico Representatives**  
Germany

**ELBV/Electronische Bauelemente Vertrieb**  
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Phone: 0049 (0)89 4602852  
Fax: 0049 (0)89 46205442

England

**Ginsbury Electronics Ltd.**  
E-mail: [rbennett@ginsbury.co.uk](mailto:rbennett@ginsbury.co.uk)  
Phone: 0044 1634 298900  
Fax: 0044 1634 290904

## DESIGN & PRODUCTS

### Analog front end digitiser ICs

*offer innovative imaging solution for home office appliances*

Wolfson Microelectronics plc has introduced a new range of analog front end (AFE) digitiser integrated circuits, which can be easily integrated into the latest generation of imaging equipment in the home or office including digital copiers, scanners (including portable bar code scanners) and multi-function printers (MFPs). Part of Wolfson's imaging portfolio, the WM8232, WM8233, WM8234 and WM8235 process and digitise

the analog output signals from CCD sensors or contact image sensors. The devices offer a variety of channel and ADC configurations, allowing system designers to choose the configuration which best suits their purpose. For the consumer, this means higher scanning speeds at high scan resolutions.

**Wolfson Microelectronics**

[www.wolfsonmicro.com](http://www.wolfsonmicro.com)

### Space saving 500mA dual POL regulator

*replaces LDOs with higher efficiency alternative*

Semtech's SC197 500 mA, dual-output, point-of-load (POL) regulator combines two PWM DC-DC regulators in low-profile 2x3x0.6mm package. Power efficiency up to 94% makes the device a higher efficiency alternative to LDOs. The SC197 also features



integrated 4-bit VID pins to provide dynamic voltage scaling, without the need for external programming resistors. Both regulators in the SC197 operate from inputs of 2.9 to 5.5 V and provide 15 pin-programmable output voltages from 0.8 V to 3.3 V, covering all the typical core and I/O voltage rails with one device.

**Semtech**

[www.semtech.com/info](http://www.semtech.com/info)

### Battery-free wireless sensor system

*monitors busbars and busways*

Micropelt launched qNODE, a wireless condition monitoring sensor designed to increase both operating safety and power availability in 24/7 production environments. Thermal energy harvesting uses the busbar current load's resistive heat to operate the wireless sensor nodes. Micropelt's chip-scale thermoelectric technology generates 140 millivolts per Kelvin of temperature differential. This permits efficient DC conversion and enough power to

sustain ultra-low power (ULP) wireless devices on a duty cycle basis, where sensing and transmitting takes fractions of a second and occurs every minute or so. It only takes a few seconds to fit the qNODE onto a busbar.

**Micropelt**

[www.micropelt.com](http://www.micropelt.com)



### M2M and geolocation made simpler

*daughter board comes with all application code*

Microchip has developed a Machine-to-Machine (M2M) platform using its PICtail Daughter Board format, that comes with all of the hardware, wireless-communication protocols and application-code examples needed to help designers jump start their fleet-management or location-based service application. Developed with u-blox, the daughter board includes the u-blox NEO-6Q GPS and LEON GSM/GPRS modules, and interfaces with



Microchip's Multimedia Expansion Board and PIC32 Starter Kit. The M2M PICtail daughter board enables phone, text, e-mail and Web communications, including images and location information.

Microchip offers free-for-download M2M software libraries to further reduce time to market.

**Microchip**

[www.microchip.com](http://www.microchip.com)



## Royalty-free capacitive touch library

for TI's MSP430 16-bit microcontroller platform

Texas Instruments has unveiled a ultra-low-power MSP430 16-bit microcontroller capacitive touch portfolio. The royalty-free MSP430 capacitive touch library gives developers the option to add touch sense capabilities to any MSP430 microcontroller. The open source software library eliminates the need to develop complex touch sensing algorithms and supports various capacitive touch sensors, including buttons, sliders,

wheels and proximity. Although the software library supports all MSP430 devices, some include new peripherals optimized specifically for touch sense applications. The MSP430 Value Line G2xx2 and G2xx3 devices include capacitive touch IOs which interface directly with capacitive touch pads.

**Texas Instruments**

[www.ti.com](http://www.ti.com)

## Capacitive type humidity SMD sensor

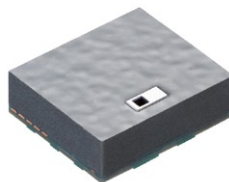
is accurate up to 100% humidity

Alps Electric Europe's HSHCA is a capacitive type humidity sensor delivered in a 2.5x2.2x1.0mm surface mount package. It precisely detects relative humidity in the range of 0 to 100 percent while delivering a high measuring accuracy of  $\pm 1.5\%$ . The humidity sensor is rated for supply voltages from 2.2V to 3.6V and operates in the -20 to +85°C temperature range. The new humidity sensor complies with the RoHS directive and

is suitable for reflow soldering. It ships in minimum packaging units of 45,000 pieces for automatic mounting, packaged on embossed tape with a width of 8mm.

**Alps Electric Europe**

[www.alps.com](http://www.alps.com)



## Development tool optimized for dual-core debug

features a shared JTAG/SWD interface

Version 3.0.7 of the Universal Debug Engine (UDE) from PLS is equipped with optimized test and debug functions for NXP's LPC4300 highly integrated dual-core SoC family and offers unlimited dual-core debugging under a single user interface. The LPC4300 family brings together an ARM Cortex-M4 with a Cortex-M0 to an

asymmetrical dual-core digital signal controller architecture. Both processors each operate with their own clock supply and their own power management. The JTAG/SWD interface is shared via shared memory.

**PLS MC**

[www.pls-mc.com](http://www.pls-mc.com)



## MP3 encoder and audio codec chip

numerous audio formats, echo cancellation

The VS1063 IC from VLSI Solution can encode an unforeseen multitude of audio formats, from MP3 and Ogg Vorbis to G.711 u-law, G.711 A-law, G.722 and 16-bit PCM. The proprietary MP3 and Ogg Vorbis encoders have been carefully tuned for highest possible audio fidelity for high-quality audio streaming or recording. The chip can play back MP2, MP3, WMA, OGG, LC-AAC, HC-AAC, FLAC, IMA, G.711 u-law, G.711 a-law, G.722 and WAV PCM formats, making it

very suitable for hi-fi audio playback and streaming applications. The codec also offers a full-duplex codec mode with optional acoustic echo cancellation for real-time voice applications over the internet and two-way radio links. Many built-in sound effects are provided.

**VLSI Solution**

[www.vlsi.fi](http://www.vlsi.fi)

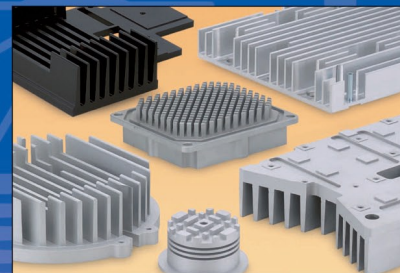


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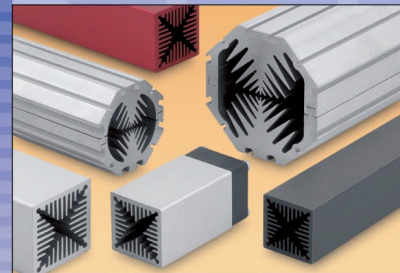
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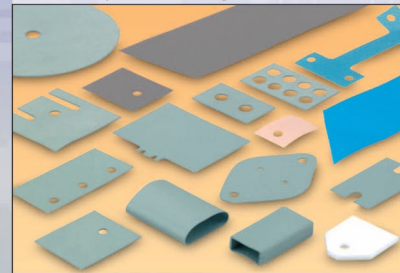
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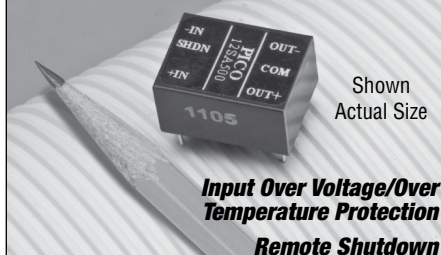
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## DESIGN & PRODUCTS

**DISTRIBUTION  
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### PCB test points

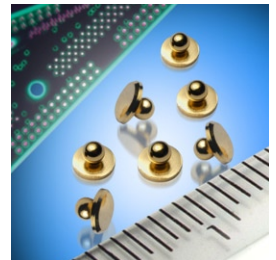
*for high temperature solder up to 300°C*

Aerco now stocks a new range of high temperature HT SMOX surface-mount test points, an extension of the PCB interconnect products from Oxley Developments. Higher temperature versions have been introduced to cater for more aggressive soldering profiles that have sustained temperatures above 200°C as used, for instance, while using RoHS compliant SAC solder. The HT SMOX test points have an additional nickel

undercoat to give a more robust finish that ensures the correct adhesion properties are achieved at higher temperatures up to 300°C.

**Aerco**

[www.aerco.co.uk](http://www.aerco.co.uk)



### EMA and Cadence extend channel partner contract

*to sell complete line of PCB design tools*

EMA Design Automation, a full-service provider of mechanical and electrical CAD tools, announced the extension of its Channel Partner Contract with Cadence Design Systems, which allows EMA to sell and support the full Cadence Allegro and OrCAD product lines. "Our customers' needs vary greatly, from simple schematic capture requirements to complex front to back PCB design needs," said Manny Marcano, president and CEO of EMA.

"Cadence PCB products, along with EMA's products and services, give our customers a wide array of solutions to meet their needs. With the scalability provided by the OrCAD and Allegro product lines, we can provide increasingly more capable solutions as our customers' needs grow in complexity."

**EMA Design Automation**

[www.ema-eda.com](http://www.ema-eda.com)

### Mouser's online electronic components database

*integrated with AltiumLive design software*

Mouser Electronics has announced a new partnership with Altium which sees live links connecting Altium Designer and Mouser's extensive part information, placing it right onto the engineer's desktop. The new links are now part of AltiumLive, Altium's new ecosystem for electronics designers.

AltiumLive and the Altium Designer combine

to help design engineers better manage data and deliver new content to speed product development. Using AltiumLive, designers are freed to create and innovate, untangling the design data knot and streamlining the design process.

**Mouser Electronics**

[www.mouser.com](http://www.mouser.com)



### ACAL BFi and Silicon Sensing sign for Europe

*to distribute Silicon Sensing's gyroscope and inertial systems*

ACAL BFi will provide specialist technical support on Silicon Sensing's full range of products including their new class of PinPoint precision MEMS navigation and pointing gyroscopes. The Silicon Sensing product range covers silicon MEMS single-axis gyroscopes, off-the-shelf and custom multi-sensor systems including multi-axis inertial sensor assemblies, inertial measurement units and integrated navigation INS/GPS products. The products are used extensively in navigation systems for mobile

satellite TV, light aircraft and agricultural equipment, as well as in industrial and consumer applications. Silicon Sensing's products will expand ACAL BFi's existing range of tri-axial accelerometers and magnetic, pressure, force, thermal, rotary and optical sensors, as well as complete compass and dead-reckoning modules.

**ACAL BFi**

[www.acaltechnology.com](http://www.acaltechnology.com)



## Win one of 5 Snowball SDKs

for open source smart phone and tablet designs



This month, ST-Ericsson is giving away five Snowball developer board kits (part number DK9500SNO10-STA) worth USD 200 each, for EETimes Europe's readers to win.

The feature-rich developer board together with the Igloo open source com-

munity launched by the company earlier this year is aimed at driving innovation of software for Android, Ubuntu and MeeGo embedded devices based on ST-Ericsson's platforms. The production-grade small-sized Snowball developer board combines ST-Ericsson's Nova A9500

dual-core application processor, with a 3D gyroscope, an accelerometer, a magnetometer, a barometer, a GPS and connectivity features. Calao Systems

designed the board, while Linaro developed the board's low-level software, which is optimized for the

Nova A9500's ARM dual Cortex A9-based architecture. The kit comes fitted with a 4/8GB eMMC, a 1GB LP-DDR2 chip, one Micro-SD card and IEEE 802.11 b/g/n WLAN as well as Bluetooth 2.1+EDR wireless capabilities (antenna excluded).

**ST-Ericsson**



Check the reader offer online at [www.electronics-eetimes.com](http://www.electronics-eetimes.com)  
[www.stericsson.com](http://www.stericsson.com)

## 8-bit USB flash microcontroller

*built-in DC-DC converter with selectable outputs*

Sanyo Semiconductor launched an 8-bit flash microcontroller with USB 2.0 Full-Speed interface function and a built-in DC-DC converter (step-up/step-down circuit) with selectable output voltages. The LC87F1864A device provides a

solution that supports stable power supply, space efficient and cost effective designs in USB card reader products, such as IC cards. The step-up circuit (charge pump) and step-down circuits (series regulator) incorporated in the LC87F1864A drive output voltage values of 5.0, 3.0 and 1.8V, or the alteration of output voltage settings via an external resistor, thus enabling stable

power supply to peripheral devices. With the addition of a Universal Asynchronous Receiver

Transmitter (UART), the IC cards interface is fully compliant with ISO7816-3 standards. In addition to a wide variety of USB card reader products, the

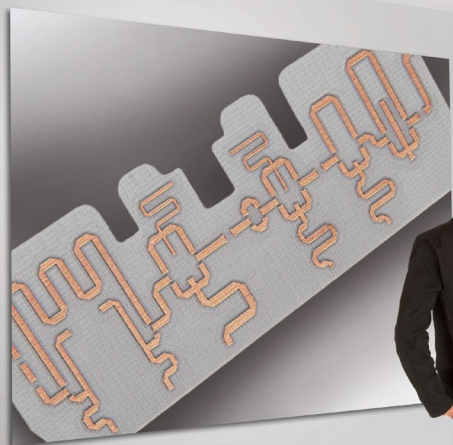
USB feature enables various types of data held on the IC card to be transmitted via USB to personal computers. The chip comes housed in a SQFP48 package measuring 7x7mm. It has an on-chip debugger function, a 16-bit timer / counter, 64KB ROM and 2KB of RAM.

**Sanyo Semiconductor**



[semicon.sanyo.com/en](http://semicon.sanyo.com/en)

## Get a New Picture of PCB-Prototyping and Production on Demand



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# Engineering software updates to the future

By Martin Harris

**THE ENGINEERING SOFTWARE** industry really is behind the times when it comes to software release cycles. While other areas of software have moved on to a more dynamic release model, engineering software is seemingly wedded to traditional release cycles.

Presumably for reasons of traceability, validation, verification, and marketing, most software packages are built to a defined level of completeness and then released, with much fanfare. Vendors apply a version number to the software so users and observers can attach some notion of age and features to it. And of course, along with each version come tuition, documentation, and a massive learning curve over the preceding version. Another practical reason for releasing software in major versions has been the limitations of delivery mechanisms – high-speed, unlimited Internet access is, after all, a relatively recent thing.

When you look at it this way it seems quite archaic, lagging behind many other IP-based industries. Yet when you have a physical product to sell – such as a car – it makes sense that you have a version (or in that case, year model). But think about music for example, one of the more mature IP-based industries. In the earlier years of the recording industry, there were similar practical reasons for a band recording a whole album of ten or so tracks, namely the vinyl and cassette delivery mechanisms of the time.

With the development of high quality perceptual compression (i.e. MP3, FLAC etc.) and affordable high speed Internet, the natural step for the music business was to allow listeners to cherry-pick the songs they like, download them and listen directly using the device that also stores the songs. This iTunes / Rhapsody / CD-Baby phenomenon is now mature, which highlights the fact the electronics design software industry (which incidentally, provides this very system of acquiring and using a product in a streamlined way), has hardly caught up to this concept itself.

Now musicians and bands are tending to release songs online as soon as they are written and recorded. The commercial mechanism actually supports this. It's easy to create and keep market momentum this way, as a band that releases singles fairly regularly is going to stay more in the forefront of the minds of their fans. There is still a place of course for complete albums, and most musicians do still "release an album". But the market no longer consumes them the same way.



**“By separating the software platform from extra plug-ins and design content, engineering software can move to a dynamic update process”**

In the same way, it's about time software vendors were able to break free of the need to withhold features, functions and fixes in their products while waiting for a large enough bundle of them to be gathered to call it a “new release”. There may be larger, more profound changes in the software that encompass new

ways of thinking about and solving problems when using it, and these would involve an update to the platform (or base version) on which all the other capabilities (let's call them plug-ins) sit. However, the plug-ins that add the extra features and functions, as well as bug fixes, are in a continuous software engineering cycle.

Assuming that application software engineering produces continuous development and improvement, and the delivery mechanism of the software supports continuous updates, then there's no good reason to hold back on delivering the upgrades as they are developed. Also, with prolific high-speed, essentially unlimited internet access, there is no longer a barrier in the delivery mechanism for installed applications.

PC-based applications can be updated regularly or even continuously. While there may be larger changes to the underlying platform of the software, that is, at the software base level, these would constitute a new revision of the platform. Previously this would have been called a “service pack”. There is no practical or technical reason why users should not be able to have it downloaded in the background, and transparently installed by the software itself (with the user's permission of course).

Likewise, other additional (new) plug-ins, such as support packages for a specific FPGA device family or a manufacturer's component library, should be available for download the moment they are made ready. Users should not have to wait for a major release to reap the benefit.

By separating the software platform from extra plug-ins and design content, engineering software can move to a dynamic update process where a continuous supply of new technology, features and content is ready to be used as soon as it's released.

As a wise man once said, “Do not withhold good from those who deserve it, when it is in your power to do so.” And so it should be in software development. ■

Martin Harris is CEO EMEA of Altium Europe – [www.altium.com](http://www.altium.com)



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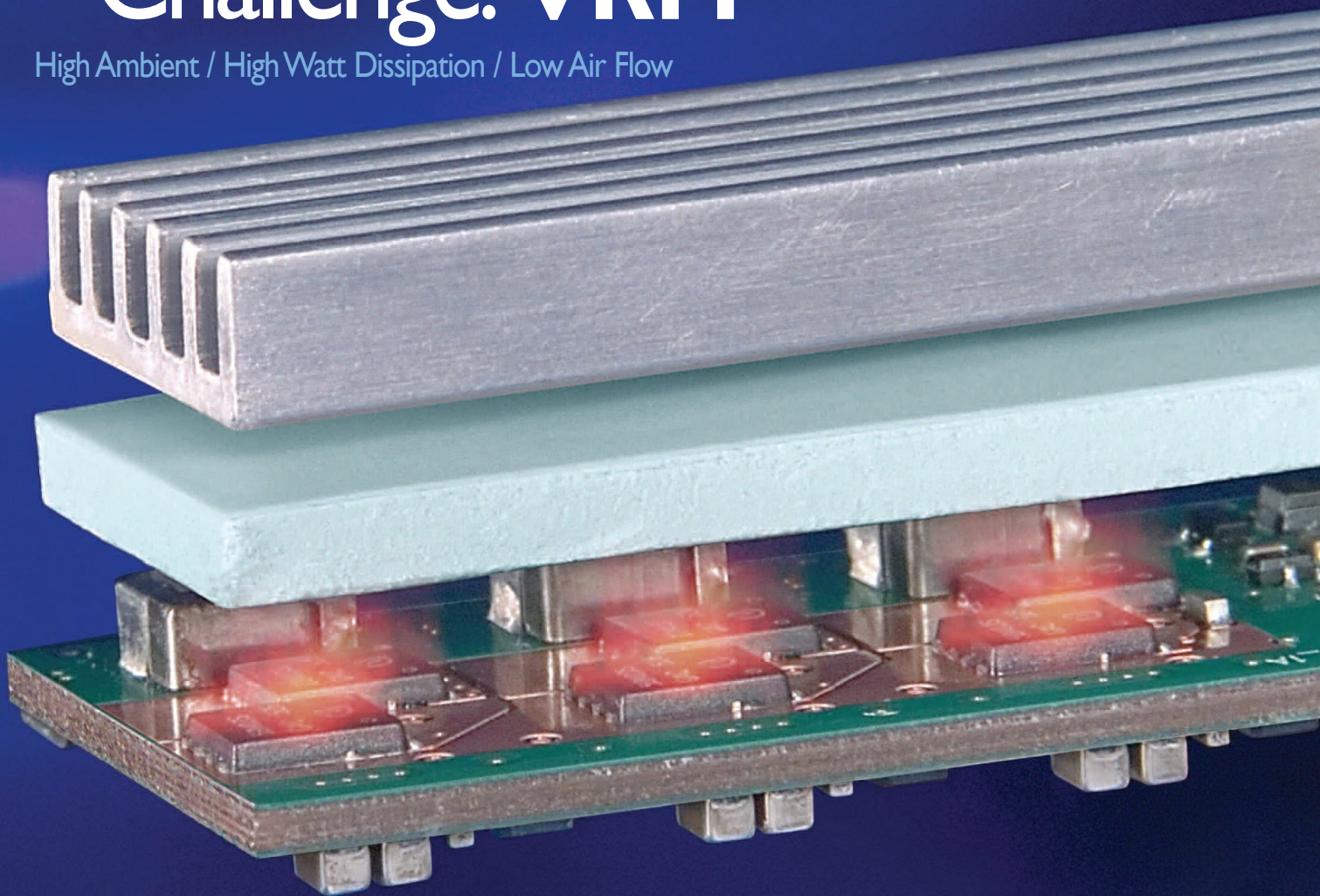
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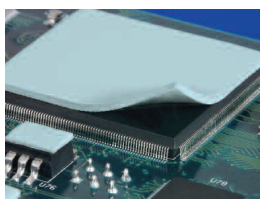
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# Thermal Challenge: VRM

High Ambient / High Watt Dissipation / Low Air Flow



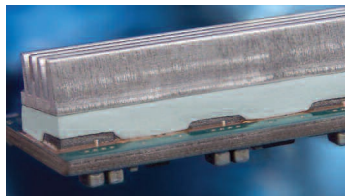
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Gap Pad 5000S35's natural tack makes application clean and easy to handle.

**Gap Pad 5000S35 is perfectly suited for high performance applications such as VRMs, BGAs and ASICs.**

Bergquist's newest S-Class is the perfect combination of softness, low thermal resistance and high thermal conductivity. With a low bulk hardness (35 Shore 00) and high thermal conductivity (5.0 W/m-K) it conforms to demanding contours while maintaining its structural integrity. It is an ideal gap filling solution for applications with fragile components that can be damaged by harder materials that cause higher mounting pressure on components. Gap Pad 5000S35 is also an excellent solution for DVD drives, memory modules, and PC boards to chassis.



Excellent interfacing and wet-out makes GP 5000S35 ideal for fragile components with demanding contours and stack-up tolerances.

**Ultra soft S-Class integrity offers easy application.**

Gap Pad 5000S35 has a natural tack that eliminates the need for additional adhesive layers that can inhibit thermal performance. Its super soft, yet elastic nature provides excellent interfacing and wet-out, even to surfaces with high roughness or topography. Gap Pad 5000S35 features an embedded-fiberglass reinforcement that makes it puncture, shear and tear resistant. No tearing, flaking or crumbling – just clean and easy handling during the assembly process.

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