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New Electronics

24 OCTOBER 2006

JUST WHEN DO YOU START INNOVATING?

Noah didn't wait until it started raining. Neither did the Stone Age end because of a lack of stone. The answer, according to Dean Kamen, is to innovate when problems need to be solved.

Special Report: Medical Electronics

Plus: • Spotting the opportunity with Domino • I'll buy that for $1! • Cementing a brick reputation • 3G meets broadband in femtocells • Meeting the needs of the signal analysis user • Resolving trade offs in switch mode power supplies

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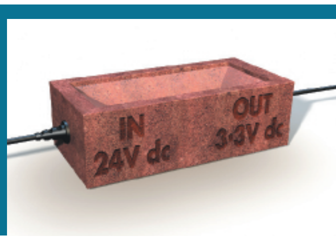

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NXP– the new company born out of Philips Semiconductors
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What if you could
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What if you could be born wiser?
founded by PHILIPS

Innovating the future

How do you solve the problem of creating tomorrow's engineers?

Graham Pitcher, *Editor gpitcher@findlay.co.uk*

We all have our ideas about what innovation comprises, so it's good to hear other people's definitions. Dean Kamen, president of DEKA Research, knows a thing or two about innovation. He says innovation is like making a Sumo wrestler look good in a tutu.

That's just one of his observations, and you can see more of them in this issue. He sees innovation as a means of solving problems, not necessarily inventing new technology. One of his successes is the HomeChoice PD, a peritoneal dialysis machine which is small enough that patients can take it anywhere they go.

Medical electronics is an area where innovation should be rife – and we highlight some successes in this issue. The technology is available, the applications certainly are. There's no reason why the UK shouldn't win its fair share of business from the growing demand created by changes in healthcare.

But Kamen's real passion is one which we should all share – encouraging kids to become tomorrow's engineers and scientists. Next year, his First Robotics competition (**www. usfirst.org**) will involve more than 30,000 schoolkids in 1300 teams in 37 regional events. The competition is a high tech spectator event which involves brainstorming, teamwork, mentoring, project management and deadlines.

Whilst the UK doesn't have anything like First Robotics, there is SETNET (**www.setnet.org.uk**), which encourages engineers to act as 'Ambassadors' in schools to promote engineering as a career. A recent meeting between the Electronics Leadership Council and the UK Electronics Association concluded that 'full support' should be given to the scheme. And we agree completely.

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INVESTOR IN PEOPLE

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Lasers to push 32nm euv

European euv development efforts gather pace. **Vanessa Knivett** reports.

Diode pumped solid state laser manufacturer Powerlase is working with the University of Central Florida (UCF) to further develop a laser produced plasma (lpp) extreme ultraviolet (euv) source. The aim is to refine the lpp approach as a potential euv source for 32nm production.

Powerlase has supplied UCF with its kilo class Starlase laser to irradiate UCF's tin doped micro droplet laser plasma source. Martin Richardson, Northrop-Grumman Professor of X-ray Photonics at UCF, recounts: "We have already demonstrated euv powers approaching 10W and expect further significant gains."

Dr Samir Ellwi, Powerlase's vice president of strategic innovations, said: "The demand is for 180W of useable power at the intermediate focus. This depends on the photoresist – if this is better in terms of sensitivity and resolution, we can come down in power."

The EC's 36month 'More Moore' EUV lithography project, now at an end, has demonstrated an euv light source capable of producing 800W using the diode pumped plasma (dpp) method. Ellwi notes that, once this has been collected, it would result in a useable power of about 180W, which is what Powerlase believes that it can achieve. Ellwi suggests that dpp is more scaleable and could produce 250W, making it appropriate for 22 and 16nm.

• Meanwhile, ASML has received its first order for a preproduction euv system – a production ready euv system could be available in 2009.

All in a respin!

A survey of design engineers in 60 European electronics companies has shown that more than 60% of their chip designs needed at least two respins.

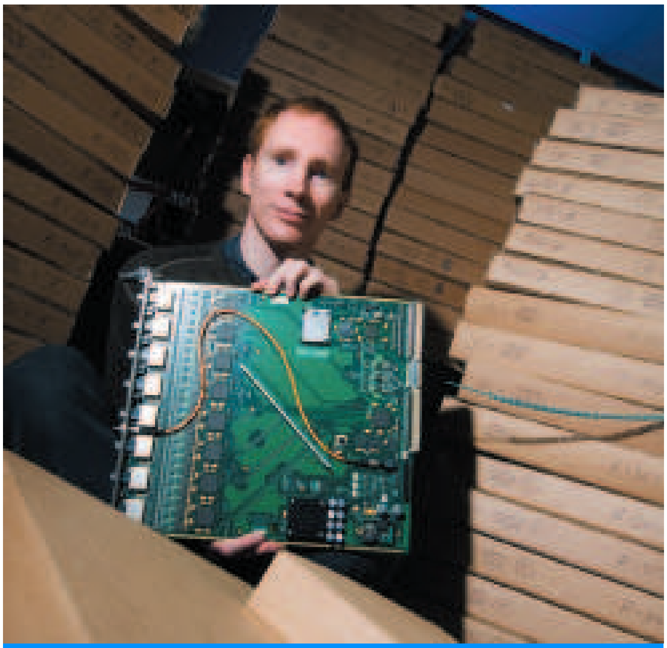
The survey, conducted by Cadence, produced responses from around 100 design engineers. Top of their list of worries was time to market, followed by cost and performance.

According to Alexander Duesener, the company's European marketing director, the number of design respins is down to a combination of increasing complexity, coupled with the need to use advanced processes to meet cost and performance requirements.

"Customers want more and more features," he claimed. "That means more complexity and nanometer geometries make things worse."

Overall, 70% of respondents' designs were targeted at 90nm or smaller processes. Wolfgang Stronski, Cadence's European field marketing director, added: "We were surprised at the speed at which this is progressing, particularly in analogue, where we believe a lot of designs will be at 65nm or below as we go forward."

• IDEAs lead sponsor Scientific Generics is to be renamed Sagentia in a move that it says will 'dispel any ambiguities ... arising from its previous name'. Chief executive Simon Davey said: "While our brand and name have changed, the underlying principle upon which our business is founded has not."



Keeping track of events

CCLRC Rutherford Appleton Laboratory has delivered the Tracker FED Readout project for the European Centre for Particle Physics (CERN). The system will process the vast quantities of data to be generated by the world's largest silicon tracking detector – part of the international Compact Muon Solenoid (CMS) experiment at CERN's Large Hadron Collider facility.

Each particle collision, or event, produces about 10Mbyte of silicon detector data and one board will handle 3Tbyte of data a second. The system, designed and developed by the CCLRC in collaboration with UK universities and manufactured in the UK, comprises hundreds of complex Front End Driver boards. These exploit massively parallel digital processing using specially programmed chips.

Watch out for fins

RF circuits and operational amplifiers have been created by IMEC using FinFET technology; mosfet double gated transistors built on a 45nm silicon on insulator substrate with a metal gate high k gate stack.

IMEC is initially targeting high gain low frequency applications (less than 5GHz), where FinFET technology offers better performance than planar bulk cmos. A two stage opamp with 50dB gain and a 2 to 8GHz tunable oscillator have been designed, processed and tested successfully.

Future work will focus on increasing FinFET speed by increasing mobility, decreasing the relatively large series resistances and/or decreasing extrinsic capacitors between gate and drain.

EC to create 'Euro MIT'

The European Commission has adopted a proposal to establish a European Institute of Technology (EIT) with a budget of €2.4billion.

According to the EC, the EIT will be a 'flagship' for excellence in innovation, research and higher education in Europe. Overseen by a Governing Board, the EIT will comprise a number of Knowledge and Innovation Communities (KICs). KICs, said to be the 'defining characteristic' of the EIT, are joint ventures of universities, research organisations and businesses which come together in response to calls for proposals from the EIT. Six KICs should be established by 2013, says the EC.

Blackfin is all eyes

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ANALOG DEVICES

Facing software challenges

System level design is part of the solution. **Louise Joselyn** reports from Sophia Antipolis.

Increasing software content, together with hardware/software codesign and integration, are today's principle microelectronic design challenges, it emerged at the SAME conference, held earlier this month in Sophia Antipolis.

Keynote speaker Thierry Laurent, executive vp of NXP, remarked: "The increased software content of today's SoC based projects is more of a challenge than the shift to 90nm technology." He enumerated other critical issues including: low power design; reducing costs and time to market; and reducing the 'cost of non quality' – respins, debug and verification.

Tackling these challenges, he believes, means moving to a higher level of design abstraction. Converging multimedia products are engendering a system on chip approach, which most certainly requires working at the system level, he said. Partnering, for both technology and tools is essential, he added.

During the subsequent panel discussion, Rudy Lauwereins, a Leuven professor working with IMEC, suggested the eda vendors were overly focused on hardware design within their system level design tool strategies and had made little effort to either create software tools or partner established software tool vendors for viable hardware/software integration tools.

Tim Barnes from Cadence said his company is responding. "The industry needs to better understand codesign and we are introducing management and methodology layers to tools to facilitate operating at different levels of abstraction. Generally there is poor use, as well as little adoption, of esl tools."

Prof Lauwereins indicated there might be a problem persuading systems companies to spend as much on software development tools as they do on eda tools. But Jacques Noel of NXP responded that if the tools truly facilitated hardware/software integration, NXP would be prepared to make a significant investment as in house testbench solutions were both costly and time consuming.

Both Mentor Graphics and Synopsys representatives, Eric Selosse and Joachim Kunkel respectively, implied that (re-)education is key. "There is still little understanding among hardware engineers of the effect or implications of their decisions on the software, except in the dsp arena, where they are moving to a higher level of abstraction," Kunkel said. "Companies need some fresh thinking. Send your engineers back to college. Talk to the PhDs and researchers – they have probably already solved some of the challenges of multicore SoCs and subsystem on chip designs," added Selosse.

SAME goes back to school

Microelectronics in Sophia Antipolis traces its roots back to the technologists and marketeers that came to the area with VLSI Technology in 1986.

Jacques-Olivier Piednoir from Cadence and SAME president, is one such veteran. Along with running Cadence's analogue design r&d efforts, he's the inspiration behind a new initiative called 'SAME goes back to School', aimed at encouraging the area's youngsters to consider engineering as a profession.

A iPod based kit has been developed to inspire 16year olds that they can design 'really cool' electronic products. The initiative is aimed at building a high tech culture to underlay the fast growing high tech business in the area and to change perceptions that engineering is 'boring'.

• Meanwhile, the SAME exhibition floor provided room for three Junior Entreprises, a highly successful programme in France, whereby engineering undergraduates, under appropriate supervision, can undertake projects for commercial organisations. The students gain practical technical and business experience, whilst companies have access to fresh new talent and a low cost resource for short term projects.

Local event, global impact

Now in its ninth year, SAME (the Sophia Antipolis Microelectronics Forum) has a two fold aim: to provide a regional showcase and networking opportunity; and to attract international attention to help build the technology reputation of the PACA (Provence Alpes Cote d'Azur) region.

Sophia Antipolis has attracted France's first high tech investment from India, in the form of Wipro Newlogic, expected to generate 60 new jobs in its first year.

Wireless semiconductor company Icera, headquartered in Bristol, has expanded its r&d office, first opened in Sophia Antipolis in January 2005, to a new purpose built facility nearby. It is already recruiting and expects to add 15 jobs before the end of this year, bringing the team in France to 60. The French operation is developing layer 1 and 2 software and the technology platforms for reference designs, to complement its Livanto HSDPA compatible wireless soft modem.

CIMPACA projects underway

Postgraduates and researchers in the PACA region are working on high profile projects under the CIMPACA project for 'secure communicating objects'.

The second round of €1.7m investment, bringing the total to €3m to date, will be made before the year end, primarily to expand the server farm with additional eda, cad and software tools, as well as rf measurement equipment. The project is beginning to attract participation from SMEs in the area, who will be able to access the server farm providing they are developing relevant projects and liaise with one of the many universities to take on a PhD.

SAME boosts start ups

Each year, the SAME forum provides a generous kick start for a carefully selected number of SMEs, start ups and spin offs.

This year saw two from Sweden, one from Belgium and three from France. Technologies include analogue eda tools, an a/d converter booster mechanism and a low power 32bit embedded micro. See New Electronics' 28 November issue for more.

Blackfin is 1 in 64 million

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ANALOG DEVICES

It's in the genes!

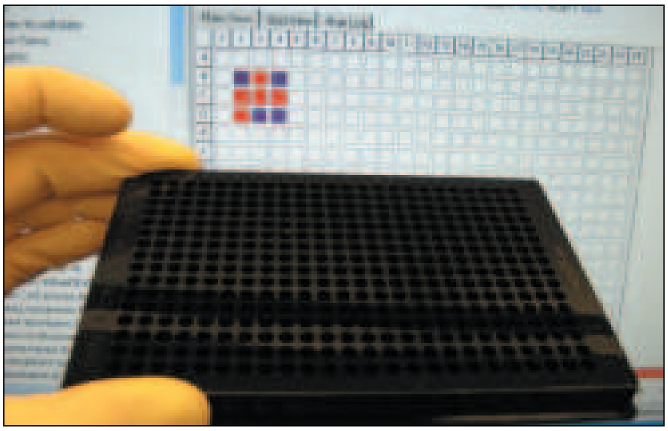


Photo: Courtesy of Columbia University Medical Center

DNA computing may be available in 10 years. **Paul Dempsey** reports.

Commercial dna computing could be less than 10 years away, according to researchers at Columbia University Medical Center and the University of New Mexico.

The team has developed a 100 circuit dna computer called MAYA II (Molecular Array of YES and AND logic gates) that can play 'noughts and crosses' and never lose.

The target is a dna computer for the diagnosis and treatment of diseases such as West Nile Virus and, possibly, cancer. The idea competes with concepts based on nanotechnology.

MAYA II comprises a cell culture plate containing pieces of dna that code for possible moves in the game and output progress to a display.

Joanne McDonald, a virologist in Columbia's Department of Medicine and the research team's leader, describes MAYA II as a 'medium scale integrated molecular circuit'. The team unveiled a dna computer with one quarter of its power in 2004.

"DNA computers won't compete with silicon computing in terms of speed, but their advantage is that they can be used in fluids, such as a sample of blood or in the body, and make decisions at the level of a single cell," McDonald said.

Feel the Power!

IBM has released further details of its dual core Power6 processor, due to debut in its System p servers from mid 2007.

At the Fall Microprocessor Forum, chief architect Brad McCredie said the chip has received a 30% performance boost from the use of 65nm technology and will clock at the upper end of the 4 to 5GHz range.

For low power, IBM has followed the trend to deliver different voltage supplies to different areas so blocks of transistors can be shut down when not required.

First test silicon was recently delivered, fabricated using an IBM process already tuned with game console chips supplied to Sony and Microsoft. It includes the latest iterations of IBM's for low k dielectric (used on the first eight of Power6's 10 layers) and silicon on insulator.

Context for Cortex

ARM has signed nine licensees for its Cortex-M3 low cost 32bit microcontroller core, although only three have yet declared their hand, according to cpu product manager Hadyn Povey.

STMicroelectronics and Actel went public at the ARM Developers' Conference, joining Luminary Micro which launched 'ARM for a dollar' Stellaris silicon earlier this year (see p36).

Neither ST nor Actel cited target applications, but sources said ST's lead project is an automotive airbag contract. Actel's deal builds on a relationship established with ARM in 2005 to integrate ARM7 cores

Gallium nitride process qualified on silicon

Nitronex has qualified the first GaN on silicon production process and is using it to fabricate a family of discrete rf power transistors for the WiMAX market.

"Our [NRF1] process, using industry standard silicon substrates, is key for a number of reasons," said Christopher Rauh, vice president, sales and marketing. "The use of 100mm silicon wafers allows us the scale to produce statistically significant and compelling reliability data, to use proven packages from the silicon industry and to quickly scale up volume production."

Two of the WiMAX chips, the NPT35015 (operating from 3.3 to 3.8GHz) and the NPT25015 (2.3 to 2.7GHz), use plastic overmould packaging, but which is relatively new to rf power. Rauh said GaN fits the WiMAX basestation market because of demand for 'power, efficiency, frequency and bandwidth beyond the specs of the current cellular market'.

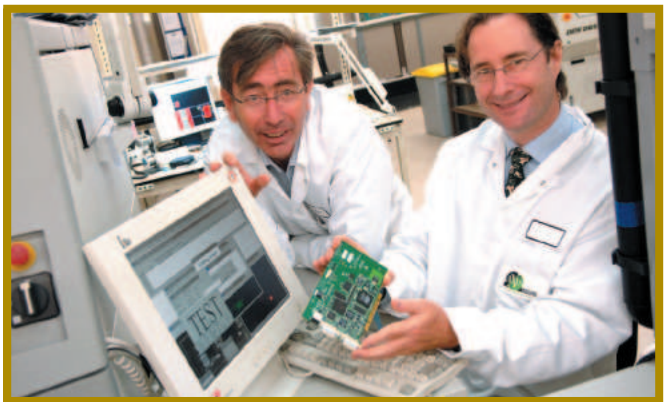
Enthusiasm and education

Growth in the electronics sector requires a steady supply of 'raw material'. **Vanessa Knivett** reports.

The first meeting has taken place between the Electronics Leadership Council (ELC) and the UK Electronics Alliance, the organisations primarily responsible for developing a strategy to address the issues raised in the Electronics and Innovation Growth Team Report.

A key focus of discussion was the perennial topic of how to attract fresh talent into the UK electronics sector – with one of the conclusions arrived at being that full support should be given to increasing the already successful SETNET scheme which appoints 'ambassadors' from the electronics sector that promote career paths in engineering to schools.

Also under discussion was the recent formation of the Electronics Knowledge Transfer Network (EKTN), thanks to a £3million grant from the Government. There was general agreement with EKTN chairman David Kynaston's recommendation that the EKTN should focus on the likely future disruptive technologies and the business skills and market opportunities that will enable them to succeed.



Axis Electronics has signed a multimillion pound outsourcing deal with Curtiss Wright Embedded Computing. The agreement will see most of Curtiss Wright's manufacturing equipment transferred to Axis, strengthening its low volume and prototyping ability.

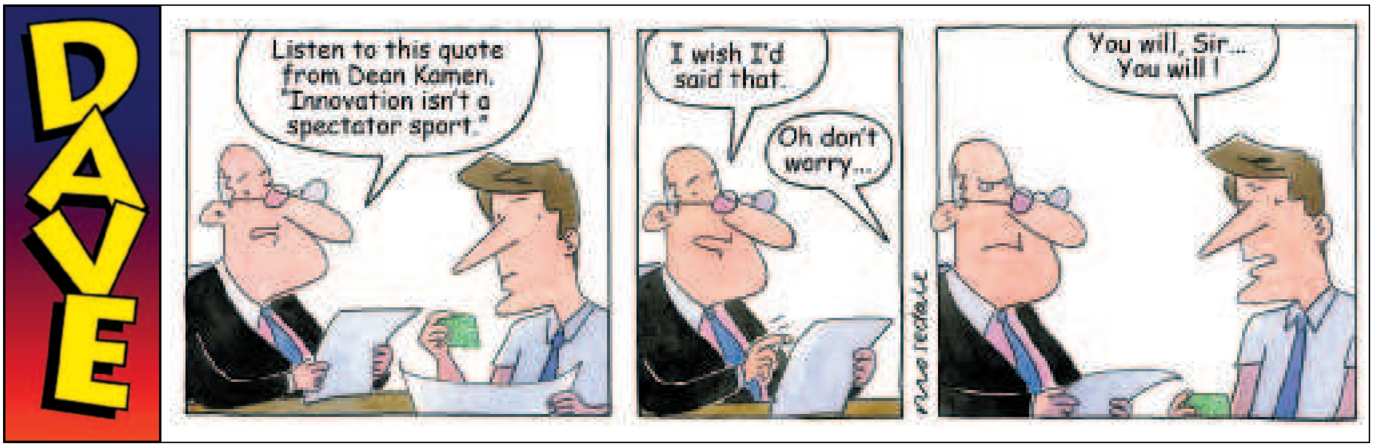
The road ahead for NXP

The owners of NXP Semiconductors – the old Philips Semiconductors – 'love' the semiconductor industry, according to executive vice president Marc de Jong.

Painting a less than happy picture of life within Philips, de Jong added that wasn't the case previously. "It was hard to get the resources needed to build the leading player in semiconductors." Nevertheless, the consortium of investors is likely to sell its holding within the next seven years.

The five investors in NXP, led by KKR, bought the company for €8.3billion, which de Jong admitted was at a 'significant premium'. "The market value was €5 to 6bn," he claimed. He believes the KKR led consortium recognised that the business renewal underway at NXP represented value.

NXP's management is now looking at ways in which it can increase the value of the company. In particular, it is looking at ways to be 'number one or number two' in the sectors it serves. de Jong noted NXP wanted to make further investments in r&d, but added that 'focused acquisitions' could not be ruled out. "These would have to enhance our position," he claimed, "For example, if we were lacking IP, then it could be that an acquisition would move us from number five to number one or two in a market." However, referring to recent speculation, he noted that Freescale 'wouldn't be a focused acquisition'.



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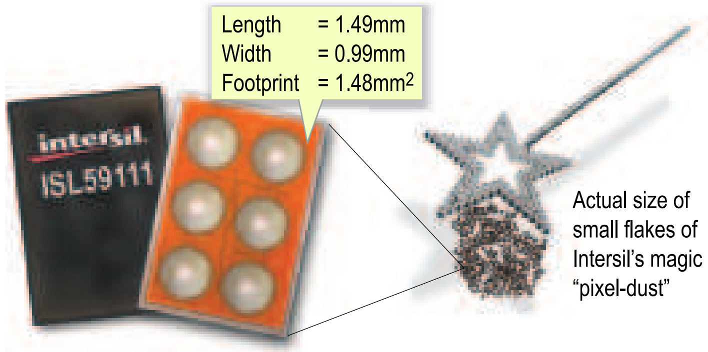

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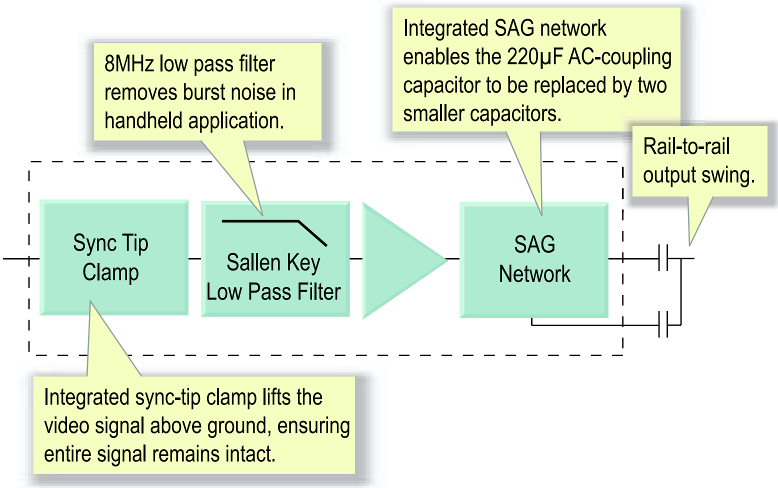
- Tiny, low profile chipscale package (ISL59111). ISL59110 and ISL59112 available in SC-70 package



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Change the world!

Innovation: the art of doing things that haven't been done before. By **Graham Pitcher**.

Innovation is critical to the survival of any business. In the electronics world, innovation is even more important, given the rapid change in both technology and the demands of the consumer.

Some have no doubt about its importance. Take Harry Tee, for example. He's chairman of the Electronics Leadership Council, which has been set up to drive the future of the UK's electronics industry. Tee is unequivocal: "I have one simple message for the UK electronics community," he said. "Innovate or die."

New Electronics, sister publication Eureka and Cranfield University's School of Management subscribe to Tee's view and recognise and celebrate innovation through the annual Innovation & Design Excellence Awards (iDEA).

Winner of this year's Innovation & Design Excellence of the Year Award was CSR, which also won the Product Innovation Award for its VoIP dongle and development kit.

You could be excused asking the simple question 'what is innovation?'. Lou Reade, editor of Eureka magazine, was one of this year's iDEA judges. He said: "We looked for factors that set companies apart from their rivals, such as: expertise in a particular branch of technology; an open, collaborative working environment; proven ability to solve customer problems; a desire to lead the market, rather than follow it; a willingness to take calculated risks; and proof of products that are successful in the market.

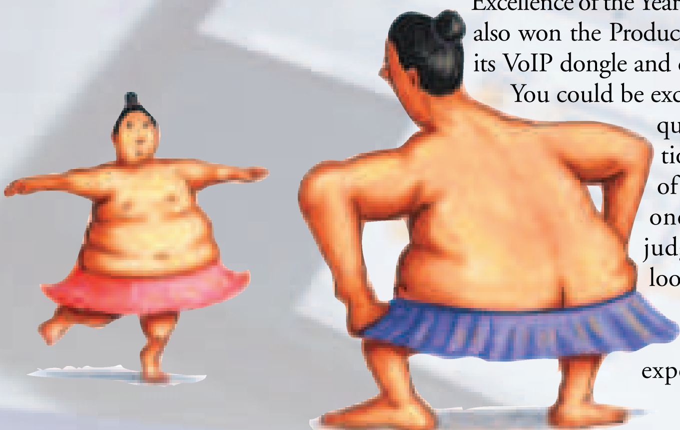


Illustration: Henning Löhlein

"The products themselves are very important. Companies need to prove their success in the market. But it's not enough that they simply have a good idea."

But here's another view of what constitutes innovation. It comes from Dean Kamen, president of DEKA Research, which numbers the Segway Human Transporter amongst its innovative developments. Kamen established DEKA in 1982 after 'dropping out' from Worcester Polytechnic Institute in the US.

According to the company, DEKA is a relatively small group of individuals with lots of innovative ideas. The company is organised to promote constant interaction between and within its electronics and software engineering groups. An on site machine shop and moulding facility are central to getting its ideas prototyped and tested as quickly as possible.

The website gives one definition of an innovative environment: 'Questioning of conventional thinking is encouraged and practised by everyone – engineers and non engineers alike – because open minds are more likely to arrive at workable solutions'.

But what is Kamen's definition of innovation? "It's like getting a Sumo wrestler to look good in a tutu."

> "It's like getting a sumo wrestler to look good in a tutu."
>
> Dean Kamen

Kamen gave his take on innovation in one of the keynote addresses at this year's NI Week, which took place in August in Austin. He expanded: "It's the unexpected results that make the biggest difference. You have to apply lots of effort and have a little bit of luck."

Kamen took the stage in Austin on his Segway wearing his trademark outfit of blue jeans and a denim shirt. During the course of his keynote, he presented a number of what he calls 'rude realities' of innovation, accompanied by some helpful suggestions drawn from the observations of others.

Innovation's Rude Reality number one, in Kamen's opinion, is that: "Great technology alone rarely constitutes innovation." He also believes that every successful project must feature what he calls the 'dark night of the innovator'. However, you have to get through that 'dark night' if a breakthrough is to be made. Illustrating this point, Kamen turned to Winston Churchill: "If you're going through Hell, keep going."

The bottom line, says Kamen, is to keep at it. "Don't get discouraged at the beginning of a development project just because you don't know what you are doing." Backing that up, he quoted Albert Einstein: "If we knew what we were doing, it wouldn't be called research, would it?"

And that brings about Rude Reality number

2. "Risk, failure and unpredictability are unavoidable."

Kamen's suggestion as to how to deal with this: "Fall behind early; the sooner you fall behind, the more time you have to catch up."

Yet surprisingly for a man who is behind what can only be described as 'breakthrough' products – amongst them the Segway HT and the IBOT mobility system – Kamen believes innovation isn't necessarily original. Another of his suggestions provides some explanation: "Innovate as the last resort." And this is backed up with a further definition: "Innovation is the art of concealing your sources."

There was a serious side to this observation. DEKA had been asked to improve a stent – a medical device used to open up clogged arteries in patients with heart conditions. The solution came from engineers who applied their knowledge of metallurgy in helicopter rotor design.

The Crown stent retained the high radial strength of the original device, but the improved design, which brought more flexibility, made it easier to insert into the patient.

To justify this, he turned to the legendary artist Pablo Picasso, who claimed 'good artists borrow; great artists steal'.

He returned to the concept of what innovation is or isn't. That gave the opportunity to unveil Rude Reality number 3: "Solving the solution is often the problem."

Again, he borrows from the writings of those who have gone before. In this case, it's the 19th Century American writer Henry David Thoreau. In his 1854 book 'Walden', Thoreau writes: "Our inventions are wont to be pretty toys, which distract our attention from serious things. They are but improved means to an unimproved end, an end which it was already but too easy to arrive at."

This quickly leads to Rude Reality number 4. "It's not what you don't know that inhibits innovation, it's what you do know that just ain't so." The thinking behind this relates to the pace of technological change. "Technical truth," said Kamen, "changes faster than any other truth."

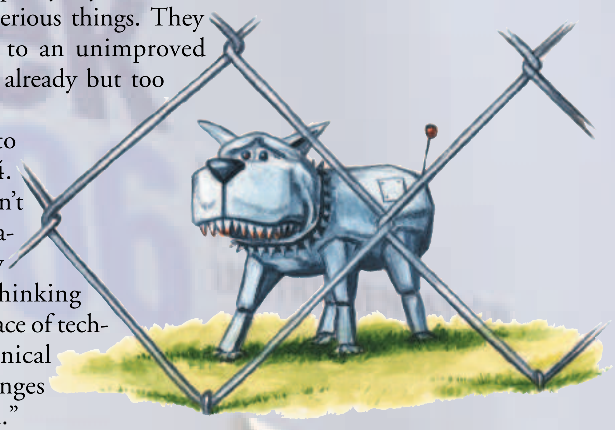
So how does a company create an innovative environment? The quick answer is that everyone needs to get involved and Kamen himself has noted before that it's easy to be a bystander. "Innovation isn't a spectator sport," he commented. "Whilst projects require management, innovation requires leadership." And he is somewhat critical of corporate management styles when it comes to handling innovation. "Management means things come out the same, whereas innovation is all about surprises. Management is all about doing things right; leadership is all about doing the right thing."

Straight into Rude Reality Number 6. "To err is human, but it's not company policy."

An interpretation of that statement is you have to fail in order to make progress. Kamen has observed in the past, talking about DEKA, that

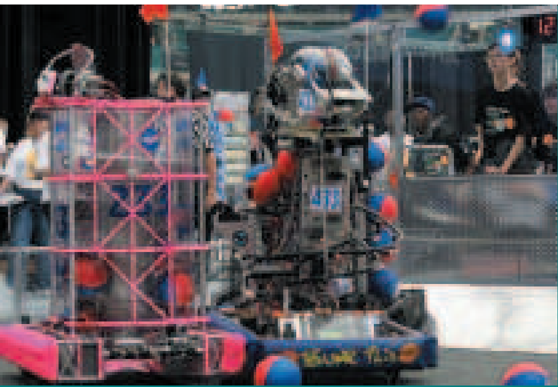
"Innovation isn't a spectator sport."

Dean Kamen



DreamWorks

Dean Kamen, president of DEKA Research, left, gave a keynote address at this year's NI Week whilst moving around the stage on his Segway.
Apart from inventing the Segway, DEKA has created a number of portable medical devices to provide better quality of life for patients.



Inspiring the new innovators

Dean Kamen is passionate about the future of engineering. When he makes his keynotes about innovation, he takes the opportunity to highlight work that is being done to develop the next generation of engineers.

And he believes that, in the coming years, scientists and engineers will be the 'superstars', rather than today's musicians and sportsmen and women.

One way in which he is turning his passion into reality is through FIRST – For Inspiration and Recognition of Science and Technology. Kamen established FIRST in 1989 as a way to make science, mathematics, engineering and technology to appear as 'cool' for kids as sports are today.

FIRST operates the FIRST Robotics Competition, in which teams of school students, sponsored and assisted by local companies and volunteers, design, assemble and test a robot capable of performing a specified task in competition with other teams. FIRST also runs the FIRST LEGO League, for 9 to 14 year old children.

He laments the fact that the US only produced 72,600 engineering graduates in total last year, whilst the output of sports management graduates was 84,000.

An important element in FIRST is engineers becoming involved in their community. Kamen says: "It's up to you to work with them to make it interesting for them to want to pursue engineering. You need to instil the passion for tools and science, as much as they now have for nonsense."

For more, go to **www.usfirst.org**

"The stone age didn't end because they ran out of stone!"

Dean Kamen

'sometimes we crash and burn'.

Now he gets serious. "Innovation is tough, so why do it?" His answer is simple. "We do it to do things that haven't been done before. Innovation, when created properly, can create entire industries."

When do you innovate was another of Kamen's rhetorical questions. "Well," he said, "it wasn't raining when Noah started building the Ark. And the Stone Age didn't end because they ran out of stone." He believes it's about finding ways to solve problems. The IBOT mobility device, for example, was developed after he saw a man struggling to get a wheelchair up a kerb.

Many people realise they need to innovate; many simply don't know how. Kamen said: "Don't define success as a lack of failure; simply embrace change."

DEKA's website gives a taste of working life there. 'We're engineers, craftsmen and designers. But first and foremost, we're problem solvers. That means we look at life a little differently, in an attempt to see beyond the obvious. It also means that in the process of solving problems we literally immerse ourselves in them, questioning everything and believing in nothing but our own ingenuity and abilities. It's a method that's helped us create effective solutions …'.

Nearing the end of his tour through the realities of innovation, Kamen answered the question of who is an innovator. "Innovators can be optimists or pessimists," he contended. "Optimists think about airplanes, pessimists think about parachutes." But whether they are optimistic or pessimistic, Kamen believes fervently that everyone needs to be enthusiastic.

Concluding, Kamen laid out what he sees as the Rudest Reality of innovation. It's a quote from Margaret Mead, anthropologist and president of the American Association for the Advancement of Science in 1975. She said: "Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has."

Kamen's view on changing the world? "Why change the world? To me that's what life is about. If you don't do that, you might as well hibernate. If everyone thinks what you do is 'normal' … it probably is. Why do that? Do something else!"

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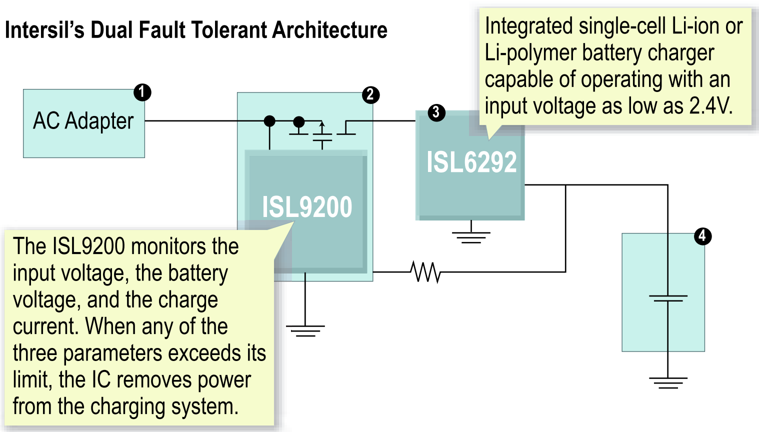

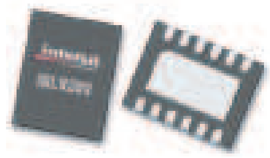

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POTENTIAL FAILURES				Consequence of Dual Failure
❶	❷	❸	❹	
●	●			❸ will fail but the protection module in the battery pack will protect the battery cell.
●		●		Both ❷ and ❹ will protect the battery cell.
●			●	❸ will limit the battery voltage. ❷ has an additional level of protection.
	●	●		The protection module in the battery pack protects the cell.
	●		●	❸ will limit the battery voltage to 4.2V, within 1% error.
		●	●	❷ will sense an over voltage case and remove the power from the system.

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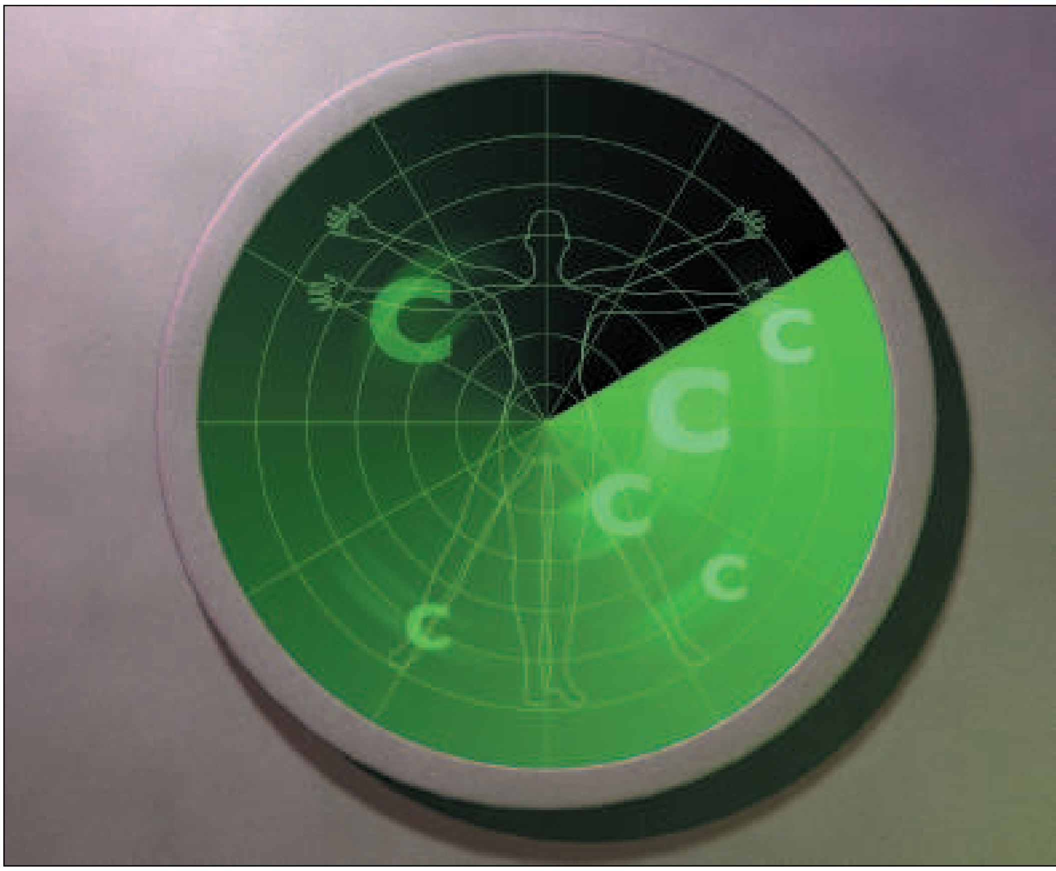
Totally obsessed with MicroTechnology

The NHS' role is not only providing healthcare, it is also a development hotbed for new technologies.
By **Vanessa Knivett**.



Catching cancer early

With strict regulation and the need for extensive clinical testing, bringing a new disease detection technology to fruition is no easy matter, even for large companies.

If you are a research team with a bright idea but no budget, it is difficult to get the funding and expertise needed. In the past, the hurdles have been so huge that innovation has gone untapped, particularly within organisations such as the NHS or the various teaching hospitals and research establishments aligned to it.

But the creation of a network of nine NHS Innovation Hubs is changing the way in which innovation is exploited within the NHS – and with success.

Medipex is the NHS Innovation Hub for the Yorkshire and Humber region. Set up to provide technology transfer services to the NHS, Medipex encourages NHS bodies and their employees to recognise the value of their ideas and provides practical support to would-be innovators – from the ideas stage through to development and final product launch.

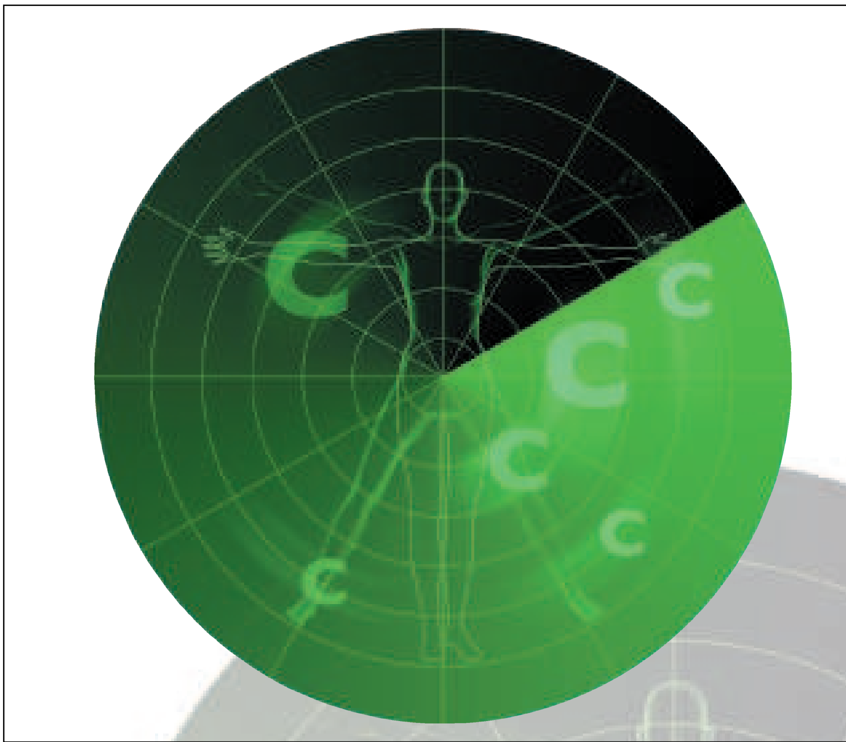
One project coming to fruition under Medipex' guidance is a cervical cancer detection probe pioneered by consultant gynaecologist Dr John Tidy at Sheffield Teaching Hospital NHS Foundation Trust and Emeritus Professor Brian Brown from University of Sheffield's medical physics department.

Richard Clarke, Medipex' chief executive, explains that whilst Medipex has only worked with Dr Tidy and Prof Brown in the last two years, it has been a long journey to get the probe to its current state. "This success is the culmination of a long standing university research project – perhaps 10 to 15 years of work – that sought to characterise human tissue. The technique that has been developed uses electrical current and frequency to differentiate between tissue types. Some three or four years ago, the research had developed sufficiently to begin differentiating cancer cells from healthy tissue. And, with the technique proving particularly successful at discovering cancer cells that are at or near the surface (unlike breast cancer), Prof Brown approached cervical cancer specialist Dr Tidy."

Probing a solution

Prof Brown and Dr Tidy's ambition is to create a small handheld device that will allow doctors to identify abnormal cells accurately during an examination. It is thought the probe will provide an instantaneous read out, detailing whether a woman will need treatment or, at the very least, additional tests. This will cut the time between diagnosis and treatment and avoid the sometimes stressful wait.

The introduction of a probe that could replace the primary screening process – smear testing – may bring substantial cost



"This project relied on skills within the trust, particularly those of a scientist who hand built the first prototype."

Richard Clarke, **Medipex**

savings for the national screening programme. At present, cervical screening – including the cost of treating cervical abnormalities – costs around £150million a year in the UK. Between 2003 and 2004, some 128,245 referrals were made to colposcopy clinics, where the extent of cancerous cells can be identified and where treatment or a further biopsy takes place.

For countries with a public screening programme, the cervical probe may be used as a diagnostic tool to help eliminate false positives and reduce the work load on the pathology services. However, with no public screening programmes in many developing countries, the probe could be a primary screening device.

Medipex works closely with the IP lead at the region's hospitals and has developed strong links with local universities, which was how it came to be involved with this project.

Asked what characteristics Medipex is looking for from individuals or groups that approach the organisation for help, Clarke recounts: "The first question is whether there is a market for the project? Whilst there is much research within the NHS focused at improving patient care, we need to prove the project has a commercial future. Secondly, do the inventors have a track record? They need to be keen to take the idea ahead – if you don't have the inventors' help and enthusiasm, it would be hard to get the project off the ground."

In this case, there was market potential, a proven and motivated team, plus the development of the underlying technology was further advanced than other projects Medipex gets involved with. Notes Clarke: "There is a lot of inventiveness in the NHS. Some of it comes from a rather 'make do and mend' culture as budgets always haven't been available for development work. So this project relied on skills within the trust, particularly those of a clinical scientist who hand built the first prototype for 'proof of principle'. Another bonus was that, when we got involved, there was already two years of clinical data."

Whilst Medipex would have supported the project earlier in its lifecycle, the development of an initial prototype meant it was a less risky enterprise and therefore easier to find funding. Nevertheless, it may take four years until a commercial version of the probe is available.

Medipex has enlisted the services of electronic design partner Triteq, which is contributing expertise in volume manufacture, test and quality engineering to further develop the original prototype.

Clarke evaluated several design and manufacturing partners, but chose Triteq because of its 'successful track record in producing software and hardware for safety critical devices', which has encompassed a number of previous medical device developments, including a foetal blood analyser. He comments: "Our initial conversations highlighted Triteq's methodical approach to product design and clear understanding of our objectives."

Triteq has chosen to develop its expertise in the medical arena, recognising the sector's buoyancy, especially in the UK – the fourth largest market in the world, according to Ken Hall, Triteq's technical director. He believes Triteq's success so far is due to a risk analysis based approach throughout its product design, quality and manufacturing processes, which has stood it in good stead with the introduction last year of IEC60601-1 year.

The combined team is now close to producing a full prototype. Recounts Hall: "Much of the initial work involves getting a detailed specification out of the inventors. However, if the appropriate work is done upfront, it pays dividends in the end – everyone is clear about what is being delivered."

The project, being advanced under the company name Aperio Diagnostic, has raised £175,000 so far. The inventors, the NHS trust, university and first stage funder Exomedica, share ownership. A further £500,000 is now required for a comprehensive evaluation of the probe. Hall is positive about its future: "We are fairly confident that similar technology can be applied to bladder, throat and anal cancer diagnosis."

Risk and susceptibility

What does the revised edition of IEC60601-1 mean for medical devices, particularly when specifying power supplies? By **Steve Elliott**.

Selecting the right power supply for a system can be problematic at the best of times. But when the supply is going to be used in medical equipment, the process becomes more complex.

Until recently, designers were required to use the second edition of IEC06060-1 when developing medical equipment, but this was not as precise as it could have been. However, the standard has now been updated to provide more clarity.

The third edition of IEC60601-1 was published in December 2005 and medical device manufacturers have been able to use it since then when designing new devices. Nevertheless, there will be a period of three to five years during which companies can produce devices to the specifications detailed in either the third or second editions. However, the second edition will be withdrawn after that.

IEC60601-1 third edition differs from the second edition in that it now includes specifications for both 'basic safety' and 'essential performance' of medical devices. The second edition was only concerned with the basic safety of devices, requiring that they did not present a mechanical, electrical, thermal or other hazard. It did not define a requirement for devices to remain functional; fail safe was adequate, and compliance to each clause was on a pass/fail test criteria without taking into consideration the essential performance of the medical device. The most important change in the third edition's requirements is that manufacturers must apply risk management (in accordance with ISO14971) to devices being certified. In essence, the device manufacturer is being forced to comply with both a product and a process standard.

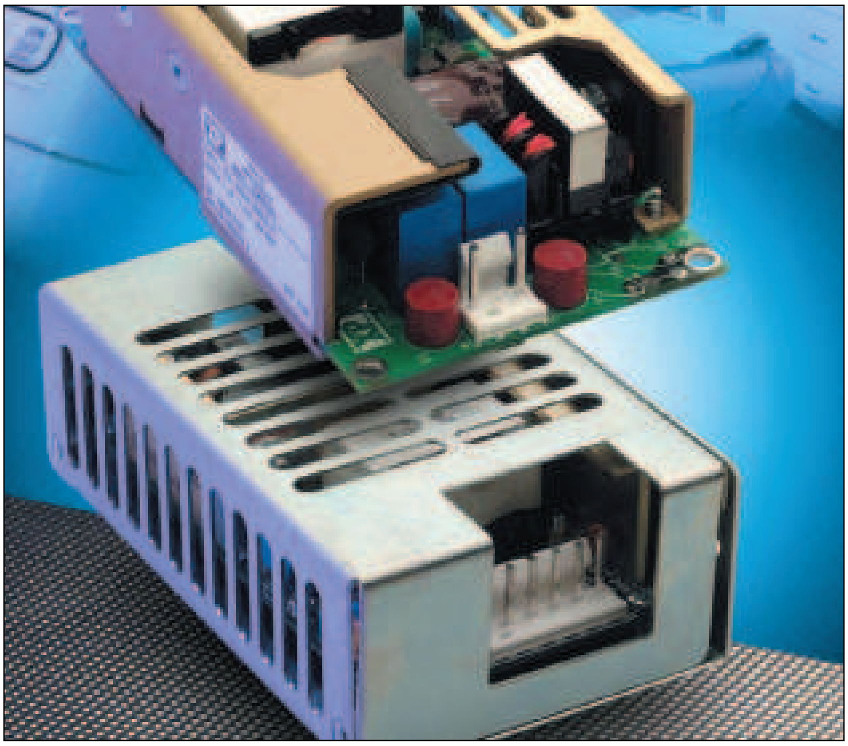
With respect to power supplies, the most important consideration is electrical safety. For the first time, the third edition now makes a distinction between the operator of a medical device and the patient to whom its operation applies. Different levels of isolation are applied to patient and operator circuits.

Susceptibility

The isolation requirements are defined as means of operator protection (MOOP) or means of patient protection (MOPP). Anything classified as MOOP will only have to meet the creepage and clearance requirements of IEC60950 – an information technology equipment (ITE) standard that is much less stringent than any version of IEC60601-1. By contrast, devices requiring MOPP must meet the specification laid down in the second edition of IEC60601-1. Another complication is that equipment could be classified as having a MOPP part and MOOP part, which is often determined by risk analysis. The third edition still maintains the same concept of a safe system but the terminology of insulation types has changed. Basic insulation is now defined as insulation providing 1 Means of Protection (MOP) and double or reinforced as insulation providing a 2 MOP rating.

In the third edition of IEC60601-1, the patient vicinity is less well defined than in the second. The latter stated that the patient vicinity was an area within a circle of 1.5m from the patient. The third edition now uses risk assessment to determine where the patient is

Elly Walton



These 100W ac/dc switchers meet industrial, ITE and medical specifications, yet cost little more than ITE only units.

"In essence, the device manufacturer is being forced to comply with both a product and a process standard."

Steve Elliott, **XP Power**

and the likelihood of them making contact with part of the medical device. It also makes a distinction between a conscious and unconscious patient – the implication being that the unconscious patient needs a higher level of protection. The safety requirements for equipment that only comes into contact with conscious patients maybe the same as the MOOP requirements for operators (what happens if a patient passed from consciousness to unconsciousness during a medical procedure is not made clear).

Selecting a supply

In theory, a power supply that meets IEC60950 could be used for some applications. This would appear to offer potential cost savings to the medical equipment oem. However, if the power unit drives any part of a circuit needing to provide a MOPP, secondary isolation will be needed to meet the isolation and patient leakage requirements. If the risk management process determines that the risk of the patient making unintentional contact with the equipment, or that the risk to a patient making intentional contact is acceptable, then a power supply providing only MOOP could be used.

Unfortunately, there is a significant complication in that such a power supply would still have to meet the earth leakage current requirements for a medical device used within the patient vicinity – so it would probably need to be modified to do this. Modifications to reduce leakage current almost always result in poorer electromagnetic compatibility (emc) performance. This is, at least in part, due to the smaller filter Y capacitors that have to be used in order to reduce leakage current. Additional filters, either within the power supply or in the form of external modules, may then be needed. The whole equipment may then need to go through the expensive and time consuming process of being re-approved with respect to safety and/or emc performance.

So, whilst a manufacturer might save a few dollars by buying an IEC60950 approved unit, rather than a power supply approved to IEC60601-1, it could limit potential applications for the end equipment and could result in the power supply having to be modified to meet leakage current requirements and emc specifications.

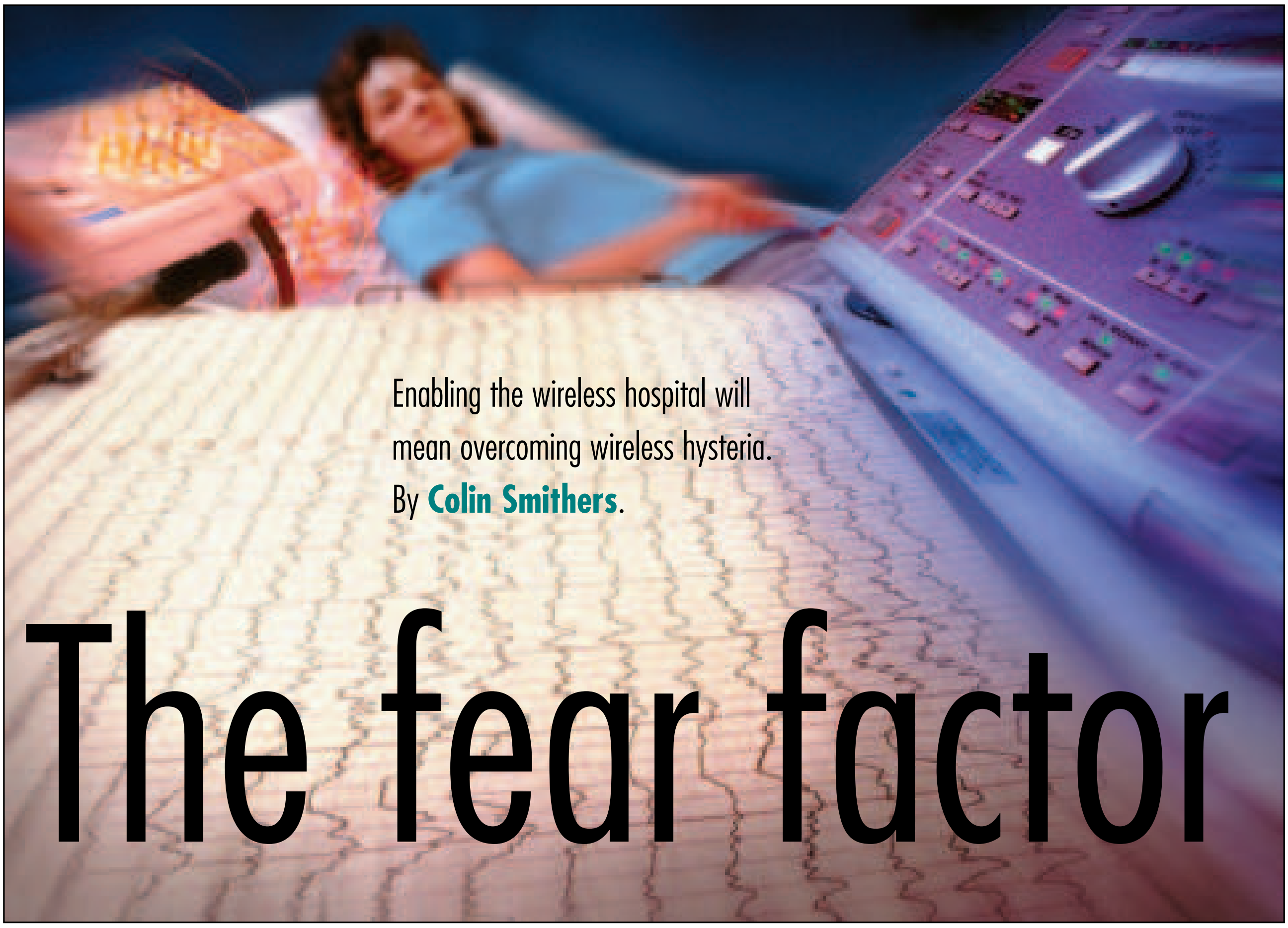
Another factor needs to be taken into account when considering the use of IEC60950 approved, rather than IEC60601-1 approved, power supplies. The use of an IEC60950 unit may limit the use of the medical device in some applications or markets due to market forces. This is present today with the second edition standard where manufactures choose to design their products to IEC60601-1, even though it may not be technically necessary in order to satisfy end customer concerns – for example, where the equipment may be physically located within a health facility.

The good news is that cost effective power supplies that meet IEC60601-1 are available. Five years ago, these were thin on the ground but recently new component technologies and design techniques have led power supply makers to produce units that simultaneously meet industrial, ITE and medical specifications. The higher volume manufacturing that this approach permits has brought down the cost of medical power.

A typical power supply in the 60W to 100W region costs around $50 in quantities of a few hundred pieces. Moving to an ITE only approved device is unlikely to produce cost savings of more than $5 and this approach is likely to limit application flexibility, lead to costly modifications to meet leakage current requirements, have a negative impact on the device manufacturers' brand, and, in extreme circumstances, put patients at risk.

Author profile:

Steve Elliott is medical industry director at XP Power.



Enabling the wireless hospital will mean overcoming wireless hysteria. By **Colin Smithers**.

The fear factor

One of the key developments in medical devices over the next few years is likely to be the growing use of wireless technology. Hospitals have been slow to adopt this technology so far, which is already widely used in most other areas. Yet wireless technology can not only save hospitals time and money, but also reduce cable clutter at a hospital bedside and allow patients to move around freely within the hospital grounds while being monitored.

Whilst the technology is available, many hospitals are still fearful of the 'risks' of rf wireless assisted devices, as is evident by the 'switch mobiles off' sign at the entrance of most hospitals.

This unnecessary hysteria stems from the early days of mobiles, when there was a concern over the robustness of some medical devices in the presence of rf energy. At the time, the Medical Devices Agency (MDA, now the Medical and Healthcare Products Regulatory Agency MHRA), an agency of the Department of Health, surveyed 178 different models of medical device, including drug/fluid infusion devices, pulse oximeters, defibrillators and various monitors. While some manufacturers' equipment was unaffected by rf, others failed catastrophically.

Electromagnetic compatibility (emc) protection has obviously improved in modern medical devices. However, hospitals still seem to make blanket bans on gsm phones, despite the recent update of a report by the MHRA which make sensible suggestions as to where gsm phones should be banned and where not.

Wireless options

There is a range of wireless technologies that could be used in the medical environment – from Bluetooth to various WiFi implementations and other proprietary standards. The requirements for the products in which the wireless technology will be incorporated, and where the products are intended to be used, will greatly influence which technology should be chosen. Issues such as interoperability, reliability, data rate and range are important to anyone designing or selecting equipment to be used in a hospital environment.

Most standards based radios, although ideal in some applications, are generally less ideal in areas where battery life is of concern, or where a guaranteed quality of service is required. In these circumstances, it may be better considering a full custom radio solution. The advantage of a custom system is that you are able to design to a quality of service level, and create system topologies which are not possible using the standards based radios.

The fastest growing area of wireless implementation is currently 'wireless vital signs monitoring'. Frost & Sullivan has predicted that the European market

for this technology will be worth $178million in 2011, but it is in the US that this movement is most rapid, owing to a unique and versatile frequency allocation known as wireless medical telemetry service (WMTS).

This has three bands at 608 to 614MHz, 1395 to 1400MHz and 1427 to 1432MHz. The 608MHz allocation is shared with radio astronomers such that, outside the range of telescopes, individual hospitals are allowed to self administer a 6MHz band in four 1.25MHz sub bands. This allows for considerable innovation in the use of the spectrum within hospitals.

"Wireless technology can not only save hospitals time and money, but also reduce cable clutter at a hospital bedeside."

Colin Smithers, **Plextek**

Plextek has already designed a high density WMTS system for a major US medical device manufacturer using this frequency allocation. This required provision of a complete system solution, including the detailed development of all rf and baseband electronics. The system specified both bedside and patient worn units, and needed to interface directly to the client's existing data collection and display system. Other requirements were a low bill of materials cost and long battery life for patient worn monitors. It also needed a high tolerance to fading as the patient moves around the hospital.

Propagation measurement

One of the early stages of the system level design was to perform detailed in hospital propagation measurements. The results of these measurements were used as the basis for path budget calculations, which were used to determine the required performance parameters of the system. Detailed simulation of the complete system, including both circuit performance and environmental parameters, allowed the appropriate design trade offs to be made, and gave confidence that the system capacity targets could be met.

System implementation

Plextek successfully defined and developed the air interface, radio and signal processing technology for the system. The end to end system design was carefully optimised to take account of battery life of the patient worn monitor units, transceiver complexity and bom costs, data transmission integrity and ease of system installation.

To achieve this, Plextek employed a wide range of state of the art digital communications design techniques based on dsp, coupled with power saving solutions and measures to compensate for the highly variable radio propagation channel.

The system provides reliable data collection and high spectral efficiency, allowing a large number of end points to be monitored simultaneously. It is now in volume production and has been successfully deployed at a large number of sites.

Problems in Europe

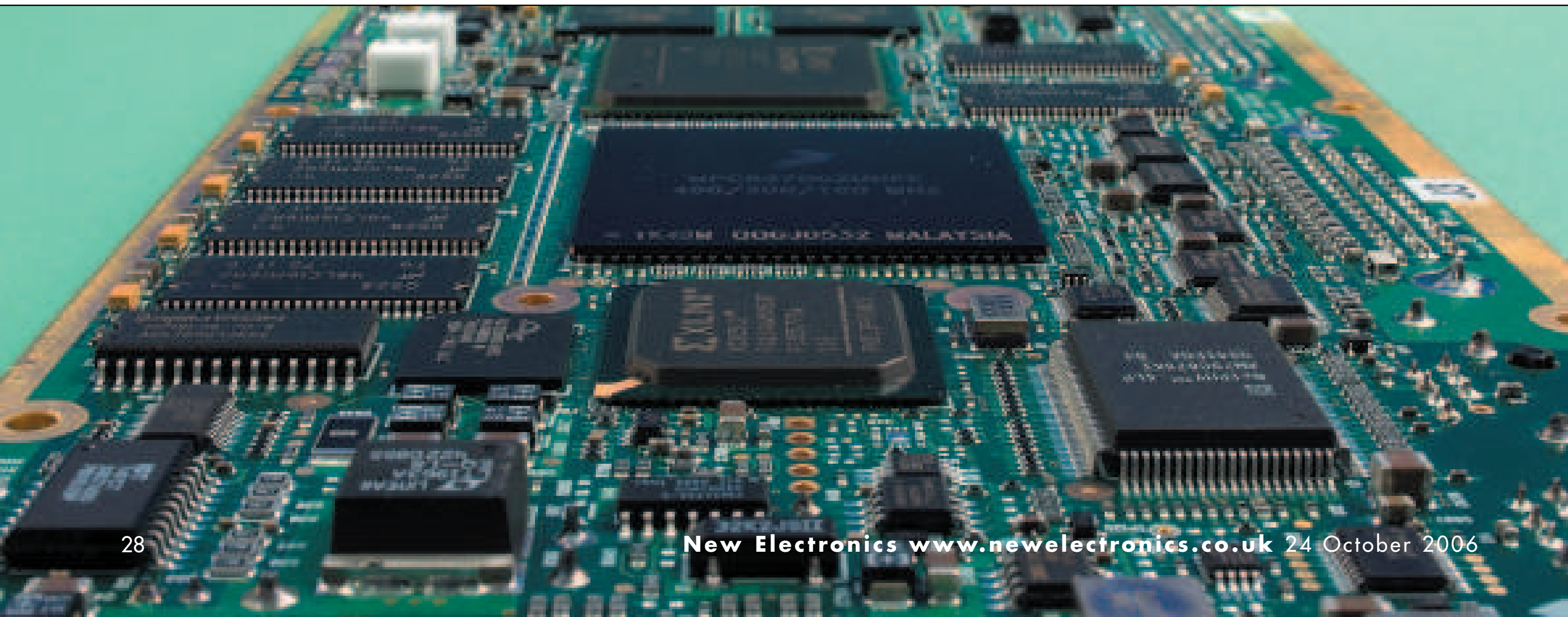
In Europe, however, there is no such allocation. There is a low power allocation at 402 to 405MHz for short range devices and there is talk of medical allocations in the 868MHz band, but it is unclear that it would ever be designated exclusively to medical devices or administered locally.

So such a system would need to use DECT, Bluetooth, WiFi or one of the unlicensed ISM bands, or in future, possibly Ultra Wideband (UWB). All of these have their individual merits and demerits, but the huge difference is that as there is no control over the local spectrum usage, interference limits the density and quality of available links.

For vital signs monitoring, where highly sampled cardiac waveforms across multiple patients are the norm, this is far from ideal. Such applications certainly make a strong case for a WMTS style allocation in Europe.

Author profile:

Colin Smithers is managing director of Plextek.



Spot the opportunity

Domino (X) set to address next generation digital video applications. By **Graham Pitcher**.

Video images, whether generated from a dvd player, received via television or captured using a hand held device, are moving towards ever higher levels of definition. This move is underlined by the recent push for high definition (HD) tv and the accompanying sales effort for lcd and plasma tvs.

Kenroy Francis, director of digital tv products for LSI Logic, noted: "Digital broadcast is entering an era of change from standard to high definition and a shift from Mpeg2 to H.264." And that, says Francis, creates a problem. "There are several million boxes in the UK which are based around Mpeg2. Whilst Sky has announced H.264 transmissions, they are being simulcast with standard definition. And any IT network coming online is going straight to H.264 because of bandwidth issues."

So Francis says H.264 is on its way. Yet the average home has several pieces of Mpeg2 based equipment. "How do you then share video content or use your existing set top box (stb)?" he asked.

LSI's response has been to extend its Domino architecture – which has been around since 2001 – to take account of these developments. The enhancement – Domino (X) – is, for the moment, an architecture, but products being rolled out next year will target professional broadcast, HD optical and HD stb applications. But the main target will be consumer devices – anything ranging from a pc to hand held portables capable of displaying, and even sharing, video content.

There are three main applications for Domino (X): transcoding, such as converting H.264 to Mpeg2; resolution change, such as HD to standard definition; and bit rate reduction. "We see this capability becoming key in the future because the industry is moving towards having large server type boxes in the home – maybe stbs, but they could be an HD dvd box – with the ability to share content with other consumer items. The ability to transcode will become commonplace in this box."

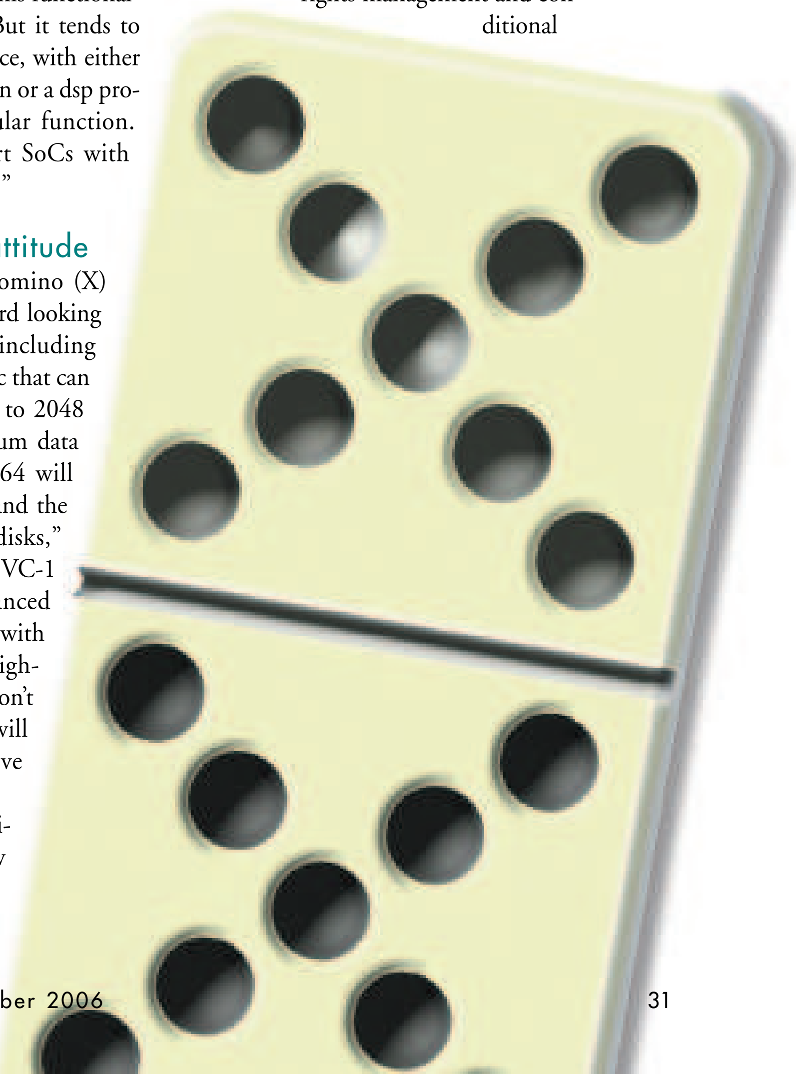
Francis acknowledges this functionality is already available: "But it tends to come as a standalone device, with either a hard wired piece of silicon or a dsp programmed for the particular function. Domino (X) will support SoCs with that functionality built in."

Forward looking attitude

According to Francis, Domino (X) devices will address forward looking compression standards, including H.264 and VC-1 – a codec that can support resolutions of up to 2048 x 1536pixels at a maximum data rate of 135Mbit/s. "H.264 will address the main profile and the high profile for optical disks," Francis continued, "while VC-1 will go to the AC Advanced Profile, probably for use with streaming video. That highlights another shift, we don't know how the internet will affect how people receive video content."

The Domino (X) architecture is scalable, to allow devices to be created for different markets. Much of the architecture is a result of LSI's acquisition of C-Cube Microsystems in 2001.

Domino (X) features five main blocks: application processor; graphics engine; security processor; video engine; and audio processor (see figure 1). Francis noted the platform supports all major audio standards and features a dedicated high performance application cpu. "It also has a powerful graphics processor, because the user interface will determine product success and ease of use is vital." But a new development is a security processor. "As well as handling digital rights management and conditional



"It has a powerful graphics processor, because the user interface will determine product success."

Kenroy Francis, **LSI Logic**

access, Domino (X) will have a security processor isolated from any bus so that people can't get access to it. This processor will recognise, for example, when hackers are trying to get access."

Bearing in mind the target consumer market, cost is an issue, so LSI has pitched the architecture to fall between the hard wired and dsp extremes. Video engine and audio processor blocks each feature a risc cpu, with hardwired microcode instructions to access known functions for encoding and decoding. "We still have flexibility in terms of how the device can be programmed to do multiple applications," Francis continued, "because we go down a long way in terms of encode and decode."

The risc processors in the video and audio blocks started life as SPARC processors. Since then, LSI has made major changes. "We've taken SPARC and done a number of things to it over the years," he noted. In the video engine, this processor is coupled tightly with a video dsp hardware block.

In terms of performance, the engine can run dual H.264 decodes simultaneously, in conjunction with the MIPS based applications processor, out of DDR II memory. "We believe we're the first to achieve this," Francis claimed. Domino (X) based devices will also be able to receive an H.264 video stream and transcode it to Mpeg2 HD 'on the fly'. "There is no storing and delivering in non real time," said Francis, adding "we believe that, in a single SoC, nobody else can do this."

The audio processor features a similarly modified SPARC, with alternations that make it more audio friendly. 'DSP like' audio functions are also available in hardware.

Pre and post video processing is also supported. "Essentially," said Francis, "Domino (X) acts as a signal processor, so it can analyse an analogue signal that's been digitised before it's encoded. On the fly analysis in the digital domain allows noise to be identified and removed." He noted these techniques are typically implemented in dvd recorders. "With an analogue input receiving an analogue broadcast, there's always noise and that can be removed. The result is a higher quality encoded signal."

For post processing, dvd recorders typically have an interlaced output. "Using the video engine," Francis noted, "we can do 3d motion adaptive deinterlacing to get very high quality deinterlacing." This feature is targeted at flat panel tvs.

Another tv related feature is the ability of Domino (X) to handle high quality scaling of video outputs. "This will support such features as picture in picture and picture alongside picture," Francis claimed.

Significant software effort

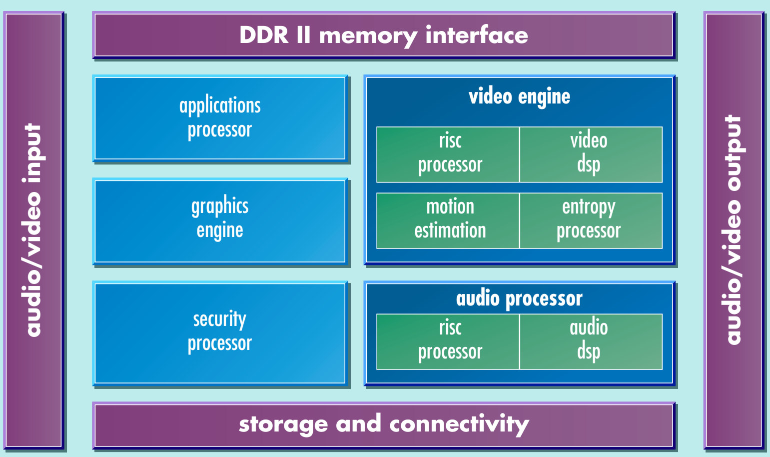
Although LSI has developed a hardware architecture, there's a lot of software involved in Domino (X). "There's a significant amount of software effort required," said Francis, "such as developing objects to do coding."

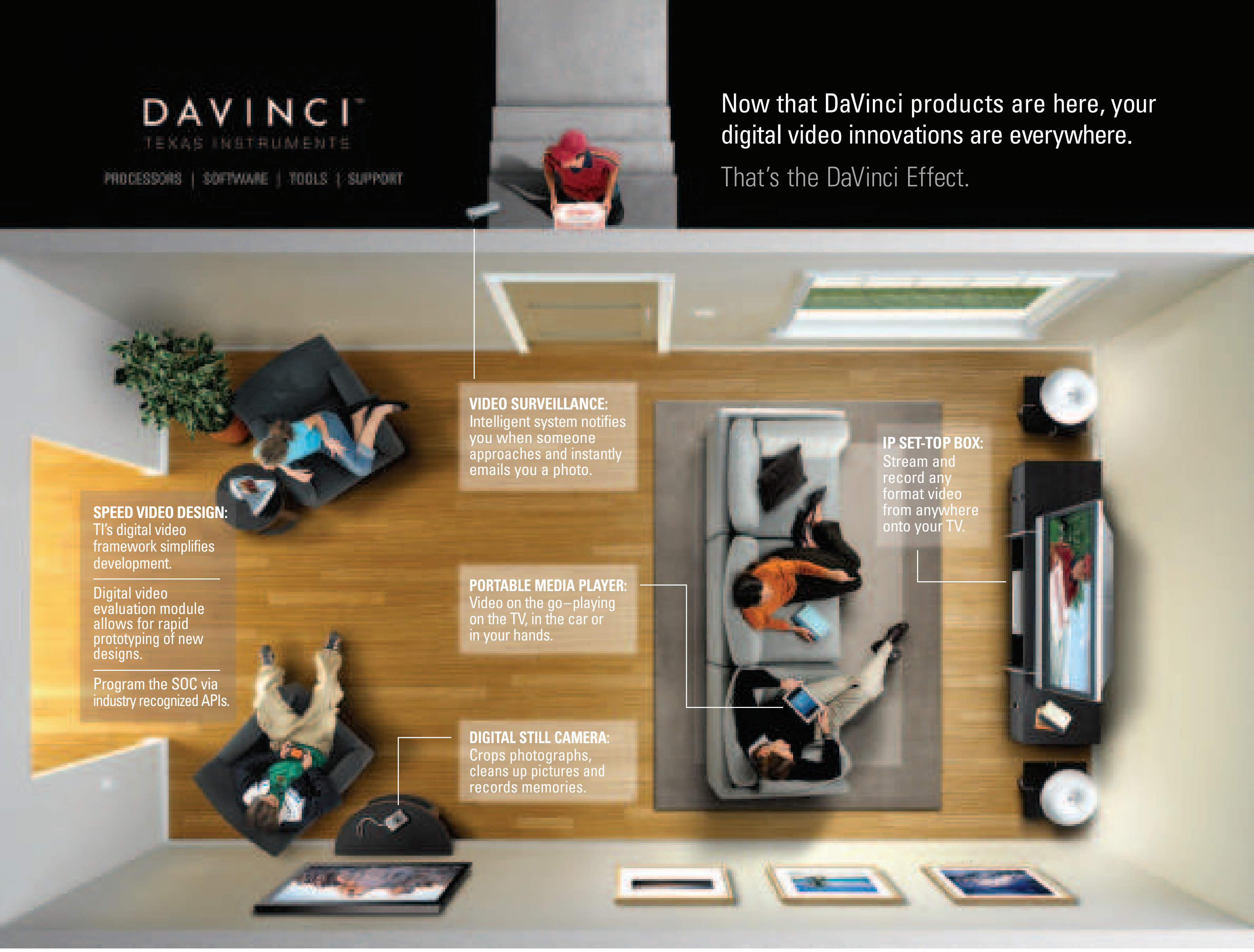
At the lowest level – the minimum required to enable the chip to perform decoding, encoding and transcoding – is LSI's proprietary C-Ware software.

And, depending upon the application, LSI will develop additional software – even up to the user interface – and come to market with a chip or work with a customer's dedicated development team. "In the optical disk area," Francis noted, "there's a level of expectation for an entire solution. In the stb market, manufacturers invest in developing apis and that's not something a semiconductor company will get into. But we are asked for high quality low level drivers."

When Domino (X) products appear next year, the consumer electronics business will require them to be made on leading edge processes. The applications processor will be either a MIPS24k or 34k running 'very fast' said Francis. "But they will be single chips," he concluded.

Figure 1: Block diagram of the Domino X architecture



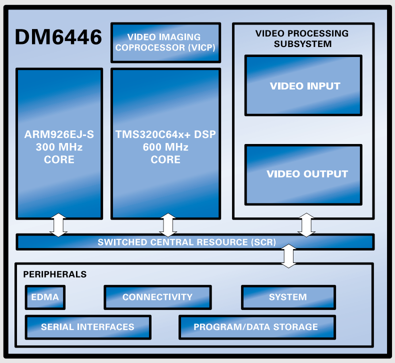


Davinci™ Technology makes astounding creativity possible in digital video devices for the hand, home and car. The DaVinci platform includes digital signal processor (DSP) based SoCs, multimedia codecs, application programming interfaces, application frameworks and development tools, all of which are optimized to enable innovation for digital video systems. DaVinci products will save OEMs months of development time and will lower overall system costs to inspire digital video innovation. So what are you waiting for? You bring the possibilities. DaVinci will help make them real.

What is DaVinci?

Processors: Digital Video SoCs:

- TMS320DM6446 – Video encode/decode
- TMS320DM6443 – Video decode



Performance Benchmarks:

STANDALONE CODECS	DM6446	DM6443
MPEG-2 MP ML Decode	1080i+ (60 fields /30 frames)	720p+
MPEG-2 MP ML Encode	D1+	n/a
MPEG-4 SP Decode	720p+	720p+
MPEG-4 SP Encode	720p+	n/a
VC1/WMV 9 Decode	720p+	720p+
VC1/WMV 9 Encode	D1+	n/a
H.264 (Baseline) Decode	D1+	D1+
H.264 (Baseline) Encode	D1+	n/a
H.264 (Main Profile) Decode	D1+	D1+

+ denotes available processor headroom for analytics and/or other features

Tools: Validated Software and Hardware Development

- DVEVM (Digital Video Evaluation Module)
- MontaVista Development Tools
- Code Composer Studio IDE

Software: Open, Optimized and Production Tested

- Platform Support Package
- MontaVista Linux Support Package
- Industry-recognized APIs
- Multimedia frameworks
- Platform-optimized, multimedia codecs:

- H.264	- AAC	- G.729ab
- MPEG4	- WMA9	- WMV9/ VC1
- H.263	- MP3	
- MPEG2	- G.711	
- JPEG	- G.728	
- AAC+	- G.723.1	

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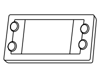
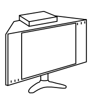
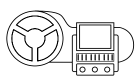
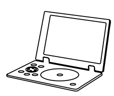
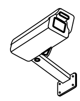

Portable Media Player


IP Set-Top Box


Automotive Infotainment


Digital Still Camera


Digital Video Innovations


Video Surveillance


Video Phone & Conferencing

Technology for Innovators™ Texas Instruments

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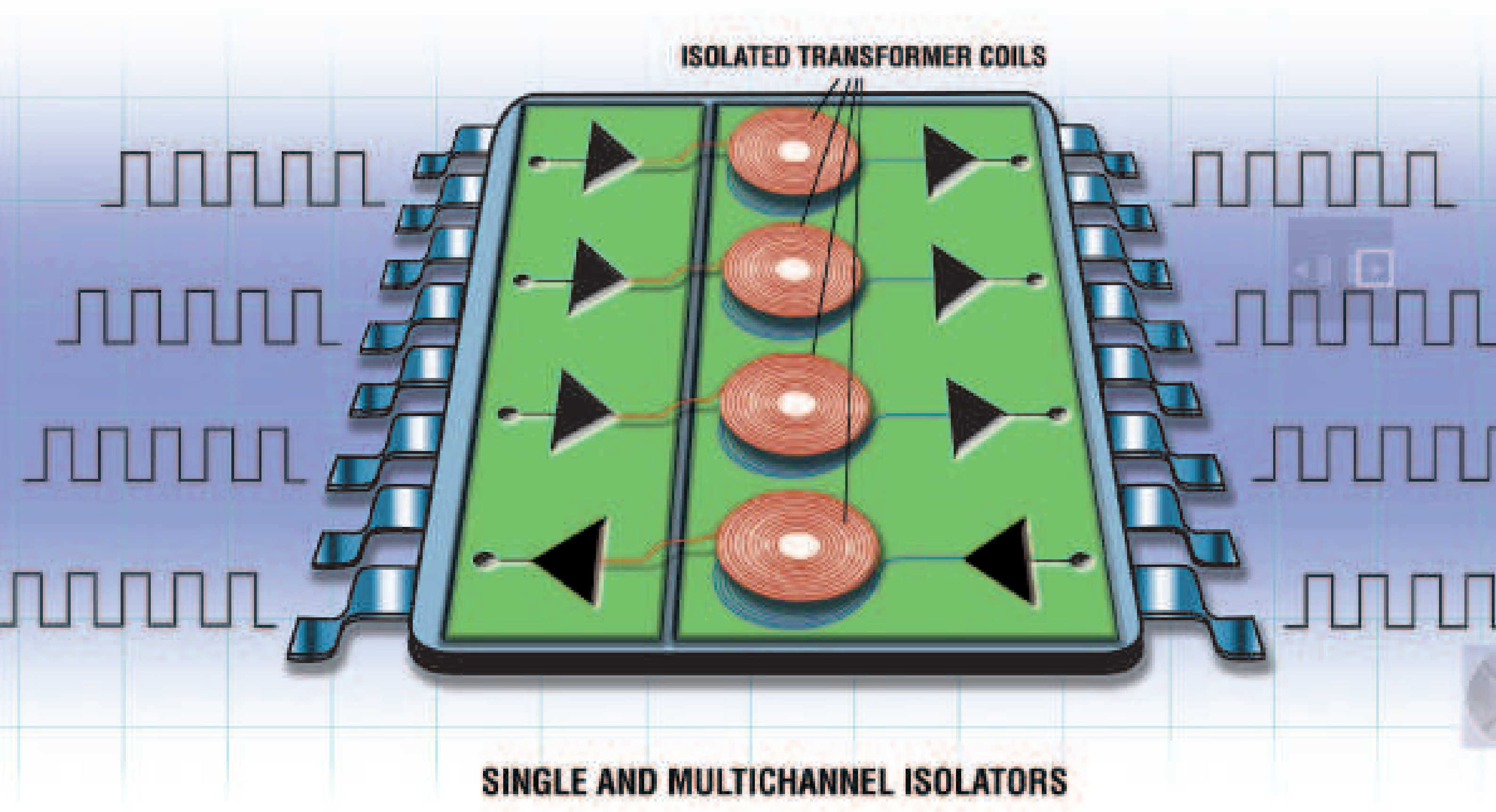

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- Dual channel, 2.5 kV data isolation
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All pricing in $U.S. 1k quantities unless indicated.

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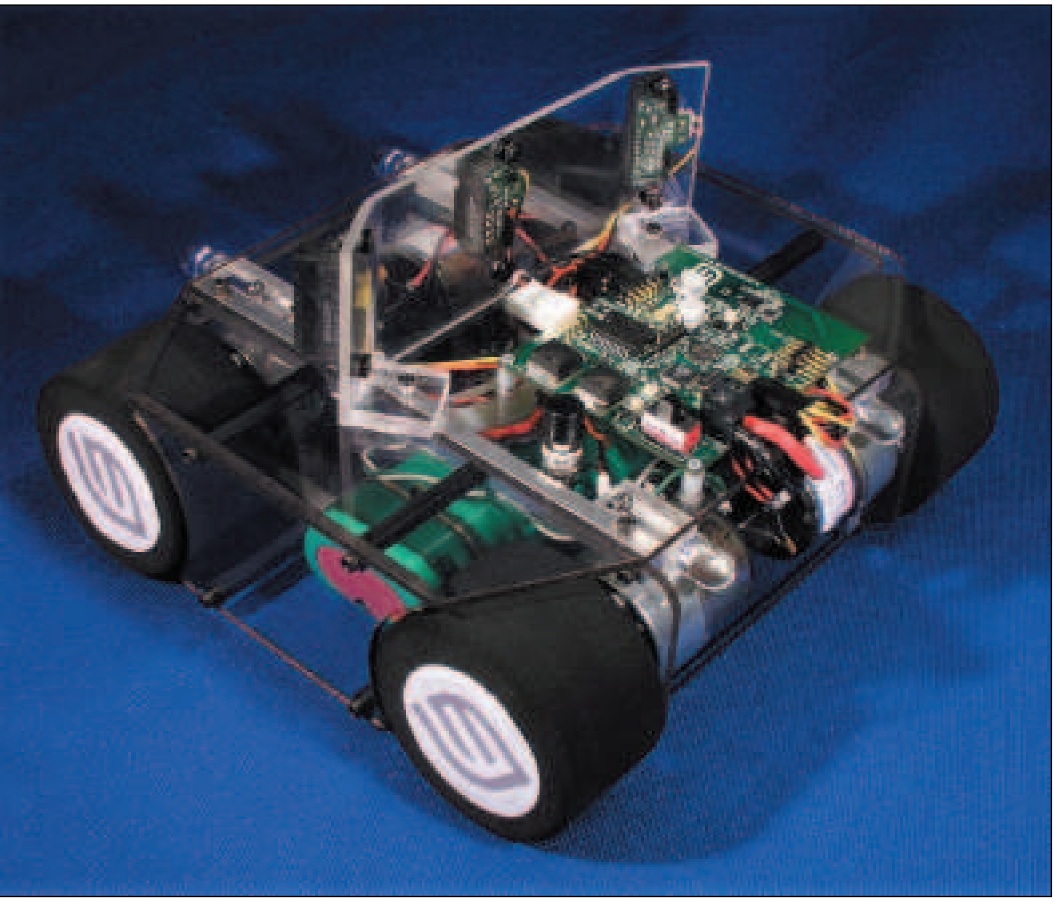


This robot car demonstrates the capabilities of Cortex-M3 based silicon. It includes features such as Zigbee radio and support for a/d converter channels. A video demonstration of the vehicle can be seen online at **www.newelectronics.co.uk**.

I'll buy that for $1!

ARM's Cortex-M3 core gets its first outing in a $1 microcontroller. By **Paul Dempsey**.

For Jean Anne Booth, chief marketing officer of Austin based start up Luminary Micro, it was the proverbial 'no brainer'.

"I've known the ARM guys for a long time. We had talked about various projects, but I was at a company that didn't want to evolve in that particular way. Still, I knew what ARM had in development and, in 2004, I was looking at what I wanted to do next," she says.

"When I looked closely at the technology and the options, I realised we could build (an) ARM (based micro) for $1 profitably. I said, 'we have to do this'."

In March, Luminary released its Stellaris microcontroller, the first based on ARM's Cortex-M3 processor. It now has 19 parts available and the $1 entry price highlights that the M3 is ARM's 32bit bid for the low cost, deeply embedded 8bit and 16bit mcu business.

ARM arranged the silicon debut for its latest core by working with a start up – not an IDM nor with an established fabless player. The parts will also go through distribution (Alpha Micro Components in the UK), although ARM once had concerns over the channel's ability to provide sufficient technical support.

There were good reasons for this choice of a start up lead partner, according to Hadyn Povey, ARM's cpu product manager with responsibility for the M3. His company had confidence in Luminary's founders – Booth and ceo Jim Reinhart had been key members of the embedded computing team at Cirrus Logic. But the decision had more to do with the disruptive nature of the new core and the target market.

"The 16bit and high end 8bit microcontroller is entrenched inside a number of our traditional partners and why would they want to upset that business? Luminary is a hungry and focused organisation and, for the M3, we can go out there with them and start creating the turbulence, accelerating the migration to 32bit," says Povey.

Another factor was the lag between ARM releasing a core and its incorporation in silicon. Povey says automotive OEMs showed early interest in transitioning to 32bit mcus. There are today nine M3 licensees, but only three have gone public – STMicroelectronics, Actel and Luminary. Right now, Whilst ST is refusing to say which applications it will target, jaws will plummet if automotive is not one of them.

"But," says Povey, "the nature of automotive is that you are filling sockets which only appear every five to 10 years. It's then a couple of years battling to win the socket. When you do win, you have to wait until the units are made, fitted into a car and are out there. That's when you hit volume and it can be a six year thing. It does not have general or immediate visibility."

Luminary is deliberately ignoring automotive. "Go into a VC and say you've got this great automotive product, but volume is a decade away, and you're toast," says Booth. Instead, the company is going after the general purpose mcu market, where visibility is distribution driven.

"[Luminary's US distribution partner] Arrow North America's 8bit micro sales last year were roughly $380million. That exceeds what's shipped by any one manufacturer directly, probably a lot of them combined. When we looked more closely, the largest customer was $1m," says Booth.

In this context, she describes the typical Luminary customer as a company with 'three to five engineers working on a development schedule that's probably nine months and buying somewhere between 5000 and 50,000 units per year'.

This profile dictated other aspects of the launch strategy, with Luminary convincing ARM that the marketing had to be based equally on what 32bit offers and the simple question 'Why not?'.

"Price does matter, because ARM for a buck is comparable to 8 and 16bit," says Booth. "But there's more to it. You need the pitch to say, 'We make this easy for you'."

Technically, the M3 is simplified in comparison with other ARM cores. For example, there is only the Thumb-2 instruction set to worry about and the entire code base is written in C/C++ with no assembly language. There is also ARM's 'eco system' of support tools, including its RealView Microcontroller Development Kit.

"One of the biggest pushes in our alpha programme was making sure we had everything in place to release product directly into the distribution channel. Is the documentation OK? Do we have the right app notes? Do we have the right tools so people can figure this out without everyone calling us?" says Booth.

"Take our development kit. We have evaluation kits that are single tool solutions, but the development kit comes with evaluation versions of a couple of different toolsets because it's targeted at 8 and 16bit upgrade guys who don't necessarily know whether they want Keil, IAR or GNU. They're coming over from 8051 or TI or Microchip and don't know what they want until they try out all the options."

So how is it going? ARM certainly seems happy with progress and Luminary is now claiming design wins in the hundreds. Turbulence, but of a good kind.

Fast track

Luminary Micro developed its Stellaris family at breakneck speed.

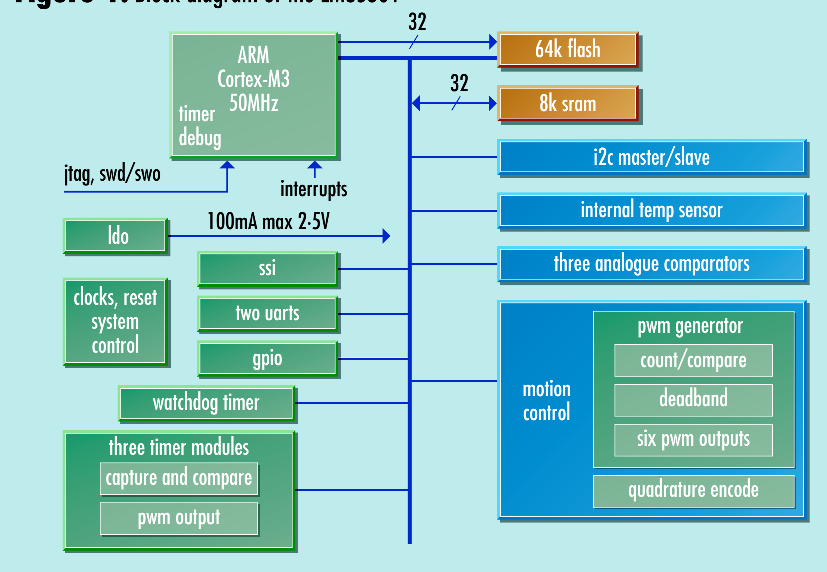
"We got first funding in February 2005 and concluded our licence with ARM at the end of March," says Booth.

"Then, we took what I'd call an engineering snapshot of the M3 in May 2005 and taped that out by September. So we were looking at some first silicon last year. We then took the first formal release in early December 2005 and taped that out 24 hours later."

Development work included 'stealth' aspects. Luminary announced it was looking for partners through anonymous emails and website banners – and only in the US, UK, Germany and Italy. "With what we we're doing and as a start up, putting the name and everything else out there would basically have said, 'Hey, look over here. Come kill us!'," says Booth.

Today, Stellaris prices range from the $1 LM3S101 to $5.47. Features include up to 64k of single cycle flash, 8k of single cycle sram, speeds up to 50MHz, and up to eight a/d converter channels running at up to 1Msample/s.

Figure 1: Block diagram of the LM3S801



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Cementing a reputation

An extensive product roll out is part of Vicor's plan to double its brick business. By **Graham Pitcher**.

Bricks – high power dc/dc converters – have come a long way since their introduction by Vicor some 20 years ago. Not only have they followed their equivalent of Moore's Law – the latest incarnation is the 1/16th brick measuring 33 x 23mm – but they've also seen a burgeoning of grade and mechanical variants.

Despite the fact that it has been in the brick market since its very beginnings, Vicor is not the market leader. One reason for this is the commoditisation of the brick market. Bob Marchetti, senior manager for product marketing with Vicor's brick division, noted that price competition was one reason, driven particularly by manufacturing in the Far East.

"We make around 8000 different products a year and these are supplied to roughly the same number of customers, who spend on average $25,000 a year with Vicor. With that many customers and products, we can't manage the pipeline to the Far East."

But Vicor is embarking on an ambitious plan to turn things around. "We have to be competitive from Massachusetts (Vicor's manufacturing base)," Marchetti continued.

The plan calls for aggressive growth in brick sales. "We want to double our brick business in four years," said Marchetti, "and are investing heavily to support this goal." He claimed that around 15% of company revenues were now being ploughed back into r&d for new products. "We've also got a dedicated group of engineering talent in the brick business which is committed to expanding our existing business. It's not just a commercial plan."

Underlying the business plan is a realisation that Vicor needs to meet changing customer needs. "And we also want to remain the technology leader in the sector," Marchetti claimed.

One of the reasons why Vicor has set itself this target is that it has seen what Marchetti calls 'significant strength' in the brick market. Having said that, he admits that price growth is 'almost zero'.

Vicor's strategy has three parts:

- Expand the product portfolio
- Mass customisation
- More flexible and aggressive pricing.

You may be excused for wondering how, when a company has around 8000 products available, the portfolio could be expanded. Marchetti said it's a matter of filling in the gaps. "Despite the fact that the product line is almost 20 years old, it's still going strong. The VI200 range has a huge number of variants, but that's not true for FasTrak."

One way in which the gaps are going to be filled, said Marchetti, is with the launch of a range of 24V Maxis: eight will be demonstrated at Electronica.

Philip Holmes

"We make around 8000 different products a year ... supplied to roughly the same number of customers."

Bob Marchetti, **Vicor**

The eight devices operate from a 24V dc input. A 3.3V out 200W model is accompanied by 300W devices with outputs of 5, 12, 15, 24, 28, 36 and 48V. These modules incorporate the company's low noise zero current and zero voltage switching topology and are said by Marchetti to be suited to such applications as industrial and process control, distributed power, medical and communications. The converters switch at frequencies up to 1MHz and their rapid transient response also makes them suitable for use in rf applications.

The modules, which are available in RoHS compliant models, measure 117 x 56 x 13mm with an above board height of 11mm.

With these additions, the 24V Maxi family now features 16 models with output voltages from 3.3 to 48V dc and power levels from 200 to 400W. The converters operate from 24V nominal input, with an input range of 18 to 36V. There are five environmental grades available, along with six pin options and three baseplates.

One reason for broadening the portfolio is to ensure the right device is available for the application. "We've always had the highest power," he said, "but not everybody needs 600W; they may only need 400W for their application. And people don't want to pay for 600W when they only need 400W."

So the reason for 'filling in the gaps' is simply so customers can get what they need without having to pay too much for the privilege.

The market into which the 24V Maxis have been launched is Vicor's traditional strength. "And it's a strong market at the moment," Marchetti observed. "We're selling a lot of products into process control, rf and military applications."

It's also creating a 36V standard output range. "We could trim 48V modules to create 36V output devices," said Marchetti, "but they would have less power because they are current limited."

With these modifications, Vicor has more than doubled the number of products in the family. "And we're doing this across the board," Marchetti enthused.

Next on the product introduction conveyor will be 375V input Maxis. "And we'll continue to add new products to the portfolio until we've increased the range by quite a lot," said Marchetti. "We're trying to provide better solutions and adding additional voltages."

Looking across Vicor's Micro, Mini and Maxi ranges, the additional products will roughly triple the number of offerings, from 89 to 242. Included in this expansion will be 110V devices aimed at railway applications. The reason, Marchetti, observed, is that there are customers who need higher power density.

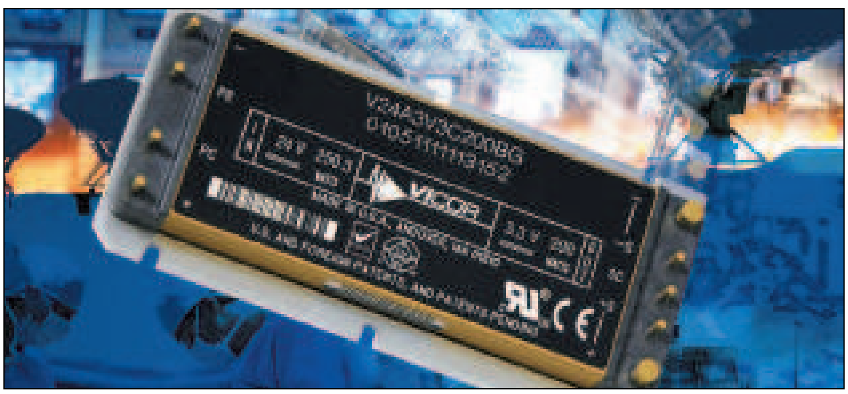
"In total," he noted, "we can take these base models and supply them in five environmental grades. Then, with different mechanical variations, we can actually supply around 22,000 different devices."

Manufacturing that number of variants might seem to pose a problem. Not so, said Marchetti. "The way our manufacturing is set up means there's no lead time for any product, nor is there a cost penalty. The real strength is that if the customer wants, for example, a through hole baseplate, we can do that."

Even the venerable 20 year old VI200 range isn't being left untouched. "We'll be expanding this range with lower input models, from 10 to 36V, plus we'll be adding a T grade, which extends the temperature operating range to –40 to 100°C."

Whilst specifications are important to all designers, cost is another big consideration. Marchetti said: "We've embarked on a program to start driving the cost out of products." He acknowledged there was just one reason for this. "We have to do this in order to become more competitive."

Vicor has already made significant investment in web based product specification. "So there's a lot of customer designs which we can do quickly," Marchetti concluded. "And our configurable products allow detailed solutions to be created from modular devices."



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Are you ready for electronica?

The world's leading electronics trade show is set to present the latest trends and developments from all areas of the market. Alongside a broad spectrum of products and technologies, the event will focus on high growth applications in the automotive, wireless and embedded segments, as well as in micro and nanotechnology. Exhibits will take up more than 152,000 m2 of floor space in 14 halls, with system solutions and advanced products being shown by more than 3000 exhibitors. Show organiser Messe Muenchen International believes that more than 75,000 people will attend.

For more information on the event, go to **www.electronica.de**. And you can save time by preregistering for the show – just follow the links from the event's home page.

A durable incremental encoder for a range of applications is set to move the world of electronic encoding on to the next generation, says Elma.

Available in the UK through Foremost Electronics, the E33 features 16 or 32 detents standard resolution and comes in a robust metal housing with metal shaft. The manufacturer claims a rotational life of 200,000 revolutions, with a constant switching torque of 2 or 3Ncm.

Elma: www.elma.com
or Stand C3.641

Altera will be exhibiting fpga based solutions for automotive electronics. Its range of programmable solutions reduces development time and costs for multiple design iterations.

Visitors will see product demos on graphics solutions for head units, rear seat entertainment and cluster displays, a central gateway demonstration as a platform for car networking applications and a MOST audio transport reference design.

Altera: visit www.altera.com
or Stand A6.A48/49

Amplicon will unveil a new solutions division and two industrial computer ranges.

The Ventrix Workstation range comprises 4U PICMG 1.3 compliant sbc based rackmount devices. New features include sliding keyboards with integrated track and two mouse buttons and flat 6.4in tft lcd with 680x480 resolution.

The Impact-E range has a small, compact and fanless rugged design, suited to a variety of embedded applications. Powered by Intel Celeron M processors, these computers provide the performance necessary for high speed and intensive tasks.

Amplicon: visit www.amplicon.co.uk
or Stand A6.746

Xilinx will be showcasing fpga based solutions for customers in all markets, but with a focus on automotive and industrial applications. Visitors will see the recently announced Virtex-5 LXT family, the second of four domain optimised Virtex-5 platforms. The LXT series, with five devices, is the first fpga to deliver fully compliant and characterised hard coded PCI Express Endpoint and Tri mode Ethernet MAC blocks.

Xilinx will also highlight its programmable solutions roadmap based on the Media Oriented System Transport (MOST) networking protocol for automotive electronics.

Xilinx: visit www.xilinx.com
or Stand A4.576

Maxwell will be announcing new BOOSTCAP ultracapacitors, which provide advanced energy storage for applications in consumer and industrial electronics, automotive, transportation and telecommunications.

The company will also show its range of ultracapacitors, running from small cells rated up to 4F up to the large MC cells at 2600F.

Maxwell: visit www.maxwell.com
or Stand B6.131

Thurlby Thandar Instruments is showing the PSA1301T: a handheld rf spectrum analyser said to set a new low price point for such products. Smaller and lighter than similar devices, it features a high resolution (480 x 320 pixel) backlit colour TFT display.

TTi: visit www.tti-test.com
or Stand A1.239

electronica 2006
components systems applications

Ramtron will showcase its new fram enhanced FM3130 processor companion and two 512kbit serial non volatile frams; the FM25L512 and FM24C512. Also featured will be the first 8051 based microcontroller with FRAM, the VRS51L3074.

The FM3130, an fram enhanced 64kbit 3V processor companion, combines the benefits of fram with an integrated real time clock in an 8pin package. The RTC, which features an alarm and a programmable frequency clock output, uses a common 12pF watch crystal. The device is available in a standard 150mil soic and a DFN package compatible with TSSOP8s.

Ramtron: visit www.ramtron.com or Stand A5.321

Silicon Laboratories will exhibit several innovative ic solutions for the communications, automotive, consumer and power markets. Products on display include:

- AeroFONE, a single chip phone for the ultra low cost handset market.
- An IEEE 802.3af compliant Power over Ethernet controller for powered device applications, and
- The Si4702/03, an fm tuner which offers a 75% reduction in pcb area over competitive offerings.

The company will also show how its 8bit mcus can be used by automotive designers to reduce time to market.

Silicon Labs: visit www.silabs.com or Stand A6.475

Visitors to Actel's stand will see fpga based reference applications that enable designs to be implemented rapidly in a single chip.

Demonstrations include: Fusion, a mixed signal fpga with a soft 32bit ARM7 microprocessor core; Igloo, a low power, high density reprogrammable asic alternative for portable applications; and Fusion PSC, which combines system supervisory functions in a single chip device.

Actel: visit www.actel.com or Stand A4.375

Analog Devices will announce mixed signal analogue solutions, embedded processors and MEMS components.

It will show its sensor technology, including the iSensor intelligent motion sensor, the AD5933 impedance to digital converter, and its capacitance to digital converters. It will also demonstrate an industrial signal chain.

ADI will also demonstrate Linux running on its Blackfin processor, and the tools and support the company provides for developing embedded applications.

Analog Devices: visit www.analog.com or Stand A4.159

TDK will be showcasing its Single Mega Cap 1210 Chip. Smaller than its standard Mega Cap, but with the same functionality, the Single Mega Cap 1210 chip is a single capacitor with special metal frame termination which allows the chip to be mounted on a pcb. Alongside high and low temperature capability, the device takes up less board space.

TDK: visit www.tdk-components.de or stand B6, 305

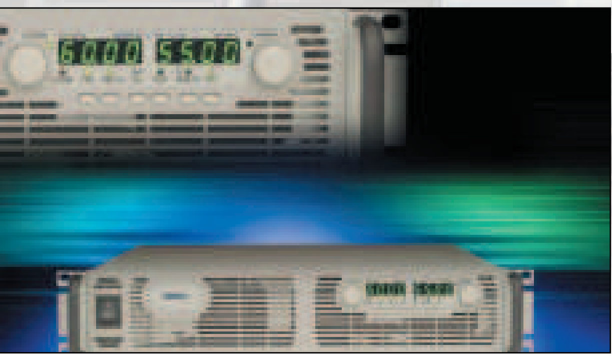
Lambda is showcasing a range of new products – from dc/dc converters to multi kilowatt power supplies.

In addition to Genesys power supplies, other new product introductions include NV300 and 700W 1U configurable power supplies which offer high power density and high efficiency.

Lambda is also introducing the PFE 500 and 700W front end models aimed at

electronica 2006

components | systems | applications



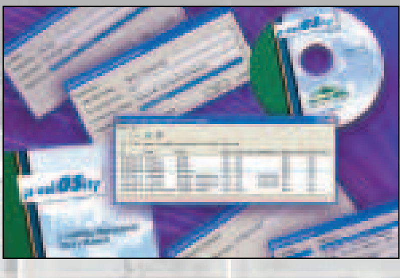
distributed power applications and rapid custom applications when combined with dc bricks and point of load converters.
Lambda: visit www.lambda-europe.com or Stand B2.205

Omron will launch what is says is a 'breakthrough' UWB chip antenna, designed to address size, performance and cost challenges in computing and consumer environments. Omron will also show a new range of innovative 'jog' dials for the latest mobile phones, MP3 players and PDAs. Both products will be demonstrated alongside the recently launched B6TS touch sensor ic and D6F sensors for detection of air/gas mass flow.
Omron: visit www.omroncomponents.co.uk or Stand C3.636

RS will present new services, technologies, and products. Practical demonstrations, aimed at engineers and designers, will illustrate the company's focus on electronic and electromechanical products.

The company is in the process of expanding its product ranges, taking its portfolio to more than 300,000 products.

Recognising the significance of wireless M2M communication, RS has launched a range of solutions that include modules for most popular wireless technologies. The company also offers a range of evaluation kits, boards and antennas.
RS Components: visit rswww.com or Stand A6.257



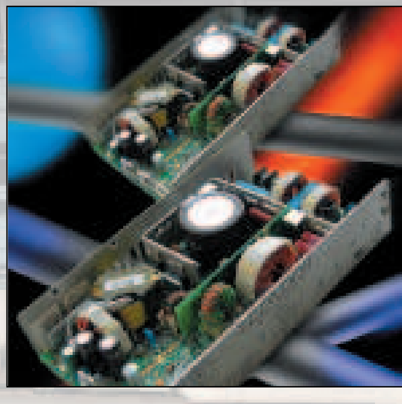
Green Hills Software will be highlighting products such as µ-velOSity, its ultra small, ultra fast royalty free microkernel for deeply embedded devices, and INTEGRITY Workstation, the POSIX certified operating system. Visitors will also see demonstrations of In-Memory TimeMachine and industry optimised software development platforms.
Green Hills: visit www.ghs.com or Stand A6.407

TI will be demonstrating practical ways to address applications in video, imaging, communications, medical, sensing, control and more. Highlights will include the latest applications based on TI's analogue innovations and on DaVinci technology.

The MSP430 microcontroller family will also be shown, along with C2000 digital controllers.
Texas Instruments: visit www.ti.com or Stand A4.125

The combination of the Condor and Ault product lines, says SL Power Electronics, makes it a leader in medical power products. Standard products range from 7W to 6kW and meet most applications.

On show for the first time will be Ault's PW130 power source for a range of PoE applications. In fact, says the company, any device under 15W that can take advantage of network power is a potential application.
SL Power: visit www.slpower.com or Stand B2.552



National Instruments will show a range of products, including the PXI-5152 general purpose digitiser/oscilloscope, the PXI Express M Series DAQ modules and CompactDAQ, a USB based modular data acquisition system. This eight slot chassis accepts I/O modules capable of measuring up to 256 channels of signals.
National Instruments: visit www.ni.com or Stand A1.317

3G meets broadband

Bringing the promise of 3G indoors. By **Roy Rubenstein**.

Mobile operators may have paid a fortune to secure 3G radio spectrum, but they have been ill served by signal coverage within the home.

"There has been a giant push around 3G that has left coverage holes in the network," says Steve Shaw, director of marketing at US network equipment maker Kineto Wireless. "They [mobile operators] don't want to put up that many more cell towers." Acquiring extra base station sites improves coverage but is costly, weakening further the business case for 3G that has proved long in coming.

However, advances in silicon, coupled with new software protocols, could change all that. Operators can now afford to put a tiny 3G base station – a femtocell – within a home. The target price for the indoor unit is less than $200.

"Such an access point is targeted at mobile operators, as you require licensed spectrum to operate it," says Chris Cox, marketing manager at Cambridge based femtocell maker ip.access. A 3G handset talks to the femtocell unit via the air interface, while the femtocell is linked to the network using the home's broadband connection.

One reason for the femtocell's appeal is that it works with existing 3G handsets – a user doesn't need to exchange their handset for a dual mode device combining cellular with WiFi. Equally, signal quality in the home is guaranteed without having to install macrocell 3G base stations and antenna sites. By carrying the resulting traffic over the fixed line network, it saves cellular network capacity and avoids costly backhaul links.

Ultimately femtocells bind customers by improving the performance of the mobile network and bundling other services with voice, such as internet access and tv.

"For the cellular carrier, the central notion [of femtocells] is to capture more of the consumer spend," says Stuart Carlaw, ABI Research's principal analyst, wireless connectivity. ABI forecasts that, by 2011, there will be 32million femtocells deployed supporting 102m users.

But there are hurdles to overcome. 3G base station functions must be crammed into a small femtocell unit and radio interference is another issue. 3G mobile networks are planned carefully in terms of frequencies and scrambling codes. With femtocells, low power base stations will be popping up in homes – and within existing 3G cells – in an ad hoc manner. If a user moves to a window and their handset detects a stronger 3G macrocell signal, will their phone switch to the that cell? In turn, if the femtocell signal is louder than a macro cell, will a passer by's phone try to connect? Operators will only be able to gauge the scale of the problem once trials begin next year.

"No one has done this in anger," says Dean Bubley, founder of Disruptive Analysis. "No one knows what it does to the frequency plans when 1000 of these

Figure 1: A standalone femtocell with an ethernet interface

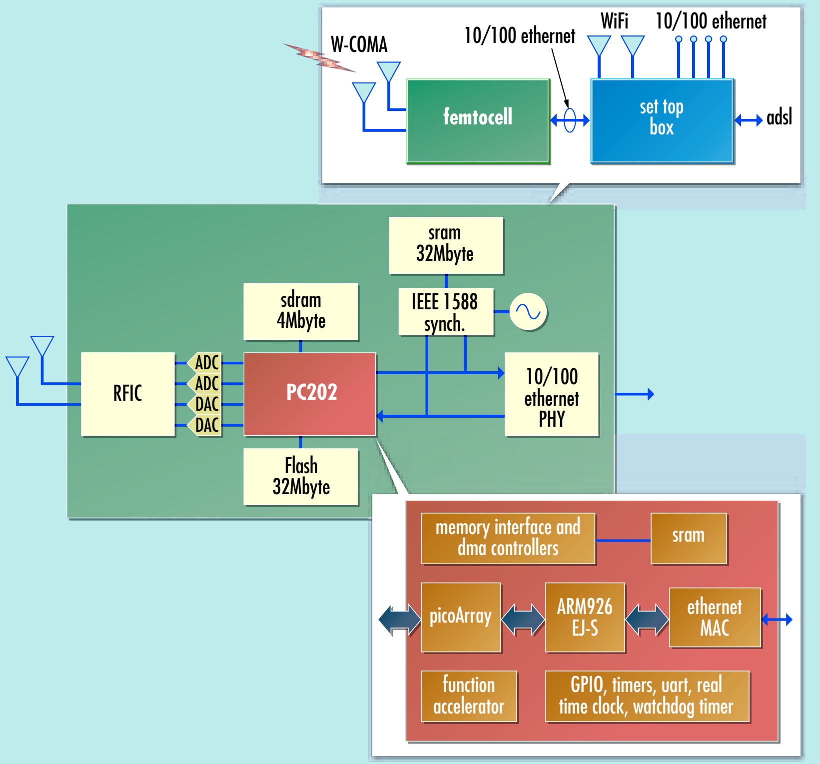
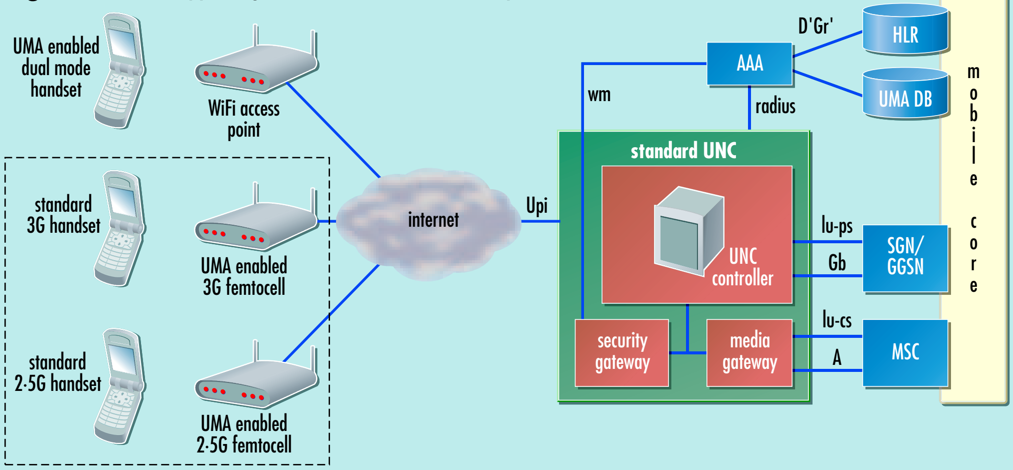


Figure 2: UMA supporting 2G and 3G femtocell access points



> "The cost of providing the extra intelligence on each femtocell for a few users is very small."
>
> Chris Cox, **ip. access**

light up in a square kilometre."

Swindon based UbiquiSys is already building trial versions of its ZoneGate femtocell and says mobile operators will start trials involving hundreds of users from spring 2007.

"Our system is made up of the [ZoneGate] access point and the management system, which uses the TR-069 standard," says Will Franks, UbiquiSys' chief technology officer and cofounder. TR-069 allows software running on the management system to communicate with the home gateway to which the femtocell is connected, enabling automated installation, device troubleshooting and remote software upgrades.

What's in the box?

In a 3G network, each base station (a Node B) is connected to a radio network controller (RNC). Typically, 50 to 100 Node Bs are served by an RNC. Node B numbers will rise to thousands – even tens of thousands – once femtocells are used.

"Each one [Node B femtocell] is now simple," says Rupert Baines, vice president of marketing at picoChip, whose multicore dsp chip has been chosen by UbiquiSys and ip.access. "All the RNC 'smarts', such as supporting mobility when a high speed train with 200 users enters a cell, and the handover between one base station and the next, none of this happens with the femtocell." A femtocell serves one household of 3G users only.

UbiquiSys' and ip.access' designs use the picoChip PC202, which has 198 dsps and an ARM9 processor. According to Franks: "The dsp array runs a scaled down version of the basestation modem, but still requires a huge amount of processing power."

In a traditional 3G network, the RNC performs most of the signaling intelligence for the access network, whilst the Node B provides the high speed lower layer functions. To scale to large numbers of femtocells, the processing functions are collapsed within the femtocell.

"The cost of providing the extra intelligence on each femtocell for a few users is very small and the cumulative effect is to cost optimise the overall system," says Cox. "It also improves air interface performance due to the faster turn around of the air interface messaging."

The lower layer functions of the 3G radio are performed by the PC202's dsp array. Tasks include interleaving the real time bits and bytes over the air. The higher layer radio functions are handled by the ARM core. These are what UbiquiSys calls layer two tasks, such as transmitting and receiving blocks of data and performing forward error correction, and the smarter still layer three radio resource controller, which starts and terminates calls.

On top of the three layer UMTS radio sit the software interfaces to the network. There are three main network interface options. Traditional 3G networks' base stations are connected to the RNC via leased lines. Since femtocell traffic is sent over the home's broadband link, the Iub interface is used. This involves the use of the IPsec protocol to transfer packet data over the network.

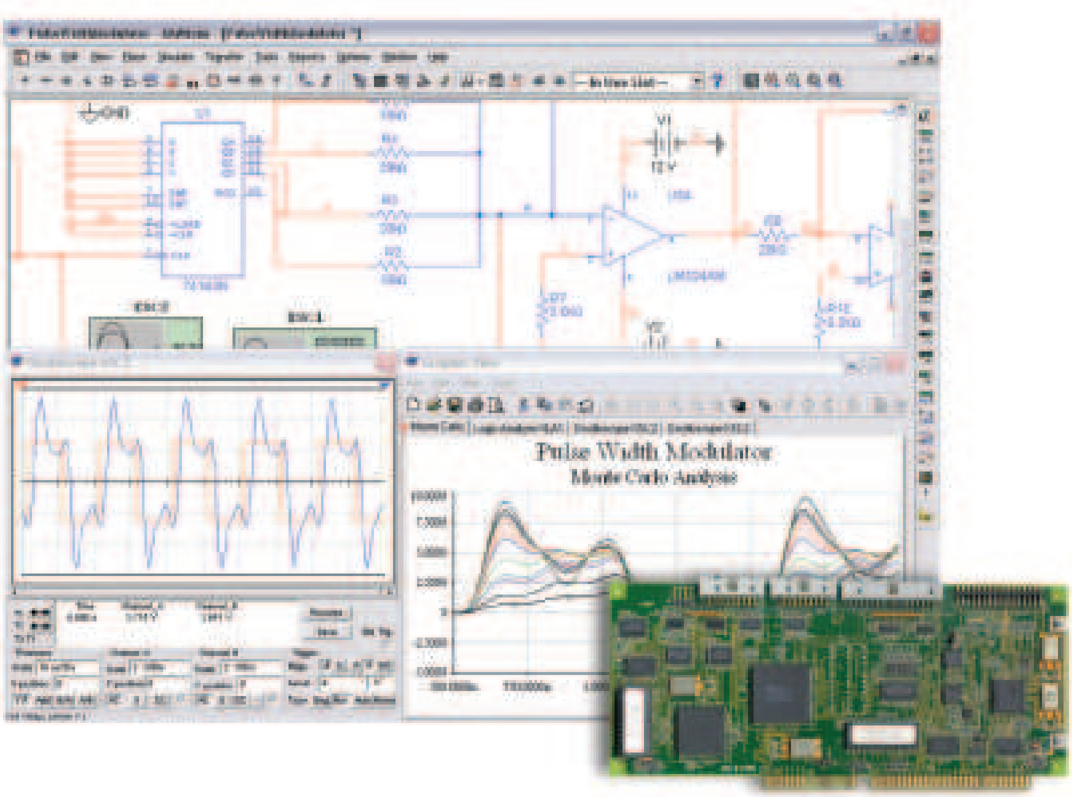
However, operators are upgrading their networks to converge on Internet Protocol (IP) technology and, as such, are considering two developments. One is the use of unlicensed mobile access (UMA) to interface the femtocells directly to a UMA network controller (UNC), such as that made by Kineto. The UNC then separates and sends voice and data traffic across the circuit switched and IP networks, respectively. The second, and ultimate, goal is to move to the IP Multimedia Subsystem (IMS), an all IP network that makes use of the Session Initiation Protocol (SIP).

Accordingly, a femtocell aimed at all three network classes needs to support Iub, UMA and SIP software clients, which all sit above the UMTS software. UbiquiSys is also adding a Java virtual machine as part of its femtocell software build. "This will create an open services environment," says Franks.

UbiquiSys says the femtocell software design is relatively straightforward. The control plane is separated from the data traffic and with the femtocell supporting data rates of up to 7.2Mbit/s, data must be handled with minimal delay. "The data traffic is point to point, while control plane messaging is switched through," says Richard Byrne, UbiquiSys' software architect.

With the industry continually shrinking radio cells, what comes after femtocells? "More femtocells," says Baines, who points out that wireless capacity can always be added by developing smaller and smaller cells.

Here's a short-circuit you'll actually like...



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Up to the **challenge**?

With the shift from 2G to 3G and plans moving ahead for 4G, wireless technology is providing new challenges for test vendors.

By **Vanessa Knivett**.

Today's wireless designs are, typically, complex. And to whichever wireless protocol/s a device belongs, there's a need to coexist with other spectrum users.

So, it's not enough to test conformance to a specific standard – it's necessary to validate all intended modes of operation, encompassing the transient and intermittent anomalies that characterise real world rf.

It's no surprise, then, that the spectrum analysers and vector signal analysers used in the main to test these devices can no longer be regarded as general purpose. An explosion of wireless protocols and transmission techniques to help rf devices resolve interference, maximise power and, in some cases, evade detection – is forcing test vendors to keep pace with advanced features and toolsets. Indeed, toolsets make sense when the needs of your customers are diverse. One size definitely does not fit all.

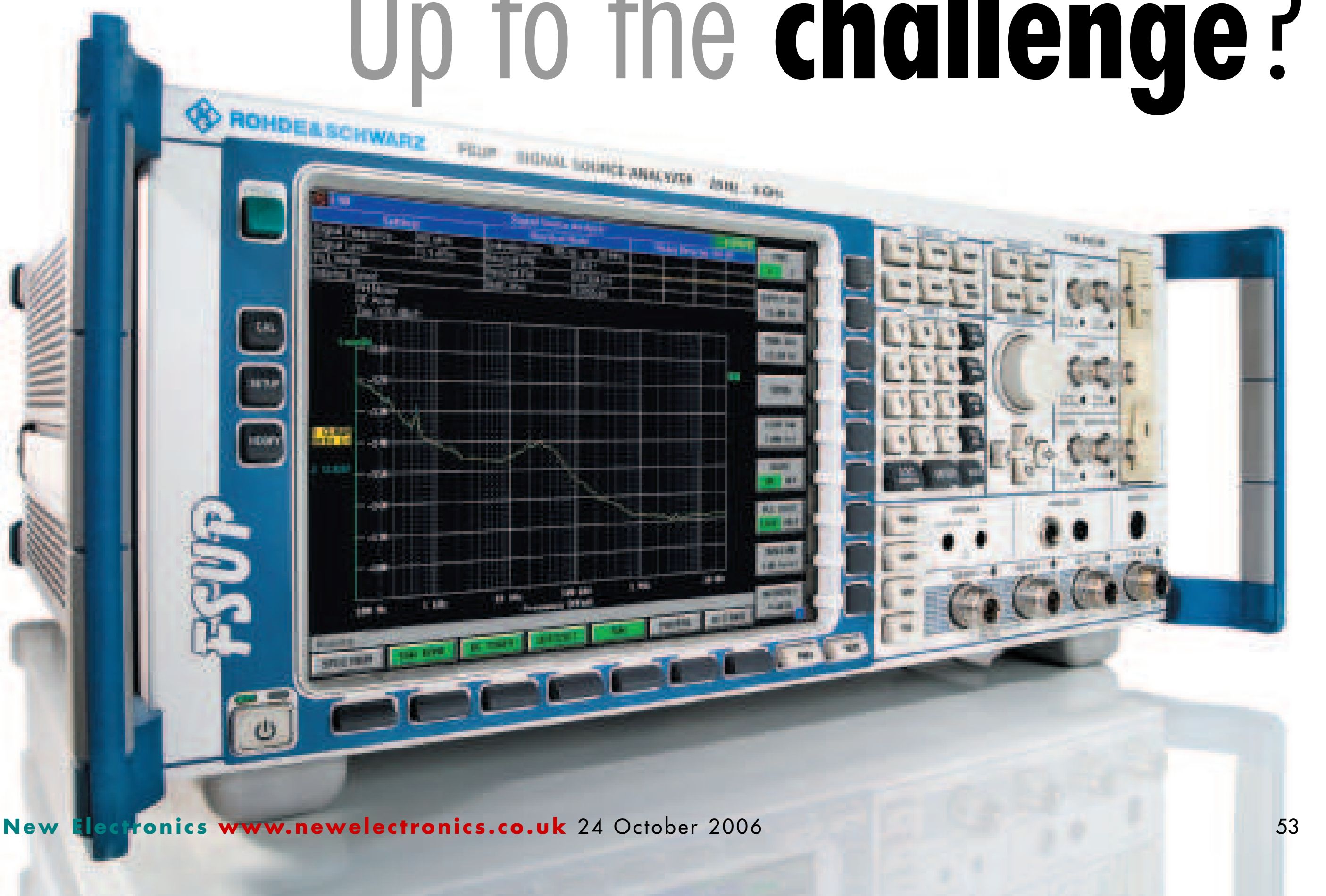
So what do some of the latest wireless test devices say about what's happening in wireless communications? One of the latest to launch is Agilent's MXA signal analyser, claimed to be the 'industry's fastest'. Niels Faché, product planning manager of Agilent's signal analysis division, claims it's a 'next generation product that redefines the offering in the mid range'. He says Agilent has improved 'five dimensions of performance'. The first involves the rf and system level specifications of the instruments, second is speed, third is applications breadth – particularly support for emerging communications standards. Fourth in Faché's selection of performance criteria is the user interface, and lastly he mentions pc connectivity.

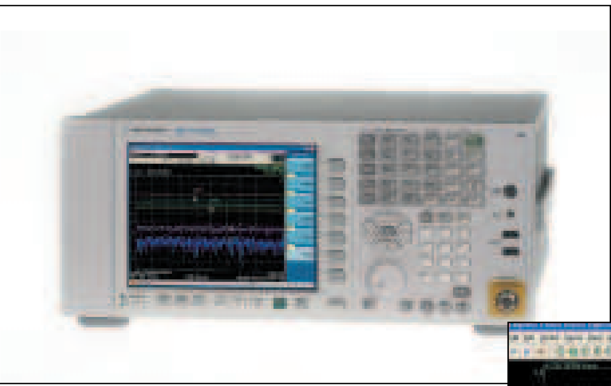
The MXA is an example of the platform approach, with a range of standards based measurements catered for and optional applications software that provides preconfigured test routines for WiMax, W-CDMA, HSDPA/HSUPA and phase noise applications. Multiple frequency ranges are supported – 20Hz to 3.6, 8.4, 13.6 and 26.5GHz – and there are two analysis bandwidths: a standard 10MHz; and a 25MHz bandwidth catering for emerging communication signals.

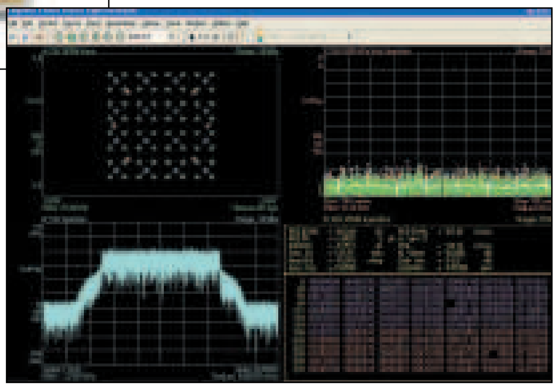
High intrinsic speed makes for faster individual measurements. Specifically, Agilent cites that a W-CDMA adjacent channel leakage ratio (ACLR) fast mode measurement can be performed by the MXA in less than 14ms. This leads to a potential acceleration in the design verification process and a reduction in the cost of manufacturing test – and the MXA caters to the needs of both environments.

But what features particularly suit the MXA to today's wireless design challenges?

The MXA can be configured as a traditional spectrum analyser, but when vector signal analysis is required, the user can switch to an optional built in application of Agilent's VSA software – a free trial version of which ships with every MXA







(shown above). This, says Agilent, provides complete vector analysis, including flexible time gated measurement of spectrum, occupied bandwidth, complementary cumulative distribution function and signal power. VSA also provides analogue am/fm/pm demodulation, plus options for digital demodulation and standard specific modulation analysis.

Keithley has taken a similar, software oriented approach to the design of its 2910 rf vector signal generator, whose software defined radio architecture enables it to adapt to evolving wireless standards. Optional built in signal generation software caters for GSM, GPRS, EDGE, W-CDMA, cdmaOne, and cdma2000, whilst its arbitrary waveform generator supports downloading of virtually any externally generated signal waveforms with up to 40MHz of bandwidth.

Tektronix has just introduced the RSA6100A series of real time spectrum analysers, designed to meet the needs of the rapidly expanding range of digital rf applications. Tektronix notes the RSA6100A's remit applies beyond the capabilities of swept spectrum and vector signal analysis to applications that include radar, mobile communications, software defined radio, cognitive radio and surveillance. It says that live rf has been achieved by improving the spectrum measurement rate so that it is nearly 1000 times as fast as the fastest swept spectrum and vector signal analysers.

"Live rf display ... provides engineers a view into signal instabilities and transients that they never knew existed."

Rick King, **Tektronix**

The first offerings in the RSA6100A series are the 6.2GHz RSA6106A and 14GHz RSA6114A, which both provide 110MHz real time bandwidth and a 73dB dynamic range. But it isn't just bandwidth, fast signal capture and high dynamic range that Tektronix sees as key to meeting wireless test needs; the ability to fully correlate time, frequency and modulation domains are just as important, particularly for analysing signals that perform frequency hopping, have pulse characteristics, modulation switching, require settling time and bandwidth changes.

Key is the DPX waveform image processor, which processes more than 48,000 spectrum measurements per second to display the live spectrum. In addition to live rf, the DPX enables the display to hold anomalies until the eye can see them to show the history of occurrence for dynamic signals and provide immediate feedback on signal variations over time. Rick King, vice president of Tektronix' real time spectrum analyser product line explains the implications: "The live rf spectrum display provided by DPX waveform image processing provides engineers a view into signal instabilities and transients that they never knew existed."

Rohde & Schwarz' FSUP, launched in June, is a combined spectrum analyser and phase noise tester that comes in various bandwidths – 8, 26.5, 46 and 50GHz. The instrument responds to what Rohde & Schwarz sees as a need for a combined instrument from those developing and producing high quality transmit and receive equipment such as communications and broadcast systems, or radar.

Phase noise testing is based on the PLL method. The instrument compares the signal source from the device under test with an internal or external reference. Users can select the source for regulating the required 90° phase offset on the phase comparator or allow the instrument to do it automatically. Offset frequency is also user defined, whilst measurement parameters such as bandwidth, filter type and number of averages are said to be easy to configure.

The ability to measure phase noise directly in the spectrum – though time consuming – is necessary in some applications because it allows higher frequency offsets to be measured. Indeed, Rohde & Schwarz claims that it is 'indispensable when measuring harmonics or spurious'.

Other functions include the ability to define different sweep ranges in which the analyser can automatically search for interference and spurious signals.

Meanwhile, known better for its test technology outside the communications domain, National Instruments has announced products that extend its data acquisition and data streaming capabilities into rf applications. Its PXI-5661 2.7GHz rf vector signal analyser offers 20MHz of real time signal or modulation bandwidth, frequency selective burst triggering and onboard signal processing for streaming data to a pc, where software such as the Modulation and Spectral Measurements toolkit gives users the means of building a next generation test system.

New communications protocols, such as mobile WiMax, are not only challenging test vendors to provide high performance traditional rf/microwave measurement capabilities, but digital modulation measurement – and the integration of satellite and 3G architectures – means the challenges for test vendors will demand more ingenuity yet.

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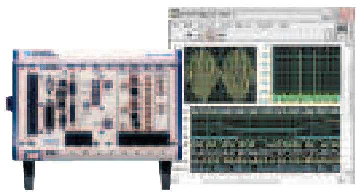

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NATIONAL INSTRUMENTS

Developments in switch mode technology are resolving the long standing trade off between efficiency and emc. By **Andy Skinner**.

Resolving trade offs

Whatever the application, power supply users want products that are small and efficient, yet have excellent emc performance. Until recently, it was difficult for designers to reconcile these requirements, but new developments in switch mode technology now are providing solutions.

In recent years, switch mode power supplies have almost completely displaced traditional linear supplies in the majority of applications. The reasons are not hard to find: for a given rating, switch mode supplies are much smaller and lighter than their linear counterparts; and they are much less costly to manufacture.

Switch mode supplies clearly have a lot to offer, but they do have one potential shortcoming. Because of the way they work, they are capable of generating radio frequency interference (rfi) or, to put this in a more commonly used term – they have poor emc performance.

To understand why this is and what can be done about it, it's necessary to take a brief look at how switch mode supplies work. In essence, they're not very complicated; they take power from the mains then rectify and smooth it to produce a high voltage dc supply of, typically, around 340V.

This dc supply is applied to an inverter stage which converts it back to ac, but at a much higher frequency than the mains supply. The exact frequency used depends on the design of the power supply, but it is almost always more than 20kHz. The high frequency ac from the inverter is then applied to a transformer which, because of the high frequency, can be very small, light and inexpensive. Finally, the output from the transformer is rectified to produce the output from the power supply itself.

There are, of course, other facets of the power supply, including some form of feedback arrangement from the output to the inverter stage to ensure that the output voltage remains constant even if operating conditions vary. The major sections described, however, are enough to explain the potential trade off between efficiency and emc performance.

As far as emc is concerned, the key section of the power supply is the inverter stage which converts dc to ac by using semiconductors, usually mosfets, as fast switches operating at relatively high power levels. This stage presents power supply designers with something of a dilemma.

If designers arrange for the mosfets to switch from on to off and vice versa very quickly (hard switching), little power is lost, since they spend almost all the time either fully on, with little voltage drop across them, or fully off, with little current flowing through them. Unfortunately, fast switching means that high levels of harmonics are generated unavoidably or, in other words, that emc performance is poor.

One solution is to stick with fast switching and suppress the harmonics by adding screening and filters to the supply. If they are to be effective, however, these measures add significantly to the size, weight and cost, reducing the very benefits which have made switch mode supplies so popular.

Soft switching?

What about slowing down the on-off and off-on transitions in the mosfets? This so called 'soft switching' is effective in reducing the generation of harmonics, but it brings another problem. Now, during the much longer switching transitions, the mosfets spend a considerable amount of time when they are neither fully on nor fully off.

During this time, they have both voltage across them and current flowing through them and, since voltage multiplied by current equals power, they generate heat. In other words, while soft switching addresses the emc problem, in its usual form it also significantly reduces the efficiency of the power supply.

Not only does this mean that energy is wasted, it also means the power supply runs hotter than necessary. This is a big problem in today's applications, where compact designs mean that thermal management is always an important issue.

Clearly, what's needed is a switch mode supply which combines the efficiency of hard switching with the emc performance of soft switching. Lambda has developed a way of achieving this and has patented its solution under the name Multi Resonant Topology (mrt).

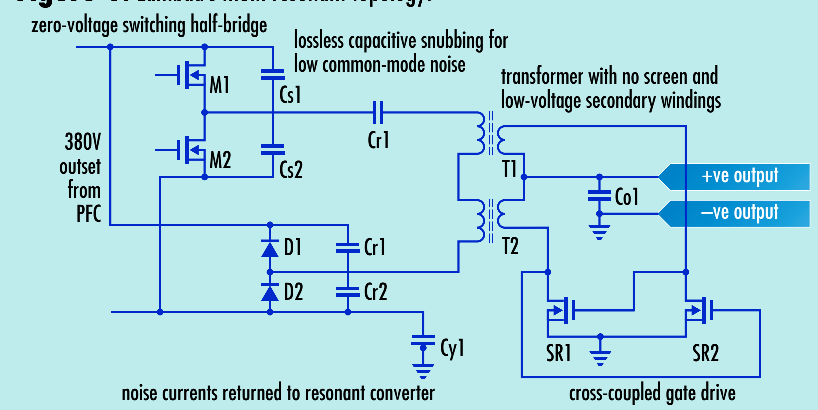
The key to mrt is to arrange for the mosfets to switch only when the voltage across them is close to zero. This is achieved by first of all arranging the operation of the inverter so the current in the primary circuit of the transformer is continuous. This can be done, for example, using variable frequency control techniques to produce a primary current in the form of a distorted sine wave where the current lags the voltage.

Under these conditions, adding a small capacitor across each mosfet gives it time to switch off with almost no voltage across it. Because there is no voltage across the mosfet when it switches, the losses are small and because the switching is soft with a smooth voltage transition, harmonic generation is minimised. A bonus is that zero voltage switching also reduces the peak stresses on the mosfets.

At this point, a word of caution is necessary. For this arrangement to work properly, the load seen by the inverter must always be inductive. If it is not, the inverter will revert to hard switching. It is relatively easy to arrange for the inverter to see an inductive load when the power supply is working near its maximum capacity, but more difficult to arrange for this when it is lightly loaded.

For this reason, some currently available power supplies give excellent results in terms of efficiency and emc performance at full load, but have very poor emc performance at reduced loads. This is a point well worth checking when specifying power supplies as shortcomings of this type are not always readily apparent from a data sheet.

Figure 1: Lambda's multi resonant topology.



Efficiency and emc

The way that Lambda has configured the resonant circuit in its switch mode supply ensures there is just enough energy stored in the magnetic components, even at light load, to work properly, which comes down to an appropriate selection of resonant components. Too much circulating current results in extra i2r losses. The result is the removal of approximately 5W out of the design and, on Lambda's modular products, no heatsinking on the mosfets, which reduces cost and has benefits from an rfi perspective.

Whilst a conventional switch mode power supply would have an output efficiency that would struggle to get to more than 80%, Lambda's topology – depending on the output voltage – achieves between 90 and 95% at the output stage.

With switch mode power supplies it has long been necessary to choose between efficiency and emc performance. Now, this trade off is no longer necessary. The latest developments give users the best of both worlds – power supplies which are small, light and cool running, and which deliver emc performance so good that the need for external filters, even in sensitive applications, is a thing of the past.

Author profile:

Andy Skinner is a product manager at Lambda UK.

Born to run

TEST & MEASUREMENT

LeCroy has unveiled three oscilloscopes that expand the bandwidth of the WaveRunner Xi and WaveSurfer Xs product families. The company has also announced that WaveScan – an advanced search and analysis feature — will be standard on all WaveSurfer Xs and WaveRunner Xi scopes.

WaveScan provides the ability to locate problems more quickly by going beyond hardware triggering, and integrating advanced algorithms to continuously scan for unusual behaviour. Up to 20 search modes are used, including: pulse width; frequency; rise time; and duty cycle.

WaveRunner Xi is available in a four channel 1GHz model, with a 2GHz model also available. Both sample at 5Gsample/s on four channels, interleaved to 10Gsample/s.

The WaveSurfer 104Xs increases the WaveSurfer range to a 1GHz bandwidth, with sample rates of 2.5Gsample/s on four channels (5Gsample/s interleaved on two channels).

LeCroy: visit www.lecroy.com

POWER

The Aspiro 48V power system from Power-One provides shelf based rectification, battery management and distribution. It uses digitally controlled rectifiers that can adapt, without derating, to a range of line, load, and temperature conditions. This ability can reduce logistics costs for service providers by enabling one solution to power a range of applications.

With 90% efficiency, the 800W rectifier can deliver 3200W from a 1U shelf. A 400W XR04.48 rectifier shares the same form factor as the 800W product; reducing initial costs for lower power systems and simplifying migration paths.

Power-One: visit www.power-one.com

BACKPLANES & BOARDS

GE Fanuc Embedded Systems has introduced the ATCA-7820, an AdvancedTCA sbc with two dual core Intel Xeon processors and up to 8Gbyte of DDR2 400 sdram with ecc.

Fully compliant with PICMG 3.0/3.1, the board combines AMC.1 Type 8S and PCI-X PMC expansion sites to create a powerful, I/O diverse platform..

Features include an AMC.1 Type 8S compliant site; a 64bit/66 MHz PCI-X PMC site; a 10/100Mbit Ethernet port; and dual USB 2.0 connections.

GE Fanuc Embedded: visit www.gefanuc.com/embedded

DISPLAYS

Sunrise Electronics has available two 3.5in modules with industrial specifications, suitable for applications such as handheld instrumentation.

Both modules feature NEC's proprietary transreflective technology, with a reflective ratio of 15% and high contrast ratio.

Supporting the quarter vga resolution, the modules display up to 262,144 colours from standard RGB input.

The NL2432HC22-40J has a luminance of 220cd/m^2 and a contrast ratio of 130:1 in transmissive and 15:1 in reflective mode. Pixels are arranged in vertical stripes. NL2432HC22-41K has a clear touch panel.

Sunrise: visit www.sunrise.co.uk

Hitting stiff **targets**

One year on from its acquisition by Avnet, Memec is now fully integrated into the company's operations and hitting some ambitious targets.

By **Georg Steinberger**.

Silica benefitted from Avnet's acquisition of Memec by gaining the Xilinx and International Rectifier franchises.

Avnet's acquisition of Memec brought significant change to the European distribution market in 2005. Now integrated within a new company – Avnet Memec – the business is established, profitable and heading for a leading position in the specialist semiconductor distribution arena. After its first full year, Avnet Memec is hitting ambitious goals, with a run rate in excess of €180million.

Looking to strengthen its position in Europe still further, the company has made its first acquisition, semiconductor and embedded systems specialist ESCO Italiana.

But Avnet Memec was not the only Avnet company to benefit from the acquisition of Memec. EBV and Silica both saw benefits from the realignment of a number of key franchises. Silica, for example, was given the entire Xilinx business and added International Rectifier its line up, whilst the EBV portfolio was strengthened with Philips, Samsung and STMicroelectronics.

With this new structure in place, Avnet has recorded high double digit growth in sales across its business units and regions during 2006. So, how does a company of Avnet's size prepare for the challenges offered by today's market?

Avnet, which operates in more than 30 European countries, has been pan European for some years, so support systems are in place to help when production transfers to a new location; often a new country or even continent. Being able to manage these logistical challenges is a clear advantage over local distributors. Having a strong European – and ultimately global – footprint allows Avnet to address production needs that move into Europe and beyond.

Meanwhile, the UK's electronics industry continues to develop. Most 'off shoring' of production has now taken place and Avnet is now giving a strong focus to the design in support structure required to develop the market place. With a high ratio of technical staff, particularly it its semiconductor business units, Avnet is helping to grow the UK's reputation as power house for board level design in Europe.

Europe, meanwhile, has always had a strong industrial electronics sector, comprising everything from automation to security and medical to lighting. This broad collection of market sectors means demand is more balanced than in the highly cyclical pc and mobile phone sectors.

Long time regarded as users of 'older' technology, the industrial electronics sector is rapidly adopting leading edge devices, including analogue components, higher level microcontrollers and rf communications. And the sector is making more use of optoelectronics.

But the success of this sector comes with a price: time to market. Customers are now looking for solutions, rather than products. This means distributors need to provide a range of services, including design and supply chain support.

Avnet EMEA recognised this five years ago and reorganised itself to provide customer support in a cost effective manner.

Looking to the future, the key challenges for distributors lie in adapting their business models. Larger distributors with flexible approaches and smaller distributors with technical specialities, who have made this transition have already seen the benefit. Those who haven't will find it harder to be successful in the future.

Author profile:

Georg Steinberger is vp communications for Avnet Electronics Marketing EMEA.

Price tracker

Category	Description	Jul	Aug	Sept
Analogue Monolithic	Amplifiers and comparators	**98.9**	98.8	**99.3**
Analogue Monolithic	Analogue interface ics	93.1	92.8	93.3
Analogue Monolithic	Voltage regulators and references	**104.9**	**105.5**	**105.6**
Capacitors	Aluminium	64.5	64.2	63.5
Capacitors	Ceramic	29.8	29.6	28.4
Capacitors	Tantalum	**43.8**	**43.9**	43.7
Connectors		**57.0**	56.8	56.5
Resistors	SMD flat chips	37.6	36.9	36.9
Filters		42.7	42.7	42.2
Crystal	kHz	46.7	46.7	45.9
Crystal	MHz	55.4	55.3	54.3
Oscillator	TCXO	47.9	46.9	46.3
Oscillator	VCXO	58.1	57.9	57.4
Oscillator	XO	50.8	50.4	**50.8**
Magnetics	Ferrite beads	33.9	33.4	32.7
Magnetics	Fixed inductors	66.7	66.2	**66.3**
Standard Logic	General purpose cmos	**74.4**	**75.9**	**77.7**
Standard Logic	General purpose bicmos	**74.1**	**75.6**	**77.9**
Standard Logic	General purpose bipolar	**86.9**	**89.2**	**91.0**
Rectifier	Schottky and ultrafast	**88.3**	**89.7**	**89.7**
Transistor	Bipolar power	**95.0**	**95.0**	**95.0**
Transistor	Power mosfet	**105.9**	**106.4**	106.3
Transistor	Small signal	88.6	88.5	88.0
Memory	Dram	58.4	**59.8**	**63.5**
Memory	Eprom/eeprom	32.5	**33.4**	33.3
Memory	sram	**46.4**	**46.6**	46.2
Memory	flash – NAND	18.9	15.0	12.0
Memory	flash – NOR	**28.0**	**28.2**	**28.2**

ANALYSIS

Driver circuits

After strong demand for interface ic units in the second quarter and extended lead times, demand has now settled and lead times are back to six weeks, whilst prices are down slightly on most devices. iSuppli expects prices and lead times will stabilise for Q1 of 2007.

Availability has not been a significant problem for interface ics, although 16pin SOIC packages have been in short supply.

Op amps

With amplifier demand softening, prices have passed their peak and are flattening out as the market settles. Lead times have moved downwards, although some specialty packages remain nearer the 12 week marker.

Voltage regulators

Prices have stabilised after consecutive months of price rises and lead times have extended to 10 to 14 weeks on most devices. For DPaks and Micro8 packages, lead times are beyond 18 weeks – a result of a mild amount of double ordering.

Standard logic

Shipment rates hit an all time high in July, although demand is now considered to be weakening now in all regions. Lead times appear have stabilised at the 12 to 14 week level, but there are still some delivery problems on certain package types.

Note:

Component prices were set at a base index of 100 in June 2002. Increasing prices are shown in red.

appointments

Manufacturing vacancies

Consultancies in this sector

Beechwood
Tel: 020 8992 8647
Email: cv@beechwoodrecruit.com
www.beechwoodrecruit.com

CTR
Tel: 01462 442727
Email: jobs@ctr.uk.com
www.ctr.uk.com

Colbern limited
Tel: 0870 3516622
Email: Bernieg@colbernlimited.co.uk
www.colbernlimited.co.uk

deBELDER associates
Tel: 0161 428 3568
Email: recruitment@debelder.co.uk
www.debelder.co.uk

epcglobal
Tel: 020 8600 1600
www.epcglobal.co.uk

GSA
Tel: 01895443181
Email: staff@gregorys.co.uk
www.gsatechnical.co.uk

MorganREM
Tel: 01296 330930
Email: info@morganrem.com
www.morganrem.com

Network
Tel: 01902 311 313
Email: careers@netrec.co.uk
www.netrec.co.uk

networx
Tel: 01943 467766
Email: apply@networxrecruitment.com
www.networxrecruitment.com

progressive
Tel: 0121 632 5555
Email: t.priestman@progressive.co.uk
www.progressive.co.uk

Teambuilder
Tel: 0118 958 3004
Email: contact@teambuilder.co.uk
www.teambuilder.co.uk

Techsearch
Tel: 0115 9483633
Email: kate.jennings@tech-search.co.uk
www.tech-search.co.uk

Vector
Tel: 01234 436 136
Email: post@vrl.co.uk
www.vrl.co.uk

VP Consulting
Tel: 01275 544568
Email: vpconsulting@blueyonder.co.uk

webrecruit.co.uk
Tel: 01392 332 842
Email: response@webrecruit.co.uk
www.webrecruit.co.uk

PCB Designer

Location: **UK** *Salary*: **Negotiable**

Outline Job Profile
PCB Design Engineer to produce electro-mechanical production datapacks for RF/Analogue/Mixed Technology PCBs. Main Duties:- PCB Library Management, Produce Schematic Diagrams from the Initial Design Engineering Concept. PCB Design Layout and Routing. Produce Full Electro-Mechanical Datapacks.

Qualifications and/or Skills
Essential: Highly competent user of CADSTAR and AUTOCAD software packages.

Desirable: Served a recognised apprenticeship. ONC/HNC in Electrical Engineering. Competent user of MENTOR DX Designer/Expedition software package.

Previous Experience Essential: Extensive PCB design experience with a background designing Analogue/Mixed Technology PCBs within a Telecomms/Defence Environment.

Desirable: Had Exposure to a Product Data Management System
Please visit our website for more opportunities.

Colbern limited

Contact: Bernadette Gough
Tel: 01438 829140
Email: Bernieg@colbernlimited.co.uk
www.colbernlimited.co.uk

Software Development Engineer - L2 Protocol Stack

Location: **South East** *Salary*: **£NEG**

A qualification in Mathematics equivalent to A or B grade at A-level. Equivalent of a good degree (1st/2.1 Hons) in a Computer Science, Electronics, Natural Science, Engineering or any Mathematically based subject.
Proven equivalent commercial experience & technical ability may be substituted for all or part of the above.

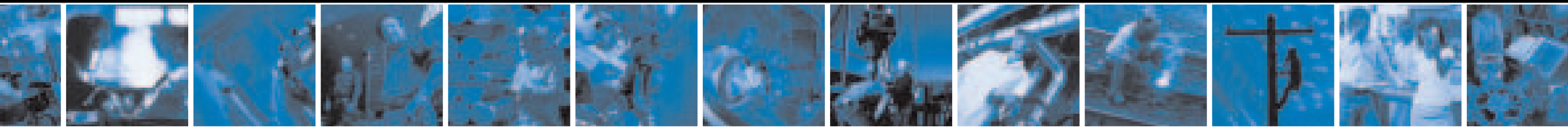
ESSENTIAL EXPERIENCE:

- Significant experience developing real-time software for microprocessor based target systems.
- Sound experience/proficiency developing software in C or C++ Programming.
- Experienced/proficient in 3 or more of the following phases of the software development lifecycle: design, code, module test, system test on Host and system test on Target.
- Experience working in a team environment, able to interact well with others.
- Good communications, logical/analytical skills.

STS Recruitment

Contact: Alex Knight
Tel: 01233 653570
Email: alex@stsjobs.co.uk
www.stsrecruit.com

Jimfinder in partnership with New Electronics for the latest Electronic and Engineering Design vacancies



appointments

Electronic and Engineering Design vacancies

Senior Avionics Hardware Engineer

Location: **UK** *Benefits:* **Commission/bonus. Company pension.**

INDUSTRY LEADING SALARY, ALL BENEFITS, BONUS, RELOCATION EXCELLENT CAREER PROGRESSION.

A South coast based, leading international aerospace company have a requirement for a Senior Avionics Hardware Engineer to assist in the development of a new hardware product within the air to air refueling section.

Excellent package to include:

- Competitive salary
- Annual bonus
- Pension
- Relocation etc

For further information please send CV to:

Contact: Jamie Cummings
Tel: 0845 200 4972
Email: jcummings@kdconsultants.com
www.kdconsultants.com

AWE can offer you a challenging career where the opportunities are up to you!

Location: **South East**

Engineering Vacancies: Chemical, Mechanical, Civil Production, Structural, Systems, Electronic, Manufacturing, Electrical.

Science Vacancies: Physics, Metallurgy, Chemistry, Computer Science, Materials Science, Mathematics, Safety, Radiological Protection.

At AWE we offer an environment that needs and encourages the best and has in place everything you need to develop a career path tailored precisely to your skills and experience.

Fewer organisations are more research led than AWE. In every area relating to modern nuclear weaponry, our activities are challenging frontiers and breaking through established barriers.

The Atomic Weapons Establishment, based at Aldermaston and Burghfield in Berkshire, develops solutions to the complex problems presented by maintaining nuclear warheads in service.

We employ staff with the highest scientific and technological skills. We are committed to stretching technology to the limits in order to address the issues involved in our field - exploring the frontiers of technology and challenging conventional thinking to deliver innovative solutions and world class results.

To find out more and apply online, visit www.awe.co.uk.
Alternatively, you can call us on 0118 982 9009 for an application form.

Graduate Design Engineer – Electro-mechanical equipment

Location: **Midlands**

Oxford Technologies Ltd supplies sophisticated electro-mechanical products and services for the remote handling and robotic markets.

We have a major contract to design and develop new devices which will be deployed by our remote handling manipulators and robots to install and remove delicate items from inside a hostile environment.

We are seeking an individual who can contribute to our work in this area by creating innovative and practical electro-mechanical devices to achieve the remote handling tasks.

The ideal candidate will be of graduate or equivalent background with at least 2 years relevant experience, be comfortable with the use of 2D and 3D CAD systems and be willing to cross the technology boundaries between mechanics, electronics and sensors.

We offer an exciting package of work in an area of fast developing high technology with rewarding short-term goals and longer term opportunities for career development.

We offer an excellent employment package with a basic salary, paid overtime, 4 weeks annual leave and other benefits.

Contact: Alan Rolfe
Tel: 01235 522119
Email: alan.rolfe@oxfordtechnologies.co.uk
www.oxfordtechnologies.co.uk

Project Engineer (Supply Chain Development)

Location: **Midlands, South, South East, UK** *Salary*: **Circa £30,000**

Highly successful, niche market, high tech electronics company seeks Project Engineer with experience in Supply Chain Development to integrate their recent overseas acquisition. You will help transfer the product to sub contract manufacturing, building invaluable supplier relationships as you go.

Working alongside the Purchasing Department, you will support them in commercial negotiation and be responsible for planning and scheduling the first production build of product and prototype, taking responsibility for test and quality.

You will be a self-motivated, results orientated graduate with experience in outsourcing, preferably from an electronics background.

A unique opportunity to join this growing and highly respected company; who have a huge passion for their product and their people. Your role will develop along with the company, possibly leading into a senior supply chain function. An interest in the music industry is a bonus

Contact: Grace Simmons
Tel: 01296 330930
Email: info@morganrem.com
www.morganrem.com