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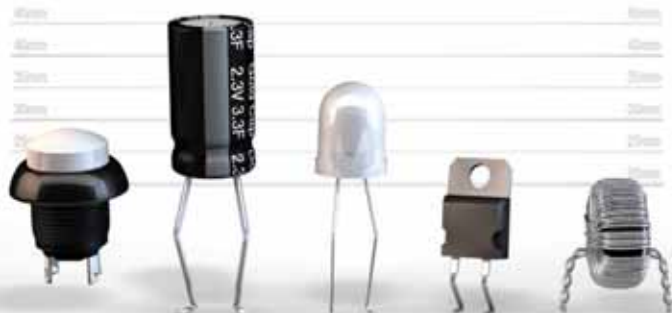
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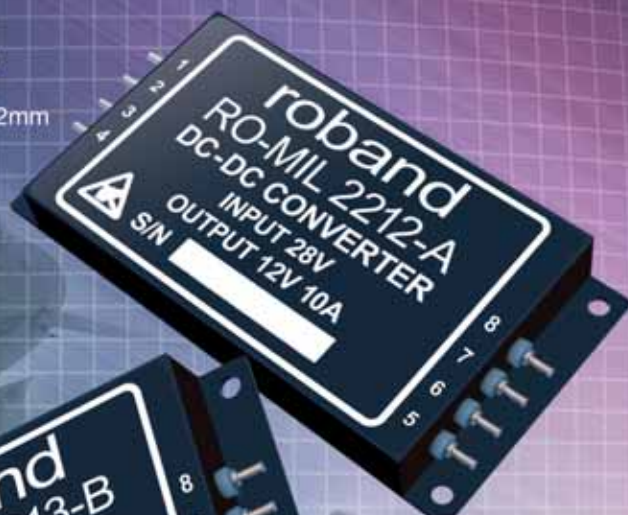
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MOBILE INDUSTRY PREDICTIONS FOR 2012

Year 2011 was another one for huge advances in the mobile industry, unfolding to deliver some of history's most developed and impressive strategies and devices. The previous year concluded with 5.2 billion active mobile accounts and as there are only 6.9 billion people on the planet, this fact says it all. It is now essential for business to adopt a mobile strategy. However, before doing so, businesses need to know what to expect from the industry and its key players.

Microsoft will double its mobile market share

With HTC, ZTE, LG, Samsung, Huawei and many others all frustrated with the increasingly public and costly legal questions surrounding the Android platform, my first prediction is that these manufacturers will spread their risk by bringing the Microsoft Windows phone into the spotlight of their service portfolio. Microsoft providing indemnities against Android-related legal action and a low, but not free, price will convince them. This action, combined with a strong joint marketing campaign, involving Nokia in the US and the launch of Windows 8 for tablets from some of the aforementioned suppliers, leads me to believe there is the possibility of Microsoft more than doubling its mobile market share by the end of 2012.

Gaming will drive growth for Sony

The mobile industry will also see some interest moves from Sony. Soon to be free from the completely unglamorous Ericsson brand, I believe Sony will become the fastest-growing handset vendor of 2012. The 'Gaming Factor' will be the unique driving force behind its growth, helped by mobile versions of the classic PS1 and PS2 games. It will be interesting to see the true depth of the mobile-gaming market.

Apple will lose its shine

Towards the end of 2011, I couldn't help but feel as though Apple's mobile brand was starting to go off, especially as there doesn't appear to be another radical new product being prepared. Now, with the prospects of more handset-related growth, exacerbated by austerity in the Western world and an out-of-reach iPhone prices for the middle classes of India and China, I believe this will result in Apple's mobile market share decline further. But as revenue growth comes from applications (apps) this shouldn't have a big impact on Apple's balance sheet.

The previous year concluded with 5.2 billion active mobile accounts and as there are only 6.9 billion people on the planet, this fact says it all

Brands will abandon native applications in 2012

On the developer side, 2011 started to show signs of an interesting shift from the development of native applications to mobile web optimisation. This shift will continue as many retailers and non-gaming brands will increasingly abandon native applications in 2012. Searching for options to battle with the recession and realising the relative costs and resource consumption associated with developing, maintaining and refreshing apps cannot be justified. Brands will also become more aware that apps often contain a fraction of a business's products. Instead, adapting to the continuous exhilarating growth of mobile internet users, businesses will be choosing HTML5 web-based technologies using server-side device detection to drive mobile traffic from their existing web sites, aided by investment in search engine optimisation. This year will be the year that businesses understand the different ways of optimising interaction.

Predictions for the world of mobile networks in 2012

Based on the last couple of years, I have some strong predictions for the world of mobile networks in 2012. Relating to T-Mobile UK being dropped as a consumer brand but retained as a business brand, it's been investing in supporting two brands for over two years and not presented any direction regarding future branding. So far its management has failed to make a decision based on three options in front of them: a) T-Mobile b) Orange or c) a new brand. I am surprised, however, to learn they're serious about creating a new brand, which will cost at least £80m and I'm not convinced it gives any benefits over staying with Orange.

Whereas in the US, Vodafone is looking set to purchase Sprint or T-Mobile for a knock-down price now that AT&T has finally got the thumbs-down from the US regulator. Verizon will then get 100% of Verizon Wireless as Vodafone sells its minority stake to please the regulator, and investors will say goodbye to big dividends from Vodafone for the next couple of years.

James Rosewell is CEO of 51Degrees.mobi, a provider of device detection, web optimisation and mobile analytics solutions

EDITOR:
Svetlana Josifovska
+44 (0)845 4790343
Email: svetlanaj@stjohnpatrick.com

PRODUCTION MANAGER:
Tania King
Email: taniak@stjohnpatrick.com

DISPLAY SALES:
John Steward
Tel: +44 (0) 20 7933 8974
Email: johns@stjohnpatrick.com

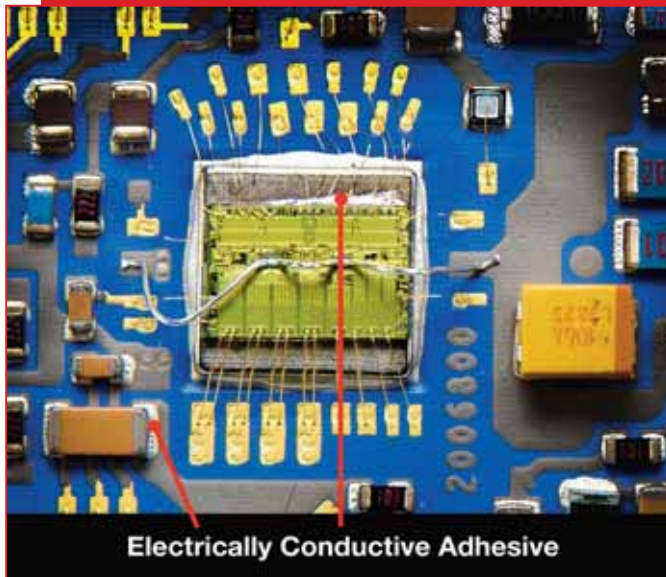
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HENKEL DEVELOPS ELECTRICALLY-CONDUCTIVE ADHESIVE, COMPATIBLE WITH LOWER-COST COMPONENTS



In a significant formulation breakthrough, Henkel Electronic Materials has developed a new electrically conductive adhesive (ECA) compatible with lower-cost, tin-terminated components that enables more cost-

effective assembly processes. The new material, Ablestik ICP-3535M1, is a pre-mixed ECA that provides low and stable contact resistance when used with 100% tin-terminated components. The benefits of ECAs are

well-known, including their lower temperature processability, streamlined manufacturing techniques, lower stress assemblies and regulatory-compliant, lead-free formulations. However, one of their few drawbacks has been the materials' inability to cope with non-noble metals on component terminations, making them useful primarily with palladium silver, silver or gold-finished components. Ablestik ICP-3535M1 now delivers all of the ECA benefits with the added advantage of tin compatibility, thereby enabling high-performance and cost-efficient processes.

"Ablestik ICP-3535M1 is extremely adaptable. The material also provides reliable component assembly to a variety of substrates including low-

temperature co-fired ceramics (LTCCs), high-temperature ceramics and OSP-finished printed circuit boards (PCBs). This flexibility is central to reducing supply-chain complexity, allowing manufacturers to source a single material for multiple applications," said Tom Adcock, Henkel's Global Product Manager for Assembly Adhesives.

Ablestik ICP-3535M1 is particularly well suited for a variety of automotive applications, but also has relevance for any environment where high reliability and cost reduction targets are important. These may include the aerospace sector, wireless datacom infrastructure (WDI) products, security devices, lighting technology and others.

Sony Unveils Next-Generation Back-Illuminated CMOS Image Sensor

Japanese electronics firm Sony has developed a next generation, back-illuminated CMOS image sensor that promises great improvements for consumer devices with cameras.

The company has created a structure that layers sections of the chip: the pixel section, containing formations of back-illuminated structure pixels, is placed over the chip that contains the signal processing circuits. With such a stacking method, large-scale circuits can be integrated vertically,

keeping the chip footprint small.

Furthermore, as the pixel and circuit sections are formed as independent chips, they can be manufactured to make either of them specialized for various degrees of image quality and functionalities. In addition, faster signal processing and lower power consumption can also be achieved using a leading process for the chip that contains the circuits, says Sony.

In comparison, conventional CMOS image sensors mount the pixel section and analog

logic circuit on top of the same chip, which require numerous constraints when needing to use large-scale circuits including adding measures to suppress noise caused by the layout of the pixel and circuit sections, and optimizing the characteristics of pixels and circuit transistors.

Sony begins shipping samples of the back-illuminated CMOS image sensor in March, but expects a wide reach for it in smartphones and other consumer devices.

everywoman selects Technology Awards finalists

The UK's largest female business community, everywoman, will announce the 2012 winners in the everywoman in Technology Awards at a ceremony on 29 March 2012 at The Savoy in London, uncovering the UK's most successful and talented women working within the technology sector. The awards are meant to encourage more women to see technology as a rewarding career choice.

Recent figures show that the number of women employed within the IT and telecoms sector has decreased. Although 47% of the UK workforce is female, only 18% of IT and telecoms professionals are women, down from 22% in 2001. The government plans an overhaul in the education of information and communications technology within schools to ensure that the UK's economic prospects are not damaged in the future. Find out more at www.everywoman.com.

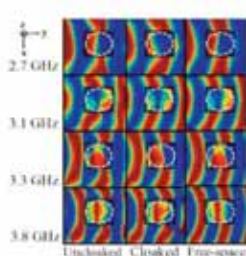
Futuristic Invisibility Cloaking of 3D Object Achieved at Microwave Frequencies

Austin, Texas-based university scientists have managed to make a three-dimensional object invisible. They cloaked an 18cm cylindrical tube in an experiment that used the so-called plasmonic metamaterials, then bombarded it with 3.1GHz microwaves.

Plasmonic metamaterials are engineered mostly of metals and insulators. Their structure is geometric in nature, with features smaller than the wavelength of light, separated by sub-wavelength distances. These features can be tweaked so the material's parameters such as permittivity and permeability will be negative, with negative refractive index, where the light bends the opposite way to that a light normally would.

In the experiment, the university researchers hit the tube with microwaves. The microwaves that bounced off the tube cancelled out with those of the

Map of microwaves in free space, when cloaked and uncloaked



metamaterial's refracting negatively, rendering the tube invisible.

"When the scattered fields from the cloak and the object interfere, they cancel each other out, and the overall effect is transparency and invisibility at all angles of observations," said the University of Austin Assistant Professor Andrea Alu.

So far the cloaking works best at 3.1GHz. In theory it can work with visible light too, however the objects will be only micrometers small.

There are other techniques that have achieved invisibility but for two-dimensional objects and, in 3D, there's a technique called "carpet cloaking", however both are of limited functionality and have not managed to mask

larger 3D objects.

For now, the plasmonic metamaterials approach has the potential to be used to camouflage military objects.

"Making objects invisible to radar is one important application," said Alu. "...Not necessarily cloaking the whole warplane but some hotspots, a part such as the tailplane because it reflects most of the energy (from microwave radar)."

Another application could be its use in counteracting backscatter of light around high-powered optical microscopes, where sensitive measurements could be easily skewed.

First Metamaterials

Materials that are today referred to as metamaterials were first suggested in 1967 by the Russian theorist Victor Veselago. However, the first metamaterials weren't constructed until 2000.

Polymer from Brown Algae May Improve Electrodes in Lithium-Ion Batteries

Environmentally-friendly algae could be used as binder material for lithium-ion battery electrodes, according to researchers from Clemson University. They found that such polymers could not only boost energy storage, but also eliminate the use of toxic compounds currently used in manufacturing the components.

Known as alginate, the material is extracted from common, fast-growing brown algae. In tests so far, it has helped boost energy storage and output for both graphite-based electrodes used in existing batteries and silicon-based electrodes being developed for future generations of batteries. Alginate is also a lot cheaper to use than these materials.

"[Alginate-based] batteries could contribute to building a

more energy-efficient economy with extended-range electric cars, as well as cell phones and notebook computers that run longer on battery power – all with environmentally-friendly manufacturing technologies," said Gleb Yushin, assistant professor in Georgia Tech's School of Materials Science and Engineering, the university partnering with Clemson on this research.

The binder is a critical component which suspends the silicon or graphite particles that actively interact with the electrolyte providing the battery with power.

"We specifically looked at materials that had evolved in natural systems, such as aquatic plants which grow in salt water with a high concentration of ions," said Igor Luzinov, professor at

Clemson's School of Materials Science and Engineering. "Since electrodes in batteries are immersed in a liquid electrolyte, we felt that aquatic plants – in particular, plants growing in such an aggressive environment as salt water – would be excellent candidates for natural binders."

Existing lithium-ion batteries rely on anodes made from graphite, a form of carbon. Silicon-based anodes theoretically offer as much as a ten-fold capacity improvement over graphite anodes, but silicon-based anodes have so far not been stable enough for practical use. Among the challenges for binder materials are that anodes to be used in future batteries must allow for the expansion and contraction of the silicon nanoparticles, and that existing electrodes use a



polyvinylidene fluoride binder manufactured using a toxic solvent. In addition, the new alginate electrodes are compatible with existing production techniques and can be integrated into existing battery designs.

This project has been partly funded by a Honda Initiation Grant and a grant from NASA.

Igor Luzinov, professor at Clemson's School of Materials Science and Engineering

MOUSER ELECTRONICS: AT THE PULSE OF MEDICAL TECHNOLOGY

Forward-thinking design engineers have been driving huge advances in almost all areas of medical technology over the past years. Treatments are getting less invasive due to the smaller size of the components, such as camera pills that can analyze the inner workings of the body without requiring exploratory surgery and new ways to gather data by using wireless connections. And within the last year, these advancements have extended to even create computers to aid in patient treatment and diagnosis.

At Mouser Electronics, focus on the design engineer is the order of the day. As a top design engineering resource and global distributor for semiconductors and electronic components, Mouser caters to design engineers and buyers by delivering What's Next in advanced technologies. Within the medical field, Mouser continues to take strides to ensure design engineers can find the most advanced products they need for their latest medical applications.

While many sectors suffered during the recession, the medical industry was one that continued to show strength. Companies shifted their focus from consumer devices, which are purchased with disposable income, to the industrial and medical industry. It offers a sustainable market that will always be in demand. And by applying new technology to the products, functionality can continue to increase.

Take Bluetooth for example. By using this technology in the medical industry, nurses can monitor more patients and gather information in a more efficient and less invasive manner, increasing the level of patient care. According to In-Stat, Bluetooth products in the industrial and medical market show the most growth potential with a compound annual growth rate (CAGR) close to 85% between 2009 and 2014. No matter what industry you are in, those are great numbers and will make any executive look twice before dismissing the revenue potential.

Another example of how technology can improve on a traditional piece of equipment is the digital stethoscope. Advanced functionality can be integrated to expand and increase the value it provides to doctors. A digital stethoscope can implement noise cancellation so that doctors can clearly



hear the heart beat – even in busy or loud hospitals, or when noisy equipment is running in the background. Believe it or not, there are even digital stethoscope apps available for the iPhone.

Given the state of the population, including old age, increased obesity and a more desk-bound lifestyle of technology workers, medical conditions need to be diagnosed, monitored and treated. One familiar piece of equipment, blood pressure monitors, are expected to have a revenue of over \$790 million alone, with most of the demand driven by requirements from the U.S. and Europe.

Of course, blood pressure monitors are not the only products in the medical market. There are a number of others, each with significant revenue expectations over the next few years. You may not have heard of pulse oximeters before, but they are a way to monitor the oxygen saturation in a patient's blood without requiring an actual blood sample, which makes the monitoring less invasive. For more information on the latest in patient monitoring, visit http://www.mouser.com/medical_patient_monitoring/.

A final example is the electrocardiograph (ECG), which monitors the patient's heart activity to diagnose cardiac issues. These products are traditionally purchased in the US, but the growing population and income levels in developing countries, specifically in the Asian Pacific region, will boost the market growth to close to 10% (even though these are high cost systems).

All said and done, the medical industry is definitely one that is to be watched closely, and Mouser is the go-to source for all the latest medical applications for design engineers. For more information on the latest medical applications and therapy, visit www.mouser.com/medical_therapy



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High reliability in Space

BOB HUNT, HEAD OF STRATEGIC TECHNOLOGY AT C-MAC MICROTECHNOLOGY, EXPLAINS HOW NEW TRENDS IN THE SPACE MARKET ARE DRIVING DEMAND FOR TRIED AND TRUSTED HIGH-RELIABILITY ELECTRONICS

Last June saw the ninth European Space Power Conference take place on the Côte d'Azur in France, and the increase in the number of delegates at the event (up by 50 to over 300 attendees) served to reinforce the fact that the space market is on the up. In Britain alone, annual turnover in the space industry is worth some £7.5bn, with employment rising at about 15% a year and the industry enjoying double-digit growth right through the recession.

But growth is not without its challenges and as the space industry adopts newer, more complex technologies, the pressure is on for

significant improvement in intelligence within the satellites through digital signal processing, routing and storage.

Satellite Power Systems

One notable trend of great interest is in Point of Load (PoL) DC-DC converters. Satellite power control and distribution unit designers are looking for low voltage power supplies that need to be mounted as close as possible to increasingly sensitive digital elements. Telecommunications satellites in particular are driving these requirements for PoL converters, used in powering a whole load of processors, gate arrays and memories. Each of these components have their feature sizes decreased regularly and require a range of low supply voltages (1.8V, 2.2V, 2.8V, 3.3V, 5V) and high currents. This increasing need for multiple voltages at higher current levels is forcing circuit board designers to re-think their designs and implement PoL DC-DC converters close to the load to minimise voltage drops, enhance regulation and ensure rapidly fluctuating high-current demands are accommodated. With a typical satellite power bus at 28V, a PoL capable of operating over a wide range of input voltages and producing a wide range of output voltages is a necessity to system designers, yet it is not readily available.

One of the challenges faced by the European space market is the constraints placed on imported electronics. These constraints lead to unforeseen costs and programme delays, and have driven European procurement policy to focus on locally manufactured products. With the growing closeness between the European Space Agency (ESA) and the Japanese Space Agency

(JAXA), it seems that this preference has been extended to include Asia as well. The challenge for European electronics companies is to provide equivalent or better products than those presently available on the global market.

Environmental Challenges

In deep space missions, temperature ranges are becoming much wider. The standard military temperature range has long been fixed at -55°C to 125°C but in space exploration the temperature extremes move farther apart. The deeper we venture into space, the cooler the temperatures (in eclipse) which electronics must function, while solar observation missions or those to Mercury require functionality at far higher temperatures. Such extreme temperature range increases the interest in custom, hybrid microelectronic modules. This was reinforced at the European Space Power Conference.

Returning to the technical challenges, the rigors of space and the high altitude above LEO (Low Earth Orbit) create a very particular set of conditions. Protection from radiation is widely recognised as critical to the operation of electronics in satellite systems. High levels of cosmic radiation threaten to influence the life-span of electronic components or destroy them. It is as much the level of dose rates as the total radiation dose itself which is of concern. Counter-intuitively, it is often the low dose rates or even single radiation events that cause the most concern and these effects must be mitigated as much as possible by the correct choice of components and their packaging. Package design with radiation-hardened components with filtering or shielding is crucial to ensure the high reliability and



Aluminium wire bonding

longevity of a system. Radiation-hardened (or rad-hard) products are essential in most satellites orbiting above LEO.

To COTS or not to COTS

Despite the increased use of commercial-off-the-shelf (COTS) component grades for aerospace and defence electronics, particularly since the Pentagon formally moved in the direction of COTS in 1994, the packaging of choice for the extreme environments of space continues to be metal or ceramic hermetic cavity enclosures.

Commercial grade products struggle to meet the performance requirements for space, primarily because of the naturally occurring radiation, the temperature extremes and rapid temperature deviations, not to mention the harsh mechanical stresses occurring during the launch of space systems. This is very important when trying to implement COTS designs into space systems.

Another important requirement for space-grade products is manufacturing lot homogeneity, which is key to maintaining repeatable performance and reliability for a given component design. When plastic-encapsulated semiconductor devices are specified, even if they all feature the same date code, there is no guarantee that each device originates from the same wafer or even wafer lot. While the device manufacturers focus on high volume markets of consumer electronics and automotive sectors, the highly specific requirements of the space industry become more marginalised. With space-grade hybrid microcircuits a vital feature is complete and full traceability to a qualified wafer – important for guaranteeing both electrical performance and radiation tolerance. For this reason, COTS products often become more expensive than space-grade products, due to the very high cost of component lot qualification.

Other Trends

Another key trend that came out of the conference is that hybrid multi-chip modules (MCMs) are being viewed as cost-efficient implementation for power conversion designs which are used repeatedly throughout the satellite. Again, hybrids are crucial to maintaining lot homogeneity compared to equivalent PCB modules incorporating discrete components.

For the harshest environments, chip and wire MCMs are hermetically sealed in metal or ceramic packages. There are many design aspects to be considered in high-reliability hermetic modules. One is the internal atmosphere within the package cavity. This is heavily affected by the sealing process controls and the choice of materials used for the substrate and component attachment.

Inappropriate organic materials can outgas moisture and corrosive ionic contaminants over time and destroy the integrity of the product. Ceramics such as Alumina are stable, rigid and non-porous, provide the substrate for the interconnect in hermetically sealed packages, avoiding the out-gassing issues associated with PCB epoxy laminates.

Out-gassing of moisture is a key concern as condensation brought on by out-gassing of organic materials can ultimately lead to failure due to corrosion, or simply to the increase in leakage currents, which can lead to circuit failure.

The correct choice of material together with tightly controlled pre-lid vacuum bake and subsequent sealing processes ensures that the low moisture environment is maintained over the full lifespan of the product. The benefits of this modular approach are cost, reliability and consistency of performance. An essential ingredient is the manufacturing excellence and



pedigree that are so vital in the space market.

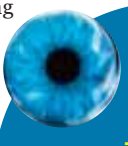
New Challenges, Trusted Solutions

Despite the focus on the new electronics challenges the space industry is facing, the conference also underlined the continuing demand for trusted MIL-STD-1553 data bus products. Other data bus protocols such as CAN, Space-wire and other bespoke designs were mentioned but always alongside 1553. Initially designed for fly-by-wire on the F16 fighter platform, this highly robust, noise tolerant and reliable data bus seems set to be around for many years to come.

The European Space Power Conference reinforced the idea that space exploration is growing at a rapid rate, venturing farther and into harsher environments than ever before. Wider temperature ranges, radiation and demand for PoL power supplies are all increased challenges, and as the cost of electronics becomes more significant in the overall budget, so will the drive to find more cost-effective solutions for key applications. This is why the industry focuses on hybrid

microcircuits, which are recognised as far more cost-effective than space-grade discrete products.

Wherever in space the industry ventures next, one thing's for sure: trusted high-reliability technology will be crucial to getting there. ●

 **The challenge for European electronics companies is to provide equivalent or better products than those presently available on the global market**



One of Three

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Low power radio links are, more often than not, used as data conduits. Streams or packets of binary data are sent from origin to destination, coded in some fashion into an acceptable baseband signal.

Even in as simple a sentence as the one above, it is possible to gloss over one of the most important aspects of the design of a data link with a few dismissive words, such as “in some fashion”. The actual method used to relate the communicated information to the modulating waveform reaching the transmitter will define the performance and the construction of the entire system.

In the simplest possible case, the data is coded as a serial stream of bits – employing any number of synchronous or asynchronous protocols, and the resulting two level “square wave”, after being suitably filtered or rounded to constrain the bandwidth, becomes the baseband signal. This approach has the benefit of simplicity and, provided the necessary framing, coding and checking is added to the stream in the “higher” layers of the link, is eminently compatible with the simple radio hardware used in ISM band applications.

Unfortunately, it has limits. The most common issue, that the data stream is an inherently DC coupled signal, while the baseband radio path is usually AC coupled is

dealt with in a number of well understood ways: quasi-DC coupled “sampling” data recover circuits, phase (Manchester) coded bit streams or the inclusion of “stuffing” bits or “whitening” functions. More intractable is the upper frequency limit of the radio baseband path.

There is frequently just too much data to fit through the channel. The most efficient two-level coding (synchronous NRZ) still has a bandwidth requirement of 0.5 times the data rate, in Hz. If a moment is taken to consider this, it becomes obvious: a bit period is (t) seconds, and the worst case (for bandwidth) data sequence is ...10101010... In the time domain this appears as a square wave with a period of (2 x t), or a frequency of half the data rate.

A practical 25kHz narrowband FM channel is hard pushed to provide a usable bandwidth much over DC-3kHz, when frequency errors and the band edge high frequency behaviour of the receiver filtering is considered. This means that a reliable 5kbit/s is about the limit for simple NRZ link. To be fair, at lower power levels the modulation bandwidth can be allowed to spread a little more, so perhaps 10kbit/s is fairer, but for higher power radios the transmit adjacent channel limits impose the lower speed.

Exceeding this limit has been the target of considerable work over the years, with a great

many different methods being proposed and used. All of these methods are founded on the same basic idea: to increase the maximum data rate necessary to use more than just two “levels” in the bit coding. In the most extreme cases, this leads to QPSK or “trellis” coding methods, where multiple increments of phase and amplitude are employed to code up to 64 levels into a single “period”.

In ISM band applications simpler techniques have found favour, where four level FM allows 2 bits per period and up to 20kbit/s in a 20kHz channel; and GMSK, selective attenuation and regeneration of the higher modulation frequency components through the use of matched, Gaussian filters has provided the market with reliable 9600 baud, high power radio modems. The price paid by these techniques is increased complexity and degraded S/N performance, and as such the range for a given transmit power compared to a simpler, slower FSK link.

There is, however, another technique that is little utilised: three level duobinary coding. This should not be confused with trinary or base three coding, which is even less used, outside of a handful of ancient Soviet mainframe designs. It is a binary coding scheme, but one which uses three discrete levels in the baseband waveform.

Before anyone’s brain explodes, I need to explain. Duobinary coding takes a conventional serial data stream and imposes a rather cunning coder rule:

Let us define the three levels as zero (o), up (U) and down (D).

A binary 0 in the original data is always

There is another technique that is little utilised: three level duobinary coding. This should not be confused with trinary or base three coding

coded as a duobinary 0.

A binary one is coded as EITHER a duobinary U or a D.

The "rule" is then that any change from 0 to 1 will produce the opposite "ones" state to the previous one.

For example 000111 will code as 000UUU, or 000DDD – it doesn't matter which!

Then 0101 codes as 0UoD and

01110110000101 codes as

0UUUoDDo000UoD and so on.

This does not look very useful, until the previous "worst case for bandwidth" state (a continuous 010101 stream) is considered. It codes as a constant 0UoDoUoD.

Sketch that and it looks like a series of pulses of alternating polarity. Smooth out the square edges into curves however and we are looking at an approximation to a sine wave, but one with a frequency equal to a quarter of the original data rate (not a half, as is the case for two level coding).

This is the main benefit of duobinary. It provides the bandwidth compression of four level coded "two bits per period" for a three level code, with the obvious improvement in S/N.

Furthermore, when considering the simple hardware of low power wireless

DUOBINARY IS A PUBLIC DOMAIN TECHNIQUE. IT IS DESCRIBED MORE FULLY IN A NUMBER OF DATA CODING TEXT BOOKS (SUCH AS "DATA TRANSMISSION" BY DOGAN & OSMAN TUGAL).

It is the coding technique used in the audio/data channels of the D2-MAC digital TV broadcasting standard; it is used in some fibre optic systems; and in certain magnetic recording formats. It is sometimes – possibly inaccurately – also referred to as "alternate mark invert" coding.

1 frame = 312mS (which equals the response time from node to master)

In-sync power consumption of a node (on for 24mS, off for 288mS) = 1.5mA

devices, it is far easier to generate duobinary (deviation at max, at min, and unmodulated) with the simple modulators often used than it is to accurately set the discrete levels of a 4FSK system.

Recovering a duobinary stream is also easier, as there is no requirement to generate and decode bit pairs, or to realise accurate inverse-Gaussian filter shapes. Just regenerate positive and negative peak values (+/-A), feed a pair of comparators with +A/2 and -A/2, and logical OR the outputs.

Lastly, duobinary has another, hidden feature: it offers a degree of inherent error detection, in that the sequences 0UoU and 0DoD – and the longer versions thereof – cannot appear in a correctly coded duobinary sequence. Looking for these conditions, or their absence, can be used as

a form of additional data integrity confirmation

Elegant, but it isn't a panacea. It isn't inherently self-clocking, like Manchester coding; it has a DC component and there are complexities involved in implementing a bandwidth efficient duobinary modem, I admit, effective filtering of the transmit waveform, recovery of data with real-world, non-ideal sequences of bits, data sampling clock regeneration to name a few, but this is a technique which will lend itself to innovative realisations, without just resorting to costly, power-hungry modem chips or DSP systems and without accepting sub-standard performance.

I'm going to grab a handful of op-amps and see what I can get working; what about you? ●

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DAVE BECKETT, PROCESS AND ENGINEERING MANAGER AT SYFER TECHNOLOGY, EXPLAINS THE IMPORTANCE AND SPECIFICALLY TAILORED SOLUTIONS OF NON-MAGNETIC CAPACITORS USED IN AND AROUND MRI BODY SCANNERS

NON-MAGNETIC, COPPER BARRIER CAPACITORS

ATTRACT THE ATTENTION OF THE MEDICAL MARKET

Rapid technological advances in medical electronics are generating significant demand for a range of passive electronic components, capacitors in particular, for use in a growing and diversified range of medical equipment.

Two parallel trends are prompting further demand through increased volume requirements of this equipment in both developed and developing countries. First, the prevalence of ever smaller and low-cost electronic devices is facilitating the development of affordable, portable medical equipment. Second, a fast developing wireless infrastructure worldwide is supporting the rapid deployment of this low cost, portable medical equipment in telemedicine applications.

Medical Equipment Sensitivities

Imaging systems represent the largest and most vibrant sector of the medical electronics industry. Among the most significant of imaging modalities in continuing development are magnetic resonance imaging (MRI) scanners, which use a powerful magnetic field to create an image, enabling doctors to visualise conditions inside various parts of the body. The magnetic field in the tunnel of an MRI scanner must be uniform to parts per million. The resolution is dependent on the strength of the magnetic field. The field strength can be inadvertently increased, not only by magnetic components inside the scanner tunnel, but also in ancillary equipment. For these reasons, it is imperative that components, such as capacitors, within and surrounding the MRI scanner, are non-magnetic, typically a maximum

relative permeability up to around $\mu_r = 1.0005$ being allowed.

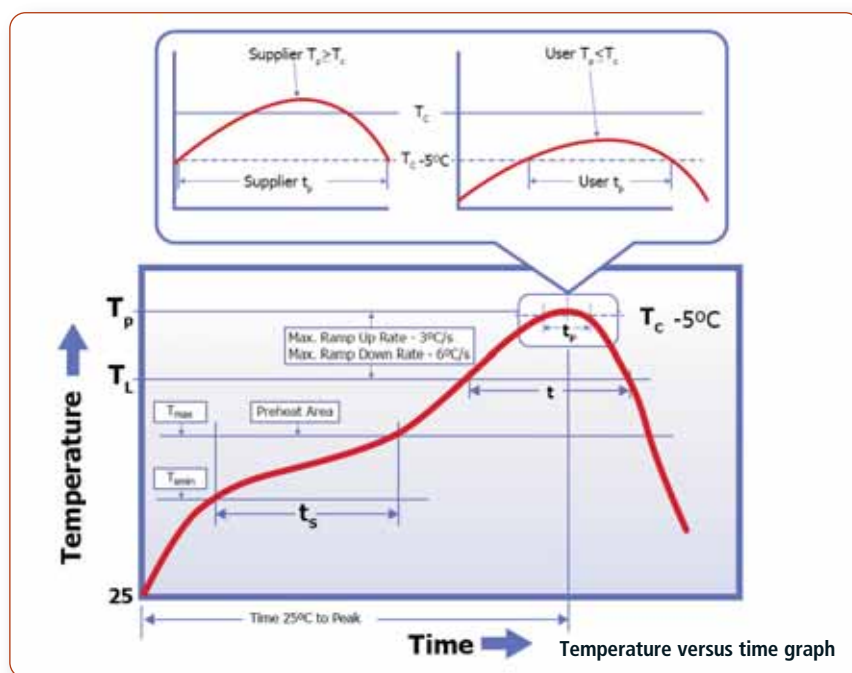
Surface mount MLCC (MultiLayer Ceramic Capacitors), used extensively in the electronics industry, are typically supplied with a nickel barrier finish. This consists of a silver base termination layer overplated with nickel, which provides protection to the base layer and improves solder leach resistance. A plated top-layer of pure tin or tin/lead is used to protect the nickel from oxidation and maintain a readily solderable finish.

Nickel, however, has magnetic properties which render it unsuitable in MRI scanner applications – a typical nickel-plated MLCC will have a relative permeability μ_r of around 1.4000. With such high field strengths involved in this type of equipment, careful selection of the dielectric material itself (in this case

ceramic) is also critical as trace elements of magnetic material (Ni, Fe, etc) can be present. Typically, such minute traces were previously regarded as insignificant, but under these extremely sensitive conditions, this is no longer the case.

Nickel Alternatives

Historically, there have been applications in various industry sectors where nickel has been unacceptable. One often used alternative is a non-magnetic 'fired' silver/palladium (Ag/Pd) unplated termination. However, the solder leach resistance of this termination type is inferior to that of capacitors with nickel barrier plating, so this option requires the use of special, low melting point, solders. These are based on the common 60/40 tin/lead alloy, but doped with a small amount of silver to prevent



the tin in the solder leaching the silver from the termination, which could result in total loss of electrical and mechanical contact to the chip. The solder alloy developed for this application is 62%Sn36%Pb2%Ag, variously known as 62s or LMP solder alloy.

The enforcement of the EU Directive 2002/95/EC (The Restriction of Hazardous Substances or RoHS directive) in 2006 means the use of certain materials found in electrical and electronic products is now prohibited, except in a few special cases. 2002/95/EC was extensively re-written in 2011 becoming 2011/65/EU (commonly referred to as the RoHS2 directive), with a significant change to include all EEE, unless specifically exempted. Importantly, medical devices are now included in the scope of the directive from 2014.

Of the banned materials, lead (Pb) tops the list, with widespread impact across electronics designers and manufacturers, requiring a complete re-think on the use of conventional Pb-based solder alloys. The removal of Pb from solders used in the assembly of electrical and electronic equipment has forced the move to tin-based solder alloys, typically tin/silver/copper. These have higher melting temperatures: a typical SnPb solder has a re-flow temperature of 179°C, whereas typical Pb-free solders have re-flow temperatures in excess of 217°C.

Significantly, the higher the percentage of tin in the solder, the more likely it is to leach the silver from the capacitor termination – typical Pb free solders have in excess of 90% Sn content. It was quickly found that doping the Pb-free solder alloy with small amounts of silver does not prevent leaching of silver from fired terminations, as it does with SnPb alloys.

Non-Magnetic Solutions

To meet the demands from the growing medical market for non-magnetic components, and to ensure compliance with the RoHS and RoHS2 Directives, UK-based capacitor manufacturer, Syfer Technology has developed a 'non-magnetic' range of plated finish MLCC products. The devices are constructed using selected non-magnetic CoG/NPO, High Q and X7R dielectrics and a non-magnetic 'copper barrier' plated finish.

Key consideration during the product development process was to ensure that the plated finish is capable of meeting the requirements of the high temperature (260°C) soldering reflow profiles, as detailed in IPC 7351A (the land pattern design standard with

guidance for lead free soldering processes, as well as reflow cycle and profile requirements) and J-STD-020 (the standard for moisture/reflow sensitive SMDs suitable for lead-free/high temperature processing).

During the development of the plating process Syfer experimented with copper solutions from a number of suppliers. Both acid and alkaline plating solutions were tried before finalising the selection of the optimum plating solution. It was important that the material is fully compatible with the dielectric and the underlying termination, and provides the most stable plating platform to ensure component reliability.

The Copper Barrier devices are packaged in case sizes from 0402 to 2225, depending on value. Values range from 0.1pF to 6.8µF and 16V to 3000V rated operating voltage, using CoG/NPO, High Q and X7R dielectrics. Operating temperature range is -55 to 125°C, making them eminently suitable for medical equipment as well as other applications requiring non-magnetic, multilayer chip capacitors. They are suitable for soldering with common lead-free solder alloys and have significantly improved leach resistance compared to a 'fired' silver/palladium (Ag/Pd) termination.

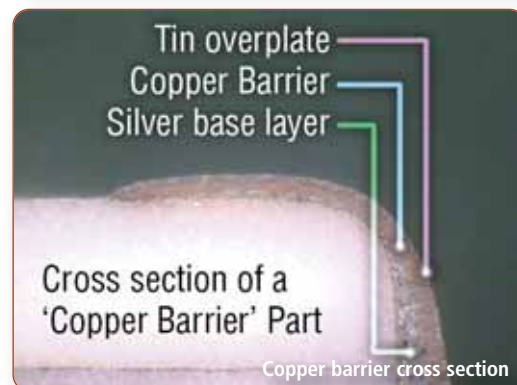
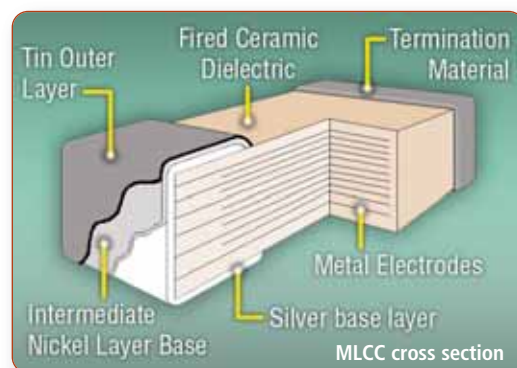
The range has a measured permeability μ_r of approximately 1.0000, compared to a typical relative permeability μ_r of 1.4000 for nickel-plated capacitors. All dielectrics in the range are also compliant with the changes included in 2011/65/EU (RoHS2) and are completely lead-free.

Versions manufactured using the X7R dielectric incorporate the FlexiCap polymer termination as standard. FlexiCap is a proprietary flexible epoxy polymer termination material, applied to the device under the plated barrier finish. This can accommodate almost double the degree of board bending than conventional capacitors, and makes them more resistant to damage under stress and temperature cycling extremes.

Finally, the same parts are also available with SnPb plated terminations for applications where the increased leach resistance is preferred, but RoHS compliance or high tin percentage solders are not required.

Stamp of Approval

In addition to undergoing extensive in-house product testing procedures, Syfer has been working closely with a number of key customers in the medical equipment sector. Several have already sampled the non-



magnetic Copper Barrier products and have reported great success. The components have received full approval for use in MRI applications and production quantities have been ordered across a range of chip sizes and capacitances. ●

INTELLIGENT MOSFETS ADD RELIABILITY

WHILE IMPROVING PERFORMANCE IN MEDICAL DESIGNS

EDMUND SUCKOW, FIELD APPLICATION ENGINEER AND MEDICAL SEGMENT MANAGER FOR NORTH AMERICA AT FAIRCHILD SEMICONDUCTOR, DISCUSSES LOAD SWITCH TECHNOLOGY AND ITS USE IN CURRENT POWER ARCHITECTURES, AND GIVES EXAMPLES OF ITS USE IN RECHARGEABLE, PORTABLE, MEDICAL APPLICATIONS

A

ll medical applications require reliable performance while still providing technological advancements. As the level of competition increases among medical electronics makers and their end applications, feature sets are frequently added in haste without considering the implications of a possible failure. But at each step

of the way for end applications, power is of critical importance.

Intelligent MOSFETs are one of the power enablers that have been increasing in popularity. Due to its simple drive requirements a standard P-channel FET is often used to switch power distribution nodes, connect charging paths, and allow for connector hot-swap and direct current flow among others. Because these devices are in the critical path, where failure results in sensors or processors being disabled, it is wise to invest in robust power switches.

Evolution of the Load Switch in Battery Applications

Ever since batteries have been introduced to electronics there's been a need for power isolation. By default, batteries used as a mobile power source means that they will be drained during use and must be recharged. Obviously, the circuit's power design directly impacts the time between normal use and charge time.

Battery technology has not seen any major improvements in recent years and promises no major breakthrough on the horizon. It is therefore up to IC (Integrated Circuit) technology to adhere to strict power consumption specifications to extend the operating time of an application.

Before we dive into load switches, we need to look at battery technology, the load on the battery and the need for load switches. To estimate the battery's life on a given charge is relatively simple to calculate if – and only if! – all current draw paths are known. It is often not the 100mA, controlled duty-cycle sensor that contributes to power depletion on its own, but the numerous < 1mA sinks that are always connected which slowly pry off energy. Also necessary to roughly add to the power equation, yet more difficult, are the transient spikes that take place when a given feature or sensor is enabled. These spikes are monitored in amplitude and duration, allowing an energy calculation for a general one-shot event, times the number of spikes. After all general loads are known, operating time calculations are straight forward.

At present, batteries are rated in mAh, instead of previous coulomb ratings, where a 1000mAh battery can supply 1A for one

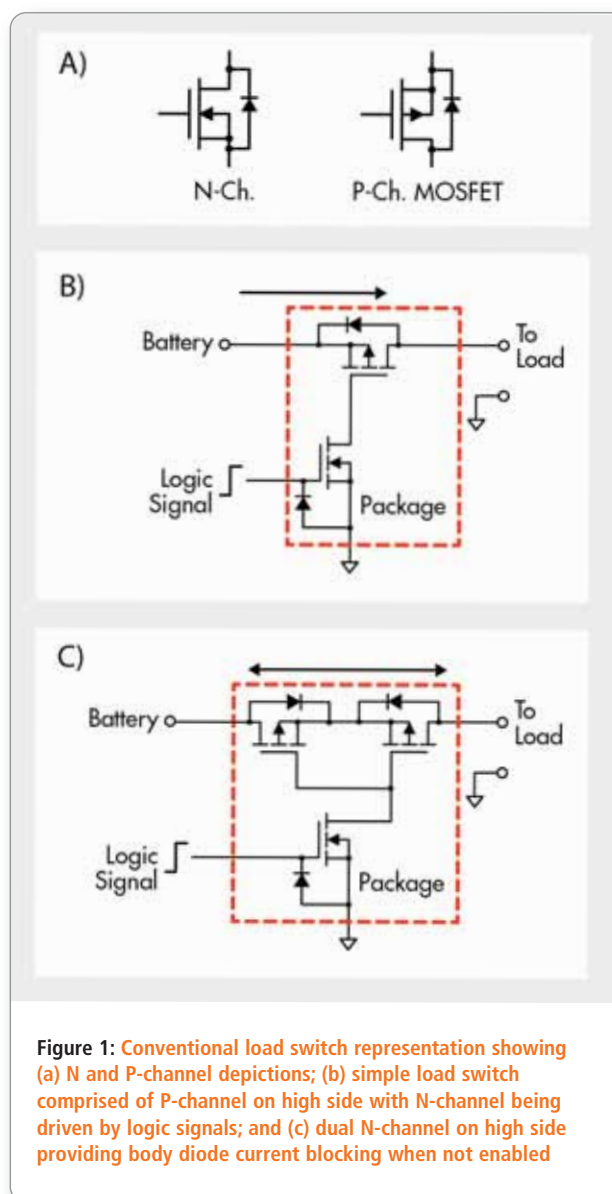


Figure 1: Conventional load switch representation showing (a) N and P-channel depictions; (b) simple load switch comprised of P-channel on high side with N-channel being driven by logic signals; and (c) dual N-channel on high side providing body diode current blocking when not enabled

hour or 100mA for 10 hours at its nominal battery voltage.

Battery operating time (h) = battery rating (mAh)/total current draw (mA)

When the operating current is distributed between a surge current, say 1500mA for 100ms, and a continuous current, for example a 20mA indicator LED for the remainder of the hour of operation, the average current for that hour can be calculated.

Average current per hour = $(1.5A \times 0.1s/3600s) + (0.020A \times 3599.9s/3600s) = 20.04mA$

Using this concept of power consumption in the time domain, it was quickly realized that load switches could be used to isolate continuous, but light, current draws. Sharp pulses for very short durations are not the main culprit, but the hundreds of uA current draws that add up if not isolated. This transition then leads to the importance of soft power ramps when power is enabled to downstream ICs to reduce undesirable large voltage spikes on the already fragile mAh battery rating.

A separate discussion can be carried on the impact of surges in power versus steady power draw. This impact on the battery can vary greatly with the chemical composition of the battery and the time between surges. It is generally accepted that surges of reasonable proportion can result in longer battery life than a light but continuous load. Please consult the battery supplier for specific guidance on this subject.

Also not discussed is the voltage decrease in the battery as it is drained. In the pure current based equations above, we assumed a constant V_{batt} . Again, this depends on the battery technology. For alkaline primary batteries (non-rechargeable), V_{max} is 1.5V, where V_{min} in most cases is assumed 0.9V. Rechargeable single cell Li-ion batteries are at a nominal state of 3.7V, yet can charge to 4.2V max, and still drop to V_{min} of 2.5 to 3V, which can have a larger effect on the actual charge.

High Side and Low Side Switches

With the understanding of how current draws can deplete the battery level, we can now investigate the various methods of isolating downstream power consumption. Terms such as high side and low side switches will be used. High side implies that that switch will be in rail path and actually source current to the load, which is returning through the ground path. The low side switch is on the opposite side of the load and sinks current to the ground path.

Applying this simple switch theory to common FET types, Figure 1 shows the basic N- and P-channel MOSFET representations for load isolation, each having their advantages and disadvantages. Starting with the PN junction refresher image of section (a), we can quickly interpret section (b) as a P-channel on the high side. The N-channel is used to drive the gate to simplify logic input control.

The disadvantage of schematic (b) is the ability to forward bias the body diode if the load voltage was higher than the battery voltage. Schematic (c) eliminates this problem with dual P-channel FETs on the high side, a very common battery isolation approach for a main rail.

Why are N-channel FETs not used for high side switches? The textbook property of the N-channel FET is that for the switch to be enabled and in its linear region, the gate voltage must exceed the drain voltage by the given datasheet threshold voltage. Since the main rail in a battery application is often the highest rail available, a bootstrap or isolated drive approach must be employed. This incurs additional cost; however, this N-channel high-side switch approach is required for higher current applications.

Depending on the voltage range,

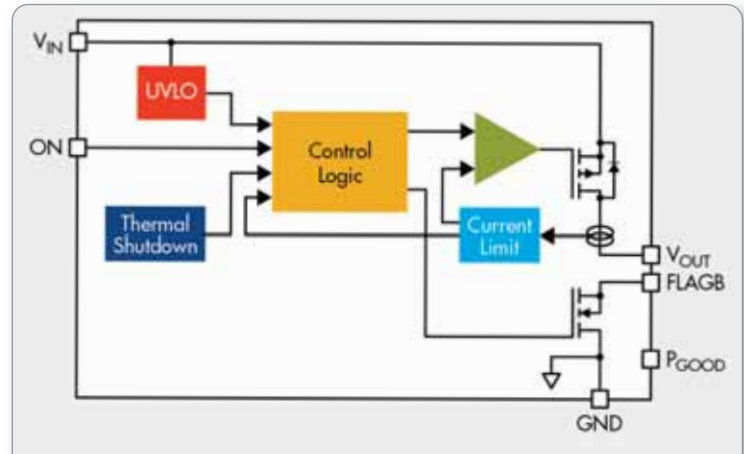


Figure 2: Typical internal block diagram of an Intellimax IC with P-channel based high side MOSFET and integrated feature set – current limit, thermal shutdown, under voltage lockout, error flag and logic voltage control

N-channel FETs have a 20-50% reduction in $R_{ds(on)}$. Whereas with P-channel FETs, aside from losses due to $R_{ds(on)}$ and higher voltages (i.e. > 200V), they are either cost-prohibitive or simply not available due to technology limitations.

Intelligent MOSFET Technology Introduction

Conventional load switches are effective for most applications, but for the purposes of this article we are focusing solely on medical applications. These units require the utmost attention to reliability and in most cases are not rechargeable, resulting in diligent power consumption calculations and isolation.

At Fairchild Semiconductor, the intelligent MOSFET functionality is addressed in the Intellimax portfolio. Figure 2 shows the typical internal block diagram, though it does vary from device to device based on desired features.

This figure is P-channel based, seen in the high side path between V_{in} and V_{out} . Pin count is minimized to keep the package as small as possible. These devices can be as small as 1mm x 1mm Chip Scale Packaging (CSP), or in the popular leadless uPak also known as MLP. For prototype needs and less space-constrained designs, SC70, SOT23 and SO8 are also available.

The operating voltage, V_{in} , of intelligent MOSFETs varies by the process on which they were manufactured. For Fairchild's Intellimax line, recommended operating voltages range from 0.8V to 5.5V.

It is important to note the difference between input voltage and control voltage. The input voltage V_{in} is the actual rating for the high side load switch. The control voltage level, labeled ON in Figure 2, is the amount of voltage required to turn the load switch on. Figure 3 is taken from the Intellimax FPF1039 datasheet and shows the actual V_{on} voltage required to turn the integrated P-channel FET on as it relates to the V_{in} supply voltage.

The datasheet specification adds buffer for process, voltage and temperature variations and states that V_{on} must exceed 1.0V to enable the switch, and must be below 0.4V to disable the switch.

Intellimax FETs integrate a P-channel FET and a logic level driver to allow simple controlling of a reduced $R_{ds(on)}$ FET, when compared to an equivalent, combined P-channel/N-channel approach

If precise current sensing and load disconnect is crucial, it is possible to add a small amount of inductance to the output. This will “buffer” the changes in current, di/dt , allowing the smart FET to more accurately sense a difference

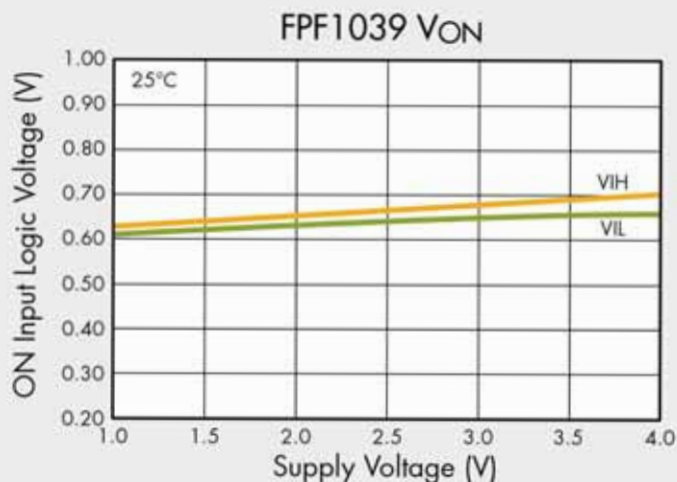


Figure 3: PPF1039 Von enabled thresholds for high and low levels as shown in the datasheet. The vertical axis is Von, while the horizontal axis shows the Vin or supply voltage

This results in a very simple drive circuit that can directly interface to a microprocessor. This Von specification varies between devices and may not always be as flat as that in Figure 3.

As mentioned earlier, this logic level Von enabled function interfaces easily to a microprocessor, but the thermal shutdown and over current protection (OCP), also interface well via the Flag pin. This feature is not integrated into the smallest Intellimax solutions, such as the PPF1039, so we turn to the PPF2303. This dual out load switch is capable of driving 1.3A loads; it is feature-rich and includes the Flag feature and reverse-current blocking. The Flag is an open drain logic level that can be tied directly to a status pin on a microprocessor. Reverse current blocking was shown in the conventional load switch figure but required a dual MOSFET approach. Fairchild's proprietary approach integrated this into the P-channel and is a bonus feature within the IC, requiring no external components.

Reverse current blocking is a must if there is ever an event where the load side of the switch could have a higher potential than the battery side. This can occur in systems having multiple batteries of the same initial voltage, or during voltage spike events. Large bulky capacitors also have a tendency to provide potential differences.

Feature Set

An often overlooked specification for load switches is the ESD rating, due to the fact that most MOSFETs of the past did not have integrated ESD-protection. Recently, ESD protection was added to discrete P-channel MOSFETs that are often used as simple cost-effective load switches. This came in the form of a back-to-back zener clamp on the gate of the FET. This adds capacitance to the gate, making it an unlikely candidate for a switching application (motor drive, power supply, etc), but did make the gate much more rugged with the 2K HBM (Human Body Model) zener addition.

Intellimax went even further and integrated an ESD structure into the intelligent FET, which doubled the ESD rating to 4KV HBM. Further ESD improvements are likely to come.

ESD is a valuable feature for medical applications since the boards are often shipped bare between assembly houses for detailed placement into plastic housing and hermetically-sealed enclosures. Each handling point is a potential risk to ESD-related failure, especially on pins and connectors interfacing off the board to a battery or mezzanine layer.

The next smart FET feature we should look into is what happens when the switch closes. A conventional load switch with a discrete P-channel simply closes and connects the input to the output, regardless whether a heavy load or large capacitance is burdening the output pin. In such an event, the input rail typically exhibits a voltage dip on the primary, which could affect delicate ADC (analog to digital converters) or sensors also tied to the rail for bias. In the past, R/C (resistor/capacitor) networks were added to the gates to slow down the turn-on, but this adds design time and size to the project. Intellimax supports a slew rate control feature to minimize rail interruptions on the input side by limiting in-rush current. Figure 4 shows an example of this in an empirical lab test. Note the effects on the Vin rail with the conventional P-channel approach on the left, versus Intellimax on the right.

Adding Reliability with Intelligent MOSFETs

Catastrophic events that require disconnecting the load from the input to prevent further damage is a key consideration when addressing reliability. Conventional load switches of the past are very straight-forward and offer no protection from current or thermal events. Current protection could be added but this would add a number of external components and require precise selection of tolerance on passive components. Even so, could the passive approach react in a short enough time to prevent downstream damage?

Thermal sensing is on a similar comparison basis. Over current and thermal shut-off event details vary from device to device. While some turn off immediately and require power to be cycled to reconnect to the load, others go through a re-try pattern continuously, turning back on after the temperature and current levels are deemed safe.

Review the datasheet closely to eliminate any confusion on device selection. For thermal shutdown on Intellimax devices – and most ICs in general – do not rely on this feature as standard practice. That is to say, if the application is anticipating thermal events during normal application, a separate temperature sense routine should be used. Relying on over temperature shutdown continuously may degrade the IC.

When sensing the over current event, the threshold level can be pre-set at the IC factory. The level can also be programmed externally with a resistor to ground on some intelligent load switches. While most have short circuit protection, more recent additions have much improved tolerances on specific current disconnects, ranging from 100mA to 2A. In just a few years, current detect tolerances have dropped from 30% to 10% accuracy.

When selecting the threshold level, note the minimum and maximum specifications that can vary over process, voltage and

temperature. Current is very dynamic so a precise and consistent transition point is difficult to provide. It is also difficult to react to very slow current ramps when approaching the detection point. If precise current sensing and load disconnect is crucial, it is possible to add a small amount of inductance to the output. This will “buffer” the changes in current, di/dt , allowing the smart FET to more accurately sense a difference. The size of the inductor would directly reflect the sensitivity of the current transition. After an over current event, each family of intelligent MOSFETs reacts differently. Some simply disconnect, others ramp down the current in predetermined steps, while some even provide a fixed voltage output at the safest sustainable current limit. Pay close attention to this specification during component selection.

Specification Comparison When Selecting Intelligent MOSFETs

After discussing the advantages, what are possible disadvantages or sensitive specifications that should be reviewed closely when selecting an intelligent MOSFET? The key value is the intelligence within the smart FET. Of course, power is required to sense current and drive the high side switch. This will be noted in the quiescent current specification in the datasheet, which is the actual current used within the IC to verify and drive the load switch. For Fairchild's Intellimax line, this spec is minimal at sub-1 μ A. There is also a leakage current listing that should be closely compared for those that are looking for the longest battery life.

The on resistance of the high side FET, labeled $R_{ds(on)}$, is the key number for calculating losses across the load switch. This $R_{ds(on)}$ will vary based on input voltage, since the same V_{in} is used to drive the high side FETs; so be realistic when targeting the R_{on} for a specific application. Do not compare the absolute lowest $R_{ds(on)}$ in two datasheets when the application will actually be operating at 50% the V_{in} used, to calculate the lowest R_{on} . Based on this R_{on} value, one can calculate the loss across the FET if the current needed by the load is known. For Intellimax, $R_{ds(on)}$ can range from 20mohms to 200mohm depending on the feature set and package size.

Another datasheet detail that can sometimes be overlooked is the

maximum voltage of the high side FET. For the lowest in $R_{ds(on)}$, the Intellimax line limits the input voltage to 6V. This is perfect for battery-powered applications, either 3.7V rechargeable cells or AA battery packs.

Due to cell phone proliferation, the 3.7V single-cell Li-ion battery pack is becoming very common in portable medical applications. However, medical applications may also require fluid pumps or fans to operate of the core battery voltage. The most common battery here is a dual or triple stacked rechargeable cell, bringing the voltage to between 8V and 12V. In the past, discrete MOSFETs were used at these voltage levels. New developments have expanded intelligent FETs to higher voltages.

The AccuPower family from Fairchild is based on a 40V absolute max, 36V recommended process, and is a considerable leap in technology for mid-voltage applications. The first IC will be 100mohm technology with the same feature set Intellimax supports but will also include an adjustable current limit and a power-good (Pgood) pin. Because of the long voltage ramp, should the load be at 36V, the Pgood function will notify the microprocessor of an acceptable rail level on the output. Adjustable current limit opens up the applications within the medical field.

The AccuPower devices can be used to drive DC solenoids, fans, pumps etc. Even if the battery is at 12V, the $L di/dt$ voltage spike across a dynamic wound load will easily surpass the breakdown of a 12V or even a 20V discrete FET. The 36V breakdown voltage supports these load types with battery voltages of 12V and possibly 24V. The PPF2700 is now available and supports such voltages.

Intelligent MOSFETs in Medical Applications

Regardless of the application, the trend for point-of-load isolation continues and intelligent MOSFETs are an enabler for higher performance and improved reliability. Maintaining the edge on a competitor's medical application requires quick feature-set implementation. Conventional P-channel FETs will continue to be used for simple switches but when reliability and time-to-market are key metrics during product design, do not overlook the recent advances in intelligent MOSFET technology. ●

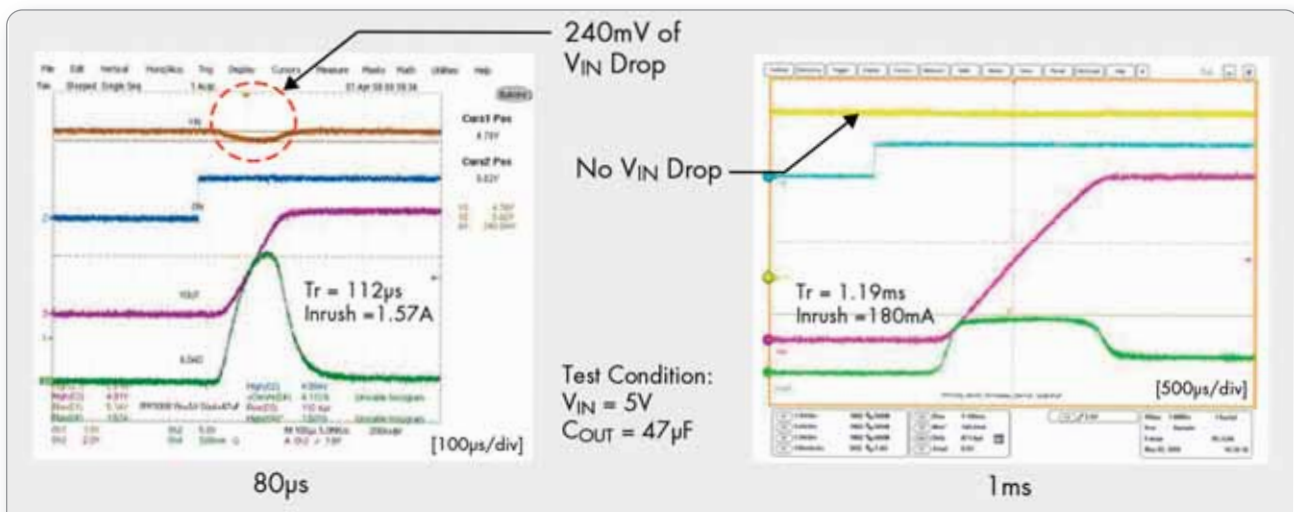


Figure 4: On the left is a conventional load switch with no current limit or in-rush control, i.e. there is no gate drive current control on the P-channel. A drop of 240mV is seen on input rail. The image on the right shows the integrated slew rate control feature of Intellimax with a flat V_{in}

MEETING MEDICAL DEVICE SECURITY STANDARDS

CHRISTINE VAN DE GRAAF, PRODUCT MANAGER AT THE EMBEDDED PRODUCTS BUSINESS UNIT, KONTRON, DISCUSSES HOW TO MEET THE MEDICAL DEVICE SECURITY STANDARDS WITH EMBEDDED PLATFORMS THAT SUPPORT THE TPM 1.2 SECURITY MODULE

The medical industry has greatly benefited from technology and the widespread sharing of data through computers, software and networks. The ability to easily exchange digitized data, however, continues to cause concerns about information and data-sharing risks and vulnerabilities.

Computer security in the medical industry is seen as critical as everyone cares about the privacy and integrity of a person's health information. The fear that the most private of personal information may fall into the wrong hands or be inadvertently altered or destroyed is the basis for the adoption of stringent standards and security measures. However, attacks can occur on any embedded system, which has propelled security as a crucial requirement to protect all confidential and sensitive data, regardless of industry or application.

The vulnerabilities of medical devices that are increasingly being used to transfer vital health patient information between health professionals and healthcare systems, or even controlled remotely, was illustrated at the recent Black Hat computer security conference in Las Vegas.

One security researcher, who is also diabetic, presented that he had identified flaws in his own insulin pump that could allow an attacker to remotely control the equipment and alter the readouts of blood-sugar monitors. The wrong dose of insulin could be detrimental.

Reliable Security

Until recently, adding reliable security has been a challenge for medical device designers because feature options have been limited due to system space constraints, power

restrictions and battery life requirements, not to mention overall cost, bill-of-material and time-to-market considerations. In addition, there is a wide and disparate list of computing devices involved in today's patient care. Designers of medical equipment, IT managers and others in charge of security are already fully aware of the complexities involved in supervising technology environments that deploy multiple components. Implementing effective security for all devices used in the medical industry means that designers must find solutions that overcome these hurdles.

What was once only mandated for military embedded systems is now needed for all other industries, regardless of network or Internet connectivity, or the perceived fear that a system is under threat.

In the medical environment, the use of computers and tablet-based devices is widespread. However, there are many more electronic systems that can connect to the Internet that are also being used, including servers, smart phones, printers, scanners and others. Plus, as more functions are being automated, increasing amounts of medical data, are being collected, analyzed and stored in this assortment of electronic devices and systems.

Then there are threats to information such as patient billing and administrative data that is exchanged daily between payers, health plans/case management, and healthcare professionals and patients by emails or otherwise.

Categorising Threats

The types of security threats typically come in two forms – passive and active. Passive threats monitor private information,

compared to active attacks which seek to alter information with the intent to corrupt or destroy the data or the network itself. Here are just a few of the types of security threats that make medical systems vulnerable:

- **Eavesdropping** – Networked communications are primarily handled in an unsecured or “cleartext” format, and without strong cryptography, data transferred over the network can be read by others.
- **Data Modification** – After an attacker has read the data, it can be modified in the packet without the knowledge of the sender or receiver.
- **Identity Spoofing (IP Address Spoofing)** – It is possible for an IP address to be falsely assumed or special programs used to construct IP packets resulting in modification, rerouting or deletion of data.
- **Password-Based Attacks** – Most operating system and network security is password-based. Legacy applications do not always protect identity information allowing an attacker to gain access as a valid user to do any number of detrimental activities, such as acquire lists of users and network information, modify server and network configurations, and delete or reroute data.
- **Denial-of-Service Attack** – As the name suggests, this type of attack prevents use of a single system or the whole network. It can send invalid data causing unusual application termination or actions and flood the network with traffic until it overloads.
- **Man-in-the-Middle Attack** – Between communication devices, this type of attack can work transparently to capture and control communications.
- **Compromised-Key Attack** – Although quite difficult, it is possible for a hacker to figure out the encryption key of a secured system. A compromised key allows the attacker to decrypt or modify data, and to

Attacks can occur on any embedded system, which has propelled security as a crucial requirement to protect all confidential and sensitive data



The diversity and number of new and dispersed medical systems are a motivating factor for OEMs to develop viable, long-term security solutions

access other secure communications.

● **Application-Layer Attack** – A fault in a server's operating system or applications is caused, allowing an attacker to bypass normal access controls to any number of threats including viruses, disable security controls and attach a program to gain control of the network and its information.

To combat these threats, security standards have been adopted such as the rigorous requirements defined by HIMSS (Healthcare Information and Management Systems Society) and HIPAA (Healthcare Insurance Portability and Accountability Act). For example, the US government's HIPAA security standards were developed for protected health information (PHI), which is any form of health data that personally identifies a patient that is either stored or electronically transmitted. HIPAA mandates that health organizations have an in-depth knowledge of the capabilities and weaknesses of their computer systems and networks.

Similarly, HIMSS has an equally broad charter to identify and evaluate security issues, threats and vulnerabilities associated with medical devices and systems and the best practices available to address those issues. HIMSS has taken an active role to coordinate with other groups and committees to leverage the positive results of existing solutions.

Effective Security Realized from The TCG

The Trusted Computing Group (TCG) is a not-for-profit organization which was formed to develop, define and promote open, vendor-neutral, industry standards for trusted

computing building blocks and software interfaces across multiple platforms.

To address the growing security issues that affect the embedded computing industry, the TCG has developed hardware-based security solutions. Using the technologies in the TCG TPM 1.2 security module, a computer or system can be made to consistently behave in specific ways, when enabled by OEMs.

Proprietary management solutions can overload systems with non-essential features, lock organizations into specific vendor solutions, increase management costs and eliminate flexibility. And yet proprietary security solutions cannot ensure global interoperability and are not capable of providing an adequate level of assurance. This is because, by nature, they have limited access to cryptographic and security expertise, and do not typically undergo rigorous review processes to back them up. Trusted and secure computing requires

cryptographic algorithms that ensure interoperability with the other elements of the platform, other platforms and the systems' infrastructure. Designed not to affect or reduce a system's productivity or introduce new obstacles in its manageability, the TPM 1.2 module provides the additional security needed to support medical OEMs in satisfying HIPAA and HIMSS security standards.

Putting the TPM 1.2 to Work

The TPM 1.2 module enables users to securely store passwords, digital keys and certificates that provide secure unique identification. Using standard software interfaces, it works with other security methodologies to provide a hardware-based approach to manage user authentication, network access, data protection and more. These security methodologies include cryptographic operations such as asymmetric key generation, asymmetric encryption/decryption, hashing (Secure Hash Algorithm (SHA-1)) and random number generation (RNG). Authentication and attestation are also important processes within the TPM to determine trustworthy platforms and are critical elements that help ensure safe embedded computing systems.

Illustrating how the TPM 1.2 delivers additional security is shown during the boot process. It measures (hashes) all the critical software and firmware components, including the BIOS, boot loader and operating system kernel, before each is loaded. By carrying out these measurements before the software starts and storing them, this data can be isolated and secured from subsequent modification attempts. When the system connects to the network, the stored measurements are sent to the server, checked against the server's list of acceptable configurations, and quarantined

FEATURES	BENEFITS
Authentication	Ensures only authorized systems are allowed access to the network
Encryption	Protection of the stored and communicated data
Network Access Control	Ensure only authorized users or systems access the network
Standards Based	Compatibility between deployed systems from different manufacturers
Secure Boot	Verify the integrity of firmware, OS and applications prior to execution

Table 1: System security benefits and features for embedded computing platforms that support TPM 1.2



Based on the energy-efficient, highly integrated AMD Embedded G-Series processor, the Kontron microETXexpress-OH is well-suited for small-sized mobile devices such as mobile 3D ultrasound scanners and imaging systems

as an infected endpoint if a non-match occurs.

Demonstrating its viability as a standard security instrument, the JTC1 (ISO/IEC Joint Committee 1) of International Standard Organization (ISO) has approved the TPM 1.2 specification as an ISO/IEC standard; designated the ISO/IEC 11889 standard.

Authentication

Medical applications that use embedded computing platforms that support TPM 1.2 offer improved security capabilities compared to other security measures with traditional tokens or smartcards. The main difference is that it uniquely supports both user and machine authentication in one token, offering a streamlined solution that ensures only authorized users and authorized systems are on the network. The TPM provides a highly secure hardware repository for safeguarding digital certificates, passwords and other essential user credentials. It also facilitates the management of verification and identification of a system by securely signing, encrypting and decrypting files.

TPM's key protection provides support for all X.509 certificate-based encryption,

thereby strengthening email security. It also offers full-drive encryption, multi-factor authentication and facilitates the security assessment of the host system.

Because TPM 1.2 is the only token that supports both user and machine authentication, it is able to provide first-factor authentication and has the capability to add an additional factor such as a PIN or password. TPM also meets enterprise multi-factor authentication requirements for remote access, and offers more system security than software-based certificates and tokens. In addition, TPM allows users to avoid separate deployment and management tasks.

For more secure wireless networks, TPM deploys stronger authentication that provides enhanced protection beyond just data encryption. It is able to securely identify a system or machine and automatically integrates with the 802.1X authentication framework.

Security Beyond the PC

The initial focus of the TCG was to develop hardware-based security for PCs, but TPM 1.2 expands its viability to enable trusted, server-

side computing and toughens all client/software interactions as well. Virtually all embedded systems can benefit from improved overall information security that can protect data at rest or in transit, and demonstrate compliance with numerous data security regulations. TPM 1.2 works so well that in a recent Forrester Research report, the leading analyst now recommends that enterprises use TPM-based servers in applications that must handle valuable data and transactions.

With virtualization capabilities, systems can be configured to run secure and real-time operating systems in secure, virtualized sessions. Virtualization technology allows developers to implement client-side virtualization so that applications and operating system functions can be designed to be completely isolated on a single processing platform. For example, one operating system can be dedicated to running a user interface, while another operating system runs secure communications and data storage applications, with each operating system completely isolated from one another.

This enables a higher level of security and reliability for sensitive communications and data storage such as those involved in the medical industry, while facilitating the development of less complex, lower power and lower cost systems.

To implement client-side virtualization, a hypervisor or a virtual machine monitor (VMM) partitions the client device into multiple environments known as virtual machines (VMs). Each VM can be loaded with its own operating system allowing developers to encapsulate different tasks, such as secure communications, data storage and user interface into different VMs.

AMD has also integrated Enhanced Virus Protection into its next-generation processors. AMD's Enhanced Virus Protection works in combination with Windows Vista or Windows XP SP2, and sets portions of system memory aside as "data only" so that any code resident in these areas may not be executed – only read from or written to. It is designed as a preventative tool that makes sure the virus is localized, short-lived and non-contagious resulting in the virus being flushed from system memory.

Solutions for Secure Systems

However, medical OEMs need more from embedded computing providers than just security. Requirements for medical systems and devices must also continue to deliver performance, bandwidth and advanced feature requirements while helping OEMs meet reduced time-to-market and overall

Trusted and secure computing requires cryptographic algorithms that ensure interoperability with the other elements of the platform, other platforms and the systems' infrastructure

New 8-bit Microcontrollers with integrated configurable logic in 6- to 20-pin packages



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The Configurable Logic Cells (CLCs) give you software control of combinational and sequential logic, to let you add functionality, cut your external component count and save code space. Then the Complementary Waveform Generator (CWG) helps you to improve switching efficiencies across multiple peripherals; whilst the Numerically Controlled Oscillator (NCO) provides linear frequency control and higher resolution for applications like tone generators and ballast control.

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AMD'S TPM 1.2 SOLUTION**PROCESSOR DEVELOPER AND SUPPLIER AMD**

is a TCG member and has integrated support for the TPM 1.2 security module as an option in its G-Series processors. Enabling highly secure systems, AMD's G-Series processors are now being offered in a range of standards-based small embedded computing platforms such as PC/104, COM Express and Pico-ITX, which are widely used in medical design.



AMD embedded G-series platform

cost of ownership. Needed are cost-effective embedded computing platforms that supply security options with advanced encryption-based protection without limiting performance. Embedded computing platforms that support the TPM 1.2 security module have been shown to be less costly which can help lower the total cost of system ownership when compared to alternative smart-card and hardware token-based solutions.

Thanks to open, vendor-neutral specifications, hardware-based security can provide flexible implementation for medical OEMs and agile deployment options for end-users as well. Kontron is assisting medical designers in meeting their security challenges with its AMD G-Series processor-based platforms. This additional security does not affect or reduce the system's productivity or introduce new obstacles in its manageability. This type of approach helps medical OEMs satisfy HIPAA and HIMSS security standards. ●

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NEURAL NETWORK IMPLEMENTATION FOR IMAGE COMPRESSION OF X-RAYS

KAMIL DIMILILER FROM THE ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT AT NEAR EAST UNIVERSITY IN CYPRUS EXPLAINS A PROJECT WHERE THE HAAR WAVELET TRANSFORM AND DISCRETE COSINE TRANSFORM ARE USED BY A NEURAL NETWORK TRAINED TO COMPRESS X-RAY IMAGES WITH THE OPTIMAL COMPRESSION RATIO

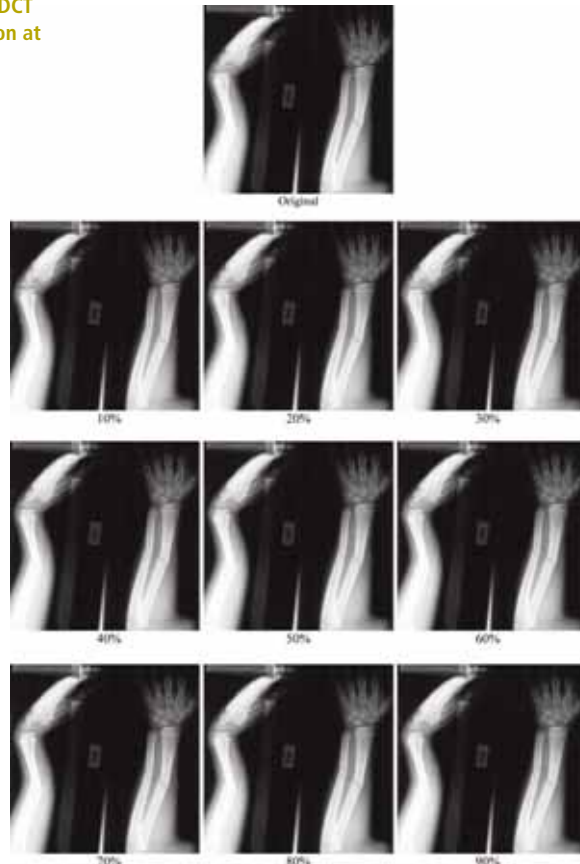
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ost images at some point will require compression before transmitting or storage, due to constrained bandwidths and limited storage capacity.

This is especially true of medical images.

X-ray images are widely used in medicine; they are the second most commonly used type of tests after laboratory ones. Teleradiology, the term for the technology used to send radiographic images or x-rays across distances from one location to another, has become one of the most used clinical techniques of telemedicine. Telemedicine refers to the use of communication and information technologies for the delivery of clinical care. Images such as scans from tomography (CT), magnetic imaging (MRI), ultrasonography (US) and x-rays can be moved from where the image was taken to a remote location for interpretation; this could be a hospital or doctor's surgery.

Figure 1: An original image, its DCT compression at nine ratios



But moving files means having to compress them. Over the years there's been a rapid development in compression methods to compress large data. However, efficient methods of compression are needed which can retain high image quality and not reduce the size of the images; an ideal image compression system must yield high quality compressed images with high compression ratio.

The Transforms Used

Discrete Cosine Transform (DCT) is one of the most popular transforms used in compression of images in standards such as the Joint Photographic Experts Group (JPEG). In DCT-based compression the image is split into smaller blocks for

computational simplicity, and the blocks are classified on the basis of information content to maximize the compression ratio without sacrificing the content.

Due to this simplicity, DCT-based image compression has been popular in medical image processing applications too. In the search for optimum compression methods, the use of DCT and artificial neural networks has also been investigated. A topology-preserving neural network has been developed for medical image compression, using the "neural-gas" network. Adaptive architecture neural networks have also been implemented for medical image compression, and a neural network classifier has been used with a combination of different image compression

techniques for various applications.

Unlike the discrete cosine transform, the wavelet transforms are not Fourier based and, therefore, discontinuities in image data can be handled with better results using wavelets. Wavelets are a mathematical tool for hierarchically decomposing functions. There is general preference to use wavelet transforms in image compression because the compressed images can be obtained with higher compression ratios and higher PSNR (Peak Signal to Noise Ratio) values.

The Haar wavelet transform is one of the wavelet methods applied in compressing digital images. Previous works using the Haar image compression include an application for adaptive data hiding of images by dividing the original image into 8 x 8 sub-blocks and reconstructing them after compression, with good image quality.

The aim of the project presented in this article is to develop an image compression system for medical x-ray image compression using a neural network classifier and two popular compression methods: the DCT and the Haar Wavelet Transform (HWT). Our novel method suggests that a trained neural network can learn the non-linear relationship between the intensity (pixel values) of an x-ray image and its ideal compression method, and the optimum compression ratio. Once the ideal method is chosen by the network, and the highest compression ratio (while maintaining good image quality) using that method is obtained, then the resulting image size could be stored or sent more efficiently.

The X-Ray Image Database

The development and implementation of the proposed system here uses 120 x-ray images from a medical image database. Both compression methods (DCT and HWT) were applied to the x-ray images using nine compression ratios (10%, 20%, ...90%); see Figure 1.

The optimum DCT and HWT compression ratios for the x-ray images were determined using the optimum compression criteria, based on visual inspection and empirical analysis. The visual inspection involved 50 people who were asked to observe the smoothness and edge continuity of certain areas within the reconstructed images, considering the change in contrast between the pixels.

Visual Contrast Entropy is the contrast weighted entropy of an image used as an

input to the neural network. In Equation 1, CWE represents the Contrast Weighted Entropy, where C is the Contrast of the image

and H_v represents the entropy of the image.

$$CWE(k) = C(k)H_v(k) \quad (1)$$

Figure 2a and 2b: Training set and testing set examples



Figure 3: X-ray image compression system. ICM: ideal compression method, OCR: optimum compression ratio

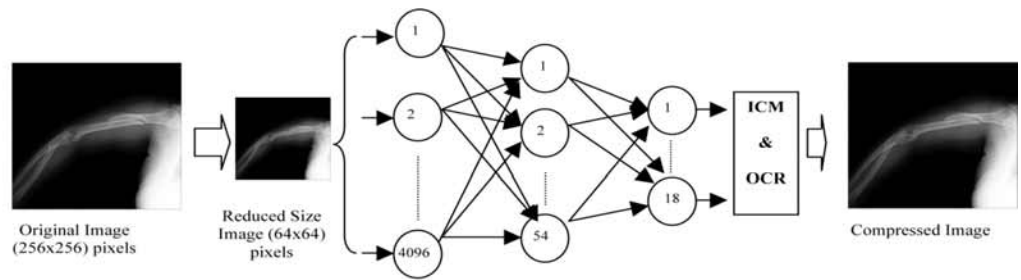
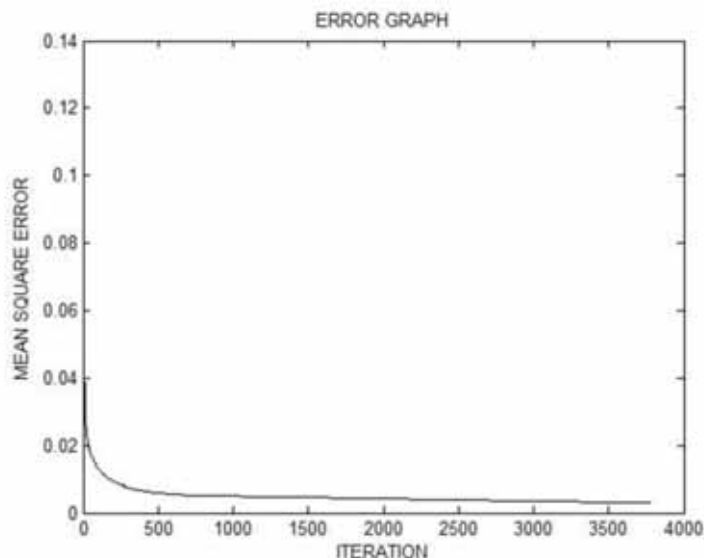


Figure 4: The neural network's learning curve



OCD	Accuracy Rate (RAOC)	Recognition Rate (RROC)
0	100%	23/40 (57.5%)
1	94.44%	35/40 (87.5%)
2	88.89%	36/40 (90.0%)
3	below 88.89%	40/40 (100%)

Table 1: Accuracy and recognition rates according to OCD

Input nodes	4096
Hidden nodes	54
Output nodes	18
Learning rate	0.0006
Momentum rate	0.4
Error	0.002
Iterations	3920
Training time (seconds)	3869
Run time (seconds)	0.015

Table 2: Neural network final training parameters

Linear Regression Analysis is applied as a statistical method, in order to compare the optimum compression ratios with the entropy of the image. The mean of the visual inspection and the contrast weighted entropy have been considered in order to decide create the targets for the neural network system. The image database is then organized into two sets:

(a) Training Image Set that contains 80 images with known optimum compression ratios and used for training the neural network within the compression system. Examples of training images are shown in Figure 2a.

(b) Testing Image Set that contains 40 images with known optimum compression ratios which are used to test and validate the efficiency of the trained neural network. Examples of these are shown in Figure 2b.

The X-Ray Image Compression System

The x-ray image compression system uses a supervised neural network based on the back propagation learning algorithm, due to its implementation simplicity and the availability of sufficient “input/target” database for training this supervised learner. The neural network compares the x-ray image intensity (pixel values) to that of the image’s ideal compression method and its optimum compression ratio, having been previously trained using images with pre-determined compression methods and ratios.

Once trained, the neural network would choose the ideal method and the optimum compression ratio for an x-ray image upon being presented with image intensity values.

Sample image resizing was used to resize the original images that were 256 x 256 pixels large into 64 x 64 pixels, deleting the next three pixels while keeping the first pixel value. Further reduction in the size of the images was attempted in order to reduce the number of input layer neurons and, consequently, the training time; however, meaningful neural network training could not be achieved as such, so the full 64 x 64 pixels image sizes were used.

The size of the input x-ray images affects the number of neurons applied in the neural network’s input layer, which has three layers: input, hidden and output.

Examples of the original x-ray images and their compressed versions using their ideal compression method and optimum compression ratios while training the neural network are shown in Figure 3.

Using one-pixel-per-neuron approach, the neural network’s input layer has 4096 neurons, its hidden layer has 54 neurons, which ensures meaningful training while keeping the time to a minimum. The output layer has 18 neurons representing the output classification of the ideal compression method and the optimum compression ratio. Therefore, output neurons {1-9} represent DCT compression at ratios (10% - 90%), whereas output neurons {10-18} represent HWT compression at ratios (10% - 90%).

During the learning phase, the learning coefficient and the momentum rate were adjusted throughout the experiments, in order to achieve the required minimum error value of 0.002, which was considered sufficient for this application. Figure 3 shows the topology of this neural network, within the image compression system.

The Results

The evaluation of the training and testing results was performed using two measurements: recognition rate and accuracy rate. Once the choice of the ideal compression method is made by the neural network, the recognition rate is defined as follows:

$$RR_{OC} = \left(\frac{I_{OC}}{I_T} \right) * 100 \quad (2)$$

where RR_{OC} is the recognition rate for the neural network within the x-ray compression system, I_{OC} is the number of optimally compressed x-ray images, and I_T is the total number of x-ray images in the database set.

The accuracy rate RA_{OC} for the neural network output results is defined as follows:

$$RA_{OC} = 100 - \left(1 - \frac{((S_p - S_i) * 10) + S_T}{S_T} \right) \quad (3)$$

where S_p represents the pre-determined (expected) optimum compression ratio in percentage, S_i represents the optimum compression ratio as determined by the trained neural network in percentage and S_T represents the total number of compression ratios used for both compression methods.

The Optimum Compression Deviation (OCD) is another term used in our evaluation. OCD is the difference between the pre-determined or expected optimum compression ratio S_p and the optimum compression ratio S_i as determined by the trained neural network, and is defined as follows:

$$OCD = \frac{(|S_p - S_i|)}{10} \quad (4)$$

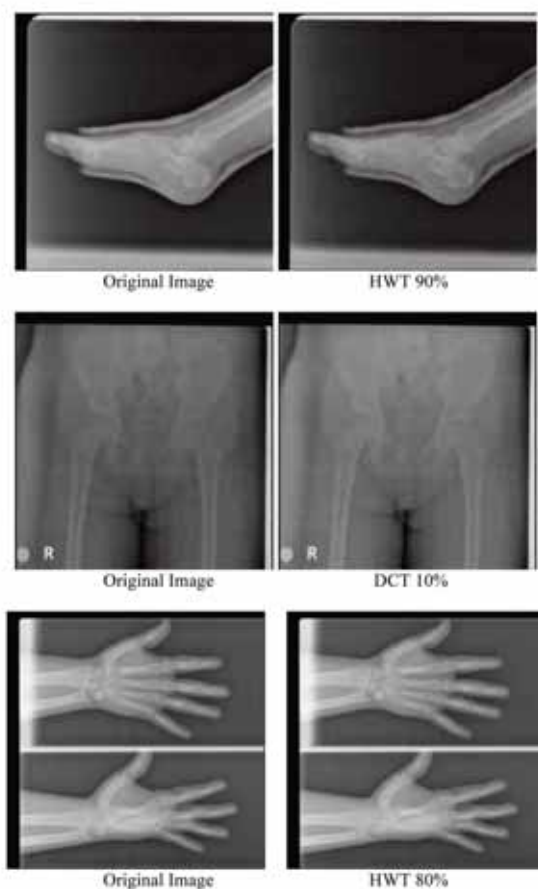
The OCD is used to indicate the accuracy of the system, and depending on its value the recognition rates vary. Table 1 shows the three considered values of OCD and their corresponding accuracy and recognition rates. The evaluation of the system implementation results uses $OCD = 1$ as it provides a minimum accuracy rate of 87.5%, which is considered sufficient for this application.

The neural network learnt and converged after 3920 iterations or epochs, and within 64 minutes and 29 seconds, whereas the running time for the generalized neural networks after training and using one forward pass was 0.015 seconds. These results were obtained using a 2.0 GHz PC with 4GB RAM, Windows Vista 64-bit OS and Matlab 2008b software.

Table 2 lists the final parameters of the successfully trained neural network, whereas Figure 4 shows the error minimization curve of the neural network during learning.

The trained neural network recognized correctly the ideal method and optimum compression ratios for all 80 training images

Figure 5: Examples of the testing set image compression using the developed system



as expected, thus yielding 100% recognition of the training set. Testing the trained neural network using the 40 images from the test-set that were not presented to the network before, yielded 87.5% recognition rate, where 35 out of the 40 images with a known ideal method and optimum compression ratios were correctly classified.

The results of this application are shown in Figure 5, including examples of the optimally compressed x-ray images as determined by the trained neural network.

Neural Network Evolution

This article describes a novel method for compressing medical x-ray images using a neural network with discrete cosine transform and Haar wavelet transform. The method uses nine compression ratios and a supervised neural network that learns to associate the grey x-ray image intensity (pixel values) with the ideal compression method and a single optimum compression ratio for the selected method.

The system then chooses from the two compression methods (DCT or HWT based), the best one to be used for a given

application. The aim is to combine high compression with good quality compressed x-ray images, thus making their storage and transmission more efficient.

The proposed system was developed and implemented on 120 x-ray images of fractured, dislocated, broken and healthy bones from different parts of the body. The neural network within the compression system learned to associate the 80 training images with their pre-determined ideal compression method and optimum compression ratios within 3869 seconds. Once trained, the neural network could recognize the ideal method and optimum ratio for an x-ray image within 0.015 seconds.

In this work, a minimum accuracy level of 94.44% was considered acceptable. Using this accuracy level, the neural network yielded 87.5% correct recognition rate of the ideal method and optimum ratios.

Future work will include the implementation of this system using Daubechies and Bi-orthogonal wavelet transform based image compression. It will also include comparison of the suggested system with the JPEG and JPEG2000 standards. ●



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MIXED SIGNAL SOLUTIONS FOR HIGH RELIABILITY, MEDICAL APPLICATIONS

ALISON STEER, PRODUCT MARKETING MANAGER FOR MIXED SIGNAL PRODUCTS AT LINEAR TECHNOLOGY, INTRODUCES SOME NEW PRODUCT LINES FROM LINEAR TECHNOLOGY'S PORTFOLIO THAT ARE WELL-SUITED FOR VARIOUS MEDICAL APPLICATIONS

Advances in medicine and medical treatments have brought the promise of more accurate diagnoses, new treatment methods and more patient-friendly medical care.

From high resolution imaging systems to drug delivery systems and implantable electronics, analog and digital ICs are playing an expanding role in the medical field. These instruments increasingly require high performance, small size and low power.

In addition, rising medical costs are accelerating the need for portable equipment capable of monitoring the patient beyond the confines of a hospital. Medical data stored in the device is downloaded to a PC or transmitted electronically back to the hospital. Portable solutions demand very accurate low power sampling ICs.

SAR ADCs for Medical Monitoring

Medical monitoring such as ECG/EEG and pulse oximetry, as well as applications for blood and fluid analysis require precision analog-to-digital conversion with sample rates up to 1Msps. Depending on the system architecture, 12-bit to 16-bit SAR type ADCs are good choices. System requirements for portability in these monitors are driving the need for low power solutions and small footprint devices.

Linear Technology has developed a family of devices targeted at handling these requirements. The LTC2383 16-bit, 250ksps-1Msps ADC family offers an excellent combination of speed, resolution and low power in a small 4mm x 3mm footprint (see Table 1). The $\pm 2.5V$ fully differential input range enables 92dB of

SNR with guaranteed THD specifications across the industrial and automotive temperature ranges. The device automatically powers down between conversions, while linearly reducing the power dissipation as the sampling frequency decreases. The LTC2383 consumes just 13mW at 1Msps. The pin- and software-compatible family includes the LTC2382 (500ksps, 6.5mW) and LTC2381 (250ksps, 3.25mW) that feature a

Since medical products can take many years before they go to production it is important to be able to design with the confidence that the parts will continue to be available. Linear has a policy of not making parts obsolete and strives to continue to support all of their released products.

proprietary sampling architecture which enables the ADC to begin acquiring the next sample during the current conversion. This extends the sample acquisition time, which allows the use of extremely low power ADC drivers, thus reducing the overall power consumption of the entire data acquisition solution. The LTC2383 family is perfect for multichannel applications where power consumption and small size are critical, such as optical encoders used in surgical equipment.

If a wider input dynamic range is required, the LTC2393 16-bit 250ksps to 1Msps ADC family offers a $\pm 4.096Vp-p$ fully differential input range with 94dB SNR performance, along with an integrated, precision 10ppm/ $^{\circ}C$ max reference. The LTC2393 is perfect for blood and fluid analysis as well as pulse oximetry applications requiring a highly integrated solution. Power dissipation is 135mW at 1Msps, and the family offers a choice of serial or parallel interface.

Linear Technology's ADC designers have also achieved breakthrough SNR performance with the recently announced LTC2379-18, 18-bit 1.6Msps SAR ADC. Not only is it the fastest 18-bit no-latency SAR ADC, but it also achieves unrivaled SNR performance of 101dB at baseband while consuming just 23mW. In addition, it offers a digital compression technique that enables the use of ADC drivers without the need of a negative rail. By adjusting the input range to $\pm 500mV$ below full-scale, the ADC interprets this as a full-scale input drive, utilizing all the digital codes with only a minimal reduction in SNR performance. This digital compression technique enables the use of single-supply ADC drivers with a lower positive supply voltage, and eliminates the cost of generating the negative rail. Overall this technique provides a lower power solution. To achieve this uncompromised AC performance, the fast settling, low noise LT6350 16-bit and 18-bit ADC driver is recommended.

Delta-Sigma ADCs for Portable Monitoring Applications

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		30Hz/50Hz ADCs with External Reference	60Hz ADCs with 10ppm/°C Reference	Fast (250Hz/1000Hz) ADCs with 10ppm/°C Reference
SPI	Single-Ended	2450/2450-1	2460	2470
	Differential	2452	2462	2472
	Packages	2mm x 2mm DFN, 3mm x 2mm DFN, 8-Lead TSOT-23	3mm x 3mm DFN, 12-Lead MSOP	3mm x 3mm DFN, 12-Lead MSOP
I²C	Single-Ended	2491	2481	2471
	Differential	2493	2483	2473
	Packages	3mm x 2mm DFN, 8-Lead TSOT-23	3mm x 3mm DFN, 12-Lead MSOP	3mm x 3mm DFN, 12-Lead MSOP

Figure 1: Linear Technology's family of tiny Delta-Sigma ADCs

	25Msps	40Msps	65Msps	80Msps	105Msps	125Msps
14-Bit	2179-14	2171-14	2172-14	2173-14	2174-14	2175-14
	2263-14	2264-14	2265-14	2266-14	2267-14	2268-14
12-Bit	2179-12	2171-12	2172-12	2173-12	2174-12	2175-12
	2263-12	2264-12	2265-12	2266-12	2267-12	2268-12
Power Consumption	40mW/ch	50mW/ch	80mW/ch	95mW/ch	110mW/ch	140mW/ch



Quad ADC
Serial LVDS Outputs



Dual ADC
Serial LVDS Outputs

Figure 2: Quad and dual high-speed ADC family

to diagnose a variety of health conditions without leaving their homes. Technology is enabling portable self-care health systems that enable monitoring such vital signs as blood pressure, blood sugar and temperature.

Home medical supervision and monitoring systems allow people to take control of their health, but these medical units must be quick, efficient and operate reliably. As portable medical sensors evolve, the need for longer battery life and smaller form-factor becomes more critical for noninvasive care.

Some medical measurements require the analog circuitry to run continuously, taking thousands or even millions of readings per second. Other applications require only a single reading per day. For these occasional tests, the analog circuitry must only power up once, take the measurement, and then sit idle running on a low power "sleep" mode the rest of the day. Low power sleep or nap modes need

to be available on the IC to enable low power consumption during the off periods.

Linear offers family of tiny, low cost, 16-bit delta-sigma ADCs for portable applications (see Figure 1), such as patient wearable ECG monitors with wireless interfaces, or temperature and glucose monitors. The LTC2470 family offers output rates up to 1ksps with guaranteed no missing code 16-bit performance, SPI or I2C interfaces and includes an internal 10ppm/°C reference to ensure optimal solution size.

High-Speed ADCs for Medical Imaging

Medical imaging applications use a wide range of high performance data converters. Ultrasound, PET/SPECT, magnetic resonance imaging (MRI) and X-ray imaging, all use multichannel sampling systems to gather image data. Since these applications require a very wide dynamic range, the dynamic



Figure 3: 16-bit single and dual high-speed ADC family

performance of the ADC is critical. High signal-to-noise and distortion (SINAD) and spurious free dynamic range (SFDR) are needed for optimal performance. Additionally, in applications such as MRI, where undersampling techniques are used, wide bandwidth sample-and-hold performance is critical.

Linear Technology has developed a line of high performance, low-power 12- and 14-bit multichannel ADCs for imaging applications. The pin-compatible family of simultaneous sampling, quad (LTC2175) and dual (LTC2268) ADCs sampling from 25Msps up to 125Msps, consume only 140mW/channel at the fastest sample rate (see Figure 2). Key features include 73.1dB SNR and 88dB SFDR at 14-bits, 800MHz full power bandwidth, serial LVDS outputs, and low power sleep and nap modes.

For applications requiring higher resolution, the new low-power family of 16-bit single and dual ADCs with flexible digital outputs offers better than 76.8dB SNR and 90dB SFDR. The single LTC2165 and dual LTC2185 ADC families provide a choice of full rate CMOS, or double data rate (DDR) CMOS/LVDS digital outputs. The LTC2195 family includes two-channel, simultaneous sampling ADCs with serial LVDS outputs.

At 125Msps sample rate, these ADCs consume just 185mW per channel from a 1.8V supply (see Figure 3), and about 1.5mW/Msps per channel at each speed grade. An SPI interface enables programmable digital output timing, programmable LVDS output current and optional LVDS output termination.

Power Supply Management for Medical Imaging

Today's high reliability medical systems require complex digital power management solutions to sequence, supervise, monitor and margin a large number of voltage rails. It is usual for a single application board to have dozens of rails, each with its own unique requirements. Typically, the power management solutions for these systems require that several discrete devices controlled by an FPGA or a microcontroller are dotted around the board in order to sequence, supervise, monitor and margin the power supply array. In this scheme, significant time and effort is required to develop the necessary firmware.

The LTC2978 octal digital power supply manager with EEPROM (Figure 4) offers medical system designers an integrated, modular solution that reduces

debugging time and effort over microcontroller solutions. The LTC2978 can sequence on, sequence off, monitor, supervise, margin and trim up to eight power supplies. Multiple LTC2978s can be easily cascaded using the 1-wire share-clock bus and one or more bidirectional fault pins to control up to 72 rails on a single I2C address bus.

In addition, the LTC2978 uses a protected block of nonvolatile memory to record system voltage and fault information in the event of a critical system failure. Preserving critical system data in nonvolatile memory allows users to identify a failing voltage rail and isolate the cause of board failures during system development, test debug or failure analysis.

The LTC2978 utilizes the industry standard PMBus command protocol in order to simplify firmware development. The LTC2978's most important features are its precision integrated reference and 15-bit $\Delta\Sigma$ ADC, which deliver $\pm 0.25\%$ absolute accuracy when measuring or adjusting power supply voltages.

The key to the LTC2978's success is Linear Technology's LTpowerPlay software tool, a free, downloadable graphical PC interface that facilitates interaction with the part in design and testing. LTpowerPlay provides a simple to use, but powerful, configuration tool for accessing the features on the LTC2978. Future Linear Technology digital power management devices will also be supported.

Isolation Requirements for Patient Protection

One important consideration when designing medical products is satisfying IEC60601-1 4kV isolation ratings for products that contact the patient. In addition, low barrier capacitance is required to help minimize leakage current in medical devices.

	LTC2383-16	LTC2382-16	LTC2381-16
Resolution	16-Bit	16-Bit	16-Bit
Speed	1Msps	500ksps	250ksps
Power	13mW	6.5mW	3.25mW
Package	4mm x 3mm DFN-16, 16-Lead MSOP	4mm x 3mm DFN-16, 16-Lead MSOP	4mm x 3mm DFN-16, 16-Lead MSOP

Table 1: LTC2383 family of low power, serial SAR ADCs with explicit Busy and Chain pins

Figure 4: LTC2978 octal digital power supply manager with EEPROM

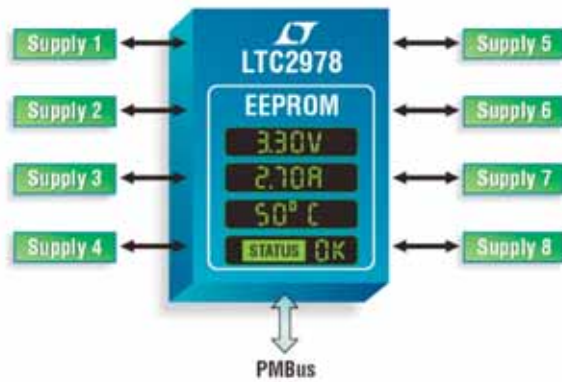
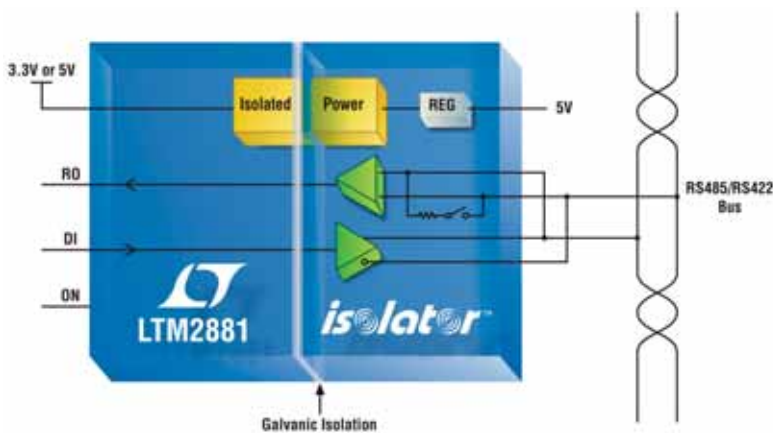


Figure 5: LTM2881 complete isolated RS485/RS422 μ Module transceiver + 1W power



Leakage paths from an enclosure that a patient or operator may be exposed to are known as “touch currents”. IEC60601 specifies the limit as 100 μ A for normal operation and 500 μ A for a single fault condition. Another leakage test specifies total patient leakage current, which is a measure of the leakage current when all applied parts required for the operation of the medical device are in contact with the patient. All components on the isolation barrier need to meet 4000VAC (or 5600VDC) isolation for a period of 1 minute, as per the IEC60601-1 standard. This standard also defines the means of patient protection (MOPP), which describes the isolation required to reduce the risk of electric shock to the patient. The isolation protection includes the creepage/clearance distances, insulation and protective earth connections.

Linear Technology helps address these requirements with a line of isolation devices offering integrated power, which

deliver up to 4kV_{RMS} of isolation with no external components required. The first products in this family include the 2.5kV_{RMS} LTM2881 isolated RS485 (Figure 5) and LTM2882 dual isolated RS232 μ Module transceivers. Both products include an isolated 1W DC/DC converter with up to 65% efficiency, offering surplus power at a 5V regulated output. Everything from coupling caps, diodes and even a switchable termination resistor (LTM2881) are integrated into the module. High ESD protection on the transceiver pins and across the isolation barrier guarantees no latch or damage.

These new devices offer a very robust solution that provides continuous communication, even through 30kV/ μ s transient events. The LTM2881 and LTM2882 offer a low EMI solution that can meet the requirements of EN 55022 Class B radiated emissions provided good layout practices are followed. ●



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IMPLEMENTATION OF THE INMARSAT BROADBAND GLOBAL AREA NETWORK **PART 2**

IN THIS SECOND PART OF A TWO-ARTICLE SERIES **STOJCE DIMOV ILCEV** OF DURBAN UNIVERSITY OF TECHNOLOGY (DUT) IN SOUTH AFRICA REVIEWS THE INMARSAT BROADBAND GLOBAL AREA NETWORK SYSTEM FOR CIVILIAN AND MILITARY MOBILE AND PORTABLE SOLUTIONS

The Inmarsat BGAN is a new, truly revolutionary communications system that enables customers to make telephone calls, to surf the web, send emails and transfer a host of data from anywhere

within the satellite footprints. Thus, this is a go-anywhere wireless packet data service, based on the Internet Protocol (IP), which offers mobile and fixed high-speed access to the Internet, web and computer networks, intranets and corporate LAN via a small, lightweight portable satellite IP modem, similar in size to a notebook PC.

As the service is based on IP, it is particularly suited to applications where data is sent in short bursts. Other BGAN applications include File Transfer (FT) and File Transfer Protocol (FTP) for downloading files from the Internet, sharing files with colleagues, as well as for web e-commerce, online ordering and procurement and secure end-to-end connectivity over a corporate VPN (virtual private network). If the service is running over a secure and shared 144kb/s rate channel, BGAN operates at more than twice the speed of current ground GPRS (General Packet Radio Service) cellular phones. It is based on MPDS (Mobile Packet Data Service) IP packet technology, so users only pay for data they send and receive, and not for time spent online such as with ISDN for example. So, this solution enables all users to always stay connected and

stand-by on the Internet web pages using a valid SIM card inserted in the BGAN satellite IP modem. The same SIM card may also be activated and used in other GPRS mobile devices for roaming between networks.

The portable BGAN satellite terminal is illustrated in Figure 1a. In Figure 1b is an optional solar panel that can charge the system in a no-power location. It can be used with a variety of compact solar solutions from 35 to 55 watts, which will charge the BGAN unit in six hours of direct sunlight.

In Figure 2a is the Harris BGAN portable terminal as used in a military/enforcement application, and in Figure 2b is the same model that can also be used onboard boats or in remote offices.

Figure 3a shows the Harris BGAN vehicular terminal, and in Figure 3b is the same model which is clearly visible on the roof of the car.

In Figure 4a is a prototype of the new Inmarsat BGAN satellite terminal. The terminal is small and compact, and very easy to use: by turning the power on, opening the lid of the device and pointing it at a GEO satellite. Power can be drawn from a 110/220VAC 50/60Hz power source. The battery is designed to provide 1 hour of continuous communication operation at peak rate and 24 hours in standby mode. The IP modem must be located so that it has an unobstructed view of the satellite. It is

supplied with an integrated GPS antenna and a receiver to enable the user to position the satellite IP modem correctly. This unit can be connected to any standard PC or handheld device. Users can then access the Internet and other network services in the usual way, through Microsoft Windows software interface or Macintosh v10.1, where they can run standard PC applications, such as email packages and web browsers. There's a USB port, an Ethernet port, but also Bluetooth and WiFi connectivity.

Satellite SCADA or M2M over BGAN

The BGAN terminal can be used for the direct point-to-multipoint broadcasting of satellite M2M or SCADA (Supervisory Control and Data Acquisition), which installations are fitted with automatic sensors that report regularly back to the control ground centres via satellite links, as shown in Figure 5. All sensors of remote cites shown on the left side of the figure can be connected via BGAN, satellite, GES, application server and VPN Internet to end users in a corporate or government control office.

In Figure 5 is a remotely controlled BGAN connected to an IOTA device via Ethernet and SCADA sensors via RS232 connector on one side and GEO satellite and GES using Packet Switched (PS) Channel of BGAN's Radio Access Network-Core Network (BGAN RAN/CN) on the other. Monitoring and Control Centre (MCC) is connected to the Internet backbone via a gateway. The BGAN unit is connected to a GPS satellite to determine the position of the remote SCADA location but it also be

The BGAN solution is a near-global satellite Internet and multimedia network with telephony, using portable or mobile terminals

Figure 1: (a) Transportable BGAN equipment; and (b) solar panel with bag



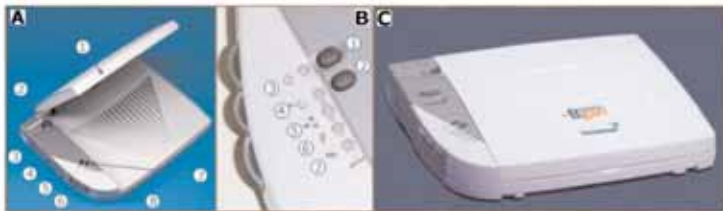
Figure 2: Transportable BGAN equipment for military and civilian applications



Figure 3: Transportable BGAN equipment onboard a car



Figure 4: Figure 4a and 4c: BGAN Satellite IP modem: (1) Integral antenna; (2) Compass; (3) SIM card; (4) Battery; (5) External power; (6) USB; and (7) Indicators. Figure 4b illustrates the control panel: (1) Power switch on/off control button; (2) Interface control button; (3) Power indicator; (4) USB indicator; (5) Ethernet indicator; (6) Bluetooth indicator; and (7) Battery indicator



connected to MCC directly via a GEO satellite to another BGAN if necessary. The modern name of wireless or satellite SCADA is Machine-to-Machine (M2M), useful for corporate and military solutions.

There is the facility to send data messages of up to 2000 bits together with one of four alert signals that can be sent as a single message.

The Wideye Sabre Ranger is an IP64 BGAN ruggedized user terminal, shown in Figure 7, specifically built for permanent outdoor remote unmanned SCADA or M2M applications. It is remotely connected to the IOTA device. IOTA is connected to the SCADA sensors and, optionally, it can be connected to the VSAT unit in case of BGAN failure. It has a ruggedized mechanical housing to

withstand all environmental challenges. Installed with a customized remote SMS control firmware, it enables remote SMS command activation.

Wideye has also developed a small portable M2M applications enabler, called the IOTA, to replace a laptop or desktop PC for use with the Sabre BGAN terminal. IOTA is most suited for unmanned operations in remote, hard-to-access or hazardous locations. The user can customize the software applications on the IOTA for command and control of their monitoring equipment and the BGAN terminal. The whole setup can be accessed remotely from the user's office via the Inmarsat BGAN satellite network for telemetry and data polling. This setup can also be used as a backup to a VSAT satellite link. The IOTA will seamlessly integrate the Sabre to the VSAT equipment and act as a watchdog to switch between the two links when one is down.

Powerful Tools

Inmarsat GAN and BGAN are very powerful tools for use in remote and rural environments for any type of ground-based civilian and military application. In addition, the integration of Inmarsat and the Cospas-Sarsat systems will improve the possibilities for any authority or utility user.

For private users, Inmarsat, Iridium, Globalstar, Thuraya, Optus, MTSAT, ACeS and other MSC operators will offer dual-mode, portable handsets for satellite and cellular connections. For group use there are the fixed or mobile handsets that can be fitted on ships, land vehicles, aircraft and in camps or bases. The MSC model of rural payphone for

villages and remote communities will offer the ability to communicate with any location in the world using voice facilities and emergency numbers for access to any type of medical, emergency or security service. The terminal will be similar to a city payphone operated by phone cards.

Finally, Inmarsat, Iridium, Globalstar

and other MSC operators have developed a military mobile, fixed and transportable satellite tactical and defense communications system for navy, ground and air forces, which can be implemented instantly. ●

If you missed the first part of this article you can order the February issue online at
www.electronicworld.co.uk

APPLICATIONS SUPPORT

THE INMARSAT BGAN SERVICE SUPPORTS COMMONLY USED NETWORK AND MOBILE INTERNET APPLICATIONS, SUCH AS:

- (a) **Instant Remote Access** – Being able to access the corporate or military LAN infrastructure at any time, to maintain productivity or obtain information from anywhere within the BGAN satellite coverage.
- (b) **VPN Connectivity** – Connecting to a wide range of corporate or government VPNs ensures end-to-end access to secure information at high speeds.
- (c) **High-Speed Internet Access** – The Regional BGAN service enables reliable and fast access to Internet web content and resources at any time and any place inside of the satellite coverage area. In reality, all mobile or fixed users can be connected to Internet roaming within remote and mobile environments.
- (d) **Store and Forward Video** – Fast and convenient, and no other mobile wireless service can deliver comparable speed and simplicity.
- (e) **Remote IT Support** – To perform all kinds of PC software upgrades and to run diagnostic tasks remotely.
- (f) **Digital Image Transfer** – With BGAN it is possible to send and receive scanned images of documents and high-quality digital images.
- (g) **E-commerce** – The recently developed Inmarsat mobile packet data service is ideal for exploiting opportunities provided by e-commerce, to engage business transactions with total security in urban and rural environments.
- (h) **E-mail** – As a backbone of business and corporate multimedia satellite communication, e-mail solutions in remote and rural industrial environments is crucial to the efficient functioning of business users, who can remain in touch with other people by sending or receiving information when required.
- (i) **Database Queries** – This very important corporate information is safely housed in corporate databases for immediate accesses.

Figure 5: Implementation of BGAN equipment for SCADA applications



Figure 6: Satellite and cellular network for SCADA via BGAN/IOTA equipment

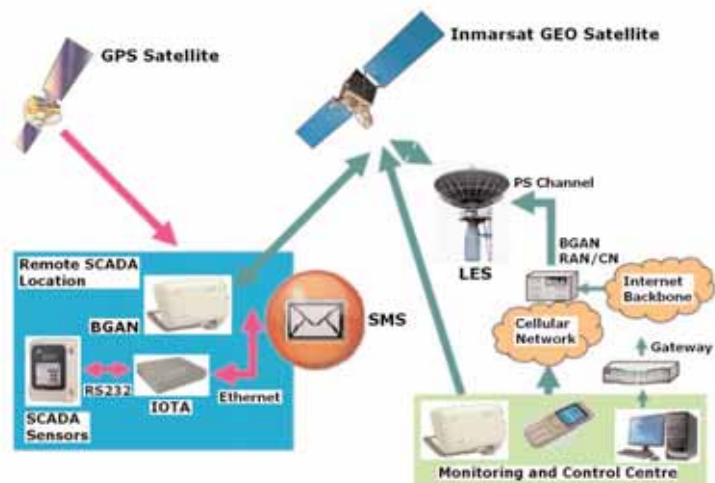


Figure 7: Transportable BGAN equipment in LAN for SCADA



BGAN IP TERMINALS USE

THESE SMALL TERMINALS ARE A VERY EFFECTIVE WAY OF REMOTELY COLLECTING AND BROADCASTING BASIC ENVIRONMENTAL INDUSTRIAL AND CORPORATE

DATA INCLUDING FOR:

- (a) **Radiation Leak Alerting** – Nuclear power stations authorities depend on SCADA to monitor waste storage sites and shipments, and provide instant alerts so that a potential leakage can be averted.
- (b) **Industrial Process Control** – SCADA equipment allows controlling many important variables such as temperature, liquid chemical flow rates, and emission levels.
- (c) **Pipeline Monitoring** – Oil and gas pipelines (electricity power lines) can run for several hundred kilometers, crossing national frontiers, and can be vulnerable to acts of nature and human malice. SCADA monitors the operating data, transmission and confirmation of commands via remote control centers, wellheads and pumping stations that are part of the oil and gas distribution network.
- (e) **Water Resources Requirement** – SCADA control and monitoring installations at remote reservoirs and on pipelines. It can give early warning of new leaks, and allow repair work to be started promptly at the right place and with the right resources. As a result there's minimal loss of water and an economical repair.
- (f) **Automatic Reporting for Ships and Vehicles** – The transportation fleet generates a mass of data that ought to be reported and analyzed in the constant search for business advantage such as: positions, mileage and speeds; cargo condition; fuel and water tanks levels; main engine condition and maintenance information.
- (i) **Lighthouses/Lighting Sea Buoys Control** – It is used for the control of optimal and continuous working conditions of lighthouses and lighting sea buoys.
- (j) **Power Stations Monitoring** – It is designated for remote control of far-flung power stations, to check voltage levels, the break down of systems and other types of monitoring to keep them working in good order.
- (k) **Meteorological Stations Reporting** – It is designed to conduct the monitoring and reporting of all necessary meteorological and hydrographic data of remote meteorological stations in rural areas.
- (l) **Water Level Control** – The monitoring service can perform remote checking of river water levels, lakes and water accumulation resources for agricultural use and hydroelectric generators.

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COMMON SKY: OPERATING IN ONE AIRSPACE

The Avionics Europe exhibition and conference celebrates its 10th anniversary this year. It will take place between the 21st and 22nd of March in Munich, Germany, and it will consist of a trade exhibition, two-day conference programme, workshops, exhibitor presentations and technology demonstrations.

Avionics Europe is one of the world's premier conference and exhibition events that discusses the issues and challenges in the future of commercial and defence avionics, and combines two conference tracks, with over 50 presentations.

Leading industry organisations, the Association of European Airlines, SESAR Joint Undertaking, EUROCAE and the German Aerospace Society and Royal

Aeronautical Societies will be hosting a series of special forums, focusing on key issues affecting the industry right now, which will steer the work and business of avionics professionals going forward.

Government programmes, such as SESAR in Europe and NextGen in the United States, seek to accommodate anticipated steady growth in commercial airline traffic in the decades ahead, while optimizing aircraft routing for efficient fuel use and low engine emissions. Meanwhile, air traffic management faces sharing commercial air space with military aircraft and unmanned aerial vehicles (UAVs).

Under the theme '*Common Sky: Operating in One AirSpace*', the Avionics Europe 2012 conference will focus on the current and future cockpit avionics and technologies for commercial, civil and military aircraft and design approaches to grow air traffic in the most safe and efficient ways possible.

The exhibition itself is a showcase of top organisations demonstrating the

leading and future technologies available on the market, with around 80 exhibitors on the exhibit floor.

Companies exhibiting include Thales, Cassidian, Wind River, PTC, Goodrich, as well as academic organizations such as the Technical University of Munich and Bundeswehr University of Munich; they will be displaying their latest research projects and products.

Forums Programme:

EUROCAE

'The Force of Standards for the Avionics Industry'

This session will explore the benefits of standards for the avionics industry from a structural perspective and demonstrate possible benefits by examining several examples.

AEA (ASSOCIATION OF EUROPEAN AIRLINES)

'SESAR Update from the Airlines Perspective'

This forum will consist of presentations by some of the airlines involved in the SESAR project. Airlines presenting include Air France and Iberia.

SESAR JU

'Avionics Developments in SESAR - Supporting the future ATM System'

This session will examine how SESAR will substantially change the way air traffic management in Europe is handled in future.

DGLR/ROYAL AERONAUTICAL SOCIETY

'Avionics and Mission Technologies'

The session will start with an overview of trends in aeronautical telemetry. A presentation about mission avionics to support air-to-air refuelling manoeuvres will follow. The session will be closed with contributions regarding multi-UAV guidance using cognitive automation as well as UAV computing.



Opening Speeches

The opening keynote speech on Wednesday 21st March will see presentations from:

Mario Araujo, Director of Engineering, TAP Portugal;

Michael Steinfurth, Head of CMAC Division, EUROCONTROL;

Eric Stefanello, EADS representative and Prosky CEO (an Airbus company).

The opening keynote will be chaired by John Keller, Conference Director and Editor-in-Chief of Military & Aerospace Electronics, who will provide some thought-provoking questions.

Avionics Europe 2012

For more details on the conference programme, workshops and forums and to register online visit: www.avionics-event.com

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NATIONAL ELECTRONICS WEEK 2012

18TH – 19TH APRIL
HALL 2; NEC BIRMINGHAM

National Electronics Week 2012 is one of the largest gatherings of industry professionals in the UK. This year it runs alongside other seven manufacturing events at the NEC (National Exhibition Centre) in Birmingham to give visitors and exhibitors a comprehensive business platform.

These events will cover over 37,000 square metres of floorspace and will have more than 1,000 exhibiting companies in five exhibition halls. Among the new features this year are:

- The Cambridge Wireless zone, which sees a mixture of SMEs and internationally-recognised brands promoting their products and services;
- The UKTI brokerage zone – an area supported and managed by UKTI which will host key international buyers.
- ARM will once again be supporting NEW:UK 2012, but this year in addition to its interactive stand it will also host the ARM Community Pavilion where a selection of its partners will be exhibiting for the first time at NEW UK.
- The Live Manufacturing Line, which is normally on site, this year will offer a difference as visitors can interact with the line manufacturers and collect components and products from their stands to create a final product there and then.
- In addition there is the POP Design Centre. “If you have no experience in this technology or have not used POP before, there is definitely something worth investigating,” said Bob Willis, POP Design Centre Manager. “Spend a couple of hours with the POP team and you will have a significant advantage when specifying or implementing this technology in the future”. Visit www.nationalelectronicsweek.co.uk/pop2012.asp to find out more.



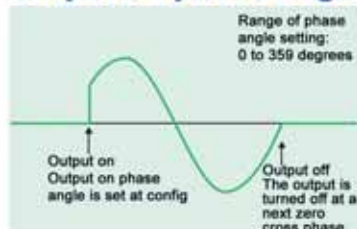
In addition to the main event, there are two seminar theatres and the programme will include process, laser technologies, embedded, design and other key industry topics – visit www.new-expo.co.uk to get an update.

For more information contact Claire Saunders, Event Director on + 44 1483 420 449 or email claire@neweventsLtd.com

NEW:UK – www.new-expo.co.uk

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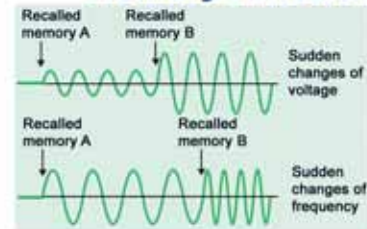
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Agilent 4195A 10Hz- 500MHz Spectrum An.	£3995	Agilent E4425B 250kHz-3 GHz Signal Generator	£4250
Agilent 53310A Modulation Domain Analyser	£1000	Agilent E4432B - UN3- (250kHz- 3GHz)Signal Gen.	£2750
Agilent 5350B /51B/ 52B 10Hz-20GHz / 26.5GHz/ 40GHz Freq. Counter from	£1000	Agilent (HP)4291B 1.8 GHz R/F Impedance Analyser	£8000
Agilent 54540C 500 MHz- 4 Ch oscilloscope	£3995	Audio Precision System One (SYS-222) Audio /Dist. Analyser	£2200
Agilent 54720D with 2x 54721A Plug-ins Oscilloscope 1GHz 4 ch.	£2000	Amplifier Research 150L Power Amplifier 150W (10kHz-200MHz)	£6500
Agilent 54750A High Bandwidth Digitizing Osc.	£1500	ENI 525LA R/F Power Amplifier 1 - 500MHz, 25 Watts	£2500
Agilent 54845A Infinium 1.5GHz- 4 Ch Osc.	£4995	Keithley 236 Source Measurement Unit	£1500
Agilent 6574A 60V-35A Power Supply	£1495	Keithley 237 High Voltage Source Meter	£2750
Agilent 81101A 50 MHz Pulse Generator	£3250	Keithley 486 Picoammeter 5.5 digit	£1100
Agilent 83630B Synthesised Sig. Gen. 26.5 GHz	£19500	Keithley 617 Programmable Electrometer	£1100
Agilent 83651B Synthesised Sig. Gen. 50 GHz	£13000	Lecroy LC334AM 500MHz - 4 Ch Oscilloscope	£2750
Agilent 83752A Synth, Sweep Gen. 0.01-20 GHz	£9995	Lecroy LC564A 1GHz - 4 Channel dig. Colour Oscilloscope	£2995
Agilent 85046A 'S' Parameter Test Set 3 GHz	£2000	Lecroy LC574AM 1 GHz, 4 Channel dig. Colour oscilloscope	£3250
Agilent 85047A 'S' Parameter Test Set 6 GHz	£3000	Marconi 2023 Signal Generator 9kHz-1.2GHz	£1500
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Is Graphene Central to the Future of Semiconductor Fabrication?

OVER THE LAST SEVERAL ISSUES OF ELECTRONICS WORLD, **JONATHAN TUCKER**, CHAIRMAN OF THE IEEE NANOTECHNOLOGY COUNCIL STANDARDS COMMITTEE, HAS PRESENTED THIS TUTORIAL ON NANOTECHNOLOGY-RELATED TEST AND MEASUREMENT TECHNIQUES. LAST IN THE SERIES

Graphene is one of the most talked-about topics in the field of nanotechnology. This crystal of carbon that is only an atom thick has outstanding electrical conductivity. It also has extremely strong, yet flexible bonds. Its hardness is greater than the hardness of diamond.

Until relatively recently, physicists did not believe that a solid crystal just a single atom thick could exist. Professors Novoselov and Geim proved otherwise with the discovery of graphene in 2004; for their achievement they won the 2010 Nobel Prize in Physics.

Potential applications of this material, sometimes described as “the perfect atomic lattice”, include the development of new super-strong and lightweight materials for making satellites, aircraft and automobiles. Electronics applications (Figure 1) may include the development of ultra fast and ultra-high bandwidth transistors, innovative displays, biodevices, single-molecule gas detectors and ultracapacitors.

The exciting thing about graphene for the semiconductor industry is that electrons travel through it unimpeded, and they behave according to quantum

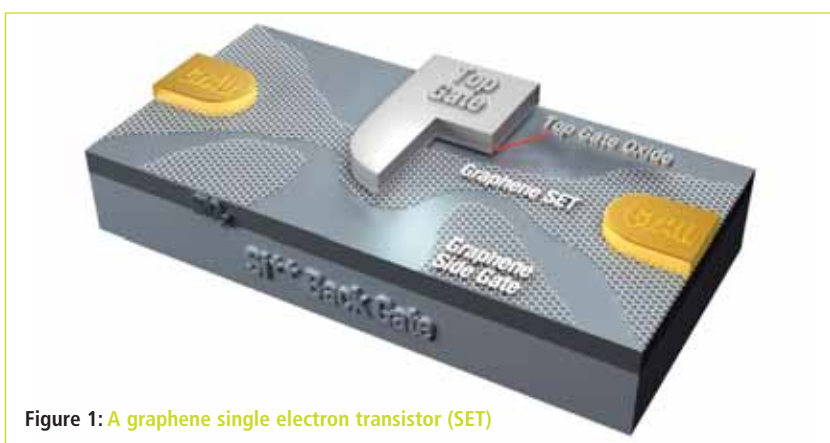


Figure 1: A graphene single electron transistor (SET)

electrodynamic principles. Carrier mobilities through graphene are around $10,000\text{cm}^2/\text{Vs}$ at room temperature, and mobility values as high as $200,000\text{cm}^2/\text{Vs}$ on suspended samples of graphene have been reported.

Graphene’s high mobility has already led to the development of very high frequency (100GHz and higher) RF transistors. But since graphene does not have a natural bandgap, many researchers are investigating methods to create one so that its high speed properties and nanoscale size could replace silicon in next-generation FETs

for digital circuitry, thereby extending the life of Moore’s Law.

Researchers characterizing graphene and graphene-based materials use Hall effect measurements and study longitudinal resistance to assess carrier mobility and look for evidence of the quantum Hall effect, whereby longitudinal resistivity decreases to near $0\Omega\text{-cm}$ (Figures 2 and 3). These measurements require very low current, precision sourcing of the order of nano-amps. However, the most important aspect of tight control over sourcing is ensuring that excessive power does not develop across the graphene sample in order to avoid destroying it. Furthermore, at nano-amp source current levels, the resulting voltages developed across the sample are extremely small, some ten to hundreds of nanovolts. These types of nanovolt-level measurements require special

The exciting thing about graphene for the semiconductor industry is that electrons travel through it unimpeded, and they behave according to quantum electrodynamic principles

instrumentation with sufficient resolution and extremely high sensitivity.

In nanovolt-level measurements, thermoelectric voltages and noise sources can significantly impact measurement accuracy, so it's important to employ techniques designed to minimize these effects. For example, using a current source that allows reversing the polarity of its signal can eliminate measurement errors due to thermal voltage offsets. Furthermore, a current source that can output low duty cycle, narrow pulses will minimize measurement errors due to resistivity changes resulting from self-heating of the graphene sample. Thus, using a current source and nanovoltmeter combination that can synchronize sourcing and measurement simplifies eliminating the thermal offsets and averaging out noise signals.

For graphene or a graphene-based material to replace silicon, it must have a

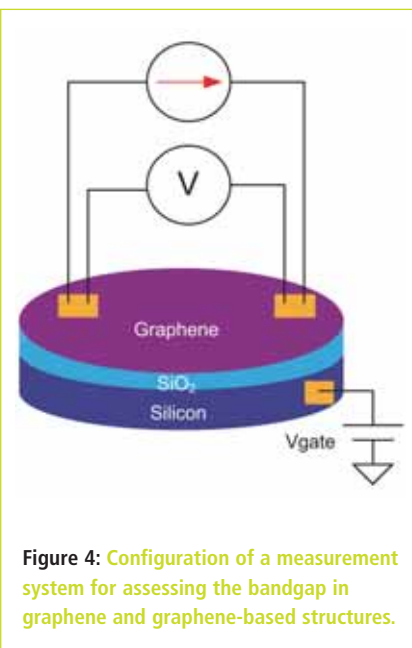


Figure 4: Configuration of a measurement system for assessing the bandgap in graphene and graphene-based structures.

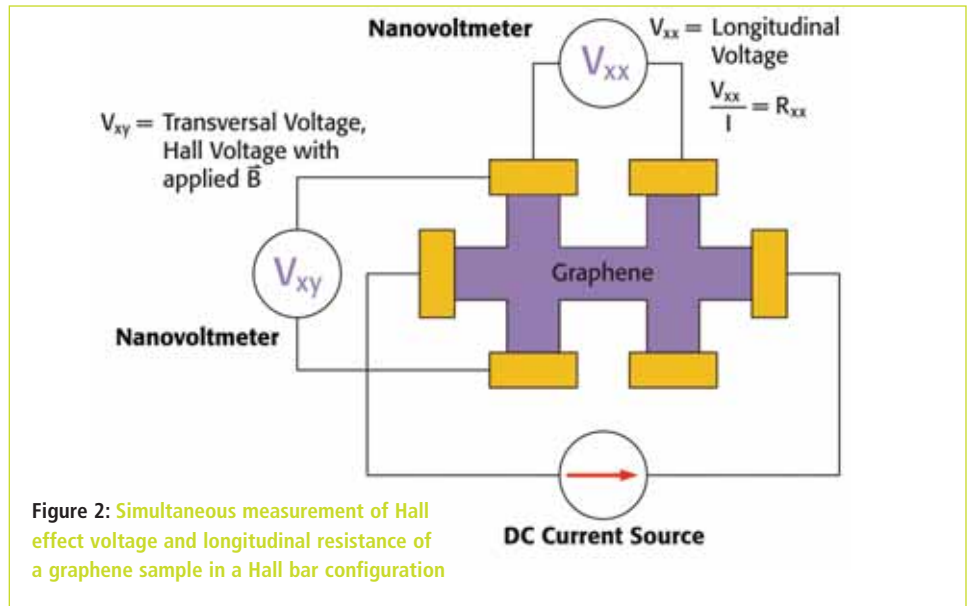


Figure 2: Simultaneous measurement of Hall effect voltage and longitudinal resistance of a graphene sample in a Hall bar configuration

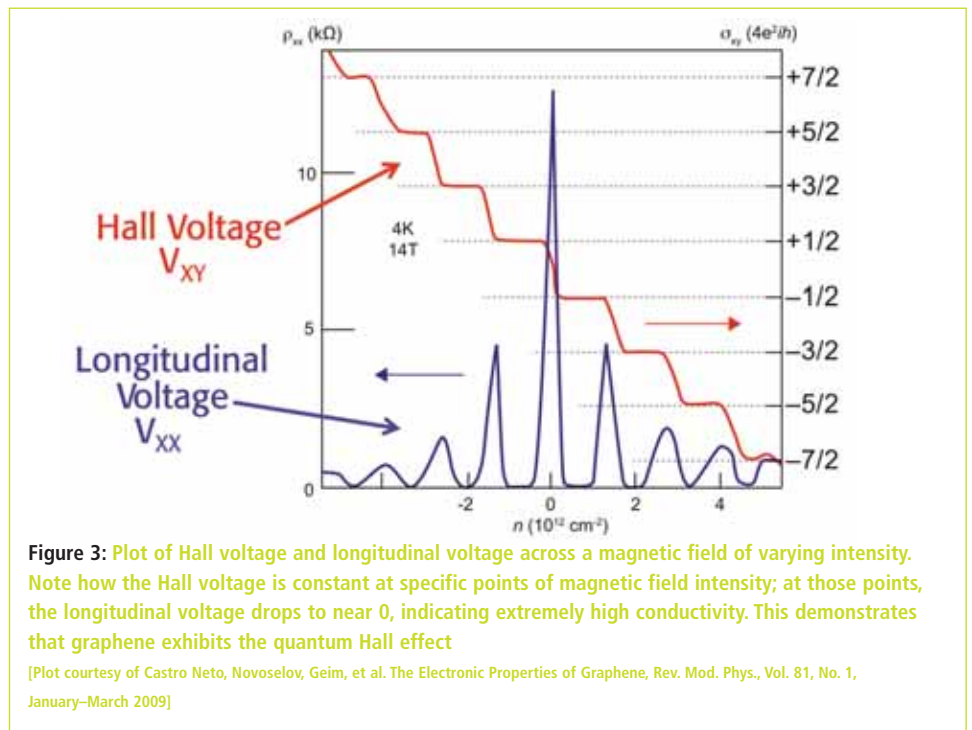


Figure 3: Plot of Hall voltage and longitudinal voltage across a magnetic field of varying intensity. Note how the Hall voltage is constant at specific points of magnetic field intensity; at those points, the longitudinal voltage drops to near 0, indicating extremely high conductivity. This demonstrates that graphene exhibits the quantum Hall effect

[Plot courtesy of Castro Neto, Novoselov, Geim, et al. The Electronic Properties of Graphene, Rev. Mod. Phys., Vol. 81, No. 1, January–March 2009]

bandgap so that a FET channel can be turned on and off. A precision SMU is needed to modulate the substrate or “gate” voltage to characterize the sample’s performance across a range of gate voltages (Figure 4). Again, a low level current source and a nanovoltmeter are required to provide low power, low level measurements. ●

If you have not seen the previous parts of this series you can order copies of those issues online at www.electronicworld.co.uk

FOR FURTHER READING

TO LEARN MORE ABOUT THE GROWING ARRAY OF TOOLS AND TECHNIQUES AVAILABLE FOR GRAPHENE MATERIAL AND DEVICE CHARACTERIZATION SEE

“Make High Quality Measurements on Graphene-Based Materials and Devices” on the web.

New EZ-Cable Clips from Harwin Reduce Interference

Harwin has expanded its range of EZ-BoardWare surface mount cable clips which can now also be used to help reduce interference when using coax cables.

Harwin's EZ-BoardWare family of surface mount PCB boardware products replace traditional components that usually require a secondary assembly process. Cable management devices, for example, are usually bulky and screwed to the board after all the other components have been automatically placed. In contrast, Harwin's EZ-Cable Clips are small and tidy and are surface mounted along with every other standard device, saving time, costs and space. A further advantage is that they do not degrade and become brittle like the plastic devices they are superseding.

Originally offered in four sizes covering 1-3mm cable diameters, the range now includes devices that can manage two 0.9mm diameter wires side by side, or one 1.32mm diameter mini coaxial cable.

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Bluegiga Development Kit From Avnet Embedded Speeds Bluetooth SMART Designs

Avnet Embedded in EMEA, an Avnet company, announced a special offer on Bluegiga's Bluetooth SMART (also known as Bluetooth 4.0) BLE 112 development kit. Costing just \$300, the kit contains everything designers need to get started quickly; for an additional \$100 Avnet Embedded will also add three more BLE112 modules and one extra dongle. Bluetooth SMART products are ideal where low-power operation, negligible latency and security are critical, like heart rate, blood and glucose monitoring sensors, as well as industrial and home automation applications.

The new generation of Bluetooth dramatically reduces power consumption while ensuring excellent performance and security. Typically Bluetooth SMART products transmit data payloads up to 15 times faster than conventional Bluetooth technology and overall power consumption is reduced by over 90%.

The development kit contains BLE112 evaluation board, BLE112 Bluetooth 4.0 SMART USB dongle, two BLE112 Bluetooth 4.0 SMART modules, firmware programming cable, cables and documentation, and access to Bluegiga's Bluetooth 4.0 software development kit.

www.avnet-embedded.eu



AVX'S 0402 MLO RF INDUCTORS OFFER TIGHT TOLERANCE IN A REDUCED FOOTPRINT

AVX Corporation has developed a multilayer organic RF inductor in a 0402 case size that offers tight tolerance in a small footprint. Providing high-Q and high self-resonance, the RoHS-compliant MLO 0402 Series inductor features an inductance range of 1nH to 32nH.

It is based on a patented multilayer low loss organic (MLO) technology, offering a route away from traditional ceramic and thin film passive SMD components. Since Copper Organic Inductors (COIs) are polymer based and use high conductivity copper interconnects in a multilayer fashion, the ability to fabricate these

components on large area substrates and in laser-direct imaging allow for improved cost and tolerance control.

The low profile MLO 0402 Series inductor also offers high SRF (self-resonant frequency), and can support frequencies well above 1GHz. These advanced devices are expansion-matched to printed circuit boards, allowing for improved reliability.

The MLO 0402 Series inductor is ideal for RF power amplifiers, low noise amplifiers, filter networks and MRI systems.

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GS1500M FOR LEADING EDGE 802.11B/G/N WI-FI CONNECTIVITY

New from Alpha Micro is the GainSpan GS1500M, a high-performance 802.11b/g/n Wi-Fi module, designed for embedded devices which require next generation Wi-Fi connectivity services, such as security cameras, home appliances and industrial control systems. The module makes it easy to add Wi-Fi connectivity to standard 8 to 32-bit microcontrollers, offering plug-and-play integration of Wi-Fi in embedded platforms using SPI or UART interfaces.

Building on GainSpan's existing ultra low power embedded Wi-Fi portfolio, the feature rich module enables new opportunities for Internet of Things (IoT) applications where 802.11b/g/n connectivity is a key requirement.

The GS1500M preserves the software architecture, feature set and is pin-to-pin compatible with the GS1011M module that is currently in production. This allows designers to use their previous hardware and software development work, preserve existing investments and ensure a smooth migration to 802.11b/g/n. In addition, the GS1500M module also offers configurable antenna options, either as built-in or external antenna.

www.alphamicro.net



Rugged Waterproof Connector for Industrial Sensing Applications

Intelliconnect (Europe) Ltd, which is based in the UK, now offers a range of multi-pin waterproof connectors available with from 4 to 14 connecting pins. The 4-way connector complements the commonly used TNC waterproof coaxial RF connector in performance and dimensions.

Remote sensing and monitoring of equipment and pipelines in industrial, water and petrochemical installations is becoming increasingly popular. Remote monitoring eliminates the need for constant manual measurement and enables planned intervention and correction to take place, reducing costly failures and emergency shut-downs of plants. Remote sensing systems typically use a range of permanently installed wireless enabled sensors which can measure the thickness of pipes for signs of corrosion, flow direction, flow rates and other critical parameters as part of a control and monitoring system. Intelliconnect has developed a range of multi-pin connectors capable of handling 3 amps of signal current and rated to IP68 in its unmated condition.

www.intelliconnect.co.uk



LECROY EXPANDS TEST PACKAGES FOR THE AUTOMOTIVE SEGMENT

LeCroy Corporation released three new test packages to address the growing automotive segment. Automobile and chip manufacturers, such as Broadcom Corporation and partners of the MOST Cooperation, turned to LeCroy for the test needs of their next generation systems. As a result, two new QualiPHY automated compliance test packages are available for MOST and the emerging BroadR-Reach standard.

The LeCroy QualiPHY (QPHY) package provides an automated test script that allows quick and reliable testing of both the MOST 50 ePHY and 150 oPHY signals.

BroadR-Reach technology was recently developed by Broadcom Corporation to provide the industry's lowest cost cabling solution for 100Mbps Ethernet connectivity over unshielded single twisted pair wiring. Engineered to meet the stringent in-vehicle requirements of the automotive industry, BroadR-Reach is optimized for multiple in-car applications and supports a variety of connectivity options for external devices. LeCroy is the only company offering a complete physical layer BroadR-Reach test solution.

www.lecroy.com



SINGLE-STRING WHITE LED DRIVER IC FOR LCD BACKLIGHTING

The new A8513 from Allegro MicroSystems Europe is a single-output white LED driver IC designed for backlighting applications in LCD displays for automotive and consumer applications and their associated application, performance and protection requirements.

The new device, which integrates a current-mode boost converter with an internal power switch and one current sink, is designed to provide a robust solution for applications such as automotive infotainment, cluster and centre-stack lighting, industrial LCD displays, portable DVD players, flatbed scanners and LED lighting.

The A8513 can operate from a single power supply from 4.5 to 40V to accommodate start/stop, cold-crank and load-dump requirements. The 2MHz switching frequency of the boost converter allows the device to operate above the AM radio band.

The new device features robust FMEA (failure modes and effects analysis) performance, and constantly monitors the state of the system to determine if any fault conditions occur, with a fault flag pin alerting the controller to possible fault conditions.

www.allegromicro.com



Mouser Offering Comprehensive LED Selection From Panasonic

Mouser Electronics Inc. is now offering a wide range of Panasonic Semiconductor LEDs, including through-hole, surface mount and infrared LEDs.

Panasonic's visible LEDs are available in through-hole or surface mount packages, in a wide variety of sizes. A broad spectrum of colors are available from red to ice blue, as well as white.

Panasonic's GaAlAs Infrared LEDs offer high power output and high efficiency in either a T1 or T1 ¾ transparent, epoxy resin package. With fast response times and high-speed modulation capabilities, these infrared LEDs are available in dominant wavelengths of 860nm and 880nm and in half-power angles of 15°, 20° and 22°.

With its broad product line and unsurpassed customer service, Mouser caters to design engineers and buyers by delivering advanced technologies. Mouser offers customers 19 global support locations and stocks the world's widest selection of the latest semiconductors and electronic components for the newest design projects.

www.mouser.com



42MBPS DC-HSDPA IP DATA THROUGHPUT SOLUTION FOR THE 8960 WIRELESS TEST-SET

Agilent Technologies Inc. announced the new E6703H W-CDMA/HSPA lab application that includes support for 42Mbps DC-HSDPA test modes and IP data connections. The application uses the recently introduced high-performance E5515E 8960 Series 10 wireless communications test-set.

The Agilent E5515E delivers sustained, end-to-end IP data throughput at 42Mbps, flexible and comprehensive RF measurements, and improved hardware capability for future requirements, making it easy and fast to stress wireless devices and verify their performance at full data-rates. The E5515E also enables LTE developers to extensively test the performance of their devices' LTE-to-2G/3G handover, when used in conjunction with the Agilent E6621A PXT wireless test-set.

The dual-carrier approach to transporting high-speed IP data is helping to bridge the gap between the widely available 3G and 3.5G networks and full LTE deployment. The 8960 promises a comprehensive and reliable 2G/3G and 3.5G performance for RF and functional tests, including dual-carrier HSDPA tests for both RF and IP data at the full 42Mbps.

www.agilent.com



Kontron Announces a M2M Deployable System

Kontron announced the availability of its Machine-to-Machine (M2M) deployable system, the Kontron KM2M806XT.

Adding to the company's existing portfolio of M2M smart services, embedded connected devices, Kontron's new ready-to-deploy hardware platform matches the requirements of M2M applications that must operate in extended temperatures and industrial environments.



The Kontron KM2M806XT comes complete with application-ready middleware and supports M2M digital device connectivity right out of the box. An optimal platform specifically for factory and smart building automation applications, Kontron's new M2M system is industrial temperature rated (-40 to +85°C) and includes a cast aluminium case with thermal management capabilities needed for operation under extended temperature conditions.

The new industrial temperature Kontron M2M system KM2M806XT is based on the Intel Atom processor architecture. The device is designed with a modular approach, which includes a carrier board, audio/video board, a Kontron COM Express mini Computer-on-Module (Kontron COMe-mTT10), an optional expansion board along with a M2M software development kit from Wind River.

www.kontron.com/M2M

Digital Miniature Ultra-Low Pressure Sensors Offer I²C And Analog Output At The Same Time

Sensortech's HCLA pressure sensors measure ultra-low gage or differential pressures from 2.5mbar full scale. The sensors perform precision digital signal conditioning and achieve very high accuracies.

The HCLA series provides a digital I²C bus interface plus an analog 0.5 to 4.5V output signal at the same time. This offers OEM customers increased design flexibility, e.g. in order to build up a redundancy functionality for safety critical applications.

The sensors can directly communicate with microcontrollers without the need for additional A/D converters. Further, digital SPI bus and custom specific outputs are available on request.

Sensortech will be at MEDTEC Europe, Booth 4758

www.sensortech.com



PICKERING INTERFACES ON COURSE FOR EXPANSION

Pickering Interfaces GmbH has reorganised its sales region for Eastern Europe. The sales office, located in Trinec/CZ, which supported the Czech Republic, the Slovak Republic and Poland, will expand its sales region to support Romania, Hungary, the Republic of Slovenia, Bosnia and Herzegovina and the Republic of Serbia.

Jaroslav Pyszko, who joined Pickering Interfaces s.r.o in 2005 as a software engineer, became sales engineer in 2010 and will now expand and support the Eastern European sales region. Pyszko is integrated into the German Sales organisation of Pickering.

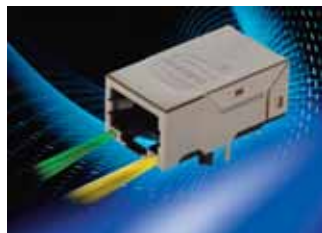
"A strongly increased interest in our products throughout the entire Eastern European region made this step possible – indeed necessary. In 2011 we experienced strong growth rates in these countries. For 2012 we are planning to further expand the sales team of Pickering Interfaces. Jaroslav has an excellent track record with our Eastern European customers. We look forward to continued growth in the region," said Matthias von Bassenheim, managing director of Pickering Interfaces GmbH.

www.pickeringtest.com

Industrial PCB Connectors With Built-In Transformers

Harting has extended its RJ Industrial RJ45 connector family by introducing a range of PCB jacks with built-in transformers. The highly compact dimensions of these RJ45 connectors enable convenient and simple integration into all established IP 65/67 interface types, from PushPull to Han 3A.

The reduced height of the new devices is also an advantage in scenarios involving plug-in cards, allowing the realisation of very low-profile assemblies and modules. The first products to be introduced are versions for 10/100Mbit/s and 1Gbit/s transmission speeds, while versions for PoE as well as individual adaptations to specific customer wishes are planned and can be rapidly executed.



For designs incorporating surface-mount LEDs on the printed circuit board, integrated light pipes enable signalling of the port status.

These industry standard female connectors can be processed by all standard soldering methods such as wave soldering or SMT reflow.

www.harting.co.uk

TDK-LAMBDA'S NV700 MODULAR POWER SUPPLIES MEET LATEST MEDICAL APPROVALS

TDK-Lambda UK has attained third edition IEC/EN 60601-1, ANSI/AAMI ES60601-1 and CAN/CSA-C22.2 No 60601-1-08 medical safety approvals for its NV700 modular AC-DC power supplies – this is in addition to the current approval to the second edition, ensuring full safety approval for medical equipment is maintained during the transition period from second to third editions.

Typical medical applications for the NV700 include clinical diagnostic systems, medical imaging equipment, dialysis systems and medical lasers. The NV700 is also well-suited to meeting the ever increasing demands of the broadcast and instrumentation markets, as well as other applications, such as ATE, automation, routers, servers and security networks.

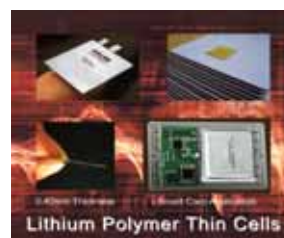
In addition to 60601-1 third edition, products in the NV700 range meet Class B conducted and radiated EMC EN55011 and EN55022 and are approved to EN/IEC/UL/CSA 60950-1 for general purpose applications and EN/IEC 61010-1 for laboratory and process control applications.

www.uk.tdk-lambda.com/nv



VERY THIN LITHIUM POLYMER PRIMARY CELLS FROM POWERSOLVE

Powersolve continues to bring innovative power products to the marketplace with the introduction of



Lithium Polymer thin cells that can be manufactured down to just 0.4mm thick. The CP Series consists of Lithium Polymer thin cells which are primary laminated aluminium thin

foil batteries with a nominal 3VDC output.

Very light in weight, the new CP Series cells are available in a wide range of standard sizes from 16mAh up to 3000mAh. Powersolve says the technology allows a customer to request a cell built to a size that suits a specific application.

The cells have a very low self discharge rate of around 1% a year with a shelf life of 10 years. The cells are safe in use, explosion proof and operate between -40 to +85°C.

The CP 452345 is a typical example of the CP Series. Measuring just 0.45mm x 23mm x 45mm, it weighs 0.7g and gives 30mAh.

Powersolve will be at this year's National Electronics Week, taking place on the 18th and 19th of April in Birmingham.

www.powersolve.co.uk

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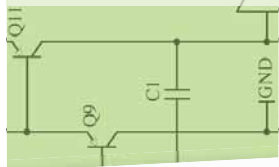
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“K COMPUTER” NO. 1 IN FOUR BENCHMARKS AT HPC CHALLENGE AWARDS

RIKEN, the University of Tsukuba, and Fujitsu Limited announced that they received top-rankings in all four benchmarks for the performance results of their “K computer” at the 2011 HPC Challenge Awards.

The “K computer” is part of the High-Performance Computing Infrastructure (HPCI) initiative led by Japan’s Ministry of Education, Culture, Sports, Science and Technology. “K” comes from the Japanese Kanji character “Kei” which means ten peta or 10 to the 16th power. In its original sense “Kei” expresses a large gateway, and it is hoped that the system will be a new gateway to computational science.

The HPC Challenge Awards demonstrate that the K computer is evaluated very highly in all-around performance as a general-purpose supercomputer. The Awards consist of the Class 1 benchmark performance competition and the Class 2 “Most Productivity” awards for the most “elegant” implementation of computationally-intensive kernels. The Class 1 awards consist of the following four benchmarks and each of which evaluates the performance of key system components – CPU computational performance, memory access performance and network transmission performance:

- Global HPL: operating speed in solving large-scale simultaneous linear equations;
- Global Random Access: random memory access performance in parallel processing;
- EP STREAM (Triad) per system: memory access speed under multiple loads;
- Global FFT: total performance of Fast Fourier Transform.

The K computer’s availability for shared use will be unveiled later this year.

IVOR CATT, Engineer and Scientist, UK: I am at a loss to comment on the “K computer”. This is even though I had world patents on a supercomputer, “The Kernel Logic Machine”, Electronics & Wireless World, March 1989, p254, now at <http://www.ivorcatt.co.uk/3evwk.htm>.

It will never be built. This is because it is an array processor with one million processors in a square 2D array with high-speed local intercommunication. This contrasts with Cray and the rest, who remain committed in principle to a single processor, and retention of the “von Neumann Bottleneck”, separating processing from memory. This is indicated by the second and third benchmarks in the “HPC Challenge Awards”. My article “Dinosaur Computers”, published in Electronics World June 2003 pp47-51, now at http://www.ivorcatt.org/icrew2003jun_0001.htm, discusses the fetishistic commitment by the whole industry to retaining the computer architecture of 1960, and refusal to exploit the special features of semiconductor technology which arrived later. Since semiconductor technology performs both memory and processing, a rethink of computer architecture should have occurred. Computer architecture is frozen at 1960.

PROFESSOR DR DOGAN IBRAHIM, Near East University in Nicosia, Cyprus:

I am happy to see that a new supercomputer has been developed. This new powerful computer will ensure that we can push the boundaries further in the vital research undertaken in a vast range of fields – from understanding the world around us better to helping shape the future. However, it is not without a respective cost, and while supercomputers have become far more efficient in the last decade, the environmental impact of the supercomputer will ironically contribute to its own meta-research.

BARRY MCKEOWN, RF and Microwave Engineer in the Defence Industry, and Director of Datod Ltd, UK:

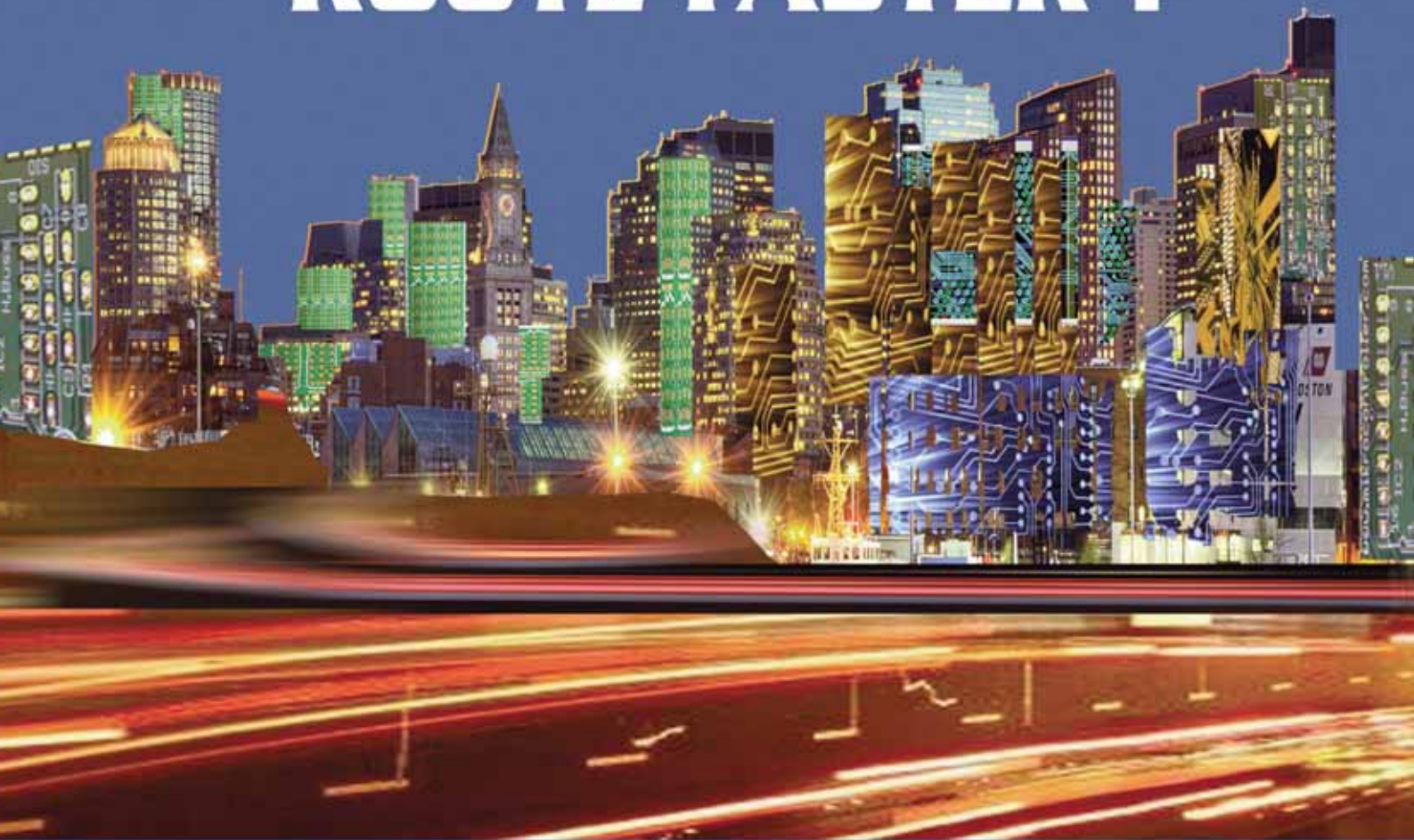
The key parameters here are the establishment of benchmarks, particularly the ubiquitous FFT for signal processing. Whereas smartphones, PCs and servers can be compared like-for-like and side-by-side for applications, supercomputers cannot. As we start to utilise supercomputers in a Cloud computing environment, other parameters pertaining to real-time applications are required to be developed: such as traffic latency framing for the public applications of 4G data traffic, particularly as regards the asymmetric nature of the up/down link 4G traffic. Consequently new interface hardware shall be required to be developed in comparison to current scientific and academic computing.

The HPC Challenge Awards demonstrate that the K computer is evaluated very highly in all-around performance as a general-purpose supercomputer

MAURIZIO DI PAOLO EMILIO, Telecommunications Engineer, Italy: The supercomputer is an essential tool for contemporary science and technology. The potential it offers for expanding basic research in areas such as cosmology, elementary particle physics and the life sciences is clear. The development of technology for biomedical analyses has brought about a dramatic increase in the amount and variety of data and information. The K computer is based on distributed memory type architecture, with over 80,000 compute nodes. It was designed to be energy-efficient, but it still consumes 9.89 megawatts! Energy consumption is becoming an important factor in supercomputing, since the average power consumption of the top ten supercomputers is 4.3 megawatts. Supercomputers systems are built by connecting multiple processing units and can require large rooms to store them. The large number of processors give off greater heat than standard computers, which is a disadvantage because they require a cooling infrastructure; a disadvantage is that supercomputers require massive external storage drives whose bandwidth is fast enough to accommodate the data being analyzed and produced.

If you are interested in becoming a member of our panel and comment on new developments and technologies within the electronics sector please register your interest with the editor by writing to Svetlana.josifovska@stjohnpatrick.com

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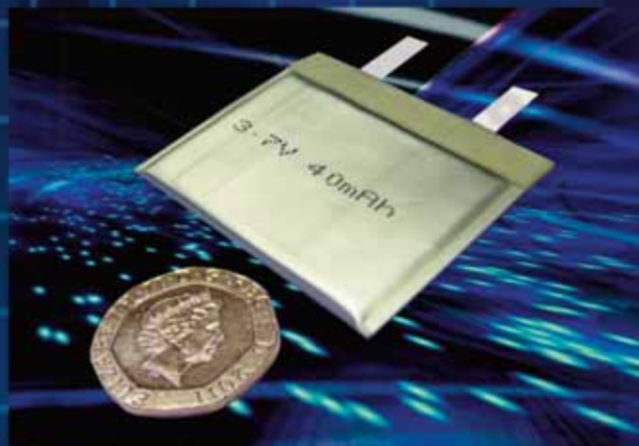
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