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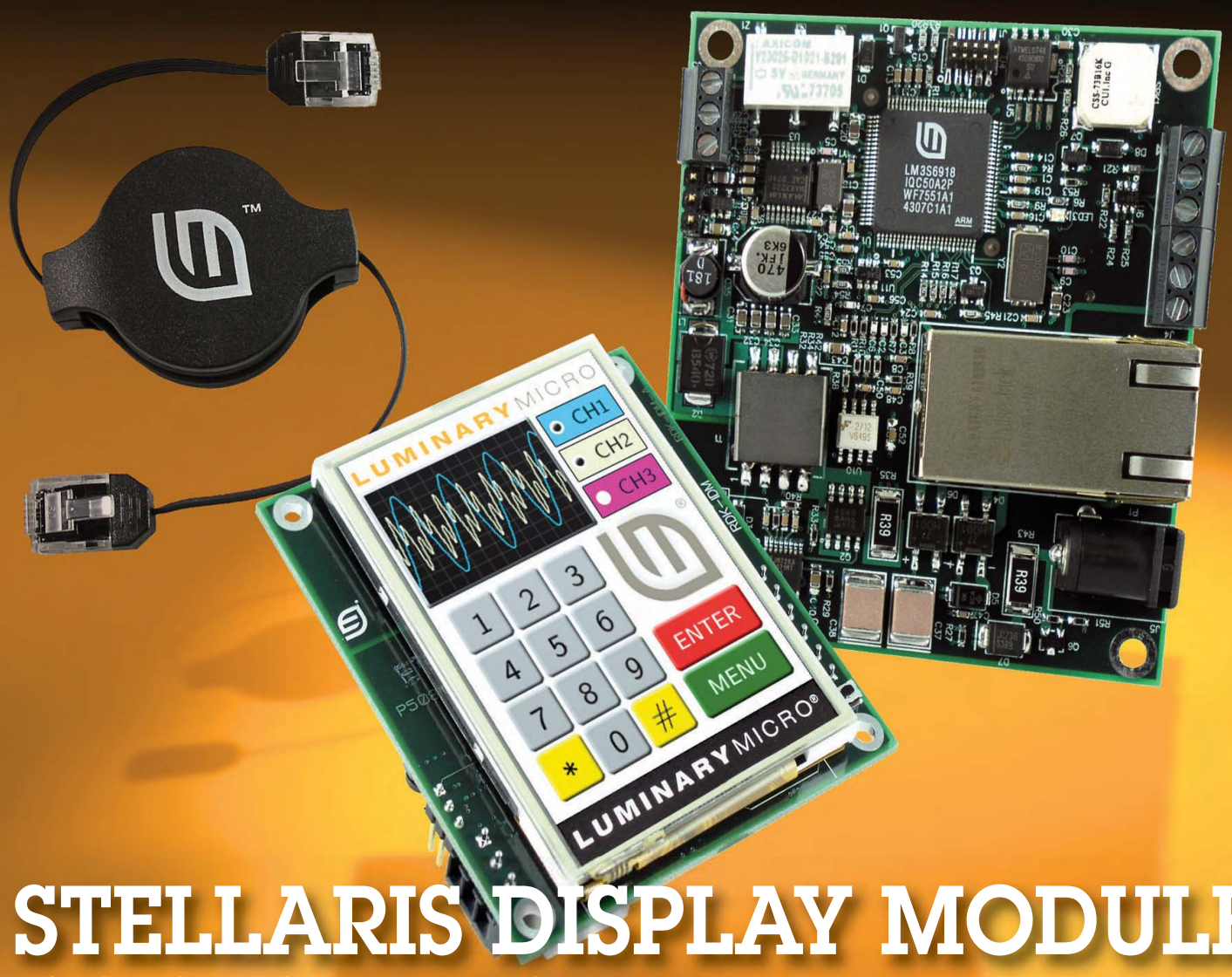

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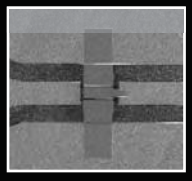

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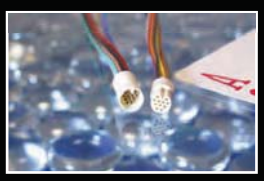

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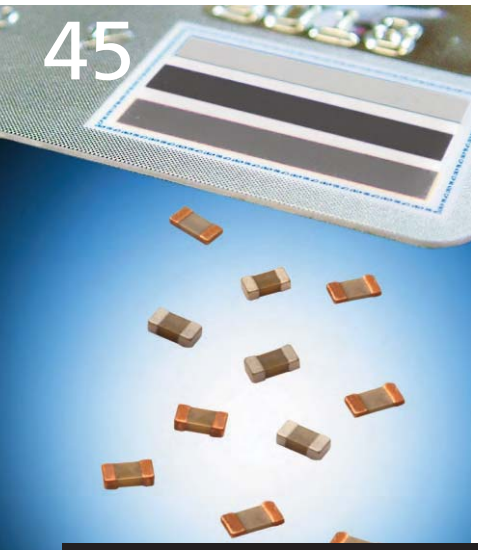

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Here are just a few of our controller and driver modules for AC, DC, Unipolar/Bipolar stepper motors and servo motors. See website for full range and details.

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Moving to Eastern Europe

STELLARIS MDL-IDM – shortcut to an intelligent HMI, says Luminary Micro on **page 24**

Over the past fifteen years, we've seen the trend of Western companies setting up manufacturing and contract-based services closer to home – in Eastern Europe. This trend seems to have intensified as many have started to eye up moving some of their operations from far afield (China, Asia) to their own back yards, where they will still achieve cost-savings, plus enjoy the added benefits of working in the same time zone, the proximity, as well as the shorter supply chains.

Somebody said that operating in some Eastern European countries is considered by many Electronic Manufacturing Services (EMS) executives as being equivalent to operating in China, in terms of total "landed costs". So, original equipment manufacturers (OEMs) are increasingly turning their attention to these smaller, emerging economies such as Romania, Bulgaria, Slovakia, Estonia, Lithuania and Belarus.

Leading global manufacturers of home appliances have already established manufacturing bases in Poland, while some EMS firms have made sizeable investments in the design services sector in the Czech Republic, with others having established footprints in Hungary.

Eastern Europe is seen nowadays as an investor-friendly destination: with a good GDP growth and knowledgeable and skilled workforce, eager to toil hard for (let's face it) not such high wages.

According to an analysis from market research firm Frost & Sullivan, Eastern European EMS market earned revenues of $10bn in 2008 with an estimated doubling of growth to $21bn by 2013. Here, the Romanian electronics manufacturing market earned revenues of over $1.6bn in 2008 and Bulgaria some $440m in the same year.

The Eastern European electronics manufacturing market alone accounts for over 50% of the overall European EMS markets and is expected to grow with the rise of the number of manufacturers in the region.

Recently, local governments in Eastern Europe have started to do their bit to encourage investments in the region too, by facilitating special economic zone (SEZ) allocations to EMS companies and providing them with tax rebates to set up their units in the region.

As global economic conditions continue to change, we are very likely to hear from more Western firms moving facilities there in years to come.

Editor
Svetlana Josifovska

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PCB-INTEGRATED CANTILEVER SENSORS OPEN UP NEW APPLICATIONS

German printed circuit board (PCB) specialist Würth Elektronik has used a novel conductive polymer to integrate cantilevers into PCBs, which can operate as sensors, with it opening doors to new industrial applications.

Current generation cantilevers are limited to simple functions such as force measurement, for example. Strain gauges are typically glued onto metal cantilevers. Designed as a Wheatstone bridge, a signal is created corresponding to the proportional value of the force effect on the cantilever. Commercial strain gauges come with values of between 1mV/V and 4mV/V, which means that the signal needs to be amplified by 250 to 1000 times before it becomes fit for purpose. But, amplification brings its own pitfalls, such as drift and EMC interferences.

Würth Elektronik's printed polymer strain gauge, on the other hand, uses the TK compensation due to the Wheatstone bridge and the matching of FR4 to the conductive polymer. The thick coating creates an exceptionally stress-sensitive resistor, so the signal obtained is around 50 times stronger than that of conventional strain gauges, which means that the amplification needed is a lot lower and, in some applications, even no longer necessary.

"The printed circuit board takes over functions, playing the role of a sensor. That generates an essential difference – the PCB is not applied as backing material for electronic components or as a connecting element, [but] it [becomes] a valuable system, able to take on additional tasks," said Peter Tiefenbach, head of polymer product management at Würth Elektronik.

The new cantilevers can be integrated into any PCB type: double-sided, multilayer, HDI or flex-rigid. The special technique of embedding the polymer hybrid as a screen-printed, passive component inside internal layers of a PCB provides a level of high packaging density with reliable connections.

Würth Elektronik says that the crucial factor to this level of integration is due to its in-house developed conductive plastic paste with "unknown new features up until now". The firm will not disclose the material's details, only that it's been developed with "targeted electrical characteristics".

The Finite Element Analysis shows the various levels of external stress loaded on a component in different colours (here, by bending)

Due to the robustness brought on by the new polymer strain gauge, the cantilever is suitable for applications that are subject to special demands in terms of temperature, humidity or environmental harshness. This type of sensor may also be used as short stroke sensor or, when combined with a diaphragm, as a pressure sensor.

University of Glasgow develops the world's smallest diamond transistor

Scientists at University of Glasgow have developed the world's smallest transistor with a gate length of just 50nm. As such, it is half the size of the previous smallest diamond transistor developed by Japanese firm NTT.

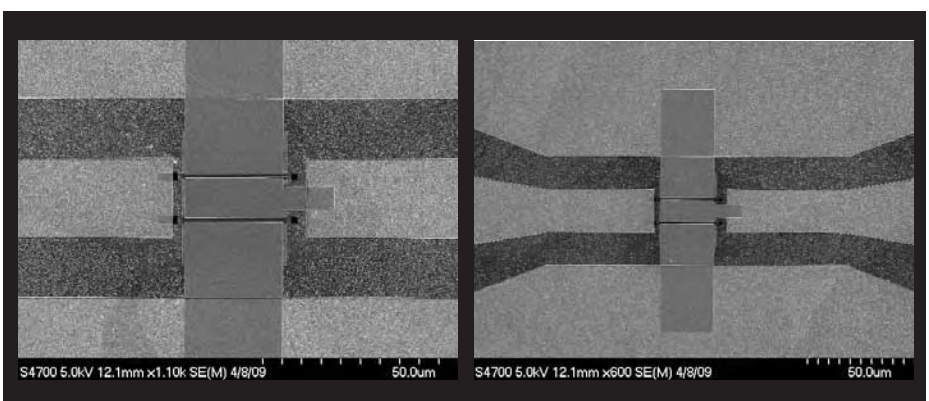
Diamond is seen as an ideal material for next generation nanoscale electronic devices due to its properties.

"Silicon and gallium arsenide are chosen [for use in today's transistors] upon what their strengths and weaknesses are," said Dr David Moran of the Department of Electronics and Electrical Engineering at the University of Glasgow. "Diamond, on the other hand, is very much an excellent all-round performer and has been described by many as a perfect material."

"By developing a diamond transistor technology, we aim to tap into the truly amazing properties of this exciting material which could prove fundamental to the development of several next generation technologies," he added.

The creation of the tiny device is part of a five-year project funded by the Engineering & Physical Sciences Research Council (EPSRC), and is the result of a collaborative project between the University of Glasgow and Heriot Watt University. Its construction was made possible through the multi-million pound facilities within the James Watt Nanofabrication Centre at the University of Glasgow, where electron beam lithography was used to create patterns and structures on the miniscule sliver of diamond.

The diamond itself is artificially made by UK firm Element 6 through a process called chemical vapour deposition.



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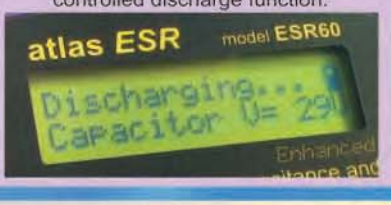

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Envirowise is planning to launch DesignBox Eco Design Forum

The sustainable business experts at Envirowise will be launching a new online eco-design forum, DesignBox, for anyone interested in saving money and the environment through sustainable design.

As well as a discussion forum, where users can share best practice and ask Envirowise experts for tips and advice, the forum will host monthly sessions with keynote speakers from the world of design. During these sessions, forum members will be able to submit questions live via an instant-messaging style interface.

The DesignBox forum has been designed to meet the latest accessibility and industry standards. Users will be able to chat in a secure area about eco-design challenges, vote on key issues and meet virtually with others who share an interest in improving resource efficiency.

With estimates that up to 80% of a product's costs are set at the design stage, Envirowise believes businesses could unlock millions of pounds in potential savings by considering eco design principles during the product and packaging development cycle.

Jenni Rosser, eco design specialist at Envirowise, said: "There is a growing appetite for information on eco-design and we believe that the DesignBox forum will help to satisfy it. We hope it will become a vibrant online community for the design industry and, along with the Envirowise website, a first port of call for eco-design news and information."

Envirowise is a UK government funded programme, dedicated to putting the sustainable use of resources at the heart of UK business practice. Since 1994 Envirowise has helped UK businesses save over £1bn by enabling them to significantly reduce their environmental footprints.

Envirowise offers all size and type businesses a range of free, independent and practical advice designed to improve their processes, profitability and competitiveness. Its new eco design forum is planned for a late May launch. To register an interest in joining the DesignBox Eco Design Forum, (**www.envirowise.gov.uk/designbox**) email: cleanerdesign@envirowise.gov.uk.

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■ In 2008 biometric vendors witnessed massive growth, says market analysts at Frost & Sullivan. Even though some biometric vendors have been affected by the downturn, there's an ongoing demand for more integrated security solutions from law enforcement, government, healthcare and manufacturing facilities. According to Frost & Sullivan, 2009 is anticipated to be a steady uphill year for the market.

"Since the rebound of global economy in 2004 from the severe economic crisis of 2000, biometrics market has gained steady momentum in Europe with 30.5% growth rate overall," says Suja Chellathurai, Frost & Sullivan analyst.

■ Less than a half of technology, media and telecoms (TMT) companies feel they have access to funding for their business than a year ago, states new research from business advisers BDO Stoy Hayward.

In 2009, only 38% of TMT businesses said it was easy to get access to new funding in comparison to 73% in 2008. In addition, the number who found it difficult to get access to funding more than doubled to 30%, up from 14% last year.

Julian Frost, Head of TMT at BDO Stoy Hayward, said: "We are really concerned about TMT firms' ability to access the funding they need to grow their businesses effectively. Financiers say to them 'meet your growth forecasts and we'll support you with additional finance'."

MICROCHIP MCUs GO TO DEEP SLEEP WITH A CURRENT OF 20NA

MCU maker Microchip has launched 8- and 16-bit microcontrollers featuring 'deep sleep' where the stand-by current is only 20nA, currently the lowest in the industry.

According to Jason Tollefson, marketing manager for advanced MCUs and architectures at Microchip, this type of feature is becoming increasingly important in a range of battery-powered applications, including smoke alarms, utility metering and wireless sensors, among others.

"There's a whole new generation of methods for harvesting power: from light, heat, vibration etc, and, in theory, they [such sensors] will require very low power; there are some applications that require a 20-year life without charging," said Tollefson.

When devices 'sleep', their RAM, flash and peripherals are still 'live' and the device needs a 5-microamp current to wake up fully. In 'deep' sleep, all these systems go to sleep too, the only functions that don't are the interrupts, power-on reset and the reset pin; the current needed to wake up this device is 50 microamps.

In its 'deep sleep' nanoWatt XLP generation of MCUs, Microchip has also added other wake-up sources to help the device recover "gracefully", says Tollefson. These include an on-board watch-dog timer and a brown-out reset.

Microchip will not disclose the full architecture of the new MCUs only that it's used "hardware-controllable, powerline switches". Any power created by leakage current from the working transistors has been avoided.

"We've made changes to our process to reduce leakage; we've raised the threshold of the transistors," added Tollefson.

The three new families are the 16-bit PIC1824F16KA, the 8-bit PIC18F46J11 and the also 8-bit J50, accompanied by development boards and tools.

USING ATOMIC LAYER DEPOSITION (ALD) IN SENSORS AND SYSTEMS

BY DR ALEC READER

The Nanotechnology Knowledge Transfer Network (NanoKTN), one of the UK's primary knowledge-based networks for Micro and Nano-technologies, was set up by the Technology Strategy Board to promote and facilitate knowledge exchange, support the growth of UK capabilities, raise awareness of nanotechnology and provide thought leadership and input to the UK policy and strategy.

The NanoKTN's activities are built around focus groups which identify the gaps in the supply chain, as well as identifying the UK's potential in innovation. This information is reported back to the Technology Strategy Board to input into their UK Nanotechnology Strategy and also provides leverage for channeling government funds into specific areas of need.

For further information on the NanoKTN and its activities visit www.nanoktn.com

ALL ELECTRONICS companies face the constant challenge to develop and commercialise new products that are competitive in the marketplace. To achieve this they are increasingly looking to the nanotechnology industry for new processes to manufacture electronic devices with features below 100 nanometre. One such process is Atomic Layer Deposition (ALD), that is capable of easily building structures measuring 100 nanometre and smaller on the most advanced applications in electronics, catalysis and sensor technology. However, in order to fully capitalise on these new processes the challenge is to establish a fluid supply chain that makes it viable for nanotechnology to be effectively introduced.

The role of the supply chain in ALD was the theme of a Nano Micro Systems focus group activity hosted by the NanoKTN and in partnership with the Joint Equipment and Materials Initiative (JEMI), on March 31st 2009. The one-day conference considered new developments in the manufacture of advanced nano-electronic devices such as leading-edge MOS structures, as well as assessed the existing gaps in the supply chain that if not bridged will prohibit companies from realising the significant commercial gains.

The event saw presentations from key players in the industry, including Metryx, Oxford Instruments Plasma Technology, Beneq, Loughborough Surface Analysis, Centre for Process Innovation (CPI) and SAFC Hitech and featured a table top exhibition, which offered a unique opportunity for exhibitors to showcase their products and services. The presentations looked at the developments of nano-electronics and nano-materials in recent years and the technologies and applications that are bringing about positive changes in these areas.

Highlights from the day included a presentation by Julia Baker, Principal Research Scientist at Kodak who looked at the development of atmospheric pressure ALD technology used in dielectrics and semiconductor layers, and Mike Petty from Loughborough Surface Analysis gave an introduction to surface analytical and depth profiling techniques.

Professor Paul Chalker from the University of Liverpool looked at the use of ALD in the manufacture of VLSI semiconductor logic and memory devices, Paul Williams at SAFC Hitech demonstrated how chemical precursors can be designed to satisfy deposition requirements and Mark Berry at Metryx analysed a mass metrology technique used to develop thin films deposited through ALD processes.

Other keynote presentations focused on the recent introduction of OLEDs (organic light emitting displays), examples of emerging industrial applications in nano-electronics, displays and solar energy and the ALD processes and services being developed by CPI.

Chris Hodson, ALD Product Manager at Oxford Instruments Plasma Technology, addressed the current trends of downscaling in the semiconductor industry and the resulting boost in the use and development of nano-electronic devices and systems. These industry changes have led to ALD becoming the method of choice for depositing high quality films with ultimate growth control and excellent step coverage, on very demanding high-aspect ratio features.

ALD was first demonstrated in 1974 by Dr Suntola in Finland and the commercial use of these methods began with the need to deposit dielectric films on MOS structures. Later, ALD was developed for large area OLED substrates, needed in the manufacture of electroluminescent flat-panel displays. With nano-electronics becoming further developed during the late 1990s and early 2000s, the need for successful ALD processes became even greater, as the demand for producing thin conformal films of a specific thickness became imperative.

NANO-ELECTRONIC DEVICES,

Within nano-electronics, ALD is a thin film deposition technique that deposits a material onto a nanostructure. The process is repeated until a thin film layer is created. The film adopts the same crystal structure as the material it is deposited on and the electrical properties of the newly created films, improve the material's electronic performance. Using processes like ALD allows manufacturers to control the electrical properties of the host material, allowing for improved performance.

ALD is currently being used in nano-electronics to deposit high-k gate oxides, high-k memory capacitor dielectrics, ferroelectrics and metals and nitrides for electrodes and interconnects. The need to control extremely thin films is essential in high-k gate oxides.

Methods of ALD are used to create high-k gate oxides such as HfO2 and nanolaminates like HfO2 – Al2O3. High aspect ratio diffusion barriers (such as Al2O3) for Cu interconnects (such as TiN), and passivation layers for OLEDs and polymers, also require ALD processes for their manufacture. Fuel cells and the highly conformal coatings used in the production of micro-fluidic and Nano Electronic Mechanical Systems (NEMS) also require the flexible and precise thickness control processes offered by ALD, to produce wear resistant, anti-stiction and chemical resistant coatings.

Why use Plasma ALD?

With the introduction of a low-temperature plasma step in the ALD reaction cycle, it is possible to deliver additional reactivity to the surface in the form of plasma-produced species. This allows ALD to be used in an even wider range of applications by improving the film quality, particularly at lower temperatures, and it also increases the number of materials that can be deposited.

Producing efficient devices is a continual challenge to the electronics market and ALD has been recognised as a vital innovation in doing this, as it is a self-limiting service that offers the benefit of giving precise thickness control. As mainstream semiconductor and other nano-electronic applications start to require a reduced dielectric layer thickness, ALD is becoming more frequently used and ever more critical.

"PRODUCING EFFICIENT DEVICES IS A CONTINUAL CHALLENGE TO THE ELECTRONICS MARKET AND ALD HAS BEEN RECOGNISED AS A VITAL INNOVATION IN DOING THIS"

Using remote plasma ALD means damages can be kept to a minimum, as well as the end result being higher quality films as a result of improved removal of impurities that lead to lower resistivity and higher density.

Plasma ALD processes also offer the widest choice of precursor chemistry available and higher quality films with more process control.

The development of ALD processes is crucial to the nano-electronics industry if we are to see an advance in the manufacture of future nano-electronics and integrated circuits.

It is clear that application areas of ALD are rapidly expanding, as a result of the increase in the number of materials that can be deposited, the widened choice of precursors, improved film quality and lower deposition temperatures that open up even greater possibilities.

Nanotechnology
Knowledge Transfer Network

There are disadvantages to using ALD, with the main limitation being the slow speed of the process, with only a small fraction of a monolayer being deposited in any one cycle. In the past this has been a problem but the films required by future electronic devices are notably thinner than they have been in the past, so the speed of the ALD is not such a critical issue.

Chris Hodson and other speakers at the event acknowledged the presence of gaps in the supply chain, that have to date been prohibitive in enabling this nanotechnology deposition technique to be adopted in electronics devices to its full commercial potential. For many of the delegates it was the first opportunity for all the various stakeholders in the supply chain to come together, along with academics, to identify and work towards bridging these gaps.

It is crucial with all new technologies to ensure that all parts of the supply chain interact and keep each other informed of developments and capabilities and it is focus groups events, like this organised by Nano Micro Systems, that encourage such knowledge exchange and promotion of new developing technologies in advanced nano-electronics devices, sensors and systems.

Dr Alec Reader is Director at the Nanotechnology Knowledge Transfer Network (NanoKTN).
The NanoKTN is one of the UK's primary knowledge-based networks for Micro and Nanotechnologies.
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LTE PROMISES A **MOBILE DATA REVOLUTION**, BUT AT WHAT COST?

Helen Karapandžić, Analyst at Analysys Mason, discloses the views of some telecom operators when it comes to LTE deployment

THE FINANCIAL crisis is putting the squeeze on business budgets, but interest in LTE is building and the first operators are expected to launch services in 2010.

For some network operators, LTE cannot come soon enough. In the period to 2015, wireless data traffic is forecast to increase tenfold in developed countries and sevenfold in emerging markets. These growth rates would require substantial increases in mobile spectrum or amount of mobile infrastructure in order to be provided over HSPA. At the same time, revenue per megabyte continues to fall, driven down by increasing competition and the introduction of flat-rate pricing.

Realistically, LTE will be the only way to profitably manage data traffic: the technology can deliver data at a sixth of the cost of UMTS over a 5 × 5MHz channel.

Compared with previous network technologies, LTE offers capex and opex savings and considerable performance improvements, including higher data rates and reduced latency, which will support new services such as gaming, TV and video. As such, LTE will not only be necessary, but it will also represent a valuable opportunity for those operators that want to differentiate their mobile data offerings.

LTE will offer great benefits to consumers, but it will not be without its challenges. It will fundamentally change the way operators and vendors do business. The value chain will be extended and segmented, and space will need to be made for application and content providers. LTE will be deployed almost on a site-by-site basis and deployment policies will be quite different to those of the past. Integrating LTE into the existing operator access infrastructure will also be challenging and will have a very important operational impact if the operator is to make the most of what LTE offers.

Operators face complex strategic choices. Operators' strategies will be delimited by their individual business objectives, as well as legacy infrastructure, local spectrum availability, the availability of devices and the demand for data services. This results in seemingly conflicting opinions. Telefónica believes that depending on traffic evolution, the origin of usage and the maturity of LTE solutions, the window of opportunity for HSPA+ may not be significant. Telefónica plans to evolve its HSPA networks by including HSPA+ features, but believes that "some of the features that require significant investment (like MIMO) may be difficult to justify economically in most cases". Conversely, Orange plans to upgrade to HSPA+ "whenever suitable, as soon as the technology becomes available." ■

TELEFÓNICA PLANS TO EVOLVE ITS HSPA NETWORKS BY INCLUDING HSPA+ FEATURES, BUT BELIEVES THAT SOME OF THE FEATURES THAT REQUIRE SIGNIFICANT INVESTMENT (LIKE MIMO) MAY BE DIFFICULT TO JUSTIFY ECONOMICALLY IN MOST CASES

Myk Dormer

What do we actually

RADIO MODULES aren't as simple as they used to be. Ten years ago, virtually all 'low power wireless devices' had the same, very limited, user interface. A clipper (and some simple baseband filtering) on the modulation input, and a squaring circuit for the demodulator output. Beyond that it was up to the user to supply pretty much all of the necessary bit, byte and frame coding and decoding, as well as buffering and providing correctly timed control signals to turn the transmitter circuits on and off.

Matters have developed somewhat. Now, many modules (and even a few chips) incorporate some form of local 'intelligence' to make the user's job a bit easier. This varies from simple bit-level coder/decoder functions, right up to complete modem or networking support, while the awkward interface of the past is now more usually a serial port of some kind (RS232 or SPI are common, USB or Ethernet are becoming more so).

But now, when you're attaching a radio module to your target design, you aren't always sure of what you're dealing with. Every manufacturer claims their designs are simple to use, seamless in operation and have functions that will satisfy every imaginable contingency…but very, very rarely is this true.

Considering the three interface types mentioned above, we can immediately discount the SPI type (modules with this interface invariably require the user to program and control their RF circuitry, which is far more awkward than just handling a baseband link) and the USB/Ethernet units (because these can communicate only with high-level applications running on a powerful host CPU: this more in the field of wireless LANs, which is outside the usual applications area for simple low-power radio devices).

This leaves 'serial port' devices. These units are intended to allow the user to use existing familiar asynchronous serial interface techniques (RS232, or rather, a simpler, logic level implementation thereof), allowing the radio link to connect to a microprocessor UART or a PC serial port. In an ideal world, such a device would exactly replace a serial cable, providing identical communication over the wireless link as over the wire.

This is not an ideal world. Before happily surging ahead and using a wireless module that claims to offer a 'cable replacement' link, there are a few very important details to consider. Remember that all 'intelligent' wireless modules put a degree of processing in the way of your data stream; this processing has limitations:

"BEFORE HAPPILY SURGING AHEAD AND USING A WIRELESS MODULE THAT CLAIMS TO OFFER A 'CABLE REPLACEMENT' LINK, THERE ARE A FEW VERY IMPORTANT DETAILS TO CONSIDER"

– **Data rate**. The link will be set to operate at a fixed baud rate. You will either need to select a unit with the correct rate to start with, or be prepared to re-program the module yourself.

Very few units allow non-standard baud rates, or deviation from the industry standard "1 start bit/8 data/1 stop bit" asynchronous format.

– **Transparency**. Not every module is capable of supporting a continuous stream of data. Some simple units have limited (one packet's worth) size buffers which, once filled, will accept no more data until the data has been processed and transmitted. Sometimes, an end-of-file character, or a separate 'transmit now' strobe signal, is needed.

Even relatively sophisticated units will allow the user interface to be set to a speed much higher than the actual 'over the RF path' data-rate.

Either the average throughput must be limited to the unit's basic transmission speed (while also ensuring that the buffers don't overflow), or a flow control protocol (using a CTS connection, or an 'X on/X off' method) must be implemented.

– **Timing**. There is often a considerable latency involved in receiving a byte, formatting it into a packet, powering up the transmitter circuits, sending the packet, decoding it, buffering it and finally outputting the byte at the receiver. For a complex, narrow-band radio modem this latency can easily reach 50-100 milliseconds, while even simple wide-band 'intelligent modules' rarely better 10-20ms.

If your system architecture involves bidirectional transfer of data, then this link latency or 'communications delay' needs to be designed into all your response time estimates and timeouts.

– **Bi-directionality**. Many data communication modules are transceivers. These units offer half-duplex operation. Almost none, with the exception of one or two very sophisticated radio modems, are actually full duplex.

mean by "TRANSPARENT"?

They cannot transmit and receive data simultaneously and there is always a transmitter turn-on (or off) time to consider, along with the communication delays mentioned above.

– **Data errors**. Despite the fact we all try to ignore the fact, RF links are not perfect media, and are subject to all kinds of interference or range-related failure modes. Rather than causing bit errors, as would be seen over the baseband path, these more sophisticated modules incorporate error checking, and in some cases limited correction, and will lose entire packets of data, rather than corrupting individual bytes.

Some units can implement acknowledge/re-transmit operation to prevent data loss, but this then impacts the transmission throughput and results in an indeterminate communication delay under poor link conditions.

The upshot of these considerations is:

Remember that, no matter the advertising claims, no wireless link is a genuine 'cable replacement'. Be aware of the differences and implications.

Read the small print. Make sure that your communication structure is really compatible with what your module manufacturer is offering.

As always, test everything.

Myk Dormer is Senior RF Design Engineer at Radiometrix Ltd ***www.radiometrix.com***

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Cameras as a Seventh Sense in CARS

Andreas Niemann, General Manager for Automotive at Sharp Microelectronics Europe, explains how CCD and CMOS camera modules improve the awareness of driver assistance systems

DRIVER ASSISTANCE systems are one of the highest-growth segments in vehicle electronics. The market analysts of Mercer Management Consulting put the annual growth in turnover at around 14% up to a level of EUR 2.5 billion in 2010 for the North American and European markets alone. Currently, systems with radar, ultrasound and infrared sensors are fighting for the lion's share of the market; the growth drivers, however, are camera-based systems. According to estimates from Sharp, the growth potential for camera sensors will be around 42% on average over the next five years. Other experts are even anticipating an annual growth of more than 60% over the same period.

The advantage of cameras as sensors for driver assistance systems is obvious: In contrast to radar, ultrasound and infrared sensors, cameras supply a complete image of the respective driving situation. For human beings, as visual creatures, it is considerably easier to precisely assess situations using a specific image instead of e.g. being informed of the distance to the next obstacle via an acoustic signal when they're trying to park.

Up to now, there has been no alternative to this abstract form of driver information. But the introduction of liquid crystal displays specially designed for automotive applications in the cockpit make it possible to inform drivers with complete image information about what is happening around their car. The most precise visual input is provided by cameras that will enhance the awareness of driver assistance systems in the future as image sensors.

Driver Information and Active Driver Assistance

Strictly speaking, the broad field of driver assistance systems is sub-divided into two segments that are fundamentally different in their technical approach. The first category involves 'visual aids' for the driver. Systems like these that aid visibility supply additional information from around the vehicle via different sensors, e.g. about obstacles or other road users in the blind spot or at night. However, it is left solely to the driver to assess this information and to react to it.

This contrasts with active driver assistance systems e.g. for avoiding accidents or adapting the speed to the density of traffic and speed restrictions. They inform the driver not only about the respective driving situation but also intervene actively in the driving process. These different

CCD and CMOS camera modules for driving assistance

CCDs and cameras help active driver assistance systems for total driver awareness

functionalities result in fundamentally different requirements of the sensors of the respective systems.

High-Speed CMOS Sensors for Real-Time Processes

Sensors for active driver assistance systems have to be one thing above all: fast. At high speed in particular, the system has to record a critical driving situation, assess it and initiate the corresponding measures in real-time, i.e. in just a fraction of a second. Cameras for systems like these, therefore, require extremely high image rates – 30 images per second at least; the requirement of the automotive manufacturers, however, tends to be in the region of between 60 and 120 images per second.

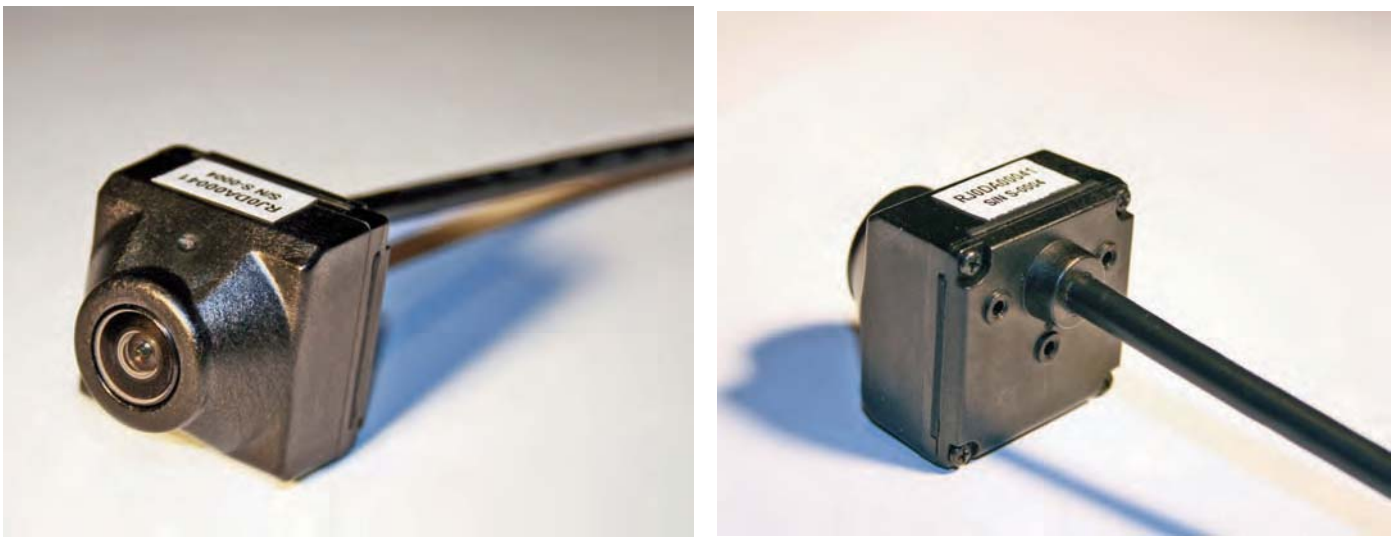
The cameras, especially when they are mounted in the front area, also have to depict the environment in detail in circumstances where there is a great contrast in brightness, e.g. from the headlights of oncoming traffic or when entering or leaving tunnels. The image sensors therefore also need a large dynamics range of at least 100dB to actively support the driver.

To record all that is happening in front of the vehicle, a large angle of vision of around 180° is also needed. Quintessentially, this means that primarily CMOS sensors are used in active driver assistance systems. As an inherent feature in the system, they achieve substantially higher image rates and greater dynamics compared to CCD technology. They are also more economical in their power consumption which is of key importance, primarily with interior cameras to monitor the driver, for example, if he or she should nod off for a moment.

Due to their compact constructional shape, extremely short focal distances and correspondingly large angles of vision can be achieved with CMOS sensors. The CMOS technology is also of benefit in integration into the on-board networks. In contrast to CCD cameras, it supplies a digital image or LVDS output signal that can be processed further by the different components of an active driver assistance system directly and above all without any delays.

	RJ0DA00041
Technology	Colour Interline Transfer CCD
Sensitivity	< 0.1 lx
Image rate	30 fps
Dynamics	~60 dB
Output signal	NTSC
Resolution	410,000
Supply voltage	9 – 16 V
Dimensions (h x w x d)	28 x 28 x 25.4 mm
Temperature range	-40 to +105°C
Impermeability	0.3Mpa/39l/min

Table 1: *Sharp Automotive camera module*



Camera module from Sharp: front and rear

CCD Modules for Greater Visibility in Dark Corners

CCD modules are the technology of choice when it comes to needing detail-rich images in low levels of outside light. With a light sensitivity of 1,200mV and above, CCD cameras also record a very precise image of their environment in poorly lit garages and dark lanes. CCD modules are, therefore, primarily used as rear-view cameras; in Japan, they are already stipulated as such for new vehicles. The lower image rate, compared with CMOS modules, is not important as reversing movements are only done at low speed anyway.

Invisible 'Eyes'

Irrespective of the technology, the use of camera modules makes special demands compared to use in conventional digital cameras or photo mobiles. Primarily, the mechanical robustness and temperature resistance are decisive criteria. Hence, the modules from Sharp are designed for a temperature range of between -40°C and 105°C, in accordance with the requirements of the European automotive industry.

The modules are also specially encapsulated, which also gives the cameras not only the necessary robustness but also impermeability – an essential requirement for the 'eyes' of an active driver assistance system; they are not only exposed to rain but also to water that splashes against the modules under great pressure and at high speed.

As cameras for active driver assistance systems are safety-relevant parts, these also have to function reliably with temporary interruptions to the power supply. Although normally used as rear-view cameras, the CCD modules from Sharp also store a reserve of electricity of one to two minutes, depending on the on-board voltage, ensuring that the modules also remain fully functioning even without a power supply.

An extremely compact constructional form is needed with the automotive modules. The requirement of the automotive manufacturers is that the cameras can be integrated into the vehicle design virtually unseen. In practice, this means that, for instance, the frame of the rear window, the outside mirror or the bumper have to accommodate the modules and this is done all the more elegantly, the more compact the CCD or CMOS modules are. Sharp currently has the smallest CCD camera module for automotive applications, measuring just 28 x 28 x 25.4 millimetres.

High-Contrast Displays of Details

The resolution is of secondary importance with camera modules for the automotive sector. For the liquid crystal displays that are integrated in dashboards in this and the next generation of vehicles themselves only have a resolution in the range of QVGA and WVGA depending on manufacturer and model.

With a resolution of 410K with the CCD modules, the cameras of Sharp already supply more image information than can be depicted by the majority of displays. The same applies for most CMOS sensors currently on the market. The contrast in the clearness of displays in the automotive sector is much more decisive than the resolution. It was only last spring that Sharp set new standards throughout the industry with the introduction of its ultra high-contrast display. The contrast of 2,500:1 ensures a clearness of display that is optimised for use in vehicles even with difficult light conditions so that image information from the different driver assistance systems remains clearly readable at all times.

Complementary Technologies

Due to their different characteristics, CCD and CMOS cameras are to be seen as complementary technologies in the vehicle sector. Whereas CCD modules have greater sensitivity and are therefore primarily used as rear-view cameras, CMOS cameras are mainly used as the 'eyes' of active driver assistance systems due to their high image rates and large dynamics ranges. Both types of camera have to meet the high requirements primarily with regard to temperature resistance, mechanical robustness, impermeability and compact constructional form.

Due to their lower complexity, driver assistance systems that assist visibility and thus CCD modules will generally be used in cars initially. The market for active driver assistance systems and as such for CMOS sensors will grow constantly over the next five years, reaching approximately a third of the overall market for automotive camera modules by 2013.

In the long-term, it is also conceivable that camera modules integrated in vehicles will assume additional functions, e.g. as surveillance cameras for parked cars, offering additional protection against break-ins and vandalism. ■

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LEDs Enter the Headlight Race

OVER THE PAST decade, the electronics content in automobiles has made quantum leaps in both the quantities and sophistication of electronic control, telematics and entertainment systems. Looking ahead, the electronic content in cars is expected to accelerate even faster. Strategy Analytics predicts that automotive electronic systems, which today compromise 25% of a vehicles cost, will jump to over 35% by 2008.

This growth is fuelled by several trends; on one end of the automotive spectrum, many historically mechanical systems such as throttle control, braking and suspension control are now being both controlled and optimized by electronic systems. At the other end, LED lighting, entertainment and wireless navigation are fast becoming standard equipment even in non-luxury automobiles. The electronic challenges of these new automotive applications are many and maintaining high reliability solutions is of paramount importance.

The focus of this article is on LED-based vehicle headlights. LED headlights give car designers unprecedented freedom in headlight design. Their distinctive look and environmentally green nature give carmakers differentiation in a competitive environment. One such car is the Audi R8 LED daytime running lights introduced in a 2008 Superbowl commercial. The headlight was the star.

Colourful Nature

LEDs are not power hungry, expensive or fragile. They run cool and efficiently, saving valuable battery and generator bandwidth for the countless other electronic features in today's high-end vehicles. Equally, they are far more durable than other lighting technologies.

Currently, there are three types of bulb-based headlights on the market that can be easily recognized by the colour of the light output: incandescent (yellowish light), halogen (yellow-white light) and HID (high-intensity discharge – blue light).

Incandescent and halogen bulbs are filament-based and destined to eventually burn themselves out. Their dim yellow colour appearance is seen in the current market as old and cheap. HID bulbs are filament-free and last longer, using a high voltage electric charge to light up the gas to produce a very bright light, but the high voltage electronics and bulbs are expensive and fragile, and the high temperature colour results in a blue tint. Even with the 'wow' factor of bright blue (or purple) HID lamps, their expense is a significant deterrent to widespread use. Plus, they cannot be dimmed.

White HB (high brightness) LED strings allow headlight designers to give their new models

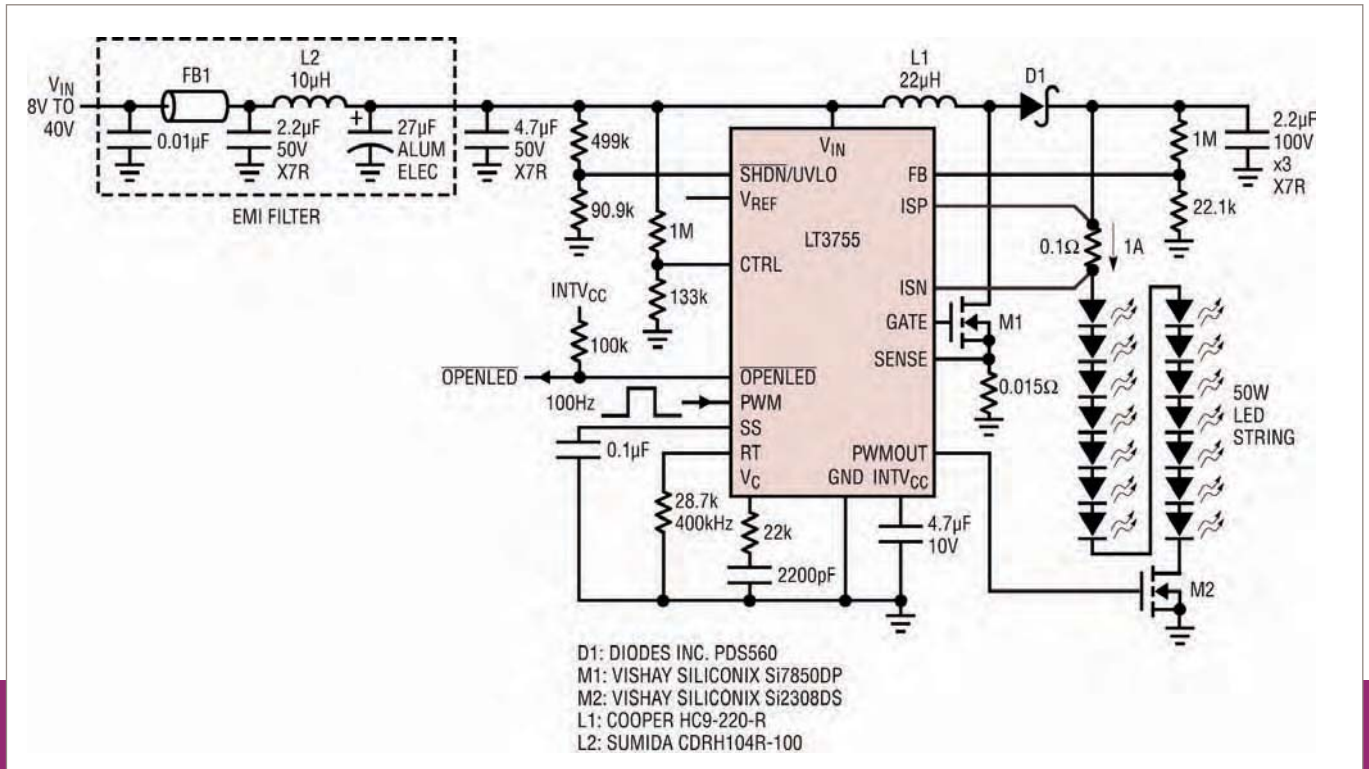

Figure 1: *LT3755 50W boost LED driver for 1A/50V automotive headlights has high efficiency and 250:1 PWM dimming*

Keith Szolusha, Applications Engineer at Linear Technology, looks at how to best drive LED headlamps in modern-day cars

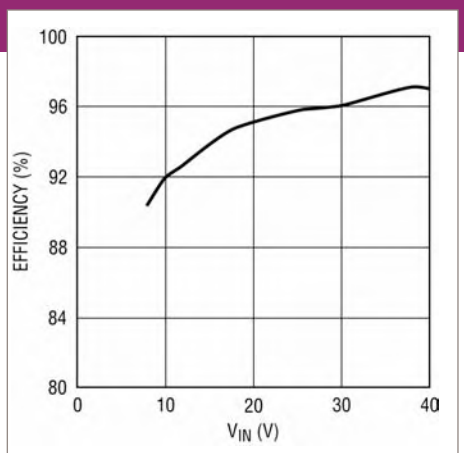

Figure 2: *Efficiency of 50W boost LED driver is over 93% at 12V input*

complete lighting makeovers. The strings can be spread out or reshaped into interesting and distinctive, novel shapes. The Audi R8 LED daytime running lights are a good example, featuring an approximately 10W LEDs. Imagine a complete headlight using 50W of LEDs. Many others are following suit. The race is on.

LED Advantages

LED headlights offer several technical advantages over other headlamp types.

- **High efficiency** LED drivers (> 93%) are combined with high lumens-per-watt white LEDs to keep required battery current low. The growth of vehicle electronics and ballooning cost of fuel create a need for high efficiency electronics to minimize the load on the generator and drain on the battery.
- **LED colour** can be either true white light (as close to daylight as possible) or any warm white colour in order to resemble "old style" headlights for the new 'retro' look, where the lights look old-school, but bright.
- **The lifetime** of the LED strings is expected to exceed that of the vehicle, giving the owner peace of mind that expensive headlamp failures and replacements are minimized, if not completely eliminated.
- **Relatively low cost and easy to use** electronics drive 50W LED headlamps. The DC/DC converter LED driver is attached directly to the battery without the need to worry about the wide-ranging battery voltage. Other high power headlight technologies, such as HIDs, require very high voltage (difficult to work with and dangerous) electronics and the expenses that come with them. The LEDs themselves are much cheaper than the alternative, and a broken LED is not expensive to replace.
- **Instant turn on and turn off** is possible with LEDs. Since they are powered by a controlled constant-current drive, they can also be PWM (pulse width modulation) dimmed and instantly run over a wide range of brightness settings without changing the colour.

Driving a 50W LED Headlight

The DC/DC converter that drives the LED is a crucial piece of the headlight design. The converter must be able to efficiently power a 50W LED headlamp with a constant and controlled LED current, while drawing on a battery voltage that can wander over a wide range. Trying to do this with discrete components or even a linear regulator is difficult or impossible. To make things even more complicated, add some other basic requirements, such as high dimming ratios at constant colour (PWM dimming), low current consumption, high efficiency (to preserve the battery system), relatively low cost, low EMI, operability in high temperature, short-circuit protection and open LED protection, and the problem looks intractable.

The solution lies with a switching regulator. For example, Linear Technology's LT3755 is a high efficiency LED Driver DC/DC converter IC that is specifically designed to drive automotive headlights. This makes it very easy to hook up, test and design a cutting-edge LED headlight system.

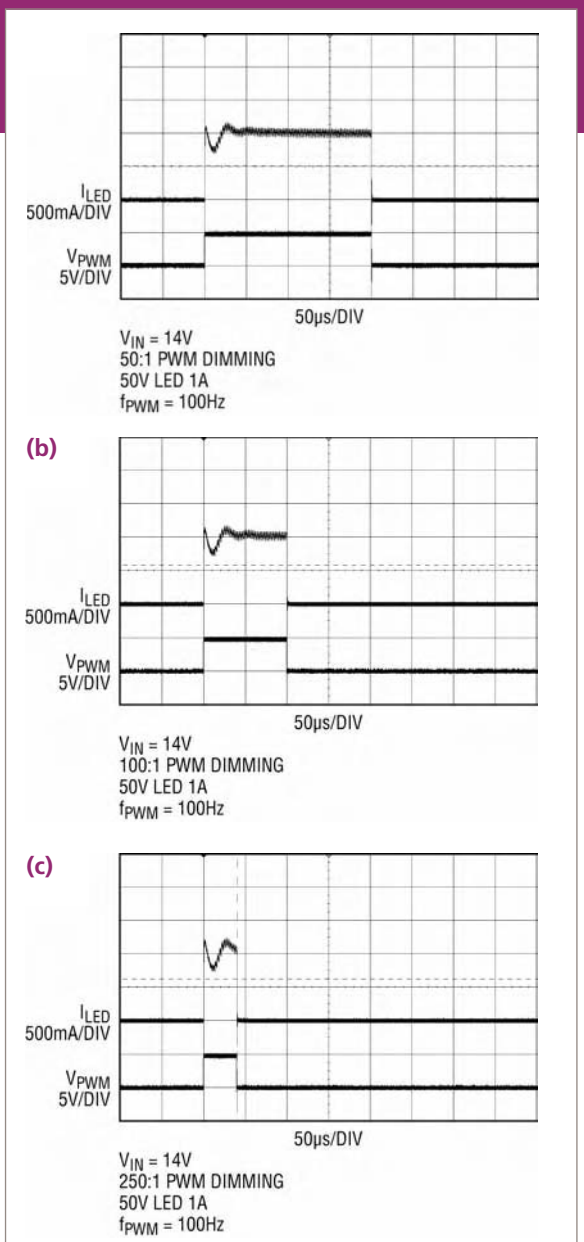

Figure 3: *PWM dimming waveforms of the LT3755 LED driver circuit show ILED maintaining constant colour at 100Hz high dimming ratios:* ***(a)*** *50:1 dimming ratio;* ***(b)*** *100:1 dimming ratio;* ***(c)*** *250:1 dimming ratio*

50W Boost LED Driver

LED strings can be driven from any DC/DC converter that can produce the proper voltage across an LED string and regulate the current through the string. In most cases, the most difficult problem is choosing the best regulator IC for the job. The LT3755 boost LED driver IC has features that make it easy to drive 50W LED

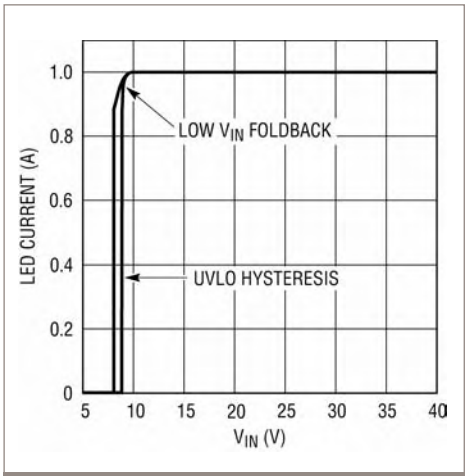

Figure 4: *LED current vs battery voltage – CTRL analogue dimming folds back LED current with VIN < 10V and under voltage lockout with hysteresis below 8V input*

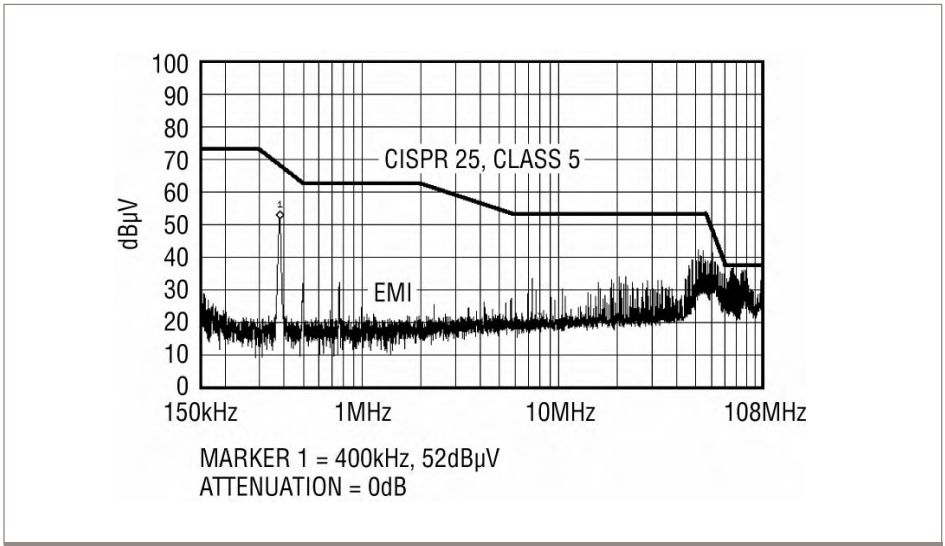

Figure 5: *Conducted EMI of LT3755 50W LED driver meets the CISPR 25 Class 5 specification*

strings from an automobile battery, while maintaining high LED current accuracy.

An automotive battery operates in the range of 8V to 16V with transients upwards of 36V for short durations. The input voltage range of the 50W headlamp driver shown in **Figure 1** is 8V to 36V for a 50V string of 1A LEDs. Given that the output voltage is greater than the input voltage, a boost topology is the natural choice for the most efficient and simple DC/DC converter solution.

The extremely high efficiency of this circuit minimizes the strain that the headlamps place on the extremely demanding electronic loading in today's luxury vehicles. The efficiency of this circuit is greater than 93% at 12V input as shown in **Figure 2**. Luxury sedans, SUVs and minivans are decorated with many electronic accessories and features that place a heavy load on the generator and the battery's standby power. Everything from navigation devices to the motors for mirror adjustment consume some power when the vehicle is idling or off. It is imperative for vehicle electronics to be highly efficient and low power when the vehicle is turned off. For the circuit in Figure 1, when the lights are off, the 12V shutdown current is less than 50µA.

The ability to vary the brightness of headlamps opens up a host of new feature possibilities. The brightness of a string of LEDs is decreased by simply reducing the current through the LEDs. This can be done by lowering the constant current (analogue dimming) or by pulsing the LED current on and off at full current (PWM dimming).

PWM dimming is obviously more involved than analogue dimming, but it has a major advantage: it maintains the same LED colour regardless of brightness, whereas LEDs change colour with analogue dimming. This is because the colour of any LED changes with operating current.

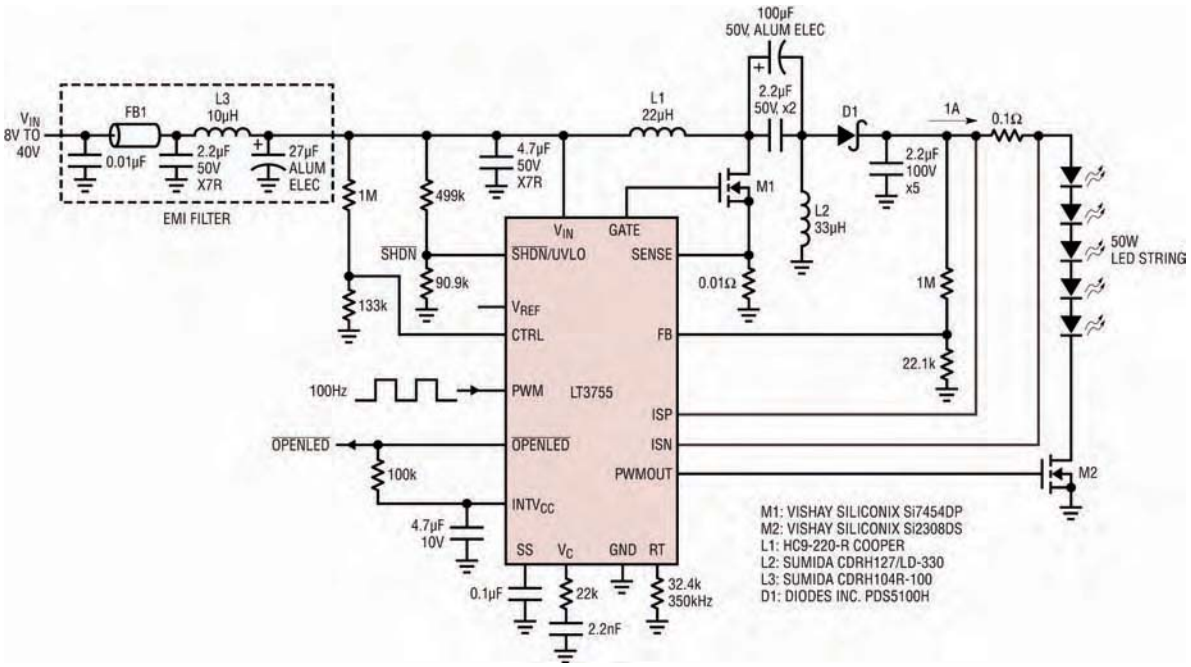

Figure 6: *LT3755 50W SEPIC LED driver for 1A/50V automotive headlights has short circuit protection, as well as high efficiency and 100:1 PWM dimming*

In PWM dimming, brightness is controlled by turning the LEDs on and off at a constant frequency. It is important to use a frequency that is high enough to be undetectable as flicker to the human eye (≥ 100Hz). Because the "on" part of the cycle is always the same current, the colour of the LEDs is not affected. Dimming is achieved by varying the duty cycle. Although the actual current through the LEDs at any given time is either 0 or "full-on", changing the duty cycle effectively changes the average current through the LEDs.

The LT3755 headlight circuit brightness can be dimmed fairly accurately via analogue dimming to 1/50 of its full current level through the CTRL pin voltage. This part also has the ability to provide much higher and very accurate dimming ratios with a microcontroller input to the PWM pin. The PWM dimming waveforms in **Figure 3** (a, b, c) show 50:1, 100:1 and 250:1 PWM dimming ratios for up to 0.4% brightness with a 100Hz PWM dimming frequency.

The frequency of PWM dimming should be 100Hz or greater so that it cannot be detected by the normal human eye under low-light conditions, when the lights will most likely be running. Human peripheral vision and low-light vision can typically detect up to 80Hz and higher in some individuals. Increasing the PWM dimming frequency is possible, but there is a proportional decrease in the maximum PWM dimming ratio. Higher DC/DC converter switching frequencies also allow higher PWM dimming ratios, but 400kHz is chosen here to keep the main EMI content of the switcher outside of the AM band.

The filter on the front end of the DC/DC converter shown in Figure 1 limits conducted EMI. A few simple L and C components reduce the conducted spectrum looking back to the battery and other electronics. Setting 400kHz as the switching frequency keeps the main content out of the AM band from 500kHz to 2MHz. The high power of the headlamp circuit means that EMI content would be significant in the switcher if left unfiltered, but **Figure 5** shows how the switching content and the EMI spectrum is below the required CISPR 25 Class 5 limits for the 50W boost circuit.

If one or all of the LEDs are suddenly removed from the output, the converter output voltage climbs to the overvoltage protect level of 56V and stops. When set properly, overvoltage protection allows the output to be opened and closed without any damage to the controller circuit or LEDs. The OPENLED output flag of the LT3755 gives feedback to the diagnostic microcontroller that there is an open output condition because the output voltage has climbed high.

50W SEPIC LED Driver

Short circuit protection is a concern for most headlamp manufacturers. The failure mode of each LED might be either short or open, and an outside factor such as removal of the LEDs while the lights are on, or improper connection of the headlamp, may lead to an open or short circuit at the output of the LED+ and LED– (or GND/chassis) terminals.

The SEPIC topology uses a second inductor and a coupling capacitor to provide a DC block for short-circuit protection from LED+ to LED– or LED+ to GND as an improvement to the boost topology in Figure 1. Although the boost topology is simpler, the LT3755 SEPIC shown in **Figure 6** has similar efficiency as the boost and has the addition of short-circuit protection. The efficiency for the SEPIC is shown in **Figure 7**.

The short-circuit waveform in **Figure 8** shows how the converter maintains control of the inductor current and, thus, switch current during a shorted output. The switch current is the sum of the inductor currents during switch on time and the catch diode current is the sum of the inductor currents during switch-off time. The ability to survive the harsh short circuit condition makes the SEPIC topology particularly robust. The unique short-circuit detect circuitry inside the controller IC is able to distinguish between collapsed output voltage due to short circuit and that due to startup.

Similar to the boost, conducted EMI of the SEPIC is well controlled with a simple filter on the front end as shown in Figure 7.

The conducted EMI measurements are similar to the boost measurements and they also meet the CISPR 25 Class 5 standard. Although the switching frequency of the controller IC is adjustable from 100kHz to 1MHz, 300kHz to 400kHz is the frequency range of choice for automotive applications, set to be as high as possible while remaining outside of the AM band. The main spike in the conducted EMI spectrum is understandably at the switching frequency of 350kHz in this application.

Switching frequency also affects solution size, efficiency, ripple current and thermals. Higher switching frequency results in smaller components and a lower cost solution, but increases AC switching losses in the switch (M1) and catch diode (D1). Lower switching frequency returns more ripple on the inductor current and can increase the heat rise of the inductor if a larger inductor is not chosen to reduce ripple.

The choice of MOSFET is optimized for the 350kHz application with a combination of low RDS(ON), a 100V drain-to-source rating, high rise and fall times at 7V, 1A gate drive and low gate charge. In a 350kHz, high voltage and high current (8A+ peak switch current limit) switcher, the rise and fall time of the main power switch is just as important as the low RDS(ON) rating. ■

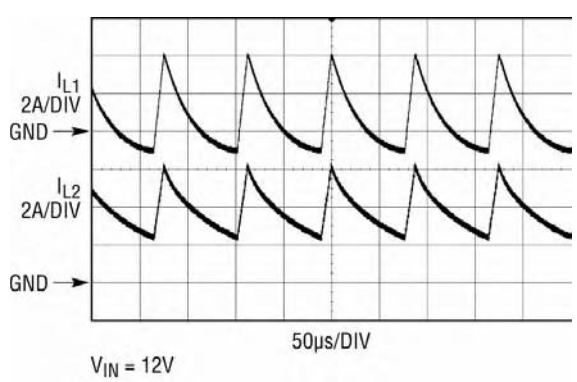

***Figure 7:** SEPIC LED driver inductor current remains under control and survives LED+ to GND short circuit*

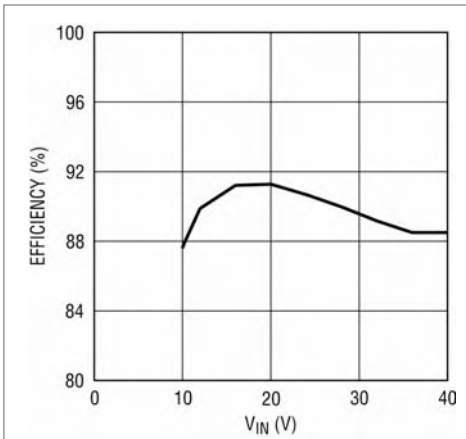

***Figure 8:** Efficiency for 50W SEPIC LED driver is over 90% above 12V input*

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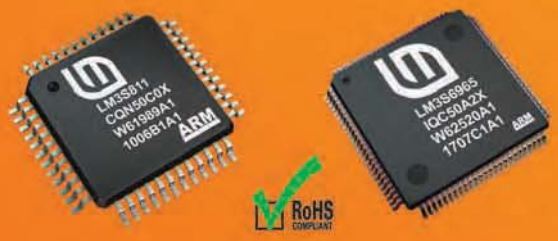

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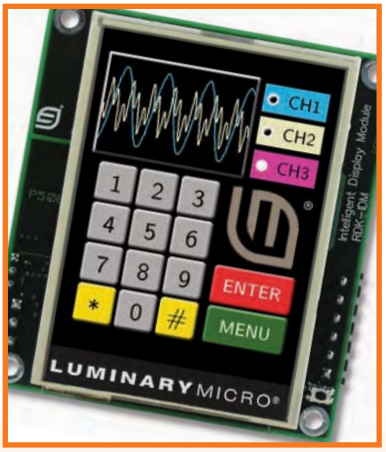

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Choosing the Best USB SWITCH

THERE IS AN established trend among worldwide portable device manufacturers to standardize and simplify their device connections using mini-USB or micro-USB connectors. To save space without sacrificing device functionality, the single USB connector must be capable of sharing multiple independent signals. In many cases adding a USB switch is the quickest and most reliable way to share a single port while greatly enhancing the functionality of the portable device.

Port sharing applications can range from allowing a single port to share both a dedicated Hi-Speed USB controller and integrated Full Speed controller to enabling a single USB port to share USB, audio and video signals.

Choosing the right switch to accomplish these goals involves looking at more than just one or two parameters on the datasheet. In many cases the best product will be chosen not only because it satisfies eye compliance requirements but because it simplifies board layout, protects against a USB fault condition, or because it saves battery power. In the following paragraphs several real-world application challenges will be outlined with key decision variables explained. The topics to be covered are:

- Achieving consistent USB eye compliance results;
- What to look for in ESD protection;
- Complying with USB 2.0 VBUS short requirements;
- Maintaining low current consumption to prolong battery life.

This information will aid designers in sorting through the different USB switch options, allowing them to choose the optimized solution for their application.

Achieving Consistent USB Eye Compliance Results

One of the challenges that system designers experience is inconsistent USB eye diagram results when comparing different USB switches in their application. Most engineers are familiar with the need for low on resistance (RON) and on capacitance (CON) in order to achieve a good eye pattern but it can be difficult to determine the appropriate balance between these two competing specifications.

It is important to understand the tradeoffs between RON and CON when selecting a USB switch. In most cases these two specifications are inversely related, where improvements in RON come at the expense of CON and vice versa. The tradeoffs between RON and CON can most easily be observed in the eye diagram.

In **Figure 1** a sample eye diagram with some marking has been provided as a reference point. Although this example shows a very clean eye diagram, it can still be used to demonstrate the effects of RON and CON on eye compliance. Lower RON values reduce signal attenuation and result in greater 'headroom' between the eye mask the superimposed eye pattern as can be seen in the included photo. Capacitance on the signal path has the effect of slowing the edge rate of the signal that manifests in the eye diagram as a more gradual slope on the rising edge.

If capacitance is too large, the eye pattern will roll over and touch the eye mask; consequently, lower CON will also improve eye compliance results. For optimal results a USB switch with low CON and RON should be selected with preference being given to CON over RON when comparing the two competing specifications.

The USB specification recommends that total capacitance on the USB data path be less than 10pF. In addition to the USB switch there are multiple contributors to total line capacitance, including the USB transceiver output capacitance, stray capacitance and any other components sharing the D+, D- lines.

In addition to the inherent switch characteristics, board design and layout also play a key role in determining USB eye compliance since they each will contribute some parasitic capacitance, as well as some signal attenuation. For this reason it is highly recommended that high-speed board design practices be applied to any PCB board which will be carrying Hi-speed USB signals and for which USB compliance is required. Some of the key practices which should be followed are:

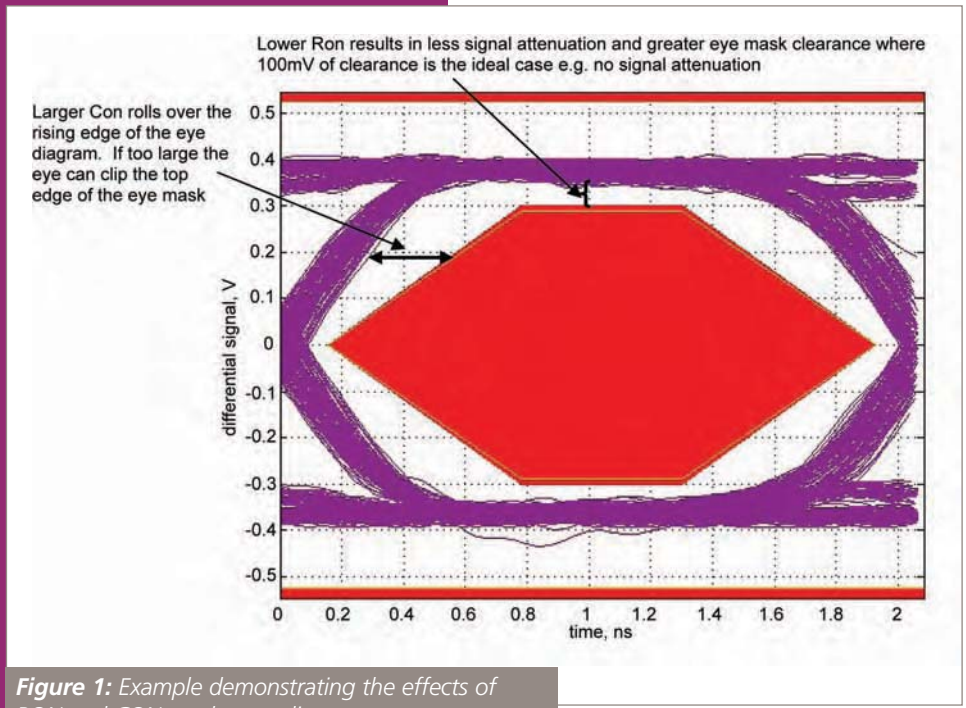

Figure 1: *Example demonstrating the effects of RON and CON on the eye diagram*

Travis Williams, Staff Applications Engineer at Fairchild Semiconductor, helps choose the best USB switch based on the USB 2.0 requirements, while solving some tough application challenges

- Always work to minimize trace lengths by placing the USB switch as close to the USB controller as possible and by placing both parts as close to the USB connectors as possible. For optimal performance we recommend that the distance from controller to switch not to exceed 1/4th of the transmission electrical length or 18mm.
- Make sure to use closely coupled 90 Ohm differential controlled impedance traces (e.g. Stripline or MicroStrip) for each D+, D- pair.
- When necessary to route differential pairs on adjacent layers try run the traces orthogonally.
- If possible place a GND strip between parallel differential pairs on the same layer. Spacing between signal pins and isolating GND lines should be as shown in **Figure 2**.
- Run differential pair sets orthogonally on adjacent layers.
- Minimize via usage on the Hi Speed USB signal lines. Only use vias where necessary.
- Minimize via diameter of the vias where possible to reduce parasitic capacitance.
- Make sure all USB transmission lines have the same lengths to minimize skew.
- Place a 0.01uF power supply bypass capacitor as close as possible to the VCC pin of the Hi Speed USB switch.

By following these board layout guidelines you will reduce the opportunity for signal reflections and improve the probably of collecting consistent USB eye compliance data.

Protecting Against ESD Events

USB switches are typically placed at or very closely to the USB connector and as such are often one of the first devices to be exposed to an ESD event. For this reason USB switches with robust ESD protection should be chosen over those without.

There are several different standards often quoted on datasheets with respect to ESD ratings. Most USB switches are given an ESD rating based on the Human Body Model (HBM) and typically will use the JEDEC standards for testing. This rating system should be considered to be the most accurate representation of actual ESD robustness for an individual IC.

A second ESD rating which has begun to show up on IC components is the IEC system level specification that was originally developed to rate the ESD level that a system could withstand. The IEC rating system, however, was never intended to guarantee individual integrated circuits since actual performance can vary greatly from system to system, even for those that use the same USB switch. For this reason the industry generally accepts 8kV of JEDEC-based HBM testing to be adequate for any product like a USB switch, which may be the first device in a discharge path.

Another important point to mention is that while USB switches guarantee a level of ESD protection they are generally only able to guarantee the level of ESD for which the USB switch will be protected. USB switches, therefore, are not able to guarantee that a given ESD event will not damage other ICs on the board since every IC will have varying levels of sensitivity.

For example, a small geometry processor will be much more susceptible to an ESD event than a relatively larger USB switch. Although the USB switch ESD protection circuitry will shunt most of the energy from the ESD event, it is still important that the other ICs on the board are protected. The initial reaction of many designers might be to add additional ESD protection devices on the D+, D- input lines. This decision should be weighed very carefully since, as already discussed, the High Speed USB eye is very sensitive to capacitive loading. Adding TVS diodes or other ESD suppression devices should only be a last resort.

The best option is to choose a USB switch with an HBM rating of at least 8kV which also has

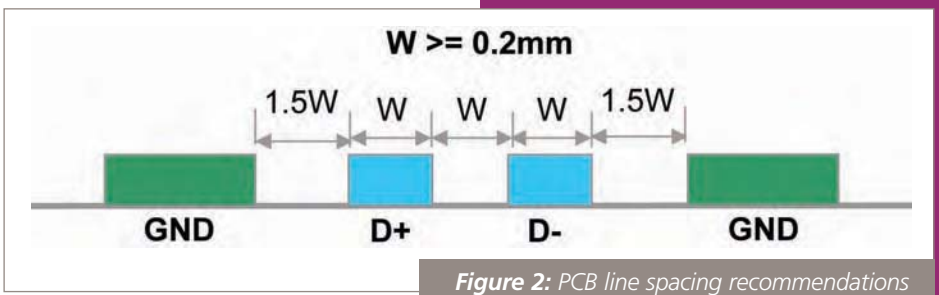

Figure 2: *PCB line spacing recommendations*

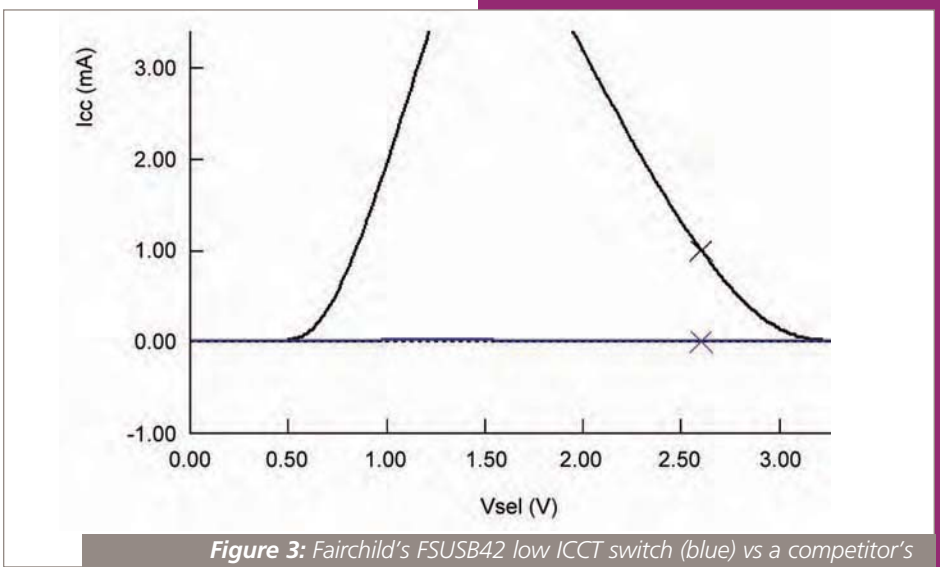

Figure 3: *Fairchild's FSUSB42 low ICCT switch (blue) vs a competitor's unprotected USB switch, when VCC = 3.8V and the select pin are driven to 2.6V*

very good USB eye performance. If after evaluating this solution the designer is still concerned about ESD protection, then they should only use specially designed low capacitive ESD protection array devices that will add less than 1pF of capacitive loading to the high speed data path.

Complying with USB 2.0 Vbus Short Requirements

To be truly USB 2.0 compliant, a USB switch should also include two other important features, namely over voltage protection and power off protection on the USB pins. The USB specification requires that any device which is in the USB signal path should be able to withstand a short condition on the D+ and D- lines for a period of up to 24 hours. Fairchild's FSUSB30 is the industry's first USB switch product to fully comply with this requirement of the USB specification. Subsequent USB switches by Fairchild and others have also incorporated this protection. This requirement is designed to protect the system from sustaining permanent damage resulting from a faulty cable or port where the 5V Vbus line is accidentally shorted to either of the D+ or D- signal lines.

In an unprotected USB switch if a VBUS short condition were to exist there are several problems that could arise. It is most common for a USB switch to be used in a battery-powered application where the max battery voltage is approximately 4.3V. In these cases a 5V short on the VBUS line would result in a current leakage path through the USB signal pins and out the USB switch VCC supply pin. The leakage could potentially be large enough to damage the USB switch or even other devices in the system sharing the same supply node. In cases where the USB switch is powered off the USB switch should provide isolation between the connector D+ and D- inputs and the USB host controller behind the switch. Switches without Power Off Protection and OVT may not guarantee that the USB switch will remain off with the signal lines isolated or that damage will not be sustained in during a VBUS short condition.

Maintaining Low Current Consumption

A final and very important consideration in choosing a USB switch is to select a switch which will help maintain long battery life in portable applications. First of all, a switch using a passive design architecture will be the most efficient choice, since they typically use less than 1uA of current even during active USB signalling when control signals are at fully driven high (VCC) or low (GND).

Some USB switch providers have chosen to employ charge pump architecture to improve their eye compliance, however, this always comes at the cost of power. A passive switch with low CON and RON values will provide adequate margin during USB compliance testing while having an almost insignificant impact on system battery life and, so, makes the best choice.

The second power saving feature to look for is "low ICCT". In many applications the USB switch must interface between a lower voltage processor or controller chip and the higher voltage USB signals. In switches without low ICCT this can result in milliamps of current while the switch control pin is driven high by the lower voltage system controller chip. Furthermore, since most USB switches are powered directly from the battery supply (or the highest available regulated voltage) and are controlled by a low voltage (1.8-2.7V) general purpose input out (GPIO) controller the potential for these periods of increased consumption is high. **Figure 3** provides an example comparing the FSUSB42 current consumption with that of a competitor's USB switch that does not have this feature. This shows that for this typical application condition, the unprotected USB switch will consume 1mA of current for the entire time the select pin is held high and the FSUSB42 will consume less than 2uA. ■

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Associate Professor **Dr Murat Uzam** from Nigde University in Turkey presents a series of articles on a project that focuses on a microcontroller-based PLC. This is the eighth article in the series, describing the counter macro CTUD_8 (up/down)

PLC with PIC16F648A Micro

THE UP/DOWN counter (CTUD) has two inputs CU and CD. It can be used to both, count up on one input and count down on the other. The symbol of the up/down counter (CTUD) is shown in **Figure 1**, while its truth table is given in **Table 1**.

The up/down counter counts up the number of "rising edges" (↑) detected at the input CU. The up/down counter counts down the number of "rising edges" (↑) detected at the input CD. PV defines the maximum value for the counter. When the counter reaches the PV value, the counter output Q is set true (ON – 1) and the counting up stops. The reset input R can be used to set the output Q false (OFF – 0) and clear the count value CV to zero. The load input LD can be used to load the count value CV with the preset value PV. When the counter reaches zero, the counting down stops.

The following section explains the implementation of eight of 8-bit up/down counters for UZAM_PLC.

CU	CD	R	LD	Operation
×	×	1	×	1. set the output Q false (OFF – 0) 2. clear the count value CV to zero
×	×	0	1	load the count value CV with the preset value PV
0	0	0	0	NOP (No Operation is done)
0	1	0	0	NOP
1	0	0	0	NOP
1	1	0	0	NOP
1	↑	0	0	NOP
↑	1	0	0	NOP
×	↓	0	0	NOP
↓	×	0	0	NOP
↑	0	0	0	If CV < PV, then increment CV If CV = PV, then hold CV and set the output Q true (ON – 1)
0	↑	0	0	If CV > 0, then decrement CV

Table 1: *The truth table of the up/down counter (CTUD)*

Macro "CTUD_8" (8-bit Down Counter)

The macro "CTUD_8" defines 8 up/down counters selected with the num = 0, 1…7. **Table 2** shows the macro "CTUD_8" and its symbol.

CU (count up input), CD (count down input), Q (output signal = counter status bit), R (reset input) and LD (load input) are all defined as Boolean variables. The PV (preset value) is an integer constant (here for 8-bit resolution it is chosen any number in the range 1-255) and is used to define a maximum count value for the counter. The counter outputs are represented by the counter status bits: CTUD8_Q,num (num = 0, 1…7), namely CTUD8_Q0, CTUD8_Q1…CTUD8_Q7, as shown in **Figure 2a**.

We use a Boolean variable, namely CTUD8_RED,num (num = 0, 1…7), as a rising edge detector for identifying the rising edges of the inputs CU or CD. To carry out logical operations within the macro "CTUD_8" we use a Boolean variable, namely CTUD8_FLG,num (num = 0, 1…7). An 8-bit integer variable CV_8+num (num = 0, 1…7) is used to count up the rising edges of the CU and count down the rising edges of the CD.

Let us now briefly consider how the macro "CTUD_8" works. If the input signal R is true (ON – 1), then the output signal CTU8_Q,num (num = 0, 1…7) is forced to be false (OFF – 0) and the counter CV_8+num (num = 0, 1…7) is loaded with "00h".

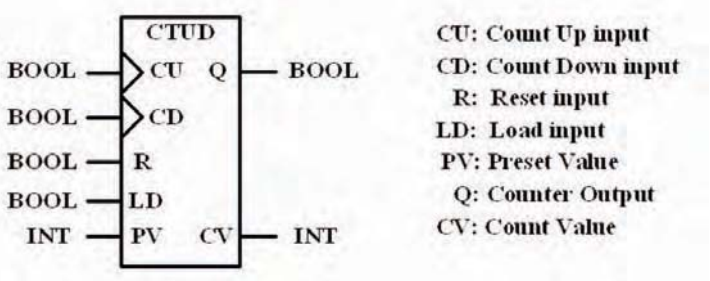


Figure 1: *The up/down counter (CTUD)*

controller – Part 8

If the input signal R is false (OFF – 0) and the input signal LD is true (ON – 1), then the counter CV_8+num (num = 0, 1…7) is loaded with PV. If the input signal R is false (OFF – 0), the input signal LD is false (OFF – 0) and the CD is false (OFF – 0), then with each "rising edge" of the CU, the related counter "CV_8+num" is incremented by one.

In this case, when the count value of "CV_8+num" is equal to the PV, then state-change from 0 to 1 is issued for the output signal (counter status bit) CTU8_Q,num (num = 0, 1…7) and the counting up stops. If the input signal R is false (OFF – 0), the input signal LD is false (OFF – 0) and the CU is false (OFF – 0), then with each "rising edge" of the CD, the related counter "CV_8+num" is decremented by one. The counting down stops when the CV reaches zero.

Example For Counter Macros

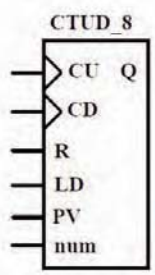
In this section, we will consider an example, namely UZAM_plc_8i8o_ex12.asm to show the usage of counter macros. In order to test this example please download the related files from http://host.nigde.edu.tr/muzam/ and then open the program UZAM_plc_8i8o_ex12.asm by MPLAB IDE and compile it.

After that, by using the PIC programmer software, take the compiled file "UZAM_PLC_8i8o_ex12.hex" and by your PIC programmer hardware send it to the program memory of PIC16F648A microcontroller within UZAM_PLC. After loading the "UZAM_PLC_8i8o_ex12.hex", switch the 4PDT in "RUN" and the power switch in "ON" position. Finally, you are ready to test the example program.

(a)

```
;--------- macro: CTUD_8 ----------------------------
CTUD_8 macro   num,cu_reg,cu_bit,cd_reg,cd_bit,
rs_reg,rs_bit,ld_reg,ld_bit,PV
      local   L1,L2,L3,L4
      btfss   rs_reg,rs_bit
      goto    L4
      movlw   00h
      movwf   CV_8+num
      goto    L1
L4    btfss   ld_reg,ld_bit
      goto    L3
      movlw   PV
      movwf   CV_8+num
      goto    L1
L3    movlw   0
      btfsc   cu_reg,cu_bit
      movlw   1
      movwf   Temp_1
      movlw   0
      btfsc   cd_reg,cd_bit
      movlw   1
      iorwf   Temp_1,W
      movwf   Temp_1
      btfsc   Temp_1,0
      bsf     CTUD8_FLG,num
      btfss   Temp_1,0
      bcf     CTUD8_FLG,num
      btfss   CTUD8_FLG,num
      bsf     CTUD8_RED,num
      btfss   CTUD8_FLG,num
      goto    L1
      btfss   CTUD8_RED,num
      goto    L1
      btfss   cu_reg,cu_bit
      goto    L2
      bcf     CTUD8_RED,num         ;--- count up---
      btfsc   CTUD8_Q,num
      goto    L1
      incf    CV_8+num,f
      goto    L1
L2    bcf     CTUD8_RED,num         ;---count down---
      movfw   CV_8+num
      xorlw   00h
      skpnz
      goto    L1
      decf    CV_8+num,f
L1    bcf     CTUD8_Q,num
      movfw   CV_8+num
      xorlw   PV
      skpnz
      bsf     CTUD8_Q,num
      endm
;----------------------------------------------------
```

(b)



CU (cu_reg.cu_bit) = 0, 1

CD (cd_reg.cd_bit) = 0, 1

R (rs_reg.rs_bit) = 0, 1

LD (ld_reg.ld_bit) = 0, 1

PV (8bit constant) = 1, 2, ... 255

num = 0, 1, ... 7

Q = CTUD8_Q.num

Table 2: *The macro "CTUD8" and its symbol*

```
.
      #include <cntct_mcr_def.inc>  ;Contact & Relay based macros
      #include <cnt_mcr_def.inc>    ;Counter macros
.
;--------------- user program starts here -----------------------
      CTU_8       0,I0.0,I0.1,.5                ;rung 1

      ld          CTU8_Q0                       ;rung 2
      out         Q0.0

      CTD_8       4,I0.2,I0.3,.10               ;rung 3

      ld          CTD8_Q4                       ;rung 4
      out         Q0.4

      CTUD_8      7,I0.4,I0.5,I0.6,I0.7,.15     ;rung 5

      ld          CTUD8_Q7                      ;rung 6
      out         Q0.7
;--------------- user program ends here -------------------------
.
```

Figure 2: *The user program of UZAM_plc_8i8o_ex12.asm*

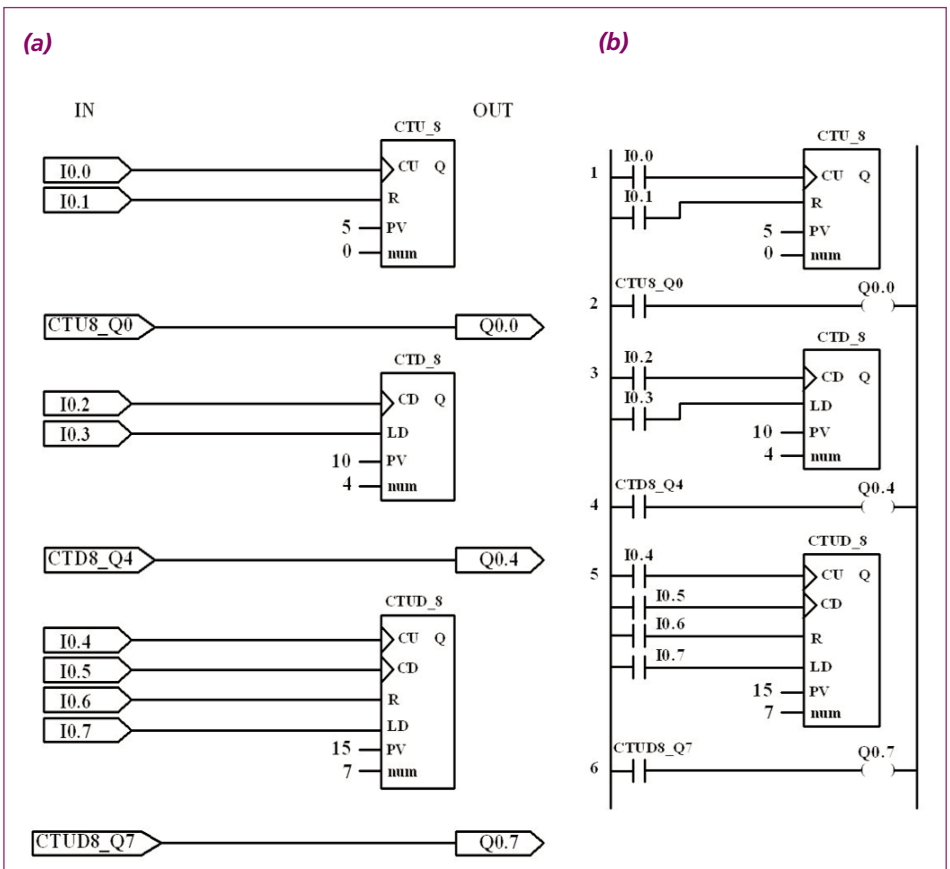


Figure 3: (a) *Schematic diagram and* ***(b)*** *Ladder diagram for the user program of UZAM_plc_8i8o_ex12.asm*

To check the correctness of the program you are referred to the related information for each counter function provided.

The example program, "UZAM_plc_8i8o _ex12.asm" is shown in Figure 2. It shows the usage of all counter macros described in Table 2. The schematic and ladder diagrams of the user program of "UZAM_plc_8i8o_ex12.asm" shown in Figure 2 are depicted in **Figure 3**.

In the first two rungs, an up counter "CTU_8" is implemented as follows: the count up input CU is taken from I0.0, while reset input R is taken from I0.1. num = 0 and, therefore, we choose the first up counter, whose counter status bit (or output Q) is CTU8_Q0. The preset value PV = 5. As can be seen from the second rung, the counter status bit CTU8_Q0 is sent to output Q0.0.

In the rungs 3 and 4, a down counter "CTD_8" is implemented as follows: the count down input CD is taken from I0.2, while load input LD is taken from I0.3. num = 4 and, therefore, we choose the fifth down counter, whose counter status bit (or output Q) is CTU8_Q4. The preset value PV = 10. As can be seen from the forth rung, the counter status bit CTU8_Q4 is sent to output Q0.4.

In the rungs 5 and 6, an up/down counter "CTUD_8" is implemented as follows: CU, CD, R and LD inputs are all taken from the inputs I0.4, I0.5, I0.6 and I0.7 respectively. Num = 7 and, therefore, we choose the eighth up/down counter, whose counter status bit (or output Q) is CTU8_Q7. The preset value PV = 15. As can be seen from the sixth rung, the counter status bit CTU8_Q7 is sent to output Q0.7. ■

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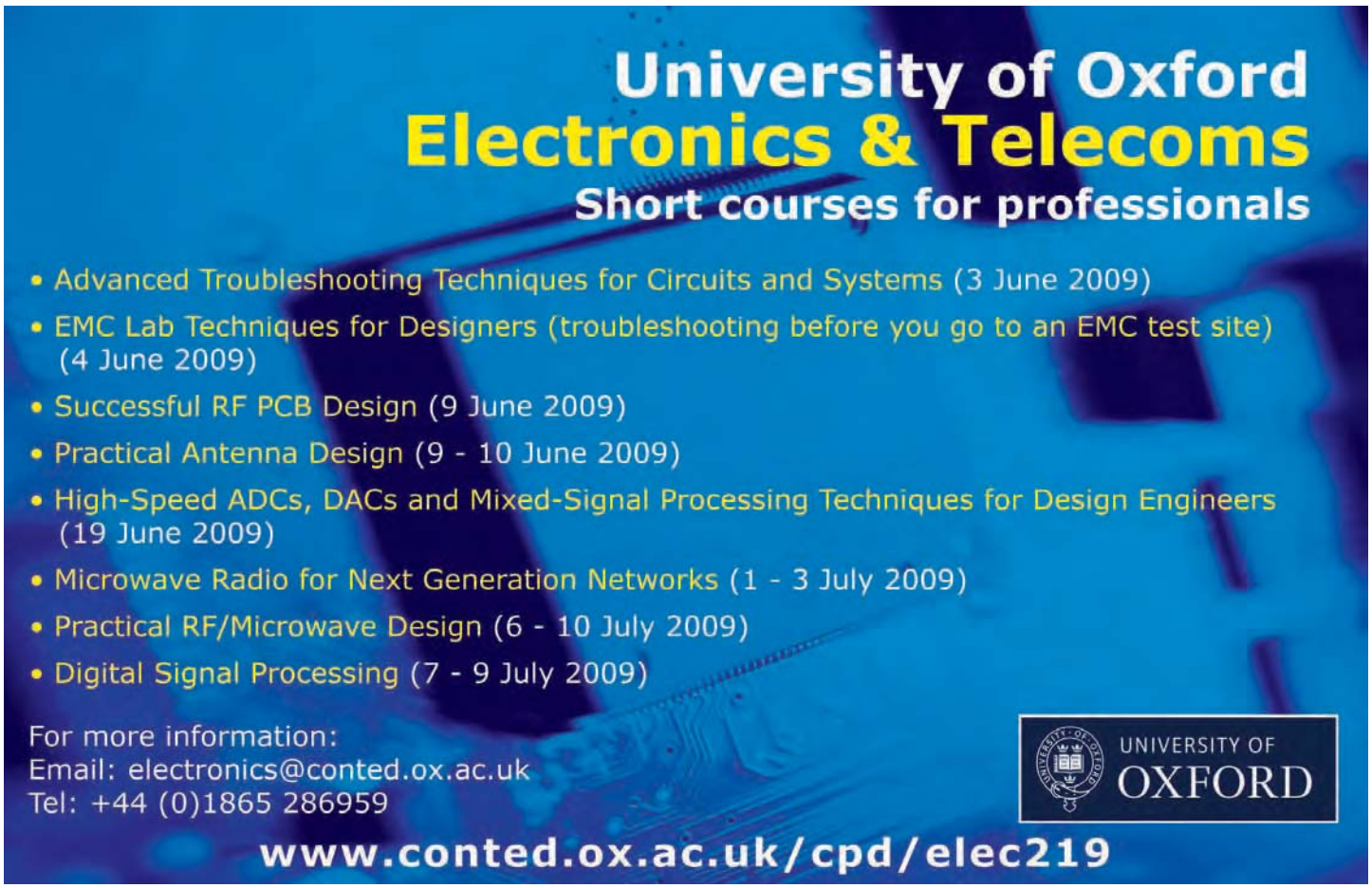
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Special DATA Acquisition Board

Maurizio Di Paolo Emilio presents a series of articles focusing on a data acquisition (DAQ) board project for the management of environmental sensors and a high-speed data acquisition system. This is the last article in the series and it summarizes the hardware and software elements used in this project

IN THE LAST few articles I described the hardware and software used for this board. I will now finish this series with a summary of the hardware and software used in this project.

The Hardware

The DAQ board is a special data acquisition system. The principal characteristics of it are:

- CPU 2GHz with the Linux operating system for hardware management;
- USB port and Ethernet connection;
- VME bus;
- Wireless and GSM connections;
- An FPGA for the execution of the logic functions.

A typical plug-in data acquisition card has a sampling rate of 30,000 to 250,000 samples/second. A high-speed data acquisition card operates at 330,000 to 20 million samples/second. Applications for such high sampling speed include wind tunnel testing, auto crash testing, video processing, ultrasonic imaging and waveform analysis.

At such high speed, the data acquisition card must be able to communicate with the computer via direct memory access (DMA). This allows the card to transfer large quantities of data directly to the computer's memory. In some cases, the card may have dual-channel DMA.

A high-speed data acquisition board often has a considerable amount of first-in-first-out (FIFO) memory. Typically, a high-speed data acquisition board can store 64,000 samples. Some can store more than a million samples, either on the board or by using additional memory on daughter boards.

Without DAQ hardware, the software is little used – and without the proper controls the hardware can be very difficult to program. The purpose to have an appropriate software is the following:

- To acquire data at a specified sampling rate;
- To acquire data in the background while processing in the foreground;
- To stream data to and from disk;
- To integrate different DAQ boards in a computer and use various functions of a DAQ board from a single user interface.

The Software

For the development of the DAQ board we can use P-Spice for the simulation of the circuit.

The MATLAB software is particularly useful in simulating FPGAs (**Figure 1**). There is a Data Acquisition Toolbox that provides a complete set of tools for analogue input, analogue output and digital I/O from a variety of PC-compatible data acquisition hardware. The toolbox makes you configure your external hardware devices, read data into MATLAB and Simulink for immediate analysis, and send data out.

FPGAs are programmed using logic circuit diagrams or a source code in the hardware description language (HDL) to specify how the device will work. They can be used to implement any logical function that an application-specific integrated circuit (ASIC) could perform, but the ability to update the functionality after shipping offers advantages for many applications.

Data acquisition is the collection of data in real time from either analogue or digital sensors that can be processed or stored by a computer. Data Acquisition Systems normally comprise an input scanner or switch, an analogue to digital converter and signal conditioning to either energize sensors or process them so they can be measured directly in engineering units and a computer to process, log and display the information.

Data acquisition systems can also form a part of a process control system, which through the use of appropriate software provides direct digital control of various industrial processes. Similarly, they can be used for data logging and process or alarm monitoring.

LabVIEW (Virtual Instrument Engineering Workbench) is a graphical programming language by National Instruments. It is especially suitable

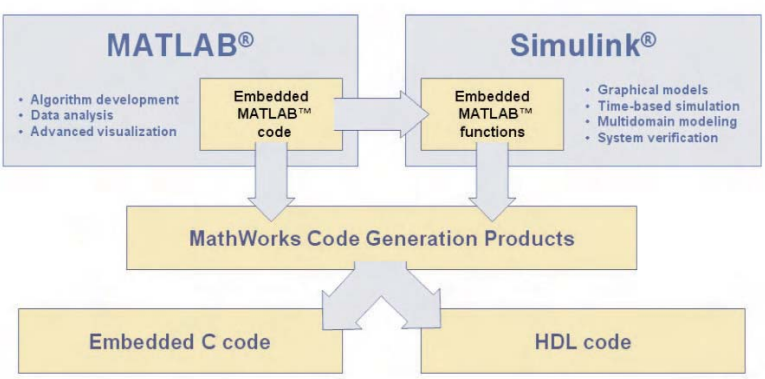

Figure 1: *MATLAB and Simulink*

PART 5

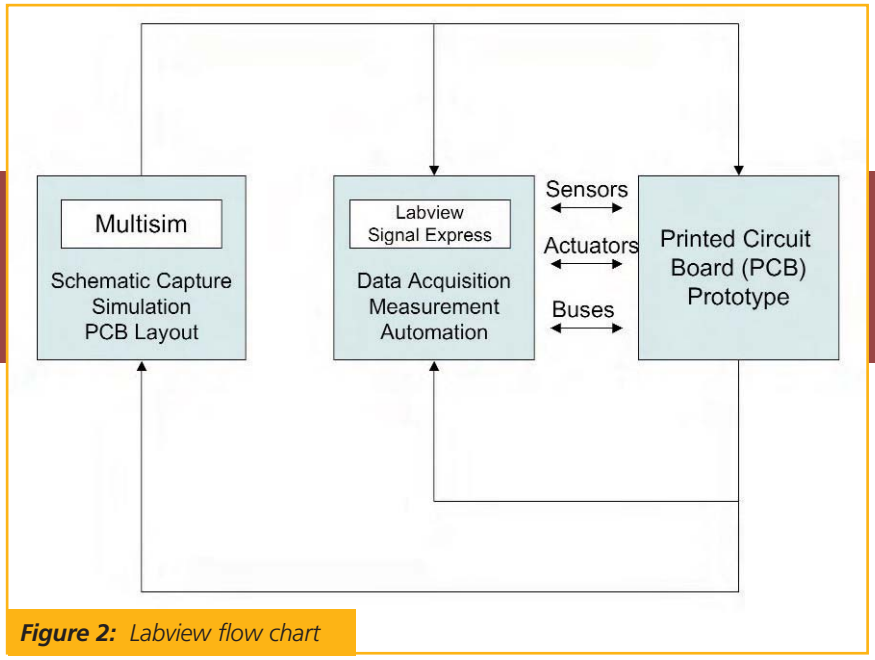

Figure 2: *Labview flow chart*

for developing automated instrumentation systems using the PC plug-in Data Acquisition (DAQ) boards. It can be effectively used for engineering data acquisition, analysis and presentation. The plug-in DAQ is a very flexible, computerized measurement of real world analogue signals (from an oscilloscope, for example) and the generation of analogue signals (for example a function generator) and much, much more (**Figure 2**).

Moreover, design engineers now can download free SPICE integration VIs (Virtual Instruments) to integrate National Instruments's LabVIEW graphical development software with SPICE and PSpice electronic design automation (EDA) tools from vendors including Cadence, Synopsys and Mentor Graphics. This integration makes it easier for engineers to test electronic designs by comparing simulations with real data.

With the SPICE integration VIs, engineers using SPICE circuit simulators can easily import simulated signals from circuit design into LabVIEW, where they can compare the expected results of their circuit design with prototype measurements. By combining SPICE simulation results with measurement data from design prototypes in LabVIEW, designers can more quickly iterate through the design process and shorten time-to-market of various electronic products. ■

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Keeping an OPEN MIND: Use of

IT security specialist **Joachim Schüth** was able to decipher the code and beat Colossus using the Ada programming language

ACCORDING TO A famous quote by Max Planck, the founder of quantum physics, truth never wins – its opponents just become extinct.

What Planck described in the context of paradigm shifts in natural sciences can often be observed in computer technology. For example, the increasing use of Linux as an alternative operating system for applications in industry and government did not emerge because senior management could be convinced, but because a new generation of IT specialists who grew up using Linux on their home computers were shifting into management positions. (For reasons of code maturity and stability I prefer the BSD derivatives over Linux, but that is a different story.)

During the work for my diploma and PhD in Physics in Professor Bodenstedt's research group at the University of Bonn, I had a similar experience concerning the choice of programming languages. We were using complex apparatus for our experiments, which had been designed by Bodenstedt. Together with two undergraduates, we were three newbies in the group and there was the generation of older students who had just finished their PhDs and would soon leave to take up jobs in industry. They had written software in Fortran to control the apparatus and do the data evaluation on a PDP-11/23. It was decided around that time that the PDP was to be retired and replaced by a VMEbus system. This system came with a C compiler, but the older students told us that C was an awful language and that programs written in it were hard to read. They advised us to continue programming in Fortran when porting the software to the new system.

Consequently, we continued to do all the programming in C rather than Fortran. Although I had taken a course in Fortran and was almost equally familiar with Fortran and C at the time, I did not find the Fortran programs easy to read due to the heavy use of common blocks (named groups of global variables). By programming in C, I missed some of the features that Fortran provided, such as runtime boundary checks, compiler generated error messages that pinpoint the line of source code where something goes wrong at runtime, and the ability to declare variable sized arrays without the clumsy use of malloc. However, I was convinced that C was the better choice for the project. Fortunately, Ada now gives me back the aforementioned features that I missed.

The moral of that experience was the fact that I did not want to become like the older students. I decided to keep an open mind towards other programming languages. Whenever I hear someone else, especially younger people, talk about a programming language that they really like, I have a look at it to see what its value is. The list of languages I came across this way includes C++, Java, Haskell and Python. I vaguely remember also flipping through the pages of a book on Ada at a local book store some 10 years back, but it did not grasp my attention at the time.

First Contact With Ada

A friend of mine works for the automotive industry and told me a while back that, for safety reasons, they were only allowed to use MISRA-C in a certain project. The MISRA standard defines a language subset of C through a long list of rules that forbid the use of dangerous C features.

Ada in Colossus Code Breaking

As I work in IT security consulting and have seen a wide range of source code quality during software reviews, it was interesting to see what code practices are used in safety critical systems. When something goes wrong with the security products that we evaluate at work, the damage is usually not catastrophic. If a design or implementation error goes unnoticed, someone might loot a bank account, steal a car, or watch Pay TV without paying. This is really minor damage compared to the loss of lives that could result from the failure of a safety critical system. Although defending against a smart attacker requires different techniques than preventing accidents, the IT security community can certainly learn from the practices used in safety critical systems design.

It was while searching the web for keywords like "software" and "safety" that I became fully aware of Ada. It seemed to be ubiquitous in the safety community. There were reports, for example, that a large airplane manufacturer only allows Ada in the development of critical software components for its aircrafts. There was also an analysis of the crash of the Ariane 5 501 rocket during its virgin flight and a piece of Ada source code from the control system was shown.

Ada was not to be blamed for the collective failure of developers and management, and to me this was just another example of Ada's use in high-profile applications. There was also a comparison with MISRA-C, which concluded that 80% of the MISRA rules are not applicable to Ada because the language does not allow the many dangerous things that C does. One report stated that while porting an application from Java to Ada, a design error was discovered because of the strong emphasis that Ada puts on variable types.

Ada was favoured so unanimously in the safety community that there had to be more to it than just someone being too lazy to learn another language. Consequently, I decided to have a closer look at Ada and I was really surprised.

I had not expected to find in Ada all the features of a modern programming language. For example, the concepts of object-oriented languages like data abstraction, information hiding, inheritance, and overloading of functions and operators, as well as useful features such as named arguments. I had thought that most of these features had been the inventions of newer languages. The fact that any discrete type can be used as an array index type, not just the predefined integer type, is a feature that sets Ada aside from most languages that I have seen so far. Array boundaries are inherent attributes of an array in Ada and thus passed along when an array is used as a function or procedure argument, helping the programmer to avoid index overflows.

The list of features is certainly not complete, but I was so impressed by Ada's strengths that I decided to seriously learn the language. Although it is not as quickly grasped as Python, for example, the concepts of Ada are clearly thought out, logical and more easily remembered than those of C++ or Java. The simplest solution to a problem is usually the least troublesome one to use, although it may not be the easiest one to find. This rule is often neglected in the design of IT systems, but my impression is that the designers of Ada thought twice before adopting any concept or language feature.

The Cipher Event

It was during the time I was learning Ada that I heard of the Cipher Event, which was organised by the British National Museum of Computing to celebrate the rebuild of Colossus Mark 2 at Bletchley Park. The Colossus machines had been used during World War II by the codebreakers in Bletchley Park to decipher the telegraph messages between high-level command stations of Nazi Germany.

The radio teletype traffic was encrypted with a Lorenz SZ42 cipher machine, codenamed "Tunny" by the British codebreakers. Colossus was an ingeniously constructed, highly specialised computing machine, which efficiently implemented statistical algorithms used to break the keys of intercepted transmissions. As one of the first computers, Colossus was ahead of its time.

During the Cipher Event, texts encrypted with a real SZ42 were transmitted from the amateur radio station at the Heinz Nixdorf Museum in Paderborn, Germany, to a receiving station in Britain. Two teams would then compete in decrypting the messages, one using the reconstructed Colossus machine, and one using a PC program that emulates Colossus in software.

The announcement of the Cipher Event also invited radio amateurs around the world to receive the messages and try their hand at decrypting them. Being a radio amateur myself and dealing with cryptography as part of my IT security work, this was an intriguing challenge for me. It is easy to produce a theoretical estimate that a modern computer could be faster than Colossus, but it was a real technical challenge to actually intercept the radio signals and to break the key of the messages in real time.

I figured that standard teletype modems and software would not be of much use because the cipher stream contains non-printable characters (control characters of the Baudot code), which might not be recorded properly, and also because the historical tone frequencies were going to be used. In addition, any loss of a character in the received ciphertexts means that the following text is no longer in sync with the steps of the SZ42 cipher algorithm. Recording a wrong character from time to time does not prevent the code breaking, but losing characters does.

I figured that I would need special reception software to analyse the audio data with a robust method of clock recovery. To perform the subsequent

cryptoanalysis, I decided to also write my own software, based on detailed material on the SZ42 and its cryptographic weaknesses that is available on the Internet.

An important decision to make was which programming language to choose. I quickly ruled out Python because of the low performance of a scripting language. I was also taking part in a competition where speed mattered, so I wanted a compiled language.

The Cipher Event was still two months away, but I knew that I would only find time during weekends to seriously work on the project. Thus the speed of code development was a factor that had to be considered. After about 16 years of intensive use of C, I felt proficient in that language, but had only studied Ada for about half a year during my spare time, writing humble programs like a Sudoku solver. On the other hand, I had the long-term goal of becoming more proficient in Ada, so I finally decided to use it in my code development for the Cipher Event, even if it might make reaching that short-term goal more difficult.

I was again surprised by Ada. I had expected to struggle with the features of a language that I had not known for long, but the programming in Ada turned out to be very enjoyable. Ada allowed me to concisely express the algorithms I wanted to implement. Computing the Fourier amplitudes of the frequencies of interest, convoluting the demodulated signal with the symbol patterns of the Baudot alphabet and extracting the teleprinter symbol stream with clock recovery based on a phase-locked loop were all easily implemented in Ada.

Representing the SZ42 in software, by declaring data types for the wheels and putting them together to a data type for the entire machine, felt a bit like building a real machine piece by piece. While implementing the cryptographic attacks on the SZ42, I could concentrate on the design of the algorithms, while their representation in Ada was straightforward.

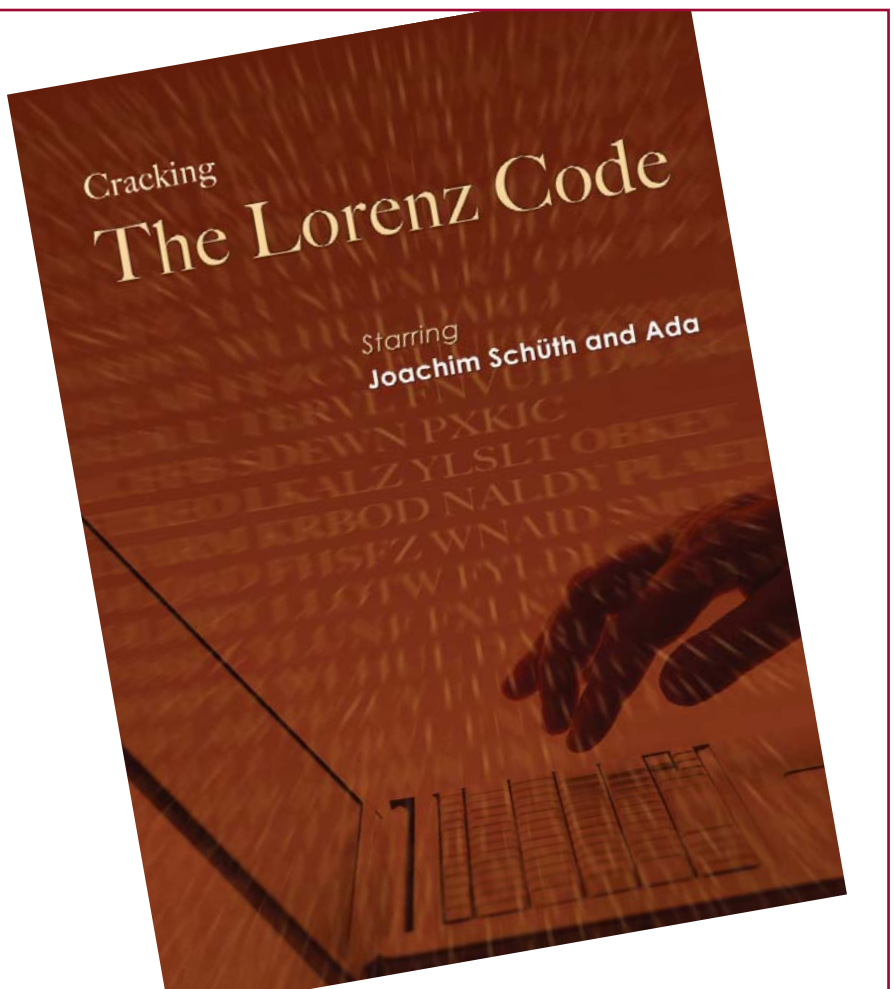
On November 15 2007, I took my laptop to the nearby radio shack of the amateur radio club of Bonn. Being initially hampered by poor radio propagation and noise, I could finally record and decrypt several of the transmitted Cipher Challenges. Running on a 1.4GHz CPU, the Ada program that does the code breaking found the correct settings of all 12 key wheels of the SZ42 within 46 seconds. This was much faster than Colossus, which completed the same task within about three and a half hours. Colossus reads the ciphertext input from a punched paper tape looping at a speed of 5,000 characters per second. On my computer, I measured the equivalent speed to be about 1.2 million characters per second, which is 240 times faster. When scaling the CPU frequency by this factor, Colossus is equivalent to a 5.8MHz computer. Measured by Moore's Law, this is an enormous speed for a machine built more than six decades ago.

After my successful decryption of the messages, I felt very honoured to receive congratulations from Bletchley Park and a prize for winning the challenge. The trip to see Colossus at work in January 2008 was much more exciting than watching my laptop.

Ada for All

Being a bit discouraged by Planck's observation, I am not writing this to convince management people of Ada's strengths. For a long time, the language was only accessible to a more or less closed group of programmers due to the lack of a free compiler. This and not any shortcomings of the language itself must be the reason why Ada has found only limited use in the past.

Thanks to the GPL version of the GNAT compiler that AdaCore contributed to the GNU Compiler Collection (GCC), there is now an Ada compiler available that software enthusiasts can use free of charge. This enables students to try out the language and universities can now offer programming courses based on Ada. Computer geeks who can afford to learn a language simply because it is cool now have access to an Ada compiler. My hope is that some day they will grow into positions in the IT industry and bring Ada into the widespread use that the language deserves, without having to convince anybody. ■



The Lorenz SZ42 cipher machine was used to encrypt the telegraph messages between the command stations of Nazi Germany and Colossus was used to break this code

TIP 1: PREVENTING AMPLIFIER DAMAGE FROM EOS

By Senior Applications Engineers Thomas Kuehl and Bonnie Baker, Texas Instruments

ELECTROSTATIC discharge (ESD) events expose amplifier pins to a short, high-voltage discharge, whilst electrical over stress (EOS) events expose the amplifier to lower over-voltages and currents, which last longer. Here's how to design a robust system outside the integrated circuit that will prevent electrical overstress damage.

ESD events happen in as little as 250ns, typically caused by improperly handling IC chips. An ESD event can enable a significant number of amperes to pass quickly straight into the IC.

Thankfully, the characteristics of ESD events are now well understood and protection is incorporated into IC design, significantly reducing the likelihood of parametric degradation, or even complete circuit failure. The problem is, however, that circuit designers can sometimes use a device's internal ESD protection to tackle EOS events – even though such circuitry wasn't intended for that purpose.

Although an IC might work perfectly before the power is turned on, it can easily and suddenly be damaged as the power kicks in and input signals are applied. The IC might overheat to the point that both the die and the package material melt.

The current paths created when an EOS event occurs in an amplifier can be unpredictable and complicated as indicated in **Figure 1**; this is especially true if high frequencies interact with stray impedances from the power supply. The ESD input protection diodes, which are normally OFF, provide a direct current path to the power.

During an ESD event, T1 turns on and clamps the voltage across the supply pins at a safe level. Remember that most ESD events occur when an IC is out of the circuit. During an in-circuit EOS event, however, the T1 might activate, thereby making a low-resistance connection between the op-amp power supply pins and allowing the current to rush in melting T1 and creating a short circuit between the amplifier's supplies. The inevitable result is overheating.

It is vital when designing your amplifier circuitry that any of the paths through the device itself can safely withstand the currents and voltages, otherwise damage will result. Taking time to discover the internal working of amplifiers' ESD circuits and their behaviour during EOS events can save you a lot of pain later. Ask your op-amp supplier about their ESD circuitry and cater for this in your design. ■

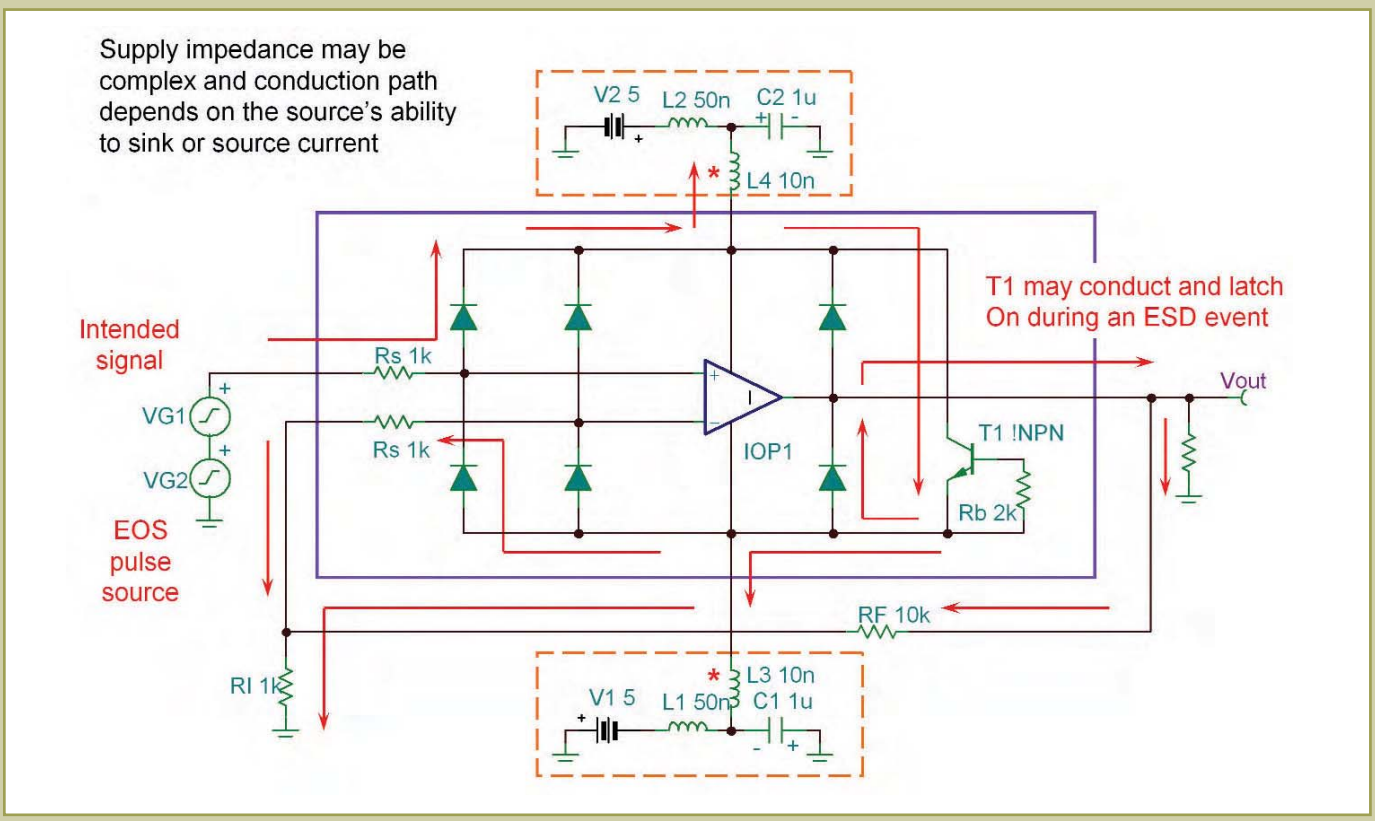


Figure 1: *Illustration of the multiple current paths caused by an EOS event*

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CONSTANT CURRENT LOW MODE CIRCUIT

FOR APPLICATIONS where some sort of beam is required and where compact dimensions, the ability to cope with extremely rough treatment and the ability to continue to provide emergency level lighting as batteries approach exhaustion is important, the halogen bulb level efficiency of white LEDs becomes acceptable.

Unfortunately, in order to produce a predictable light output, as well as remain inside the maximum current and thermal dissipation ratings of the devices, it is necessary to operate them with a series resistance, which can reduce overall efficiency by as much as a factor of two, depending on the expected range of operating voltages. To limit this by using a battery with the lowest suitable voltage leaves a little leeway to supply the required constant operating current at the fairly 'stiff' operating voltage of around 3.6V (a set of four Ni-MH cells could range from 5.8V straight out of the charger to under 4.4V, as the batteries approach exhaustion).

It would be convenient to have switch-mode circuit that will supply a dependable constant current from above 6V down to as little as 4V (representing the minimum safe discharge voltage for a battery of four cells, without the danger of reverse charging any one cell) and then drop down to a low emergency level to give adequate warning of the state of the batteries.

Integrated solutions are available, but most have an inconvenient combination of features including under-voltage drop out, and inability to drive the chopper device to an always on (DC) state, which make them unsuitable for this kind of service.

The circuit shown here gives a linearly controllable constant current by monitoring the voltage dropped by a very small resistance in the load path and using this to control the duty cycle of the chopper MOSFET (this must be the special low voltage gate drive type).

Having chosen the current required to drive the chosen devices for the desired light level, the circuit must be set up with a low resistance (say 3 ohms for 1 amp) in series with a multimeter, adjusting the 50K variable resistor to give the correct output at 5V. If you have a variable supply, it is interesting to observe the operation of the circuit while varying the supply from 6.5V down to below 4V.

The current drawn varies from a lowest level at 6.5V of close to half the current supplied to the load up to the actual stabilized current at around 4V, representing the condition that the supply is no longer being chopped and the MOSFET is permanently on. Below this level, the device is no longer being fully enhanced and resistance levels start to rise, giving the linear type emergency lighting mode.

The devices can then be safely permanently substituted observing correct polarity. Some 36 standard 30mA LEDs (they must be the same type and preferably from the same batch) connected in parallel will happily guzzle 1.1A (about 3.8W), so care is needed.

Whilst the circuit will operate at 6V, it will no longer give any protection from reverse charging of individual cells, the constant light output will give no warning that battery voltage has dropped, and consumption is at its highest when supply is low.

A simple adaptation (Z1, RA and the circuitry around TR1, not needed when used to drive LEDs) allows a peak maximum output voltage to be set – this makes the circuit useful for exceedingly efficient charging of batteries which need constant current charging up to a definite endpoint voltage. Its action is simply to squelch the pulses being supplied to the output circuit and, so, removes the drive entirely independently of the state of the current monitoring loop. This voltage is a multiple of the Zener voltage determined by the ratio of the resistors at TR1 base, which could with advantage be made variable for fine adjustment.

All transistors are standard PNP BC558/2N2906 types, D2 and D3 are IN4001, D4 and D5 1N4148; D1 should be an extremely low threshold Schottky rectifier of 3A rating. Note that the absolute maximum for the 74HC14 is 7V.

Andrew Ziemacki
UK

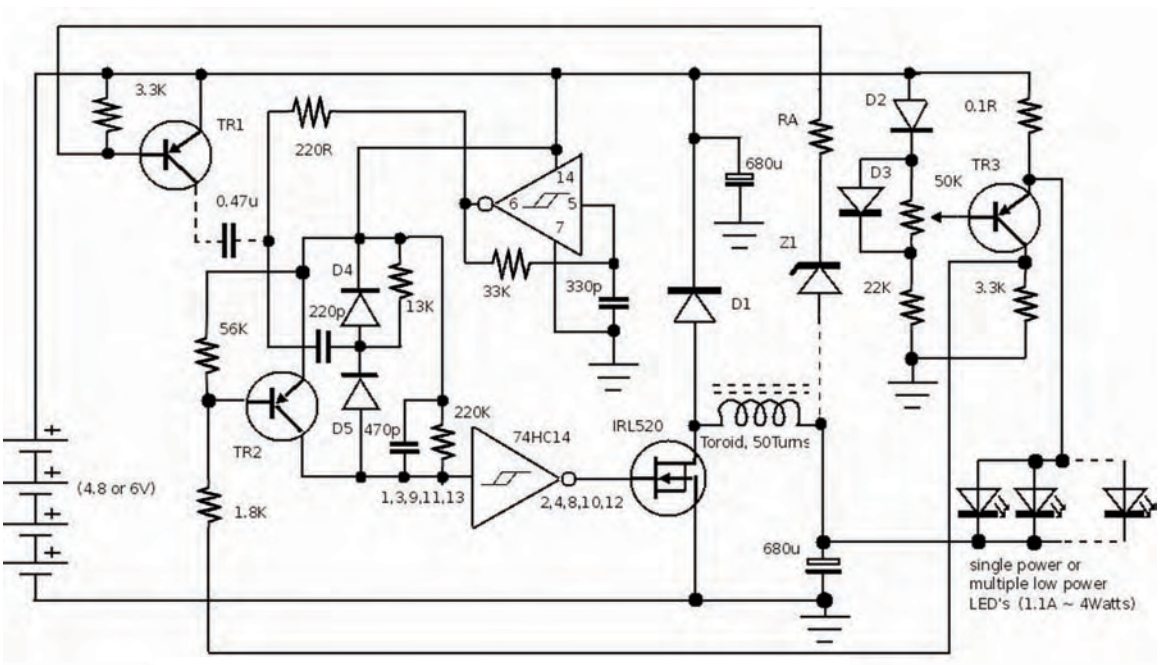


Figure 1: *Heavy duty constant SM supply for low voltages*

'ALIEN' SINEWAVES CONCEPT?

I was amused to see that Mr Catt had mentioned my article on transmission lines (Letters, May 2009) to launch another tirade against well-known researchers concerning his "Catt Question". Mr Catt criticised my use of sinewaves in the article, which shows that he missed the point entirely. This article was to illustrate the fact that transmission lines can be used to demonstrate that electromagnetic waves can be reflected. This concept was, I found, alien to junior engineers whose experience had been with DC electricity (including AC mains), which never usually reveals such phenomena.

It is unfortunate that Mr Catt's criticism implied that something else might happen if we discount sinewaves, because these reflections will occur even for a single step-function waveform. However, we cannot easily demonstrate a standing wave with single-step waveforms.

Nevertheless, the transmission line model can explain Mr Catt's long-posed question. I thought that the reason most people had given up trying to debate this with Mr Catt is that it turns out to be a non-problem.

Suppose we had a transmission line made up from a parallel pair running from Land's End to John O'Groats. Perhaps this might be a 300-ohm line, exhibiting a propagation delay of maybe 5ns/m then if one were to apply a 240Vdc signal to the wires at Land's End, were another measuring the voltage across the wires at John O'Groats, he would record a delay of about 5ms before the pulse arrived.

Provided the observer had not placed a matched load on the wires, we would also get a reflection. Now consider the charge on the wires. Let us assume that only electrons, for the sake of argument, conveyed the charge. On the negative lead, these electrons would have flowed in along with the pulse, i.e. from Mr Catt's west. On the positive wire, there will be a shortage of electrons, which will have flowed away, towards Land's End, as the pulse arrived. They don't know they have to move until the pulse reaches John O'Groats.

If you prefer, these are from the North. So it seems Mr Catt's question is non-existent in reality: the charge causes the electrons to flow and, for the positive wire, the electrons came from the wire; for the negative, from the supply. This basic principle seems never to have been violated during the many decades Mr Catt has posed his "question".

There are now several electromagnetic solvers available. I suggest Mr Catt uses one of these 3D Maxwell simulators to see where the electrons come and go. He can then count the electrons before and after his pulse if he wishes. Actually, the spread of a charge in capacitor plates makes for quite pretty images when presented as a movie.

John Ellis

TRANSMISSION LINE TRANSIENTS

Ivor Catt asks the question: "When a voltage step travels down a transmission line at the speed of light guided by two conductors, where does the negative charge come from on the bottom conductor to terminate the electric field between the conductors?" (The Catt Question, Letters, EW May 2009).

He declares that two eminent scientists provided completely contradictory answers to that question, but neglects to quote any references which allow readers to check the validity of this assertion.

He then goes on to imply that electromagnetic theory is not capable of analysing the transient phenomena associated with high speed logic, and concludes that it is necessary to introduce a new theory: 'Theory C'.

It would seem that his search for a complex explanation has led Mr Catt up a blind alley. An engineering approach to the problem would be to set up an experiment, observe how an actual line does respond to a step input, then to analyse and assess the results.

So a 15-metre length of 2-core mains cable was purchased and a signal generator used to inject a square wave of 6 micro-seconds duration into one end. Figure 1 is a schematic illustration of the set-up.

The interface circuitry at the near end was designed to provide low-value source impedance, whilst the far end of the cable was open circuit. This provided a configuration in which several reflections could be observed for each step of the input waveform.

The input voltage was monitored by one channel of an oscilloscope via a simple potentiometer network, whist the output current was monitored by the second channel via a current transformer. Waveforms were recorded as accurately as possible.

A circuit model was developed to simulate the assembly-under-review, and this was subjected to transient analysis. This was a trial-and error process. It took some time to complete this task, but the eventual response was a fair representation of the waveform displayed on channel 2 of the scope. This simulation is reproduced in Figure 2.

The first step, from zero to 20mV, was exactly as expected. This was followed by a flat response for about 180 nano-seconds, the time taken for the front edge of the pulse to arrive back at the near end. Since the distance involved in the round trip was 30 metres, the velocity of propagation had to be about 170 metres per micro-second; about half the speed of light. This is fairly reasonable, since there was quite a lot of dielectric material in the cable.

The trailing edge, from 20mV to -18mV, is probably the most informative feature of the waveform. Textbook theory would predict a step change between these two levels. Instead, the current waveform follows an exponential decay. Only one explanation is possible: current is departing from the transmission line via capacitive coupling between cable and environment. Moreover, it must be emanating from the signal conductor, since that is the only conductor that is being energised.

The picture emerges of a current transient propagating along the surface of the signal conductor and creating the wavefront of an electromagnetic field. This spreads out in the same way as the bow wave of a ship.

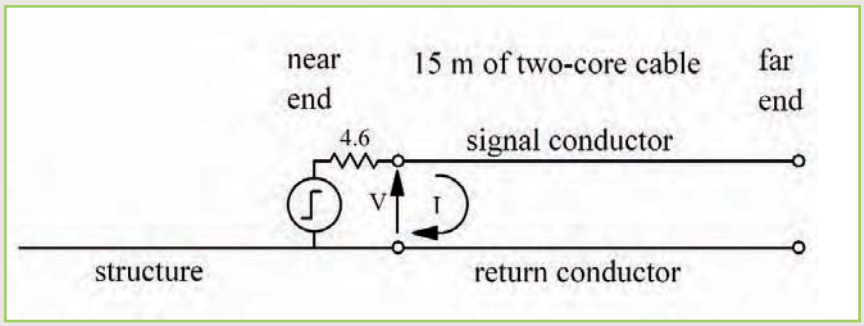
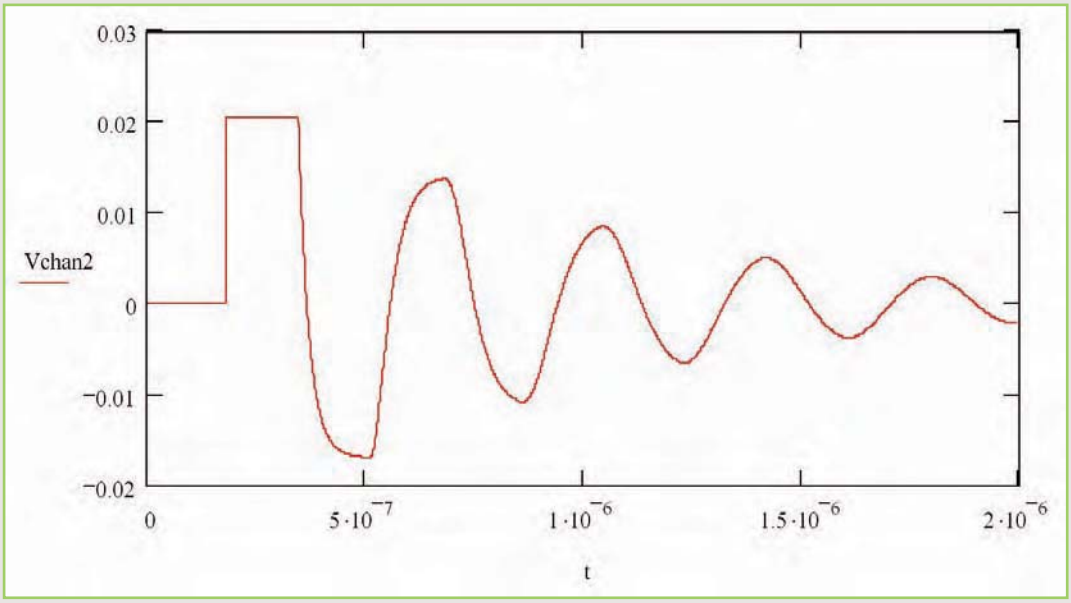


Figure1: *Test of transmission line*

Figure2: *Current waveform, as monitored by channel 2 of oscilloscope*



Since the conductors of the transmission line are 2mm apart, the wavefront does not reach the return conductor until the current pulse has progressed at least 2mm along the signal conductor. When the wavefront does reach the return conductor, it creates a return current which flows back towards the near end. During the time taken for this to happen, all the electromagnetic energy of the pulse is released to the environment. Since this happens for every increment of length, it must happen along the whole length.

Viewing the configuration of Figure 1, it is clear that a conducting path exists along the structure, through the generator and 4.6-ohm resistor, to the signal conductor. This path acts as an aerial and is the source of the radiated current. There is no aerial-mode current at the far end, since that end is isolated. Hence, the differential-mode current arriving at the far end is balanced. Reflected current must also be balanced. This means that there is minimal radiation from the cable due to reflected current.

Subsequent reflections are of a distributed wavefront. Each incremental step in the forward wave delivers a transient current pulse into the environment. So the square wave gradually changes into a sine wave.

So the answer to The Catt Question is:

Electric charge on a transmission line manifests itself as a current. Current in the lower conductor is created by an electromagnetic field emanating from the upper conductor.

In the experiment outlined above, electronic test equipment was used to observe the voltage and current waveforms. Each waveform was recorded in a table of values of amplitude versus time. A circuit model of the cable was derived from electromagnetic theory, and component values calculated using spatial measurements.

The model was extended to simulate the test equipment. Time-step calculations were carried out to determine the transient response. The model was modified to achieve correlation between theoretical and observed waveforms. Concepts of electromagnetic theory were used to explain the coupling mechanisms involved.

There was no need to invoke the complexities of time-frequency transformations. There was certainly no need to invent a completely new theory.

Ian Darney

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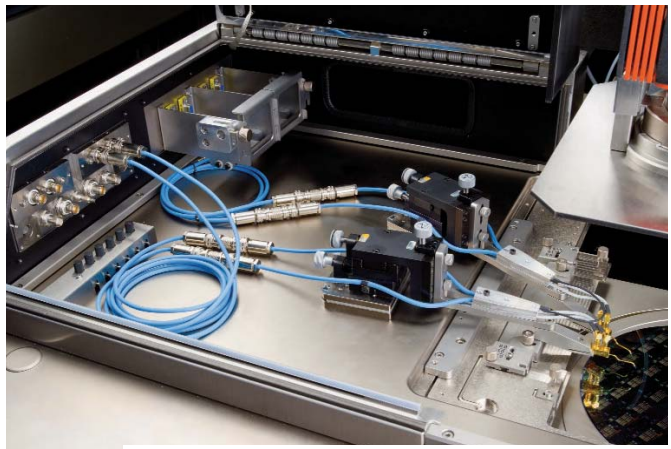


ONLY MIXED-SIGNAL INTER-CONNECT SOLUTION FOR SEMICONDUCTOR DEVICE PROBERS IS AVAILABLE NOW

Keithley Instruments has introduced the test industry's only cabling solutions capable of handling I-V, C-V and pulsed I-V signals with a single set of cables (patent pending). The new cabling kits are based on a patent-pending design that speeds and simplifies the process of making DC Current Voltage (I V), Capacitance Voltage (C V) and pulsed I V testing connections from any modern semiconductor parameter analyzer to a Cascade Microtech or SUSS MicroTec prober. The cables are designed for compatibility with Keithley's Model 4200 SCS Semiconductor Characterization System, as well as with other test instruments used for characterization.

The design of these high performance triaxial cable kits makes them ideal for those whose characterization requirements demand frequent switching between measurement types. These new cable kits eliminate the need for recabling when switching between measurement types, also eliminating the measurement errors that often result from cabling errors. Two versions of the cable kit are available – one optimized for use with Cascade Microtech probers and the other for use with SUSS MicroTec probers.

Characterizing semiconductor devices electrically and understanding the processes used in their production demands a wide array of measurements, including DC I V, C V, and pulsed I V measurements.

www.keithley.com

THREADED SWITCH PROBE COPES WITH LATERAL FORCES

The new P888/G from Peak Test Services is a normally open-threaded switch probe incorporating an integrated ball as the contact element at the top of the plunger.

This probe can be used in applications involving lateral forces without any reduction of its life cycle. It can also be used in airtight modules or vacuum test fixtures. The switch element inside the threaded probe is electrically isolated from the probe body to provide a voltage-free system.

The P888/G is available in two different size ranges, with projection heights of 16.7-18.2mm and 12.0-14.3mm, respectively. Maximum switching current is 1.0 A, and typical probe resistance is 25 milliohms.

www.thepeakgroup.com

1.6GHZ INTEL ATOM 12.1" FANLESS PANEL PC IS IP67 SEALED

Designed for use in wet or dusty environments, the new marinised Panel PC from BVM is a powerful 12.1" ruggedized fanless unit, sealed to IP67, which provides local computing capability in the harsh conditions to be found in marine, transport, avionics, kiosks, signage, self-service terminals and industrial automation applications.

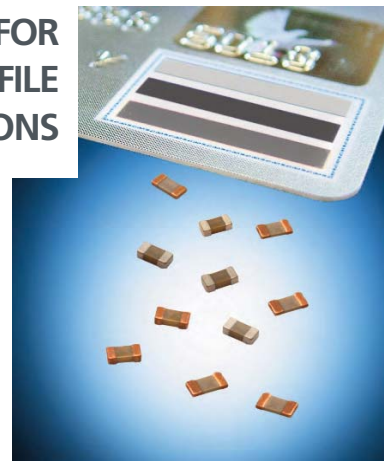
The super high brightness 1000cd/m^2 12.1" screen with a 700:1 contrast ration is readable in direct sunlight and auto-adjusts in accordance with the ambient light level. To preserve the dust and waterproof capability of the unit, special IP67 sealed interface cables for power, USB, RJ45, COM port, CAN bus port and audio I/O are available.

For enhanced versatility, the device is CANbus enabled for use in automotive applications as standard and can optionally be supplied with an 802.11b/g/n wireless LAN interface with internal antenna giving a maximum data transfer rate of 300Mbit/s in two streams.

The heavy-duty die-cast aluminium enclosure both protects the electronics against shock and vibration to MIL-STD-810F and acts as a heatsink, enabling fanless operation. The 1.6GHz Intel Atom processor has a 533MHz FSB with up to 2GB of RAM; two USB 2.0 ports, one wired Gigabit LAN port, an RS232 and a RS232/422/485 serial port are provided as standard. A 2.5" SATA HDD bay is provided for bulk storage.

www.bvmltd.co.uk

NEW ULTRA-THIN 0402 SURFACE MOUNT CERAMIC CAPACITORS FOR LOW PROFILE APPLICATIONS



AVX Corporation, manufacturer of advanced passive components, has just released a new series of ultra-thin ceramic capacitors targeted at applications where low profile is vital, such as smart-cards, high-density SIM cards and memory modules.

The new UT parts have the same footprint as 0402 devices but are only as thick as conventional 0201 products. However, they retain the same voltage and capacitance ratings of the standard thicker 0402 capacitors.

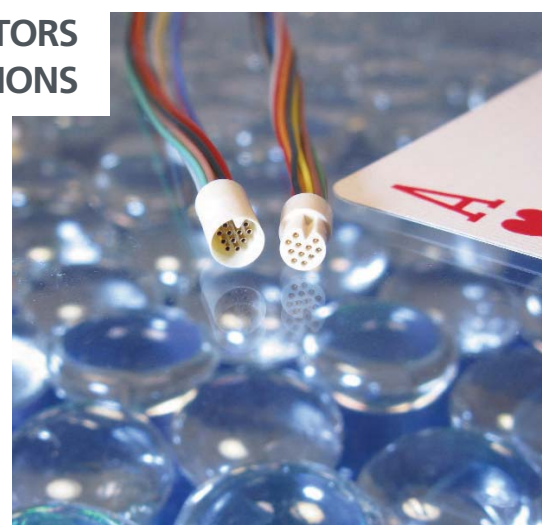
Thanks to a novel chemical termination system which allows very precise and highly repeatable termination thickness and dimensions, parts can be produced that measure just 0.3mm high with a capacitance value of 10nF and a voltage rating of up to 25V. Operating temperature is -55 to +85degC. Insulation resistance is 100,000MΩ minimum. ESL is 164pH; ESR is 75.6mΩ.

The new UT ceramic capacitors suit applications in any design where the thickness of components is the major hurdle.

AVX is expected to introduce even thinner 0.15mm devices for embedding within PCBs, saving even more space, later in the year.

www.avx.com

OMNETICS MIL-QUALITY CIRCULAR NANO CONNECTORS IN HOMELAND SURVEILLANCE APPLICATIONS



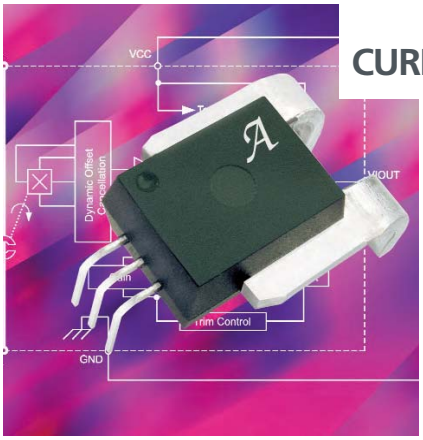
Omnetics Connector Corporation, manufacturer of miniature high-rel connectors, has announced its new circular Nano products, one of the smallest circular connector families to use a MIL-quality contact system around, ideal for fulfilling the specific requirements of the Homeland Surveillance market. 32 AWG size wiring with Teflon insulation is terminated into 0.635mm pitch plastic insulated circular connectors that mate to surveillance camera and night-vision systems.

Omnetics connectors are extremely lightweight, yet also use Omnetics's patented split-end contact, named Nano Flex Pin, which not only meets, but substantially beats the specifications laid down in Mil-DTL 32139. This ensures long-term reliability and high quality.

Shock and vibration performance data shows that these connectors offer constant signal fidelity, even when subject to extremes of shock and vibration, such as during helicopter flights and the hard landings of UAVs. Other popular applications of these nano-circular connectors include satellite communications equipment where size, weight and temperature are critical.

With a total mated length of 9mm and outer diameters ranging from 3.1 to 5.5mm, these small connectors withstand temperature variations from -55 to +125degC. They feature polarized hard gold-plated contacts shrouded in Omnetics's unique liquid crystal polymer housing to MIL-M-24519, making them capable of more than 2,000 mating cycles.

www.omnetics.com



CURRENT SENSOR OFFERS 50-200A CURRENT RANGE

The new ACS758 from Allegro MicroSystems Europe is a thermally enhanced, high-current, Hall-effect based, linear current sensor that provides an economical and precise solution for AC or DC current sensing.

The new device offers a number of performance enhancements compared to Allegro's earlier generation of current sensors, including a wider current range, increased device bandwidth and faster response times, reduced output noise, enhanced output accuracy and the inclusion of an integrated electrostatic shield to drastically reduce the amount of ripple present on the device output signal when the integrated conductor is subjected to high dV/dt signals.

Featuring a 50-200A current range, 120kHz bandwidth and up to a fourfold reduction in output noise, the ACS758 is ideally suited to applications in motor control, load detection and management, power-supply and DC/DC converter control, inverter control and overcurrent fault detection.

A 3µs output rise-time in response to step input current makes the ACS758 suitable for short-circuit protection applications, while an anti-aliasing filter eliminates ripple in average current measurements on motors, inverters and DC/DC converters.

The device consists of a precision, low-offset linear Hall sensor circuit with a copper conduction path located near the Hall sensor die.

www.allegromicro.com

HANDHELD MULTIMETERS COMBINE RELIABILITY AND SAFETY

The Yokogawa TY500 Series is a new range of general-purpose, handheld, digital multimeters which combine reliability, ease-of-use and safety for use in field maintenance applications.

Featuring a basic accuracy of 0.09% and a 3.5-digit 6000-count backlit display with a 31-segment bar graph, the TY500 Series includes true RMS measurements as standard, along with functions such as thermocouple temperature measurement, low-pass filtering and optional current measurement using a clamp sensor.

An important contribution to field site safety is provided by safety shutters, which prevent erroneous insertion of the test leads into the current measurement terminals.

The TY500 Series conforms to the requirements of the EN61010-1 safety standard (1000V, CAT.III, 600 V CAT.IV).

There are two models in the TY500 Series: the standard Type TY520 and the advanced Type TY530. Both will measure DC voltage, AC voltage, DC current, AC current, resistance, frequency, temperature and capacitance, as well as carrying out continuity checking and diode testing. A low-pass filter is included as standard, and a direct reading current function is available via an optional current clamp sensor.

Additional features include a logging-mode memory for 1600 data points, maximum/minimum/average calculation, switchable RMS/mean detection, USB communication and an optional DMM communications software package.

www.yokogawa.com

THE NEW WAVEFORM REFERENCE

The HMF series combines two arbitrary waveform generators with a sample rate up to 250MS/s, 14-bit resolution, a bandwidth of 25/50MHz and 8ns rise time. Both units have a bright QVGA colour – TFT display to display all functions and parameter.

They support sine, square and triangle waveforms and arbitrary functionality. The arbitrary function delivers sin(x)/x, Cardiac, white and pink noise. User-defined signals, up to 256kpts with up to 50MHz bandwidth, can be generated. The arbitrary waveforms can be defined internally, with an external PC-software or load from a USB-stick.

The operating mode burst, wobbeling, gating, external triggering and the following kinds of modulation AM, FM, PM, PWM, FSK (int. and ext.) are available for all signal forms. The HMF series have a pulse generator for pulses with a frequency of up to 25MHz (HMF2550), a pulse width range from 10ns to 999s at 5ns resolution.

Both HMF have a USB/RS-232 interface for remote control. Ethernet/USB or GPIB (IEEE-488) are optional. The generators are available from May 2009 at a price point of 1130 EUR respective to 1440 EUR.

www.hameg.com

KEITHLEY UPGRADES MODEL 4200-SCS FOR SOLAR CELL TESTING

Keithley Instruments has introduced a variety of hardware, firmware and software enhancements to its award-winning Model 4200-SCS Semiconductor Characterization System. The Keithley Test Environment Interactive (KTEI) V7.2 upgrade includes nine new solar cell test libraries, an expanded frequency range for the system's Capacitance-Voltage (C-V) measurement capability and support for the company's new nine-slot Model 4200-SCS instrument chassis.

The new test libraries included in KTEI V7.2 expand the Model 4200-SCS's capabilities for solar cell I-V, C-V and resistivity testing applications, which are increasingly important, given the growing interest in and governmental support for alternative energy technologies. The software upgrade also supports Drive-Level Capacitance Profiling (DLCP), a new solar cell testing technique that was difficult to perform accurately using earlier test solutions. DLCP provides defect density information on thin film solar cells. Existing Model 4200-CVU Capacitance-Voltage Unit cards, which were introduced in November 2007, can be readily modified to support this testing technique.

The Model 4200-CVU's frequency range has been expanded to 1kHz-10MHz from 10kHz-10Mz to support DLCP testing. This extended frequency range also expands the system's applications, providing support for testing flat panel LCDs and organic semiconductors such as organic light-emitting diodes (OLEDs).

www.keithley.com

POWERSOLVE'S 100W DC/DC MODULES CAN BE HEATSINK OR CHASSIS MOUNTED

Powersolve announces the TEP-100 family of 100W isolated, high performance, DC/DC converter modules packaged in a rugged, compact metal case. Suitable for a wide range of applications, the Tracopower TEP-100 family has been designed primarily for industrial applications, where no PCB mounting is possible and the module has to be mounted on a chassis.

Four threaded M3 inserts in the module make chassis mounting or the attachment of a heatsink for optimal thermal management very simple. For easy installation there is also a chassis mount adaptor available with screw terminals for connection.

The TEP-100 series offers 12 models with output voltages from 5 to 48VDC and wide input voltage ranges of 18 to 36VDC or 36 to 75VDC. Models are also available with a wide 4:1 input voltage range and reduced output power of 75W.

A very high efficiency allows an ambient operating temperature up to +60°C with natural convection cooling and without the need of power derating. Further features include output voltage trimming, remote ON/OFF and under voltage lockout. The wide input voltage range and reverse input voltage protection make these DC/DC converters an ideal solution for battery-operated systems.

www.powersolve.co.uk

INTELLIDENT SELECTS THE STAR MICRONICS TUP900 FROM DED

Intellident has selected the Star Micronics TUP900 kiosk printer from DED for use in its self-service library kiosk solution smartServe, a premium self-service solution using the power of RFID. The smartServe kiosk allows library customers to issue, renew and return items, then check their account status and pay any fees using a full range of payment facilities integrated into the kiosk.

Being used successfully in public, academic and private libraries in the UK, France and the Netherlands, the TUP900 forms a key part of the smartServe kiosk, being used to print a full receipt for the customer if required following a transaction. As a way to make customers feel more confident in using the kiosk, intuitive features have been added, such as the receipt output slot, which features a flashing light to direct the user to take their receipt when it is ready.

Selecting the TUP900 for use in the smartServe kiosk came down to a few key issues, although cost was a consideration, the main issues for Intellident were ease of use, form-factor and reliability. As the kiosk is designed to operate 24/7, reliability was a huge factor in the decision making process, the TUP900 met the criteria easily.

www.ded.co.uk

NEW ULTRA MINIATURE QUARTZ CRYSTAL RANGE

IQD Frequency Products has launched a new range of ultra miniature quartz crystals measuring only 2.0 x 1.6 x 0.35mm. The CFPX-188 series crystals are designed for use in consumer electronics and computing applications.

Built around a fundamental AT cut quartz crystal whose angle has been optimized for a specific frequency/temperature performance, the CFPX-188 uses a flexible mounting structure to withstand shock and vibration. Utilizing quartz with a thickness of around 0.05mm at 30MHz, the CFPX-188 uses evaporated silver electrodes with the quartz being held in place with a conductive adhesive. The CFPX-188 crystals are suitable for use in applications where space is an issue such as set-top boxes, personal video recorders (PVRs), games consoles and smart-card readers.

Available in a range of fundamental frequencies from 20MHz to 50MHz, the CFPX-188 is housed in a hermetically sealed, four-pad ceramic SMD package and can be specified to stabilities down to ±10ppm over a standard operating temperature range of –10 to +60°C.

CFPX-188 crystals can be delivered in both bulk-pack and tape-and-reel formats.

www.iqdfrequencyproducts.com

MINIATURE SURFACE MOUNT, CURRENT SENSE, RESISTORS MAXIMISE PRECISION

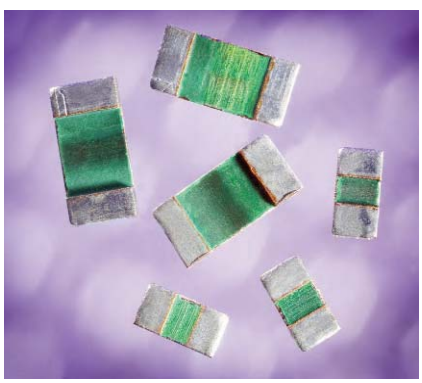
Welwyn Components has introduced metal element resistors in miniature surface-mount 1206 and 2010 sizes, delivering high surge-withstand capability and low parasitic inductance for precision current sensing in monitoring, control, protection and measurement circuits.

The 1-watt ULR1S in the 1206 outline and 1.5-watt ULR15S in the 2010 outline are available in ultra-low ohmic values from 1m-ohm to 10m-ohms, in 0.5m-ohms increments up to 6m-ohms. 7m-ohms, 8m-ohms, 9m-ohms and 10m-ohm values complete each series. The devices can be specified with either 1% or 5% tolerance. They have low temperature dependency of 50ppm/°C for consistent accuracy over a wide temperature range.

Combining high precision with very low ohmic values, these resistors maximise conversion efficiency and minimise the effect of sensing on the surrounding circuitry. A single ULR1S or ULR15S can replace multiple chip resistors of higher resistance in applications such as motor control, process control, switching circuits, lighting controls, power-conversion equipment and safety systems.

The all-metal construction of these resistors also yields a wide operating temperature range, from -55°C to +170°C. This makes them an ideal choice for applications such as industrial and automotive.

www.ttelectronics.com



GREEN HILLS SOFTWARE ADDS VIRTUALIZATION TO PLATFORM FOR SECURE NETWORKING

Green Hills Software, secure operating systems supplier, has announced a major enhancement to its Platform for Secure Networking, adding secure virtualization and new reference platforms.

Its approach to system virtualization enables a complete Linux operating system and its applications ecosystem to securely and seamlessly coexist with the performance, reliability-critical and real-time portions of networking devices, all on a single general purpose microprocessor. System availability is increased by eliminating the possibility for a non-critical application failure or corruption in the Linux environment to compromise the critical real-time packet traffic applications and services running on the Integrity RTOS.

High availability and secure isolation between networking subsystems is assured by Integrity, the world's first Common Criteria EAL6+ certified operating system technology. The Integrity advanced security architecture prevents denial-of-service attacks while guaranteeing optimal real-time performance for packet processing applications.

The Green Hills Platform for Secure Networking is a comprehensive platform consisting of operating systems, secure virtualization, development tools and middleware that enable developers to create secure, powerful, high-performance connected electronic products in the least time and at the lowest cost. In addition to Green Hills Software's Multi, the industry's leading embedded software development toolset, the platform offers the Green Hills Integrity and Velosity operating systems, Integrity PC secure virtualization, advanced file systems, dual IPv4/IPv6 TCP/IP host and routing stack, web server, SSH, SSL, wireless communications and security software, Layer 3 IP routing and management software, USB, and a variety of other tightly integrated networking and application protocols.

www.ghs.com

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VICOR 'POWERTECHTORIALS' ON CD

Vicor has launched a new educational initiative for power design engineers to provide support throughout the power systems design process from selecting the optimum architecture to meeting EMI regulations.

A series of 'PowerTechtorials' is the first phase and is now available on CD. Each CD serves as a one-on-one tutorial, containing technical presentations and lab demos, that can be revisited as needed. The tutorials address everyday technical issues and answer real-world questions on power system design topics, providing engineers with practical advice for solving design challenges that arise in a broad range of different applications. In addition, the interactive CD contains useful links to the Internet for easy access to product datasheets, related articles, application notes and more.

Volume 1 contains three videos covering the following topics: 'Vicor DC-DC Converter Theory Overview'; 'Improving Output Filtering' and 'Input Overvoltage Protection'. Engineers who sign up to receive their free 'PowerTechtorial' CD Volume 1 will be able to suggest topics to be covered in future editions and will also have the opportunity to ask presenters a question.

Volume 2 will be available in the second half of the year and will include topics such as 'Improving EMI filtering' and 'Thermal considerations'.

www.vicoreurope.com/techtorial1

AWS GROUP INCREASES CAPABILITY OF SMT LINE

AWS Cemgraft, part of the AWS Group, one of the UK's independent Electronic Manufacturing Solutions (EMS) providers, has invested in an upgrade of its surface mount production line to handle large boards.

Cemgraft worked with surface mount assembly equipment maker, Juki Automation Systems, and reflow oven manufacturer, Heller Industries, to develop its automated line to handle boards measuring 663 x 145mm. The longest board that could be handled previously was 510mm.

"We try to work with our customers to ensure that their boards can be made on our automated production lines, rather than using batch production, which is slower and more expensive," said Jamie Maughan, Cemgraft Operations Director. "Sometimes, large boards can be accommodated by grouping all the surface mount components at one end of the board. However, in this case there was a high concentration of SMDs – BGAs, QFPs etc – all across the length of the board."

By changing the software and altering some mechanical hard stops, Juki modified its KE-2060RE high-speed, fine-pitch, assembly machine to enable it to handle boards up to 680mm in length. The Heller reflow ovens were also able to be profiled with a suitable temperature profile, and screen printing equipment enhanced ensuring that Cemgraft can offer a full production process.

Equally important is changeover time, which has been kept to just 20 minutes.

www.awselectronicsgroup.com

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